5kW fuel cell system specification

Disclaimer

This manual contains safety guidelines and operation suggestions. However, this does not mean that this manual can cover all situations. The customer is responsible for meeting all local safety requirements to ensure the safety of the fuel cell system during operation, maintenance and storage.

Although every effort has been made to ensure the accuracy and completeness of the information contained in this document, Jiangsu Qingneng Co., Ltd. reserves the right to change the information at any time and assumes no responsibility for the accuracy of the information.

The following actions will void the fuel cell system warranty:

- In any case, disassemble or improperly tamper with a fuel cell system.
- Operate the fuel cell system in a manner not specified in system Settings or in the product-specific user manual.
- Damage to a fuel cell system due to accident, misuse, human injury, or negligence.
- Use of impure or incorrect fuel.
- Supply hydrogen to the fuel cell system using a hydrogen source that does not meet the requirements of Horizon.
- The hydrogen source pressure that does not meet the requirements of Horizon. is used to supply hydrogen to the fuel cell system.
-

Do not, under any circumstances, attempt to disassemble or tamper with the system. If disassembly or tampering occurs, the warranty is void. If you have any questions about the system and its technology or need help, please contact jason@horizonfuelcell.com

Content

1. Product Uses and Functions

1.1 Product Uses

Horizon 5kW fuel cell system is one of the best fuel cell systems in the hydrogen fuel cell industry, which is mainly used in forklift trucks, emergency power supplies, and university test and experiment systems.

1.2 Product Function

Hydrogen fuel cell is a power generation device that converts the chemical energy of hydrogen and oxygen directly into electrical energy. The basic principle is that hydrogen in the anode through the catalyst action to release electrons, electrons through the external circuit to the cathode, protons through the proton exchange membrane to the cathode and with oxygen under the action of the catalyst, water, electricity and heat. Fuel cell systems have the following advantages:

High efficiency: the fuel cell directly converts chemical energy into electrical energy, without the intermediate conversion of thermal energy and mechanical energy (generator), and is not limited by the Carnot cycle effect;

Zero emissions: The fuel of the fuel cell is hydrogen and oxygen, the only emission is water, it does not produce carbon monoxide and carbon dioxide, nor does it emit sulfur and particles. Therefore, hydrogen fuel cell system is the true sense of zero emission, zero pollution, hydrogen fuel is the perfect energy;

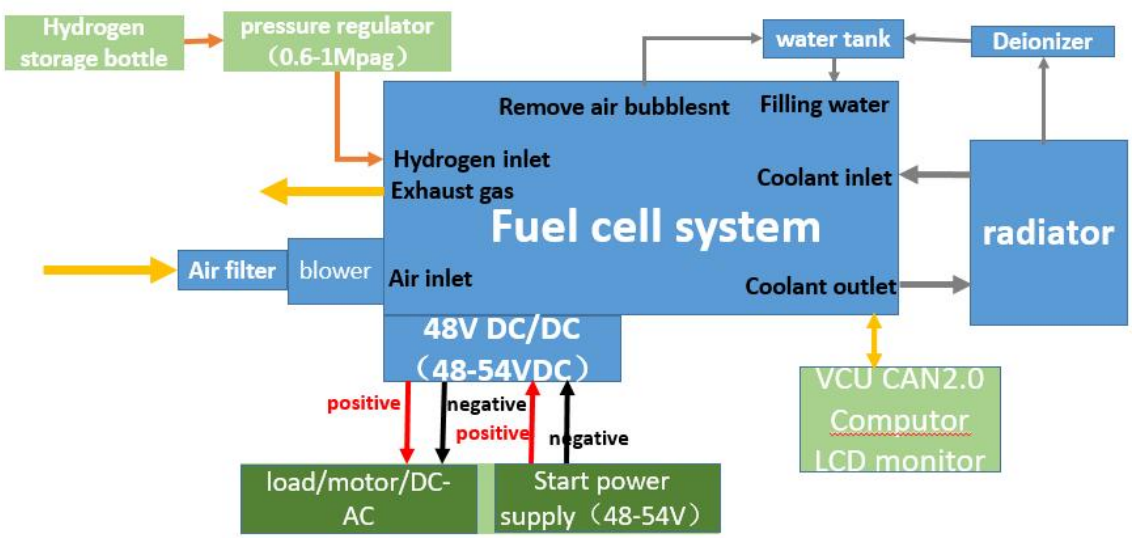
Short hydrogenation time: Hydrogen fuel cell system use hydrogen storage tanks to store fuel, each time the fuel is used up, continue to hydrogenate to the hydrogen storage tank. Each refueling time is about 5-10 minutes.

2. Product performance introduction

2.1 Working Principle

The fuel cell system is a power generation device that converts the chemical energy of hydrogen and oxygen directly into electrical energy. Its core part is the electric pile, which needs to match the oxygen supply system, hydrogen supply system, heat dissipation system, electrical control system, etc.

The air compressor draws air from the environment, filters it through the air filter, humidifies the air through the humidifier, and finally enters the fuel cell stack. The hydrogen is stored in the hydrogen storage tank of the hydrogen supply system, passes through the decompression device, and enters the fuel cell stack. After the reaction of hydrogen and oxygen, water, electricity and heat are generated, and the excess heat generated by the reaction is carried out by the heat dissipation system, and is dissipated by convection with the atmosphere through the radiator. The generated electricity is converted through the DCDC boost to supply power to external loads. The water produced by the reaction is discharged into the atmosphere along with the air remaining from the reaction and the trace amount of hydrogen that is not fully reacted. In addition, the system also needs a 24V low-voltage power supply platform to accurately control the system under different working conditions through CAN and controller, and to exchange information with the client control system through the control system. The working principle of the gas-electric system is shown in Figure 2-1.



The blue module is the material delivered with the fuel cell system, while the others need to be prepared by customers.

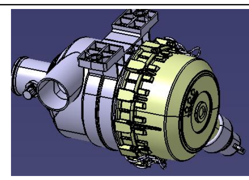
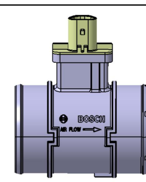
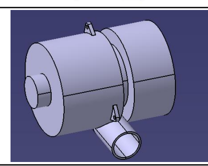
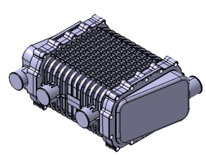
Figure 2-1: Schematic diagram of the fuel cell system

2.2 Product Composition

Functionally, the fuel cell system is mainly composed of five subsystems: oxygen supply system, hydrogen supply system, heat dissipation system, electrical control system and fuel cell stack.

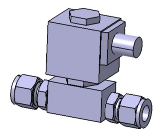
1. Oxygen supply system: Oxygen supply system is mainly composed of air filter, air flow meter, air compressor and humidifier, etc. The diagram and function of each part are shown in Table 2-1:

Table 2-1: Oxygen supply system parts list

No.	Item	Drawing	Function
1	Air Filter		Purify the air
2	Air Flow Meter		Monitoring feedback of air flow
3	Air compressor		Provide air for the system
4	Humidifier		Adds humidity to the air entering the stack

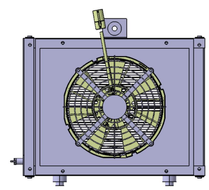
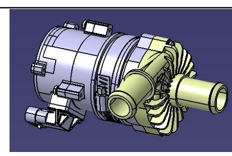
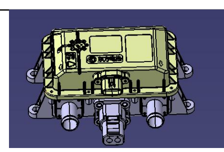
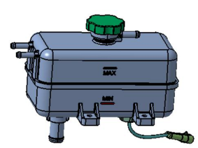
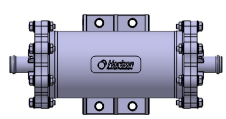
2. Hydrogen supply system: The hydrogen supply system is mainly composed of hydrogen storage bottles and solenoid valves, and the parts and functions are shown in Table 2-2:

Table 2-2: Hydrogen supply system parts list

No.	Item	Drawing	Function
1	Solenoid valve		Control the entry of external hydrogen

