Enapter

EL 2.1

Hydrogen Generator (35bar)

Owner's Manual

Rev. 05 – October 2020

PREFACE

Thank you for choosing an Enapter hydrogen generator system. Please study this manual carefully before attempting to operate the device.

If you have any further question on the installation of the device, please contact the Enapter support team. Quote the system serial number when contacting us; you can find the serial number on the back of the modules.

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Scope of the document

This manual provides the installers, users and owners with the information needed to carry out the installation of the EL2.1 safely and as intended.
Keep this manual in a safe place and readily available. Always follow its instructions. It is the operator's responsibility to ensure that an installed electrolyser system is in proper condition at all times. Please observe any additional local requirements applicable to the installation and operation of the hydrogen generator system. This owner's manual functions as general document and covers installation, maintenance, and operation.

Approved use

The EL2.1 hydrogen generator system has been designed to produce pure hydrogen that can be used directly for Fuel Cell or other hydrogen consuming applications.
The unit must only be operated for this purpose, according to the specifications and instructions provided in this manual.
Observance of this manual is part of "normal use".

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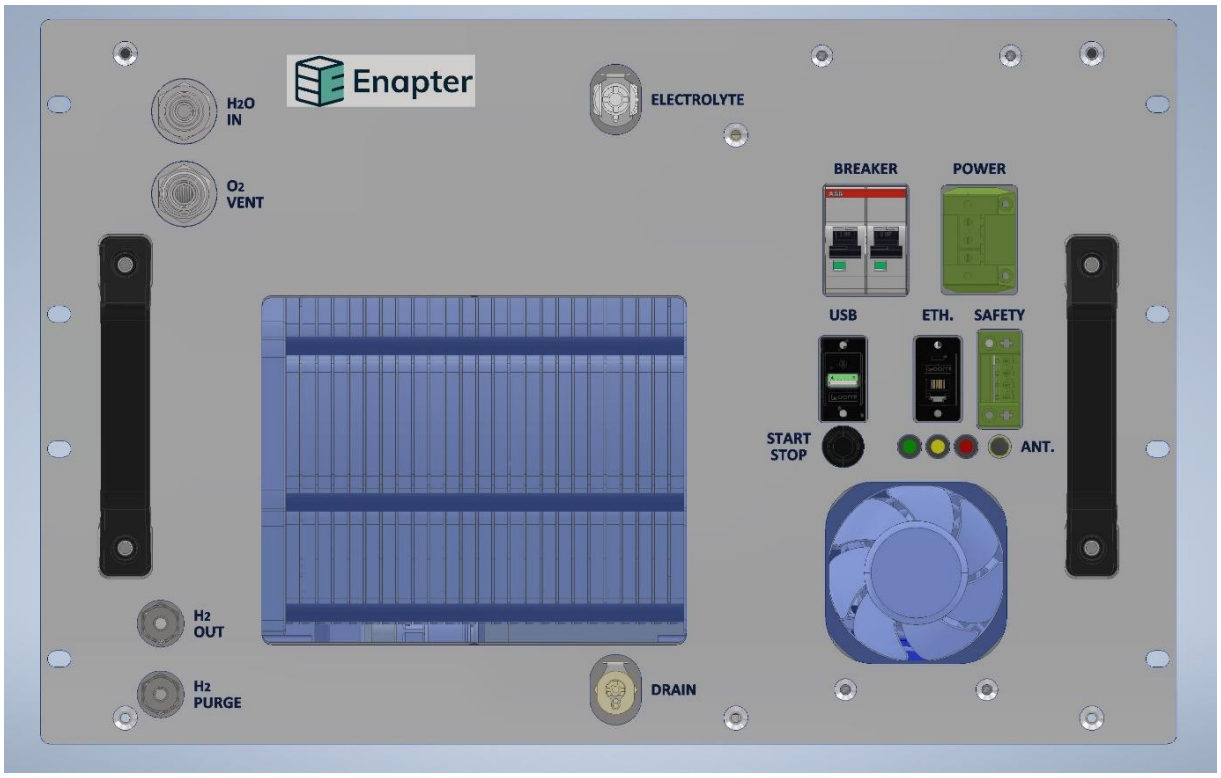
PRODUCT OVERVIEW

Enapter's patented anion exchange membrane (AEM) electrolyser is a standardized, stackable and flexible system to produce on-site hydrogen. The modular, easily maintainable design – paired with advanced software integration – allows set up in minutes and remote control and management. To achieve the required hydrogen production capacity, simply stack this electrolyser inside standard 19" racks or any housing you wish.

Front Panel



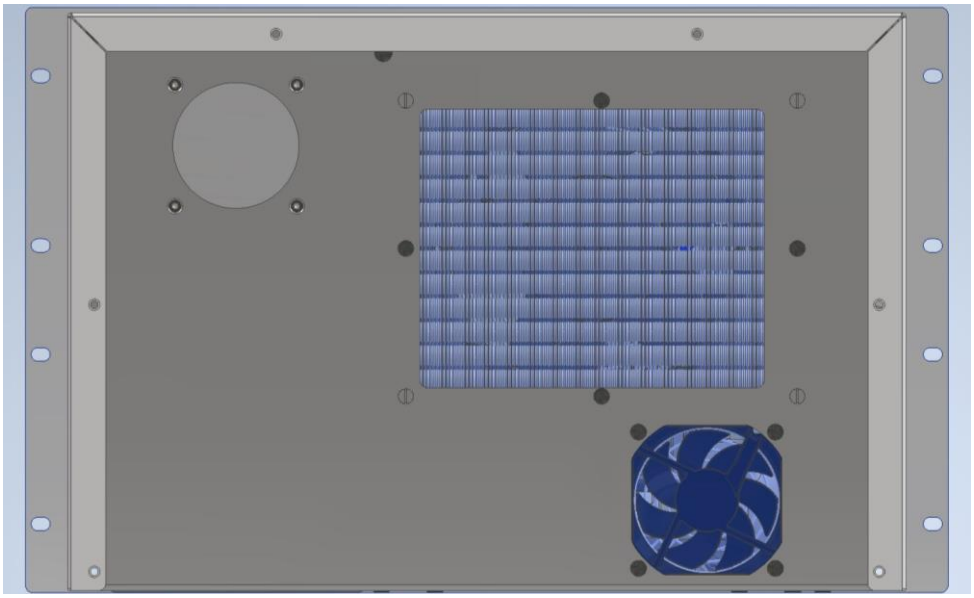
The front panel of the EL2.1 includes all physical connections of the device – allowing for easy access for installers and maintenance personnel only from one direction, as well as simple integration into standard 19" racks and cabinets.

1) H_2O In
   - John Guest Pushfit female bulkhead connector (8mm OD pipes)
   - Requirements: Water input conductivity <20 µS/cm, input pressure = 0.5 → 4 bar
2) O_2 Vent – please refer to the **Vent Connection Guide** below
   - John Guest Pushfit female bulkhead connector (10mm OD pipes)
   - Output: O_2/H_2 gas mixture and water vapour
3) H_2 Out – please refer to the **Hydrogen Outlet Connection Guide** below
   - ¼" double ferrule female compression Swagelok tube fitting 1/4" bulkhead (SS-400-61)
   - Output: 500 NL/hr of H_2, up to 35 bar
4) H_2 Purge – please refer to the **Purge Connection Guide** below
   - ¼" double ferrule female compression Swagelok tube fitting 1/4" bulkhead (SS-400-61)
   - Output: Up to 20 NL/purge

5) Electrolyte
   - CPC quick connector 10 mm
   - Only used during routine maintenance for filling the electrolyte into the device
6) Drain
   - CPC quick connector 6 mm
   - Only used during routine maintenance to drain the EL2.1, and to prepare the device for transport.
7) Breaker – Integrated magnetothermal circuit breaker to protect the EL2.1 from overcurrent and short-circuits
8) Power – please refer to the **Electrical Connection Guide** below
9) Safety – please refer to the **Safety Chain Connection Guide (Optional)** below
10) Ethernet – Connection to access external Modbus control features of the EL2.1
    - Find more below by accessing the information online via handbook.enapter.com.
11) ANT. – Antenna port
    - This is where a miniature antenna is attached to connect the device to the local network via Bluetooth and Wi-Fi, enabling real-time updates and monitoring for the user via the Enapter app and cloud.
    - Do not touch the antenna when the device is powered on!
12) Start/Stop
    - Manual start and stop button, please refer to the **Manual Start/Stop** section below
13) LEDs
    - Status LEDs, please refer to the **LED States** section below
14) USB – For maintenance use only.
    - Do not use without prior notification and assistance from trained Enapter service personnel!

Back Panel

The back panel of the EL is used to blow out warm air. Please leave at least 30 cm space behind the module to allow for adequate airflow. Never obstruct the ventilation openings!



TECHNICAL SPECIFICATIONS

	EL2.1
Nominal Hydrogen Production	0.5 Nm^3/hr 1 kg/24 h
Delivery Pressure	Up to 35 barg
Nominal Power Consumption per Nm^3 of H_2 produced (beginning of life)	4.8 kWh/Nm^3
Hydrogen Output Purity	~99.90 % (H_2O ≈ 1000 ppm)
Electrical	Nominal power consumption: 2.4 kW (max. 3 kW) Breaker: C13
Input Water Requirements	Conductivity <20 µS/cm
Process Liquid	1 % KOH solution
Dimensions	L:482mm H:310mm W:4mm
Weight	55 kg
Control System Included	EMS
Communications	Wireless (Wi-Fi, Bluetooth), Ethernet, Modbus TCP
Remote Shutdown	Enapter Cloud Service, Enapter App, Modbus TCP, Safety chain (dry contact)
Safety	
Maximum H_2 contained within	20 NL
Conformity	**CE certified according to the machine directive 2006/42/CE** EN ISO 12100 – 1 EN ISO 12100 – 2 ISO 13849 EN 61010 EN 61000-6-3 EN 61000-6-2 ASME B31:12
Noise at 1 m	<60dB
Ventilation and Safety Recommendation	Indoor: Ventilation depends on room size, Hydrogen detection system with a safety circuit is recommended Outdoor: Protect from outside environmental influences, if integrated into a cabinet. Ensure the safety concept of each integrated module is respected.
Environmental	
Operating Conditions	5°C to 45°C, up to 95% humidity, non-condensing
IP Rating	20
Interfaces	
H_2 Outlet	1/4" Swagelok Tube Fitting
Vent Outlet	10 mm John Guest Speed fit
Purge Outlet	1/4" Swagelok Tube Fitting
Water Inlet	8 mm John Guest Speed fit
Fill and Drain Port	CPC quick connector 6 mm drain CPC quick connector 10 mm KOH refilling

SAFETY INSTRUCTIONS

Warnings and Hazards

The following terms and symbols are used in this manual to indicate important text passages which must be given particular attention:


Warns of fatal/serious injury


Warns of injury


Warns of physical damage to the product


Do not open or dismantle


Keep away from sources of heat and ignition.
No naked flames


No smoking


Minimum two persons required to handle the item


Wear Personal Protective Equipment


Wear hearing protection

General safety

Any user, installer and operator must be aware of the following:

1. The machine is **not intended** to be used in a potentially explosive area
2. **We decline any responsibility resulting from improper use of the EL2.1:**
    a. Caused by the utilization of poor water quality
    b. Caused by supplying too high of a water inlet pressure
    c. Caused by leaking gas connections on the front panel of the device (Improper mounting of tubing)
    d. Caused by supplying the wrong voltage to the machine
    e. Caused by improper installation of the machine
3. With regards to the **design and installation of the hydrogen outlet, purge and vent lines**, the customer must follow Enapter's installation guide, but also ensure full compliance with local safety guidelines and regulations.
4. It is the installers/users or owners responsibility to **regularly check and maintain the purge and vent lines**, as well as to keep the lines free of ice or obstructions.
5. It is the installers/users or owners responsibility to **regularly check and clean the air intakes and outlets of the device**, as well as to keep the air inlets/outlets free of obstructions.

