
HYDROXPAND · USER MANUAL

HXB-V1

2 kW hydrogen generation system

User Manual



DOCUMENT CONTROL

Document control

Document information

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About this manual

This manual is the formal print edition of the HydroXpand web handbook. Its content is the same as the web handbook.

The web handbook is updated first. Where this print and the web differ, the web handbook is current. Each chapter shows its own update date at the top.

Read the safety chapter first. The meaning of the signal words (danger, warning, caution, notice) is in its first section.

Revision history

Rev.	Date	Description
1.0	2025-12-02	First version
2.0	2026-01-16	General revision
2.1	2026-03-11	Product photo revision
2.2	2026-06-11	General revision
2.3	2026-09-08	Electrolyte revision (0.3 M → 0.1 M KOH, recommended temperature 60 → 50 °C)
3.0	2026-10-02	Full revision built from the web handbook, which is now the master text
3.1	2026-10-04	Modbus TCP support added, stack voltage split into 46 V setting and about 40 V in operation, manual emergency stop stated as app only
3.2	2026-10-04	Electrolyte change procedure added; decommissioning now checks hydrogen pressure before powering down
3.3	2026-10-04	Pre-maintenance stop split by task, DRAIN connection corrected (ferrule fitting, no valve), electrolyte 0.1–1 M (0.1 M recommended), hydrogen leak check at first start, 2 vol% hydrogen-in-oxygen warning, 50 A voltage about 38 V new and 40 V in service
3.4	2026-10-04	Safety messages reworked: consequences added and signal words corrected (caution level used), oxygen fire warning, no oil or grease on oxygen lines
3.5	2026-10-04	Static ignition and hot-surface warnings added
3.6	2026-10-04	Check and if-not lines added to key steps
3.7	2026-10-04	Modbus TCP data format and register areas added
3.8	2026-10-04	Pressure mode removed: hydrogen pressure set at order by relief valve (0/10 barg; 30 barg by agreement); depressurise with Emergency STOP before decommissioning
3.9	2026-10-04	Pressure option corrected: 30 barg to 35 barg (under verification; by agreement)
3.10	2026-10-04	Downstream build-up drawing (Figure 8-1) added

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01 Safety

HXB-V1 · updated 2026-09-30

The HXB-V1 makes hydrogen and oxygen, runs on mains power with high direct current, and circulates a corrosive electrolyte. Three hazards live in one machine, so the safety rules come in three strands.

This chapter covers immediate safety actions only. Diagnosis is in the troubleshooting chapter, and that work happens after the area is secure and only by qualified people.

HAZARDS **Hydrogen · electricity · electrolyte** PPE **Depends on the task** WHEN TO READ **All of it, once, before installing**

HOW TO READ THIS CHAPTER

First time

There is no section here to skip. Read it through once before installing, and keep the emergency response section next to the system.

Done this before

Re-read the signal words and the emergency response. Use the rest when checking against your own site safety rules.

Signal words

This handbook and the manual use the same signal words. They differ in severity, so read them as such.

SIGNAL WORD	MEANING
 DANGER	A situation that will cause serious injury or death if not avoided
 WARNING	A situation that could cause serious injury or death if not avoided
 CAUTION	A situation that may cause minor or moderate injury if not avoided
 NOTICE	Information that is not about personal injury but prevents equipment damage or loss of performance

PRACTICAL NOTES

The symbols on the machine mean the same things

- The front panel carries symbols for general warning, electric shock, explosion, no open flame, no smoking, no objects in front of vents, and wear PPE.
- When you see one, look up the instruction that goes with it. Do not act on the symbol alone.

Hydrogen

DANGER

Hydrogen explosion hazard

- The HXB-V1 makes hydrogen during normal operation. It is colourless and odourless, highly flammable, and forms explosive mixtures with air, especially in a confined space.
- The flame is almost invisible. Do not rely on your eyes to tell whether it is burning.
- It is lighter than air and collects at ceilings and other high points.
- Keep the area ventilated and remove ignition sources from around the unit. Check for leaks as described below.
- Very little energy is needed to ignite it (about 0.02 mJ), so even a static spark can set it alight. Earth the hydrogen lines and equipment, and where a leak is suspected avoid clothing and plastic tools that build up static.

Ventilation and detection

- Operate only in a well-ventilated area, or connect the vents to an engineered exhaust system.
- Do not operate in a sealed or poorly ventilated room.
- HXB-V1 is not certified for explosive atmospheres. Do not install it in an area classified as hazardous (an ATEX or equivalent zone). Place it in a non-hazardous area kept free of explosion risk by ventilation.
- For indoor installation we strongly recommend a hydrogen detection system with an appropriate safety circuit.

Ignition control

- Keep smoking, open flames, welding, grinding and any spark-producing work away from the system and the vent outlets.
- Use electrical equipment suited to the area classification wherever hydrogen may be present.

Checking for leaks

- Use an approved method: a hydrogen detector or leak detection solution.
- Never use an open flame to check for a leak.

WARNING

If hydrogen in the oxygen stream exceeds 2 vol%, stop electrolysis and contact us.

- Hydrogen crossing the membrane builds up on the oxygen side and can form an explosive mixture in the oxygen line and separator.
- The control app does not show this value. To measure it, fit a hydrogen analyser or detector after O2 OUT.
- This is a safety limit, not a warranty or free-replacement threshold.

 DANGER

If you suspect a hydrogen leak, stop at once. An ignition source can set off a fire or explosion.

- Stop operating at once and follow the emergency response section below.
- Warn people nearby and keep ignition sources away.
- Increase ventilation according to your site procedure.
- Do not restart until qualified personnel have found and corrected the cause.

Vent lines

 DANGER

Never combine a hydrogen vent line with an oxygen vent line.

- The two gases meeting in one line form an explosive mixture. Route them to separate safe discharge points.
- Vent lines must stay open. Do not fit valves or devices that could inadvertently close one.
- Do not restrict the lines or create backpressure.
- Keep them free of obstructions, kinks, debris and trapped liquid.
- Condensate can freeze. Use slope, drain points, insulation or heat tracing as your site conditions require.
- Provide a drain point or water trap at the low point so liquid cannot block the line.
- Route the outlets away from ignition sources and follow local codes and site safety rules.
- Do not place objects in front of the vent outlets.
- If you connect the hydrogen outlet to downstream equipment or storage, provide overpressure protection as the code and your system design require.

 WARNING

Where oxygen is concentrated, things catch fire easily and burn fiercely.

- Around O2 OUT and the oxygen vent end the oxygen concentration is high. Cloth, paper and oil ignite easily, and burning clothing causes burns.
- Keep combustibles and ignition sources away from the release point and ventilate. Never use oil or grease on oxygen lines and fittings.

Electrical

 DANGER

Electric shock and arc flash

- The system contains mains AC wiring and high-current DC circuits. Contact with a live conductor causes serious injury or death.
- Isolate mains before opening a cover or touching wiring. Electrical work is for qualified personnel only.

- Electrical installation must be done by qualified personnel.
- Provide overcurrent protection and a disconnecting device to local code.
- Earth the system and everything connected to it correctly.
- Never connect or disconnect power cables under load.
- Voltage can remain after shutdown because of stored energy. Switch off, isolate, wait for it to discharge, and measure the terminal voltage before handling anything.
- Do not short the terminals with a tool.
- Get the polarity right and make the terminations tight. A loose connection causes overheating and arc faults.
- Keep electrical parts dry and away from electrolyte.
- Do not remove covers while powered. Do not touch terminals, busbars or wiring until power is isolated and verified dead.

Electrolyte

WARNING

Corrosive alkaline electrolyte

- KOH solution is corrosive and causes severe skin and eye burns. Alkali burns hurt later than they start, so it is easy to miss the contact.
- Handle it with sealed goggles and alkali-resistant gloves. If it touches you, rinse at once with plenty of water and follow the emergency section below.

CAUTION

In operation the electrolyte, lines and stack reach up to 70 °C. Touching them bare-handed causes burns.

- Wear gloves when touching them in operation or just after a stop. Confirm they have cooled before opening a line or draining electrolyte.

- Handle it according to the SDS and your site procedures.
- Use only KOH-compatible materials: containers, tubing and fittings alike.
- Avoid splashing when filling or draining tanks, hoses or filters.
- For a spill, contain and clean it by your site procedure and dispose of the waste to regulation.
- On contact, flush with water immediately and seek medical attention if needed.
- An eyewash station and a safety shower must be available near where KOH is handled.

PPE

NOTICE

Where your site rules are stricter than this document, follow your site rules.



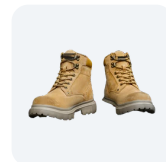
Safety glasses



Sealed goggles



Alkali-resistant gloves



Closed-toe shoes

Routine operation and monitoring

Safety glasses, closed-toe shoes and suitable work clothing

Handling electrolyte

Splash-proof goggles or a face shield, KOH-resistant gloves, and a chemical apron or lab coat

Working directly on the stack

Safety glasses and work gloves, plus whatever the task needs. Near power cables or terminals, add electrical protection

Emergency shutdown and response

DANGER

Do not delay an emergency shutdown.

- In any abnormal or hazardous situation, personal safety comes first. If you are unsure, stop and evacuate by your site procedure.

The common sequence

For a visible gas or electrolyte leak, an unusual noise, smoke, fire nearby, or visible damage.

- 1** If it is safe to approach, stop the system and leave it off.
- 2** Press Emergency STOP in the control app.
 - The unit has no emergency-stop button. The red button on the front is Reset and does not stop operation.
 - If you cannot reach the app at once, go straight to the next step and isolate power at the external disconnect.

3

Isolate power at the external mains disconnect.

4

Warn people nearby, evacuate anyone not needed, and restrict access to the area.

5

Follow the site emergency plan and notify the responsible safety officer.

6

Do not resume until qualified personnel have found and corrected the cause.

What each situation adds

Suspected hydrogen leak

Do not operate switches or equipment that could spark in that area. Keep ignition sources away and increase ventilation by your site procedure. Do not re-enter until authorised personnel declare it safe.

Suspected vent blockage or icing

Keep people away from the discharge point. Do not try to clear the blockage until the piping is fully depressurised and isolated. Only qualified personnel do this work.

Electrolyte spill or exposure

Avoid skin and eye contact with the spill. Follow your site spill response. If a person is exposed, rinse with water immediately, follow the first aid in the SDS, and seek medical attention if needed.

02 Receiving and storage

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Inspect the packaging and system on arrival, then store it until installation. Record any damage or missing items before connecting it.

MOVING **Lifting aid or 2 people or more** STORAGE TEMPERATURE **5 °C or above**

HOW TO READ THIS CHAPTER

First time

Read unpacking and inspection in order. Check storage conditions if installation will wait.

Done this before

Go straight to the inspection checks and storage conditions.

Unpacking and inspection

Before you start

Prepare the delivery documents, order details, a camera, and a lifting aid or people to move the unit.

Work sequence

CAUTION

It weighs 51.3 kg. Lifting it alone can injure your back, or you may drop it on your feet.

- While packaged, take a pallet jack or forklift under the pallet. Once unpacked, use a lifting aid or at least two people.
- Never lift it by the front panel, the connectors, or attached hoses and cables.

1

Look at the outer packaging first.

- Check for damage, deformation and signs of impact.
- Note any damage on the delivery documents and photograph it. You will need that for a carrier claim.

2

Open the box carefully.

- Keep the blade shallow: it can damage the port threads or the protective caps.
- The box is a close fit, so do not pull the unit out by hand. Cut away the top and side panels first, then remove the foam in order.

Move the unit into place.

- Set it on a stable, level surface that can take the weight.

Inspect it by eye.

- Check the enclosure for dents, cracks and deformation.
- Check the fluid ports, connectors, power inlet and Ethernet port on the front for mechanical damage.
- Look for signs of leakage or residue around the ports and fittings, and for anything that loosened in transit.
- Verify the model and serial number on the nameplate.

Inspection completion criteria

Verify the model and serial number against your order. The enclosure, ports and connectors must be undamaged, with no leakage traces or residue around the fittings.

If a check fails**⚠ WARNING****If anything is damaged or missing, do not connect power or piping.**

- Record the condition and photograph it.
- Tell us and the carrier immediately, and agree what happens next before you operate.
- If it suffered a severe shock or was tipped in transit, do not install or operate it even if it looks intact.
- Running a unit damaged in transit can leak hydrogen or electrolyte and lead to fire or burns.

PRACTICAL NOTES**Keep the packaging**

- You will need it if the system moves or goes back for service. Stack service works by return shipment, so this actually comes up.
- The box is 500 × 710 × 330 mm and the heat-treated wooden pallet is 500 × 710 × 120 mm, in case you are planning where to keep them.

What we check before shipping

Every unit is tested on the items below at our factory, and the results go out with it in the factory acceptance test report. The report also records the serial number and the hardware, firmware and app versions. Quoting these versions when you contact us speeds up diagnosis.

- Appearance, wiring and connectors, part labelling, electrolyte tubing connections
- Power-up, firmware, communication with the PC and data logging

- That the unit stops safely when the connection to the PC is lost
- That the level, overfill and tank pressure switches work and trigger emergency stop
- Water make-up, circulation pump, flow control, heater and cooling fan, temperature control
- Valve states in normal operation and on emergency
- Constant-current and constant-voltage operation of the stack supply, pressure sensors, relief valve setting
- Hydrogen leak sensor and electrolyte leak sensor
- No unexpected stop, alarm, leakage or hot spot (thermal camera check) during a continuous run

What to recheck on site

- The serial number on the report matches the nameplate
- On first power-up the app connects and the LED shows STANDBY (yellow)
- After installation and before the circulation pump is started, the flow reading stays still near zero

The acceptance check for the first run is in the Quick start chapter.

Before installation


NOTICE

Never let it freeze. Keep it at 5 °C or above at all times.

- We remove as much electrolyte as practical before shipment, but residual liquid and moisture stay inside the stack, the tubing, the pump, the valves, the tank and the heat exchanger.
- If that liquid freezes it damages the membrane, the seals and internal parts, and it shows up as a leak or a fault after installation.

Temperature	5 °C or above at all times
Orientation	Upright, as marked on the packaging
Packaging	Leave it in the original packaging
Port protection	Keep the shipping caps and plugs on until installation
Vibration	Avoid sustained vibration. It loosens fittings, fasteners and electrical connections, and that leads to leaks and faults.
Humidity	Keep it dry and free of condensation. Store indoors and out of direct sunlight.
Stacking	Do not stack heavy items on top of the package.

After inspection

03 Installation and battery limits

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What you need between delivery and the system sitting in its place, including where our supply ends and your site begins.

Installation must be done by someone familiar with hydrogen safety, electrical safety and alkaline electrolyte handling. Read the safety chapter first.

WEIGHT 51.3 kg · two people or more **CLEARANCE** Front 300 mm · rear 400 mm **LOAD** 100 kg or more

AMBIENT 5–45 °C

HOW TO READ THIS CHAPTER

First time

Start with unpacking and incoming inspection on the day it arrives. Reading the site and battery-limit sections before delivery makes the preparation quicker.

Done this before

The site conditions and the battery-limits table are all you need.

What arrives and what you prepare

Included



The HXB-V1 itself

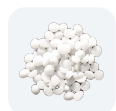


The user manual, sent electronically



The factory acceptance test document

Prepare separately unless ordered



Electrolyte, the KOH solution



DI water



The Ethernet cable and the AC power cord



A hydrogen dryer, if you need a lower dew point and higher purity

Photos show the type of item only. Water container photo by Safilol222299 (Wikimedia Commons, CC BY-SA 4.0, background removed and edited). The edited version is released under CC BY-SA 4.0.

Your site provides



A control PC or laptop



A chemically compatible container for the electrolyte



A container for DI water make-up



A drain container for used electrolyte



KOH-compatible tubing and fittings



Whatever valves, sensors and safety or relief devices your site design requires

Photos show the type of item only. Water container photo by Safilol222299, tubing photo by Best Tech Nick 25 (Wikimedia Commons, CC BY-SA 4.0, background removed and edited). Both edited versions are released under CC BY-SA 4.0.

NOTICE

Check anything your site provides for compatibility with the HXB-V1 before installing.

- That covers the dryer, flow meters, vent and drain routing parts, and any extra sensors or valves.

Unpacking and inspection

Where it goes

WARNING

Inadequate site conditions create serious hazards.

- Without enough ventilation, leaked hydrogen can build up and explode; a wrongly routed vent releases hydrogen and oxygen indoors.
- Meet every installation condition below (ventilation, clearances, vent routing, ambient temperature) before you install.

Surface or rack	A stable, level surface or a 19-inch 6U rack. It must support at least 100 kg, counting the unit plus hoses and cables.
Front clearance	At least 300 mm, so you can connect and disconnect tubing, plug in power and Ethernet, see the LED and reach the power switch.
Rear clearance	At least 400 mm. Do not block the rear exhaust airflow.
Ambient temperature	5–45 °C
Ventilation	Indoors, well ventilated. Not in a sealed room or a small unventilated enclosure.
Ceiling	Hydrogen is lighter than air and collects high up. Avoid covered ceiling spaces where it can accumulate.
Discharge points	Decide where O2 OUT, H2 OUT and H2 VENT each discharge safely before you start.
Hydrogen detection	If your site risk assessment calls for it, fit a detector and put alarm and response procedures in place.

Before installation

Battery limits

What is inside the one box and what belongs to your site. When you review a quotation, line it up against this boundary first.

Inside the unit	The stack, the electrolyte tank and circulation pump, the heat exchanger, the heater, power conversion, control and instrumentation, and the safety interlocks. You do not have to assemble a separate balance of plant.
-----------------	--

Upstream is yours	The DI water supply, making up and storing electrolyte, the incoming power and breaker, and earthing.
Downstream is yours too	Vent and exhaust routing, the dryer, compression and storage, the connection to the point of use, and whatever overpressure protection the code requires.
Who repairs what	Repair and replacement of site equipment is the customer's responsibility. We interpret the alarms and operating trends to judge the system's behaviour and tell you whether factory service is needed.

