Test Project (Offline)

BRICS-FS-15_Industry 4.0

2022 BRICS Skills Competition

Project Description

2022 BRICS Skills Competition - Industry 4.0 offline competition adopts the form of two person team competition;

Competition time: 4 hours in total;

The test project consists of four modules;

This competition is based on the design and debugging of Industry 4.0 equipment. The main test is to use simulation technology, web development technology and digital twin platform to build, operate and maintain Industry 4.0 equipment, and complete tasks such as simulation design, programming and debugging of Industry 4.0 equipment. .

The test project includes the following contents, and it is necessary to complete the digital twin in virtual and reality and the debugging of each module:

1. Industry 4.0 production line programming and debugging
2. Digital design
3. Networking and Web application development
4. Virtual and Real Joint Commissioning of Industry 4.0

The total score of the project/module is 100.

Module	Content	Assessment score
A	Industry 4.0 production line programming and debugging	25
B	Digital design	20
C	Networking and Web application development	20
D	Virtual and Real Joint Commissioning of Industry 4.0	30
	Professionalism	5
Total		100

Precautions:

1. The program files created by the contestants during the competition must be stored in the "E:\Skill Competition\Station Number" folder.

2. Damage to I/O components, PLCs, fixtures, servo motors and drivers due to improper operation will be dealt with according to the deduction table.

3. During the competition, the computer data should be saved in time to avoid data

loss due to unexpected situations such as power outages.

4. The competition provides electrical schematics, pneumatic schematics, reference programs, models and related materials.

Module A: Industry 4.0 Production Line Programming and Debugging

I. Program and debug the competition equipment according to the information provided.

1) For equipment ventilation, adjust the air source pressure to 0.4-0.6Mpa;

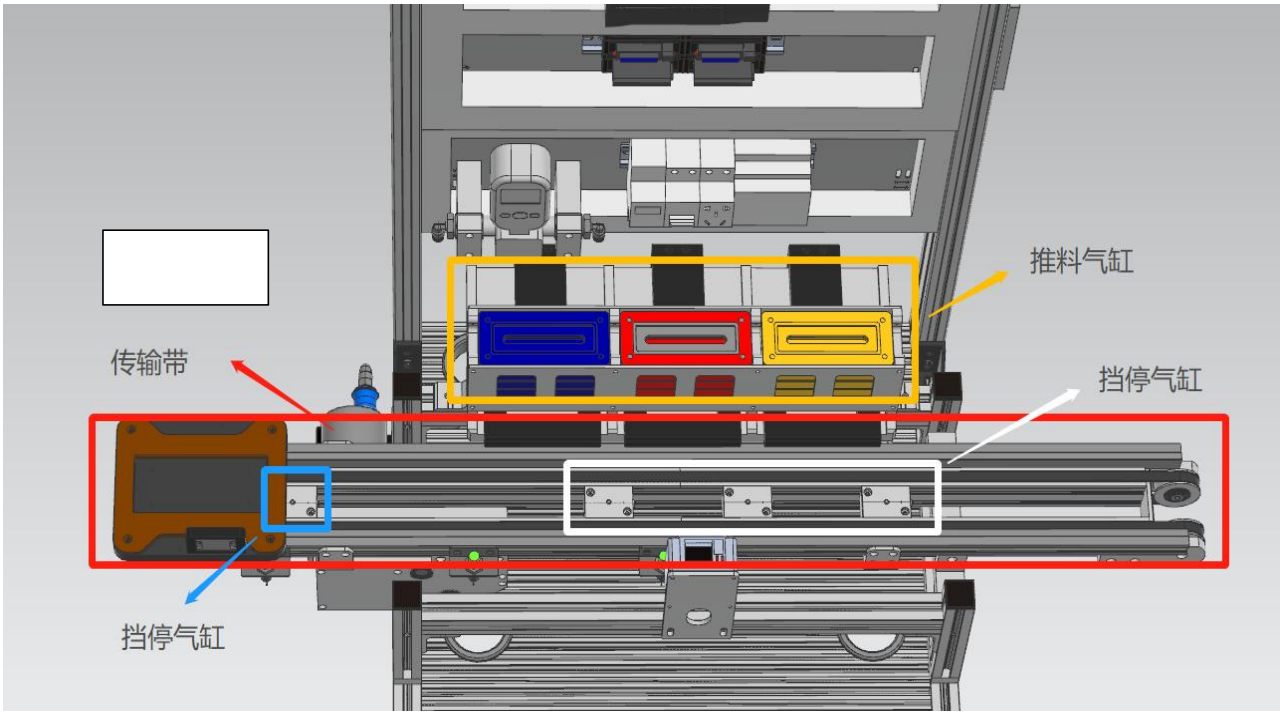
2) Driver parameters shall be adjusted by the player according to the use situation

3) The range of RFID chip data write or read value is as follows;

No.	Name	Content	RMKs
1	Order No.	1001-9999	
2	Bottom box color	1: blue bottom box 2: red bottom box 3: yellow bottom box	
3	Bookmark color	1: Blue bookmark 2: Red bookmark 3: Yellow bookmark	
4	Box cover color	1: Blue box cover 2: Red box cover 3: Yellow box cover	
5	Position No.	1: Position 1 2: Position 2 3: Position 3	

4) Manually place the bottom box in the bin of the bottom box feeding station (3 in blue, red and yellow, respectively in A0001, A0002 and A0003 bin), and manually place the bookmark in the bin of the bookmark feeding station (3 in blue, red and yellow, respectively in B0001, B0002 and B0003 bin), Manually place the box cover in the bin of the box cover assembly station (3 in blue, 3 in red and 3 in yellow, respectively in positions C0001, C0002 and C0003).

II.Bottom box feeding station



Bottom box feeding station

1) Click the HMI "stop 1" button, the stop cylinder 1 is pushed out through the extension of the cylinder push rod, the corresponding cylinder limit sensor signal is triggered, and the signal status is displayed on the HMI; click this button again, the cylinder push rod retracts .

2) Click the HMI "conveyor belt" button, the motor drags the conveyor belt to drive the tray to the right; click this button again to stop the tray from running.

3) Click the HMI "Blue Feeding Cylinder" button, the bottom box is pushed out through the cylinder push rod extending; click this button again, the cylinder push rod retracts, the corresponding cylinder limit sensor signal is triggered, and the signal status is displayed on the HMI .