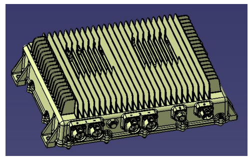
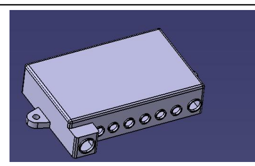
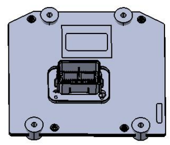
3. Cooling system: The cooling system is mainly composed of radiator, water pump, PTC heater, water tank and deion meter, etc.The parts are shown in Table 2-3:

Table 2-3: Heat dissipation system parts list

No.	Item	Drawing	Function
1	Radiator		Removes excess heat from the system
2	Water pump		Powers the cooling cycle of the fuel cell
3	PTC heater		For heating the coolant when the system starts up
4	Fill water tank		Filling water and purge air for the fuel cell system
5	Ion Exchange		Absorbs ions in the coolant and reduce the conductivity of the coolant

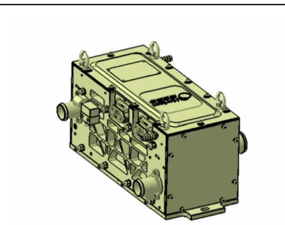
4. electrical control system: The electrical control system is mainly composed of DCDC, low-voltage distribution box and controller, parts diagram and function as shown in Table 2-4:

Table 2-4: Electrical control system parts list

No.	Item	Drawing	Function
1	DCDC		Convert the stack voltage to provide a high voltage platform for external loads
2	Low voltage distribution box		Provide low voltage power platform for the internal electrical appliances of the system
3	Controller		The control system, the system communicates with external loads

5. Fuel cell stack: The fuel cell stack is the core component of the fuel cell system, which is the part of the reaction of oxygen and hydrogen and the output voltage. The diagram and function of the parts are shown in Table 2-5:

Table 2-5: Fuel cell stacks

No.	Item	Drawing	Function
1	Fuel cell stack		Oxygen and hydrogen react to produce power

In addition to the above components, the fuel cell system is also equipped with some sensors to feed back the temperature, pressure and humidity signals in the operation of the controller system, so that the controller system can real-time other parts in the work in the appropriate state.The internal oxygen supply system and cooling system components also need to be connected between silicone tubes and multi-pass joints to ensure the flow of fluids in the system; The hydrogen flow in the system is connected by stainless steel pipes or wire hoses.The fixing of each component of the system requires support, and the whole system needs to fix the frame, and is fixed together through the frame connection.Finally, many electrical parts in the system need to be connected with high-voltage or low-voltage wiring harnesses.

2.3 Product operating conditions

2.3.1 Fuel and coolant requirements

The fuel cell reactor generates electricity by converting the chemical energy generated by the reaction of hydrogen and oxygen in the air into electrical energy, and uses the coolant to circulate heat inside the reactor. Therefore, in order to ensure the normal operation of the reactor, the fuel gas, oxidation gas and coolant have strict requirements. Table 2-6 lists the detailed requirements.

Table 2-6 Gas and liquid specifications

Fuel gas（> 99.97% H_2）	
Other components	＜300ppm
	＜2ppm CO_2
	＜0.1ppm CO
	＜5ppm H_2O
	＜2ppm Hydrocarbons
	＜5ppm O_2
	＜300ppm He
	＜200ppm N_2、Ar
	＜0.004ppm Total sulfur compounds
	＜0.01ppm Formaldehyde
	＜0.2ppm Formic acid
	＜0.1ppb NH_3
	＜0.05ppm Total halogenated compounds
Oxidizing gases (air)	
O_2	＞20.95%
N_2	＜78.08%
Other gas components	
	＜0.1ppm CO
	＜1% CO_2
	＜1ppm O_3
	＜0.01ppm SO_2
	＜0.04ppm Hydrogen sulfide
	＜0.025ppm NO
	＜0.05ppm NO_2
	＜0.008ppm Volatile Organic Compound

	＜0.01ppb NH_3
Atmospheric particulate components	
	＜90μg/m^3 PM10
	＜15μg/m^3 PM2.5
Coolant	
	50% deionized water + 50% glycol
	Particle diameter＜100μm
	Conductivity＜2μs/cm

Warning:

➢ Choice of coolant should be prudent, the widespread use of coolant in the market may not applicable, it may contain additives to lead to high conductivity, insulation resistance is too low, and therefore need to be coupled with the device which can monitor electrical conductivity.

2.4 System Performance

Table 2-7 lists the 5kW system performance parameters.

Table 2-7: 5kW fuel cell system parameters

/NO.	performance parameters	Specific parameters
1	System rated power output（kW)	5（DC efficiency loss is not included）
2	Stack rated power（kW)	6
3	System idle Power（kW）	≤1
4	Cell Number（cells）	90
5	Efficiency of the system（%）	≥42（DC efficiency loss is not included）
6	Operating ambient temperature	-10-40℃
7	Storage ambient temperature	-10-60℃
8	Response time (start-up to idle)	＜30S（Ambient temperature > 5℃）
9	-10℃ low temperature start time	＜15min
10	Operating ambient humidity	0-95%

11	Operating pressure	≤50kPa
12	IP rating	IP54
13	Vibration noise	≤89dB
14	Rated Power	5kW@54V
15	System size (mm)	860*820*825
16	System weight(kg)(Includes DC and radiator)	180
17	DC output voltage(V)	54
18	Stack operating temperature(°C)	60-70
19	H2 purity	＞99.97%
20	Hydrogen inlet pressure（Mpag）	0.6-1
21	Hydrogen reserved interface mode	1/2 inches Card sleeve joint
22	Hydrogen flow rate(l/min)	≤250
23	Insulation resistance (Ω/V)	≥500Ω/V
24	Coolant	≤2us/cm

3. System operation

The fuel cell system has a set of electrical control system, the system can allow the relevant engineers to the fuel cell system manual, automatic or monitoring operation, and is also set up automatic alarm and protection device, when the fuel cell system in operation failure will automatically send an alarm signal or even shut down, in order to ensure that the fuel cell system is in normal working state at any time Or notify engineers to perform maintenance.

3.1 Routine check before startup

Fuel cell engine systems need to be checked before starting but are not limited to the following:

1．Check the appearance of the reactor module. Check whether the fuel cell stack module is damaged, deformed, etc., and whether the surface is scratched.

2. Hydrogen concentration detection. Use a hydrogen leak detector to detect the hydrogen concentration above the system. If there is a leak point, open the hydrogen valve under ventilation to find the leak point and carry out maintenance.
3. Check the interface. The cooling water valve of the fuel cell engine system is closed, and there is no leakage or loosening at the interface. The hydrogen pipe joint is free of debris and fixed firmly and reliably; Reactor cooling water inlet and outlet pipe interface is not loose, no leakage; Air pipe clamp is not loose, fixed firmly; The external plug-in of can cable is connected properly without loosening. The 24V low-voltage wiring harness of the controller is properly connected. Weak current connection line no empty plug hanging, fixed firmly.
4. water tank water level check. The water level of the water tank must be ensured within the normal water level range. If it is insufficient, the specified coolant needs to be added.
5. Check the radiator. Check the radiator for damage or deformation and for leakage.

3.2 Running Process

It is necessary to monitor whether the relevant parameters and status are normal in real time during the system operation. Items that need to be monitored are: whether the communication is normal (no interference, delay or acceleration), loading rate, output voltage and current. You can click the system status, stack status, History fault buttons at the bottom of the control panel to enter different interfaces to understand the corresponding information, and you can view the real-time status of relevant data during the operation of the stack.

3.3 Resetting System Fault

If related fault information is reported during the system running, perform the following operations to restore the system status to standby:

1. Turn off the 24V power supply;
2. If you start the system again according to the normal startup process, the system status is displayed as standby on the screen.

3.4 Safety Precautions during use

Periodically check whether the fuel cell system has abnormal phenomena such as water leakage, gas leakage, hydrogen tail row length opening or other abnormal sound, and timely report and deal with it, and periodically check whether the water level of the water tank is normal every day.

