T-2.5KW

FUEL CELL UPS SOLUTIONS

Updated Dec 26, 2016

T-2.5KW_UM_V1.5

Disclaimer

This manual incorporates safety guidelines and recommendations. However, it is not intended to cover all situations. It is the responsibility of the customer to meet all local safety requirements and to ensure safety during operation, maintenance and storage of the fuel cell system.

Although all efforts have been made to ensure the accuracy and completeness of the information contained in this document, Horizon reserves the right to change the information at any time and assumes no liability for its accuracy.

Actions that will void the fuel cell system warranty:

- Attempt, under any circumstance, to disassemble or inappropriately tamper with the fuel cell.
- Operate the fuel cell with a controller not designed and built by Horizon for the specific fuel cell.
- Operate the fuel cell with valves and blowers, which are not provided by Horizon for the specified fuel cell and controller.
- Disassemble the fuel cell.
- Disassemble the controller.
- Operating the fuel cell and controller that is not in the setup and/or specified in the user manual provide for the specific product.
- Operate the fuel cell stack without the controller produced by Horizon or with the controller not produced by Horizon.

Do not attempt, under any circumstance, to disassemble or inappropriately tamper with the fuel cell. There will be no repair, replace or refund should disassembly or tampering occur. If you have questions or need help with regards to the fuel cell and its technology please contact:
support@horizonfuelcell.com

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1. Important Safety Information

Please read all instructions carefully prior to product use and keep this manual for future reference.

The safety guidelines included here may not cover every situation. Use common sense.

Although the T-series systems are designed with simple, easy-to-use interfaces, prudent safety measures should be followed.

1.1 General information

For this unit to generate electrical power, a supply of hydrogen fuel is necessary. It is important for any operator to be aware of, understand, and follow all local safety requirements related to the handling of hydrogen and compressed gases. Ensure that your facility conforms to all local regulatory requirements, including building codes and recommendations.

The fuel cell system has built-in safeguards and is designed to shut down automatically if any out of range operating condition occurs. Possible situations include low cell voltage, high current, high temperature, low fuel pressure.

- Do not operate the stack on a grade of more than 45℃.
- Do not connect or disconnect power cables when the fuel cell stack is energised.
- Do not dismantle the system. Contact Horizon if you have any concerns about operation.

1.2 Using Hydrogen

WARNING! FIRE OR EXPLOSION
Keep all sources of ignition away from hydrogen.

This unit uses hydrogen fuel. Hydrogen is a colourless, odourless and flammable substance. It is highly combustible in the presence of oxygen and burns with a colourless flame.

Leaking gas may be hot and pose a burn danger. Stop the flow of gas – if you are not in danger and use water to cool the area. If fire occurs, do not attempt to extinguish flames, allow the fire to burn out.

Prevent overexposure to hydrogen. Hydrogen is non-toxic but can act as a simple asphyxiant by displacing the oxygen in the air. There are no warnings before unconsciousness results. When operating the stack in an enclosure:

- Ensure ventilation slots are clear and unobstructed at all times during operation.
- Operate within the temperatures limits stated in the manual.
- Never operate if an alarm condition exists.

1.3 Handling Compressed Gas Cylinders

WARNING

Do not handle compressed hydrogen gas cylinders without training or experience.

- Use a pressure regulator to control the fuel inlet pressure to the system.
- Do not alter the fitting on a regulator. Ask experienced personnel for help.
- Do not attempt to force gas cylinder threads.
- Never transport a gas cylinder with regulators attached. Ensure cylinder caps are in place. Always use a cylinder cart with a safety strap or chain.
- Secure a high-pressure cylinder to a bench, post, or fixed object to avoid accidental contact.
- Avoid unnecessary contact with On/Off valves. They can easily move to “On” by accident.

1.4 Hydrogen Leakage

Hydrogen is colourless, odourless and tasteless. Hydrogen is non-toxic but can act as a simple asphyxiant by displacing the oxygen in the air. There are no warning symptoms before unconsciousness results.

WARNING

Inhaling hydrogen can lead to unconsciousness and asphyxiation. Hydrogen molecules are smaller than any other gas, making hydrogen more difficult to contain. It can diffuse through many materials considered airtight. Fuel lines, non-welded connections, and non-metal seals such as gaskets, O-rings, pipe thread compounds and packings present potential leakage or permeation sites. Furthermore, hydrogen’s small molecule size results in high buoyancy and diffusivity, so leaked hydrogen will rise and become diluted quickly.

Constant exposure to hydrogen causes hydrogen embrittlement in many materials. The mechanisms that cause hydrogen embrittlement effects are not well defined. Factors known to influence the rate and severity of hydrogen embrittlement include hydrogen concentration, hydrogen pressure, temperature, hydrogen purity, type of impurity, stress level, stress rate, metal composition, metal tensile strength, grain size, microstructure and heat treatment history. Moisture content in the hydrogen gas may lead to metal embrittlement through the acceleration of the formation of fatigue cracks. Hydrogen embrittlement can lead to leakage or catastrophic failures in metal and non-metallic components.

As a preventative measure, the stack must be operated in a well-ventilated area in order to inhibit potential hydrogen accumulation.

WARNING

Always operate the stack in a well-ventilated area and ensure that ventilation slots are unobstructed.

1.5 Flammability and volatility

Hydrogen is flammable over concentrations of 4 – 75% by volume in air, and is explosive over concentrations of 15 – 59%. As a result, even small leaks of hydrogen have the potential to burn or explode. Leaked hydrogen can concentrate in an enclosed environment, thereby increasing the risk of combustion and explosion.

Hydrogen flames are pale blue and are almost invisible in daylight due to the absence of soot. Due to its high buoyancy and diffusivity, burning hydrogen rises unlike gasoline, which spreads laterally.

A flammable or explosive hydrogen mixture is easily ignited by a spark or even a hot surface. The autoignition temperature of hydrogen is 500 °C (932 °F). The energy of a hydrogen gas explosion is 2.4 times that of gasoline or methane for an equal volume. Hydrogen gas explosions are therefore more destructive and carry further.

WARNING
A mixture of hydrogen and air is potentially flammable and explosive and can be ignited by a spark or a hot surface.
As in the presence of any fuel, all sources of ignition, including smoking, are not permitted in the vicinity of the stack.

WARNING
Keep all sources of ignition away. Smoking is not permitted in the vicinity of the stack.

1.6 Oxygen Depletion

Oxygen is a colourless, odourless, non-toxic and tasteless gas. Oxygen is essential for life in appropriate concentrations.

Ambient air contains up to 21% oxygen. Oxygen levels below 19.5% are biologically inactive and may act as simple asphyxiants. Effects of oxygen deficiency may include: rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgement, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death. At concentrations below 12%, immediate unconsciousness may occur with no prior warning symptoms.

WARNING
Lack of oxygen can lead to unconsciousness and asphyxiation.
As a preventative measure, the stack must be operated in a well-ventilated area in order to compensate for the oxygen used within the fuel cells.

WARNING
Always operate the stack in a well-ventilated area.

1.7 Electrical Safety

WARNING
Avoid contact with an exposed fuel cell stack. Electrical shock can cause personal injury or death.

• Do not touch fuel cell plates or any electrical components at any time. A running fuel cell stack is a potential electrical hazard that can cause burns or electrical shock.
• Do not wear metallic jewelry rings, bracelets, watchbands, or necklaces – when you are close to an exposed fuel cell stack.
• Minimise static discharge. If possible, ground all equipment.
• Minimise conductivity. Avoid contact with surfaces that are in contact with water or gases. Do not operate or store in wet or damp conditions.
• Never use damaged extension cords.

WARNING
Do not touch fuel cells, cell voltage monitoring equipment or electrical components. Electronic components can also be damaged as the result of static discharge. To minimise this, ground all equipment in contact with the stack. Never use damaged extension cords. Minimise conductivity by avoiding surfaces in contact with water; hands and clothes must be dry. Do not operate or store the stack in wet or damp conditions.

WARNING
Minimise static discharge. Ground all equipment. Residual reactants within the stack can develop a charge in a matter of minutes when turned off. A reading of zero volts across the entire stack does not guarantee that all fuel cells are uncharged.

WARNING
Always assume that the fuel cell stack is charged. Jewelry (such as rings, necklaces, bracelets and watches) may concentrate an electric current when it comes into contact with charged components, or when a shock passes through the human body. Accordingly, no jewelry should be worn near the stack.

WARNING
Do not wear jewelry near the stack.
No pungent odor, paint and perfume are allowed around stack.

1.8 High Temperature

The fuel cell stack is designed to operate at normal temperature. Operating the system when the environment temperature is above 45ºC may cause the performance drop.

WARNING
Avoid contact with the fuel cell stack or components that convey process or cooling air.

1.9 Terminology

PEM fuel cell:
A PEM (Proton Exchange Membrane) fuel cell is a device that converts hydrogen and oxygen into water and electricity.

Reactants:
Reactant is a material used to start a chemical reaction. In the fuel cell the reactants are air and hydrogen by which the electricity will be generated.

Humidification:
Humidity, the fuel cells need for running.

Blower:
Supply air to the fuel cells and meanwhile decrease the temperature in the stack.

Mass flow per minute:
The total amount of the hydrogen flow through the fuel cell every minute, which the hydrogen supply can be calculated.

HFCT:
Horizon Fuel Cell Technologies

2. Introduction

Thank you for choosing Horizon's T-2.5KW system as your power generating solution. Based on Horizon's expertise in modular, redundant fuel cell systems, the T-2.5KW system is the next step in simplicity, scalability, modularity and reliability, providing clean, quiet, and reliable power for backup power applications.

2.1 About This Manual

This manual is intended to provide customers with all the information needed to select, install, operate, maintain, and troubleshoot the T-2.5KW system.

2.2 PEM Technology

While there are a number of fuel cell technologies available, the most common and practical technology for standby power is the proton exchange membrane, or PEM, fuel cell.

The only inputs to the fuel cell are industrial Grade 3.5 hydrogen (99.995% H2 concentration) and oxygen (air), with the only byproducts being pure water/vapor and heat. As a result, fuel cells are considered a green technology, making them an attractive solution for installations with emissions restrictions.

One of the other attributes of a fuel cell that makes it attractive for deployment in many applications is that a fuel cell produces DC power. This makes a fuel cell akin to a standby rectifier source, as the power provided from the fuel cell can be directly connected to the site's DC power bus. In an outage situation, the fuel cell turns on automatically, providing DC power, which was formerly provided by the rectifiers. DC output also makes the fuel cell ideally suited for hybrid applications with solar (photovoltaic), wind and battery systems.