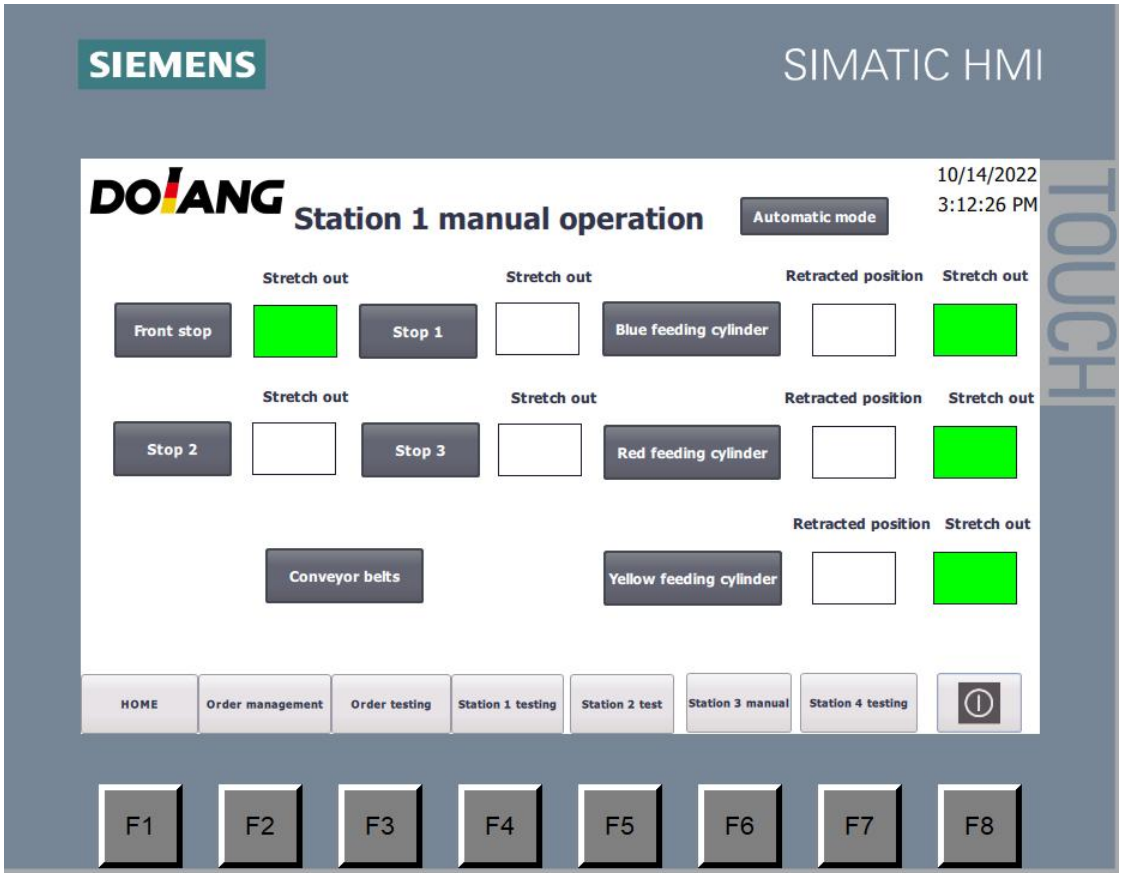
4) According to the referee's request, fill in the material information, click the "RFID write" button of the HMI, and write the material information.

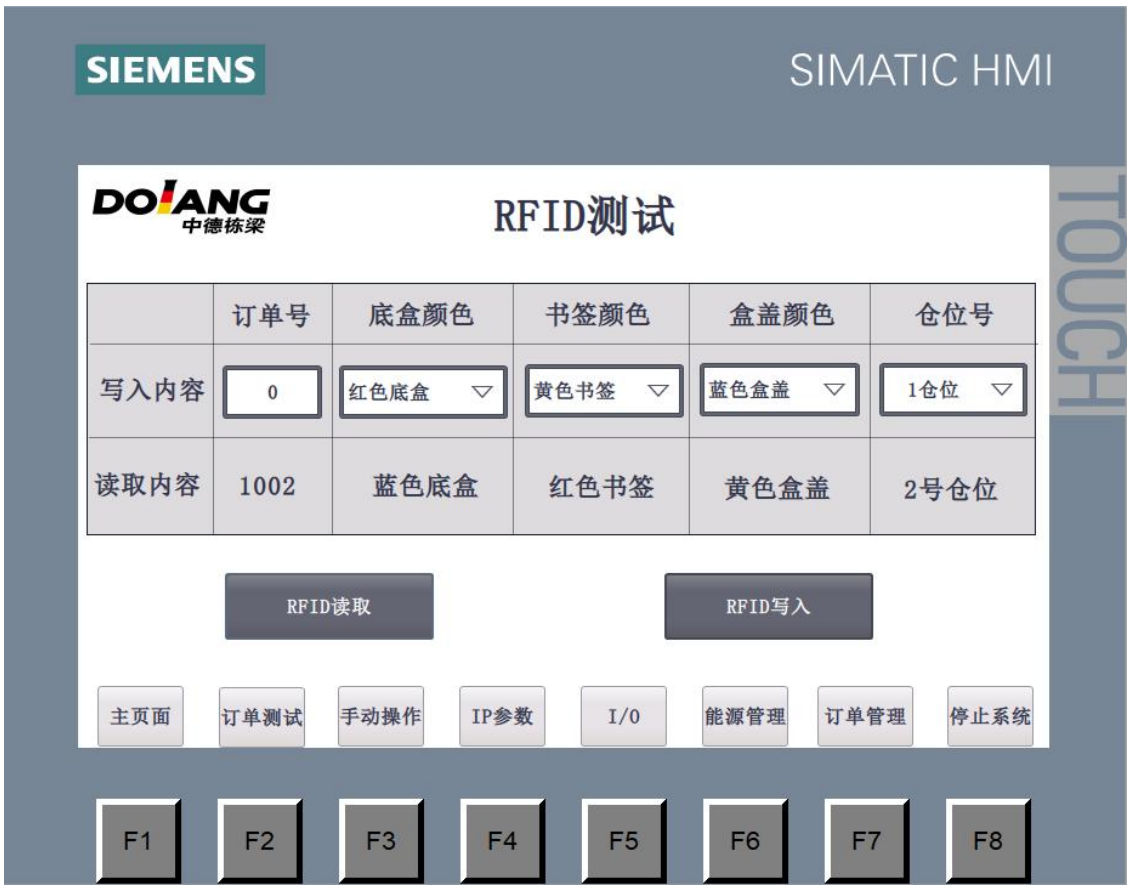
5) Adjust the parameters of the energy module, and display the values of "real-time gas flow" and "real-time power consumption" on the HMI in the form of a trend view.

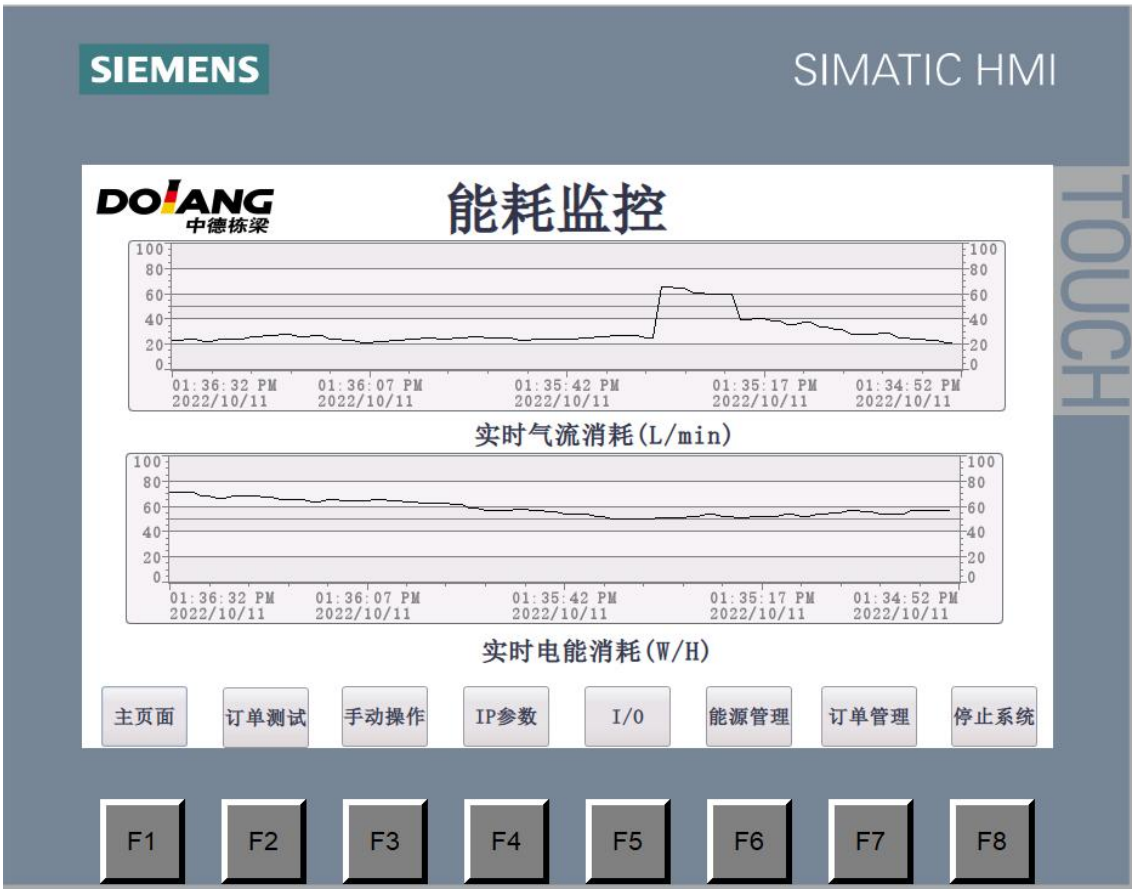
6) The function table of energy consumption monitoring interface is as follows:

NO	Name	Content	RMKs
1	Real-time air flow consumption (L/MIN)	0-150	real-time display
2	Real-time air flow consumption (L/MIN)	0-2000	real-time display

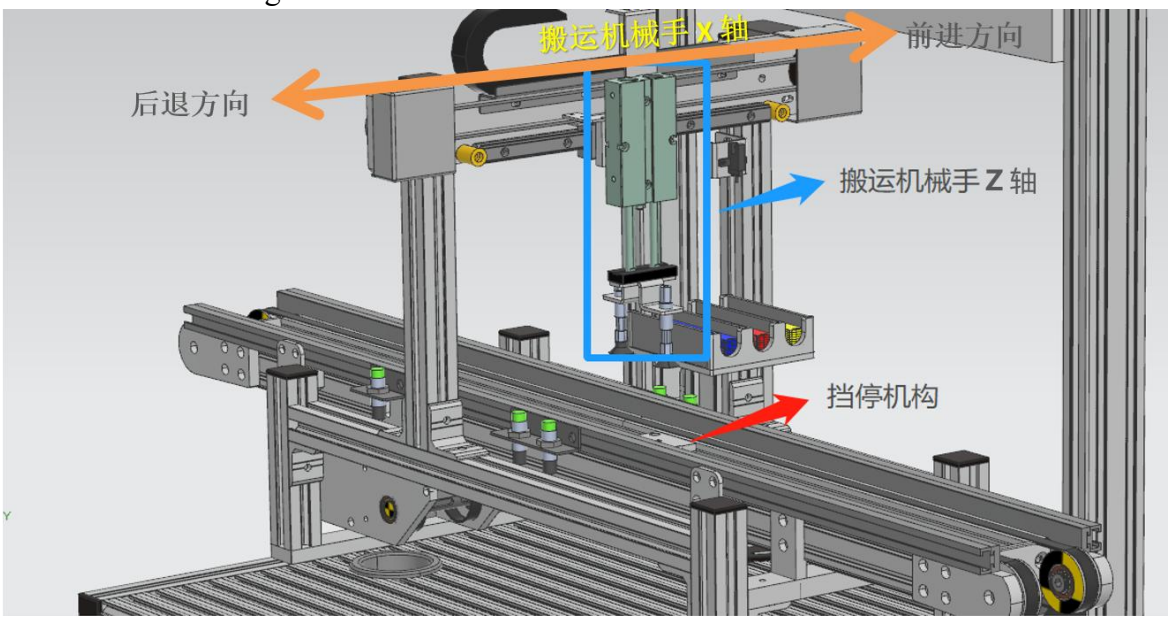
7)Reference photo as follows


SIEMENS
SIMATIC HMI
DOANG
Station 1 manual operation
Automatic mode
10/14/2022
3:12:26 PM
TOUCH
Stretch out
Stretch out
Retracted position
Stretch out
Front stop
Stop 1
Blue feeding cylinder
Stretch out
Stretch out
Retracted position
Stretch out
Stop 2
Stop 3
Red feeding cylinder
Retracted position
Stretch out
Conveyor belts
Yellow feeding cylinder
HOME
Order management
Order testing
Station 1 testing
Station 2 test
Station 3 manual
Station 4 testing
F1
F2
F3
F4
F5
F6
F7
F8


SIEMENS
SIMATIC HMI
DOANG
中德栋梁
RFID测试
TOUCH
订单号
底盒颜色
书签颜色
盒盖颜色
仓位号
写入内容
0
红色底盒
黄色书签
蓝色盒盖
1仓位
读取内容
1002
蓝色底盒
红色书签
黄色盒盖
2号仓位
RFID读取
RFID写入
主页面
订单测试
手动操作
IP参数
I/O
能源管理
订单管理
停止系统
F1
F2
F3
F4
F5
F6
F7
F8



III.Bookmark feeding station



Bookmark feeding station

1) Click the HMI "conveyor belt" button, the motor drags the conveyor belt to drive the tray to the right; click this button again to stop the tray from running.

2) Press the "X-axis forward" button on the HMI, the motor drives the handling manipulator to move forward in the X-axis direction, release the button, the motor stops running; press the

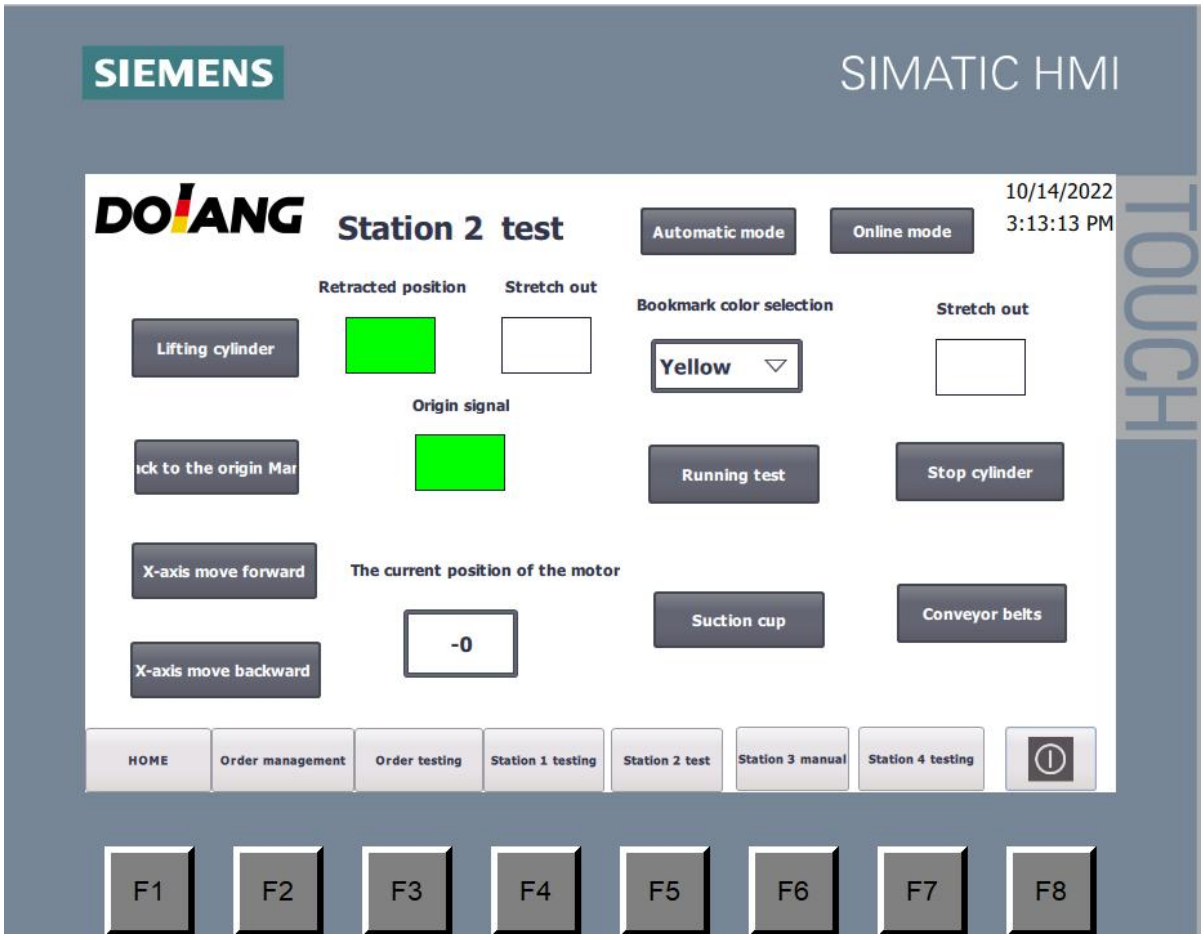
"X-axis backward" button on the HMI, the motor drives the handling manipulator to move forward. Backward in the X-axis direction, and display the real-time position of the handling manipulator on the X-axis on the HMI.