1. network monitoring personnel need to do a good job of monitoring, timely detection of problems and deal with them, do a good job of recording the use process.
2. the user timely collects the system operation data during the operation and maintenance of the equipment, so that the system data is downloaded regularly and recorded.
3. should avoid operating the system in areas with serious air pollution (such as: black smoke, burning whip, heavy dust, oil paint, etc.).
4. Do not allow open flames around the system.

3.5 System Communication Protocol

For details, please refer to the Communication Protocol.

3.6 System Errors are reported

Please refer to the Fault Code Table for details.

4. System operations

The fuel cell system is mainly composed of fuel cell stack module, hydrogen supply module, oxygen supply module, cooling module, and electrical control module. The hydrogen supply module provides the hydrogen required for the reaction of the fuel cell system. The oxygen supply module provides the air needed for the fuel cell system reaction. The cooling module is mainly used for heat dissipation of the fuel cell system through the circulation of coolant. The electrical control module controls the components of the entire system.

4.1 System Connection Description

You need to connect the tailpipe of the system, the hydrogen inlet (connected to the hydrogen source), and the high voltage end of the DCDC (connected to the load). After all the pipes are connected, a certain amount of deionized water is manually added to the system kettle.

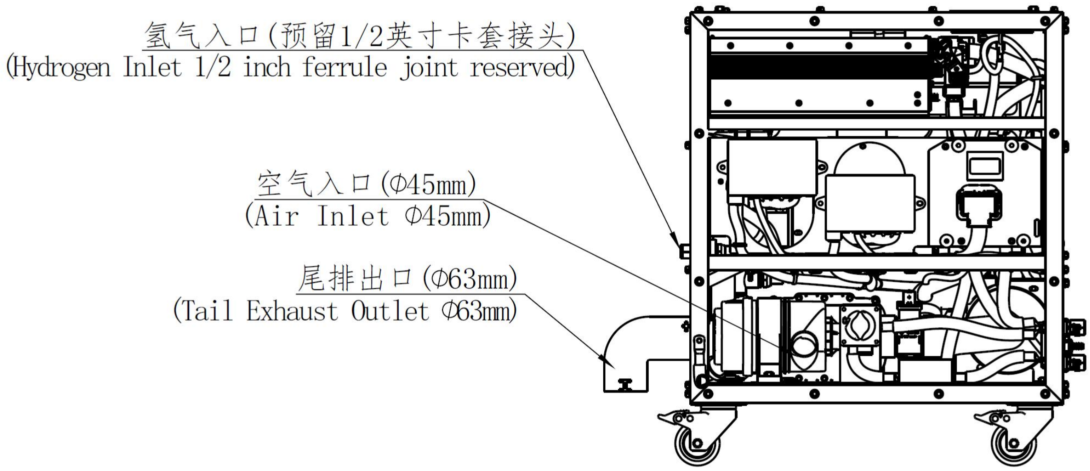


Figure 4-1 a System connection diagram

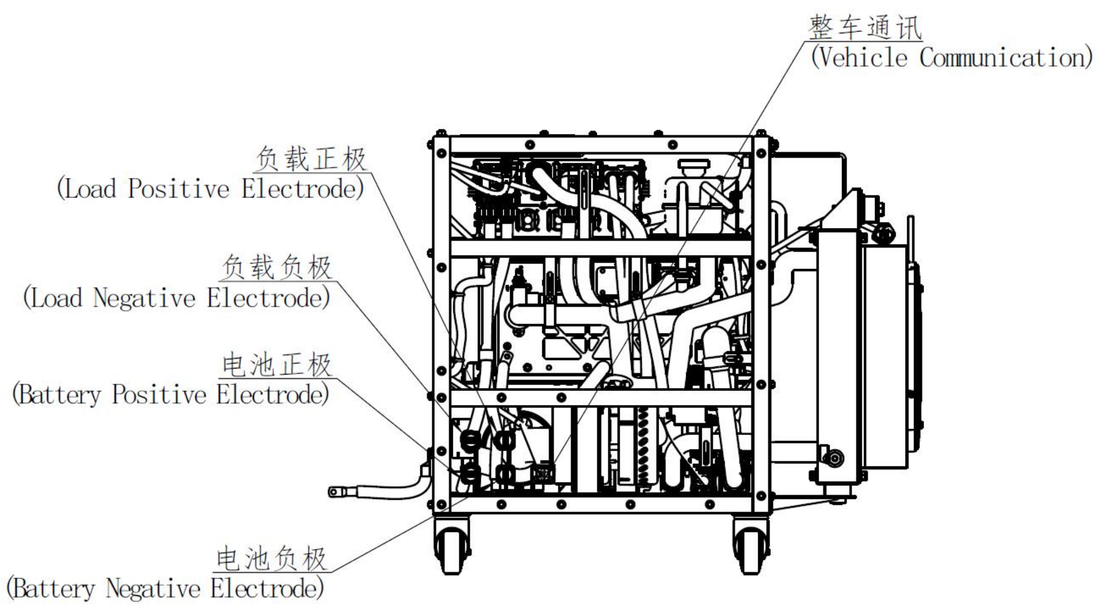


Figure 4-1 b System connection diagram

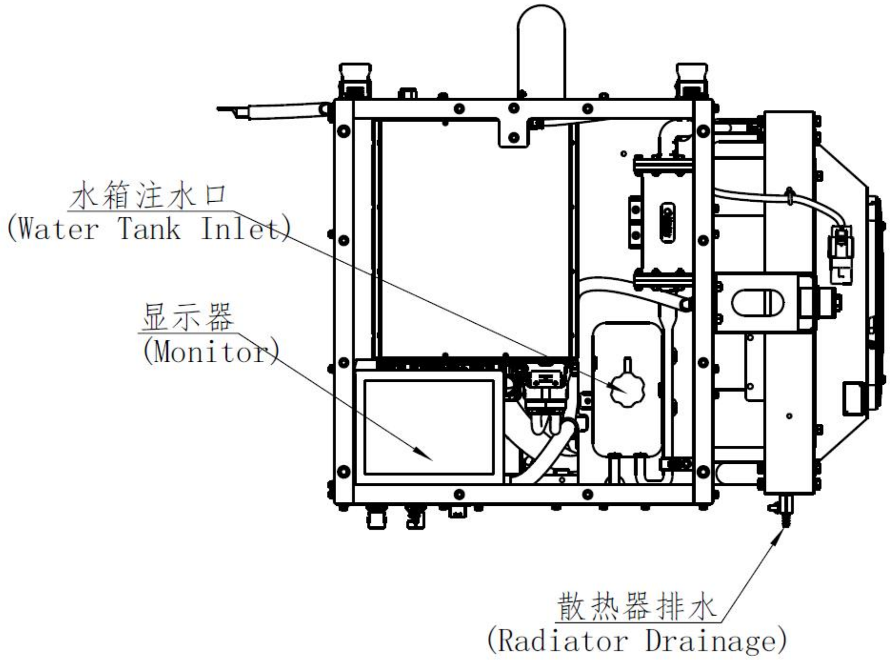


Figure 4-1 c System connection diagram

4.2 System Communication Cable Connection

As shown in Figure 4-2, this is how the communication lines between the system and the computer are connected. We connect with a communication line configured by KVASER, one end of the communication line is connected to the CAN2 interface of the system ECU, and the other end of the KVASER is connected to the computer.