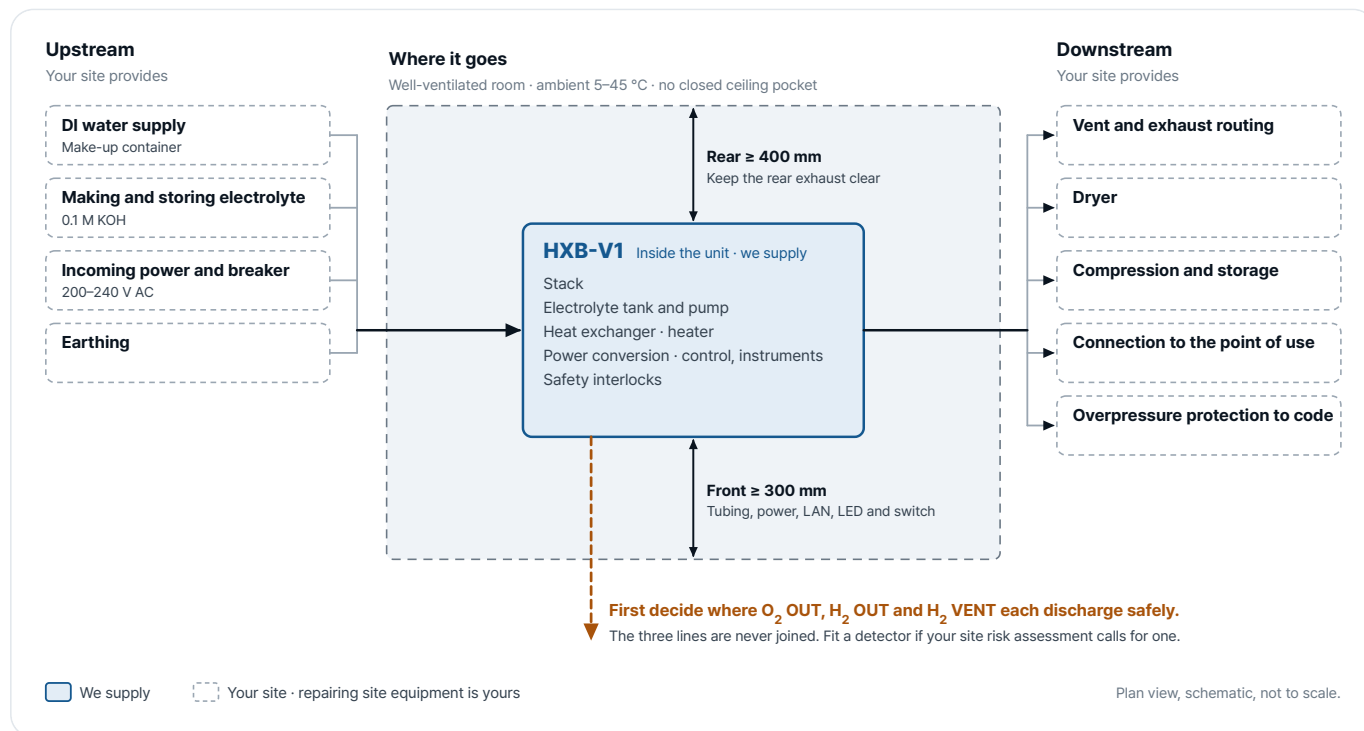


Figure 3-1 Battery limits and placement. The blue box is what we supply; dashed boxes are yours. Plan view, schematic, not to scale.

TECHNICAL BACKGROUND

If you are still deciding how to build the downstream

- Without a dryer a 0 barg unit delivers 98-99% hydrogen; with one it is 99.999% or better. A 10 barg unit delivers 99% without a dryer.
- The purity you need comes from the application, so decide whether you need a dryer first. The components pages set out the dryer and the compression and storage options.

04 Quick start

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The sequence from delivery to your first hydrogen and the acceptance check. Half a day is enough once everything on the checklist is at hand.

Before installing, review the site space, ventilation and utility requirements in Installation and battery limits.

TIME Half a day **PEOPLE** 1 (2 recommended for handling electrolyte) **PPE** Eye protection · alkali-resistant gloves

PRIOR KNOWLEDGE No electrolysis experience · basic hydrogen, electrical and alkali safety

ACCEPTANCE No leaks · stable flow and level

HOW TO READ THIS CHAPTER

First time

Work through the steps in order. Practical notes explain the reasoning and common mistakes; the last two sections cover acceptance and what to record.

Done this before

The acceptance check and the records are what you need. Recommended setpoints and operating ranges are in the operation chapter.

1. What to prepare



1 × PC

Runs the control app (HXB HMI). The app ships with the system; ask us if you need the latest version.



1 × Ethernet cable

Connects the PC directly to the system.



1 × AC power cord

C19 plug. The inlet on the system is C20.



Tubing

One electrolyte and water inlet, one electrolyte drain, two hydrogen outlets, one oxygen outlet.



Electrolyte

About 5 L of 0.1 M KOH for the first fill, made up in DI water from KOH of 95% purity or better. Anything from 0.1 to 1 M can be used; 0.1 M is recommended. The reference values in this handbook (conductivity, voltage) are for 0.1 M.

DI water



For automatic make-up during operation. Recommended ASTM D1193 Type II (1.0 $\mu\text{S}/\text{cm}$ or below at 25 °C), maximum 30 $\mu\text{S}/\text{cm}$.

Photos show the type of item only. Tubing photo by Best Tech Nick 25, water container photo by Safilol222299 (Wikimedia Commons, CC BY-SA 4.0, background removed and edited). Both edited versions are released under CC BY-SA 4.0.

Mixing the electrolyte

0.1 M KOH contains about 5.6 g of pure KOH per 1 L of final solution. Adjust the weighed amount for reagent purity, dissolve in DI water, cool to room temperature, then make up to a final volume of 1 L.

01 Wear protective equipment

Wear eye protection and alkali-resistant gloves. If it contacts skin, rinse immediately with running water; alkali burns hurt later than they start.

02 Add KOH to water

Always add the KOH to the water, never the other way round: reversing the order causes violent local heating and splashing. Add it a little at a time and stir.

03 Cool to room temperature

The solution gets hot as it dissolves. Let it cool to room temperature before it goes into the system.

Water and electrolyte care

Feed-water quality

Take feed water from a stable, well-maintained purification system, and avoid sources high in organics, silica or particulates. Type III or IV water can be used for short-term testing, but it shortens maintenance intervals and accelerates degradation.

When to replace electrolyte

Replace the electrolyte on condition and performance trend rather than on a fixed interval, because KOH is not consumed during operation the way water is. Replace it if you see discolouration or solids, or if the voltage trend shifts at a comparable operating point.

Before you start

**DANGER**

Proceed only once installation is complete and you have read the safety chapter.

- Ventilation and safe discharge routing must be in place. Without both, do not begin.
- Running without ventilation and a vent path lets leaked hydrogen collect indoors, where it can explode.

- All five lines are connected and each runs to a safe place.
- Power and Ethernet are connected and the control app finds the system.
- The electrolyte for the first fill and the DI water for make-up are ready.
- You are wearing eye protection and alkali-resistant gloves.

2. Identify the front-panel ports

Start with the labels on the front panel. Every fluid port is a 1/4-inch double-ferrule fitting. Naming can differ between revisions, so follow the labels on your own unit.

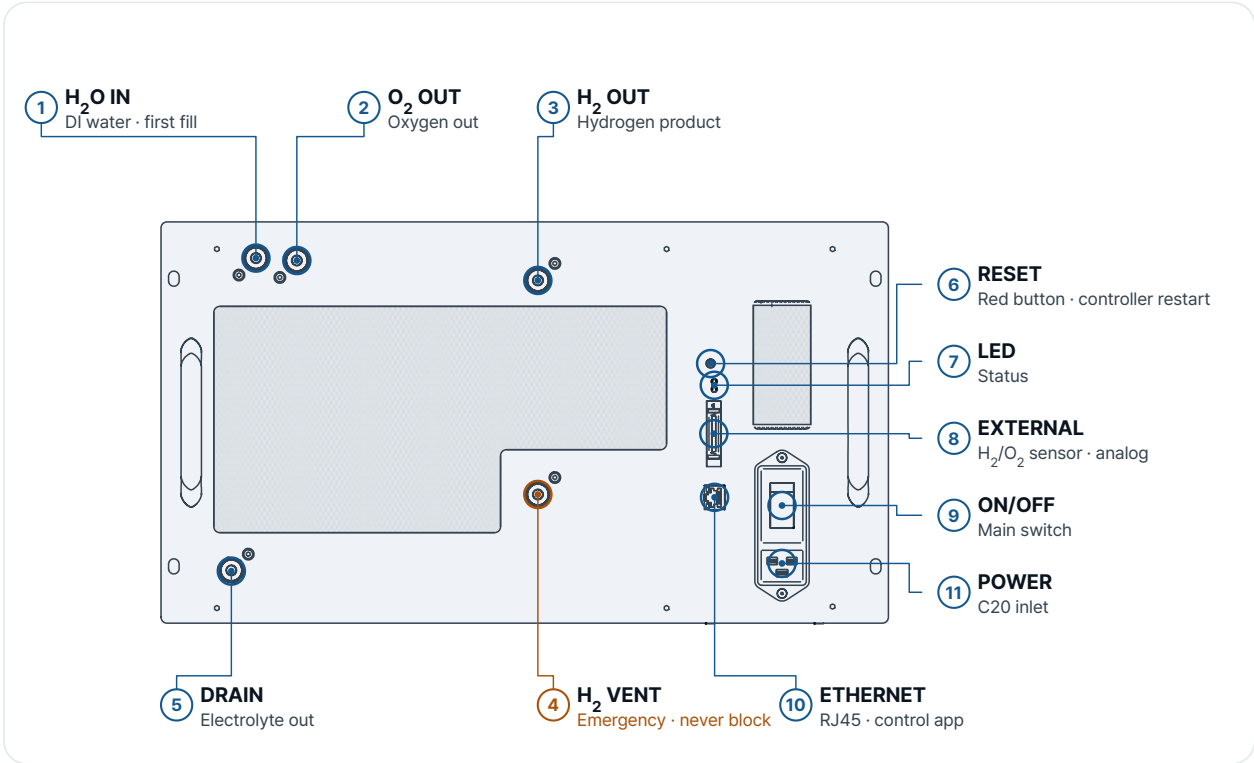


Figure 4-1 HXB-V1 front panel and port layout. The labels are engraved in English. Layout can differ between revisions, so follow the labels on your own unit.

NO.	LABEL	WHAT PASSES THROUGH	CONNECTION
1	H2O IN	DI water in. The first electrolyte fill also goes in here	1/4-inch double ferrule

NO.	LABEL	WHAT PASSES THROUGH	CONNECTION
2	O2 OUT	Oxygen out	1/4-inch double ferrule
3	H2 OUT	Hydrogen out. This is the product line to your point of use	1/4-inch double ferrule
4	H2 VENT	Hydrogen leaves here in an emergency. Never fit a valve or plug it	1/4-inch double ferrule
5	DRAIN	Electrolyte out	1/4-inch double ferrule
6	Reset	The red button. Restarts the controller into STANDBY. Press it to release an emergency stop. It is not a button for stopping operation	—
7	LED	Shows the operating state. How to read it is in the operation chapter	—
8	External	For an external hydrogen or oxygen sensor	Analog signal
9	ON/OFF	Main power on and off	—
10	Ethernet	How the control app reaches the system	RJ45
11	Power	Mains power cord	C20 inlet

PRACTICAL NOTES

If double-ferrule fittings are new to you

- There are two metal rings, the ferrules, inside the nut. Tightening the nut drives them onto the tube surface to make the seal. It is not a thread-sealing joint, so no tape is involved.
- The tube has to be seated fully before you tighten. If it is short, the ferrules bite in the wrong place, the joint leaks, and that tube end cannot be reused.
- Follow the fitting maker's instructions for how far to turn it. Over-tightening damages the ferrules and the body. If it leaks, check that the tube is fully seated before tightening further.

PORT	FUNCTION
H2O IN	Electrolyte for the first fill, then water make-up
H2 OUT	Hydrogen outlet
O2 OUT	Oxygen outlet
H2 VENT	Hydrogen vent and relief outlet for emergency release

PORT	FUNCTION
DRAIN	Electrolyte drain. Connect a hose only while draining
Ethernet	RJ45 for the control app, connected to the PC
Power	C20 AC inlet
Power switch	System main power
LED	System status. What each state means is in the operation chapter
External port	Optional. Analogue input for an external hydrogen or oxygen sensor
Reset	Red button. Restarts the controller, releases an emergency stop

3. Connect the tubing

Connect every line you need before operating.

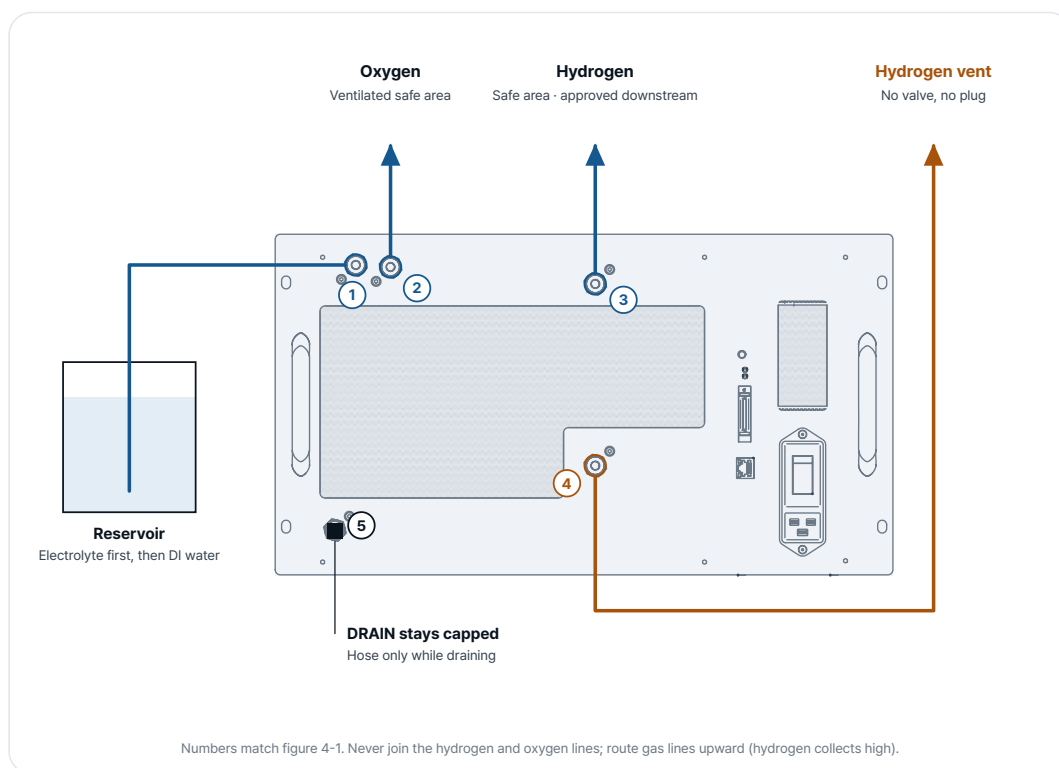


Figure 4-2 Tubing routes. Numbers match figure 4-1. Keep the hydrogen and oxygen lines separate and route gas lines upward.

1

Electrolyte and water inlet

- Connect tubing to H₂O IN.
- Leave the free end ready to place in a reservoir: electrolyte at first, then DI water.

2

Hydrogen outlet

- Route H2 OUT to a well-ventilated safe area or to approved downstream equipment, following your site rules.
- Route H2 VENT to a well-ventilated safe area as well.

3

Oxygen outlet

- Route O2 OUT to a well-ventilated safe area, keeping the lines separate so the gases cannot mix.

4

Electrolyte drain

- Keep DRAIN capped during normal operation.
- Connect a drain line only when you are draining. There is no valve, so it flows the moment the cap is off.

PRACTICAL NOTES

How to decide where the lines go

- Hydrogen is far lighter than air and collects at the top of a space. Route the vent and hydrogen lines upward toward ventilation rather than letting them hang low.
- Do not send them into a dead-end ceiling void, a sealed cabinet, or a tight space at head height. Those are the places escaped hydrogen accumulates.
- Keep the hydrogen and oxygen lines separate. The point of this step is that the two gases never meet in one line or one vessel.

DANGER

Blocking H2 VENT traps hydrogen, which can burst the line or leak and explode.

- H2 VENT is the emergency release path. If it is blocked, pressure has nowhere to go.
- If it is blocked the pressure cannot escape: the line can rupture, or hydrogen leaks into the unit or the room and causes a fire or explosion.
- Fit no valve, plug or filter on the vent line, and run its end to a safe place away from people.