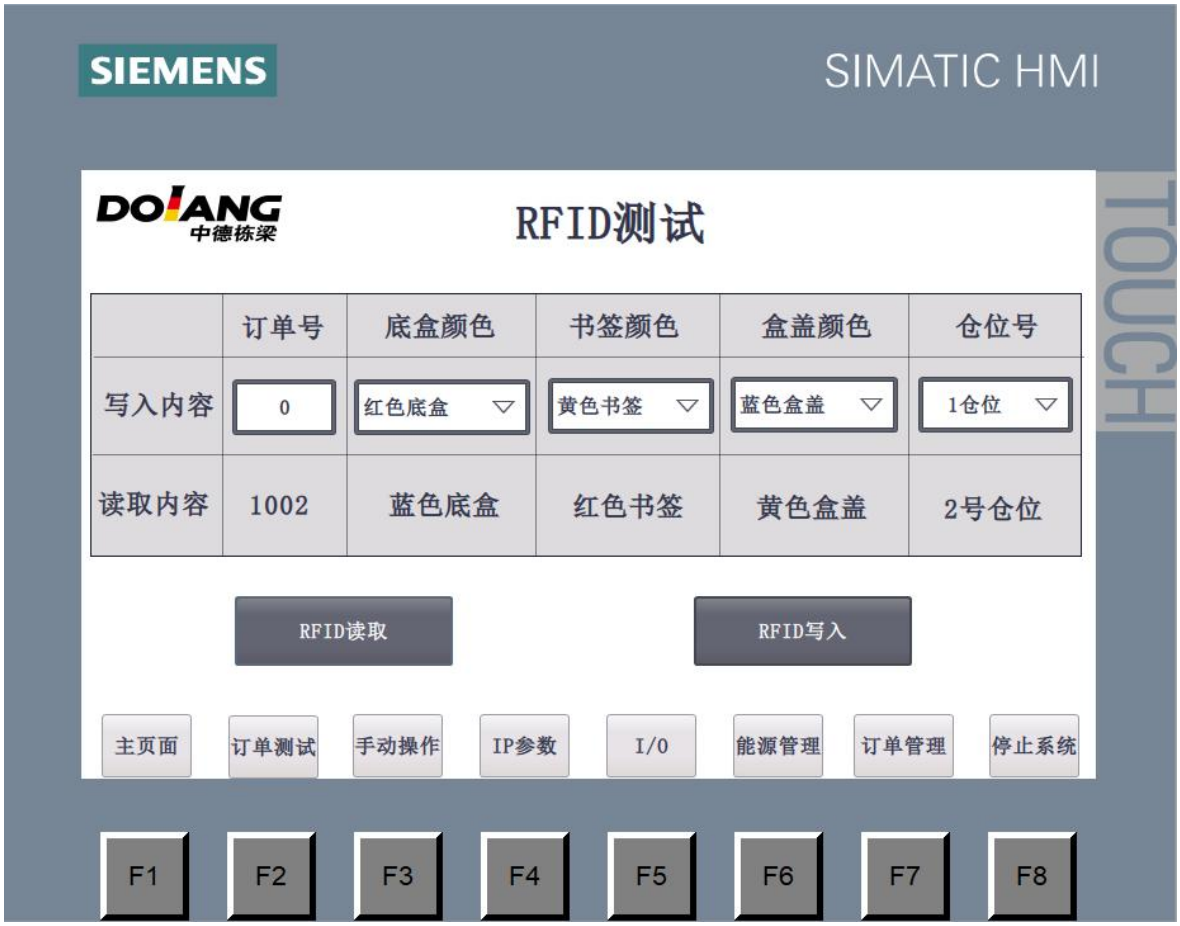
3) Click the "Lift Cylinder" button of HMI, the cylinder push rod is extended and pushed out, click this button again to retract the cylinder push rod, the corresponding cylinder limit sensor signal is triggered, and the signal status is displayed on the HMI.

4) By clicking the "X-axis forward" and "X-axis backward" buttons, operate the manipulator to move to the top of the blue bookmark bin along the X-axis, and press the "Lifting Cylinder" button of the HMI, the lifting cylinder drives the vacuum suction cup close to the bookmark, Press the "suction cup" button, the suction cup solenoid valve is energized, the bookmark is adsorbed on the vacuum suction cup, and the "lift cylinder" button of the HMI is pressed again, the lift cylinder drives the vacuum suction cup to rise and hold for 3 seconds, press the "suction cup" button again , the bookmark is released from the suction cup.

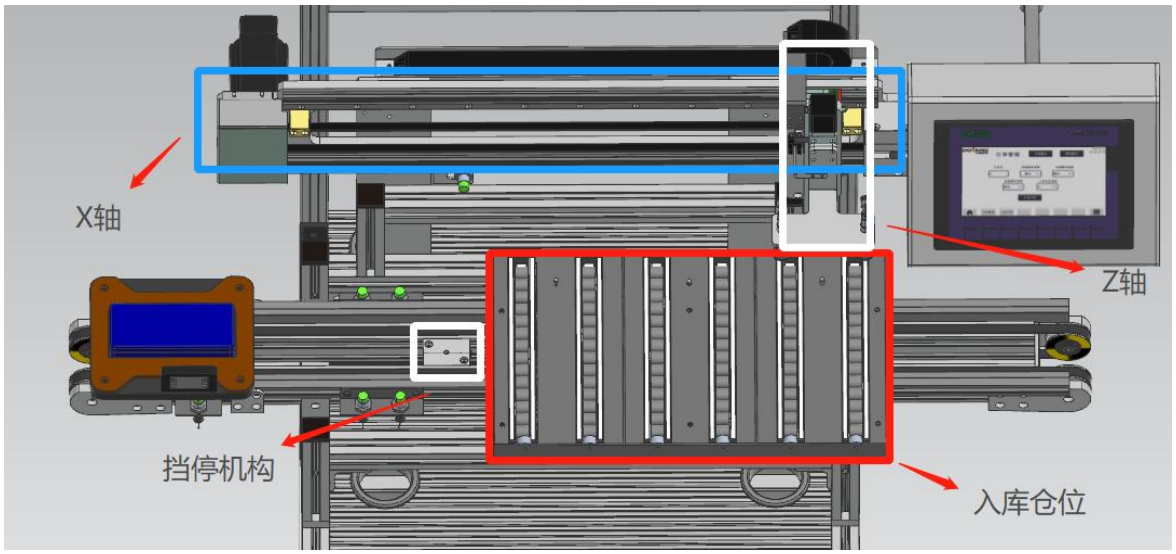
5) According to the referee's request, read the material information from the RFID chip and display it on the HMI through the "RFID read" button of the HMI.

6) HMI reference screen is as follows:





IV.Storage station



Storage station

1) Click the HMI "conveyor belt" button, the motor drags the conveyor belt to drive the tray to the right; click this button again to stop the tray from running.