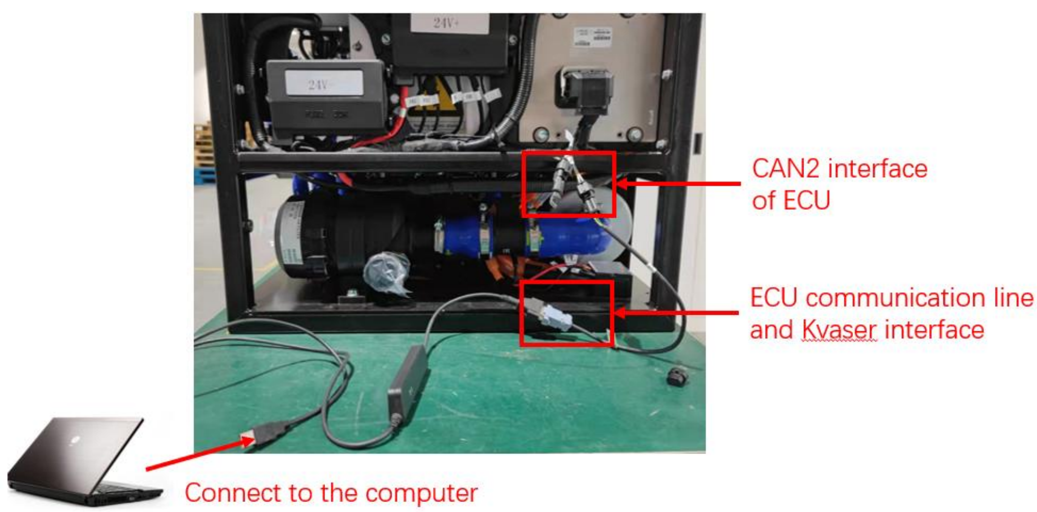


Figure 4-2 Communication line connection

4.3 Screen Control description

As shown in Figure 4-3, it is the control interface of our system, which can start and shut down the system and modify the power through the control of the screen.

Operation 1：When you click this button , it will become Set Remote Control , At this time, it can be operated on the display screen, Otherwise, Ethernet operation will be performed.

Operation 2：This button is the lock key of the screen, Clicking this button will become Set Control Lock , before power setting and other operations can be performed . Otherwise, the screen will not operate.

Operation 3：This is the system emergency stop button. When the button becomes Reset Normal Mode , the system will be in emergency stop state.

Operation 4：After the power setting is completed, click this button to change to STOP to start the system. Clicking again will stop the system.

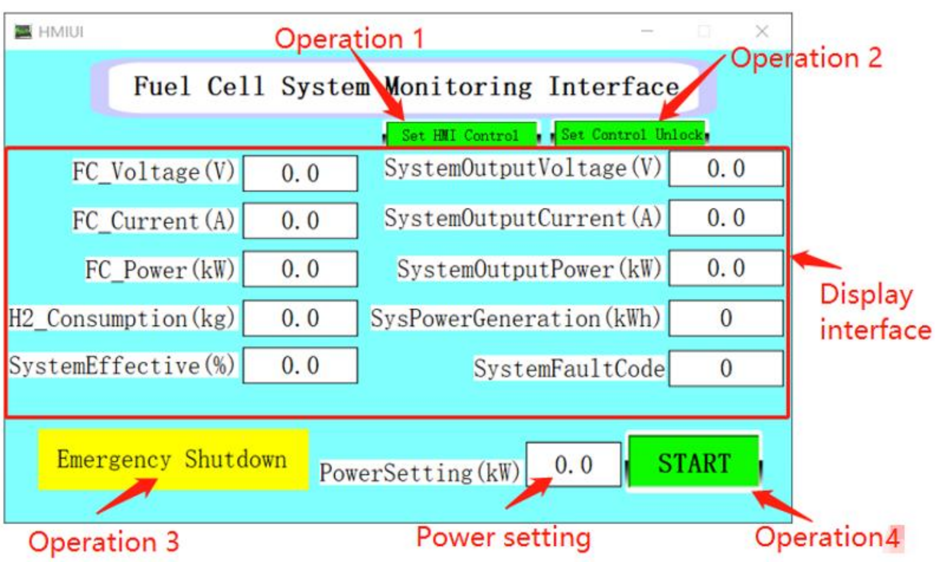


Figure 4-3 Screen control interface

5. Software operation instructions

5.1 Open the Software

Unzip the application package, run Horizon VL series monitor.exe. Note: if the package decompressed to the C drive, please right click the computer mouse to allow Horizon VL series monitor.exe operation in administrator mode. Otherwise, the software can't write to Excel and blf file, thus failed to recording.

5.2 Getting Started

First, make sure the fuel cell system is properly wired. Second, supply the 24V power. Third, click the Run button, as long as the CAN connection indicator shows ONLINE, it means the system communication is run correctly, Forth, wait the system to complete self-check, then it runs into standby status, after that the fuel cell system is ready to operate.

Note: It is necessary to add enough deionized water and expelling all the air in the coolant circuit to start the fuel cell system for the first time.

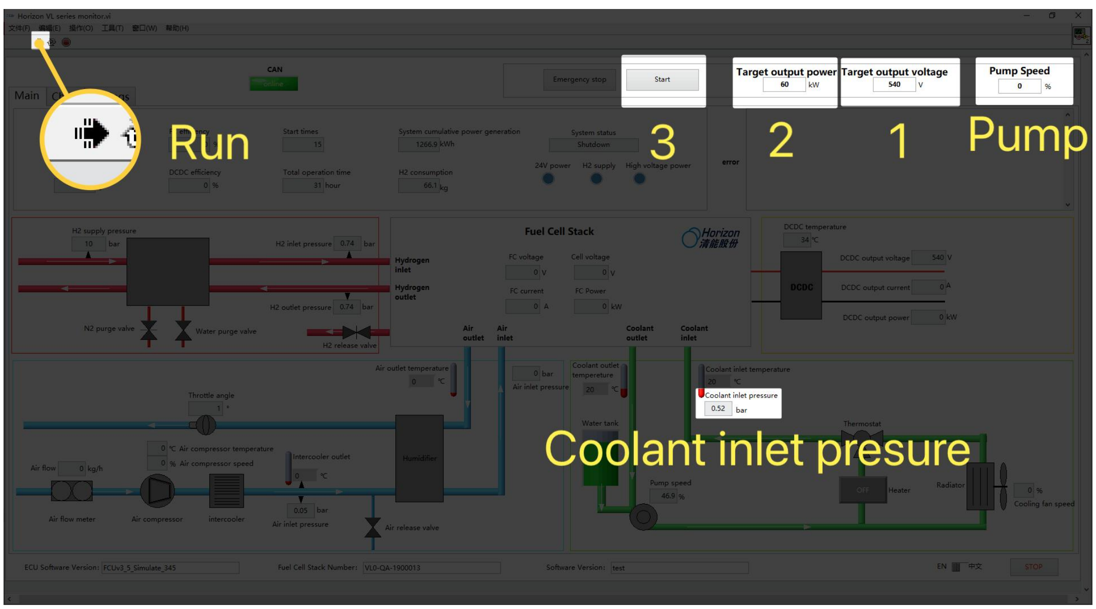


Fig5-1 Software operation interface

Start steps

1) . Set the output voltage which is marked in 1；

2) . Set the target power which is marked in 2；

3) . Click the button which is marked in 3 to start the fuel cell system. If the system need to be stop, please click the button marked in 3 again.

Before run the fuel cell system, the water pump need to be turn on to expelling the air in the coolant line. When the coolant inlet pressure stabilizes between ± 0.01 bar, it can be considered that the air in the coolant circuit has been emptied. The specific steps to set the pump speed and waiting time can refer to the following table. Make sure that the pump speed is 0 before start the Fuel Cell System.

Pump speed	10%	20%	30%	40%	50%	40%	30%	20%	10%	0%	50%
Waiting Time	2min	2min	2min	2min	2min	2min	2min	2min	2min	2min	2min

5.3 Monitoring System Status

5.3.1 Main

On the main page, you can see various real-time observation values from the fuel cell system.