4. Power on and connect the PC

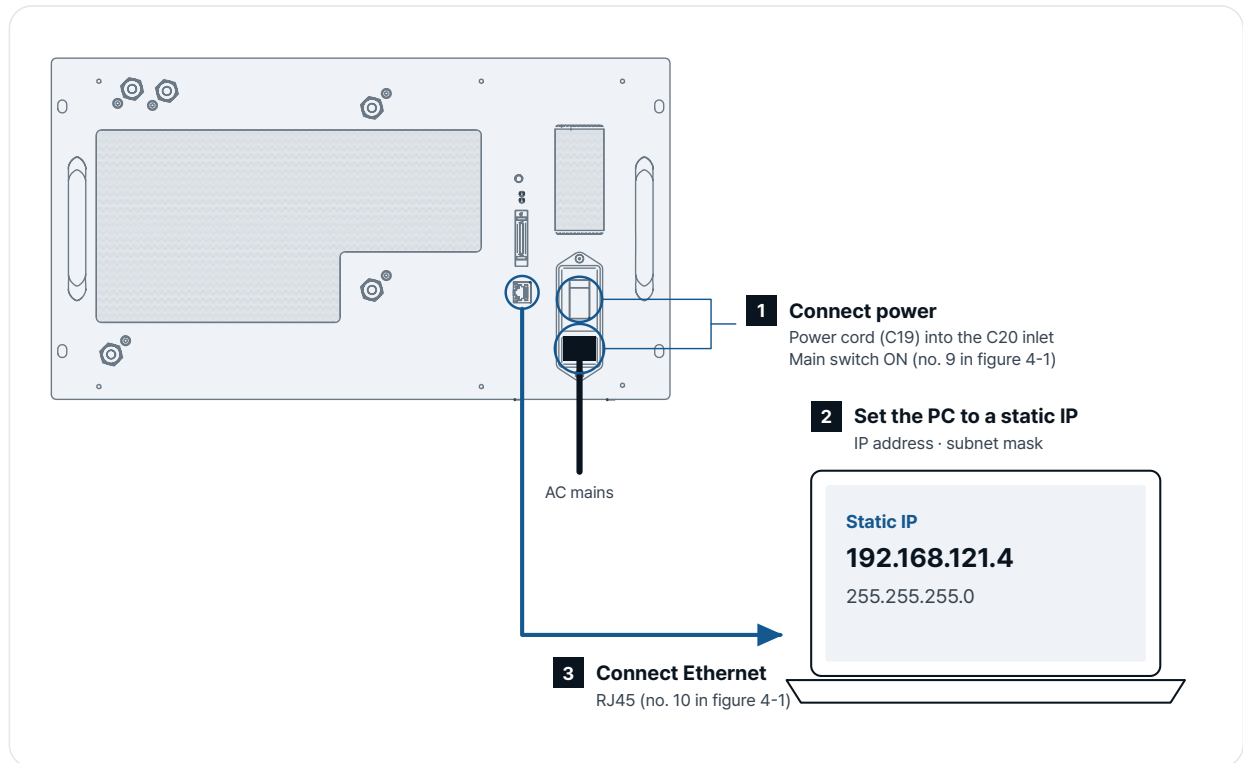


Figure 4-3 Power and PC connection. The numbers in squares are the step numbers below.

1

Connect power.

- Plug the AC cord into the C20 inlet.
- Switch the main power ON.
- **Check** The front LED lights up.
- **If not** If the LED stays dark, check the power cable, the outlet breaker and the main switch.

2

Set the PC network to a static IP.

- IP address 192.168.121.4
- Subnet mask 255.255.255.0
- These addresses are the same on every HXB-V1. Units are told apart by the Device ID on the rear label.
- To run several units from one PC, tell us when you order. We set a different static IP on each unit before shipping and give you the list of addresses.

3

Connect the PC to the system with the Ethernet cable.

5. Create a project

1

Launch the app and Project Manager opens.

2

Click New Project.

3

Enter the project details.

- Project name
 - Description, optional
 - Device ID, exactly as printed on the label on the rear panel.
-

4

Click Create, then click Start on that project in the list.

5

Confirm two things on the top bar.

- Connection = ONLINE
 - Logging = ON
 - **Check** Both read as shown and the front LED turns yellow (STANDBY).
 - **If not** If it shows OFFLINE, recheck the LAN cable and the PC's fixed IP (192.168.121.4, 255.255.255.0) and restart the app. If the LED does not return to yellow, press the red Reset button once.
-

PRACTICAL NOTES

What setting a static IP actually does

- Normally a router hands your PC an address. This system does not do that, so you set the address on the PC side by hand and the two can then find each other. That is what the address in the previous step is for.
 - That Ethernet port becomes dedicated to the system: your office network and the internet will not work through it. If you need both, add a USB Ethernet adapter so you have two ports.
 - To undo it, switch the same setting back to automatic.
-

6. Fill and prime the electrolyte

Work from the P&ID screen in the app. Use the same sequence at first start-up and whenever you change the electrolyte.

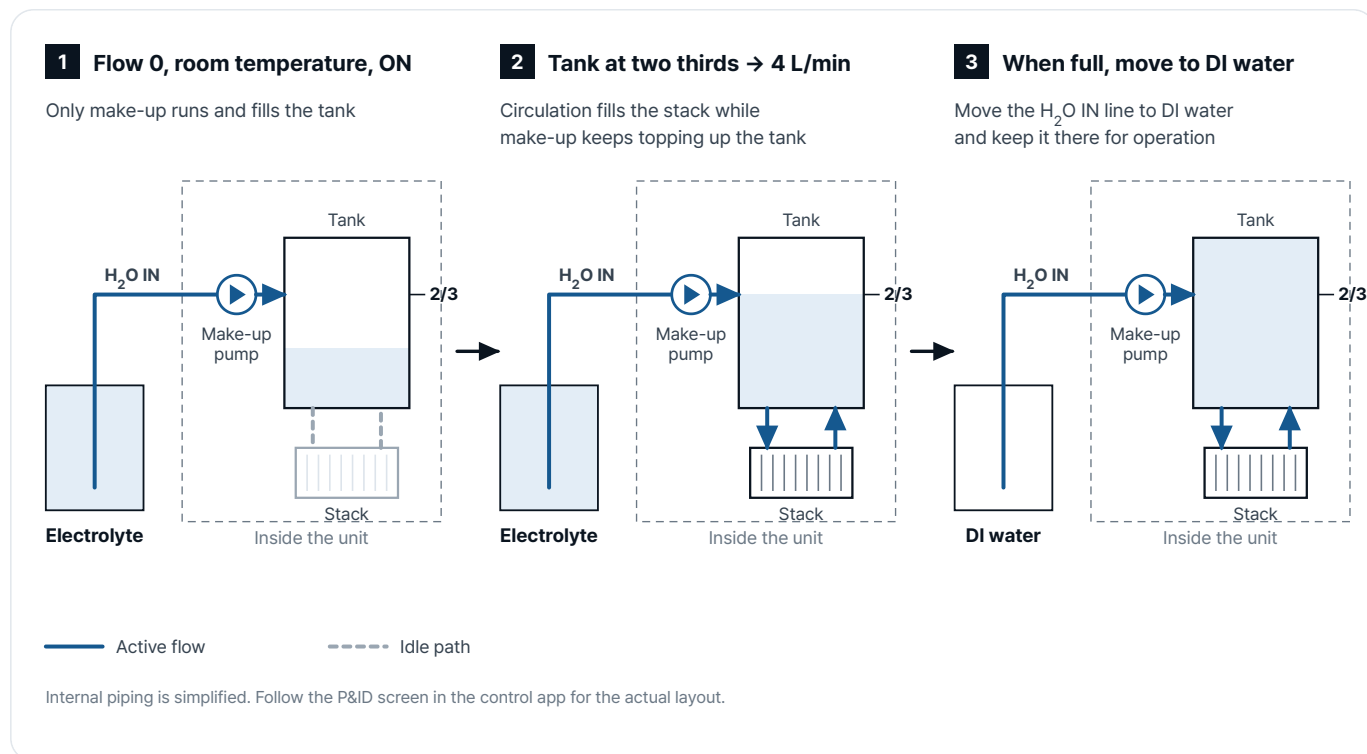


Figure 4-4 Electrolyte fill and priming sequence. A simplified concept diagram; the P&ID screen in the control app shows the actual layout.

- 1** Prepare about 5 L of electrolyte for the first fill.
- 2** Submerge the free end of the H₂O IN line fully in the electrolyte.
- 3** Set the targets in Electrolyte Control and click Apply.
 - Leave the temperature at room temperature. No heating yet.
 - Leave the flow at 0. No circulation yet.
- 4** Turn Electrolyte Control ON.
 - The make-up pump fills the internal tank automatically and the tank graphic on the P&ID fills with blue.
 - **Check** The LED turns blue (EL_CTRL) and the tank on the P&ID fills blue.
 - **If not** If the tank does not fill, check that the end of the H₂O IN line is fully submerged and the line is not kinked. If the LS101 alarm appears, follow [the make-up section](#).
- 5** When the tank reaches two thirds, start circulation to fill the inside of the stack.
 - Leave Electrolyte Control ON, enter a flow of 4 L/min and click Apply.
 - **Check** Flow settles near 4 L/min. A brief wobble at first while air clears is normal.

- **If not** If it keeps fluctuating or will not rise, see [Symptom D](#).

6

Continue until the tank is full.

- Make-up keeps topping the tank up while circulation fills the stack.

7

Move the H2O IN line to the DI water reservoir.

- Keep it there from now on. Topping up with water, not electrolyte, is the normal operating configuration.

PRACTICAL NOTES

Why you start with the flow at 0

- Running the circulation pump while the tank is empty draws air instead of liquid. The flow never settles and the pump suffers.
- So you fill the tank first and only start circulation once it is about two thirds full, pushing liquid through the inside of the stack. That is what priming means.
- The most common mistake is the line lifting above the liquid surface. With a shallow container or stiff tubing the end rises as the level drops. Weigh the end down or use a deeper container.

What electrolyte control actually does

The shape of the filling procedure makes sense once you understand this one switch.

PRACTICAL NOTES

One switch turns on three functions together

- Turning electrolyte control on activates make-up, circulation and temperature control at the same time. There is no separate switch for each.
- So for filling you set the flow to 0 and the temperature to room temperature, which leaves circulation and heating idle. Switch it on in that state and only make-up does any work.
- With the tank empty the level sensor reads low, so the system runs the make-up pump and draws electrolyte from the reservoir on the H2O IN line. It carries on by itself until the tank is full.

Raising the flow to 4 L/min once the tank is two thirds full works the same way: circulation starts pushing liquid through the inside of the stack while make-up keeps topping the tank up.

7. Warm up

1

Keep Electrolyte Control ON.

2

Enter a temperature of 50 °C and click Apply.

- This is the recommended value.

3

Confirm on the P&ID that the cartridge heater turns on and heating begins.

- **Check** The electrolyte temperature starts to rise towards the setpoint (50 °C).
- **If not** If it does not rise, look for the heater alarm (CH 101) in Alarms & Events.

8. Start electrolysis

1

Confirm the system is ready for power.

- Electrolyte level is in the normal range.
- Flow is stable at the setpoint of 4 L/min.

2

Enter voltage and current in Power Control and click Apply.

- 46 V and 50 A are recommended, not required.

3

Turn Power Control ON.

- **Check** The LED turns green (H2 RUN) and the current starts to rise. Hitting the voltage limit (46 V) first is normal at the start.
- **If not** If the current does not rise or an alarm appears, switch Power Control off and check [the alarm table](#).

NOTICE

You do not need to wait until the electrolyte reaches 50 °C.

- Heating with the tank heater alone, with no power on the stack, takes longer. Starting electrolysis brings the electrolyte up to temperature faster while it circulates.

9. Check

Watch either the P&ID or the Dashboard.

- Stack voltage and current respond to your targets.
- Electrolyte level stays in the normal range.
- Flow stays stable near the setpoint.
- Temperature climbs toward the setpoint.

What normal looks like during warm-up

For a setting of 46 V and 50 A.

- At first the electrolyte is cold and the voltage limit is reached first: voltage sits at 46 V and current stays below 50 A.
- As the temperature rises the current target is reached: current holds at 50 A and voltage drops below 46 V.

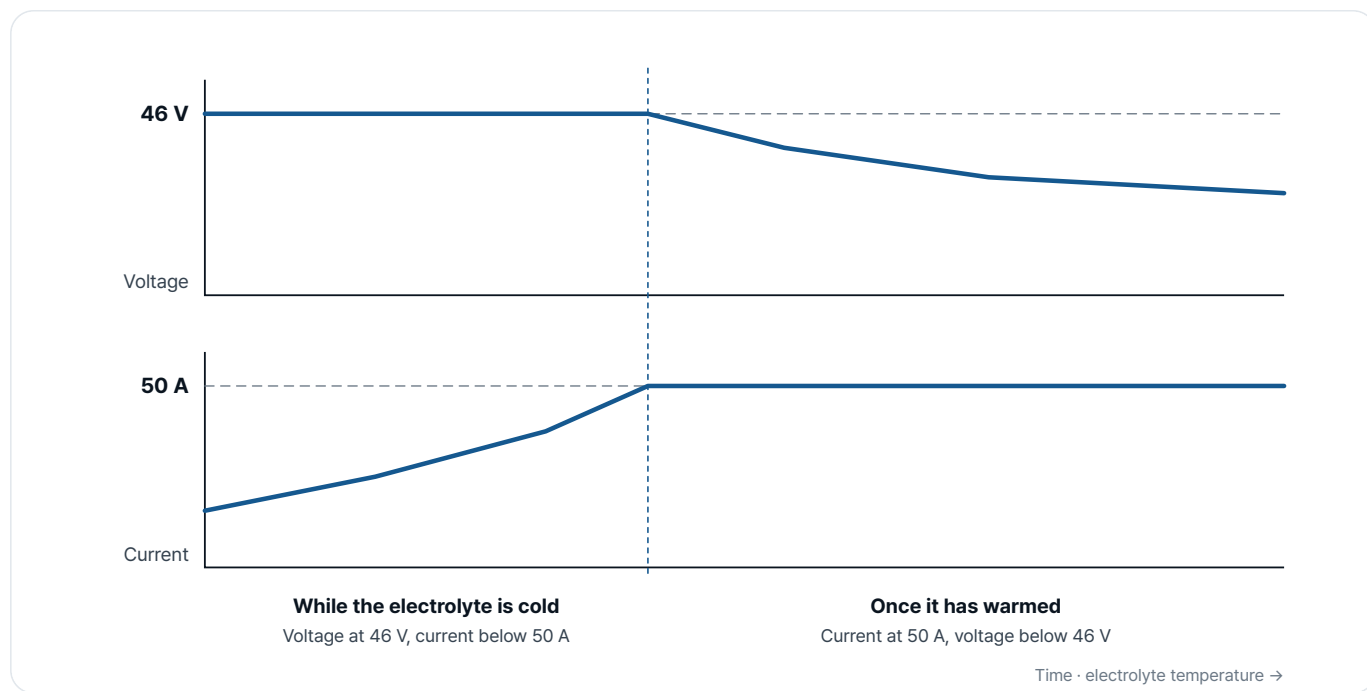


Figure 4-5 Normal behaviour during warm-up. A concept diagram of the shape only, not a measured curve; how long it takes depends on the installation.

TECHNICAL BACKGROUND

If you plan to run pressurised

- Choose the hydrogen outlet pressure, 0 barg or 10 barg, when you order; we fit the matching relief valve before shipment. A 10 barg unit always builds to 10 barg in operation. 35 barg is under verification and supplied by agreement. Pressurising can reduce downstream compression, at the cost of higher gas crossover and tougher sealing.
- Continuous operation at 10 barg has been verified. Control is galvanostatic, so current holds at its setpoint as pressure rises, and the voltage increase measured in verification was below 1%.
- A 10 barg unit builds to 10 barg from the very first start. Before starting, confirm that every part from H2 OUT to the end of your downstream line is rated for 10 barg, and check each joint for leaks while the pressure rises.

Acceptance

Check the following once electrolysis is running. If all four hold, treat the commissioning as accepted.

Leaks No visible electrolyte leakage at the fittings or ports.

Hydrogen leaks	Once hydrogen pressure has built, apply leak-detection fluid or hold a hydrogen detector to the H2 OUT and H2 VENT fittings and the downstream joints: no bubbles and no reading. The fluid or detector is supplied by you.
Flow and level	Flow is stable at the setpoint and the electrolyte level stays in the normal range.
Voltage and current	They respond to the targets you set.

How it behaves while warming up

With 46 V and 50 A set. If it moves like this, it is behaving normally.

- At first the electrolyte is cold and the voltage limit is reached first: voltage sits at 46 V and current stays below 50 A.
- As it warms the current target is reached: current holds at 50 A and voltage drops below 46 V.

WARNING

Do not move on if the criteria are not met.

- Reduce the load or switch power control off, and keep electrolyte control on briefly to cool down.
- Then open the alarms and events and work through the troubleshooting chapter.
- Carrying on with a leak or an abnormal state can lead to a hydrogen leak or overheating.

What to write down

What you record now becomes the baseline for judging whether performance has changed. Without a baseline you cannot tell, months later, whether the voltage has risen.

- The date and who ran it
- The electrolyte specification and the date it was made up
- The stack voltage and current once settled, with the electrolyte temperature and flow at that moment
- How those compare with the factory acceptance test figures
- Any alarm that appeared during commissioning

PRACTICAL NOTES

The app can keep the record for you

- While the PC is connected and logging is on, operating data accumulates continuously. Export it as csv from Project Manager and keep it.
- Making the commissioning run its own project makes it easy to find later.

05 Operation and control

HXB-V1 · updated 2026-09-30

How to run a commissioned system day to day: what the six front-panel LED states mean, the start-up and shutdown sequences, recommended setpoints and operating ranges, water make-up, and how to read alarms.