2) Press the "X-axis left" button on the HMI, the motor drives the handling manipulator to move forward along the X-axis, release the button, the motor stops running; press the "X-axis

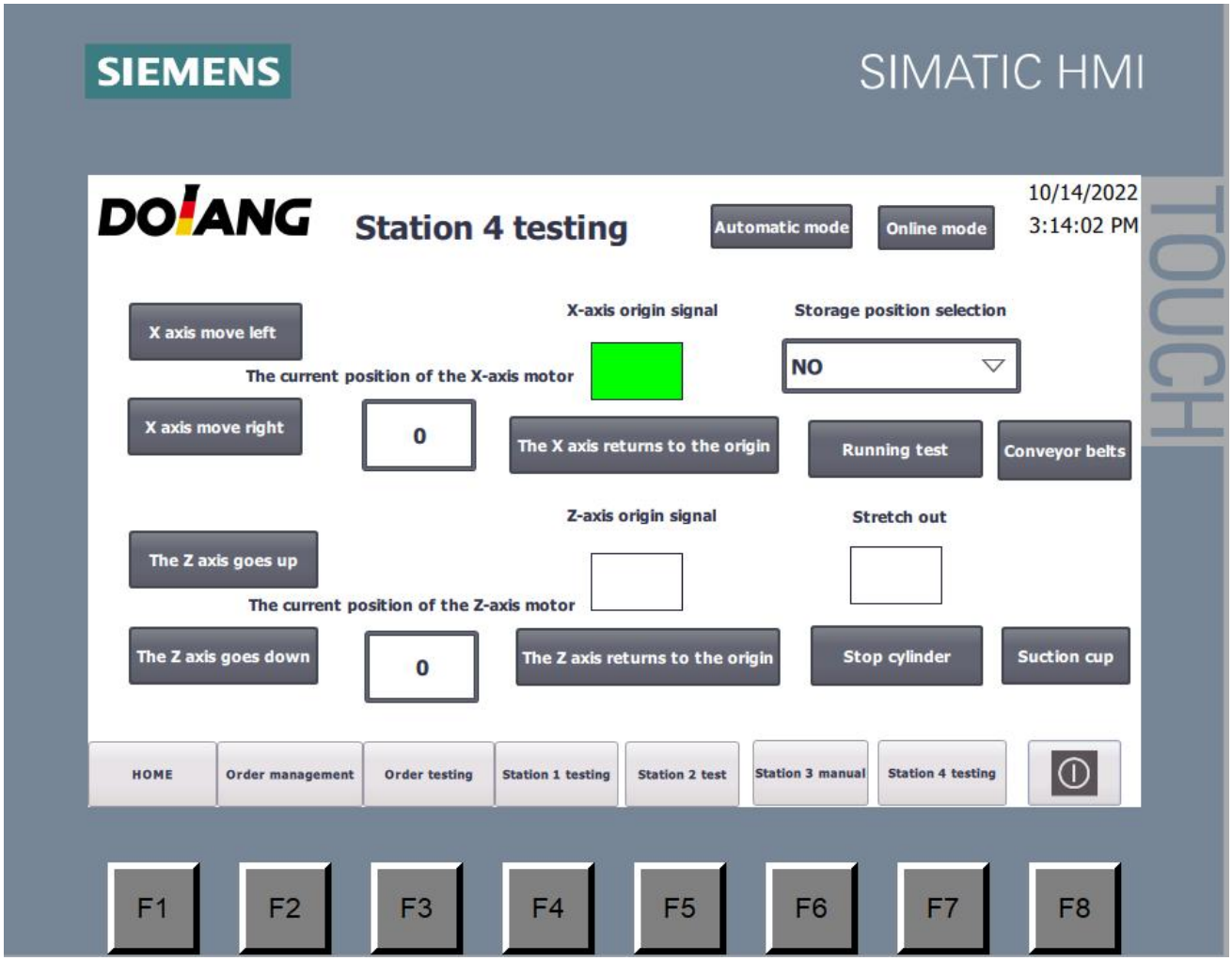
right" button on the HMI, the motor drives the handling manipulator along the X-axis. Backward in the X-axis direction, and display the real-time position of the handling manipulator on the X-axis on the HMI.

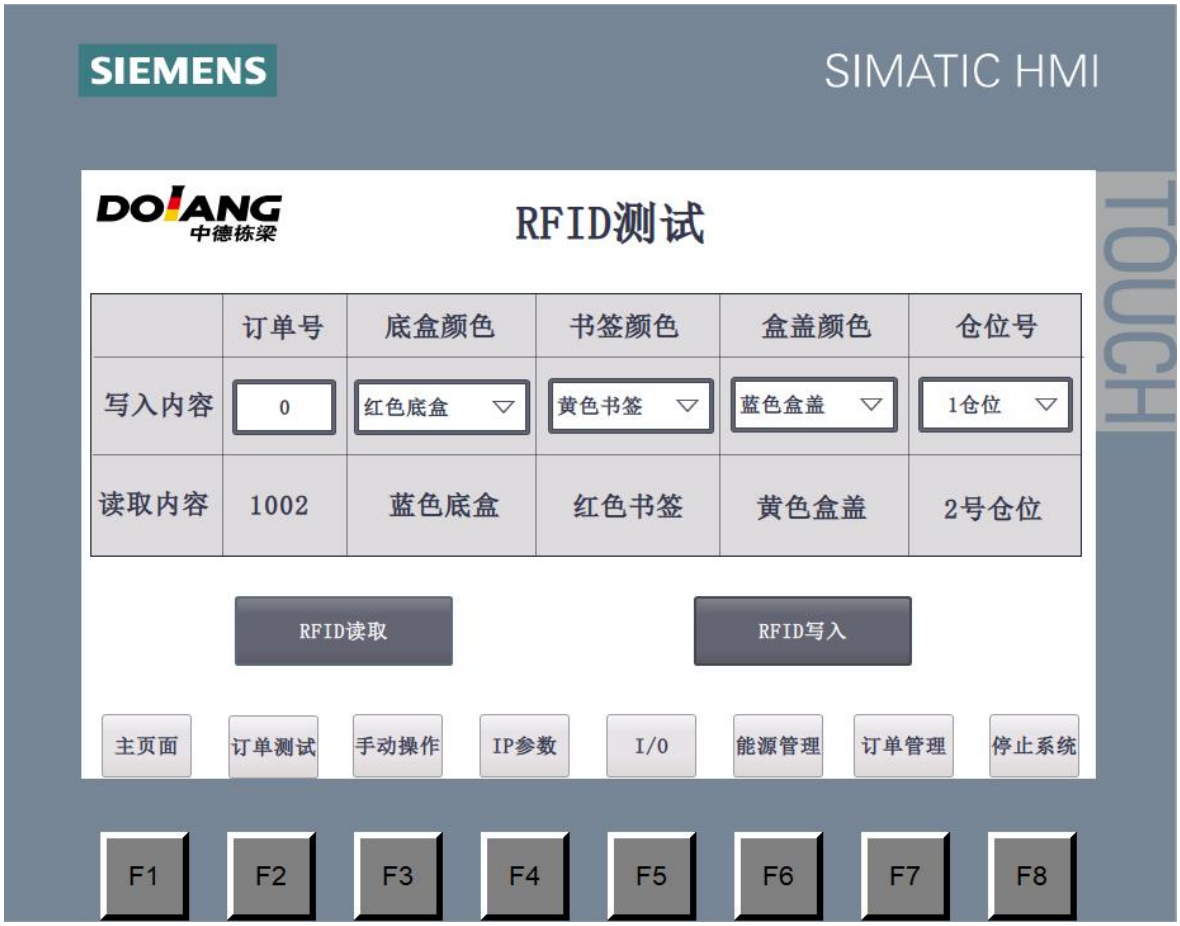
3) Press the "Z-axis up" button on the HMI, the motor drives the handling manipulator to move forward along the Z-axis, release the button, the motor stops running; press the "Z-axis down" button on the HMI, the motor drives the handling manipulator to move along the Z-axis The direction is backward, and the real-time position of the handling robot in the Z axis is displayed on the HMI.