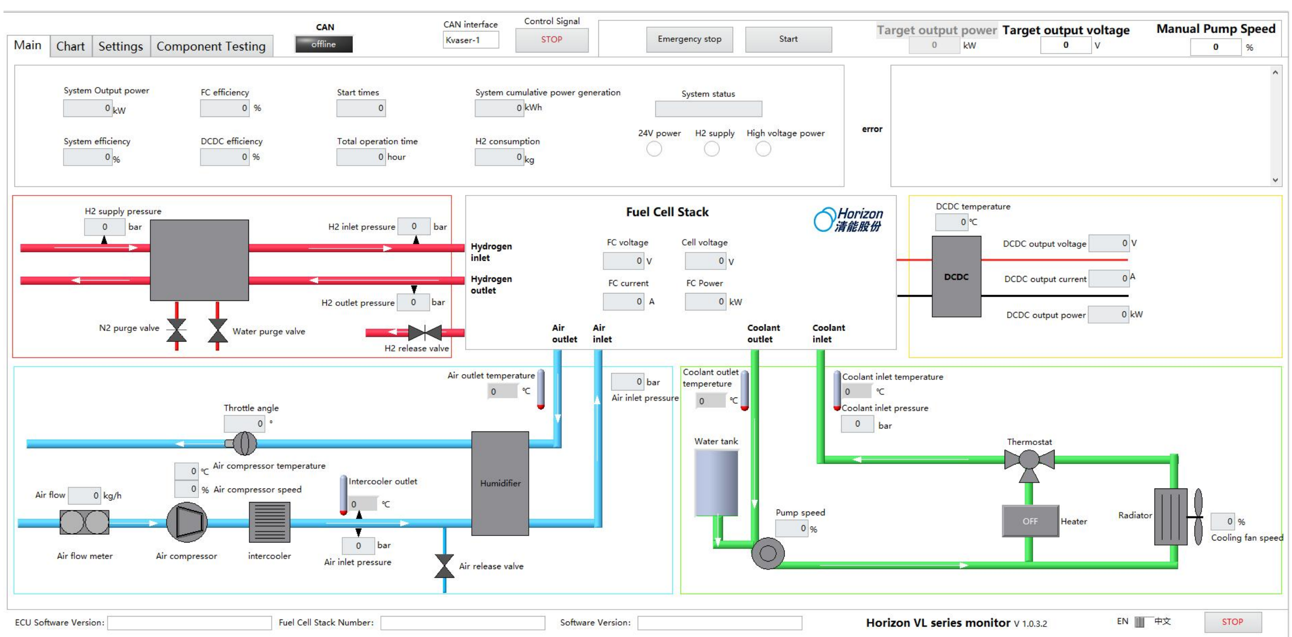


Fig5-2 Main interface

5.3.2 Chart

On the chart page, you can see the Historical data curve of some observed values. Both X axis and Y axis can change the axis range by modifying the numbers on both sides of the axis, Y axis supports mouse operation. When the mouse moves into the corresponding Y-axis range, the Y-axis can be zoomed in and out by the mouse wheel.

4: The option on the left side of the chart can be checked to show/hide the curve.

5: The box on the right is the curve setting option, you can change setting items such as curve color

Fig5-3 Chart interface

5.4 Calibration Parameters

This operation has a high risk and must be carried out under the guidance of Horizon Fuel Cell Technologies.

(I): Click the path selection icon to select the file. The calibration interface will appear when the correct file is selected.

(II): Click to select the parameter you want to modify, The selected row will be highlighted. Click the value again, and the value can be modified when it becomes the input state.

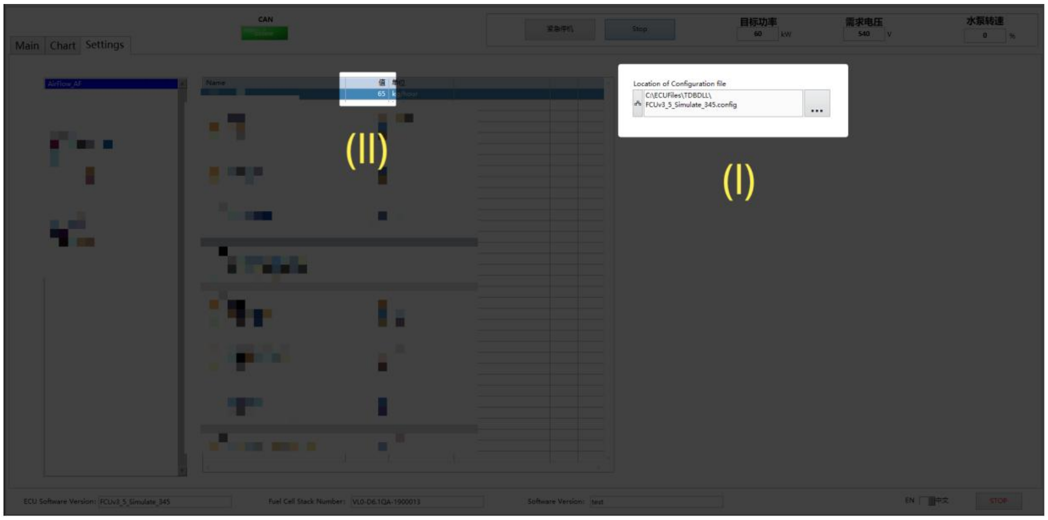


Fig5-4 Calibration parameters interface

5.5 System Shutdown

Click the Stop button and wait for the system to execute the shutdown command. When the system status turn into standby, it means the shutdown command is over.

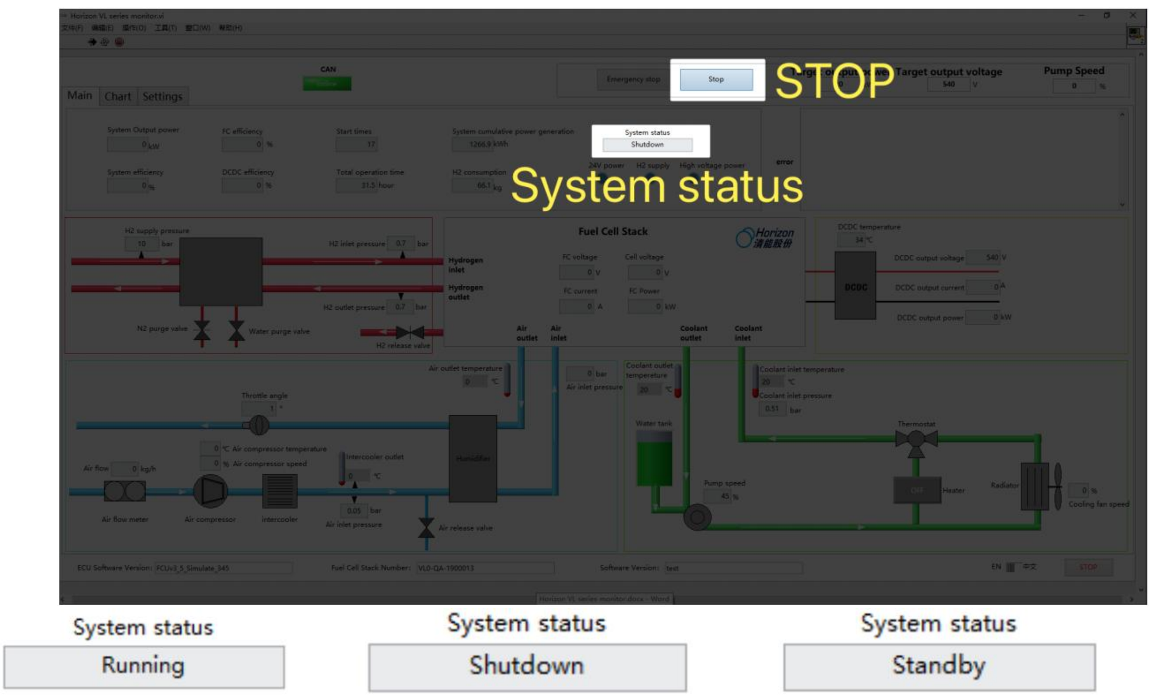


Fig5-5 Shutdown steps

5.6 Firmware Update

When the stack is in self-check, standby and fault state, you can click the update ECU firmare button to update the program. Select the .srz file required by the update program and click start to start the update. After the program is updated, click update ECU firmare again to shrink the window before starting the operation.