The following rules should always be observed:

1. **Keep the work area clean**. Clutter can create hazards around the device. Keep the work area well illuminated.
2. **Do not use the machine in explosive atmospheres**. Do not use the machine near flammable substances.
3. **Handle** the power supply cable with care. **Do not pull** the electric cable to disconnect it from the plug without removing power from it first. Keep the electric cable away from heat, oil, water and sharp edges.
4. **Protect yourself** from electric shock. Avoid any contact with earthing surfaces.
5. **Never expose** the device to rain or very damp conditions.
6. **Keep children and people without explicit knowledge** of the device and its function away to a safe distance.
7. **Only use** demineralized water according to the specification stated in this manual.
8. **Never operate** the device in confined spaces without additional safety infrastructures, such as active ventilation or hydrogen detection systems.
9. **Always wear personal protection devices:**
    a. **Wear protective goggles and nitrile gloves** when handling the electrolyte solution.
    b. **Wear ear muffs or plugs** in noisy areas.
    c. **Wear gloves when handling the device.** Always wear appropriate PPE when handling the modules.
    d. **Wear appropriate footwear** when handling the device.
    e. **Use lifting aids** if available when lifting the device. Never lift the device alone. Know your local and site-specific health and safety rules and act accordingly.
10. **Always disconnect** the machine from electricity before any maintenance and transport.
11. **Only use** the machine in the way and for the purposes mentioned in this manual. If the machine is employed for uses other than what is specified in this manual, unforeseen hazards may present themselves.
12. **Use the handles** when lifting and moving the device.
13. **Never attempt to repair the machine** by yourself. The machine must be repaired only by qualified people who use original spare parts; otherwise, risks may arise for the operator.
14. **Do not store** the unit at temperatures below 2°C.

List of Hazards

Any system-operator, -integrator, end-user and technician who operate, service, maintain or install the device must be aware of the potential dangers associated with its use, in order to implement sufficient processes in case of an accident or emergency.

Always ensure that the system is installed and operated in compliance with local code, regulations and standards. Do not install, operate or maintain the system without explicit knowledge or help from experienced and licensed system integrators, the manufacturer or external certifying bodies.

Hydrogen hazard

Hydrogen itself is not a hazardous substance – however, its properties can make it hazardous in interaction with other substances and environments.

It is the User's responsibility to implement a safety system to manage the EL2.1's outputs – more information about this is below.

Danger of explosion – exploding hydrogen can kill.
Leaking hydrogen can ignite and burn the skin.
High levels of hydrogen concentrations can cause asphyxiation!
Do not inhale hydrogen – be safe.
Do not use without a suitable ventilation and safety system in place!
Incorporate the unit, especially the vent line, into the operational safety concept.
Avoid heat in the vicinity of the system and the hydrogen source.
No smoking, no naked flames.
Comply with local safety regulations.
In the case of escaping gas, keep away and keep inflammable materials away.
Prevent electrostatic charging of the device.
Ensure proper installation of the hydrogen supply.
Check the hydrogen lines and connectors regularly for leakages.

Mechanical Hazards

Generic mechanical hazards are often ignored and commonly cause injuries. To avoid this, we recommend wearing appropriate Personal Protective Equipment (PPE) and using suitable tools at all times when handling the device and packaging material.

Whilst the handling of the packaging material and preliminary installation does not require specialised technicians, a general training with regards to lifting heavy loads and general safety briefings are required to perform these tasks safely.

Operators must comply with the general safety principles during the handling phases. In particular:

Caution!
Before handling, moving and commissioning the system – assess the hazards of the operation and study the manual. Appropriate PPE must be worn, such

as cut resistant gloves, safety shoes, protective goggles, etc. depending on the activity.
Ensure to clear the area of work before starting to mount the device.
The device is heavy and must be lifted by at least 2 people – plan around this and allow ample space to move around.
Do not lift the device over your head.

Caution!

During handling of the device, be cautious and use the handles on the device to minimise the mechanical risks, such as:

- Impacts and crushing injuries due to uncontrolled movements of the load
- Dropping the device, causing crushing injuries
- Loss of stability, leading to entanglements and other injuries.

The packaging/device must be handled **by at least two people.**

Electrical hazards

Do not touch the antenna when the system is powered on. The unit poses no special electrical hazards, as long as the following instructions on safety measures are observed and the **Electrical Connection Guide** below is applied correctly:

Caution!

- Handle the electrical installation with care. Ensure that the plug is fastened into the connector to avoid any loosening of the wiring.
- Use only the supply voltage specified on the rear of the device.
- Do not short-circuit inputs and outputs.
- Do not reverse the polarity of inputs and outputs.
- Do not insert any mechanical parts, especially metal parts, into the product through the ventilation slots.
- Do not use liquids near the product.
- Never use the product if any part of it has been immersed in water.
- **Do not** touch the antenna when the unit is powered on, ensure you are not charged before mounting/dismounting the antenna.

WARNING!

Always turn off the power supply when the product is being cleaned, maintained or transported.
Any servicing, other than cleaning and routine user maintenance, must be performed by trained, Enapter-endorsed technicians.

Chemical hazards

Potassium Hydroxyde is used in the electrolyser as the main process liquid (Electrolyte).

This electrolyte is typically delivered pre-mixed with the electrolyser but is sometimes provided as a powder to be diluted. For more information on this process, please refer to **Appendix** II below.

Warning! Refer to the Material Safety Data Sheet (MSDS) of all chemicals used before handling them. All persons mixing, draining and handling the electrolyte must be informed about any potential hazards involved with these activities.


Attention: Wear appropriate Personal Protective Equipment. Avoid any contact with eyes and skin.
If you come into contact with the solution, immediately wash the affected area and refer to the material safety data sheet of potassium hydroxide supplied with the electrolyser.

Attention: Carefully read the instructions contained in this manual before beginning work. Follow the instructions – if you have any questions, please contact the Enapter support team.
Ensure all material used to store and contain your electrolyte solution is chemically compatible with it.

In the event of physical contact with the undiluted substance, refer to the material safety data sheet of potassium hydroxide and follow the instructions below.

First Aid Recommendations

- In the event of skin contact, take off contaminated clothing immediately. Wash off with soap and plentiful water. Consult a doctor.
- In the event of eye contact, rinse carefully with plentiful water for at least 15 minutes, and consult a doctor.
- If ingested, do not administer anything to people that have fainted. Rinse mouth with water. **Consult a doctor immediately.**

Chemical information

Substance: Potassium Hydroxide
CAS no.: 1310-58-3
EC no.: 215-181-3
Classification: C.
R Phrases:R22,R 36/38, R43, R42
S Phrases: S24-37, S39, S62
(see Safety Material Data Sheet included in the shipment)

Drained solution

Before draining the electrolyser through its dedicated port, wear appropriate personal protective equipment. For more information, refer to **Appendix** III below. Collect the liquid in an appropriate container and place in a chemical waste container. Do not flush to sewer. Dispose of the liquid in compliance with applicable local regulations.

Thermal hazards

Thermal hazards such as burns and scalds for contact with high-temperature surfaces (which can only present themselves in case of failure of some internal components of the device) can be prevented by applying the following safety instructions:

- Ensure the device can only be accessed by authorized and trained personnel.
- Operators and maintenance personnel must wear appropriate Personal Protective Equipment (PPE) when handling the device.
- Remove the supply of power before any service, transport and installation of the device.
- Never open the device, unless you have been specially trained for service by Enapter.
- Any servicing, other than cleaning and user maintenance must be performed by specialist personnel and with the power supply switched off.

Environmental hazards

The device has been designed for use in standard ambient conditions, respecting stability requirements (in the absence of seismic or hydrogeological events of particular intensity).

The EL2.1 has not been designed for outdoor use. It is the User's responsibility to protect the system and all its accessories against atmospheric phenomena such as direct sunlight, rain, snow and lightning. For more information about the integration of the device in cabinets, please refer to **Appendix** IV below.

Acoustic hazards

According to the requirements stated into the Machine Directive 2006/42/EC, the following topics have been considered:

- The noise level at a workplace of a machine (the emission sound pressure level) has to be mentioned and specified in the user manual if it exceeds 70 dB(A).
- Sound power has to be determined and declared if the emission sound pressure level exceeds 80 dB(A)

During regular operation, the EL emits a noise level below the maximum acceptable threshold for long time exposure (80dBA).
However, a sudden purge (either caused by system shut down or unforeseen error) **can be louder than 85 dB, depending on the purge line installation**.
Due to this, Enapter recommends wearing PPE (earplugs) while working around the device.

INSTALLATION

Please refer to the "**Safety instructions**" section for a detailed list of instructions – it is required for all installers and technicians to follow these general set of rules as a minimum precautionary measure to allow the safe installation and commissioning of the system.

Any person working on the system must be familiar with the hazards and risks associated with installing, commissioning and running the EL2.1.

Tools, material and accessories required

The following tools and equipment are needed to set up the device successfully.