The fuel cell is akin to a generator, in that the fuel cell is sized for the power requirement, and can run indefinitely provided it has a source of fuel. This means fuel cells, when coupled with an appropriately sized fuel storage solution, can function effectively for long reserve times as a standby power source in customer applications.

The T-series system is designed to be a backup power solution for DC power applications within the transportation, security, wire line and wireless telecommunications, utility, and government sectors.

The T-series system is intended to augment traditional DC power systems. A simplified DC connection diagram is shown in Figure 2-1.

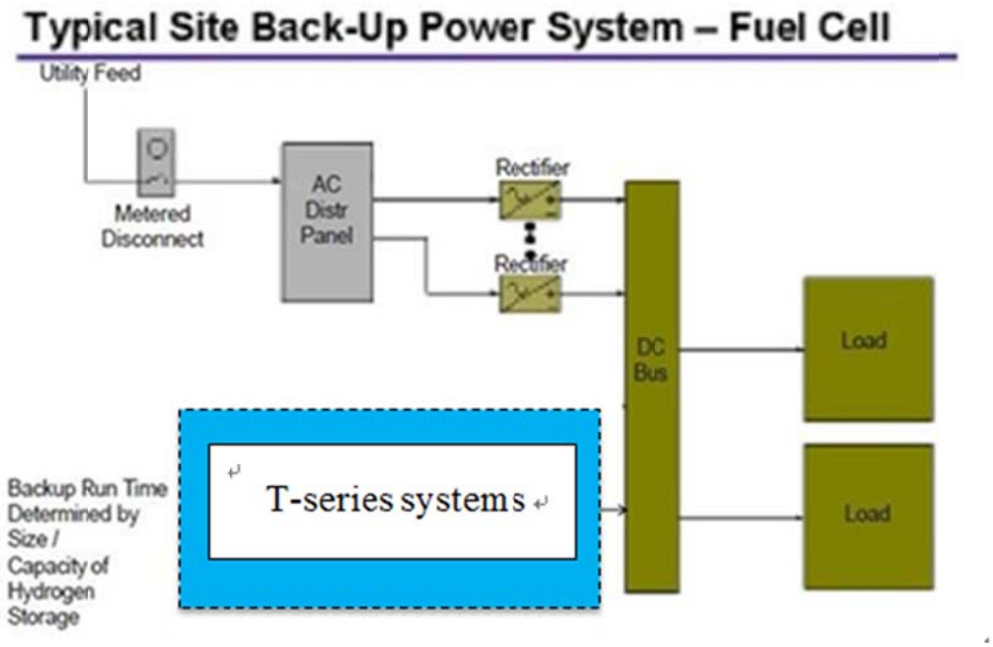


Figure 2-1. T-series backup power system

2.3 The Horizon Solution

Horizon's T-series system provides a single, fully integrated system that fits within a standard equipment rack. The chassis includes a reformer system, a fuel cell module, an integrated control and power electronics for a complete system in a single chassis.

The T-series system will provide a complete generator unit capable of providing up to 1,000W of DC power from a T-1KW system or 2,500W of DC power from a T-2.5KW system or 3,000W of DC power from a T-3KW system or 5,000W of DC power from two T-2.5KW systems.

T-series systems are air-cooled, eliminating the need for liquid pumps and heat exchangers. The system is self-hydrating, eliminating the need for a separate source of water. These features, along with the fuel cell's integrated self-exercise functionality, significantly reduce maintenance.

3. The T-2.5KW System

This section describes the operating principles of the T-2.5KW system. The T-2.5KW system functions as a fueled DC power source. The unit can be started and stopped manually or automatically. Because its electrical output is DC, the T-2.5KW system can be installed directly in parallel with other DC equipment. The rated output voltage is 48V.

For proper operation, the T-2.5KW requires airflow. A source of clean air must be supplied. The exhaust air is humid, which may condense on cooler surfaces, and may contain trace hydrogen, and therefore should be vented outdoors. There is a small periodic fuel purge (or “bleed”) that must also be vented outdoors. A minimum installation for basic operation requires the T-2.5KW to have all air exhausts and fuel inlet and outlet exhaust connections plumbed, and that the unit be connected to a DC bus at the appropriate voltage, with an appropriate load. A complete installation will include protection from weather and temperature. All Horizon outdoor enclosures provide proper protection from weather and temperature.

3.1 T-2.5KW Models

- The introduction of the front panel of T-2.5KW system, please see figure3-1.

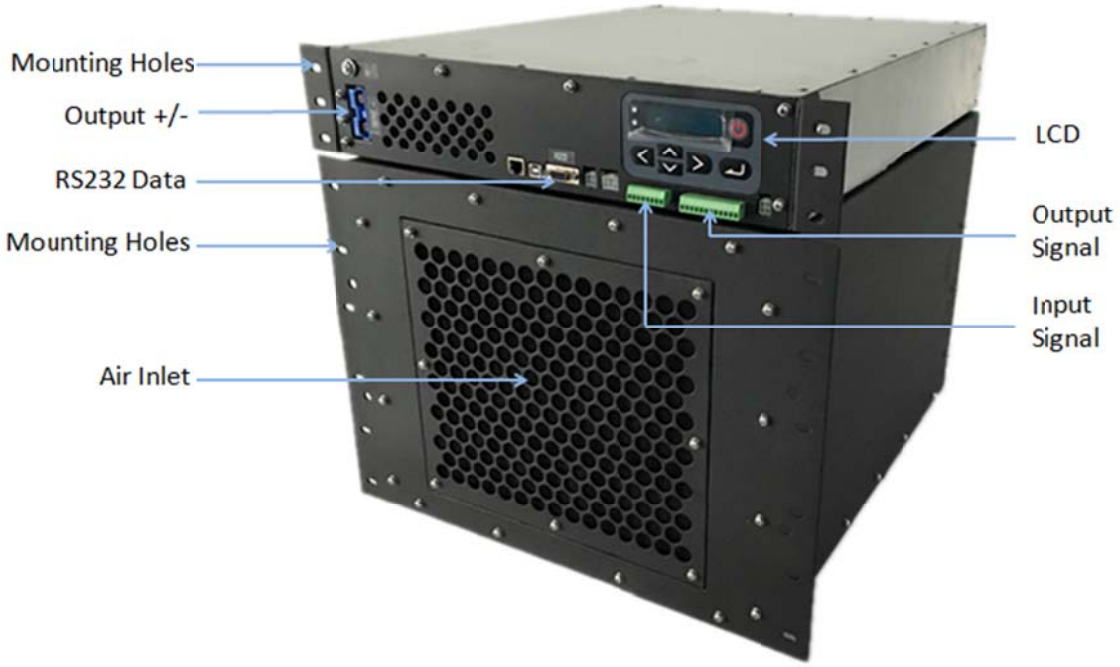


Figure 3-1. The front panel introduction of T-2.5KW

- The introduction of the rear panel of T-2.5KW system, please see figure3-2.

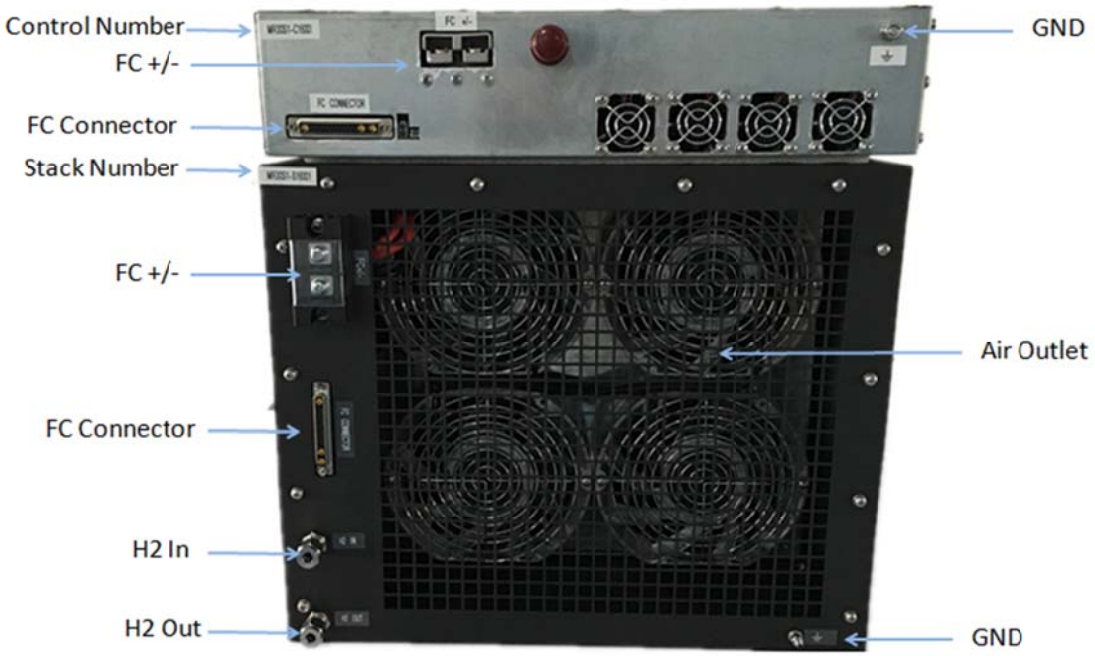


Figure 3-2. The rear panel introduction of T-2.5KW

Table 3-1 shows the specification of T-2.5KW system. For detailed specifications, please see Appendix A.

Table 3-1 ECOBOX-MR Specifications

Model	Rated Power	Output Voltage	Detail Information
T-2.5KW	2500W	48V	Appendix A

In a chassis-only configuration, the T-2.5KW system is rated for indoor installation only. And for outdoor installation, the T-2.5KW system may be mounted in a 19" or 23" 2-post rack or 4-post rack.

Both indoor application and outdoor application, T-2.5KW system will always be required away from flammable and explosive goods and places (such as the gas station), and the sewer drainage outlet, and chemical plants which will produce harmful gases, etc.

3.2 Chassis Features

WARNING

To avoid property damage, personal injury or loss of life, DO NOT attempt to operate this unit until all directions have been read and understood.