RECOMMENDED POINT 50 A · 50 °C · 4 L/min WATER USE About 0.55 L/h LED STATES Six

HOW TO READ THIS CHAPTER

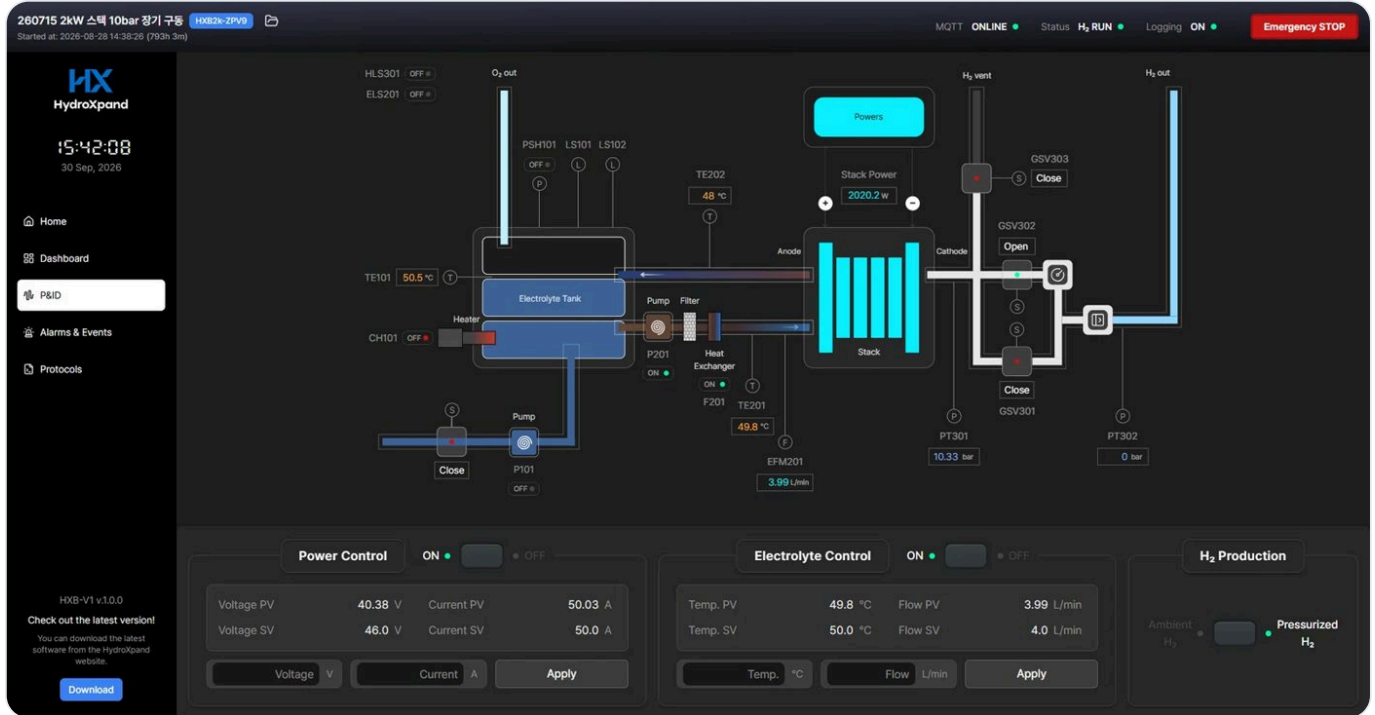
First time
Read just two sections first: the front-panel LED states and daily start-up. Those two are enough to run the system every day; the rest is reference for when you need it.

Done this before
Go straight to the recommended setpoints and to water make-up. The section on operating points not being reached covers the constraints when using this as an evaluation station.

The control app

The system is operated from a desktop app. The tabs run left to right in working order, and the actual controls live on the P&ID tab.

Home	Session summary and safety snapshot
Dashboard	Trends and KPIs for stability and performance
P&ID	The main control page: apply setpoints and operate
Alarms & Events	Alarms, events and command history
Protocols	Automated sequences for repeatable tests



The P&ID screen. This is where setpoints are applied and the system is operated, and where most of the actions in this chapter take place.

Top bar

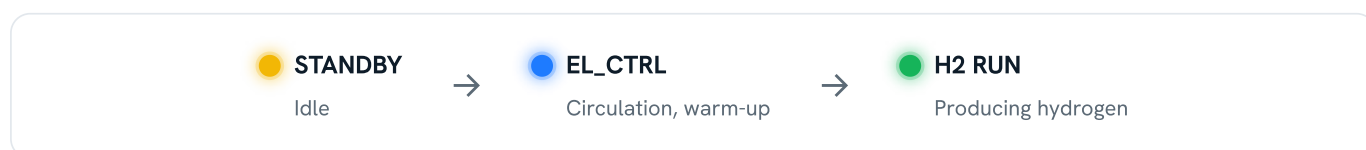
MQTT	Whether the app is connected to the system
Status	Whether the system is running or stopped
Logging	Logging state
Emergency STOP	Immediate shutdown

Front-panel LED states

A single front-panel LED shows the system state. Six states are distinguished by colour and blinking.

STATE	COLOUR	MEANING	ACTION
EMERGENCY	Red, solid	Emergency stop is active and operation has stopped	Remove the cause, press the red Reset button on the front panel or Emergency STOP in the app once to release, then restart in the normal order
DISCONNECTED	Red, blinking	The link to the control app on the PC is lost	Check the Ethernet link and launch the app. If the LED does not return to yellow, press the red Reset button or Emergency STOP once to release

STATE	COLOUR	MEANING	ACTION
 STANDBY	Yellow	Idle, no hydrogen production	Normal idle state
 EL_CTRL	Blue	Electrolyte control on, power control off, no hydrogen	Warm-up, cool-down or circulation
 PWR_CTRL	Purple	Stack power is on while electrolyte control is off	Not a recommended state. Turn Power Control off and return to the normal sequence
 H2 RUN	Green	Normal hydrogen production	Normal operation; keep watching the app



- There is enough DI water for the run you have planned.

Sequence

- 1** Confirm the safety snapshot on Home is normal.

- 2** Check on the Dashboard that temperature, current and voltage trends look plausible.

- 3** **P&ID, Electrolyte Control**
 - Set the temperature and flow targets and click Apply.
 - Turn Electrolyte Control ON.
 - Confirm the LED changes to EL_CTRL.
 - **If not** If the LED does not change to EL_CTRL or the flow does not rise, switch Electrolyte Control off and check Alarms & Events.

- 4** **P&ID, Power Control**
 - Set the voltage and current targets and click Apply.
 - Turn Power Control ON.
 - Confirm the LED changes to H2 RUN.
 - **If not** If the LED is not H2 RUN or an alarm appears, switch Power Control off and check the alarm table.

- 5** In Alarms & Events, confirm no alarm appeared during ramp-up and that your commands were logged.

WARNING

Powering a stack with no electrolyte circulating can damage the membrane and let hydrogen and oxygen mix.

- Current without circulation dries and overheats the stack. Hydrogen crosses the damaged membrane into the oxygen side, creating a fire risk, and the stack is permanently damaged.
- Switch Electrolyte Control on and confirm the flow is stable before you switch Power Control on.

Recommended setpoints and operating ranges

PARAMETER	RECOMMENDED	OPERATING RANGE
Stack current	50 A	15-67 A
Stack voltage	Set 46 V · at 50 A about 38 V new (datasheet 37.8 V), rising to typically about 40 V in service	24-48 V
Electrolyte temperature	50 °C	RT-70 °C
Electrolyte flow	4 L/min	2-5 L/min
Hydrogen pressure	As ordered	0 or 10 barg (chosen at order; 35 barg by agreement)

PRACTICAL NOTES

Recommended and range mean different things

- The range says what the system will tolerate. The recommended value says what works well over the long run.
- For your first runs, leave the recommended values as they are. The right-hand column is what you consult when a test needs different conditions.

NOTICE

The operating range states allowable limits, not conditions under which performance is guaranteed.

- For stable operation and lifetime, work near the recommended values and avoid running continuously at either end of the range.

When the operating point you set is not reached

Running galvanostatically inside the rated window is not a concern. Both a voltage setpoint and a current setpoint are applied together, however, and the combination is constrained, so in the tests below the operating point you request may not be delivered as entered.

- IV-curve measurement, where the operating voltage sweeps over a wide range
- Low-current evaluation of a short stack or a third-party stack
- Operation below or above the recommended current window

What to know before using this as an evaluation station

- The system is both a finished hydrogen generator and a stack test bench. The stack module can be removed, disassembled and replaced, so different stack designs can be tested on the same balance of plant and control platform.
- Operating points outside the rated window are constrained by the power settings, however. Inside the range where a rated stack runs galvanostatically there is no issue.
- If you plan to sweep an IV curve over a wide voltage range, or to evaluate a short stack at low current, tell us the target operating points before you order and we will confirm what is achievable first.

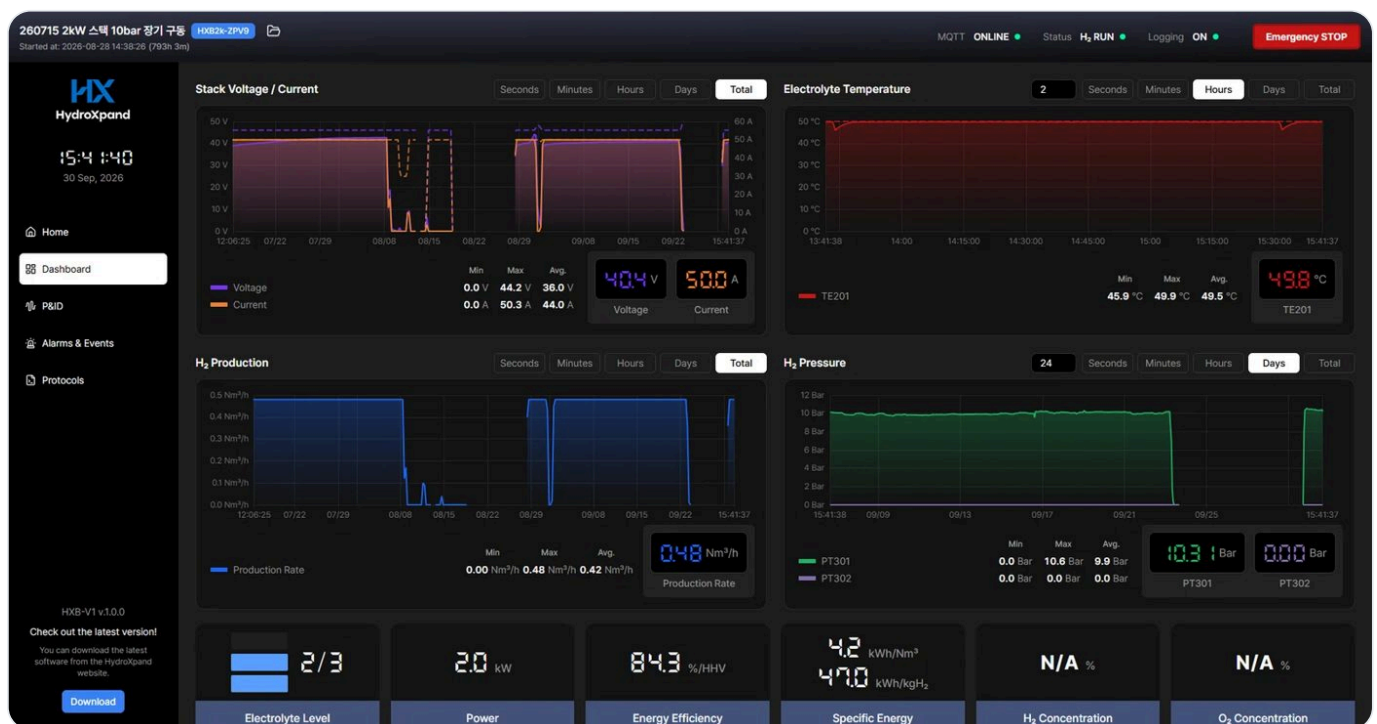
If you plan to use the HXB-V1 as an evaluation station, send us your target operating points and test plan. Our engineer will come back with what is achievable and how to set it.

What to watch during operation

⚠ WARNING

If hydrogen in the oxygen stream exceeds 2 vol%, stop electrolysis and contact us.

- Hydrogen crossing the membrane builds up on the oxygen side and can form an explosive mixture in the oxygen line and separator.
- The control app does not show this value. To measure it, fit a hydrogen analyser or detector after O2 OUT.
- This is a safety limit, not a warranty or free-replacement threshold.



The dashboard. It shows trends rather than single readings; check the items below here. The app's specific energy and efficiency are based on stack power; system figures are in the specification table.

Stack voltage and current

Confirm they respond to your targets and stay steady. If voltage jumps or swings widely at constant current, stop and investigate.

Electrolyte level	It must stay in the normal range. If it trends down or becomes unstable, stop and correct the make-up condition.
Electrolyte flow	It must stay stable near the setpoint. Temperature control and safe operation both depend on it.
Electrolyte temperature	It should move toward the setpoint and settle. If it keeps rising despite circulation and cooling, stop and investigate.
Alarms	Do not ignore a recurring alarm. Investigate it immediately.

Water make-up

Water is consumed during operation, so make-up is needed to hold both level and concentration. Keep the H₂O IN line submerged in the DI water reservoir and the system tops itself up.

NOTICE

Insufficient make-up water can cause rapid overheating and permanent stack damage.

- An empty reservoir, a blocked suction line or air ingress lets the level fall and the concentration rise. Cooling capacity drops, stack temperature climbs quickly and membrane degradation accelerates. In severe cases the stack fails irreversibly.
- If the level trends down, flow becomes unstable or temperature rises abnormally, reduce load or stop electrolysis at once, restore stable make-up and circulation, and only then continue.

Measured make-up

From our own tests on a 23-cell 2 kW stack at 50 A and 60 °C.

Theoretical consumption	About 0.39 L/h at 50 A
Measured consumption	About 0.53–0.55 L/h at 50 A
Why measured exceeds theory	Water evaporates and leaves with the product gas. Moisture exits through both the hydrogen and the oxygen outlet.
Make-up interval	Under the same conditions it typically triggers about every 1.5 hours
Sizing the reservoir	Unless your own measurements say otherwise, plan on 0.5–0.6 L/h. Never let the reservoir run dry during operation.

Reading the level indicator

- The tank graphic in the control app has three bars. One to three bars is normal.
- When the level switch (LS 101) senses low level the make-up pump runs, and it stops when the upper level is reached. The level moving between one and three bars is normal.
- A separate overfill switch (LS 102) sits above that. If it trips, the unit goes to emergency stop. This means too much electrolyte was filled or water keeps flowing in.
- If make-up keeps failing, the unit goes to fault stop. An empty DI water reservoir will eventually stop operation.

When make-up starts to fail

Make-up usually degrades before it stops. In our long-run tests the time taken by a single make-up grew to several times normal before make-up stopped altogether. Check the path as soon as you see the signs below.

- A single make-up takes longer than usual.
- The level indicator stays at one bar for longer.
- The make-up interval changes although the operating conditions are the same.

Reservoir empty	Refill with DI water. Size the reservoir for the intended run time.
Suction hose not submerged	Make sure the end of the H2O IN hose sits submerged near the bottom of the reservoir and is not kinked or crushed.
Reservoir too far below the unit	The higher the make-up pump has to lift water, the more likely it is to fail to draw. Keep the reservoir at about the same height as the unit.
Air in the hose	A long run of air in the hose breaks suction. Fill the hose with water and reconnect it.

WARNING

If a low-circulation or make-up failure alarm appears, do not wait for the unit to stop itself. Stop electrolysis straight away (Power Control OFF).

- There is a delay between the alarm and the automatic stop. If the stack stays energised during that time, heat builds up with too little circulation and the stack can be permanently damaged.
- A damaged membrane lets hydrogen and oxygen mix, creating a fire risk.

Normal shutdown

WARNING

Do not use the main power switch as the first step of a normal shutdown.

1

Stop electrolysis.

- Turn Power Control OFF on the P&ID.
- Confirm current drops to 0 A and the LED changes from H2 RUN to EL_CTRL.

2

Cool the stack and electrolyte.

- Keep Electrolyte Control ON for a while. The LED stays at EL_CTRL.

3

Stop circulation.

- Turn Electrolyte Control OFF and confirm the LED changes to STANDBY.

4

After shutdown

- Confirm no alarm is still active in Alarms & Events.
- Visually check the front-panel ports and external tubing and fittings for leaks.

Alarms and events

The Alarms & Events page holds two tables. Alarms are abnormal conditions that need attention; Events are the history of commands and actions. Use Clear All only after the underlying condition is resolved.

Alarms

ID	Time	Category	Label / Message	Value / Limit	Status
13365	2026-09-29 18:50:52	PROC	PT301 H2 Production pressure high	10.0 bar / 10 bar	Active
13362	2026-09-29 18:14:34	PROC	PT301 H2 Production pressure high	1.4 bar / 1 bar	Active
13364	2026-09-29 18:41:12	PROC	PT301 H2 Production pressure high	10.0 bar / 10 bar	Resolved
13363	2026-09-29 18:14:51	PROC	PT301 H2 Production pressure high	10.2 bar / 10 bar	Resolved
13361	2026-09-29 18:02:50	PROC	TE201 Electrolyte temperature high	78.78 °C / 60.0 °C	Resolved
13360	2026-09-29 17:39:53	PROC	EFM201 Electrolyte flowrate low	0.1 slm / 3.2 slm	Resolved
13359	2026-09-29 17:26:43	SAF	LS102 Electrolyte tank level abnormally high	Unsafe condition	Resolved
13358	2026-09-29 17:20:46	PROC	EFM201 Electrolyte flowrate low	0.5 slm / 3.2 slm	Resolved
13357	2026-09-29 17:19:47	EQUIP	P101 Electrolyte makeup pump fault detected	Actuator fault detected	Resolved

Events

ID	Time	Type	Action	Status
123	2026-09-29 18:14:31	Command	High-P Production: On	Applied
122	2026-09-29 17:55:32	Command	Power: On	Applied
121	2026-09-29 17:55:30	Command	Voltage: 46 V, Current: 50 A	Applied
120	2026-09-29 17:41:55	Command	Temperature: 50 °C, Flow Rate: 4 SLM	Applied
119	2026-09-29 17:38:54	Command	Temperature: 25 °C, Flow Rate: 4 SLM	Applied
118	2026-09-29 17:38:59	Command	Electrolyte Control: On	Applied
117	2026-09-29 17:26:45	Emergency	Emergency Stop	Applied

The alarms and events screen. Alarms above, command history below.

Three alarm levels

Alarms fall into three levels according to what the unit does. When an alarm appears, first see which level it is. The way back to operation differs by level.