Tools

- 9/16" combination wrench
- 5/8" combination wrench
- Plastic pipe cutter
- Phillips head screwdriver
- Stainless steel pipe cutter
- ¼" Tube Bender





Material

- Stainless steel AISI 136- ASTM A269 -1/4" OD X 0,89 mm w.t.
- 8mm OD LLDPE pipe
- 10 mm OD LLDPE pipe



Accessories (included in the box)

- Electrolyte filling bag (labelled)
- Safety chain jumpers
- Ferrite for power input cable
- Swagelok Nut and Ferrule set

Unpacking

The unit has been carefully inspected before shipping. Visual checks for damage and functional tests should be performed upon receipt.

Please do not dispose of the original shipping materials. We will not accept the unit if returned without the original shipping boxes or equivalent for safe transport. In the case that you cannot keep the shipping boxes, please recycle responsibly.

Attention! If any damage has occurred during transport, please report this immediately to the shipping agent and supplier. Afterwards, the unit should be returned according to the shipping instruction provided in this manual, in the section "Transport, Maintenance and Recycling".

Warning!

Never lift the EL2.1 out of the packaging alone. An EL 2.1 weighs over 50 kg. Use lifting aids if available.

Due to their weight and size, it is recommended to use a pallet cart or similar devices to manoeuvre the box upon delivery.

If the box must be lifted somewhere, always lift with at least two persons.

EL2.1 Connection Guide

The following part will outline the instructions for creating safe connections to and from the EL2.1 electrolyser. This will also include output management guides, safety-related instructions and instructions for connecting power to the device and integrating a non-critical safety chain.

Always ensure that the system is installed and operated in compliance with local code, regulations and standards. Do not install, operate or maintain the system without explicit knowledge or help from experienced and licensed system integrators, the manufacturer or external certifying bodies.

If any further questions should arise, please contact the appropriate Enapter service and support teams who will answer any questions about the installation and integration of the electrolyser.

Gas connection instructions

All pressurised hydrogen gas connections are Swagelok tube fittings for 1/4" OD tubes. The outlets to be connected using these instructions are labelled **"H_2 Out"** and **"H_2 Purge"** on the front panel of the EL2.1.

Follow the below instructions carefully – please refer to the Swagelok manufacturers installation guide for any further details: An Installer's Pocket Guide for Swagelok® Tube Fittings (MS-13-151).

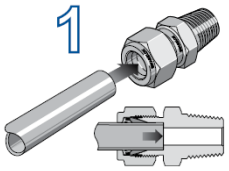
Tools required

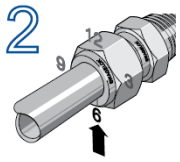
The following tools and materials are required for this task:

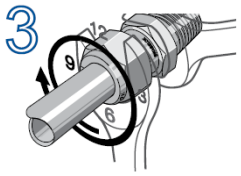
- 9/16" Open key wrench
- 5/8" Open key wrench
- 1/4" Tube
  Ensure the material chosen for this task is compatible with Hydrogen operation!
- 1/4" Nut and Ferrule (Swagelok)



Instructions





1. Fully insert a ¼ inch stainless steel tube into the bulkhead union, with the nut and ferrule in place on the fitting.
2. Rotate the nut finger-tight, then mark the 6 o'clock position on the nut.
3. Hold the fitting body steady on the device using the 5/8" open key wrench.
4. While holding the fitting body steady, tighten the nut **one and one quarter turns** to the 9 o'clock position with the 9/16" open key wrench.
5. To ensure a leak-proof connection is made, another quarter-turn of the nut (to the 12 o'clock

position) is recommended.

Always check each connection for leaks! For more information, please refer to Appendix I below.

Water and vent line connection instructions

H20 IN: The water inlet connector is a push-fit John Guest bulkhead, with an outside diameter of 8mm. This inlet port is used for the automatic refilling of de-ionized water which is required to be supplied to the device from a pressurised source.

Follow the below instructions carefully – please refer to the John Guest manufacturers technical support guide for any further details: John Guest Technical Support.

Tools required

The following tools and materials are required for this task:

- Plastic tube cutter
- John Guest push-fit locking clips (8 mm)
- 8 mm diameter LDPE tubing
  Ensure the tubing chosen for this task is pressure-resistant to at least 4 bar!

Instructions

1. Cut the tube square and remove sharp edges. Ensure the outside diameter is free of score marks, and the cut is perpendicular across the tube. Fully insert the tube into the fitting. Connect the other end of the pipe to the pressurised water supply.
2. Pull the tube to check it is firmly held in place, then secure the connection by inserting the 8mm red fastening clip.
3. To disconnect, ensure the line is depressurized. Then push the collet against the fitting, while simultaneously pushing the tube into the fitting. Holding the collet in this position pull the tube out of the fitting in one smooth motion.

O_2 VENT: The O_2 vent outlet is a push-fit John Guest bulkhead, with an outside diameter of 10mm. This outlet port is directly connected to the electrolyte tank, and its primary function is to evacuate the produced Oxygen. Apart from that, a small quantity of Hydrogen (less than 2%) and up to 25 mL/h of water is produced. If multiple Electrolysers must be connected together, a KOH resistant Check valve must be connected immediately to the **"O_2 VENT"** on the direction of the flow with a maximum cracking pressure of 0,02 barg.

Follow the below instructions carefully – please refer to the John Guest manufacturers technical support guide for any further details: John Guest Technical Support.

Tools required

The following tools and materials are required for this task:

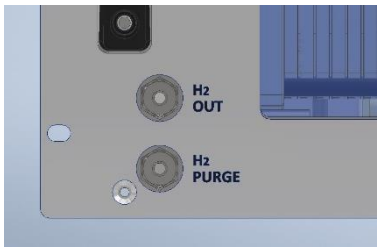
- Plastic tube cutter
- John Guest push-fit locking clips (10 mm)
- 10 mm diameter LDPE tubing
- 10 mm KOH resistant Check valve for vent line (max crack pressure of 0,02 barg), only in case of multiple Electrolysers are connected in parallel.

Instructions

1. Cut the tube square and remove sharp edges. Ensure the outside diameter is free of score marks, and the cut is perpendicular across the tube. Fully insert the tube into the fitting. The inserted pipe diameter must be 10 mm Ø. As mentioned previously, this line will have oxygen in its majority, with a small percentage of hydrogen (less than 2%) and a production of around 25 ml/h of water vapor, which depending on external environmental conditions will condense inside the line, so it must have a suitable container to retain and drain this water in compliance with local and national regulations. The **"O_2 VENT"** line must be led to an external safety area. In case multiple Electrolysers are connected together in parallel, insert a small piece of 10 mm Ø tube and immediately place the check valve as close as possible from the vent outlet, then continue with the steps previously explained.
2. Pull the tube to check it is firmly held in place, then secure the connection by inserting a red 10mm fastening clip.
3. To disconnect, push the collet against the fitting, while simultaneously pushing the tube into the fitting. Holding the collet in this position pull the tube out of the fitting in one smooth motion.

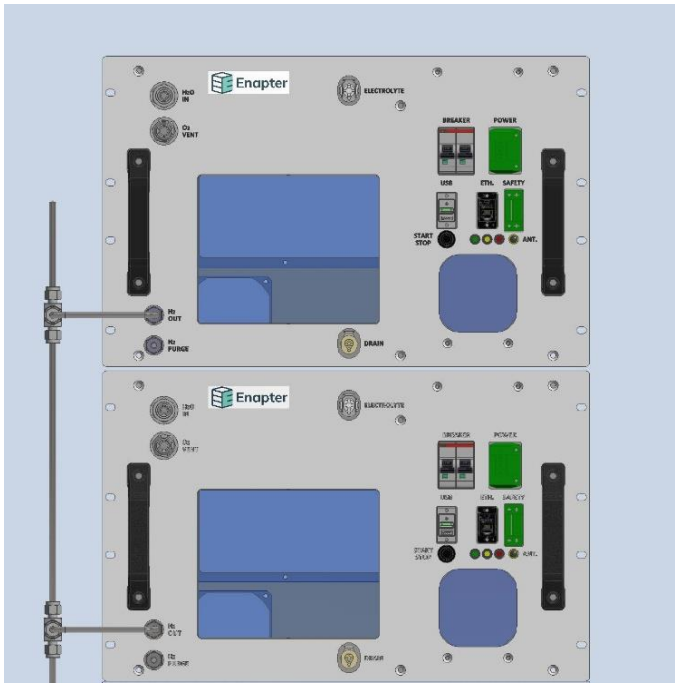
Hydrogen Outlet Connection Guide

Following the steps outlined in the gas connection instructions above, connect the H_2 Out port, located at the bottom left of the front panel, directly to your hydrogen storage.



Warning!

All pressurised connections must be inspected and checked for leakages. Failure to do so significantly increases the risk of explosion.
Enapter is not responsible for any damage caused by improperly installed equipment.



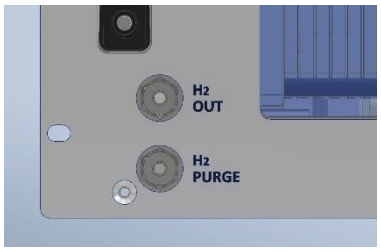
Several units of EL2.1s can be safely connected together. In order to manage the hydrogen output, simply connect as many devices together as needed. The recommended way to do this is to combine up to 5 (five) EL2.1s in a 19" rack and to then connect the H_2 via a common output line to the left of the units.

The advantage of this is that the individual connections do not require piping with strict tolerances as U-Bend connections are simple to manufacture and tolerant to deformation. Additional benefits include a prolonged service life for the pipe fitting connectors and the ability to add and remove devices from a cabinet without taking all the piping off. This eases maintenance times and costs significantly.

In case a higher hydrogen output purity is required, connect all hydrogen outlets directly to the dryer inlet, up to the allowed maximum drying flow rate of the dryer. If the drying is not required, it is recommended to fit valves between the tank and the hydrogen generator to be able to isolate each component during maintenance.

Purge Connection Guide

Following the steps outlined in the gas connection instructions above, connect the H_2 purge port, located at the bottom left of the front panel, to your hydrogen purge outlet.



During ramp-up, after ramp down and also periodically during operation, the EL2.1 depressurizes and releases up to 20 litres of hydrogen within 2 seconds. The result is a momentary flow rate of around 36 Nm^3/hr which comes out of the H_2 Purge outlet. Additionally, with each major purge of the device, between 1-10 ml of water (mostly liquid) is released with the gas.

Attention!

It is not the responsibility of Enapter S.r.l. to install and ensure the purge line is appropriately managed and maintained. **Carefully refer to local rules and regulations, apply industrial safety standards where possible and assess the risks associated with the operation of the device!**

Attention!

Do not insert any check valves or obstructions into the purge line. This can cause irreparable damage to your hydrogen system.

