The First World Vocational College Skills Competition
“Carbon Neutral Renewable Energy Engineering” Skill

“Engineering Practices and Operations” Test Project

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I. Notice for Competitors (Please Read Carefully before the Competition)

1. If there is any problem with missing pages or illegible handwriting in the Test Project (“TP”), please indicate the problem to the judge and have the TP replaced.

2. The total mark is 100 points.

3. Competitors should not write their names or information related to their walks of life on the Carbon Neutral Renewable Energy Engineering Skill Competition in the First World Vocational College Skills Competition (the “Competition”) papers submitted, or the results will be null and void. In the record sheet, data and texts should be filled in black ink and handwriting should be clear. For illegible handwriting, the TP will be regarded as null and void.

4. Competitors should follow the Competition rules and safety rules during operations to ensure the safety of person and equipment. If there is any violation, corresponding points will be deducted from the overall results of the examination in accordance with relevant rules.

5. If the precious device is damaged due to a human cause by the competitor during the Competition, the team will be stopped from the Competition with their results recorded as zero points.

6. If the competitor commits cheating, disobeys the decision of the judge, or disturbs the order of the workshop, the jury president will deduct corresponding points according to the rules. For a serious circumstance, the competitor will be disqualified from the Competition, with the result recorded as zero points.

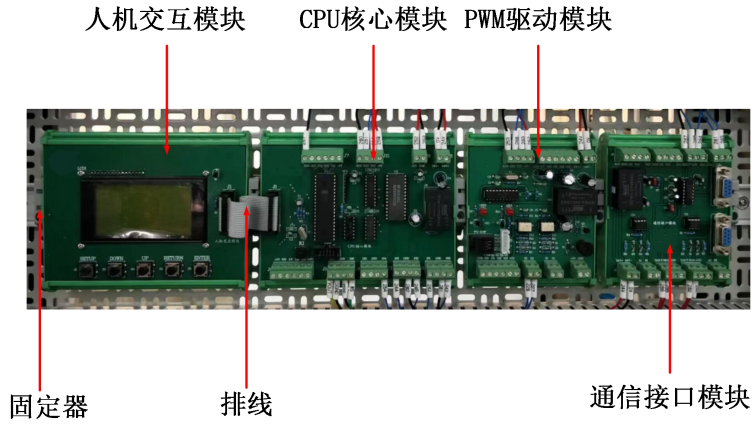
7. Competitors should cherish their equipment and conserve consumables. During the Competition, competitors should not step on the leads, routing slot covers or other materials or tools.

8. During the Competition, competitors should store the operating records or program files generated by systems in the catalogs and folders designated in the TP in accordance with the TP requirements; otherwise, zero points will be awarded.

II. Equipment Installation and Connection

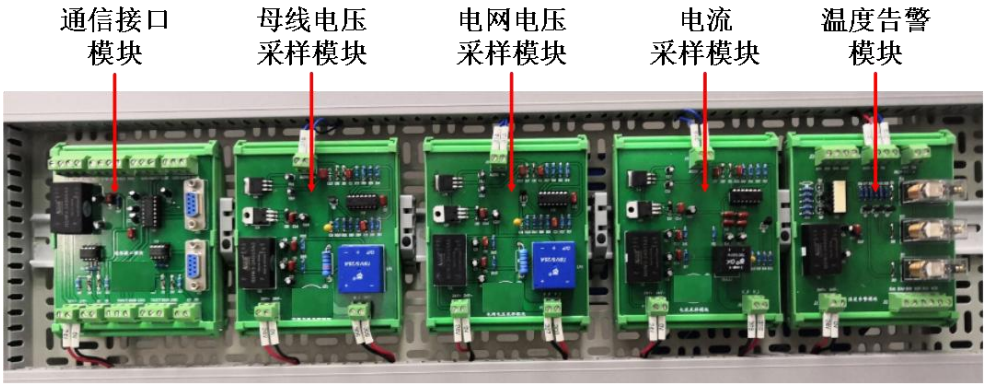
1. Equipment installation

(1) Install the “CPU core module” and “Man-machine interaction module” on the “Energy conversion and storage control system” guiding track correctly and then fix them.



