

The First World Vocational College Skills
Competition

“Carbon Neutral Renewable Energy
Engineering” Skill

“Innovation in Engineering Projects” Test
Project

“Innovation in Engineering Projects” Test Project

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.

9. In this module, competitors can take a screenshot of the content related to the pictures of upper computer for storage in line with personal needs. Those pictures can be leveraged for the summary reports in the third “Presentation of Engineering Projects” module.

II. Establishment of Photovoltaic Power Station

1. Project implementation

In accordance with the provided “Electrical diagrams of the analog energy control system (photovoltaic)” (located in the folder of “Carbon Neutral Renewable Energy Engineering\Electrical design” on the desktop), competitors should complete the connection of electric circuits between the programmable logic controllers (“PLCs”) peripheral devices (drives, limit switches and photo-sensor transmitters).

(1) As the terminals of PLC peripheral devices have been pulled on the terminal boards, competitors only need to connect the PLC and corresponding terminal boards; and

(2) 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 electrical diagrams, 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.

2. Requirements for basic functions

Competitors should write and debug the Mitsubishi PLC programs in line with the electrical diagram to meet the following functional requirements:

Photovoltaic arrays should automatically track analog light sources and move back and forth. When tracking, photovoltaic arrays should always be aligned with analog light sources in a forward direction.

(1) After pressing the yellow “Analog light source control” button

(with self-locking function), the analog light source stepper motor starts to work. When the yellow button bounces, the motor should not run.

(2) Upon pushing the “Start” button (green) of “Analog light source control”, the analog light source stepper motor begins to move back and forth intermittently (move and stop for a while). Competitors should in line with the signals of light sensors, control the stepper motors up, down, right and left so that solar panels can move in synchronous with analog light sources and keep aligned with the light sources in a forward direction.

(3) When moving to the left limit switch, analog light sources will return to the right one in conformity with the original path, thus completing a running cycle. Then those light sources and solar panels will repeat the periodical motion.

(4) After touching the “Stop” button (red), all stepper motors will stop running; and after pressing the “Start” (green) button again, all the motors continue to operate.

3. Innovative design

After completing the preceding tasks, competitors can design innovatively combining the application requirements for engineering.

III. Design and Debugging of the Energy Conversion and Storage Control System

1. Requirements for basic functions

Competitors should write and debug the major CVT control program based on the provided source program (located in the folder of “Carbon Neutral Renewable Energy Engineering\Maximum power tracking” on the desktop) and program flowcharts at the workshop. Therefore, the

following functional requirements will be satisfied:

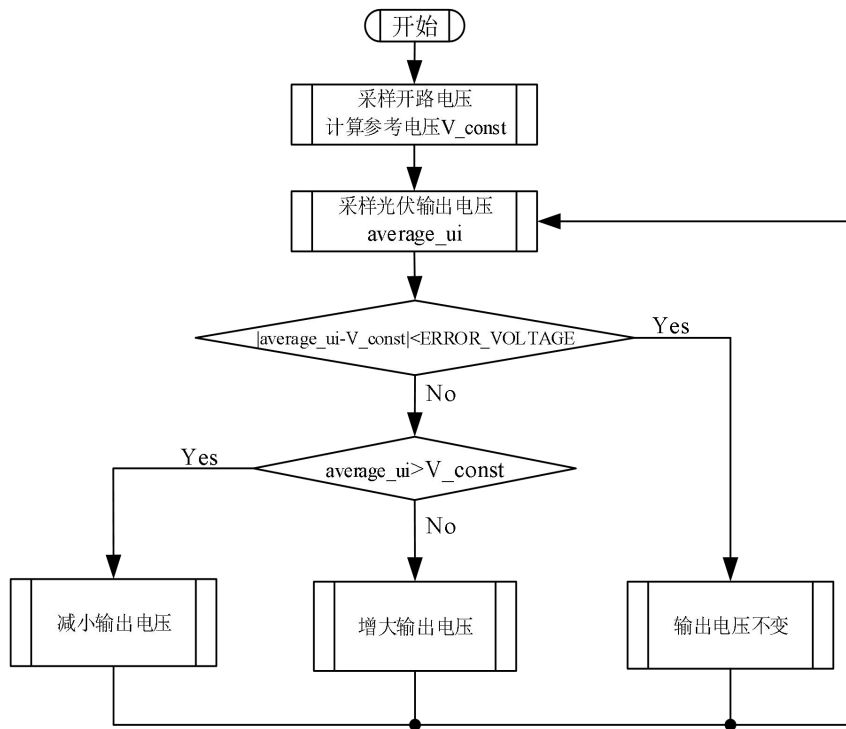


Figure 1 Flowchart

开始	Start
采样开路电压	Sampling open circuit voltage
计算参考电压 V_const	Calculate reference voltage V_const
采样光伏输出电压	Sampling photovoltaic output voltage
减小输出电压	Decrease output voltage
增大输出电压	Increase output voltage
输出电压不变	Unchanged output voltage

Analog light sources should be static and perpendicular to photovoltaic arrays, and photovoltaic output should keep charging the

24V storage batteries. When light source intensity is in the strongest status, photovoltaic output power should be greater than 5 W as required. After the functions are confirmed to be realized, the competitor should retain the modified project and indicate it to the judge. Additionally, functions should be verified under the supervision of the judge, and values of the photovoltaic output voltmeter, ammeter and wattmeter should be logged in Table 1. Both the judge and competitor should sign for confirmation. It is required that data on voltages should be precise to one decimal place, and currents and power to two decimal places.