LEVEL	WHAT THE UNIT DOES	TO RESUME	TYPICAL CAUSES
Warning	Shows and logs the alarm. Operation continues.	No need to stop, but check the cause. If the same warning keeps returning, contact us.	Temperature or flow starting to drift from the setpoint; fan, pump or heater not responding as commanded
Fault stop	Switches off stack power first, then electrolyte control a few seconds later, and goes to STANDBY. It only triggers while electrolyte control is on.	Remove the cause, then start again from STANDBY in the normal sequence.	Water make-up failure, loss of circulation flow, overtemperature, sensor failure, valve or contactor fault
Emergency stop	The unit itself switches every control off at once and opens the H2 VENT valve. The LED turns solid red.	Remove the cause, then press the red Reset button on the front panel or Emergency STOP in the app once. It does not clear by itself when the cause goes away.	Hydrogen leak detected, electrolyte leak detected, tank overpressure, tank overflow, hydrogen overpressure, loss of connection to the control app

WARNING

An emergency stop releases hydrogen through H2 VENT all at once.

- People or ignition sources near the vent end risk burns from a fire or an explosion.
- Route the vent end to a safe place away from people and never block it.

Releasing an emergency stop

1

Confirm yourself that the cause is gone.

- Once released, the unit does not trip again even if the cause is still there. Check before you release.

2

Press either the red Reset button on the front panel or the Emergency STOP button in the control app, once.

- Reset restarts the controller into standby. It takes a few seconds.

- Press Emergency STOP in the app only once. Pressing it again after release puts the unit back into emergency stop.

3

Check that the front LED has turned yellow (STANDBY).

4

Start again in the normal order.

- After release, electrolyte control and power control are both off. Switch on electrolyte control first, and power control only once circulation and temperature are stable.
- Use Clear All only for alarms whose cause has been resolved.

Category column

Depending on the app version, the category column of the alarm table shows one of the four below. The category tells you where the alarm came from. Use the three levels above to judge what the unit did.

SAF	Safety-related condition
PROC	Process condition
EQUIP	Equipment or actuator abnormality
COMM	Communication or network issue

Fields on an alarm

An identifier, the time it was raised, the category, a short label, a message, the measured value against the limit, and the current status. Sending these to us verbatim speeds up diagnosis.

Reading the label

The label is the tag of the sensor or part that raised the alarm. It matches the same tag on the P&ID screen of the control app. Some tags are absent on some unit versions.

LABEL	WHAT IT IS
TE 101	Electrolyte tank temperature
TE 201 · TE 202	Electrolyte temperature at stack inlet · outlet

LABEL	WHAT IT IS
LS 101	Tank level switch. Starts and stops water make-up
LS 102	Tank overfill switch
PSH 101	Tank pressure switch
EFM 201	Electrolyte flow meter
P 101	Water make-up pump
P 201	Electrolyte circulation pump
CH 101	Electrolyte heater
F 201 · F 401	Cooling fan · axial fan
PT 301 · PT 302	Hydrogen production pressure · hydrogen outlet pressure
GSV 301 – 303	Hydrogen solenoid valves. 303 is the vent valve opened on emergency
HLS 301	Hydrogen leak sensor
ELS 201	Electrolyte leak sensor
CT 201	Stack current measurement
MC 401	Stack power contactor

WARNING

Respond to alarms immediately and never bypass a safety function.

- With a safety function bypassed the unit will not stop on a hydrogen leak, overpressure or overheating, which can lead to fire or explosion.

PLC and SCADA integration (Modbus TCP)

The unit supports Modbus TCP over Ethernet. A PLC or SCADA system can read operating data without the control app and, once it takes control, write setpoints and run commands too. Ask us for the latest register map.

Role Modbus TCP server (slave)

Address	The unit's LAN port · 192.168.121.2 · port 502 · Unit ID 1 (units shipped as a multi-unit set use the address list supplied with them)
Concurrent connections	Up to 5
Update rate	Measurements update once per second. Poll at 1 s intervals.
What you can read	Operating state, interlock and emergency-stop status, measurements such as temperature, pressure, flow, current and voltage, and the active setpoints
What you can write	Stack voltage and current, electrolyte temperature and flow setpoints, and run commands. Applied only after control has been handed over.

Data format and register areas

AREA	FUNCTION CODES	ACCESS	CONTENTS
Coils	FC01 · FC05 · FC15	Read/write	Run commands (power control, electrolyte control and so on)
Discrete inputs	FC02	Read	17 actual operating states (level switches, heater, valves, emergency-stop state and so on)
Input registers	FC04	Read	32 measurement channels, the setpoints in force and the unit status
Holding registers	FC03 · FC06 · FC16	Read/write	Setpoints, control source, watchdog

- Real values are IEEE-754 32-bit floats over two registers. As shipped the high word comes first (ABCD); if your PLC expects the low word first, it can be changed on site.
- Addresses are given both as zero-based protocol addresses and in the traditional 4xxxx form.
- RTU and ASCII are not supported; Modbus TCP over Ethernet only.

The full register map with every address will be published in this section once it is final. Until then, ask us through [a technical enquiry](#) and we will send the latest version.

Monitoring only

Nothing to configure. Connect and read. Writes are not applied until control has been handed over.

Integrating with a PLC

Once the unit is integrated with your PLC, the control app is not used. The unit has one LAN port, and the PLC takes it.

Still works	Alarm evaluation and warnings, fault stop and emergency stop. The unit's firmware evaluates and executes all of them, so they behave the same without the control app.
Your PLC or SCADA must do	Display and data logging. The control app's csv logging is no longer there, so record the values you need in your SCADA. We need those records to diagnose any issue.
Connection supervision	Instead of the link check with the control app, the Modbus watchdog supervises the connection to the PLC.

Handing over control

- As shipped, the control app holds control. For a PLC to control the unit, hand control to the PLC at commissioning and save that setting on the unit. The register map explains how.
- Control can only be taken with the watchdog enabled. If the PLC stops signalling within the set time, the unit releases every run command, stops operating and gives up PLC control. Once the PLC takes control again, operation can resume.
- When the watchdog expires the unit gives up PLC control without notice, and so does a restart if the control setting was not saved. Have the PLC confirm on every cycle that it still holds control.
- A rejected write does not return an error response. Always read back after writing to confirm the value was applied.

WARNING

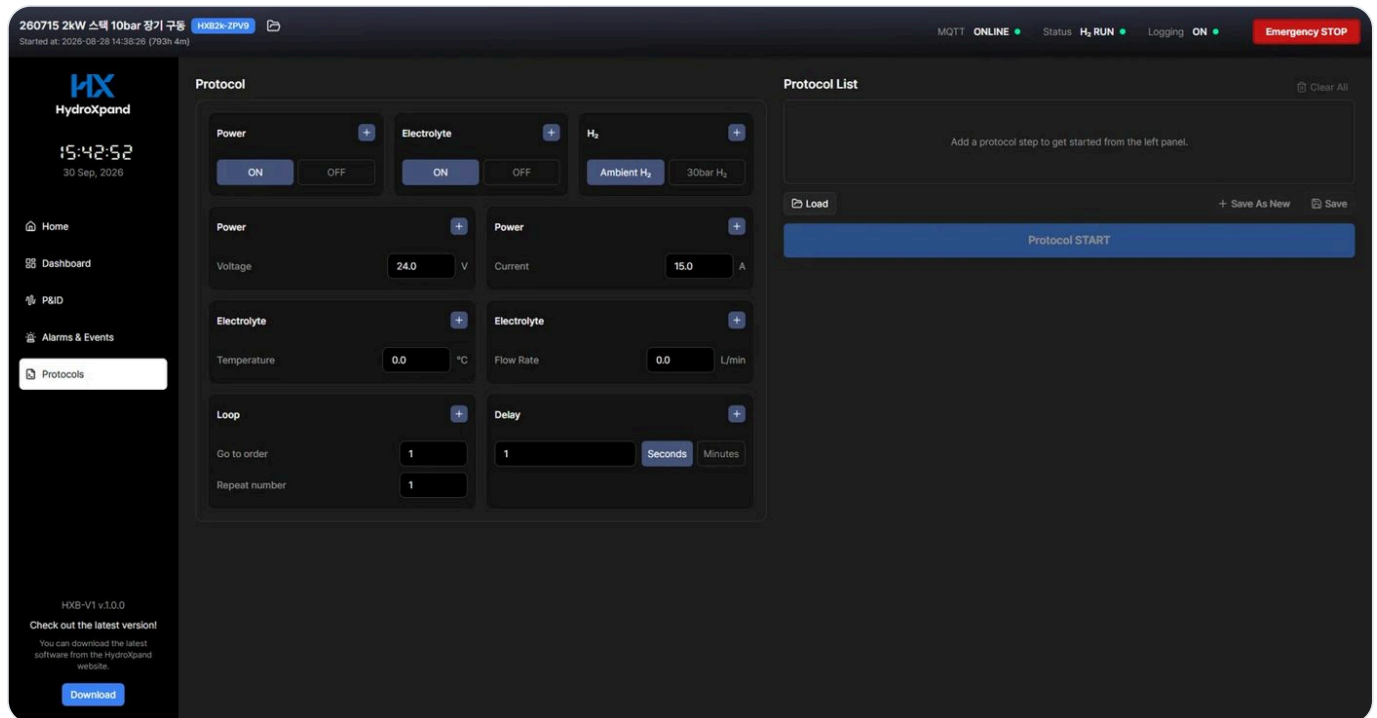
Do not build your emergency stop on a Modbus command.

- A command over a network cannot be guaranteed to arrive when a cable breaks or a switch fails. The unit has no emergency-stop button and no external emergency-stop input; the only manual emergency stop is Emergency STOP in the control app. Build the site emergency stop as an external circuit that cuts power to the unit, and use Modbus only to read the emergency-stop status.
- Modbus has no authentication. Keep the control system on a network segment separate from office networks.

Protocols and data logging

Protocols

Used for repeatable sequences such as ramp-and-hold tests and long runs. A protocol is an ordered list executed top to bottom, and its steps can switch electrolyte control and power control on or off, apply setpoints, wait, and loop a section.



The protocol screen. Steps run from top to bottom.

NOTICE

A protocol changes the system state automatically. Watch the system while one is running.

Automatic logging and export

- While the PC is connected and Logging is ON, operating data is recorded continuously.
- Use Project Manager to organise runs and to export the records.
- Select the project, then export from the project options menu; the file comes out as csv.

06 Control app

HXB-V1 · updated 2026-09-30

The HXB-V1 is operated from the HXB HMI desktop app. This chapter is a reference organised by screen: installation and connection, projects, what each screen shows and what you do there, reading the alarm and event tables, protocols, and exporting your records.

The start-up and shutdown sequences are in the operation and control chapter, and what each alarm means and what to do is in the troubleshooting chapter. This chapter also points you to those sections.

APP **HXB HMI desktop app** CONNECTION **Direct Ethernet cable to the PC** RECORDS **Logged automatically · export to csv**

HOW TO READ THIS CHAPTER

First time
Do the installation and project sections first; the unit only appears in the app once both are done. The rest is reference to look up with the app in front of you.

Done this before
Find the screen you are looking at in the screen table. If an alarm is showing, go to the alarms and events section.

Installation and connection

The app	It ships with the system. Ask us if you need the latest version.
PC network	Set a static IP: address 192.168.121.4, subnet mask 255.255.255.0. The address is the same for every HXB-V1. To run several units from one PC, tell us when you order: we set a different static IP on each unit before shipping and give you the address list.
Cable	Connect the PC directly to the unit with an Ethernet cable.

PRACTICAL NOTES

That Ethernet port becomes dedicated to the unit.

- Your office network and the internet will not work through it. If you need both, add a USB Ethernet adapter so you have two ports.

 NOTICE

Once integrated with a PLC or SCADA, the control app is not used.

- The unit has one LAN port and the PLC takes it. Display and logging then have to happen on the SCADA side.

Projects

Opening the app brings up Project Manager first. Operating records accumulate per project, and you export per project too. Keeping a separate project for each test or run makes records easy to find later.

1

Click New Project.

2

Enter the project details.

- Project name and an optional description
 - Device ID, exactly as printed on the label on the rear panel
-

3

Click Create, then click Start on that project in the list.

4

Check the connection and logging on the top bar.

- MQTT showing ONLINE means the app is connected to the unit.
 - Logging must be ON for operating data to be recorded.
-

NOTICE

Do not run with Logging OFF.

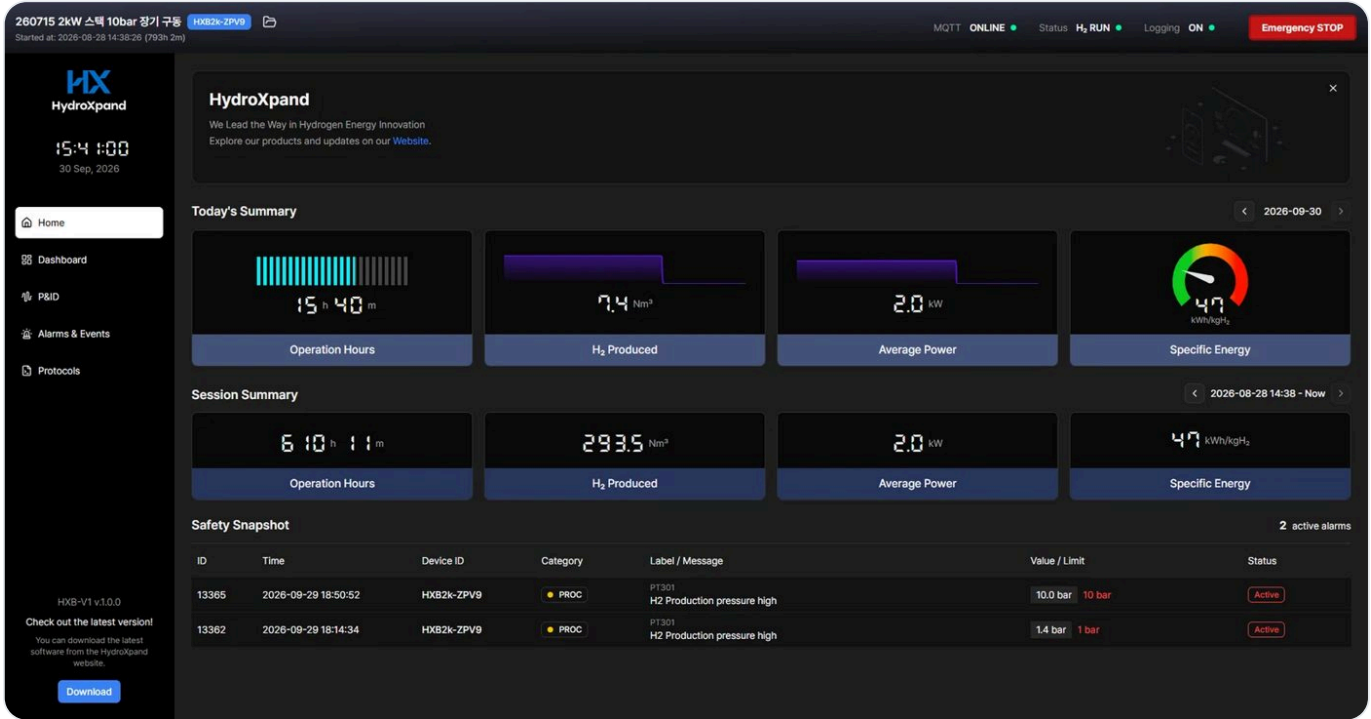
- Without records there is no way to trace a problem back. It is also the first thing we ask for when you contact us.
-

The screens

The tabs sit in the left-hand menu in working order. The actual controls are on the P&ID screen; the other screens are for watching.

SCREEN	WHAT IS ON IT	WHEN TO USE IT
Home	A summary for the day and for the current session (run time, hydrogen produced, average power, specific energy) and the Safety Snapshot, a list of recent alarms	Checking the safety state before start-up
Dashboard	Trend charts for stack voltage and current, electrolyte temperature, hydrogen production and hydrogen pressure, with the time window switchable between seconds, minutes, hours and days	Watching stability and performance while running

SCREEN	WHAT IS ON IT	WHEN TO USE IT
P&ID	Sensor readings shown on a diagram of the tank, circulation path and stack, with the Electrolyte Control and Power Control panels	Applying setpoints, starting and stopping
Alarms & Events	The alarm table and the event (command history) table	When an alarm appears, or to confirm a command went through
Protocols	Automated sequences for repeatable tests	Repeating the same test



The Home screen, captured on 30 Sep 2026 from our long-run test unit. The app's specific energy is based on stack power.