人机交互模块	**Man-machine interaction module**
CPU 核心模块	**CPU core module**
PWM 驱动模块	**PWM drive module**
固定器	**Holder**
排线	**Wiring**
通信接口模块	**Communication interface module**

(2) Install the “Power grid voltage sampling module” in the correct position of the mesh rack of “Grid-connected inverter control system” and then fix it.



通信接口模块	**Communication interface module**
母线电压采样模块	**Busbar voltage sampling module**
电网电压采样模块	**Power grid voltage sampling module**
电流采样模块	**Current sampling module**
温度告警模块	**Temperature alarm module**

2. Equipment connection

(1) Connect the “CPU core module” and “Man-machine interaction module” by 20P wiring.

(2) In line with Table 1, select the designated linetype, and complete the wiring of “CPU core module”. All leads connected must be pressed with connecting terminals. The leads must be covered with the cable markers provided by the workshop. In addition, the numbering requirements of cable markers should be consistent with those of connection tables, and the character directions of the markers also consistent with the electrical panel’s as a whole. Routing should be placed into the slots in which the external routing should be organized.

Table 1 Connection of CPU Core Module

No.	Position of the starting point		Position of the ending point		Cable marker No.	Lead specification
	Name of module	Terminal number	Name of module	Terminal number		
1	CPU core module	J2:IN0	DC voltage and current collecting module 1	J2:Vout1	243	12 blue
2		J2:GND		J2:GND	261	23 black
3		J2:IN1		J2:Vout0	242	12 blue
4		J3:IN2	DC voltage and current collecting module 2	J3:Vout1	245	12 blue
5		J3:GND		J3:GND	262	23 black
6		J3:IN3		J3:Vout0	244	12 blue
7		J4:IN4	Temperature alarm module	J4:TM	254	12 blue
8		J7:GND	Communication interface module	J8:GND	287	23 black
9		J8: 24 V+	Terminal board XT	2:9 up	24 V	23 red
10		J8: 24 V-		3:3 up	0 V	23 black
11		J9: +5 V	PWM drive module	J1: +5 V	252	23 red
12		J9:GND		J1:GND	253	23 black
13		J11: +5 V	Temperature alarm module	J4: +5 V	259	23 red
14		J11:GND		J4:GND	260	23 black
15		J11:RXD	Communication	J9:R1OUT	281	12 blue

16		J11:TXD	interface module	J8:T2IN	284	12 blue
17		J5:IN6	Terminal board XT	5:8 up	WS	23 red
18		J5:GND		5:9 up	WSGND	23 black
19		J5:GND		5:6 up	SGND	23 black
20		J5:IN7		5:3 up	VOUT	23 red

(3) In line with Table 2, select the designated linetype, and complete the wiring of “Power grid voltage sampling module”. All leads connected must be pressed with connecting terminals. The leads must be covered with the cable markers provided by the workshop. In addition, the numbering requirements of cable markers should be consistent with those of connection tables, and the character directions of the markers also consistent with the electrical panel’s as a whole. Routing should be placed into the slots in which the external routing should be organized.

Table 2 Connection of Power Grid Voltage Sampling Module

No.	**Position of the starting point**		**Position of the ending point**		**Cable marker No.**	**Lead specification**
	Name of module	**Terminal number**	**Name of module**	**Terminal number**		
1	Power grid voltage sampling module	J1: 24 V+	Terminal board XT	1:8 up	24 V	23 red
2		J1: 24 V-		2:4 up	0 V	23 black
3		J2:V_P	Drive circuit module	J4:V_P	307	23 red
4		J2:V_I		J4:V_I	308	23 black
5		J3:Vs	Interface module	J5:Vs	313	12 blue
6		J3:AGND		J5:AGND	314	12 blue

(4) Connect the aviation socket between the “Analog light source tracking device” photovoltaic output and “Analog energy control system”

photovoltaic output, with the numbers of cable markers of connecting wires as V1+, V1-, V2+, V2-, V3+, V3-, V4+ and V4-.

3. Power on procedures

Power on equipment in accordance with the electrical operating procedures.

III. Software and Hardware Configuration

1. Parameter setting of voltmeters and ammeters of the energy conversion and storage control system

Figure 1 is a schematic diagram of voltmeters and ammeters. In accordance with the tips on the panels of those meters and requirements in Table 3, set the “Communication address” and “Baud rate” of the two types of meters, store them, and then exit.