Please contact the Enapter support team for questions with regard to the purge line setup.

The released hydrogen will pose a risk of explosion – therefore, it has to be led into a safe area, which is defined by the absence of any source of ignition. We recommend to lead the purge output to a safe area, described in the section "**Safety areas around the purge and vent outlet**" below, and to elevate the purge outlet to at least 3m above the Electrolyser. If this is not possible, you may also manage the purge in other ways, such as using a flare stack, burn box or forced dilution.

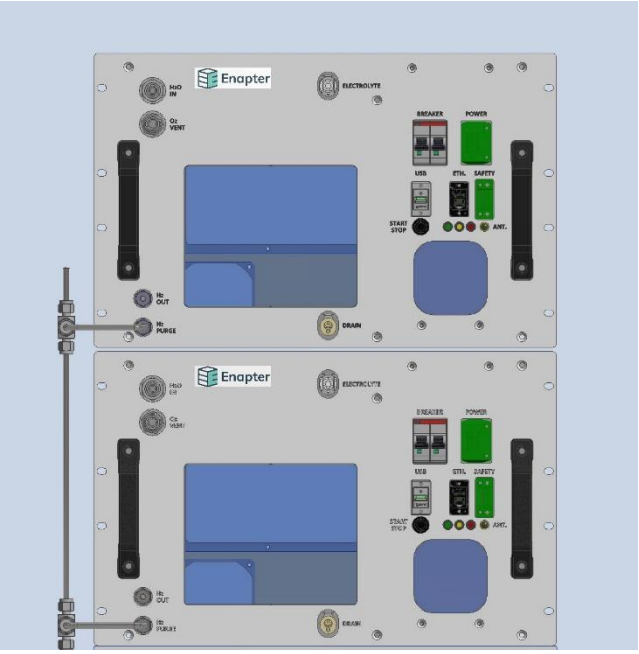
Warning!

The gaseous outputs from the oxygen vent and the hydrogen purge must be kept separated. Mixing of these outputs results in an explosive atmosphere.

Warning!

Follow local directives, rules and regulations for the safe dispersion of the purged gas. Ensure a satisfactory safety concept is in place and is being utilised to manage the hydrogen purge.

It is the installer's/user's or owner's responsibility to **regularly check and maintain the purge line**, as well as to keep the line free of ice or obstructions.



Several units of EL2.1s can be safely connected together. In order to manage the hydrogen purge in a simple way, simply connect as many devices together as needed. The recommended way to do this is to combine up to 5 (five) EL2.1s in a 19" rack and to then connect the purge lines via a common line. If a dryer is also integrated, its purge outlet can be connected in parallel to the installed Enapter hydrogen generators.

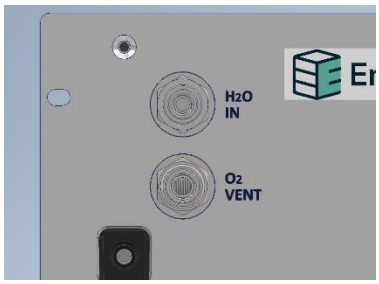
The common purge line on the side of the devices offers the advantage that individual connections do not require piping with strict tolerances as U-Bend connections are simple to manufacture and tolerant to deformation, compared to straight piping connections. Additional benefits include a prolonged service life for the pipe fitting connectors and the ability to add and remove devices from a cabinet without taking all the piping off. This eases maintenance times and costs significantly.

Never obstruct the output of the purge – do not place any check valves, or other system components which stop the flow of air to equalise the internal stack pressure, into the purge line.

Please be aware that when larger hydrogen systems are created by putting together several modules, the piping downstream may have to be sized differently. It is the customer's/system integrator's responsibility to ensure adequately sized purge piping is selected, which does not limit the purge flow. The customer/system integrator must ensure that the purge outlet satisfies all relevant local rules and regulation, in terms of noise emission, risk assessments, maintenance and all other relevant areas.

Vent Connection Guide

Following the steps outlined in the water and vent connection instructions above, connect the "O_2 Vent" port, located at the top left of the front panel to your oxygen vent outlet.



The O_2 vent line presents the most demanding line management. Please study this section carefully. The oxygen vent line carries the produced oxygen out of the electrolyser. However, due to the hydrogen crossover inside the AEM stack, the gas output from this line has a maximum concentration of 2% hydrogen. The remaining output comes in the form of water vapour, which often condenses in the line resulting in a water output of around 10-20 mL/hr.

Warning!

Do not insert obstructions into the vent line. This can cause irreparable damage to your hydrogen system. Ensure that the condensed water is not allowed to accumulate in the vent pipe and can drain out of the line safely. Regularly check the vent line for a build-up of obstructions.

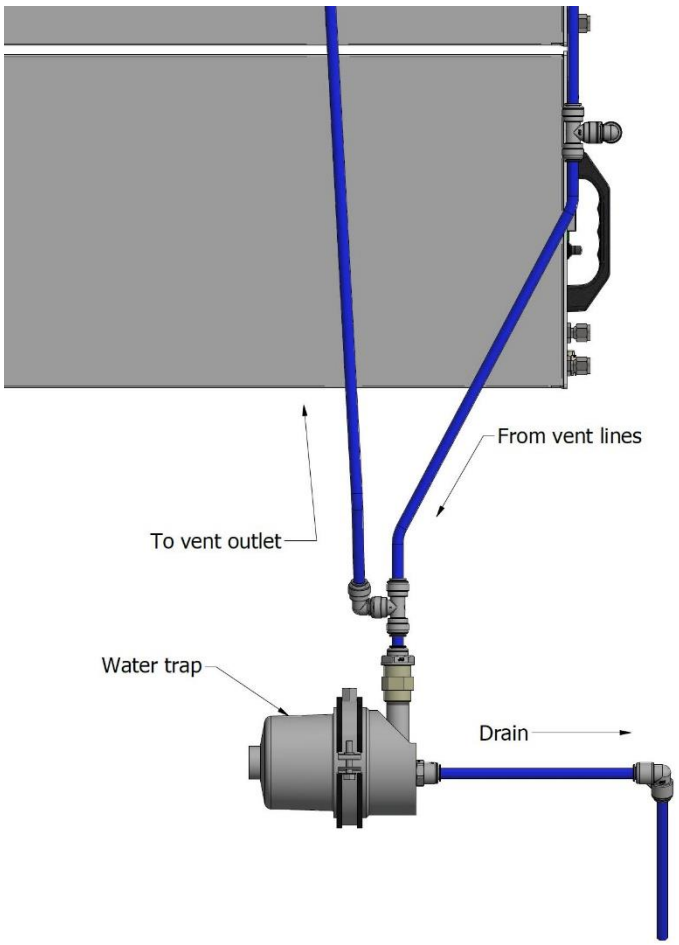
Please contact the Enapter support team for questions regarding the vent line setup.

Attention!

The total pressure loss inside the vent line can **never exceed 0.5 bar** – minimise pressure losses. If the backpressure inside the line builds up, the system will go into error mode – however, permanent damage to the system can occur from overpressures.

Enapter is not responsible for any damage caused to the system from mismanaged vent line arrangements.

To connect a device, create a connection using 10 mm LDPE pipe to the port labelled "O_2 Vent". Several units of EL2.1s can be safely connected together; simply connect the devices together as needed, via a 10 mm vent line which should run vertically along the side of the electrolysers. Just bear in mind since in the case of having only some of them producing, the condensed water vapor as well as the oxygen can go to the electrolytic tank of the electrolyzer that is not producing and from this way to cause the system to go into error. So, **Please remember the installation of a check valve after every Vent outlet.**



At the bottom of the vent line, a drain trap or similar condensed water management device should be fitted. If this is not integrated with the vent line, another way must be found to allow water to drain out of the system safe from the vent line.

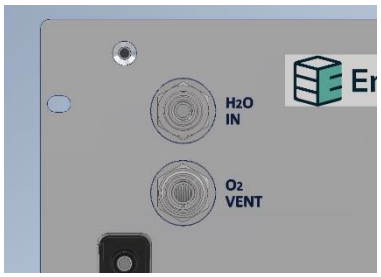
We recommend to lead the gaseous outputs from the oxygen vent to a safe area, described in the section "**Safety areas around the purge and vent outlet**" below, and to elevate the outlet to at least 3m above the electrolyser. If this is not possible, you may also manage the output in other ways, such as using a forced dilution of the output.

Warning!
The gaseous outputs from the oxygen vent and the hydrogen purge must be kept separated. Mixing of these outputs results in creating an explosive atmosphere.

When integrated into a rack or cabinet, we recommend the vent output (oxygen) to be located at the top of the mounting solution, with a drain trap on the lowest possible mounting position. It is then possible to fully separate the outputs – the oxygen gas mixture can be led to a safe area, while the water can be safely drained.

Water Inlet Connection Guide

Following the steps outlined in the water and vent connection instructions above, connect the "H_2O IN" port, located at the top left of the front panel, directly to your water supply.



Warning!

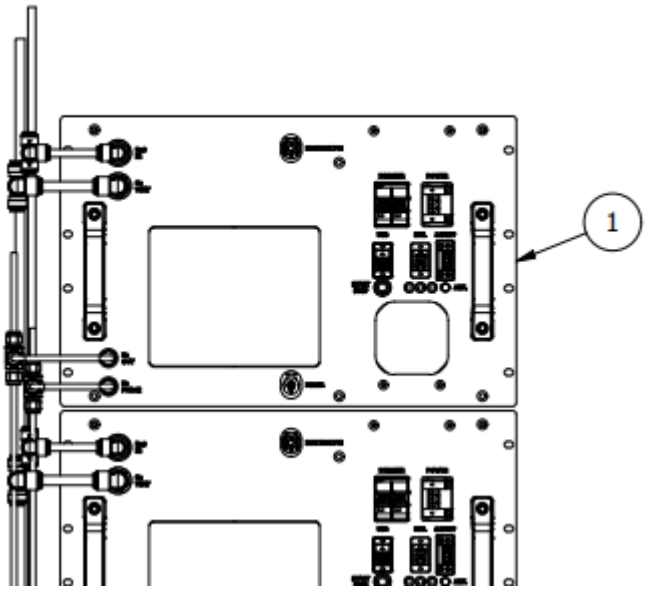
Ensure water pressure on the input line never exceeds 4 bar. This can cause irreparable damage to the electrolyser system and create significant leakages. Enapter is not responsible for any damage or injury resulting from the misuse of our products.

Attention!