3.2.1 LCD Display

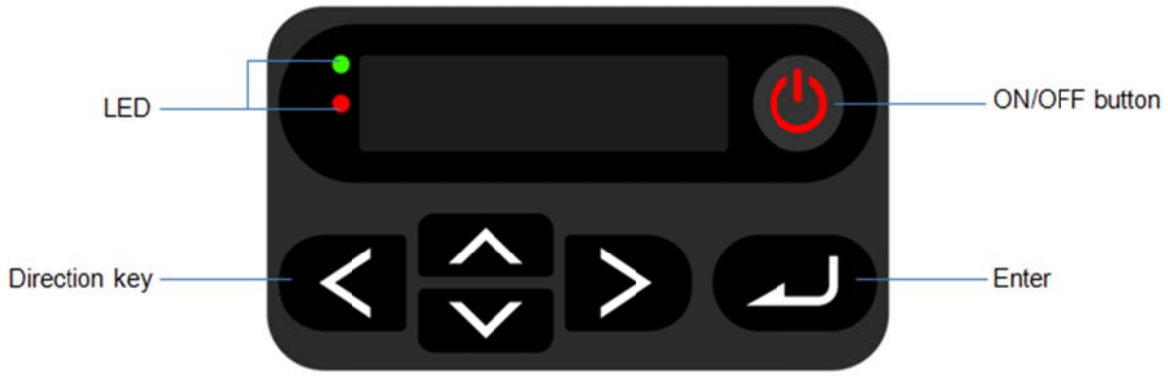


Figure 3-3. The LCD Display

3.2.1.1 Switch and Buttons

- Press the ON/OFF switch for 1 Sec to power on the system.
- Press the ON/OFF switch for 1 Sec to turn off the system.
- The direction key and enter can be used to set the output voltage and system mode.
- The up and down key can be used to check the information one by one during the normal operation.

- System will shut down or enter into error mode when error happens.

1) Recoverable: press ENTER button for 3 seconds to restart the system.(Refer to Table 3-2)

Table 3-2 Recoverable error

No.	Display	Description	Analysis
1		Hydrogen pressure too low, less than 0.3Bar	1. Hydrogen supply pressure low. 2. Leakage occurred on hydrogen supply channel.
2		Stack voltage too low, less than 31V	1. Hydrogen supply is not enough. 2. Stack was stored for a long time, need more exercising.
3		External battery voltage too low, less than 43V	1. External battery broken.
4		Output voltage too high, more than 59V	1. Load changed suddenly.

2) Unrecoverable: the LCD will keep showing the error information for 3 minutes. During 3 minutes, you can press ON/OFF switch for 1 Sec to turn off the system. Or it will turn off automatically after 3 minutes.

Table 3-3 Unrecoverable error

No.	Display	Description	Analysis
1		Hydrogen concentration too high, more than 1%.	1. Leakage occurred on hydrogen supply channel.
2		Stack current too high, more than 100A	1. Controller broken.
3		Stack temperature over 70C. Alarm and turn off the load for 15 seconds when occurs; shutdown, when the fourth time occurs within 5 minutes.	1. FC+/- connector short circuit. 2. Stack fans stop working. 3. Stack temperature sensor broken.
4		Output short circuit, when the battery voltage less than 25V	1. Output+/- connector short circuit.
5		Set voltage fail	1. For voltage precision protection. Regards to the fuel cell technology contact: support@horizonfuelcell.com

6		Set current fail	1. For current precision protection. Regards to the fuel cell technology contact: support@horizonfuelcell.com
7		EEPROM memory fail	1. For system protection. Regards to the fuel cell technology contact: support@horizonfuelcell.com

3.2.1.2 LED Indicators

Green:

- Lighting during the normal operation.
- Flashing during the starting procedure.
- Flashing during the standby mode.

Red:

- Lighting when the error happens.
- Lighting when the alarm happens.

3.2.2 LCD display information

- System operation status display
- System error display
- Stack and battery parameter display

3.2.2.1 Set Output Voltage

Press the ON/OFF switch to start the system, then the LCD display shows the system starting information. Press ENTER within 5 seconds to enter the system output voltage setting process. If there has no action in 5 seconds, the system will use the value which is set last time. The detail system output voltage setting process please find in figure 3-5.

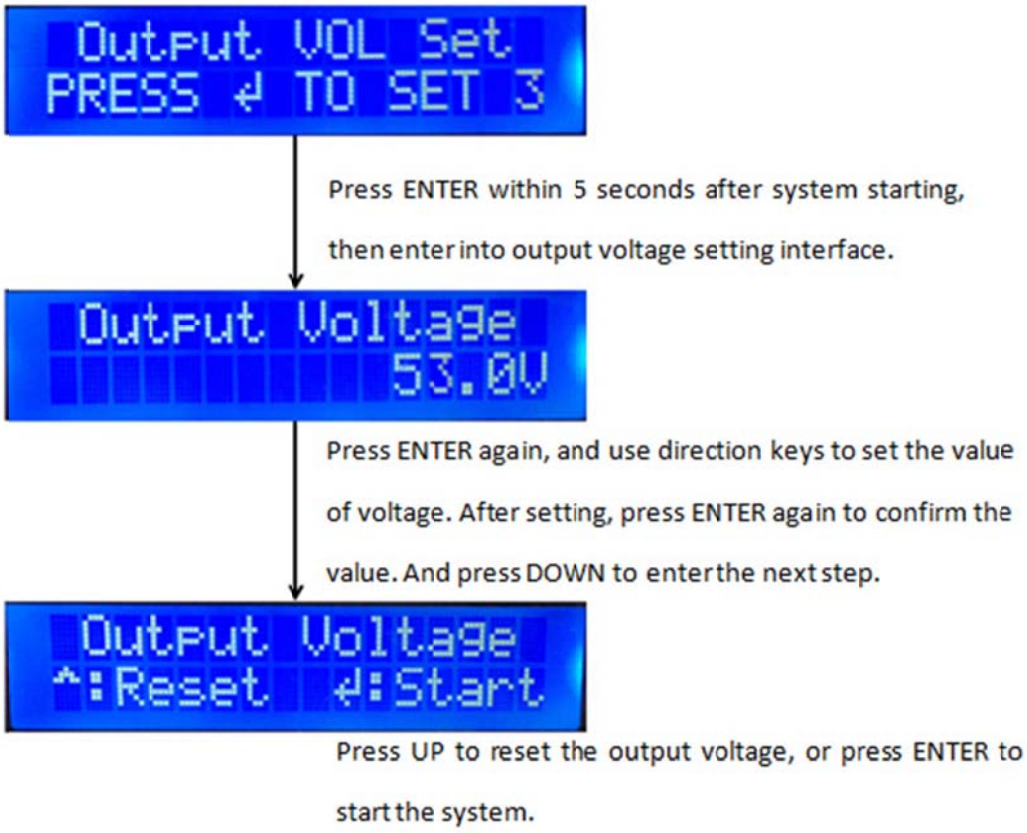


Figure 3-4. System Output Voltage Setting Process

3.2.2.2 Set System Mode and Condition

After starting, customer can set the system mode during operation. T-2.5KW system has three modes, which is Primary Mode, Manual Mode and Low Volt Mode. Use direction keys to choose the system mode setting interface. And press ENTER to enter into the system mode setting process. Then use the direction keys and ENTER button to choose and set the mode. The detail system mode setting process please find in figure 3-6.

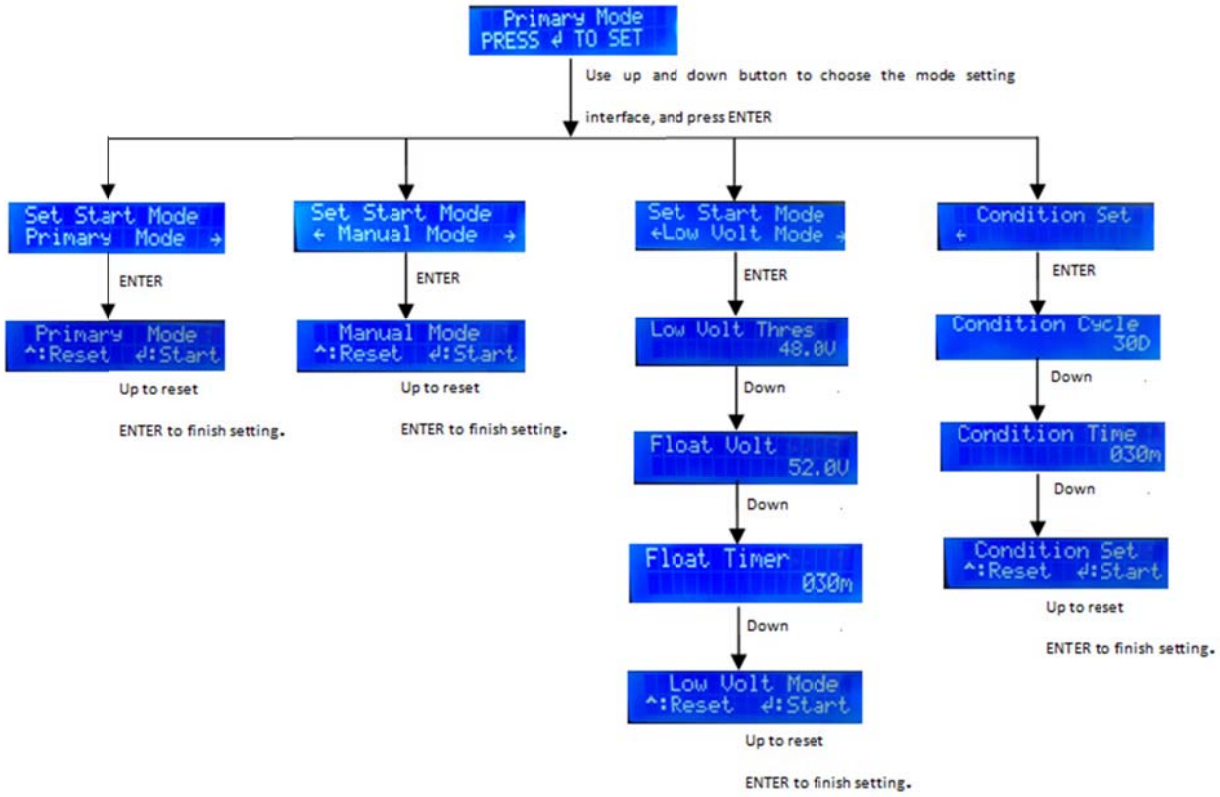


Figure 3-5. System Mode Setting Process

- System mode setting

There have three modes which are Primary Mode, Manual Mode and Low Volt Mode. The customers can press left or right key to choose the system mode.