4) By clicking the "X-axis forward", "X-axis backward", "Z-axis upward", "Z-axis downward" buttons, operate the X-axis and Z-axis of the manipulator to move, drive the vacuum suction cup close to the bookmark, press the "Suction cup" ” button, the suction cup solenoid valve is energized, the bookmark is adsorbed on the vacuum suction cup, press the “Z-axis up” button of the HMI again, operate the manipulator to drive the vacuum suction cup to rise (greater than 30mm) and hold for 3 seconds, press the “suction cup” again button, the bookmark is detached from the suction cup.

5) According to the referee's request, read the material information from the RFID chip and display it on the HMI through the "RFID read" button of the HMI.

6) HMI reference screen is as follows:

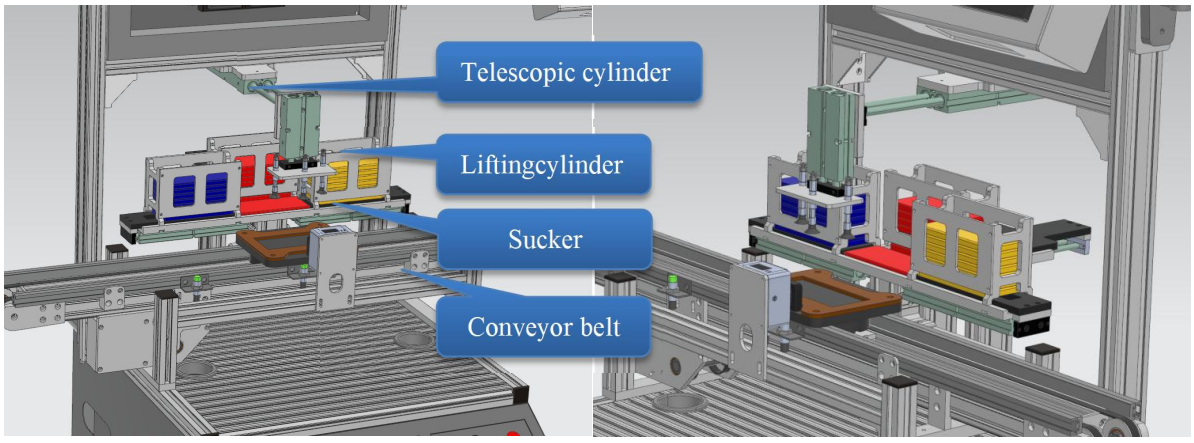

SIEMENS
SIMATIC HMI
DOIANG
Station 4 testing
Automatic mode
Online mode
10/14/2022
3:14:02 PM
TOUCH
X axis move left
X-axis origin signal
Storage position selection
The current position of the X-axis motor
NO
X axis move right
0
The X axis returns to the origin
Running test
Conveyor belts
Z-axis origin signal
Stretch out
The Z axis goes up
The current position of the Z-axis motor
The Z axis goes down
0
The Z axis returns to the origin
Stop cylinder
Suction cup
HOME
Order management
Order testing
Station 1 testing
Station 2 test
Station 3 manual
Station 4 testing
F1
F2
F3
F4
F5
F6
F7
F8



Module B: Digital Design

I.Task introduction

Import the Industry 4.0 model (main file name is DLIM-4212) into the digital twin software, create "electromechanical objects", "signals", connect to the PLC and HMI of the lid assembly station by configuring "external signals" and "signal mapping" ; Write PLC and HMI programs, and complete the operation process of the "box cover assembly station" of the Industry 4.0 model by operating the HMI.



II Project and task description

Simulation process of box cover assembly station:Issue order information, manually place the tray, the belt runs, and the stop mechanism acts. When the tray reaches the corresponding stop mechanism, the bottom box feeding module pushes the bottom box of the corresponding color to the tray according to the order information, and writes the order information to the RFID chip through the RFID reader. The stop mechanism acts, the belt runs, and the tray enters the next station.

Module C: Networking and developing WEB applications

I.Task introduction

According to the requirements of the task book, configure the industry 4.0 network device layer, complete the connection of the network cable of each module, the setting of the IP address and the function test.

II. Networking and connectivity test

1) Configure the security gateway according to the requirements, and set up a double-layer network. For the IP address, see the IP address table.

2) Check the network connectivity of the device through the network command (ping).

DLIM-4212 Industry 4.0 Technology Application System IP Address Table		
NO	Name	IP address
1	Bottom box feeding station PLC	192.168.1.10
2	Bottom box feeding station IO module	192.168.1.11
3	Bottom box feeding station HMI	192.168.1.12
4	Bottom box feeding station RFID	192.168.1.13
5	Bookmark Feeding Station PLC	192.168.1.20
6	Bookmark Feeding Station IO Module	192.168.1.21
7	Bookmark Feeding Station HMI	192.168.1.22
8	Bookmark Feeding Station RFID	192.168.1.23
9	Box cover assembly station PLC	192.168.1.30
10	Box cover assembly station IO module	192.168.1.31
11	Box cover assembly station HMI	192.168.1.32

12	Box cover assembly station RFID	192.168.1.33
13	Storage station PLC	192.168.1.40
14	Storage station IO module	192.168.1.41
15	Storage station HNI	192.168.1.42
16	Storage station RFID	192.168.1.43
17	Storage Station V90 Servo	192.168.1.44
18	ECU Gateway-LAN1	192.168.1.1
19	ECU Gateway-LAN2	192.168.0.1
20	Energy Management Module	192.168.1.50
21	Computer 1	192.168.0.10
22	Computer 2	192.168.0.11

III. Web Development

Develop the WEB interface, publish the website in the LAN, and realize the following functions:

1) Design the login interface, only authorized users can log in to the system.

2) Design the order release page to complete the order release.

The function table of the order placing interface is as follows:

NO	Name	Content/Function	Permission	RMKs
1	Orders issued	Order issued to PLC	administrator operator	
2	Exit	Exit system	administrator operator	

3	system status	run, stop	administrator operator	real-time display
4	Order No.	Create order serial number 1000-9999	administrator operator	Manual selection
5	Position selection	0001,0002,0003	administrator operator	Manual selection
6	Bottom box color selection	Blue, red, yellow	administrator operator	Manual selection
7	Bookmark color selection	Blue, red, yellow	administrator operator	Manual selection
8	Box cover color selection	Blue, red, yellow	administrator operator	Manual selection

3) According to the order list, log in to the operator interface, issue an order through the WEB page, and complete the production (see module D for the workflow).

NO	Order mode	Bottom box color	Bookmark Color	Box cover color	Position
1	WEB	Blue	Yellow	Blue	0003

Reference interface design

Module D: Virtual and Real Joint Commissioning of Industry 4.0

I.Order information

The order information is as follows:

NO	Order mode	Bottom box colar	Bookmark color	Box cover color	Position
1	HMI	Red	Blue	Red	**0001**
2	MES	Blue	Yellow	Blue	**0003**
3	WEB	Yellow	Red	Yellow	**0002**

II. Process description

The specific process requirements are as follows: (After the automatic running starts, the players cannot interfere with the running process)

Bottom box feeding station: issue order information, manually place the pallet, the belt runs, the stop mechanism acts, the pallet reaches the corresponding stop mechanism position, the bottom box feeding module pushes the bottom box of corresponding color to the pallet according to the order information, and writes the order information to the RFID chip through the RFID reader, the stop mechanism acts, the belt runs, and the pallet enters the next station.