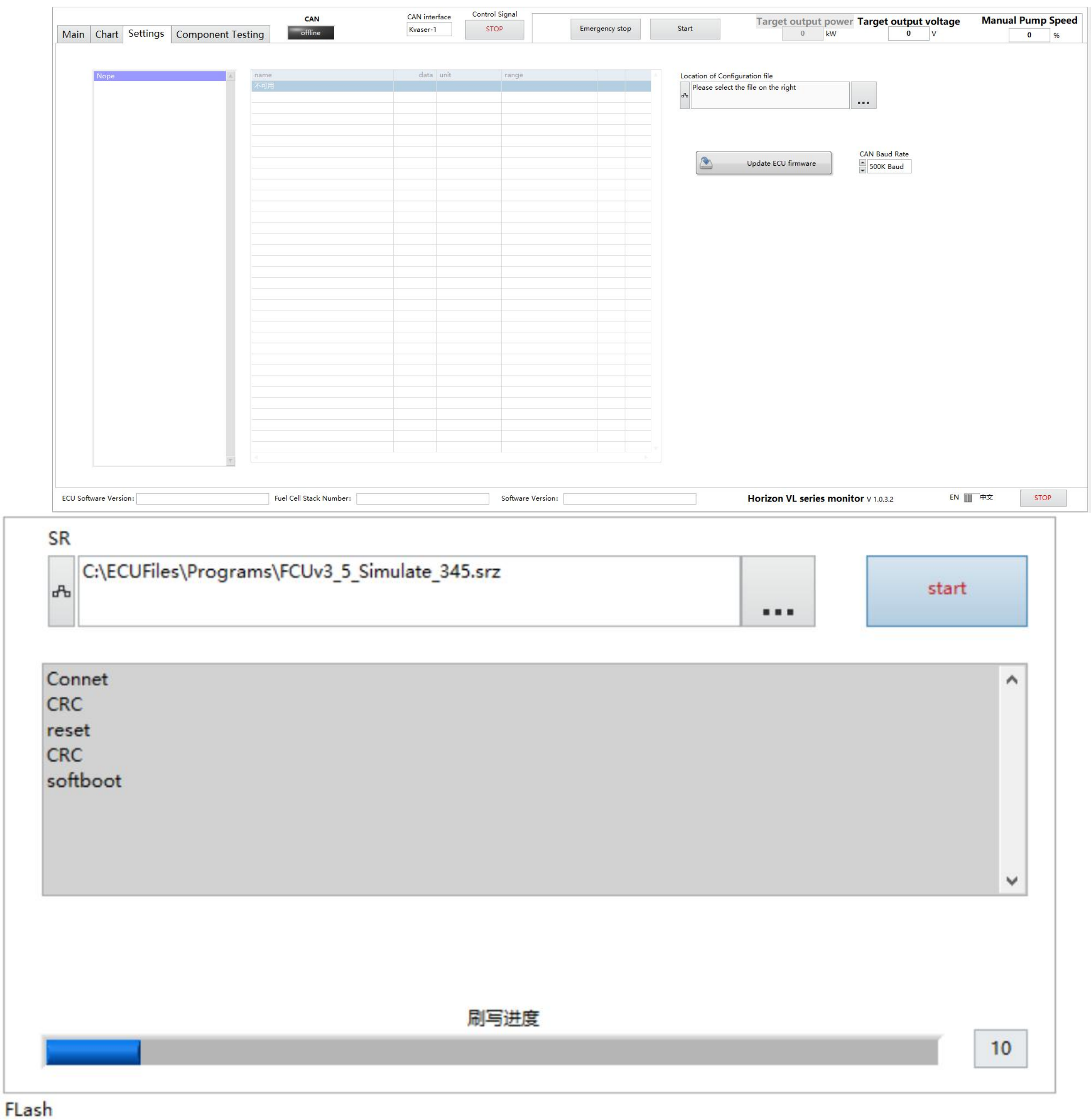


Fig 5-6 Firmware update

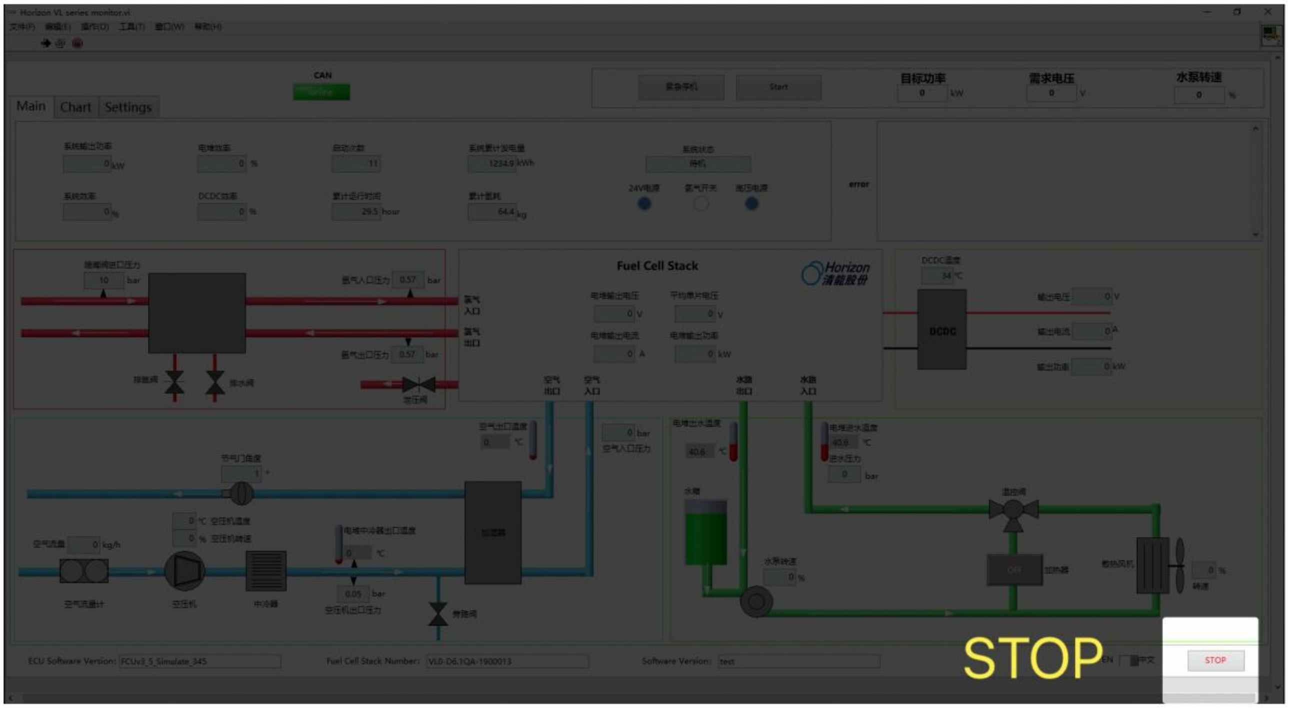
5.7 Open the exhaust valve manually

Before the pure hydrogen test, you need to manually open the exhaust valve, and then open the intake switch to ensure that the exhaust time exceeds 5s, and then close the exhaust valve (at this time the intake switch is normally open), then the system can be operated.

Component Testing is the control interface of the exhaust valve switch.

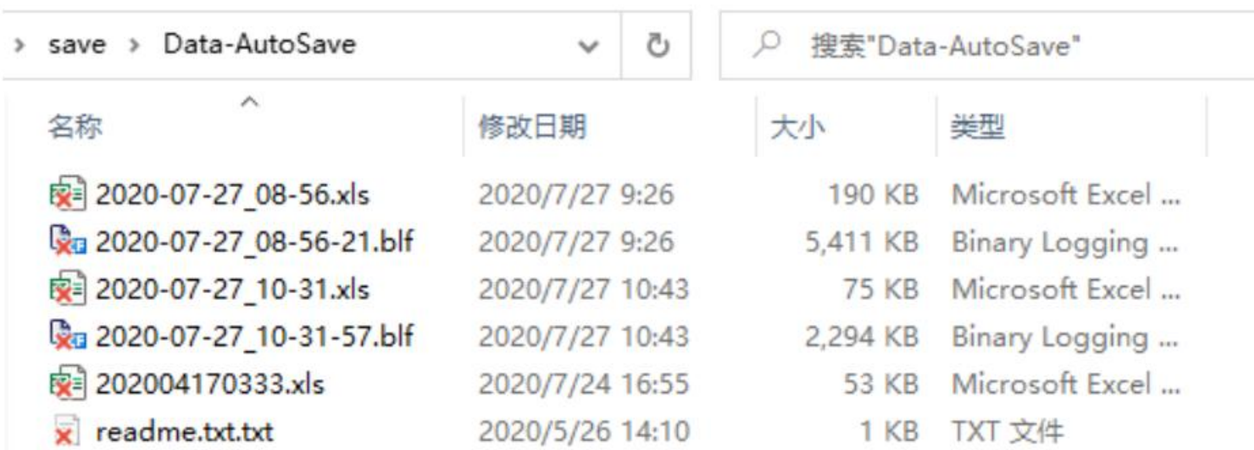
5.8 Stop Horizon VL series monitor

Click the STOP button to stop the Horizon VL series monitor software running.