When setting the values in “Low Volt Thres”, “Float Volt” and “Float Timer”, press Enter to let the cursor appear, and then use direction keys to choose and change the value.

1) Primary Mode

When the system starts in Primary mode, once the system has achieved the Grid Power signal, the unit will return to Standby. And without the Grid Power signal, the system will start to normal operation.

2) Manual Mode

When the system starts in manual mode, the system will never return to Standby. The front panel ON/OFF switch allows the user to manually turn the system on to generate power. And the only method to stop the unit is by pressing the switch again.

When choose Primary Mode or Manual Mode, press enter to the next interface, then press enter again to start the system or press up key to reset the system mode.

3) Low Volt Mode

When the system starts in low volt mode, the unit will attempt to achieve an output voltage which is the value set in the Float Volt field. Once the system has achieved and held float voltage for a period of time (set in the Float Timer field), the unit will return to Standby. This mode functions as a battery charge mode, charging up an external battery to the float voltage, and then returning to Standby. When the batteries discharge to the low voltage threshold, the system will start again. This charge/discharge method is useful for very small loads, where the battery is properly sized to support the small load, and is recharged by the fuel cell. The fuel cell system will operate "thermostatically", turning on at the low voltage threshold, and turning off after holding the output at the float volt setting until the float timer expires. When primary power is restored to the site and the bus voltage is held at or above the float volt setting until the float timer expires, the unit will return to Standby and remain there, provided the bus voltage remains above the low volt threshold.

Low volt mode is a useful option for off-grid hybrid systems that are relatively low power. The fuel cell is used to charge the batteries, and the batteries then carry the load for extended periods. The total system solution is most efficient for small loads that are <5% of the fuel cell capacity, with an appropriately sized battery.

When started in low volt mode, the fuel cell will deliver power until the output bus voltage reaches the user-set float voltage (whether because the unit has sufficient power to support the load and charge the batteries, or because the external power was restored). Once the float voltage is achieved, a user-adjustable float timer will start. When the float timer expires, the unit will stop delivering power and return to Standby.

Low Volt Threshold in the user interface is used to set the voltage at which the system begins to operate when either Low Volt Mode is enabled. This voltage must be at least 0.5V below the value set in Float Volt.
The low volt threshold range is from 43.2V to 53V (factory default is 48V).

Float Volt in the user interface is used to set the voltage at which the system returns to Standby.
And the range of float volt is from 50V to 57.6V (factory default is 52V).

Float Timer in the User Interface is used to set the timer that determines the end of the float mode. Float timer can be set from 5 to 120 minutes in 5 minute increments (factory default is 30 minutes).

- Condition setting

Fuel cell need regular operation to keep membrane hydrated to maintain the performance. If the backup power system is not frequently used, it will be needed to operate the stack for about 30 minutes a month.

During the normal standby mode, the system will start to operate, when standby time reaches the value which is set as “Condition Cycle”. And system will back to standby, until the operating time reaches the value which is set as “Condition Time”.
The range of condition cycle is from 14 days to 60 days (factory default is 30 days).
The range of condition time is from 30 minutes to 120 minutes (factory default is 30 minutes).

3.2.2.3 Recover time setting

For protection, when the hydrogen pressure becomes lower than 0.3Bar, the system will stop output and wait for few minutes. After few minutes, the system will output again if the pressure is higher than 0.3Bar. The waiting time is allowed to be changed according to user requirement.
The factory default is 5 minutes.

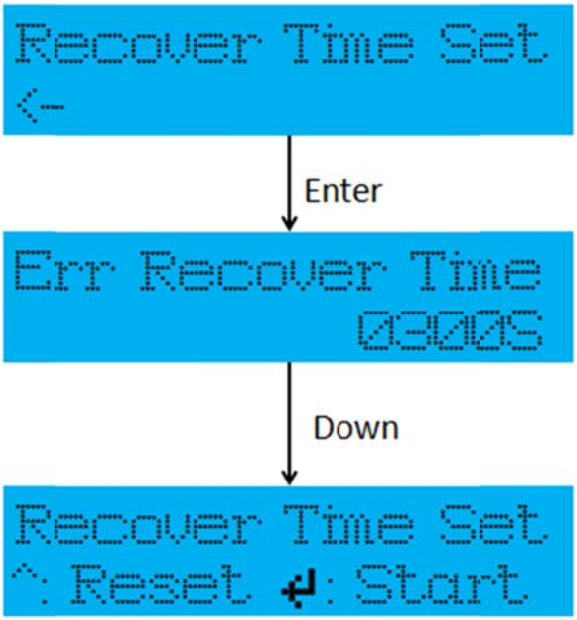
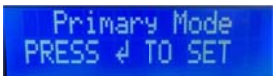


Figure 3-6. Recover Time Setting Process

3.2.2.4 Operation Information

Table 3-4 Operation information

System phase	Display	Note	Solutions
Startup		System starting process Spend 40 seconds	
		Startup ok, system going to normal operation	
Normal operation		Operation System operation time	
		System mode setting interface, press ENTER when you want to change the system mode.	
		System output voltage System output current	
		System output power Ambient temperature	
		Fuel cell voltage Fuel cell current	
		Fuel cell temperature Battery voltage	
		H2 concentration Fuel cell fans speed	
		The last alarm information The last error information	The detail description please find in Appendix B
Standby phase		System standby System operation time	
Shut down phase		Start to shutdown procedure	
Alarm interface	 	To display cabinet door opened/closed alarm message. It will not shut down the system	if you have questions or need help with regards to the fuel cell and its technology contact: support@horizonfuelcell.com

	ALARM! ALARM! GRID POWER ON ALARM! ALARM! GRID POWER OFF	To display GRID Power ON/OFF alarm message. It will not shut down the system	if you have questions or need help with regards to the fuel cell and its technology contact: support@horizonfuelcell.com

3.2.3 Air flow

The T-2.5KW system filtered air inlet is on the front panel of the chassis. The unit's air exhaust is on the rear panel of the chassis.

3.2.3.1 Cleaning or Replacing the Air Filter

WARNING

Do not use any cleaners on the air filter as these may leave a residue that could interfere with the proper operation of the fuel cell cartridges.

The filter of controller will not be suggested to change.

When installed without the outdoor cabinet, once a year or every 400 hours of operation (whichever comes first), the air filter should be checked periodically and cleaned or replaced as necessary. In the T-2.5KW system, the filter is located on the front of the unit (see Figure 3-7).

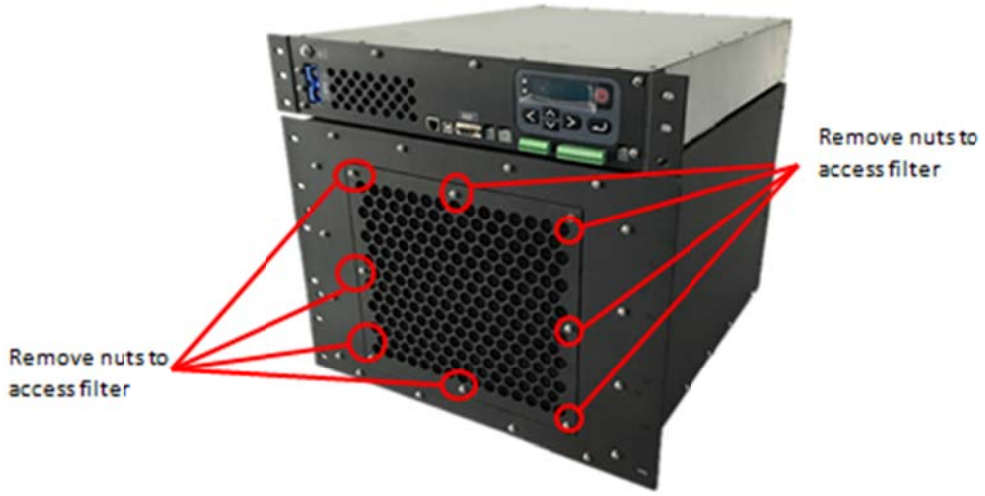


Figure 3-7. Filters in rack-mount installations.

When installed in the outdoor cabinet, which has a filter on the door, the filter of the system will not be suggested to change until as necessary.

To replace the filter, a sparse filter will be suggested to minimize pressure loss in the incoming air stream. And the thickness should not more than 5mm.

The suggested size of filter of the fuel cell stack module will be 278" * 308" * 3".

3.2.3.2 Ventilation System

The ventilation system should be inspected annually and maintained free of obstruction for proper venting.

An indoor rack installation should include room ventilation with sufficient filtered make-up air to provide adequate airflow to the unit. And the air exhaust area should be always keeping fluent.

Either in an indoor rack installation, or a closed cabinet (indoor or outdoor), the air exhaust must be ducted outside to prevent the accumulation of humid air, which can condense on cooler surfaces.

3.2.4 FC+/-

The positive and negative outputs are provided on the back panel connector. The T-2.5KW stack is connected to the T-2.5KW controller at the fence type connector on the rear panel.

WARNING

- DC terminals should always be considered electrified when connected to a DC bus.
- Observe proper polarity when connecting the power leads.

3.2.5 Output+/-

The ECOBOX-MR system is connected to the user's DC power bus at the fence type connector on the rear panel.

For safety, Horizon suggests to connect a circuit breaker which current is 60A, between the system output connector and the load.

WARNING

- DC terminals should always be considered electrified when connected to a DC bus.
- Observe proper polarity when connecting the power leads.

3.2.6 FC Connector

Connect the T-2.5KW stack with the T-2.5KW controller to achieve the control of fuel cell stack operation.

3.2.7 RS 232

RS232 Database output port

- First, we need to connect these ports and do the setup.
- Connect the Uart1 port on the hardware to the relevant PC serial ports. Use the RS232 data line to connect the Uart1 with the RS232 connector on the controller rear panel. After confirming connection, open HyperTerminal software, you can see the interface as shown in Figure 3-7. Fill in the connection name, and then press OK.