Ensure your water input quality is sufficient. The EL2.1 requires DI water for refilling, with a conductivity **lower than 20 µSiemens/cm. DI water with a higher conductivity will irremediably damage the stack.** If a device is damaged from the input of low-quality water, Enapter is not responsible for any damage caused.

After performing the first-time filling (filling the device with the supplied electrolyte solution), the device will consume water during operation, at a rate of around 400 mL/hr. The refilling is then triggered automatically from the "H_2O IN" port, this occurs periodically during operation, or directly after ramp down.

In order to supply the EL2.1 with clean DI water for refilling, water must be present in the electrolyser water refilling pipe at a pressure between 0.5 bar and 4 bar. If the EL 2.1 does not detect the water's presence, the system will not refill and will stop operation while it waits for water input pressure to appear.



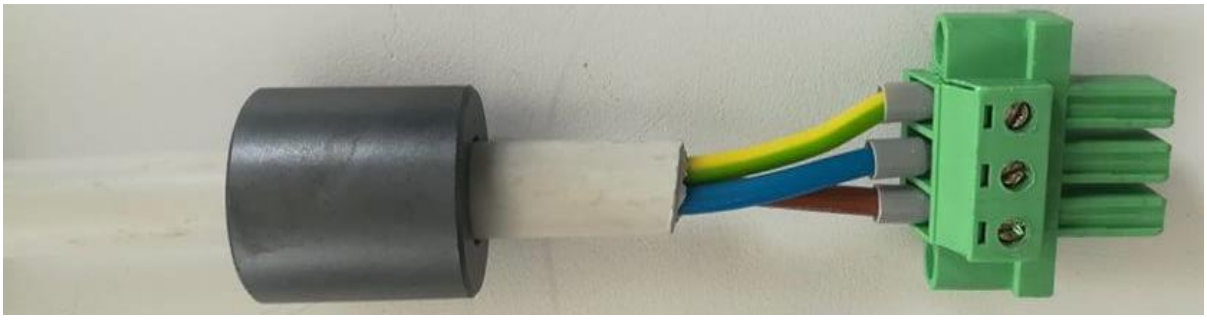
To connect a device, create a connection using 8 mm pipe from a pressurised DI water source and the "H_2O IN" port.

Several units of EL2.1s can be safely connected together. In order to manage the water input, simply connect the devices together as needed, via a common water input line. It is recommended to have at most 9 (nine) devices supplied by the same water line when connected only to a WTM, to facilitate faster refills.

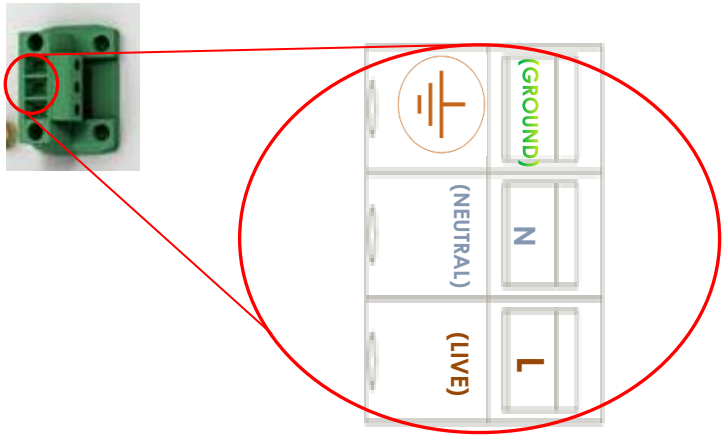
Electrical Connection Guide

Attention!
Double-check all the wiring connections **before** supplying power to the device. Failure to adhere to the following instructions can damage the device and lead to hazardous conditions in and around the device!
Never handle the electrical connections with wet hands!

Before mounting the power input cable to the male connector, ensure the Ferrite (included with each electrolyser) is in place around the cable. The ferrite has an internal diameter of 13.77 mm (350 Ohm, 150 MHz) and can simply be slid over the cable.



Connect the EL 2.1 as shown below to the socketlabelled "Power". In the image below, brown is live, blue is neutral, and the yellow/green is the ground. Follow the relevant safety standards and ensure compliance with local and national regulations using the male connector in the correct orientation, as shown below.



The EL2.1 has a magnetothermal breaker (C13) on the front panel, which protects the device from overcurrent, and was selected according to IEC/EN 60898-1 and IEC/EN 60947-2.

However, we still recommend installing a protective device against overload and short circuits on the power supply line; this must be selected in relation to the devices maximum power consumption and in compliance with all local and national safety requirements. To further increase electrical safety of the hydrogen generation system, we also recommend installing an SPD (Surge Protection Device) to protect the Electrolyser from potential over-voltages generated by lightning strikes, as well as an appropriately sized differential breaker for the installation.

The EL 2.1 must be connected to ground to prevent users from contact with dangerous voltage and to allow the correct functioning of the device. The grounding system must comply with local and national regulations.

Programming Ports

The front panel features a USB and an ethernet port.

ETH. - This Ethernet port allows Modbus access for system integrators. The Modbus command interface table can be accessed online via Enapter handbook.

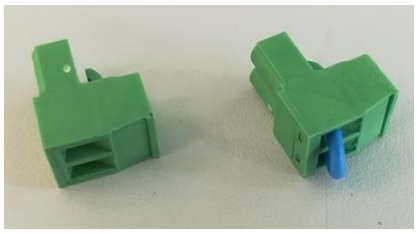
USB - This USB port acts as the primary board programming port that allows wired firmware upgrades for the EL board. These updates are performed by Enapter Srl. Please do not use it without a previous agreement with the Supplier.

Attention!
Do not use the programming port. It must only be used after special authorisation and instructions from an Enapter support team member.

Safety Chain Connection Bypass

The EL2.1 is able to be integrated into existing dry contact safety chains. If a safety chain needs to be integrated, please jump to the next section below, **Safety Chain Connection Guide (Optional)**.

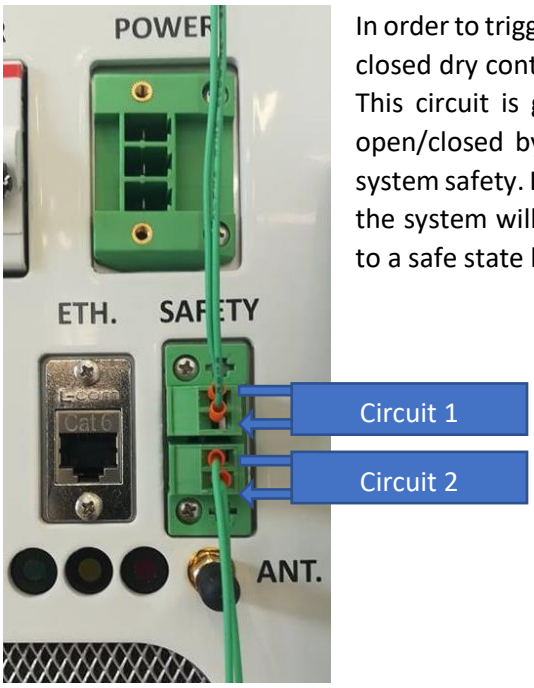
To disable the safety chain functionality, Insert the two supplied included safety chain jumpers on the front panel of the EL into the port labelled "SAFETY" on the front panel of the EL.



Safety Chain Connection Guide (Optional)

Connect the male connector to the female port on the device, labelled "Safety". The dry contacts are normally-closed type.

The pins are, from top to bottom, S1, COM1, S2, COM2. This allows the EL to not only receive a dry contact signal but also to pass it on to the next Enapter device, allowing the installer/operator to daisy chain as many Enapter devices as wanted to a common safety signal.



In order to trigger the safety shutdown of the device, connect a normally closed dry contact circuit to Circuit 1, using the specially supplied plug. This circuit is generally achieved by a relay system that is triggered open/closed by signals sent from a switch or sensor used to ensure system safety. If the circuit is interrupted (i.e. the dry contact is opened), the system will immediately cease all hydrogen production and return to a safe state by purging.

To pass the signal on to the next Enapter device, connect the two free contacts (Circuit 2) to the nearest Enapter device (connecting it to the Circuit 1 of the next device). In case the safety circuit is triggered by an opened contact, all connected systems will stop. Opening the Dry Contact circuit will cause the stack to be immediately de-energised and the Electrolyser to depressurise and to go into fatal error. Dry contacts should not be used for normal start and stop operation. Unexpected power cuts to the stack without normal ramp downs can shorten the device's lifetime and damage the system!

ELECTROLYSER MONITORING TOOLS

The EL 2.1 can be monitored and controlled remotely by authorised users by logging into Enapter's cloud services on a web browser (https://cloud.enapter.com/login).

The EL 2.1 comes with a preinstalled UCM (Universal Communication Module), which provides the immediate ability to monitor and manage the device. It does this by sending data to the Enapter Cloud, which stores it in a time-series database and provides real-time or on-demand visualization of collected data on customizable dashboards. In order to ensure that the UCM supports the latest protocols and security fixes, over-the-air updates are also supported.

Every EL2.1 can be directly integrated with the Enapter Software-Defined EMS (Energy Management System). The UCM inside the EL2.1 connects either directly to Enapter Cloud, or via an Enapter Gateway which readies your system for Industry 4.0 – to find out more, please visit https://handbook.enapter.com/.

Any user of Enapter products can now integrate a wide range of devices and analogue inputs into the hydrogen production environment. System data of integrated devices is read continuously and is then securely transmitted to the cloud, which can be accessed from anywhere in the world at https://cloud.enapter.com/ or with Enapter's mobile application.

After the setup of the device is finished, the EL2.1 can be managed via the mobile or web dashboard, which includes Automated Control and Monitoring functionality by customisable logic of the Enapter Rule Engine (requires an Enapter Gateway on the site).

Mobile Application

Enapter's mobile application makes the installation of any energy system quick and easy. If any part of your hydrogen system encounters an issue, the mobile app is able to send push notifications to the user alerting them to the situation. This functionality is available via Wi-Fi or 3G network, all over the world.

To find out more, please refer to the online Enapter handbook.

COMMISSIONING OF THE EL2.1

IMPLEMENTING SYSTEM SAFETY

In order to complete a successful setup of your system, each connection made to and from the hydrogen generator must be inspected and tested. Additionally, depending on the installation, a minimum amount of system engineering is required around the electrolyser.

Always follow best practices, apply your local code of regulation (if applicable) and follow industry standards for the implementation of safety systems to manage the risk of running and storing hydrogen.