Top bar

MQTT	Whether the app is connected to the unit. It should read ONLINE
Status	Whether the unit is running or stopped
Logging	Logging state. It should read ON
Emergency STOP	Immediate shutdown. Pressing it once also releases an emergency stop

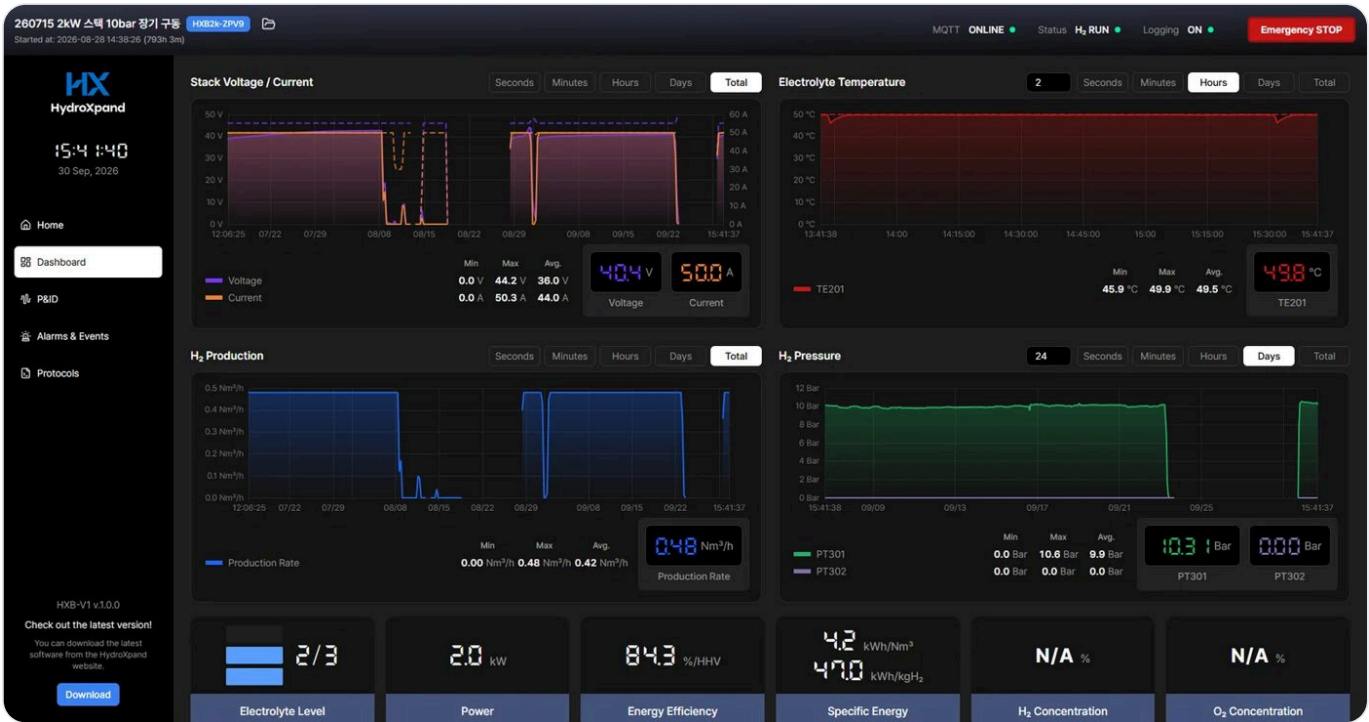
NOTICE

Menu names and layout can differ slightly between app versions.

- The app version is shown below the left-hand menu. Include it when you contact us.

Where you operate: P&ID and Dashboard

To start, switch on Electrolyte Control on the P&ID first, then Power Control once circulation and temperature are stable. Stopping is the reverse. On each panel, enter the target values and click Apply for them to take effect.



The Dashboard. It shows trends rather than single readings. The app's specific energy and efficiency are based on stack power; system figures are in the specification table.

- Stack voltage and current respond to the targets and stay steady.
- Electrolyte level stays in the normal range.
- Electrolyte flow stays stable near the setpoint.
- Electrolyte temperature moves toward the setpoint and settles.

PRACTICAL NOTES

Switch the time window as you look.

- A short window shows jumps and fluctuation; a long one shows trends such as a slowly rising voltage. The same chart tells you different things at different windows.

Reading the alarm and event tables

The Alarms & Events screen holds two tables. Alarms are abnormal conditions that need attention; Events are the history of commands and actions. The refresh icon updates the tables.

ALARM COLUMN MEANING

ID Alarm identifier

Time	When the alarm was raised
Category	Where it came from: SAF safety, PROC process, EQUIP equipment or actuator, COMM communication
Label	The tag of the sensor or part that raised it, matching the tag on the P&ID screen
Message	What is abnormal
Value / Limit	The actual value against the alarm limit
Status	Whether it is still active or has been resolved

ID	Event identifier
Time	When it was recorded
Type	Event type
Action	The command or action recorded
Status	The status of that command or action

 NOTICE
Use Clear All only after the cause is resolved.

- Clear them without knowing the cause and it becomes hard to tell whether the next one is new or a repeat. Note the alarm rows down as they are before clearing.

PRACTICAL NOTES

The event table tells you whether a command took effect.

- If you clicked Apply and the value does not seem to have changed, check in the event table whether the command was recorded and what its status was.

Protocols

Used for repeatable sequences such as ramp-and-hold tests and long runs. A protocol is a list of steps executed from top to bottom, with four kinds of step available.

Electrolyte Control On or off, with temperature and flow setpoints

Power Control	On or off, with voltage and current setpoints
Delay	A wait
Loop	Repeat a section

NOTICE

A protocol changes the unit's state automatically. Watch the unit while one is running.

- Keep the start-up order inside a protocol too: the step that switches on electrolyte control must come before the step that switches on power control. If safety is at risk, press Emergency STOP.

Exporting records

While the PC is connected and Logging is ON, operating data is recorded continuously. The records accumulate in the project and are exported as csv.

1

Open Project Manager.

2

Select the project to export.

3

Export from the project options menu (⋮) and download the csv file.

PRACTICAL NOTES

When you contact us, send the csv as it is.

- Do not trim or average it; we need the period before and after the event to find the cause. Sending the alarm rows and the app version with it speeds up the reply.

07 Maintenance

HXB-V1 · updated 2026-09-30

What to check and how often, when to change the electrolyte, and whether a rising voltage is normal. Decommissioning and storage have their own chapter.

DAILY Leaks · noise · smell · readings ELECTROLYTE No fixed interval · by condition

STACK SERVICE Return it; we replace the MEA only

HOW TO READ THIS CHAPTER

First time

Start with the daily, weekly and monthly lists and copy them into your own check sheet. Reading performance trends becomes useful a few months in.

Done this before

Go straight to reading performance trends and deciding when to change the electrolyte.

The intervals are guidance, not rules

NOTICE

The real intervals differ from site to site.

- They depend on running hours, load pattern, ambient conditions, electrolyte quality and your test plan. Heavy research use needs more frequent checks.
- The lists below are a starting point. Run it for a few months and adjust them to your site.

WARNING

Before any maintenance, stop the unit in the way the task requires.

- Wiring, covers or electrical parts: stop electrolysis (0 A, Power Control OFF) and isolate the system from mains before you touch them.
- Draining or filling electrolyte: leave mains on, switch only Electrolyte Control off and follow [the replacement steps](#). The electrolyte may be at about 50 °C.
- Hydrogen-side tubing: confirm in the control app that the hydrogen pressure (PT301, PT302) reads 0 before you open it.

The check lists

Daily, or each shift

- No leaks or wet marks around the tubing, fittings and front-panel connections.

- No wetness or white crystals on or under the base of the unit. If you see any, stop operating and find the leak. Leaked electrolyte that dries out leaves KOH that can form a conductive path and melt nearby parts.
- No noise, vibration or smell that differs from usual. The fan always makes some noise and vibration while running; look for a change from normal.
- The front-panel LED and the app show normal operation with no active critical alarm.
- Stack current and voltage are reasonable for the setpoint.
- Electrolyte level, flow and temperature are within range.
- The discharge area is clear and ventilated, with no ignition source nearby.

Weekly

- Look back at the stack voltage at comparable operating points.
- Check that level, flow and temperature stayed stable.
- Look for alarms that keep recurring, and their pattern.
- Inspect hoses and fittings for wear, discolouration, crystal residue and small weeping leaks.
- Inspect cable routing and connectors for abrasion, looseness and overheating marks.
- Confirm the tubing supports are not loading the fittings and ports.

Monthly

- Check the electrolyte for discolouration and solids.
- Inspect the vent and drain paths for blockage, corrosion and salt build-up, and clean as needed.
- Clean the ventilation openings and the area around them so dust does not accumulate.
- Update the maintenance record: running hours, electrolyte change dates, alarms, observations and corrective actions.

Maintenance log

The unit logs operating data, but not electrolyte concentration and changes, the water used, leaks or anything done by hand. Keeping these columns lets us narrow down a cause quickly when something goes wrong. Write one line at every check.

COLUMN	WHAT TO WRITE	EXAMPLE
Date	Day of the check	2026-10-05
Total run hours	The value on the control app Home screen	312 h

COLUMN	WHAT TO WRITE	EXAMPLE
Operating point	Current, electrolyte temperature, pressure	50 A · 50 °C · 10 barg
Stack voltage	Measured at the same operating point. This column is for the trend	41.2 V
Electrolyte	Whether it was changed, conductivity at 25 °C, colour and foam	Not changed · 21.4 mS/cm · clear
Feed water	Quality (conductivity) and the day the reservoir was refilled	0.8 µS/cm · refilled
Leaks and crystals	Base of the unit, ports and fittings, vent ends	None
Alarms	Alarms raised since the last check and how often	Electrolyte flowrate low ×1
Action taken	Anything done by hand, such as cleaning, part replacement or a setting change	Cleaned fan filter
Checked by	Who did the check	(signature)

PRACTICAL NOTES

Send this log with any enquiry

- Electrolyte concentration, change dates and feed-water quality in particular are not in the unit's records, so we have no other way to know them.

Changing the electrolyte

NOTICE

There is no fixed replacement interval.

- What gets consumed during operation is water; the KOH itself is not. So you replace it on condition and performance trend, not on a calendar.
- Replace it when you see discolouration or solids, when the voltage trend shifts at a comparable operating point, or when you suspect it has been diluted or concentrated.

Best practice: measure conductivity regularly

When the KOH concentration falls, the electrolyte's conductivity falls with it. Measuring conductivity regularly therefore tells you the state of the electrolyte before the voltage starts to rise. A conductivity meter is all it takes.

When	Measure once right after filling fresh electrolyte and record it as your baseline. After that, measure once a month, always at the same point: just after a water make-up has finished is best. Between make-ups the water level drops and the electrolyte concentrates, so readings taken at random times vary widely even for the same electrolyte.
How	Stop electrolysis and let it cool, put on PPE, and draw a small sample from the DRAIN port into an alkali-resistant container. Read the 25 °C value on a temperature-compensated conductivity meter. At a different temperature the same electrolyte reads differently.
Reference	0.1 M KOH reads about 20–23 mS/cm at 25 °C. Comparing with your own baseline is more reliable than the absolute value.
Below half the baseline	Replace the electrolyte and find the cause. The most common one is electrolyte crossing the membrane to the hydrogen side: touch pH paper to the droplets from H2 OUT, and if it reads alkaline this is the case. A wet base, or wetness or white crystals around the stack, means it is leaking out. See Where electrolyte escapes below. Leave the cause in place and the fresh electrolyte will go the same way. In our concentration test (2 kW stack, 50 A), halving the concentration raised the stack voltage by about 1 V (about 2.5%).
Above that	Keep running and measure again next month. If it keeps falling month after month, though, KOH is escaping somewhere: check Where electrolyte escapes below before it reaches half.
Make-up more frequent than usual	A sign that electrolyte has started to escape. The make-up pump replaces what is lost with water, so make-up becomes more frequent and the conductivity drifts down as a result. It shows before the conductivity reaches half, so check the pH of the H2 OUT droplets and the base and stack surroundings now, and contact us.



Figure 7-1 Deciding replacement from conductivity. Compare with your own baseline rather than the absolute reading. The points on the graph are illustrative.

If you cannot measure conductivity

Replace the electrolyte if you see any of the following. You will find out later than by measuring conductivity, so we recommend getting a conductivity meter where possible.

Voltage creeps up at the same operating point	The electrolyte concentration may have fallen. It looks like stack degradation, but voltage often recovers with fresh electrolyte alone. Measure the concentration before suspecting the stack.
Make-up interval or level behaves differently	If make-up runs more or less often than usual at the same operating point, electrolyte is escaping somewhere or water is short. Compare with the make-up entries in your maintenance log.
Moisture at H2 OUT tests alkaline	During steady operation, touch pH paper to the moisture coming out of H2 OUT. If it tests alkaline, electrolyte is crossing to the hydrogen side. Replace the electrolyte and contact us.
Restarting after a long idle period	While idle, carbon dioxide from the air can dissolve and weaken the electrolyte. If you cannot measure it, replace it before restarting.
Heavy foaming	Electrolyte is carried out through O2 OUT with the foam, so concentration and level both fluctuate. Replace it and watch whether the foam returns. If it does, contact us.
Discoloured or with solids	It is contaminated or something has dissolved into it. Replace it, photograph the drained electrolyte and contact us.
After fixing a leak or replacing parts	While it leaked, KOH escaped and make-up water took its place, so the concentration is already low. Replace all of it once the repair is done.

How to change it

Have about 5 L of fresh 0.1 M KOH solution (made the same way as in the quick-start chapter), an alkali-resistant container for the old electrolyte, 1/4" tubing to fit to DRAIN, safety glasses and alkali-resistant gloves ready.

WARNING

Straight after operation the electrolyte is hot alkaline liquid at about 50 °C and burns on contact.

- Put on your protective equipment and place the container under DRAIN before you loosen the cap. Liquid comes out the moment the cap is off.
- If you are not in a hurry, let it cool first. Switching off only Power Control and leaving Electrolyte Control on to circulate cools it faster.

1

Stop electrolysis.

- Set Power Control to OFF and confirm the current falls to 0 A.

2

Set Electrolyte Control to OFF.

- Left on, the make-up pump draws water back in through H2O IN as the level drops.
 - Mains power can stay on. DRAIN connects to the electrolyte loop only.
-

3

With the container under DRAIN, remove the cap, push 1/4" tubing fully home and tighten the nut, leading the tubing into the container.

- DRAIN is the same 1/4" double-ferrule fitting as the other ports and has no valve. It flows the moment the cap is off, so have the tubing and nut in hand before you start.
-

4

Drain until the flow stops.

- A little liquid left in the stack and tubing is normal.
 - **If not** If the flow stops partway, check that the tubing is not kinked and is pushed fully home.
-

5

Undo and remove the tubing, then refit and tighten the DRAIN cap.

6

Fill and prime with fresh electrolyte, exactly as in "Fill and prime the electrolyte" in the quick-start chapter.

- Put the end of the H2O IN tube into the fresh electrolyte, then switch Electrolyte Control ON with flow at 0 and temperature at room temperature. When the tank is two-thirds full, set the flow to 4 L/min; when it is full, move the H2O IN tube back to the purified-water container.
 - Do not put the old electrolyte back or mix it with the new.
-

7

Check DRAIN and the front ports for leaks.

- **Check** The ports and fittings are dry.
 - **If not** If it leaks, switch Electrolyte Control off, retighten that fitting and check again.
-

8

Take a new baseline.

- The conductivity straight after the new fill is the baseline for the next decision (step 1 of figure 7-1 above).
-

9

Record it.

- Write the date, the state of the old electrolyte (colour, solids) and the new baseline on the electrolyte log.
-

Do not pour the old electrolyte down the drain; dispose of it under your site's chemical waste procedure.

Where electrolyte escapes

In normal operation the KOH does not decrease. If the concentration falls anyway, KOH is escaping somewhere and the make-up pump is replacing the loss with pure water. There are three ways out.

WHERE

HOW YOU CAN TELL

Out of the stack

A seal between cells is leaking. The stack perimeter or the base of the unit gets wet or grows white crystals. A small leak may never trip the leak sensor and show only as a slow fall in concentration.

Inside the stack, across to the hydrogen side

Electrolyte crosses the membrane from the oxygen side (anode) to the hydrogen side (cathode) and leaves with the hydrogen. Moisture from H2 OUT tests alkaline on pH paper. A fast depressurisation after pressurised operation can give briefly alkaline moisture, so check during steady operation.

From the electrolyte tank

The tank gasket, a joint or a connecting fitting is leaking. The base of the unit gets wet or the electrolyte leak alarm appears. The tank sits inside the enclosure, so unless you are qualified, do not open it; contact us.

In every case, contact us rather than just replacing the electrolyte again and again. Leaks from the stack are handled through stack service.

WARNING

Chemical burn and corrosion hazard.

- Follow the electrolyte and PPE sections of the safety chapter and the SDS. You need splash-proof goggles and alkali-resistant gloves.
- Collect the drained electrolyte in a chemically compatible container and dispose of it to regulation.
- A splash in the eye can cost you your sight.

Cleaning

Exterior

- Wipe with a cloth dampened with clean water. Never spray liquid onto the system.
- If needed, use ethanol on painted and metal surfaces only, applied to the cloth, avoiding labels and seams.
- KOH residue shows up as white crystals: dissolve it with a water-dampened cloth and wipe again with clean water.

- Do not clean during operation. Stop the system first, especially before wiping near the ventilation openings, connectors or front-panel fluid connections.

Interior

 **DANGER**

Behind the covers are mains AC and high-current DC: an electric shock can kill.

- Perform a normal shutdown, isolate mains power, and confirm it has cooled before opening any cover.
- If you find significant internal leakage, corrosion or electrical contamination, do not restart. Contact us.
- Interior cleaning is for qualified personnel only, and only with the system fully de-energised.

Reading the performance trend

Stack voltage creeps up over time, from electrode and membrane degradation and from operating history. The question is not whether it rises but how.

PRACTICAL NOTES

Compare like with like

- The comparison only means something at the same current setpoint and a similar temperature and pressure. Under different conditions the same stack gives a different voltage.
- So it helps to fix one or two operating points and periodically record the voltage at just those points.

Can be normal	A slow, steady rise over a long period
Worth investigating	A step change at constant current, a large rise or fall over a short period, especially with the stack or electrolyte temperature climbing too, and large fluctuations at constant current

When it looks wrong, look outside first

- Whether the electrolyte condition or concentration has drifted
- The DI water quality and any source of contamination
- Whether flow and temperature are stable and cooling is working
- The hydrogen and oxygen routing, backpressure, and anywhere gas gets trapped
- The sensors and analysers, and the wiring and connections

If it persists after those checks, contact us with the operating history and the trends you recorded.

Voltage rises for several different reasons

- Resistance grows: the membrane and ionomer lose conductivity, the electrode loses conductivity, and contact resistance rises at the interfaces.
- Kinetics slow: catalyst activity falls, catalyst detaches or agglomerates, and the surface oxidises and reconstructs.
- Mass transport suffers: gas and liquid transport get limited, passages block or wet poorly, and bubbles do not clear.
- Or the electrolyte itself: concentration drifts because make-up is unbalanced, carbonate forms from CO₂ exposure, or impurities get in.
- That is why the trend matters: it separates normal gradual degradation from an abnormal change caused by off-nominal conditions.