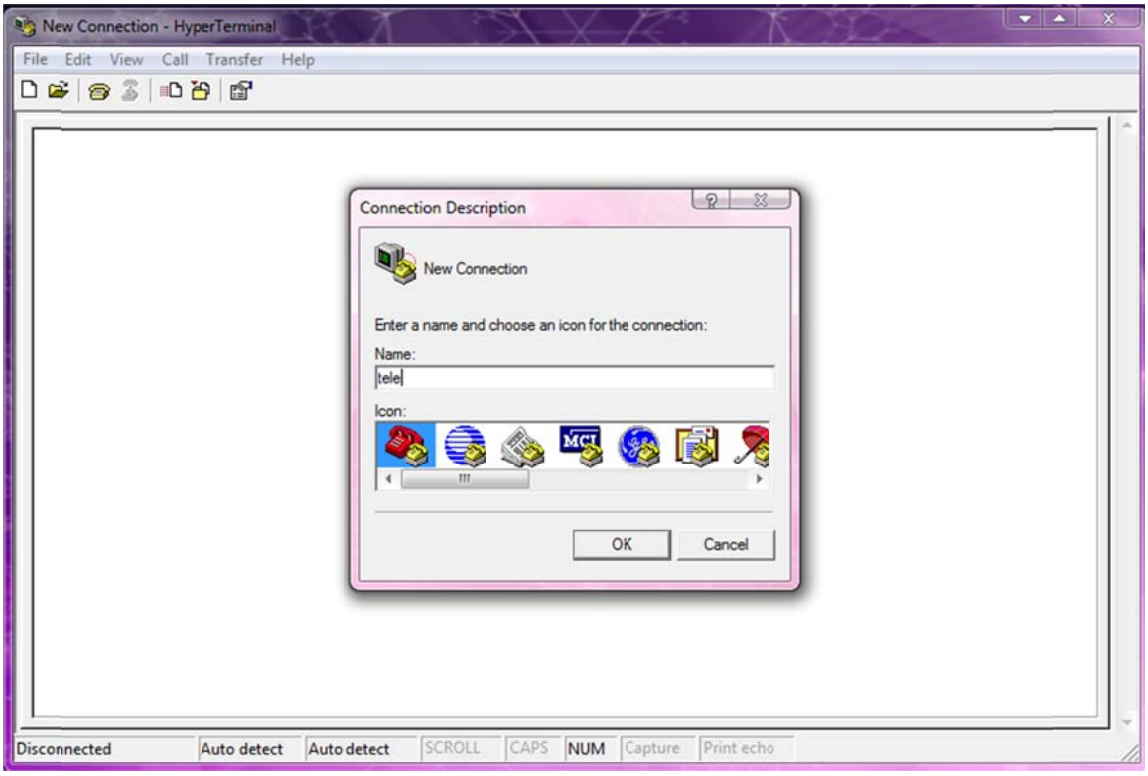


Figure 3-8, Hyper Terminal Interface

- Select COM port when connect them. In some PCs, there might be 2 ports. Such as COM1, COM2… Please make sure the port connecting to the platform is selected and press OK. Displayed as Figure3-8.

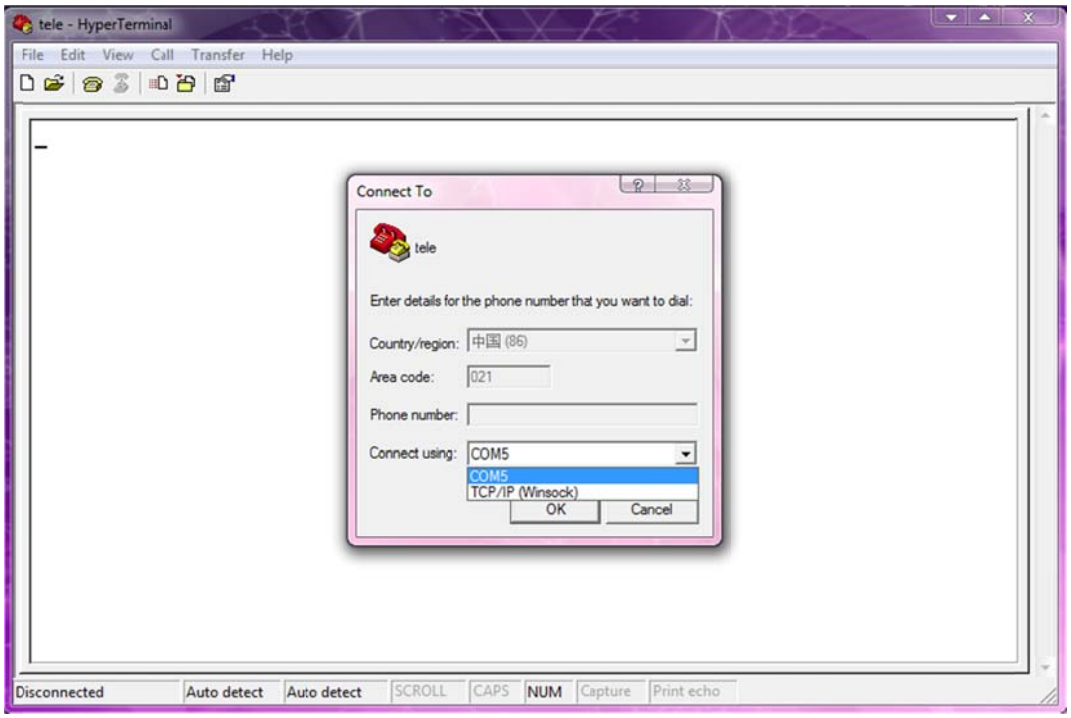


Figure 3-9, Connecting Interface

- Change the bits per second (B) to 9600 bps and Data flow (F) to none. (Note: This enables input from terminal interface). Showing in Figure3-9.

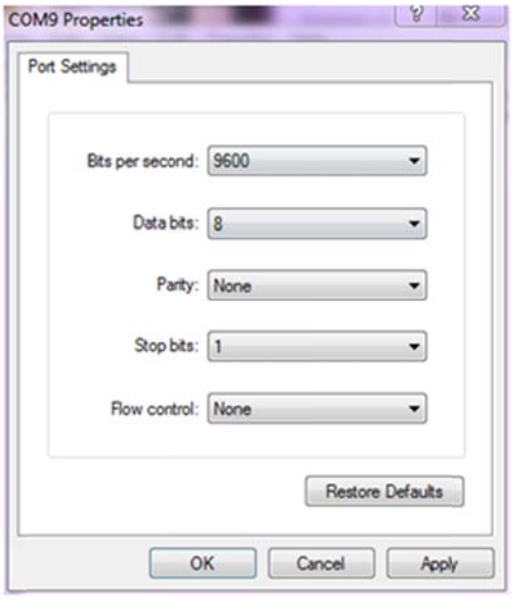


Figure 3-10, COM port Setting Interface

- Then press Confirm to start showing the system information.
- COM port Setup. Setting up ASCII: File – Properties – Settings, check the box "Append line feeds to incoming line ends" as shown in Figure 3-11 and 3-12.

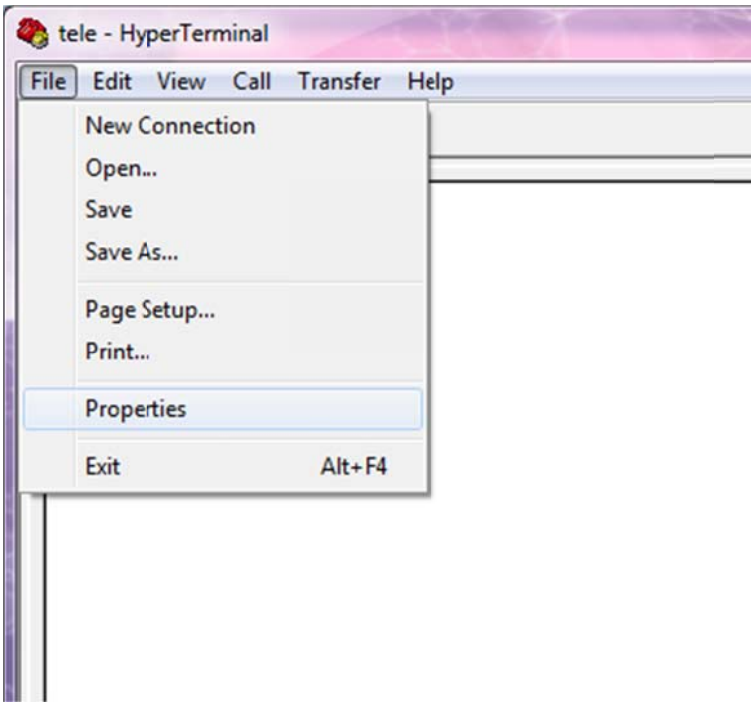


Figure 3-11, ASCII setup

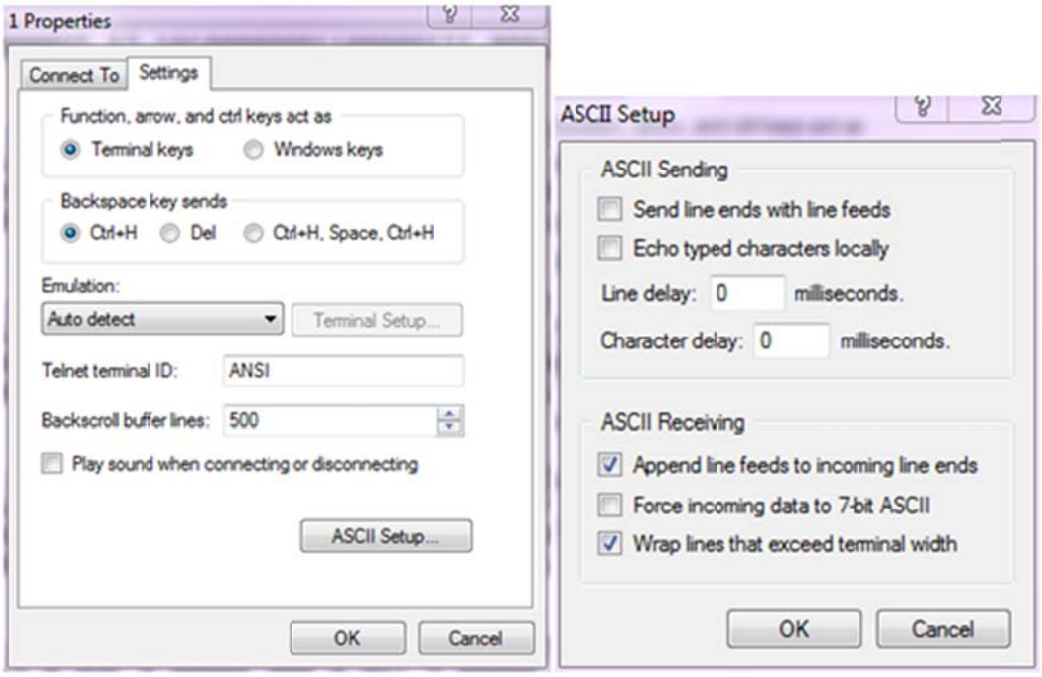


Figure 3-12, ASCII Setup

- On the Menu bar, Click Transfer -> Capture Text, and select a save path to save it. Click Start to start recording the data.