Figure 1 DC Voltmeter and Ammeter

光伏输出电压	Photovoltaic output voltage
光伏输出电流	Photovoltaic output current

Table 3 Communication Parameters of Voltmeter and Ammeter

No.	Location	Name	Communication address [Addr]	Baud rate [bAUd]
1	Energy conversion and storage control system	Photovoltaic output voltmeter	04	9600

2		Photovoltaic output ammeter	01	
3		Storage battery voltmeter	05	
4		Storage battery ammeter	02	
5	Grid-connected inverter control system	Inverter input voltmeter	06	
6		Inverter input ammeter	03	

2. Parameter setting of inverter output electricity meter of the grid-connected inverter control system

(1) Set the “Communication address” and “Baud rate” of “Inverter output electricity meter”, with the operation procedures as follows: Enter the password “0001”; set the communication address as “007”; set the baud rate as “9600” and save it; and enter the interface of power parameters.

IV. System Debugging

1. Photovoltaic power generation system

As required, test the characteristic parameters of photovoltaic power generation system, and complete the data in Table 4. Calculate the power in the table with the number of groups of logged data no less than 16. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

(1) With test data from the photovoltaic output voltmeter and ammeter, select the test points of data in a rational, independent and real-time manner (points of short and open circuits must be included) to

draw smooth curves.

(2) Select the first group of data as the state point of short circuit whereas the last one of open circuit.

(3) Adjust the intensity of light sources to the strongest. Adjust the adjustable varistor, test the output characteristics of photovoltaic components, and record the data. Ensure that data on voltages is precise to a single digit, and currents and power to two decimal places.

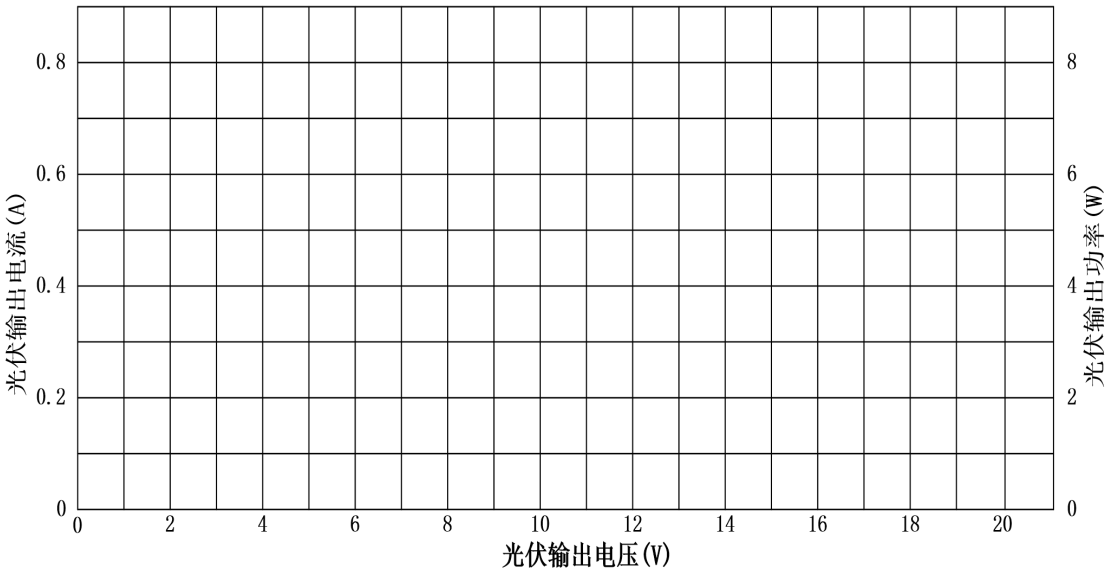
(4) Draw the V-I and V-P curves. Identify the maximum power, and values of short and open circuits, and record them in Table 5.