We recommend that both the H_2 Purge line and the O_2 Vent line are properly connected and tested by the Installer/User and directed to a **safe area** (described in the section "**Safety areas around the purge and vent outlet**" below). If this is not possible, you may also manage the purge in other ways, such as using a flare stack, burn box or forced dilution. When forced dilution is utilised, all components used in this process must not be able to ignite the hazardous substances.

Warning!
It is the responsibility of the integrator to ensure best engineering practices are applied to the hazardous substances which are released during the operation of the EL2.1!
The customer/system integrator must ensure that the outlets satisfy all relevant local rules and regulation, in terms of noise emission, risk assessments, maintenance and all other relevant areas.

During ramp up, and during regular operation, the system performs periodical purges to guarantee high purity H_2 on the outlet, as well as to release condensed water from the produced H_2. Additionally, the purge line doubles as a safety release for overpressure situations. Meanwhile, during operation, a mixture of oxygen and 2% H_2 gas is released from the oxygen vent line, at a rate of around 0.25 m^3/hr. Both outputs need to be managed safely.

Please be aware that when larger hydrogen systems are created by putting together several modules, the piping downstream of the vent and purge line may have to be specially dimensioned for the project. It is the customer's/system integrator's responsibility to ensure adequately sized piping is selected, and the function of each of the lines does not affect the operation of the hydrogen generators.

The User must comply with all safety instructions described in this manual and in particular:

- Avoid any risk of explosive concentration of hydrogen near the electrolyser. Do not place the device into a sealed or unventilated room, without an applied specialised safety concept. For further questions, please contact the Enapter support team.
- Do not place flammable materials in the proximity of the device.
- Do not use naked flames/do not smoke near the electrolyser.

If you have any questions relating to the safety and installation of the EL2.1, please refer to the Enapter handbook, or contact Enapter support online via the cloud, or by email or telephone.

Safety areas around the purge and vent outlet

Attention!
The following section is only to be used as a guide for basic system sizing and installation. It is the installer's/owner's responsibility to ensure the vent and purge line outputs are safe and to apply their own safety concept to their installation.
Carefully ensure that all outputs from any system are managed appropriately and satisfy local codes and regulations.

Generally, there are two options:

The extents of this **safety area** depend on different parameters, for example, the diameter and the length of piping leading to the safe area, the vent spout design, exit velocity and wind conditions.

1. Preferably, customer/system integrator/operator calculates the measurements of the safety area based on the provided data for each specific output and applies industrial standards such as the following to their system design, safety concept and site documentation.
    a. NASA: Safety Standard for Hydrogen and Hydrogen Systems
    b. EIGA Doc 211/17: Hydrogen Vent Systems for Customer Applications
    c. EIGA Doc 75/07/E: Determination of Safety Distances
    d. CGA G5.5: Hydrogen Vent Systems
    e. API 521: Pressure-relieving and Depressuring Systems
2. Or follow the recommendations of Enapter for systems up to 8 (eight) devices. The safety area is cylindrical and has a height of 10 meters and a radius of 5 meters. Note that depending on the design of the purge piping and exit velocity, this area also extends in the direction of the ground by at least 1 meter.
   Never place the vent outlet near the purge outlet to minimise the risk of explosion. Leave at least 3 meters space between the gas outlets.

PREPARING FOR H2 PRODUCTION

Now that the device is connected, here is what to do next to get the system running.

Pairing the Electrolyser to the cloud

It is time to power on the device for the first time.

Using the Enapter app, add your device to a site. For detailed information on this, please refer to the mobile application handbook.

Step 1) To start using the application, you need an account in the Enapter Cloud. If you already have an account, simply skip this step.
To create an account, click on the create account button of the first screen.
Step 2) After logging in on the Enapter app, create a site – a virtual environment which will house all of the telemetries collected from the devices in your system connected to the cloud via UCMs (Universal Communication Modules).
Step 3) Add the EL2.1 to the site by scanning the QR code located on the front panel of the system.

Manual refilling of Electrolyte

Your system is now ready to be commissioned for its first use. You will notice that the device you have just successfully paired to the cloud using the Enapter App has started in **maintenance mode** and is prompting you to perform the first-time filling.

Time required	5 minutes
Materials required	Safety Glasses Nitrile Gloves 3.6L of 1% KOH solution



To prepare the electrolyser for operation, before DI water is added automatically, it must be filled with the electrolyte which is usually included in the shipment. If it was excluded, it can typically be procured or purchased locally. Please refer to **Appendix II below**.




Warning! Refer to the Material Safety Data Sheet (MSDS) of all chemicals used, before handling them. All persons using, preparing and filling the electrolyte into the systems must be informed about any potential hazards involved with their activities.
Attention: Mix the electrolyte solution in accordance with good industrial hygiene and safety practice and wear appropriate Personal Protective Equipment as specified by the Material Safety Data Sheet (MSDS) of the electrolyte solution. Avoid any contact with eyes and skin.
Attention: Carefully read the instructions below before beginning work. Follow the instructions – if you have any questions, please contact the Enapter support team.
Ensure all material used to store and contain your electrolyte solution is chemically compatible with its contents.

Step 1) Put on PPE. The minimum required equipment are safety goggles to protect from splashes and nitrile gloves. Ensure your working area is clean to avoid chemical contamination and potential exposure hazards.

Step 2) Attention: the unit should be kept powered on, follow the instructions on the app.

Step 3) Make sure the "O2 VENT" has no tube or fitting attached to it.

Step 4) Carefully raise the first-time filling solution above the device. Never lift the electrolyte above your eye level.

Step 5) Fully insert the supplied male CPC quick connector into the valve bulkhead labelled "Electrolyte" shown in the picture above.

Step 6) The solution will start filling immediately, if this does not occur, ensure the vent line is not obstructed.

Stop filling immediately if the App prompts you to stop!

If it is not stopped immediately and exceeds the maximum level, the electrolyzer will go into error and the solution may flow out of the vent line. If this happens, the tank must be drained, put the electrolyzer back in maintenance mode and repeat the process.

Step 7) Ensure all of the solution has been filled into the device.

Step 8) To disconnect, push the button and pull the connector out of the bulkhead.

You are done!

The device is ready to be used. If you have any questions relating to the safety, installation and control of the EL2.1, please refer to the Enapter handbook or contact Enapter support online via the cloud, or by email or telephone.

CONTROL, FUNCTIONS AND SYSTEM STATES

Before powering on the device, ensure the power cable is connected correctly, and all water, vent, purge and hydrogen pipes are properly connected and secured as described in this manual.

Remote Start/Stop

The EL can be started remotely using the Enapter app or cloud, by any user with access and correct permissions to the site the device was added to. For detailed information on this, please refer to the mobile application handbook.

The device can also be used and controlled remotely via the Modbus interface. For more information on this, please refer to the online Enapter handbook.

Manual Start/Stop

When the device is in standby mode, **push the start/stop button for 3 seconds**, this will start the electrolyser.

To stop the electrolyser, simply push the start/stop button. The electrolyser then ramps down and purges the contained H2 to return itself to a safe state.

Warning!
Do not unplug/disconnect the power to the EL 2.1 without either manually or via software control shutting down the device safely. Unexpected power cuts can shorten the device's lifetime and damage the system!

Maintenance Mode

Maintenance mode can be manually enabled using the Enapter App. This is used to safely fill and drain the device, as well as to guide you through inspection and other routine maintenance tasks.

For detailed information on this, please refer to the mobile application handbook.

Ramp Up

The ramp up time of the AEM Electrolyzer depends on the electrolyte temperature (the ramp up is slower at cooler temperatures and quicker in warm temperatures). Typically, the system will start with a hydration period of 60 seconds, and then ramp up to the nominal production rate with the following values:

- **Warm-up time (time taken for the EL to heat up):** The electrolyte working temperature in the AEM Electrolyzer is 55°C. The Electrolyzer can usually reach a heating ratio of 1 °C/min, at 55°C reaches maximum efficiency. For example, if we start the machine with an electrolyte temperature of 25°C it will take about 30 min to be fully operational and perform at its maximum efficiency.
- **Ramp up time (time to reach nominal production rate):** Usually, the 500 NL/hr production rate is reached in about 2/3 of the total warm-up time (the warm up time is 30 min, so if you start at 25, you will need 20 min to reach max production rate).
- **Build pressure time:** When the system starts and the Electrolyzer starts to heat up, the hydrogen production starts immediately, and the maximum production rate is reached later. With standard set-points, the pressure is completely built in 1/6 of the total warm up time (if you start at 25 °C, then the warm-up time is 30, so you need 5 min to build pressure).

During ramp up, the system performs periodical purges to guarantee high purity H2 on the outlet, as well as to release condensed water from the produced H2.

TRANSPORT, MAINTENANCE AND RECYCLING

The EL 2.1 Hydrogen Generator is designed to provide many hours of service with minimal maintenance. Proper care and maintenance by qualified personnel help maximize the operating life of the unit. The device was designed **for easy maintenance and to be a repairable device**. The modular design principle and repairability allow the hydrogen generator systems to be utilised in a large variety of applications, as well as in off-grid installation with a high degree of confidence.

Routine Maintenance

The unit should be inspected annually for apparent signs of physical deterioration. All hydrogen connections must be tested for leakages regularly; we recommend using one of the techniques listed in **Appendix** I below.

After commissioning, the process tank must be emptied at least once a year and new electrolyte filled into the device. For more information, please refer to **Appendix** III below, which details the draining process of the EL2.1.

And then follow the instructions for the **Pairing the Electrolyser to the cloud**

It is time to power on the device for the first time.

Using the Enapter app, add your device to a site. For detailed information on this, please refer to the mobile application handbook.

Step 4) To start using the application, you need an account in the Enapter Cloud. If you already have an account, simply skip this step.
To create an account, click on the create account button of the first screen.

Step 5) After logging in on the Enapter app, create a site – a virtual environment which will house all of the telemetries collected from the devices in your system connected to the cloud via UCMs (Universal Communication Modules).

Step 6) Add the EL2.1 to the site by scanning the QR code located on the front panel of the system.

Manual refilling of Electrolyte above. It is recommended to clean the device at the same time – described in the **Cleaning** section below.

Depending on the frequency of use, it is possible that the process tank needs to be emptied and refilled more than once a year. By connecting your device to the cloud, it is possible to receive alerts when the device voltages start increasing – this typically signifies a needed electrolyte change. After the electrolyte change, the electrolytic stack will return to a lower voltage, decreasing power consumption of the device and increasing its lifetime.

Warning!

Any maintenance activities, excluding the ones listed in the Routine Maintenance and installation sections, are only allowed to be performed by trained technicians!