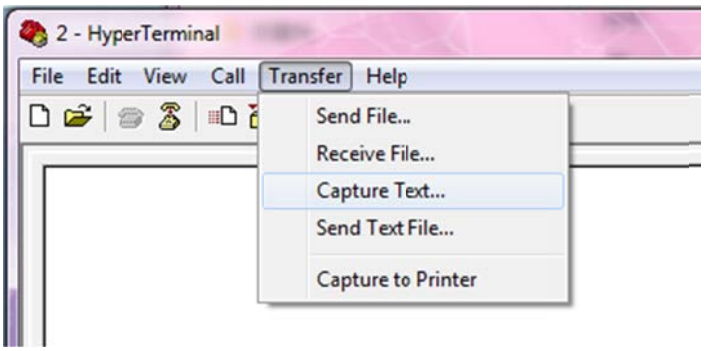


Figure 3-13, Data saving interface

Figure 3-14, Save Data

- Figure 3-15 please find the data instructions.

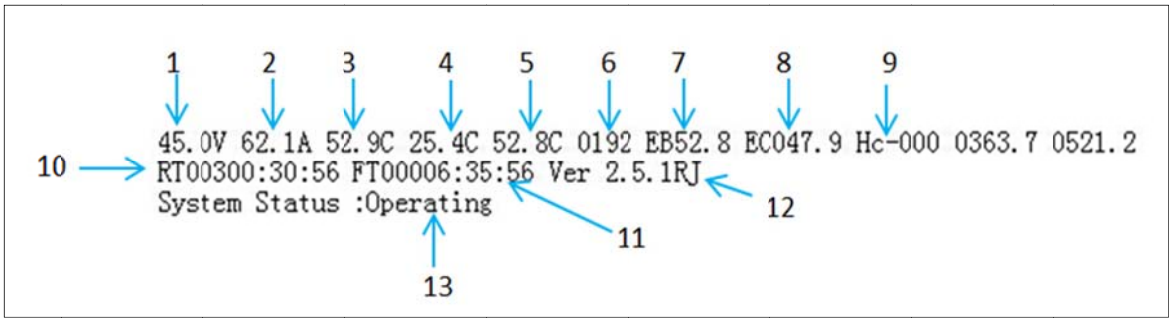


Figure 3-15, Data instructions

Table 3-5 RS232 Data Instructions

No.	Instructions	Comment
1	Stack voltage	
2	Stack current	
3	Stack temperature	
4	Ambient temperature	
5	Stack target temperature	
6	Speed of fans	0192 means 19.2%
7	Output voltage	
8	Output current	
9	Hydrogen concentration	000 means 0%
10	Total system operation time	
11	System operation time with power output	
12	Software version	
13	System operation status	

3.2.8 Input signal

A user input signal connector is provided on the rear panel of controller. The connector has clamp-type terminals that are engaged with a screwdriver.
The input signal connector places an entry in the controller when the two pins are connected (shorted) together.

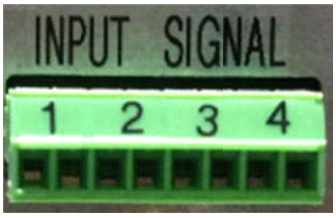


Figure 3-16, Input signal connector

Table 3-6 Input signal connector description

No.	Signal Name	Description		Comment
1	Reserved	1:	1: Short Circuit 0: Open Circuit	For future using.
		0:		
2	Cabinet Door Switch	1: Door opened.		
		0: Door closed.		
3	Reserved	1:		For future using.
		0:		
4	Grid Power Signal	1: Grid Power Off.		To start, short pins together.
		0: Grid Power On.		

3.2.9 Output signal

A user output signal connector is provided on the rear panel of controller. The connector has clamp-type terminals that are engaged with a screwdriver. The detail circuit diagram of signal output connector please find in Appendix C.

Four outputs are provided:

- **Error Signal Output (Major)**: With the normal condition, there has no alarm asserted. This output activates when the system goes into Major Error and cannot deliver power for any reason (including loss of external bus power). Some conditions may be external to the system, and will be indicated in the LCD Display.
  Output signal when the following situations happen:
  1. Recoverable:
     - Hydrogen pressure too low
     - Stack voltage too low
     - External battery voltage too low
     - Output voltage too high

2. Unrecoverable:
   - H2 leakage
   - Stack current too high
   - Stack temperature too high
   - Output short circuit
   - Set voltage fail
   - Set current fail
   - EPPROM memory fail

- **System Operation Status**: This relay output is used to send a notification when the unit is operating. The relay is available as Normally Open, or Normally Closed. The relay is in its normal condition when inactive, and changes state when system operating.

- **Alarm Signal Output (Minor)**: With the normal condition, there has no alarm asserted. This output activates when the system goes into Minor alarm to make customer attention, indicating cabinet door opened or grid power off when operating in Primary Mode, while still allowing the unit to deliver power.

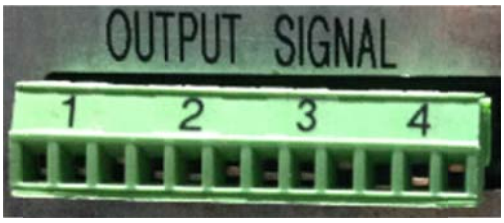


Figure 3-17, Output signal connector

Table 3-7 Output signal connector description

No.	Signal Name	Description		Comment
1	Error Signal Output	NO Output	NO=Normal Open. Close on alarm NC=Normal Closed. Open on alarm	Asserted when error happens.
		Common		
		NC Output		
2	System Operation Status	NO Output		Asserted when fuel cell stack is operating.
		Common		
		NC Output		
3	Alarm Signal Output	NO Output		Asserted when door opened.
		Common		
		NC Output		
4	Reserved	NO Output		For future using.
		Common		
		NC Output		

4. Operation

WARNING

To avoid property damage, personal injury or loss of life, DO NOT attempt to operate the T-2.5KW system until all directions have been read and understood.

When running, the unit will operate similar to a power-limited voltage source. The unit will supply power, attempting to achieve the output voltage. If the power limit of the unit is reached before the output voltage is achieved, the system will sustain its maximum power output. This maximum power output may be less than the unit's rating due to temperature, altitude, reduced airflow (due to restrictions of intake or exhaust flow), reduced fuel flow (due to regulator pressure or hydrogen bleed obstruction), or fuel cell aging.

From start-up, a properly maintained T-2.5KW system will achieve 60% power in approximately one minute, and peak power in approximately 10 minutes at 20°C and sea level. This warm-up period is required for the fuel cell to heat itself sufficiently to evaporate the water created during the electrochemical process of making electricity and water from hydrogen and oxygen. Though the fuel cell could make full power almost instantly, doing so while cool would cause water to accumulate within the fuel cell, preventing gaseous hydrogen and oxygen (air) from reaching the reaction surfaces. Therefore, the system is controlled to make as much power as possible while allowing the water generated by the reaction to be evaporated to the atmosphere.

4.1 Hydrogen Connection

Follow the figure 4-1 to connect the hydrogen input tube and the hydrogen output tube with the T-2.5KW system. Horizon suggests to keeping the hydrogen input high pressure around 1.2Bar to 2Bar. And use the pressure regulator to adjust the hydrogen input low pressure between 0.55Bar and 0.75Bar.

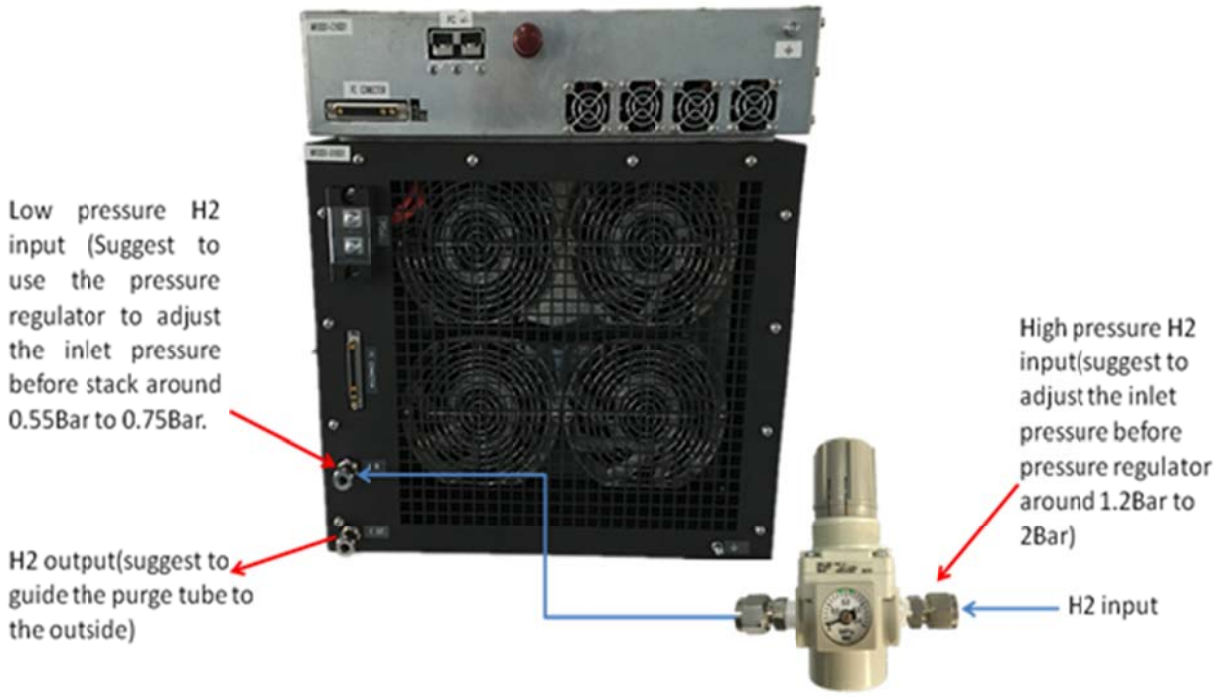


Figure 4-1. hydrogen connection

Figure 4-2. direction of pressure regulator

4.2 Wire Connection

A fuel cell system with multiple chassis can be configured as a single bus system, or as a multiple bus system. Figure 4-4 illustrates the detailed wiring connections for an indoor T-2.5KW system installation.