Table 4 Test Record on the Characteristics of Photovoltaic Arrays

No.	Voltage (V)	Current (A)	Power (W)	Workstation No. signed by competitors Workstation No. signed by competitors	Judge's signature
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					

14					
15					
16					
17					
18					
19					
20					
21					
22					
23					

Note: When the value of an adjustable resistor is adjusted to the minimum, the circuit will be taken as a short one. If the current value of photovoltaic output ammeter represents a short circuit current, the data should be recorded in the table.



光伏输出电压（V）	**Photovoltaic output voltage (V)**
光伏输出电流（A）	**Photovoltaic output current (A)**
光伏输出功率（W）	**Photovoltaic output power (W)**

Figure 4 Photovoltaic V-I Curve and Power Curve Graph

Table 5 Maximum Power, Short Circuit Current and Open Circuit Voltage

Maximum power	Short circuit current	Open circuit voltage

2. Wind power generation system

(1) Record the data of “Storage battery voltmeter” and “Storage battery ammeter” in Table 7 when the frequency converter is powered on but not activated. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

(2) In the light of the setting values offered in Table 6, set the parameters of frequency converters.

Table 6 Parameter Settings

Parameter No.	Setting value	Name	Content
ALL.CL	1	All parameters cleared	Parameters should be reset to the original value
P.1	30.00	Upper limit on frequency	The upper limit on output frequency should be set

(3) Set the parameters of frequency converters: Enter the "PU operating mode" to set the frequency to "27.00Hz" and then confirm the value. Activate the "Frequency converter", and record the data of the "Storage battery voltmeter" and "Storage battery ammeter" in Table 7. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

Table 7 Voltages and Currents Outputted by Storage Batteries

Operating state of frequency converters	Storage battery		Workstation No. signed by competitors	Judge's signature
	Voltage (V)	Current (A)		
Stop				
Start				

(4) Stop the "Frequency converter" and power off it.

3. Energy conversion and storage system

(1) Operate the buttons of charging and discharging controllers and set the following parameters: Voltage of charging halt to batteries: 29.84 V; voltage of loading halt: 22.06 V; voltage of loading startup: 23.94 V.

(2) Activate the photovoltaic power generation, run the man-machine interaction module, and regulate the duty ratio of PWM

output. In case that the value of storage battery ammeter reaches the maximum, log the data on photovoltaic output and on the voltages and currents of storage batteries. It is required that data on voltages should be precise to one decimal place and currents to two decimal places. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

Table 8 Record Sheet of Functional Inspections

Photovoltaic output		**Storage battery**		**Workstation No. signed by competitors Workstation No. signed by competitors**	**Judge's signature**
Voltage (V)	**Current (A)**	**Voltage (V)**	**Current (A)**		

4. Grid-connected inverter power generation system

Close the photovoltaic power generation, and log the data on "Storage battery voltmeter" and "Storage battery ammeter" before and after the "Off-grid inverter" operates respectively and under "Off-grid load". It is required that data about voltages should be precise to one decimal place and currents to two decimal places. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

Table 9 Working State of Off-grid Inverters

Off-grid inverter	**Off-grid load Working state**	**Storage battery**		**Workstation No. signed by competitors**	**Judge's signature**
		Voltage (V)	**Current (A)**		