Remove power from the device before working on it in any way.
Wear PPE at all times during the maintenance of the device.
Do not open the device!
During maintenance, avoid heat in the vicinity of the system and the hydrogen source. No smoking, no naked flames.
Prevent electrostatic charging of the device.

Before starting to work on the system, ensure you are aware of the local health and safety rules and regulation, as well as action plans if an accident occurs.

Cleaning

When performing the routine maintenance processes and checks, the machine should be inspected and cleaned. Start by carefully using a vacuum cleaner to clean out the ventilation openings/grills. Afterwards, use a damp cloth (no acids, aggressive or abrasive substances) to clean the outside of the unit.

Warning!
Remove the supply of power **before** cleaning the device. Never handle the electrical connections with wet hands. Ensure the device is dry before returning the supply of power to it.
Attention!
The internal components of the device do not need to be cleaned and must not be accessed by the user for cleaning.
Only trained and authorised personnel is allowed to open and inspect the device for maintenance reasons.

Disposal

Enapter is fully committed to **recycling** the EL 2.1 and its components.

Please return the device to Enapter at the end of life, where we will fully recycle the system.

By ensuring this product is correctly recycled, you will help to further reduce your impact on the environment and aid us in making the world cleaner and greener.

Transport

Before transport, verify the electrolyte tank has been emptied according to **Appendix III** below, and seal the connections on the front panel of the device. To seal the connections, simply insert the red plugs that were supplied with the device into their respective bulkheads and place the plastic caps on

the hydrogen outlet and purge. Ensure the device is transported in an upright position, and that an indicator for this is clearly visible on the outside of the packaging.

Attention!
We may not accept the unit if returned without the original shipping boxes or equivalent for safe transport. If damage occurs during the return of a system under warranty, Enapter will not cover the costs of repair.

Warning!
Never lift an EL2.1 alone, as it weighs over 50 kg. Use lifting aids if available. Due to their weight and size, it is recommended to use a pallet cart or similar devices to manoeuvre the box upon delivery.
If the box must be lifted somewhere, always lift with at least two persons.

Attention!
During winter, or when outside conditions are below freezing, the shipping box has to be additionally marked with a label informing the shipping agent that the package may not be exposed to temperatures below 2°C at any time.

APPENDIX

Appendix I. Hydrogen Leak Testing

As part of a hydrogen system, it is of vital importance to check every connection made for leaks. For more information on this matter, please refer to the appendix of ASME B31.12.

There are three main ways we recommend checking for leaks:

1) Surface hydrogen detection
2) Soap bubble testing
3) Pressure drop testing

Surface hydrogen testing

Using a calibrated hydrogen sniffer, slowly check for leaks around each connection.

Pros

- Precise, it can pinpoint even small leakages
- Can grade leakages according to leakage rates

Cons

- Does not work when there are elevated levels of hydrogen in the atmosphere

Soap bubble testing

Using a mixture of soap and water (please ensure the soap used is compatible with the materials used), the solution is dropped on individual connections using a small pipette. If the connection bubbles, a leak is present.

Pros

- Can be fast for larger leaks on small parts when testing multiple at one time.
- Accurate, it works even with elevated background H2 levels
- Best method for detecting exact leak location detection.
- Low equipment cost.

Cons

- Cannot detect tiny leakages
- No leak rate or test result information.
- Added cost: Parts must typically be dry
- Slow: Detecting small bubbles on typical parts can take much longer than other methods.
- Risky: An extremely operator dependent technique with a high possibility of passing actual failures.

Pressure drop testing

This test is performed by isolating individual sections of a pipe while monitoring the pressure contained within over time and should be performed at the maximum operating pressure of the system. If a drop in pressure is observed, which cannot be attributed to changes in temperature, a leak exists.

Pros

- Useful for final verification during system commissioning
- Can verify several connections at the same time

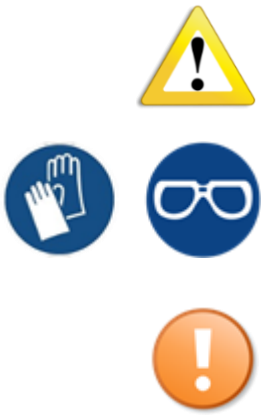
Cons

- Cannot detect exact leakage source
- Cannot grade leakage rates accurately

Appendix II. Preparing the electrolyte solution

Time required	5-10 minutes
Materials required	Safety Glasses Nitrile Gloves Clean 5L container 3.6L of DI-water (Conductivity < 20 µS/cm at 25°C) Chemical scales 36 g of KOH pellets

For routine maintenance, new electrolyte solution must be prepared. Regular changing of the electrolyte in the electrolyser helps prolong system life. This solution or chemical can generally be procured and purchased locally. However, if you are struggling to source the materials involved, please contact your Enapter Technical Support team.



Warning! Refer to the Material Safety Data Sheet (MSDS) of all chemicals used, before handling them. All persons using, preparing and filling the electrolyte into the systems must be informed about any potential hazards involved with their activities.

Attention: Mix the electrolyte solution in accordance with good industrial hygiene and safety practice and wear appropriate Personal Protective Equipment as specified by the relevant Material Safety Data Sheet (MSDS). Avoid any contact with eyes and skin.

Attention: Carefully read the instructions below before beginning work. Follow the instructions – if you have any questions, please contact the Enapter support team.

Ensure all material used to store and contain your electrolyte solution is chemically compatible with its contents.

Step 1) Put on PPE. The minimum required equipment are safety goggles to protect from splashes and nitrile gloves. Ensure your working area is clean to avoid chemical contamination and potential exposure hazards.

Step 2) Ensure the selected KOH resistant container is large enough to contain the solution entirely. Verify the container is clean, and no debris is visible inside. If you are unsure – go to step 3, otherwise, skip to step 4.

If you are preparing the solution in advance – clearly mark and label the solution. Keep out of the reach of children and untrained persons. Never store chemicals above eye-level.

Step 3) Thoroughly rinse the container with DI-water, at a minimum three times. Before continuing to step 4, perform another visual check to see if any other debris may be visible.

Step 4) Fill 3.6L of DI water with a conductivity below 20 µS/cm at 25°C into the KOH resistant container.

Step 5) Carefully measure out the required amount of KOH. To create a 1% KOH solution, you must add 36g of KOH into the 3.6L of DI-water.
Attention: Most KOH is not sold at 100% purity, you will have to adjust the amount of KOH pellets added to the solution, according to the KOH purity purchased.

Step 6) Fill the KOH into the container with the DI water. **The KOH reaction with water will produce a lot of heat until the pellets are fully dissolved!** Immediately stir the solution or mix it around the container with the lid firmly closed.

Appendix III. Draining the EL2.1

Time required	5-10 minutes
Materials required	Safety Glasses Nitrile Gloves Clean 5L container



The module must be drained for transport, installation and before the routine changing of the electrolyte in the electrolyser to prolong system life. To do this the device must be first switched into maintenance mode, using a command from the Enapter App. Follow the steps outlined on the App, or use the instructions below.




Warning! Refer to the Material Safety Data Sheet (MSDS) of all chemicals used, before handling them. All persons draining and handling the electrolyte from the systems must be informed about any potential hazards involved with their activities.

Attention: Wear appropriate Personal Protective Equipment. Avoid any contact with eyes and skin.

If you come into contact with the drained solution, immediately wash the affected area and refer to the material safety data sheet of potassium hydroxide and potassium carbonate.

Attention: Carefully read the instructions below before beginning work. Follow the instructions – if you have any questions, please contact the Enapter support team.

Ensure all material used to store and contain your electrolyte solution is chemically compatible with its contents.

Step 1) Put on PPE. The minimum required equipment are safety goggles to protect from splashes and nitrile gloves. Ensure your working area is clean to avoid chemical contamination and potential exposure hazards. **Enable maintenance mode using the Enapter App.**

Step 2) Attention: the unit should be kept powered on, if possible.

Step 3) Prepare the container to catch the drained liquid and insert the end of the drainpipe into it.

Step 4) Fully insert the supplied male CPC quick connector into the valve bulkhead labelled "Water Drain". The solution will start pouring out immediately.

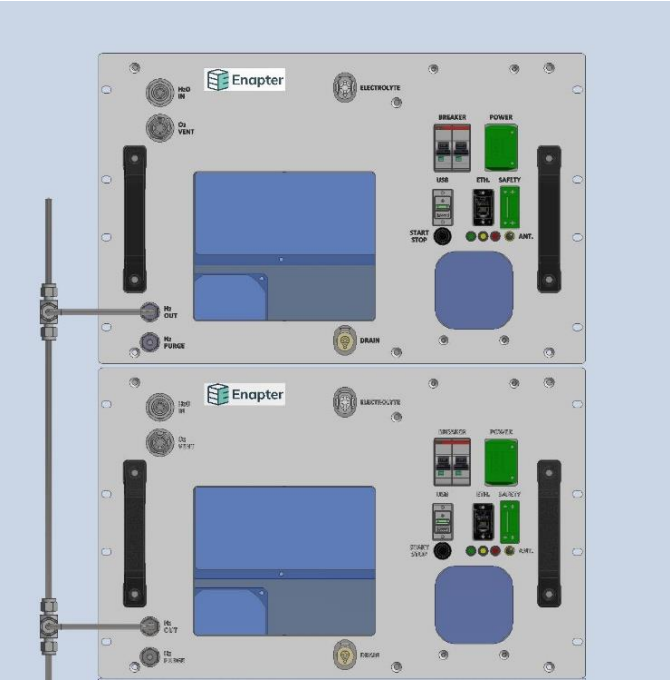
Step 5) Once water stops pouring, safely remove the drain connector.

Step 6) Collect the drained liquid in an appropriate container and place in a chemical waste container. Do not flush to sewer. Dispose of the liquid in compliance with local and national regulations.

Step 7) To disconnect, push the button and pull the connector out of the bulkhead.

Appendix IV. Integration in Cabinets

In this appendix, technical information to allow safe and proper integration of cabinets using Enapter hydrogen generator systems is given. The focus will be on cabinets for the indoor installation of the electrolyser modules. The user/integrator must at a minimum comply with the manufacturer's instructions described hereafter and apply available industrial standards for system safety as well as comply with local rules and regulation for the installation, integration and deployment of hydrogen storage systems.