5.9 Data Record

After the program runs correctly, Labview will automatically save the datas to the folder named Save which belongs to the same foder where the application programmes located.



6. Maintenance and repair

6.1 Regularly Maintenance of Fuel Cell System

The daily maintenance of the fuel cell system is divided into: daily inspection and maintenance, monthly inspection and maintenance and long-term parking inspection and maintenance. The following is a brief description in the form of a table.

Table 6-1： Daily Inspection and Maintenance Record of Fuel Cell System

No.	Maintenance item	Specific operation method	Estimated time	Note
1	After starting, observe whether the parameters are normal	Start the fuel cell system after it is power on, observe the parameters through the display screen as well as visual inspection	5min	If there is a fuel cell system failure, please contact Horizon after-salers

Table 6-2 Weekly Inspection and Maintenance Record of Fuel Cell System

No.	Maintenance item	Specific operation method	Estimated time	Note
1	Check the level of coolant	Visually check tank level	3min	When it is below the MIN line of the minimum scale, timely fill the fuel cell special antifreeze to the level not higher than the MAX line of the maximum scale line
2	System hydrogen leak detection	Power on the fuel cell system to start working for 5 minutes,, and normally shut down the system, and detect the leakage points of each joint through the handheld hydrogen concentration measuring instrument.	5min	If the hydrogen concentration meter shows a hydrogen leak of more than 25ppm, tighten the joint until it shows less than 5ppm. If a single connector is tightened for more than 3 times, replace it with a new one.
3	System clean	Remove foreign objects in and around the fuel cell system with an air gun or	5min	Clean with no foreign matter

		vacuum cleaner (do not use a water gun to clean)		

Table 6-3 Monthly Inspection and Maintenance Record of Fuel Cell System

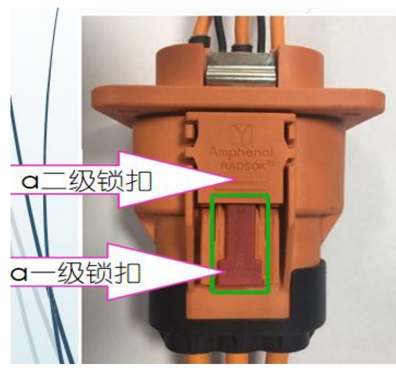
No.	Maintenance item	Specific operation method	Estimated time	Note
1	High and low voltage electrical components	Check whether the high and low voltage plug-in is loose, whether the wiring harness is firmly fixed, and whether there is wear	5min	Each high voltage and low voltage plug-in of the system has a latch. Visually check whether the latch is in place. If the latch is not installed, the plug-in is loose. Example: The plug-in latch is in place 
2	System component fixation inspection	Check components such as water filters, water tanks, air filters, silencers, deionizers, etc. for firmness, and check bolts for looseness	5min	If it is loose, tighten it according to torque requirements. For details, see 5.2.3 Torque requirements.
3	Radiator inspection	Check the radiator surface for foreign objects	5min	If yes, clean it up in time
4	Air inlet, air filter inlet	Check the air inlet inlet, dust cap and air filter inlet for blockage, catkins, etc	10min	If yes, clean it up in time
5	Fixture of system and pipe line	Check whether the bolts are loose or worn, and whether the clamps on the pipeline are loose.	10min	If it is loose, tighten it according to torque requirements. For details, see 5.2.3 Torque requirements.

Table 6-4 Fuel Cell System Long-term Storage (more than 30 days) Maintenance Record Sheet

No.	Maintenance project	Specific operation method	Estimated time	Note
1	Long downtime before storage	Ensure that the fuel cell is normally shut down and purged, and the 24V power main brake is closed. If the planned shutdown time is greater than 90 days, the fuel cell system and the coolant in the pipeline need to be emptied.	10min	(special antifreeze for fuel cell must be used when the lowest ambient temperature is below 5℃)
2	Fuel cell system operates regularly	Open the 24V handle switch, start the fuel cell to work for more than 20 minutes, and then shut down the system normally	30min	The fuel cell starts and stops once a month

6.2 Maintenance of System Components

6.2.1 Maintenance of system components

In order to ensure the safe and stable operation of fuel cell systems, periodic preventive maintenance of the fuel cell system is required to ensure the safe operation of the system. Maintenance tasks are performed according to the maintenance schedule. Record each maintenance task and date. Table 4-5 lists the maintenance requirements.

Table 6-5 Maintenance list

No.	Item	Maintenance category	Maintenance cycle	Remarks
1	Coolant filter	1. Cleaning 2. Exchange	1) 1,000h 2) 10,000h or 1 year	If the coolant needs to be drained, simultaneous cleaning of the coolant filter is recommended
2	Air filter element	1、 Cleaning and de-dust 2、 Change	1) 500h 2) 2,000h	Based on the actual operating environment, the final replacement mileage is subject to actual conditions
3	Deionizer	Change	500h	The replacement of the

				deionizer depends on the alarm threshold of the test insulation value or the requirement of the conductivity value. The final replacement depends on the actual value. It is recommended to replace the deionizer when the conductivity value exceeds 5us/cm.
4	Fuel cell specific coolant	Exchange	6,000h or 1 year	
5	H2 concentration sensor	Calibration	1time/year	
6	Fix point and connector	Check	2,000h	Check all fixed points and connectors of the fuel cell system once every 2,000 hrs to check whether the connections of fixed points and connectors are loose For fixed points and connectors, see Section 6 of 6.2.2.
7	Radiator	Cleaning and dusting	1,000h	
8	Hydrogen leakage detection at each joint of the system hydrogen circuit	Power on the fuel cell system start working for 5 minutes, and normally shut down the system, and detect the leakage points of each joint through the handheld hydrogen concentration measuring instrument.	1,000h	If the hydrogen concentration meter shows a hydrogen leak of more than 25ppm, tighten the joint until it shows less than 5ppm. If a single connector is tightened for more than

				three times, replace it with a new one.
9	Low voltage distribution box fuse	Check	1,000h	Multimeter Check whether the fuse works

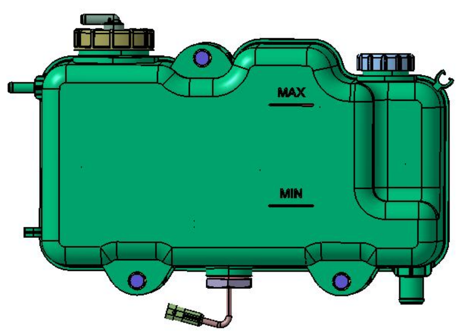
6.2.2 Maintenance operations of system components

1、 Regularly check of coolant is required for fuel cell system

1) If the minimum ambient temperature is below 5 ° C, all coolant needs to be replaced with fuel cell antifreeze. Select a fuel cell antifreeze whose freezing point is lower than the lowest ambient temperature based on the lowest ambient temperature.

2) Fill according to the liquid level every month, and the water level of the water tank should be between the minimum MIN and the maximum MAX water level, as shown in Figure 5.1 below.