Decommissioning and storage

08 Upstream and downstream

HXB-V1 · updated 2026-09-30

This chapter covers what goes into the unit (upstream) and what happens after the hydrogen leaves H2 OUT (downstream). Upstream is DI water, electrolyte, power and the control PC; downstream is what comes out and in what state, what you stack on top of it for your application, and the conditions the system itself imposes when you attach something.

The drying and purification layers, what each one does, and the models we can source today are set out on the components pages. This chapter covers only the HXB-V1 side and the order in which to decide.

SCOPE **What goes in, and from H2 OUT to the point of use** WHEN TO READ **Before you order, and before you install**
DECIDE FIRST **The dew point, purity and pressure your application needs**

HOW TO READ THIS CHAPTER

First time

Write down what your application requires as numbers, then read from the first section. Look at what comes out before deciding what to attach.

Done this before

Check just the backpressure section and the measurement section. Those two are what usually catch you when you change the downstream.

What goes in

There are four things upstream. Your site provides all of them; electrolyte circulation, heat management and power conversion are inside the unit. Where our supply ends is set out in [Battery limits](#).

DI water	Topped up automatically through H2O IN while running. ASTM D1193 Type II advised (1.0 µS/cm or less at 25 °C), 30 µS/cm at most. Without your own measurement, plan on 0.5-0.6 L/h.
Electrolyte	About 5 L of 0.1 M KOH for the first fill. After that only water is added, and replacement is judged by conductivity .
Power	200-240 V AC · 50/60 Hz · single phase · 2.4 kW. Connect a C19 cord to the IEC 60320 C20 inlet (16 A), with an external breaker and earthing.
Control PC	Connected over Ethernet and run from the desktop app. To tie it into a PLC, use Modbus TCP .

What leaves the outlet

Downstream design starts from these figures. All of them are without a dryer attached.

ITEM	FIGURE	WHAT IT MEANS DOWNSTREAM
Flow	Up to 500 NL/h	0.5 Nm ³ /h, about 8.3 NL per minute. Downstream equipment is usually rated in these units.
Pressure	0 barg or 10 barg	Chosen when you order; we fit the matching relief valve before shipment. A 10 barg unit always builds to 10 barg in operation. 35 barg is under verification and supplied by agreement. Anything above that is the downstream compressor's job.
Purity	98–99% at 0 barg · 99% at 10 barg	Most of the balance is water. With a dryer it is 99.999% or better.
Moisture	Saturated	It condenses in the pipework and vessels as the gas cools. That is what pools at the low points.
Port	1/4-inch double ferrule	All five ports (H2O IN, H2 OUT, O2 OUT, H2 VENT, DRAIN) use the same fitting.

PRACTICAL NOTES

Most of that purity figure is water.

- What the stack produces is moisture and trace oxygen. Nitrogen is not made by the stack; it comes in from purge gas and air left in the pipework, showing up after start-up and after maintenance and not growing during operation.
- So taking 98% to 99.999% is mostly a matter of removing water. Oxygen removal is a layer that comes after that.

WARNING

H2 VENT and O2 OUT are not product lines. Do not attach downstream equipment to them.

- H2 VENT is the safety vent that relieves pressure in abnormal conditions. It has to stay open, and nothing that can close or block it may be fitted.
- Product hydrogen leaves through H2 OUT only. Never combine the three lines: joining a hydrogen line to an oxygen line is an explosion hazard.

What to decide first

The downstream is not a choice between methods but a stack of layers built to a requirement. Fix what the application demands as numbers first, and the number of layers follows.

1

Write down the dew point and purity the application requires, as numbers.

- Use the figures from the specification if you have one; if not, tell us what it is for. The application alone is usually enough for us to narrow it down with you.

2

Write down the pressure you need.

- If the pressure at the point of use differs from the storage pressure, note both. This decides whether you need a compressor at all, and whether to run the system at 0 or 10 barg.

3

Decide whether you store it or use it as it is made.

- Storing brings compression and vessels with it, plus the overpressure protection and permitting the code requires. Using it as produced turns the question into whether the application tolerates a varying flow.

4

Decide how many units and add up the flow.

- Downstream equipment is selected on the combined flow. One unit is 0.5 Nm³/h, and if you plan to add units later it is better to size for that from the start.

5

Then build the layers.

- An application that only needs a lower dew point stops after one or two layers. One that sets a purity target adds the later ones.

APPLICATION	WHAT IT USUALLY REQUIRES	THE TRAIN IT NEEDS
Stopping condensation in pipes and vessels	A dew point only	One or two front layers that only remove water
Process supply and analysis	Water down to ppm level	Drying
Fuel cells and refuelling	Both water and trace oxygen	Drying plus oxygen removal

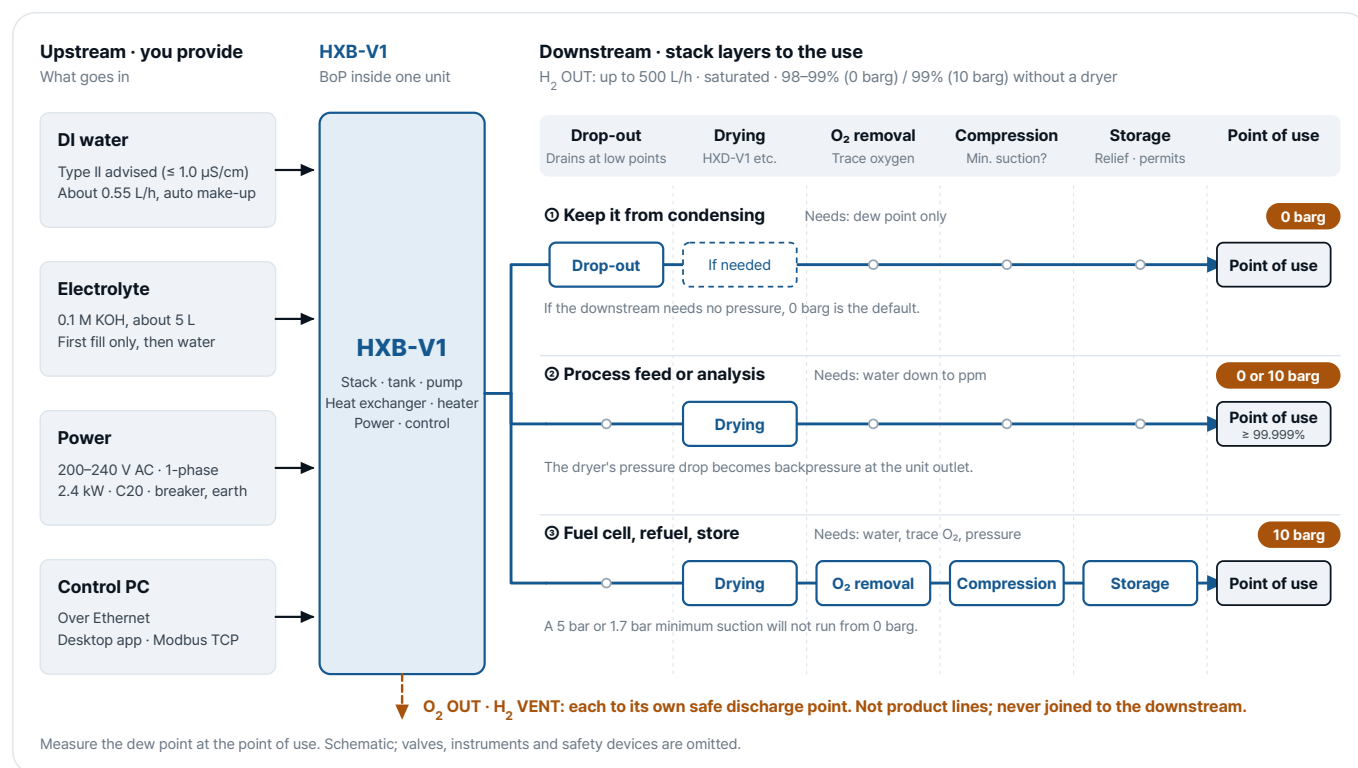


Figure 8-1 Upstream and downstream. Left, what goes into the unit; right, downstream build-ups by use. The outlet pressure is chosen when ordering. Schematic; valves, instruments and safety devices are omitted. Models you can buy for each layer are on the components page.

NOTICE

Using dew point in place of purity produces the wrong specification.

- 99.999% means total impurities, water and oxygen and nitrogen together, at or below 10 ppmv. A dew point describes water alone.
- At atmospheric pressure a dew point of -60°C is already past 10 ppmv on water alone. Removing every trace of oxygen would still not reach 99.999%. That purity requires drying further.
- A dew point is stated with its pressure. -40°C at atmospheric and -40°C at 10 barg are entirely different conditions.

Attaching drying and purification

Scale is the first obstacle. A single HXB-V1 produces $0.5 \text{ Nm}^3/\text{h}$. General-purpose industrial hydrogen dryers typically start around $5 \text{ Nm}^3/\text{h}$, and even the small units built for electrolyzers stop at about $1 \text{ Nm}^3/\text{h}$. Products that fit this band are scarce, which is why we are building the HXD-V1 modular dryer.

What to check

- Whether the rated flow covers this scale. A model with a minimum flow will not run properly at $0.5 \text{ Nm}^3/\text{h}$.
- The inlet pressure it needs. Dryers that run at 0 barg and dryers that assume a pressurised feed are different machines.
- The pressure drop. That figure becomes backpressure at the system outlet.
- How it regenerates. Pressure-swing regeneration vents some product gas each cycle, and at a small flow that loss weighs more.

- Consumables and their intervals. Adsorbents and getters are parts you replace when they are spent.
- Certification in the country of installation. Establish first whether the location calls for an explosion-proof rating.



NOTICE

The dryer's pressure drop comes back as backpressure.

- Fitting a high pressure-drop dryer to a 0 barg unit puts backpressure on the system outlet. If you plan to order 0 barg, ask for the dryer's pressure drop as a specification and check it.

TECHNICAL BACKGROUND

If you plan to run several units together

- The choice of dryers widens above a single unit's flow. If more units are coming, size for the combined flow: it is usually cheaper and easier to run than several single-unit dryers bought later.
- A shared train does need pipework that lets the rest keep running when one unit stops. Tell us the conditions and we will look at that layout with you.

Compression and storage

The compressor sets what has to come before it. Each one has a minimum suction pressure, and if the upstream cannot deliver it the compressor will not run. This is the real reason to order the system at 0 or 10 barg.

EXAMPLE	MINIMUM SUCTION	WHAT THE SYSTEM MUST DO
Air-driven, two stage, double acting	5 bar	A 0 barg unit will not drive it. You have to order 10 barg.
Air-driven, single stage, double acting	1.7 bar	A 0 barg unit still falls short. Without a boost ahead of it, you have to order 10 barg.



NOTICE

Both figures are gauge pressures.

- Read the minimum suction against the system outlet pressure and the maximum discharge against your target storage pressure. The two rows above are models we hold quotations for; the components page lists more.

PRACTICAL NOTES

Ordering 10 barg makes the downstream easier and asks more of the stack.

- A higher outlet pressure can cut a compression stage or remove the compressor altogether. In exchange, gas crossover and the demands on the seals both rise.
- If storage is not the point, 0 barg is the default. It is also what we recommend for general test operation.

What storage decides

Overpressure protection	When you connect the hydrogen outlet to downstream or storage equipment, provide overpressure protection to your code and design. The protections inside the system do not protect your equipment.
Permitting and installation	High-pressure gas permitting and site installation stay with the site owner. What we can handle also changes with the storage pressure and capacity.
The manufacturer's warranty	Compressors and vessels we source come with the manufacturer's warranty unchanged. We also carry the overseas purchase and customs.

Do not create backpressure

This is the most common problem introduced by adding a downstream. Narrow or block the path out and the pressure pushes back into the system.

- Fit no valve and nothing that can block on the vent and relief lines. They have to stay open.
- Do not run with a downstream valve closed. Confirm the path is open before start-up.
- Do not kink or pinch the tubing, and keep it free of debris and residue.
- Put a drain or water trap at the low point. The outlet gas is saturated and pooled water will block the line.
- Watch for freezing. Vent and relief lines holding condensate can freeze shut. Use slope, drain points, insulation or heat tracing as your site requires.
- Keep objects away from in front of the vent outlets.

NOTICE

Problems caused by abnormal backpressure are excluded from the warranty.

- That covers improper vent and relief routing, a blocked or closed vent, and downstream backpressure contrary to this handbook.

What to measure, and where

There is no hydrogen purity analyser inside the system. Downstream quality has to be measured downstream, and where you measure decides the number.

MEASUREMENT	WHERE	WHY THERE
Dew point	At the point of use	The dryer outlet dew point is not the dew point at the point of use. Moisture held on the pipe walls desorbs downstream and reads higher there. The longer the run, and the longer it stood idle, the wider the gap.

MEASUREMENT	WHERE	WHY THERE
Oxygen in hydrogen	Where the specification applies	The order of magnitude decides the instrument. Establish first whether you manage this in ppm or only need percent-level confirmation.
Pressure	At the system outlet and at the point of use	The difference between the two is the downstream pressure drop, and it is how you notice backpressure appearing.
Flow	At the system outlet	This is the reference point for production. Measured after the dryer, the figure has the regeneration loss taken out of it.

PRACTICAL NOTES

The system can take an external sensor signal and log it with everything else.

- The External Port on the rear takes an analogue signal from an external hydrogen or oxygen sensor. Use it when you want downstream readings on the same time axis as the operating data.
- Record a dew point with its pressure. A dew point without its reference pressure cannot be read by the next person.

The oxygen outlet

This is the side people forget when planning a downstream. Splitting water produces oxygen too, half the hydrogen by volume.

- Route O2 OUT to its own safe, well-ventilated discharge point.
- Never combine it with a hydrogen line or vent. It needs a separate discharge point.
- An oxygen-enriched atmosphere raises the fire risk. Keep combustibles away from the discharge area.
- The oxygen stream is saturated too. Keep water from pooling at the low points.

NOTICE

Tell us separately if you intend to use the oxygen.

- The standard configuration assumes safe discharge. Recovering the oxygen for use means reviewing purity and pressure along with pipe material and cleanliness.

The boundary, once more

Everything in this chapter belongs to your site. We can source it for you, but the design responsibility and the permits stay with the site owner.

What the system does It delivers hydrogen to H2 OUT at the selected pressure and flow, and relieves pressure through H2 VENT in abnormal conditions.

What your site does	Vent and exhaust routing, drying and purification, compression and storage, the connection to the point of use, downstream instrumentation, and whatever overpressure protection and permits the code requires.
Where we can help	Give us the conditions and we will settle the configuration with you and source it. We also carry the overseas purchase and customs.

09 Decommissioning and storage

HXB-V1 · updated 2026-09-30

Shut down and disconnect external connections before moving or storing the system. This is not a procedure for opening the stack.

PERSONNEL **Qualified personnel** PREPARATION **Chemical PPE · drain container · port caps**

HOW TO READ THIS CHAPTER

First time

Confirm shutdown, power isolation and depressurisation before draining and disconnecting.

Done this before

Review the work sequence and storage conditions.

Decommissioning and storage

DANGER

Never decommission a system that is still energised or pressurised.

- Qualified personnel only. Ensure ventilation and remove ignition sources from the work area.
- Live power means electric shock; trapped pressure makes hydrogen and electrolyte spray out when a fitting is undone, leading to fire or burns.

1

Bring it to standby with a normal shutdown.

- Switch power control off and confirm the current drops to 0 A.
- Keep electrolyte control on briefly to cool down.
- Switch electrolyte control off and let it cool toward ambient.

2

Before powering down, confirm in the app that the hydrogen pressure is released.

- On a 10 barg unit, press Emergency STOP in the control app to release the pressure through H2 VENT.
- Go on only when the hydrogen pressure on the Dashboard (PT301, PT302) has come down to 0.

3

Power it down completely.

- Switch the main power off and unplug the power cord.

Drain the electrolyte.

- Put on chemical PPE and prepare compatible containers.
- With a container under DRAIN, remove the cap, fit 1/4" tubing and tighten the nut, leading it into the container. There is no valve, so it flows the moment the cap is off. Drain until the flow stops.
- Undo the tubing carefully and refit the cap.

Disconnect the tubing.

- Never loosen a fitting to vent gas. Disconnect only after shutdown, depressurisation and draining are done.
- Cap each port as you go, to keep dirt and moisture out and residual liquid in.
- Finish with a visual check around the front-panel ports and fittings for leakage and unusual smell.

NOTICE

In storage too, never let it freeze. Keep it at 5 °C or above.

- Even after draining, residual liquid and moisture stay in the stack and the tubing. Freezing damages the membrane and the seals.

Disposal

- Drained electrolyte is strongly alkaline waste. Never pour it into a drain or storm water; label the container with contents and concentration and hand it to a licensed waste contractor.
- Treat rags and gloves used on electrolyte as the same waste.
- Contact us before disposing of the unit or the stack. We will advise how to handle the stack and electrodes.

After disconnection

Check that the power cord is disconnected, disconnected ports are capped, and no leakage is visible around ports and fittings. Residual liquid remains, so prevent freezing in storage.

10 Warranty and service

HXB-V1 · updated 2026-09-30

This chapter covers the warranty and service for one HXB-V1 system. If you bought a bare stack or electrodes the terms differ, so please ask us.

Support comes in two tracks: a defect warranty for faults present at delivery, and a stack service programme that restores performance lost through operation. Degradation is not a defect, so the two have to be read apart.

APPLIES TO **The HXB-V1 system** TERM **12 months from shipment** METHOD **Return to base** RESPONSE **24 to 48 hours**

HOW TO READ THIS CHAPTER

First time
The scope section and the exclusions section together give you the picture. The rest is for when something actually goes wrong.

Done this before
Read [the disassembly rule](#) and [the stack service section](#). Those are the two that matter when you plan service work.