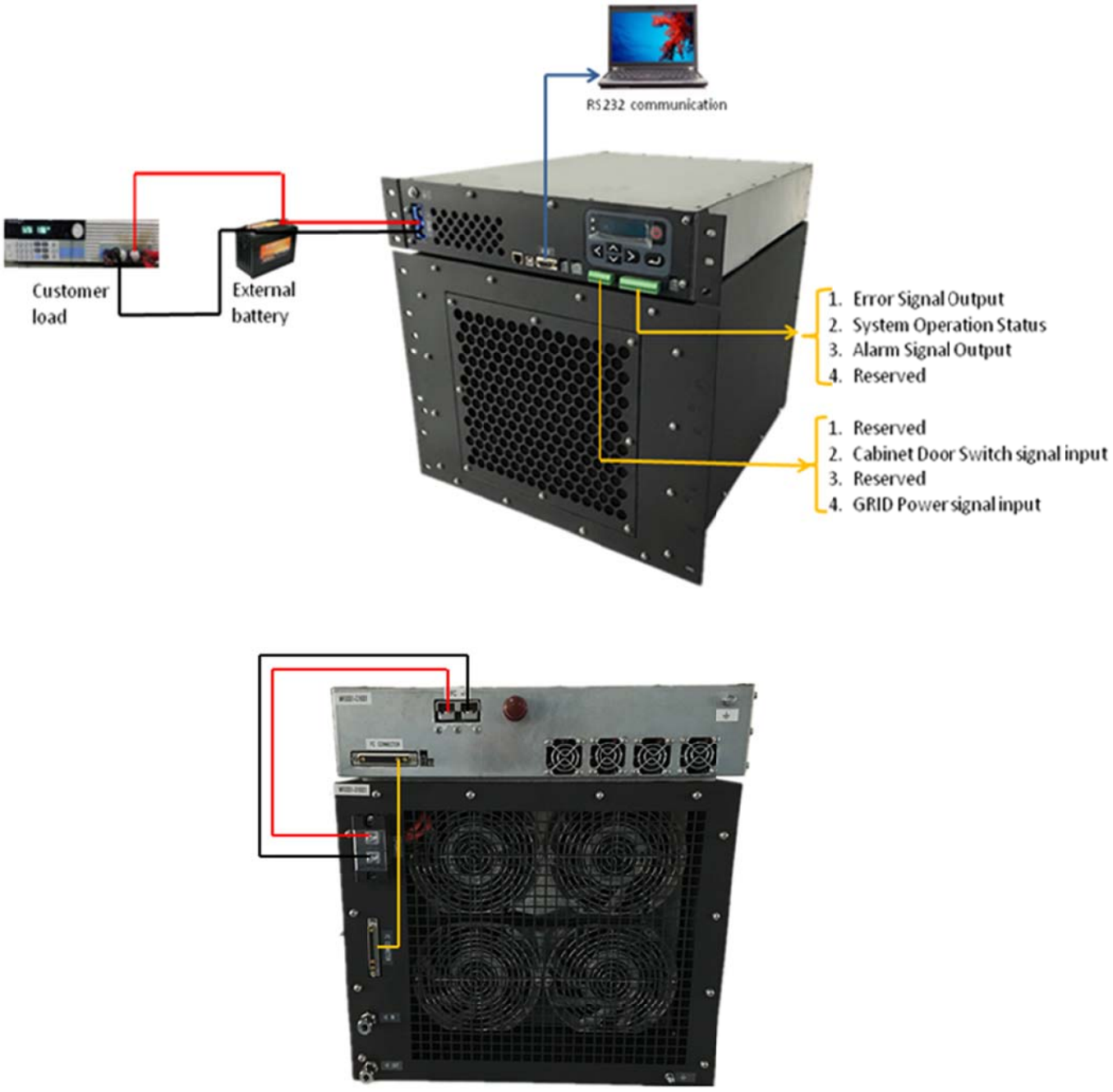


Figure 4-3. T-2.5KW system wiring connections

4.3 Grounding

Using acceptable practices, as specified by NFPA 70 and National Electrical Code 250.166, connect a chassis ground wire to the chassis ground terminal provided on the T-2.5KW system front and rear panel The ground wire size shall be a minimum of 10 AWG.

5. Applications Engineering

This section provides information to assist with the selection of the best-suited T-2.5KW system configuration for the desired application. It also outlines site considerations for optimal fuel cell performance.

5.1 Storage Requirements

The T-2.5KW system requires placement into service and periodic operation or exercise in order to maintain proper hydration. Horizon recommends that the T-2.5KW fuel cell system should operate at least 30 minutes per month. When not in operating, the system should be stored in controlled environments (5~45°C).

5.2 Site Requirements

WARNING
To avoid fire hazards, do not locate the fuel cell system next to stored gasoline or other flammable vapors and liquids.

5.3 Load Engineering

Sizing the application must consider both the actual site load and any additional heater load within the T-2.5KW system due to cold environments. Site load should be determined by measuring the actual DC power output of the rectifiers during normal operation. Name-plate ratings of equipment should not be used to determine power requirements.

Appendix A: T-2.5KW Specifications

T-2.5KW Technical Specifications	
SPECIFICATION	VALUE
Power Rating	0 to 2,500 W @ 20°C and 101.3 kPa
Current Rating	0 to 47A @54V
Voltage Adjustable	43.2 to 57.6 V DC
Voltage ripple	±1V
Controller Dimension(WxDxH)	430mm x 550mm x 88mm
Stack Dimension(WxDxH)	430mm x 550mm x 356mm
Controller Weight	13.5 kg
Stack Weight	40.3 kg
Ambient temperature	－10^{o}C to +45^{o}C Standard (additional heating needed when temperature less than 0^{o}C, during operation)
Recommended cold start temp	More than 5^{o}C
Relative Humidity	0－95% Non－Condensing
Communications	RS232
Reactants	Hydrogen and Air
Cooling	Air (integrated cooling fan)
H2 inlet pressure	0.55-0.75Bar
Hydrogen purity	≧99.995% dry H2
Consumption	≦0.78 Nm3/kWh (Average at max. load)
Start up time	≦2minute at ambient temperature
Efficiency of system	≧42% at peak power
Temperature De-rating	1.25% per °C over 40°C
Altitude De-rating	3.5% per 500m over 1,000m
Max noise	Normal operation: <70 dBa at 1.5 meters
Storage Temperature	－20^{o}C to + 50^{o}C Standard

Appendix B: System error and alarm information

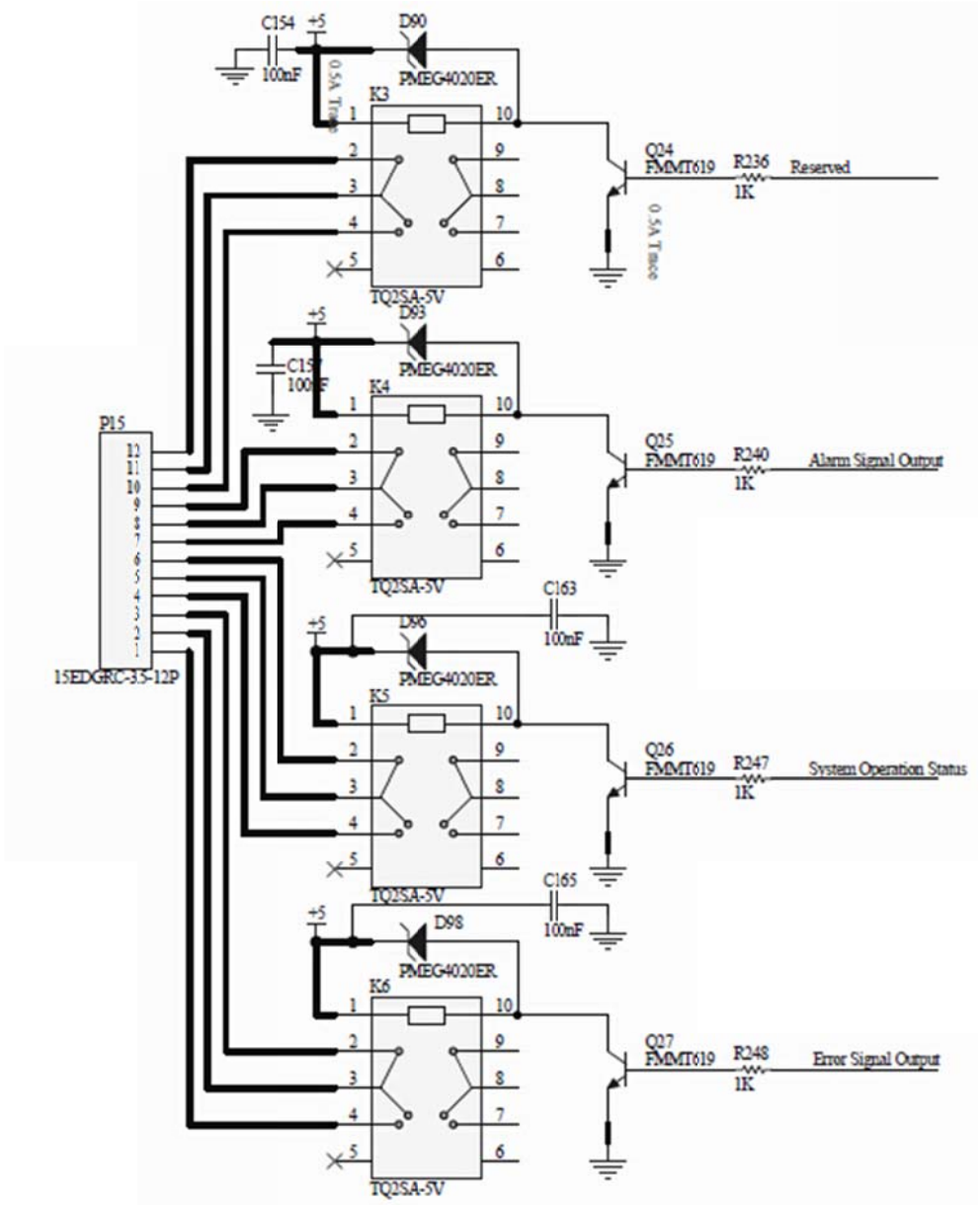
Appendix B-1: Last ALM: XXXX

First no.	0	no alarm	
Second no.	0	no alarm	
Third no.	0	no alarm	
	2	FC temperature high	
Forth no.	/	**1**：GRID Power OFF **0**：GRID Power ON	**1**:door open **0**:door close
	0	0	0
	1	0	1
	2	1	0
	3	1	1