Bookmark feeding station: the belt runs, the stop mechanism acts, the tray and the bottom box reach the stop mechanism, the order information in the RFID chip is read through the RFID reader writer, and the corresponding bookmark is carried into the bottom box slot by the manipulator according to the order information. The stop mechanism acts, the belt runs, and the tray enters the next station.

Box cover assembly station: the belt runs, the stop mechanism acts, the tray and semi-finished products arrive at the corresponding stop mechanism position, the order information in the chip is read through the RFID reader writer, the box cover is moved to the bottom box by the manipulator according to the order information to complete the assembly, the stop mechanism acts, the belt runs, the tray enters the next station, and the digital twin equipment simultaneously performs virtual and real linkage.

Box cover assembly station: the belt runs, the stop mechanism acts, the tray and semi-finished products arrive at the corresponding stop mechanism position, the order information in the chip is read through the RFID reader writer, the box cover is moved to the bottom box by the manipulator according to the order information to complete the assembly, the stop mechanism acts, the belt runs, the tray enters the next station, and the digital twin equipment

simultaneously performs virtual and real linkage.

III. HMI order mode:

Improve PLC and HMI programs, issue orders through HMI, and complete order production and management.

1) Design the order information selection area, you can select "Order Information", and after pressing the "Create Order" button, the selected order attributes will be generated and an order information will be displayed on the HMI.

Order information: order number, bottom box color, bookmark color, box cover color, storage bin number.

2) By pressing the "Order Issue" button on the HMI, the system will issue the created order.

3) After pressing the "Stop Production" button on the HMI, the production of the current order will be suspended.

(4) MES order mode:

(5) WEB order mode:

On the basis of module D, improve the WEB page and PLC program to complete the functions of order issuance and order display.

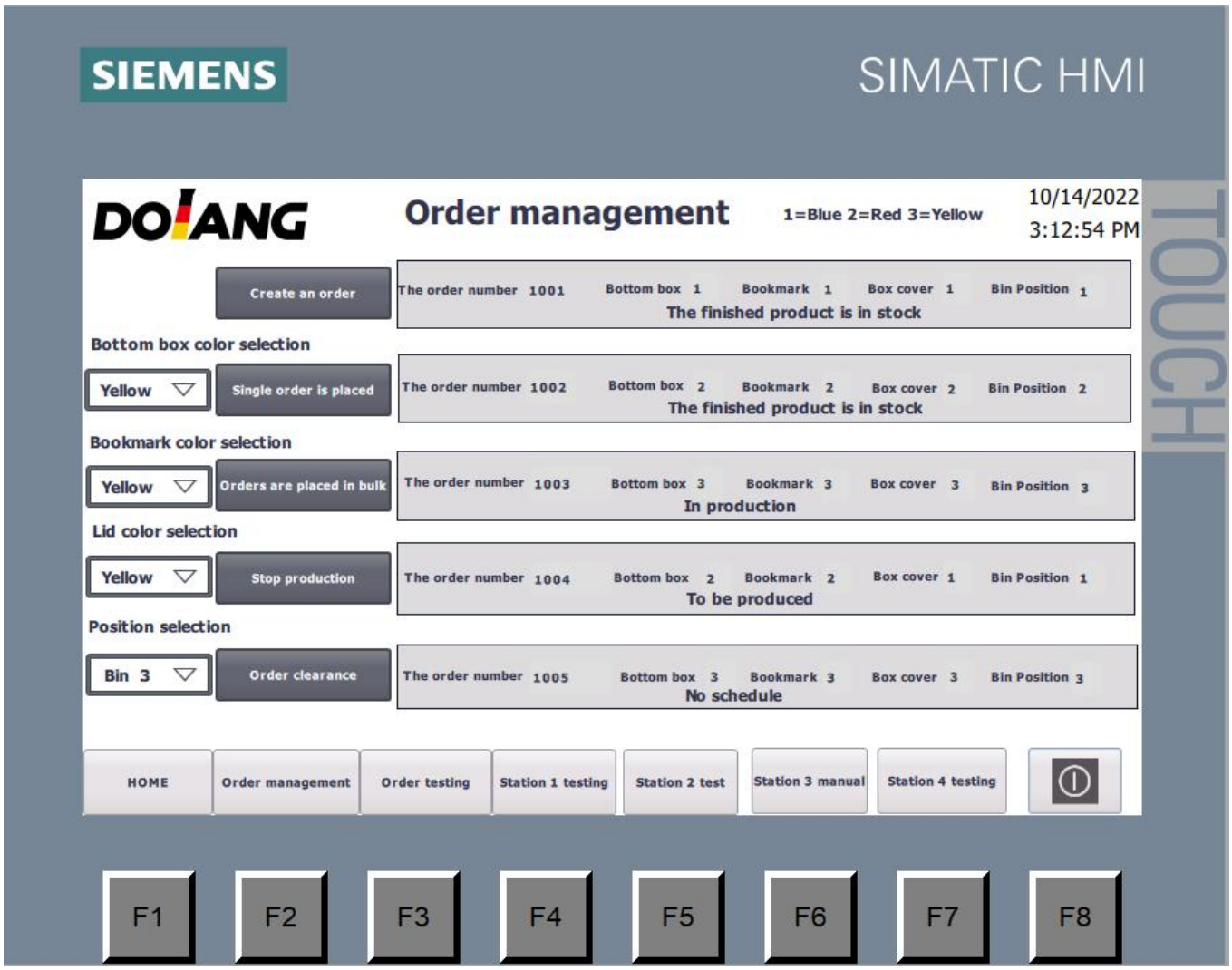
1) Design the order display interface to display the status of the current order in real time.

The function table of the order display interface is as follows:

NO	Name	content	Permission	RMKs
1	Current order number	Display the order number of the current production	administrator operator	real-time display
2	Current order source	Display HMI, web page, MES order source	administrator	real-time display
3	Current order bottom box color	blue, red, yellow	administrator operator	real-time display
4	Current order bookmark color	blue, red, yellow	administrator operator	real-time display
5	Current order box cover color	blue, red, yellow	administrator operator	real-time display
6	Current order stock No.	0001,0002,0003	administrator operator	real-time display

The WEB reference screen is as follows:

HMI reference screen is as follows:



Appendix 1 IO Allocation sheet

Bottom Box feeding station PLC body					
No	**input**	**variable name**	**No**	**Output**	**variable name**
1	**I0.0**	start button	**1**	**Q0.0**	start light
2	**I0.1**	stop button	**2**	**Q0.1**	stop light
3	**I0.2**	reset button	**3**	**Q0.2**	reset light
4	**I0.3**	manual automatic button	**4**	**Q0.3**	manual automatic light
5	**I0.4**	emergency stop button	**5**	**Q0.4**	emergency stop light
6	**I0.5**	Pre-station inspection	**6**	**Q0.5**	Position cylinder 1
7	**I0.6**	Trolley number detection switch 1	**7**	**Q0.6**	Position cylinder 2
8	**I0.7**	Trolley number detection switch 2	**8**	**Q0.7**	Position cylinder 3
9	**I1.0**	Trolley number detection switch 3	**9**	**Q1.0**	Inverter start
10	**I1.1**	Trolley number detection switch 4	**10**	**Q1.1**	Manual place troy cylinder
11	**I1.2**	Position cylinder 1 up	**11**		
12	**I1.3**	Position cylinder 2 up	**12**		
13	**I1.4**	Position cylinder 3 up	**13**		
14	**I1.5**	Manually placed tray inspection	**14**		
Bottom Box feeding station I/O module					
No	**input**	**variable name**	**No**	**Output**	**variable name**
1	**I10.0**	Bottom box material detection 1	**1**	**Q10.0**	Tri-color light - red
2	**I10.1**	Bottom box material detection 2	**2**	**Q10.1**	Tri-color light - yellow
3	**I10.2**	Bottom box material detection 3	**3**	**Q10.2**	Tri-color light - green
4	**I10.3**	Push cylinder 1 exten	**4**	**Q10.3**	Push cylinder 1
5	**I10.4**	Push cylinder 1 retract	**5**	**Q10.4**	Push cylinder2
6	**I10.5**	Push cylinder 2 extend	**6**	**Q10.5**	Push cylinder3
7	**I10.6**	Push cylinder 2 retract	**7**	**Q10.6**	
8	**I10.7**	Push cylinder 3 extend	**8**	**Q10.7**	
9	**I11.0**	Push cylinder 3 retract	**9**	**Q11.0**	
10	**I11.1**		**10**	**Q11.1**	