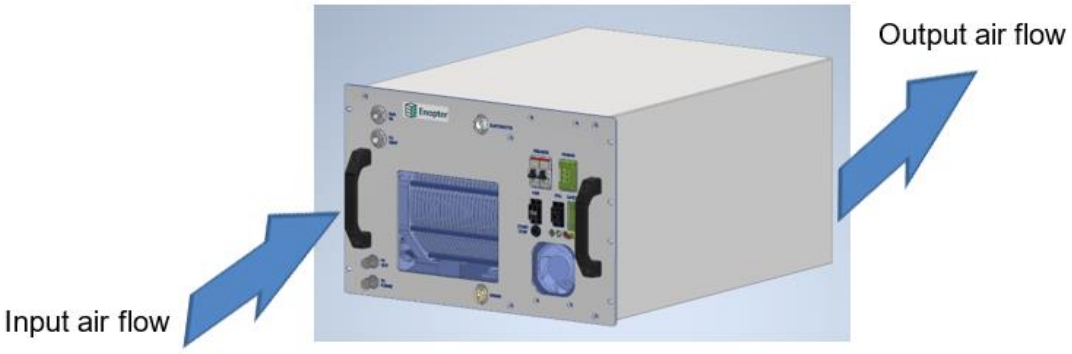
The EL2.1 is designed to allow simple installation of 19" racks and cabinets. By allowing each device to share common connections, such as the gas and vent outlets, the integration is streamlined for quick and flexible installations. We recommend using common lines to the left of the devices for all gas and water connections and to create all necessary electrical ducting on the right of the devices. This method allows individual devices to be pulled out of the cabinet without dismounting all connections from other devices. The lines should be offset from another, either vertically or horizontally depending on space available to the integrator, as shown on the picture on the left.

Another advantage of this mounting system is that it reduces the stress on the individual bulkheads. Connecting straight pipes between modules requires manufacturing the connecting pipes with very tight tolerances, but with the offset connections, it is possible to connect the electrolysers to the common lines using U- or L-bends, which are tolerant to slight inaccuracies and temperature-related changes to the system.

Management of air flows

Never allow the cabinet in which the device is installed to obstruct the Electrolyser's air intakes or outlets. While ducted air systems are possible to be used for the purpose of ventilation, the integrator must verify that the devices can circulate air through their systems as usual. For indoor use, perforated doors typically allow sufficient airflow for the modules.

All Enapter devices utilise front to back airflow (shown below) in order to allow a compact design; many cabinets/racks can thus be mounted directly next to each other. Airflow must be allowed to enter from the front and exit from the back, passing through the modules.



If the natural, unforced airflow in and out of the cabinet from the individually integrated modules cannot be guaranteed, there are two more ways to integrate devices safely. First one can rely on forced airflow, the integrator must achieve at a minimum 50 m^3/hr of air flowing through the system per standard hydrogen generator. In this case, the rear side of the cabinet must allow the hot air exhaust to escape unobstructed. To achieve this in the most straightforward way, leave at least 30 cm space behind the cabinet. It remains the responsibility of the system integrator to enable a correct and safe installation of cabinets in this way.

If forced airflow cannot be implemented efficiently – for example when using air-conditioning for integration in particularly hot environments – it is possible to allow little to no air exchange in the cabinet. However, in this case, hydrogen levels must always be monitored within the cabinet, and power must be removed should any leakages be detected.

Warning!
It is the responsibility of the integrator to ensure the safety concepts of each device integrated into the cabinet is upheld.
Contact Enapter support for help when starting a new integration project!

Cabinet

The front side of the cabinet housing the EL2.1 must be accessible to manage all electrical and mechanical connections and to maintain the device. Enapter recommends the installation of the EL 2.1 into a cabinet with a base of at least 600x800 mm to ease the design and integration of all associated piping, systems and safety components. The resulting cabinet must adhere to local safety rules and regulation – ensure that the cabinet can be deployed and fixed safely.

Attention!
It is the responsibility of the integrator to ensure that all devices contained in the cabinet are kept within operating limits. This may require active temperature/climate control.
Contact Enapter support for help when starting a new integration project!

Appendix V. LED States

The 3 LEDs located next to the right handle on the front panel help indicate the system status and operating condition. For more information on machine status and operation conditions, the cloud services and Enapter app detail the specific device states and error/warning messages please see the Handbook.

During normal operation, the LEDs indicate the status of the machine.

Action	Description	LED
Power on	The device will turn on as soon as the required input voltage is supplied to the EL2.1 and perform a start-up self-check.	Red, yellow & green blink thrice
Stopped	The machine is not producing hydrogen, waiting for action.	Green off
Stand-by (Max pressure state)	The device reached maximum pressure (normally 35 bar) and will resume hydrogen production automatically when the restart output pressure setpoint is reached.	Green blinking
Button Press	When the start-stop button is pressed.	Red, yellow & green blink once
Maintenance mode	The device is in maintenance mode.	Yellow steady
Locate device	When locate device is enabled via remote control.	Red, yellow & green blinking
All other states	Normally operating.	Green steady

When there is an error, the LEDs also indicate the status of the machine

Severity Code	Severity Level	Description	LED	Comment
W	Warning	• The system will continue to work. • Heads-up event which should be taken into account to avoid Error or Fatal Error. • The warning can be reported using remote monitoring and resolved automatically by the system.	Yellow blinks	e.g. No input Water Pressure and internal water tank is full.
E	Error	• The system stops. • Errors will be reported using remote monitoring. These can be resolved by switching the system into maintenance mode. • Some errors can be solved remotely.	Red blinks	e.g. No input water pressure and internal water tank is empty
F	Fatal Error	• The system stops. Unrecoverable error. Hardware repair required. • A fatal error will always be reported using remote monitoring. • Please contact Enapter support. This error can't be resolved without intervention by the Enapter support team or trained technicians.	Red and Yellow blink	e.g. Pressure sensor is not connected or broken.
	Panic	• The system stops. • Panic error levels will not be reported using remote monitoring and can't be fixed. • Please contact Enapter support.	Red steady	

Appendix VI. Error Codes

Below is a list of all the errors that can be triggered while using the electrolyser. For detailed information on this, please see the Handbook.

Error Message	Severity Code	Routine Code	Component	Condition	Description
FP_01	F	P	--	Voltage < 2.9V	BURNOUT DETECTED, RESTORE POWER AND RESET SYSTEM
FP_02	F	P	--	Updated firmware has new mandatory settings	NEW PARAMETER HAS BEEN ADDED TO CONFIGURATION, PLEASE RE CHECK AND WRITE A ONE. CONTACT ENAPTER SUPPORT OR CERTIFIED PARTNER
FC_10	F	C	P107	--	PUMP BROKEN
FT_10	F	T	TT106	Temperature > 58°C	TOO HIGH ELECTROLYTE TEMPERATURE
WT_20	W	T	F103A	Rotation < 600rpm	ELECTROLYTE COOLING FAN BROKEN
ET_10	E	T	TT102A	Temperature < 6°C	Electrolyte temperature too low
FR_10	F	R	LSHH102A	Water level over level switch	TOO MUCH HIGH ELECTROLYTE LEVEL
FR_20	F	R	LSL102D	Water level below level switch	TOO MUCH LOW ELECTROLYTE LEVEL
FR_50	F	R	LSL102D LSM102C	--	WATER SENSOR CONFLICT LOW MEDIUM
FR_51	F	R	LSM102C LSH102B		WATER SENSOR CONFLICT MEDIUM HIGH
FR_52	F	R	LSH102B LSHH102A	--	WATER SENSOR CONFLICT HIGH VERY HIGH
FR_40	F	R	--	--	CHECK WATER LEAKS
FR_30	F	R	--	--	TOO HIGH-WATER INLET PRESSURE
WR_10	W	R	PT105	Pressure > 5barg	WARNING TOO HIGH-WATER INLET PRESSURE
WR_20	W	R	PT105	Pressure < 0.5barg	WARNING TOO LOW WATER INLET PRESSURE
WR_21	W	R	--	--	WARNING REFILLING TIMEOUT
WR_51	W	R	LSL102D	--	WARNING DRAIN COMPLETELY
WR_52	W	R	LSL102D	--	WARNING REFILL TO LOW LEVEL
WU_10	W	U	PT101A	Pressure is > atmospheric pressure + 10%	Gas side pressure is not atmospheric. Ramp-Up is not possible (pressure too high for start)
WS_20	W	S	--	--	WARNING MAX PRESSURE
WS_21	W	S	PT101A	Pressure spike > 2%	WARNING DRIFTING PT101A
FD_20	F	D	PT101A	Pressure drop > 2%	HYDROGEN LEAKS
FX_01	F	X	PT101A	Pressure > 37bar	Hydrogen inner pressure too high
FX_02	F	X	WPS104	Water sensor is wet	Water presence
FX_03	F	X	PSU 48V	No voltage from PSU	PSU broken
FX_04	F	X	HASS	Current > 58A	Stack current too high
FX_05	F	X	TSH106	--	Backflow temperature too high

FX_06	F	X	PT101A	--	Hydrogen leaks
FX_07	F	X	TS108	Temperature > 75°C	Electronic board temperature too high
FX_08	F	X	PSH102	--	Electrolyte tank pressure too high
FX_09	F	X	TSLL102B	--	Electrolyte temperature too low
FX_10	F	X	PSHH102B	--	Hydrogen pressure too high
FX_30	F	X	PT105	--	Water inlet pressure transmitter broken
FX_31	F	X	TT102A	--	Electrolyte tank temperature transmitter broken
FX_32	F	X	FM106	--	Electrolyte flow meter broken
FX_33	F	X	TT106	--	Electrolyte backflow temperature transmitter broken
FX_34	F	X	PT101A	--	Hydrogen inner pressure transmitter broken
FX_35	F	X	PT101C	--	Outer hydrogen pressure transmitter broken
FX_36	F	X	F1084B	Rotation < 3000rpm	Chassis circulation fan broken
FX_37	F	X	F108C	Rotation < 3000rpm	Electronic compartment cooling fan broken
FX_38	F	X	TS108	--	Electronic board temperature transmitter broken
FX_39	F	X	HASS	--	Current sensor broken
FX_40	F	X	External switch	--	Dry contact error
FF_10	F	F	--	--	Frozen pipes
FL_01	F	L	--		Huge H2 leak detected
WO_10	W	O	PT101C	Pressure > 25 barg	Outer pressure is too high to run blowdown routine
WO_20	W	O	--	--	The Blowdown procedure will be started at H2-production start
FO_30	F	O	PT101C	--	The purge line is obstructed or the adjustable check valve (CV101B) cracking pressure is set incorrectly
WH_10	W	H	ModBus	Heartbeat Packet was not received in time	Lost ModBus safety heartbeat communication
WH_11	W	H	Gateway	Heartbeat Packet was not received in time	Lost Gateway safety heartbeat communication
WH_12	W	H	UCM	Heartbeat Packet was not received in time	Lost UCM safety heartbeat communication