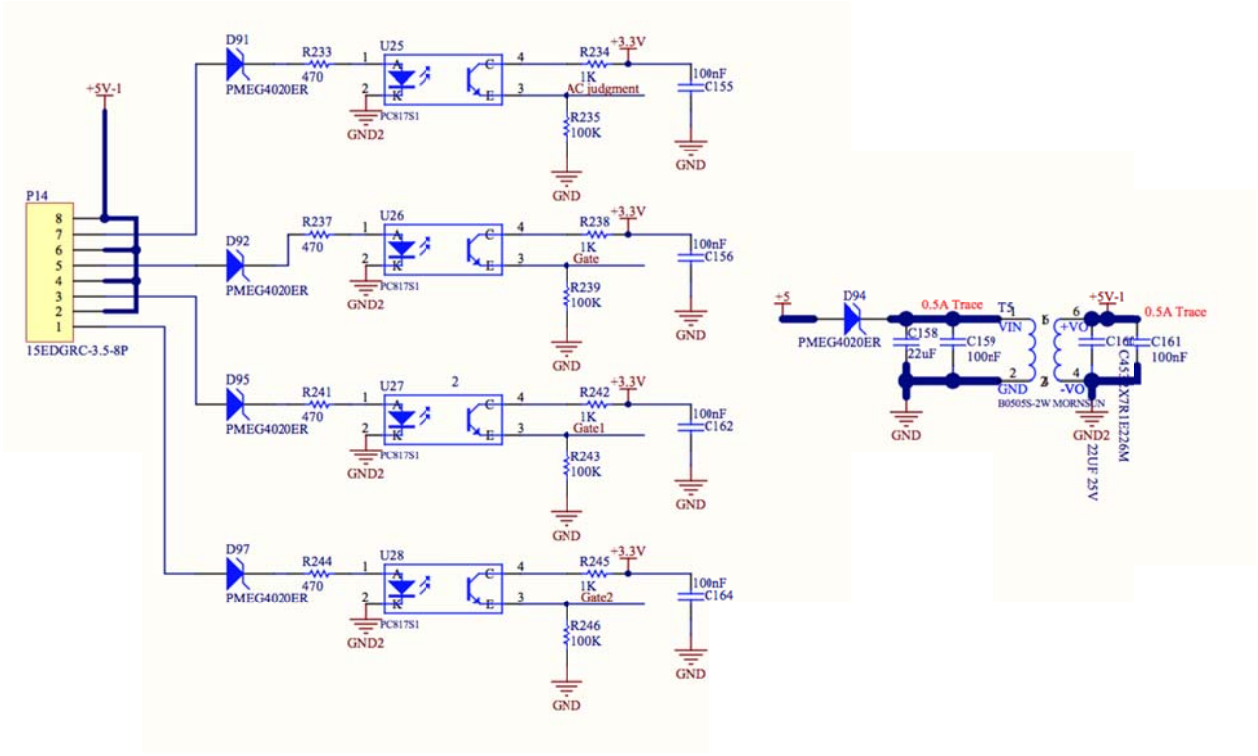
Appendix B-2: Last ERR: XX

Error information	Description
00	No error
01	EEPROM memory failed
02	FC voltage too low
03	FC current too high
05	FC temperature too high
22	External battery voltage too low
30	Output voltage too high
32	Output short circuit
34	Set voltage fail
35	Set current fail
43	H2 leakage
48	H2 pressure too low

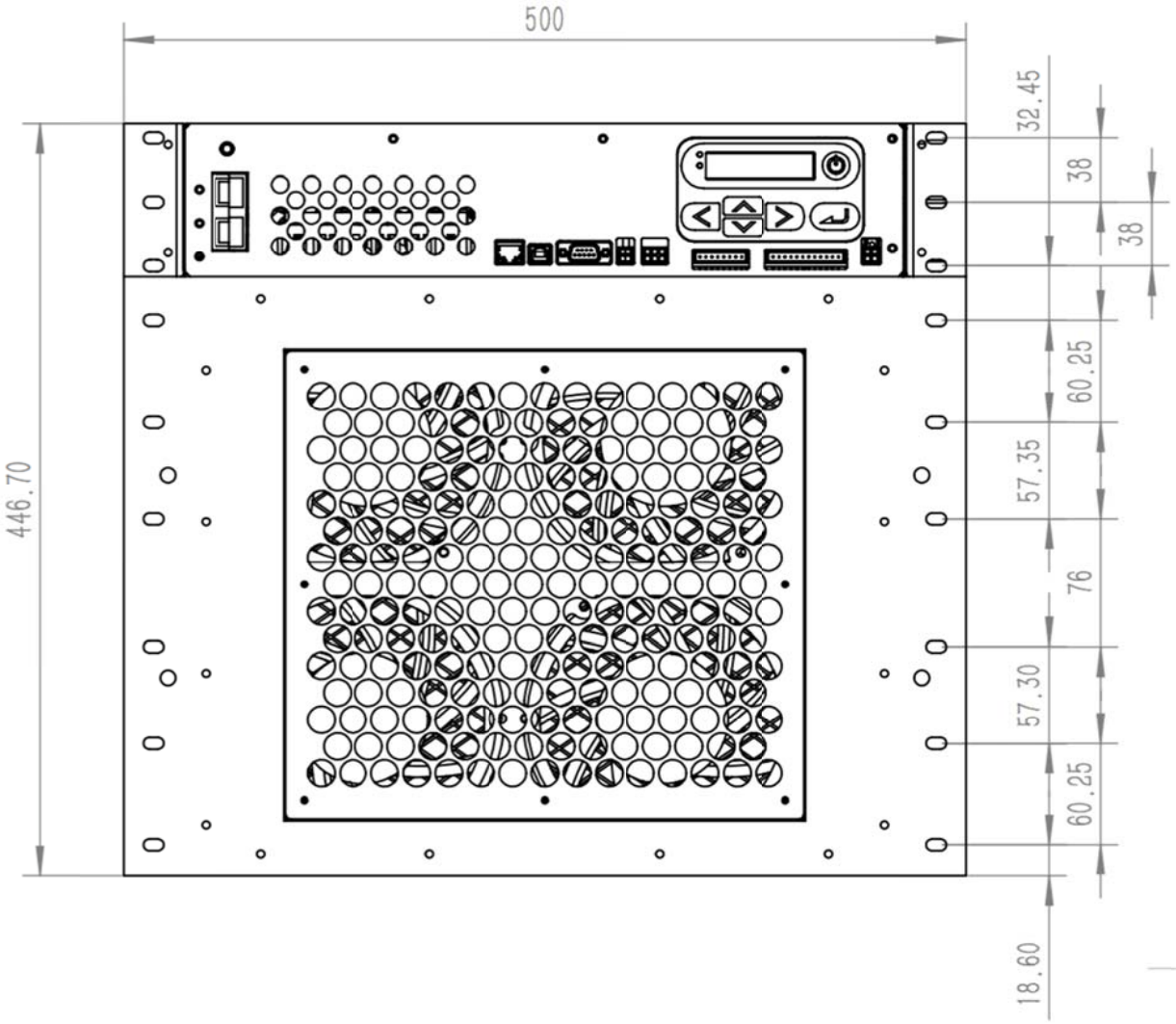
Appendix C: Circuit Diagram of Signal Output Connector

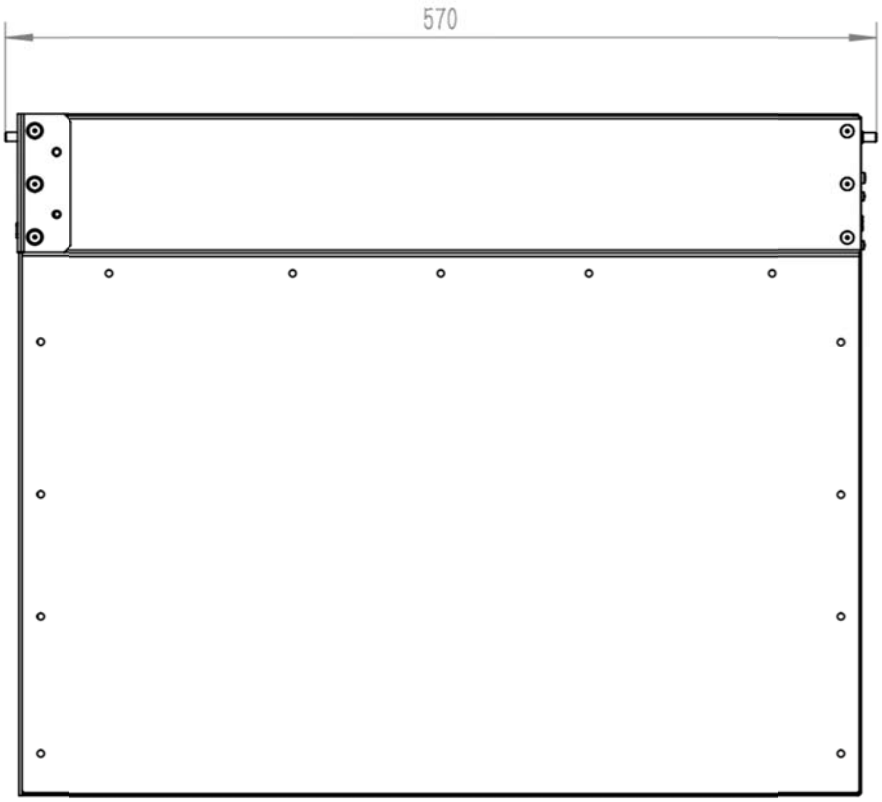


Appendix D: Circuit Diagram of Signal Input Connector



Appendix E: T-2.5KW Drawing:

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