Bookmark feeding station PLC body					
No	**input**	**variable name**	**No**	**Output**	**variable name**
1	I0.0	start button	1	Q0.0	stepper motor pulse
2	I0.1	stop button	2	Q0.1	stepper motor direction
3	I0.2	reset button	3	Q0.2	start light
4	I0.3	manual automatic button	4	Q0.3	stop light
5	I0.4	emergency stop button	5	Q0.4	reset light
6	I0.5	Pre-station inspection	6	Q0.5	manual automatic light
7	I0.6	Trolley number detection switch 1	7	Q0.6	emergency stop light
8	I0.7	Trolley number detection switch 2	8	Q0.7	Position cylinder 1
9	I1.0	Trolley number detection switch 3	9	Q1.0	Inverter start
10	I1.1	Trolley number detection switch 4	10	Q1.1	
11	I1.2	Step origin	11		
12	I1.3	Position cylinder 1 up	12		
13	I1.4		13		
14	I1.5		14		
Bookmark feeding station I/O module					
No	input	variable name	No	Output	**v**ariable name
1	I10.0	Bookmark material detection 1	1	Q10.0	Tri-color light - red
2	I10.1	Bookmark material detection 2	2	Q10.1	Tri-color light - yellow
3	I10.2	Bookmark material detection 3	3	Q10.2	Tri-color light - green
4	I10.3	Telescopic cylinder extend	4	Q10.3	Suction cup solenoid valve
5	I10.4	Telescopic cylinder retract	5	Q10.4	Telescopic Solenoid Valve
6	I10.5		6	Q10.5	
7	I10.6		7	Q10.6	
8	I10.7		8	Q10.7	
9	I11.0		9	Q11.0	
10	I11.1		10	Q11.1	

Box cover assembly station PLC body					
No	input	variable name	No	Output	variable name
1	I0.0	start button	1	Q0.0	Backup
2	I0.1	stop button	2	Q0.1	Backup
3	I0.2	reset button	3	Q0.2	start light
4	I0.3	manual automatic button	4	Q0.3	stop light
5	I0.4	emergency stop button	5	Q0.4	reset light
6	I0.5	Pre-station inspection	6	Q0.5	manual automatic light
7	I0.6	Trolley number detection switch 1	7	Q0.6	emergency stop light
8	I0.7	Trolley number detection switch 2	8	Q0.7	Position cylinder 1
9	I1.0	Trolley number detection switch 3	9	Q1.0	Inverter start
10	I1.1	Trolley number detection switch 4	10	Q1.1	
11	I1.2	Positioning cylinder 1 up	11		
12	I1.3		12		
13	I1.4		13		
14	I1.5		14		
Box cover assembly station I/O module					
No	input	variable name	No	Output	variable name
1	I10.0	Lid material detection1	1	Q10.0	Tri-color light - red
2	I10.1	Lid material detection2	2	Q10.1	Tri-color light - yellow
3	I10.2	Lid material detection3	3	Q10.2	Tri-color light - green
4	I10.3	Push cylinder 1 extend	4	Q10.3	Push cylinder 1
5	I10.4	Pusher cylinder 1 retract	5	Q10.4	Push cylinder 2
6	I10.5	Push cylinder 2 extend	6	Q10.5	Push cylinder 3
7	I10.6	Push cylinder 2 retract	7	Q10.6	Suction cup cylinder
8	I10.7	Push cylinder 3 extend	8	Q10.7	Telescopic cylinder
9	I11.0	Push cylinder 3 retract	9	Q11.0	Lifting cylinder
10	I11.1	Telescopic cylinder Extend	10	Q11.1	
11	I11.2	Telescopic cylinder retract	11	Q11.2	
12	I11.3	Lifting cylinder up	12	Q11.3	
13	I11.4	Lifting cylinder down	13	Q11.4	
14	I11.5		14	Q11.5	
15	I11.6		15	Q11.6	
16	I11.7		16	Q11.7	

Warehouse station PLC body					
No	input	variable name	No	Output	variable name
1	I0.0	start button	1	Q0.0	stepper motor pulse
2	I0.1	stop button	2	Q0.1	stepper motor direction
3	I0.2	reset button	3	Q0.2	start light
4	I0.3	manual automatic button	4	Q0.3	stop light
5	I0.4	emergency stop button	5	Q0.4	reset light
6	I0.5	X-axis origin	6	Q0.5	manual automatic light
7	I0.6	Z-axis origin	7	Q0.6	emergency stop light
8	I0.7	Pre-station inspection	8	Q0.7	Positioning cylinder 1
9	I1.0	Trolley number detection switch 1	9	Q1.0	Inverter start
10	I1.1	Trolley number detection switch 2	10	Q1.1	
11	I1.2	Trolley number detection switch 3	11		
12	I1.3	Trolley number detection switch 4	12		
13	I1.4	Positioning cylinder 1 lift up	13		
14	I1.5		14		
Warehouse station I/O module					
No	input	variable name	No	Output	variable name
1	I10.0	Finished box material detection 1	1	Q10.0	Tri-color light -red
2	I10.1	Finished box material detection	2	Q10.1	Tri-color light - yellow
3	I10.2	Finished box material detection 3	3	Q10.2	Tri-color light - green
4	I10.3		4	Q10.3	Suction cup solenoid valve
5	I10.4		5	Q10.4	
6	I10.5		6	Q10.5	
7	I10.6		7	Q10.6	
8	I10.7		8	Q10.7	
9	I11.0		9	Q11.0	
10	I11.1		10	Q11.1	

Appendix 2 MES Variable table

Name	Data Type	Offset value	Start Value
Current voltage	Real	0	0.0
Current electric current	Real	4	0.0
Current power	Real	8	0.0
Accumulated electric energy	Real	12	0.0
Current airflow	Real	16	0.0
Cumulative airflow	Real	20	0.0
1# Equipment status	Int	24	0
2# Equipment status	Int	26	0
3# Equipment status	Int	28	0
4# Equipment status	Int	30	0
1# blue bottom box warehouse	Int	32	0

Name	Data Type	Offset value	Start Value
1#Red bottom box warehouse	Int	34	0
1# Yellow bottom Box Warehouse	Int	36	0
2#Blue bookmark warehouse	Int	38	0
2#Red bookmark warehouse	Int	40	0
2# Yellow bookmark warehouse	Int	42	0
3# blue box lid warehouse	Int	44	0
3# Red box lid warehouse	Int	46	0
3# Yellow box lid warehouse	Int	48	0
4# Blue finished product warehouse	Int	50	0
4# Red finished product warehouse	Int	52	0
4# Yellow finished product warehouse	Int	54	0
Equipment completed order number	Int	56	0
current order number	Int	58	0
Current order bottom box selection	Int	60	0
Current order bookmark selection	Int	62	0
Current order box lid selection	Int	64	0
Current order warehouse selection	Int	66	0
Confirm the device is completed, order number information has been updated	Int	68	0
Accumulated energy reset	Int	70	0
Accumulated airflow reset	Int	72	0
Backup	Array[0..99] of Int	74	