Table 1 Record Sheet of Functional Inspections

No.	Inspection content	Photovoltaic output and values of voltmeter	Photovoltaic output and values of ammeter	Workstation No. signed by competitors	Judge's signature
1	Photovoltaic output power \geq 5W				

2. Innovative design

After completing the preceding tasks, competitors can design innovatively combining the application requirements for engineering.

IV. Debugging and Operation of the Grid-connected Inverter Power Generation System

1. Measurement of grid-connected inverter data

Set the parameters of grid-connected inverter: “Busbar setting (V)”:

U = 0120; “PI setting of current”: P = 1500, I = 0300;

“Feed-forward setting (V)”: FW = 0038; “Dead zone setting (ns)”: DB = 2560. Activate the inverter and fill in the following table before and after inverter grids are connected. 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 2 Values of Meters before and after Inverter Grids Connected

No.	Item	Inverter input		Inverter output		Workstation No. signed by competitors	Judge's signature
		U(V)	I(A)	Uc(V)	Ic(A)		
1	Before grids are connected						
2	After grids are connected						

3. Measurement of inverter output data under loads

Measure the data of voltages and currents before and after the AC and DC loads are connected: After inverters run normally, complete the values of inverter output electricity meter under no-load, DC and AC loads in the following table. It is required that data on voltages should be precise to one decimal place and currents to two decimal places whereas

other data should be logged in line with the readings of meters. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

Table 3 Values of Inverter Output Electricity Meter under No-load, DC Load and AC Load

No.	Item	Inverter output electricity meter					Workstation No. signed by competitors	Judge's signature
		Uc(V)	Ic(A)	Pc(W)	Qc(VA)	PF		
1	After grids are connected (No load)							
2	After grids are connected (DC load)							
3	After grids are connected (AC load)							

4. Measurement of inverter output data after the PID parameters are changed

Stop the inverter and set the parameters of the grid-connected inverter: “PI setting of current”: P = 0150, I = 0030; activate the inverter and complete the value of the inverter output electricity meter in Table 4; and repeat the previous operations with only the “PI setting of

current” changed: $P = 1500$, $I = 0300$. It is required that data on voltages should be precise to one decimal place and currents to two decimal places whereas other data should be logged in line with the readings of meters. Before data recording, the competitor should give a sign to the judge, and then record data under the supervision of the judge.

Table 4 Value of the Inverter Output Electricity Meter after the PID Parameters of Current Loops are Changed

No.	Item	Inverter output electricity meter					Workstation No. signed by competitors	Judge's signature
		Uc(V)	Ic(A)	PF	Voltage THD	Current THD		
1	P = 0150 I = 0030							
2	P = 1500 I = 0300							

V. Operating Optimization of the Energy Monitoring and Management System

1. Requirements for basic functions

In line with the offered communication parameters of meters, utilize the force-control configuration software on the equipment to fabricate three images, respectively: “Communication status”, “Electricity parameter” and “Real-time curve”. Store those images in the folder of “Carbon Neutral Renewable Energy Engineering\ Configuration engineering” on the desktop.

Operate the data generated by control systems and complete functional tests of such buttons as “Communication status”, “Electricity

parameter” and “Real-time curve”.

Specific requirements for images:

As a functional navigation window, the “Top window” always displayed during system operations, includes such buttons as “Communication status”, “Electricity parameter”, “Real-time curve” and “Exit”. If the buttons of “Communication status”, “Electricity parameter” and “Real-time curve” are clicked, corresponding functional windows will be presented below the window.

(1) Image I: Communication status

“Communication status” will monitor the status of voltmeters and ammeters regarding photovoltaic output, storage batteries and inverter input and output, and inverter output electricity meters in real time. In addition, the red indicator means abnormal communication whereas the green one means normal. The use of color codes is described in the upper left of the window by the graphic method.

(2) Image II: Electricity parameter

Click the “Electricity parameter” button in the “Toolbar”, with the “Function” window displaying electricity parameters of photovoltaic components (output voltage, current and power), storage battery panels (DC voltage, current and power), inverter infan (DC voltage, current and power) and inverter outfán (AC voltage and current, frequency, active and reactive power, active electricity and power factor).

(3) Image III: Real-time curve

Click the “Real-time curve” button in the “Toolbar”, with the “Function” window displaying real-time voltage, current and power curves of photovoltaic arrays, storage batteries and inverter input and

output, and the active electricity of inverter output.

Table 5 Communication Parameters of Meters

No.	Location	Name	Communication address [Addr]	Communication port	Baud rate [bAUd]
1	Energy conversion and storage control system	Photovoltaic output voltmeter	04	COM1	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	COM2	
6		Inverter input ammeter	03		
7		Inverter output electricity meter	07	COM5	

2. Innovative design

After completing the preceding tasks, competitors can design innovatively combining the application requirements for engineering.