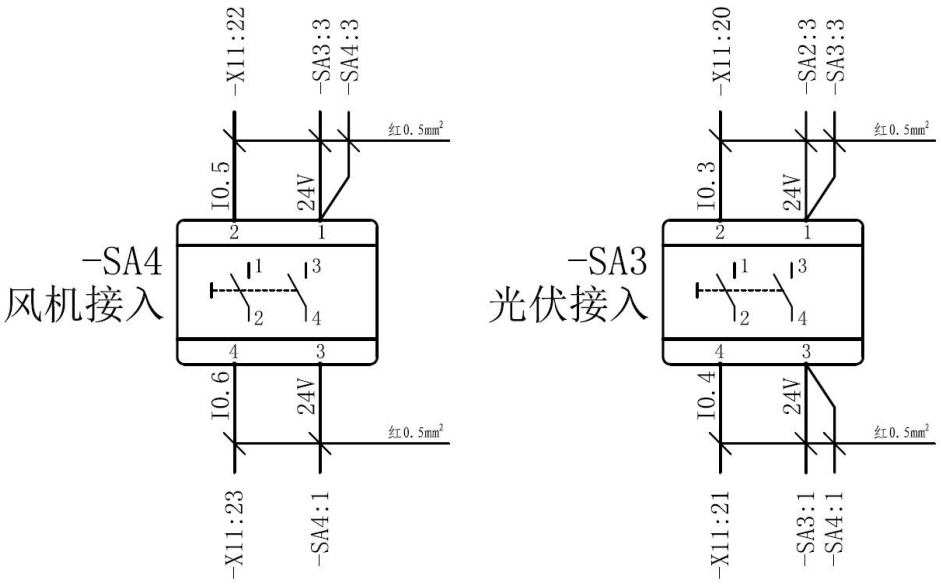
Before operations					
After operations					

V. Task for Electrical Design

In accordance with the provided “Template for wiring diagrams of the analog energy control system (photovoltaic)” and “Electrical diagram of the analog energy control system (photovoltaic)” (located in the folder of “Carbon Neutral Renewable Energy Engineering\Electrical design” on the desktop), competitors are required by leveraging the CAD software to complete the design for wiring diagrams of the analog energy control system (photovoltaic) and analog light source tracking device.

1. The template for wiring diagrams is provided uniformly. Device symbols for drawing the wiring diagrams have been arranged in the template for wiring diagrams. Please do not change the placement of devices randomly.

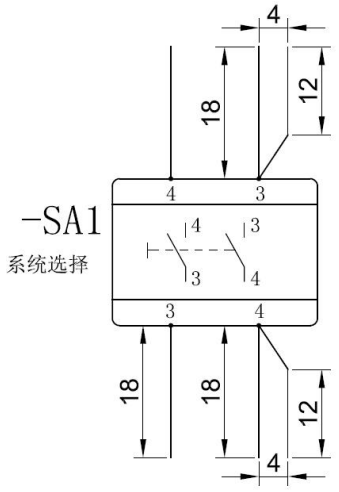
2. Requirements for drawing wiring diagrams are:



-SA4 风机接入	**-SA4 fan connection**
-SA3 光伏接入	**-SA3 photovoltaic connection**

Sample of Wiring Diagrams

(1) Leads for connection should be represented by solid lines, and interrupt lines should be adopted for drawing with the wiring position in the center of solid dots. The width of connecting wires should be 0.35 mm with two outlets up and down. If there are two output lines at the same end-point, the second line should be pulled out from the right of the first. For the drawing method, see the following example:



-SA1 系统选择	**-SA1 system selection**

(2) In terms of line No. of connecting wires (such as 24 V and I0.3), the Song typeface should be applied, with the height of characters being 2.5 and width factor 1.

(3) The marks of traverse points should utilize the “Item designation: Terminal designation”. For instance, “-SA4:1” on the third pin of connecting wire of an SA3 device in the sample of wiring diagrams represents that this position should be connected with the first pin of an SA4 device. Correspondingly, “-SA3:3” on the first pin of connecting wire of an SA3 device reflects that this position should be connected with the third pin of an SA3 device. In terms of marks at traverse points, the Song typeface should be applied, with the height of characters being 2.5 and width factor 1.

(4) As for the specifications, colors and other marks of connecting leads, the Fangsong typeface should be adopted, with the height of characters being 1.5 and width factor 1.

3. In line with the “Electrical diagram of the analog energy control system (photovoltaic)”, competitors should complete the drawing of electrical wiring diagrams in the template for wiring diagrams involving air switches (programable logic controllers (“PLCs”), switching power supplies and adjusting modules of light sources), PLCs, stepper drives (analog sunlight sources, and up, down, left and right control) and corresponding stepper motors, switching power supplies, adjusting module of light sources, analog sunlight sources, control buttons of light sources, start buttons, stop buttons, emergency stop buttons, photo-sensor transmitters, limit switches and grounding bars.

4. Wiring diagrams that have been drawn should be named “Wiring diagram of the analog energy control system (photovoltaic) + workstation No.dwg”. For instance, documents of the competitor at No.01 workstation should be named “Wiring diagram of the analog energy control system (photovoltaic) 01.dwg” and stored in the folder of “Carbon Neutral Renewable Energy Engineering\Electrical design” on the desktop.

Note: The version of preservation formats of wiring diagrams and CAD documents should be earlier than Version 2010.