Figure 5.1 Filling water tank



2、Radiator maintenance

1）Make sure fuel cell system is power off and is cut off from high and low voltage system

2）Use high-pressure air gun to clean up branches, leaves, and other foreign objects inside the protective net, and use high-pressure air to purge the electronic fan blades and motor grooves to clean up the deposited dust;

3）Use high-pressure water gun (≤5bar) to clean the surface of the radiator, and clean the dust, catkins, leaves and other foreign matters deposited on the fins of the radiator;

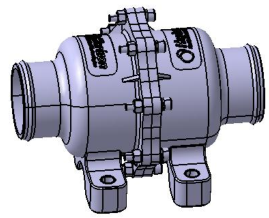
4）Dry radiator fan by using high pressure air.

3、regularly check coolant filter

1）Make sure fuel cell system is power off and is cut off from high and low voltage system;

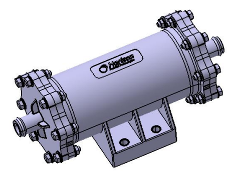
2）drain and recycle coolant, remove coolant filter, using high pressure water to clean filter screen;

3）Re-install coolant filter and refill the coolant to cooling system.



coolant filter

4、Deionizer change procedures



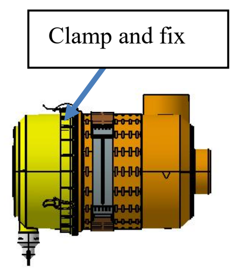
1） Lower the coolant in the system to the level below the deionizer

2） loosen bracket of two ends；

3） replace old deionizer with new one；

4） install brackets of two ends

5、Air filter change procedures:



1）loosen five clamps of air filter ；

2）take out used filter screen and replace with new one ；

3）Combine the shell and fix five clamps.

6、Check fixed points and connector connection

1）Check whether bolts are loose at the mounting point, radiator, air compressor, intercooler humidifier integrated module, water pump, electric reactor, DC, ground points, and bonding points.

2）Check whether the DCL 24V negative terminal grounding point, DCL 24V positive power supply fuse box, high voltage component shell grounding point, heat dissipation fan 24V negative power supply grounding point, fuel point system and grounding point, fixing bolts are loose.

3）The 24V positive fuse of the heat dissipation fan is a power supply plug. Check whether the plug latch is in place.

6.2.3 Torque requirements for standard parts and universal parts

Bolt	Corresponding torque	Clamp	Corresponding torque
M5	5±0.5N.M	Clamp 11-20	3±0.5N.M
M6	10±1.0N.M	Clamp 14-27	3±0.5N.M
M8	24±2.4N.M	American double clamp 17-32	5.4±0.8N.M
M10	45±4.5N.M	German double compensation clamp 25-40	5.4±0.8N.M
M12	75±7.5N.M	German double compensation clamp 30-50	5.4±0.8N.M
		German double compensation clamp 40-60	5.4±0.8N.M
		German double compensation clamp 60-80	5.4±0.8N.M
		American double clamp 22-32	5.4±0.8N.M
		Heavy clamp with pad 30-80	8±0.8N.M

6.3 After-sales

If the problem of maintenance of the fuel cell system cannot be solved, please contact Horizon technical support.

7. Transportation and storage

7.1 System Transportation

- During transportation, the product should not be subjected to severe vibration, impact or placed upside down.

- The transportation temperature should be in the range of -20 ℃ ~ 40 ℃.
- The product should be able to adapt to sea and air transportation conditions.
- When the product is transported by sea or air, it should be sealed and packed with other protective measures to avoid unnecessary damage.

7.2 System Storage

The product is placed in a dry and ventilated environment, and the storage temperature is in the range of 5 ℃ ~ 35 ℃.

Long term storage

- Long-term storage means that the system will not boot for more than 1 month
- The fuel cell system has a long-term storage of its recoverable attenuation, which requires that it be turned on once a month for at least 20 minutes each time.

8. Safety

Fuel cell stacks generate high voltage electricity, and high temperature, high pressure gas and liquid flow when the fuel cell system is running. Please strictly observe all warnings, cautions and safety instructions. Failure to follow these instructions may result in safety accidents such as burns, electric shocks, and electric shocks.

8.1 General Safety

1. The fuel of the fuel cell system is hydrogen and oxygen, so open flames are strictly prohibited.
2. In the non-operating state, there may be residual voltage in the fuel cell stack. Check the voltage before maintenance.
3. When the system is running, please make sure that all interfaces, screens and electrical enclosures are firmly connected.
4. Do not place or use the fuel cell stack in a humid environment.
5. When operating a fuel cell stack or system, remove jewelry, watches, rings, and metal objects to avoid short circuits.

8.2 Safety at High Temperature and High Pressure

1. When operating in an outdoor environment, the temperature of the fuel cell stack can reach 80 ° C and above. Do not touch the stack during the operation of the stack or within a short period of time after the stack comes to a stop.

2. When high-pressure gas is used in fuel cell stacks or auxiliary systems, there may be a risk of shock. Before opening each pipeline and fittings, the entire circuit needs to be depressurized.

3. The fuel cell stack is assembled under high pressure. Do not disassemble the stack at will.

8.3 Safety at High Voltage

1. Before operating the stack, connect the positive and negative voltages of the stack to a suitable load.
2. If the electrical equipment is not completely insulated somewhere, electric leakage of stack may occur. Leakage may occur inside or outside the stack module. Minimize the leakage, ensure that all electrical equipment and wires in the stack module are completely insulated, and ensure that electrical equipment are insulated.
3. Select the high-voltage wiring harness of the stack according to the required voltage, current and insulation temperature. According to the specific application and operating environment of the end customer, it meets the conditions of rated voltage, current load, rated insulation temperature, etc.
4. In the case of insulation failure, never touch conductive parts such as bus or connectors.
5. Ensure that all electrical interfaces and electrical connectors are properly installed and connected. It is not necessary to apply great force when installing electrical interfaces and electrical connectors to avoid damage to the stack.
6. Please avoid the following unsafe situations:

- Incorrect grounding;
- Foreign substances or debris appear between the components of the stack and the hardware, resulting in a reduction in insulation performance;
- Operate electrical wires or electrical equipment with wet hands, or touch wet ground;
- Use worn wires;
- Each electrical interface is incorrectly connected or reconnected multiple times;
- Short circuit occurred;

8.4 Safety of Hydrogen

1. Hydrogen is a colorless, odorless, highly flammable gas.
2. When operating hydrogen, strictly follow the specifications and the recommendations of the gas supplier.
3. Hydrogen is non-toxic, but will consume oxygen in the air and cause hypoxia. No alarm will occur before an accident occurs.

Hydrogen molecules are smaller than any other gas molecule, so hydrogen molecules are difficult to dissolve. Hydrogen can diffuse through a variety of air-tight materials. Fuel pipelines, non-welded connections, non-metallic materials, such as gaskets, O-rings, pipe threads, packaging, etc. may have potential leak points or penetration points. Moreover, because the molecular size of hydrogen is small, it will produce great buoyancy and diffusivity, so the leaked hydrogen will diffuse, and it will soon be diluted in the atmosphere. The hydrogen leak rate of the stack will gradually increase with the increase of the service life of the stack.

The responsibility for detecting and mitigating hydrogen leaks is up to the customer. Hydrogen leaks that originate from the stack, can be quickly detected by a hydrogen detector. It is important to have warning systems in place before the hydrogen / oxygen mixture reaches a flammable concentration.

8.5 Safety of Stack Ablation

When the stack is operating, it may cause internal stack ablation. The following conditions may cause stack ablation:

- When operating the stack, the stack is severely under-hydrogenated (insufficient exhaust, the stack is in a supercooled operating state for a long time);
- Operate the stack beyond its maximum operating temperature.

8.6 Safety of Hypoxia

When the stack is operating, it consumes oxygen. When the stack is poorly ventilated and the floor space is small, special attention needs to be paid to the oxygen concentration to not fall lower than health requirements.

8.7 Warning Sign Description

(1) Cautious of high temperature warning signs:

（2）Cautious of electric shock warning signs:

（3）Prohibition of stepping warning signs

（4）Antifreeze warning sign