What is covered

Term	12 months from the date of shipment, or from acceptance where an acceptance procedure applies.
Applies to	The HXB-V1 system. The stack inside it is covered as part of the system.
What is warranted	That the product conforms to its specification and is fit for its normal purpose. What is covered is defects in materials and workmanship at delivery.
Remedy	A defect attributable to us is repaired at no charge, or replaced with an equivalent or better product or part where repair is impractical. A replacement may be new or refurbished and carries the remainder of the original term.
How it is repaired	Return to base, that is at our premises.
Freight	You pay to send it, we pay to return it.
Test before shipment	Every unit gets a factory acceptance test before shipment, and the results go out with the delivery documents. That record is the baseline for any later warranty decision.

Your contract takes precedence over this chapter.

- This chapter is for guidance. Where your contract, quotation or purchase order says something different, that applies instead.

PRACTICAL NOTES

The system's own components are looked at slightly differently.

- The HXB-V1 contains pumps, valves, sensors, the controller, power electronics, a heat exchanger, wiring and fittings. These are assessed only for defects in materials and workmanship at delivery.
- Anything arising from installation, utilities, contamination, corrosion, misuse or normal wear is excluded and handled as paid service.

Keeping the warranty valid

All four have to hold. Time left on the term does not help if one of these is broken.

- The system is installed, operated and maintained according to this handbook and our instructions.
- Water and electrolyte quality meet the specification.
- Protection and safety functions remain in place and working. Research conditions agreed in writing are the exception.
- You provide the records and data needed for diagnosis when we ask.

PRACTICAL NOTES

Records are what protect the warranty.

- The system logs the operating data by itself. What it cannot log is the electrolyte specification and replacement dates, the water quality you used, and any change to piping or parts. Keeping those three by hand is what makes a decision quick.

What is excluded

- Operation outside the recommended specification: electrical, thermal, pressure, electrolyte concentration, and flow and cooling conditions.
- Out-of-spec or contaminated water or electrolyte, corrosion, scaling, particle ingress, improper draining or storage, freezing, and exposure to chemicals we have not specified.
- Unauthorised modification, tampering, bypassing a protection function, and use of non-approved parts or consumables.
- External causes: power supply faults and surges, site utility failures, improper installation, accident, misuse, and transport damage after delivery.
- Normal wear and consumption of consumables such as the MEA, gaskets and O-rings. Where a defect in materials or workmanship at delivery is demonstrated, it is covered.

- Improper vent and relief routing, a blocked or closed vent line, and downstream backpressure contrary to this handbook.
- Damage from careless handling, and acts of nature.



NOTICE

Opening the system enclosure is a modification.

- Changing the wiring, altering the control or firmware, or bypassing a safety function ends the cover from that point. The HXB-V1 is a finished product for which we have issued a CE declaration of conformity.
- Removing the stack from the system and opening the stack itself are different acts. The next section separates them.

The rule on disassembly

The stack is not bolted together but held by compression. That is where the line falls between a normal procedure and disassembly.

WHAT YOU DO	WARRANTY
Remove the stack and return it	A normal procedure. Follow our instructions, and get the return confirmed first.
Loosen the compression bolts and open the stack	Performance and leakage after opening are not warranted. A defect identified before opening stays covered.
Open the enclosure and alter wiring, control or firmware	A modification. Not covered.

PRACTICAL NOTES

The bolts around the end plates are the stack's compression bolts.

- Disassembly begins the moment those come loose. Taking the stack out of the system is not opening it.
- The line is drawn there because reassembly quality determines performance and leakage. In this assembly the compression is the setting.



NOTICE

You do not have to open the stack to replace the MEA.

- Send us the stack and we open it, replace only the MEA, reuse the hardware and send it back. That is the stack service in the next section.

Stack service

Stack performance and life are set together by the operating environment, water and electrolyte condition, operating patterns and normal ageing. Many stack problems are therefore not manufacturing defects at delivery,

and this programme exists for those.

When to use it

- Cell voltage behaviour stays abnormal.
- Symptoms consistent with crossover appear.
- Internal leakage is suspected.
- Performance has dropped and the operating conditions do not explain it.

Principle	Paid. Unless agreed otherwise in writing, stack service is provided on a paid basis.
What is charged	The MEA replacement cost and consumables agreed in advance. Ask us and we will tell you the amount.
Additional work	Where non-consumable parts or special rework are needed we quote first and proceed only on your approval.
How it is done	Only the MEA is replaced; end plates, bipolar plates, cell frames and fasteners are reused. Functional checks follow.
After replacement	For six months after a paid replacement we warrant the workmanship and the replaced parts. Normal degradation is not included.
Freight	Handled as specified in the contract or quotation, as are duties, taxes and logistics costs.

NOTICE

If hydrogen in the oxygen stream exceeds 2 vol%, stop and contact us.

- This is a safety limit. It is not a warranty threshold or a criterion for free replacement. How to measure it is in [the Safety chapter](#).

NOTICE

Do not ship without confirmation.

- Contact us first for a return authorisation and packing instructions. We may ask to check some things remotely before confirming.
- Drain the electrolyte and package the unit so it cannot leak or corrode in transit. Items arriving in an unsafe condition may be refused for safety reasons.

How the decision is made

Whether a case goes to the defect warranty or to paid service is decided on evidence. Four things go into it.

- The factory acceptance data and delivery records, which form the baseline.

- Your operating records: current and voltage, temperature, maintenance history, and how water and electrolyte were handled.
- Photographs or video of the condition and the installation context.
- Inspection results from returned items, where there are any.

WHAT THE EVIDENCE SHOWS

HOW IT IS HANDLED

A defect attributable to us at delivery

Repair or replacement at no charge under the defect warranty

Degradation, environment or use conditions

Stack service or another paid option

The evidence is insufficient to establish responsibility

Stack service or another paid option

You or a third party opened the stack

Stack-related issues fall outside the defect warranty; we support them on a paid basis where feasible

PRACTICAL NOTES

Thin evidence flows to the paid side.

- That is why the eligibility section stresses records. The system logs the operating data, but electrolyte, water and change history exist only if you write them down.

When something goes wrong

1

Contact us

- Send the symptom and the operating records. You get a detailed reply within 24 to 48 hours.

2

Remote diagnosis

- Because the system runs from a PC we look at the same data with you and work out the cause. Many cases end here.

3

Return instructions

- If it does not resolve, we send return and packing instructions. The stack is designed to be opened and reassembled, and this is routine work for us.

4

Diagnosis and repair

- On arrival we report the diagnosis and the schedule before proceeding. Repair time depends on the fault, so we do not promise it in advance.

PRACTICAL NOTES

Start your message with these.

- The model and serial number, the stack current and voltage at the time, electrolyte flow and temperature, the alarm code, and when it appeared: during start-up, ramping, steady operation or shutdown.
- Hydrogen flow, pressure and purity and oxygen purity help if you measured them. It is fine if you did not.

What comes with it

- Training on installation, start-up and service, held here in Korea.
- Remote support: we look at the desktop app together and go through the operating data.
- Long-run raw data, shared on request.
- Stacks are serviced by the engineers who designed and built them.

NOTICE

Repair and replacement of site equipment is yours.

- That covers the DI water supply, the downstream hydrogen equipment, and the external piping and valves connected to H2 OUT. We interpret the alarms and operating trends to judge the system's behaviour and tell you whether factory service is needed.

11 Specifications and reference

HXB-V1 · updated 2026-09-30

What the HXB-V1 is for, how it looks and what flows inside, its specifications and electrical ratings, and the terms used in this handbook. Read it once before installation and come back when you need a value.

Intended use

The HXB-V1 is a 2 kW AEM water electrolysis system that makes hydrogen from DI water with a 0.1 M KOH electrolyte. One 6U 19-inch rack holds the stack (HXS-2), electrolyte tank, pumps, heat exchanger, power and controls.

- Laboratory research on AEM stacks, electrodes and operating strategies
- Small-scale hydrogen production and system-integration test beds

WARNING

Do not use it like this.

- Filling it with another electrolyte or a contaminated liquid
- Running beyond the current, voltage, temperature, pressure or flow limits
- Running with poor ventilation or discharge routing, or with piping where hydrogen and oxygen can mix
- Bypassing or disabling safety devices, interlocks or sensors
- Opening or repairing the stack or safety-related parts without authorisation
- Modifications that weaken insulation, earthing, wiring or overcurrent protection
- Installing it outdoors or where condensation forms
- Doing so can lead to fire, explosion, electric shock or chemical burns, or damage the equipment.

Installation, operation and maintenance are for people who know hydrogen safety and venting, high-current DC and alkaline electrolyte handling. If you modify the unit or run it outside the recommended conditions, verifying safety and performance is your responsibility and the warranty may change (see Warranty and service).

Product views



Figure 11-1 The HXB-V1. Appearance may vary by revision.

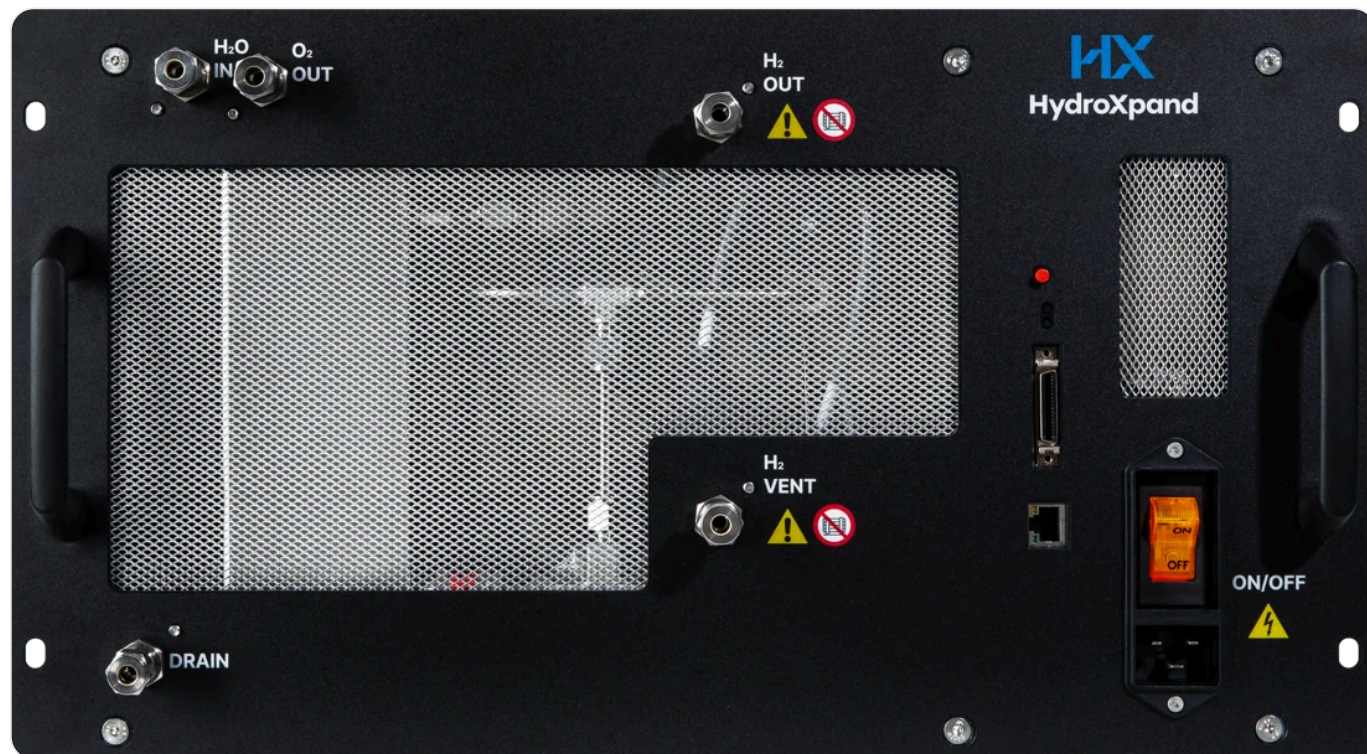


Figure 11-2 Front. For port numbers and names, see figure 4-1 in Quick start.

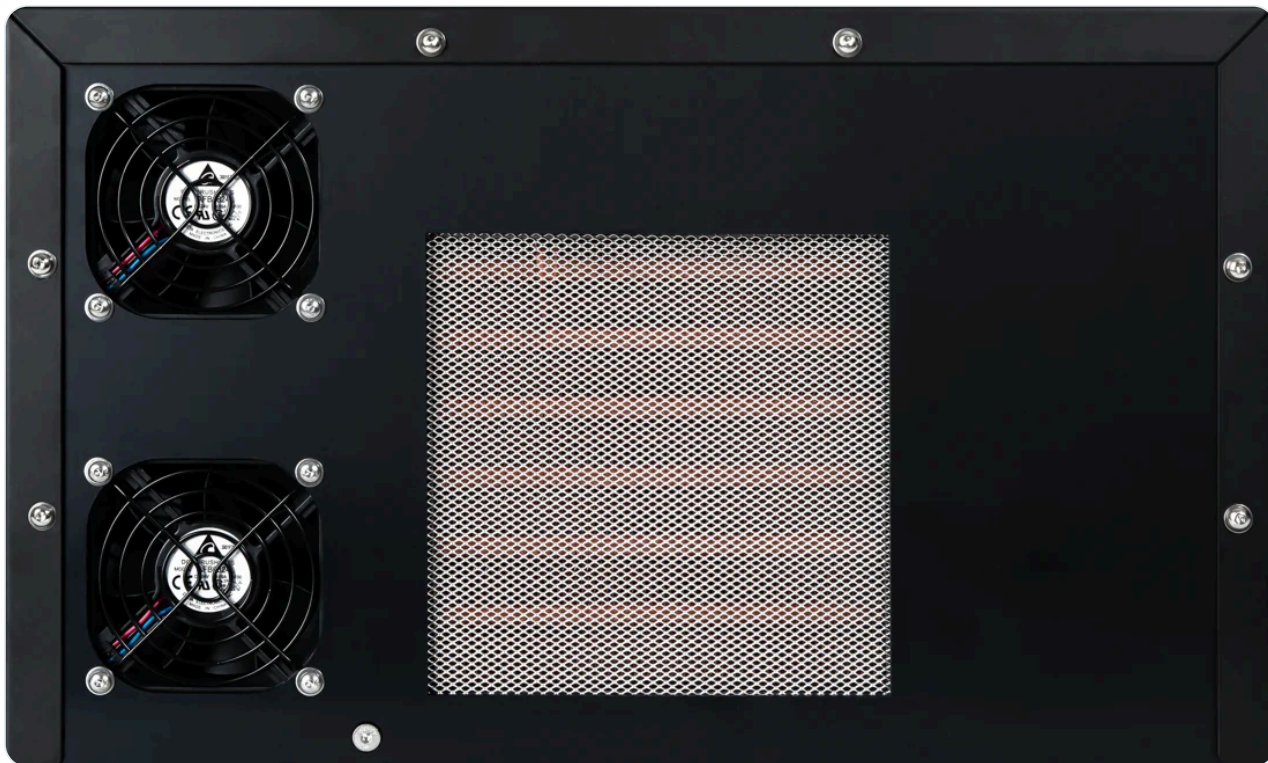


Figure 11-3 Rear. The Device ID on the label identifies the unit.

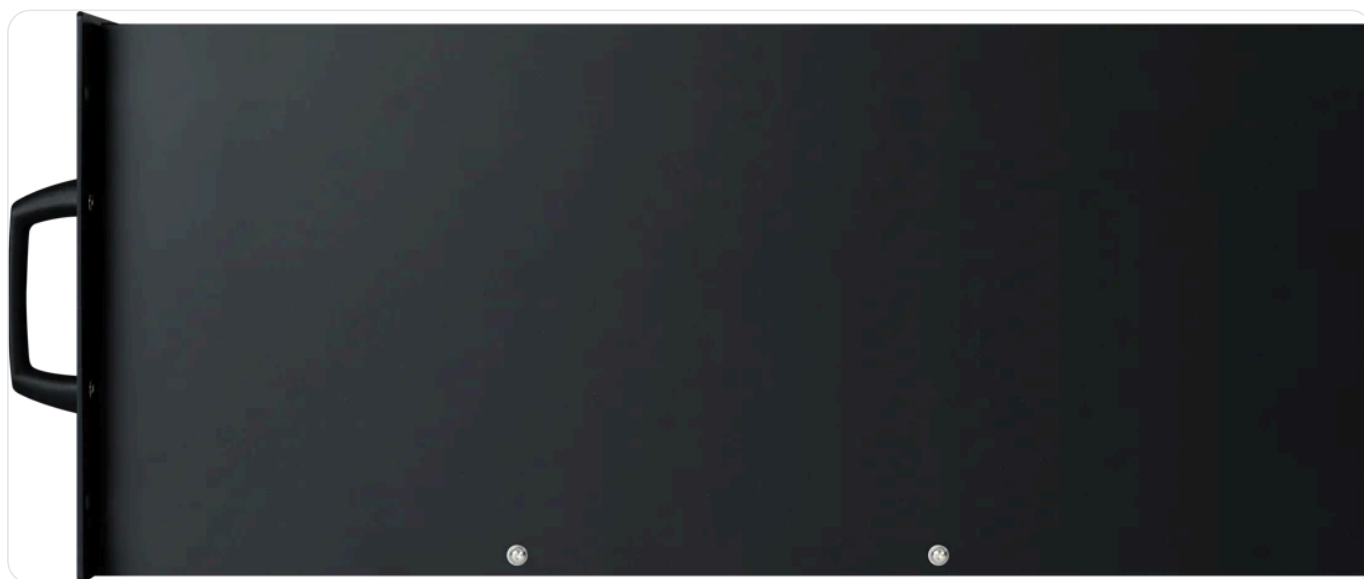


Figure 11-4 Side

Flow inside the unit

Electrolyte leaves the tank through the circulation pump and heat exchanger into the stack; oxygen and electrolyte return to the tank, where they separate. Hydrogen leaves the stack on its own line to H2 OUT. The make-up pump replaces the water used, through H2O IN.

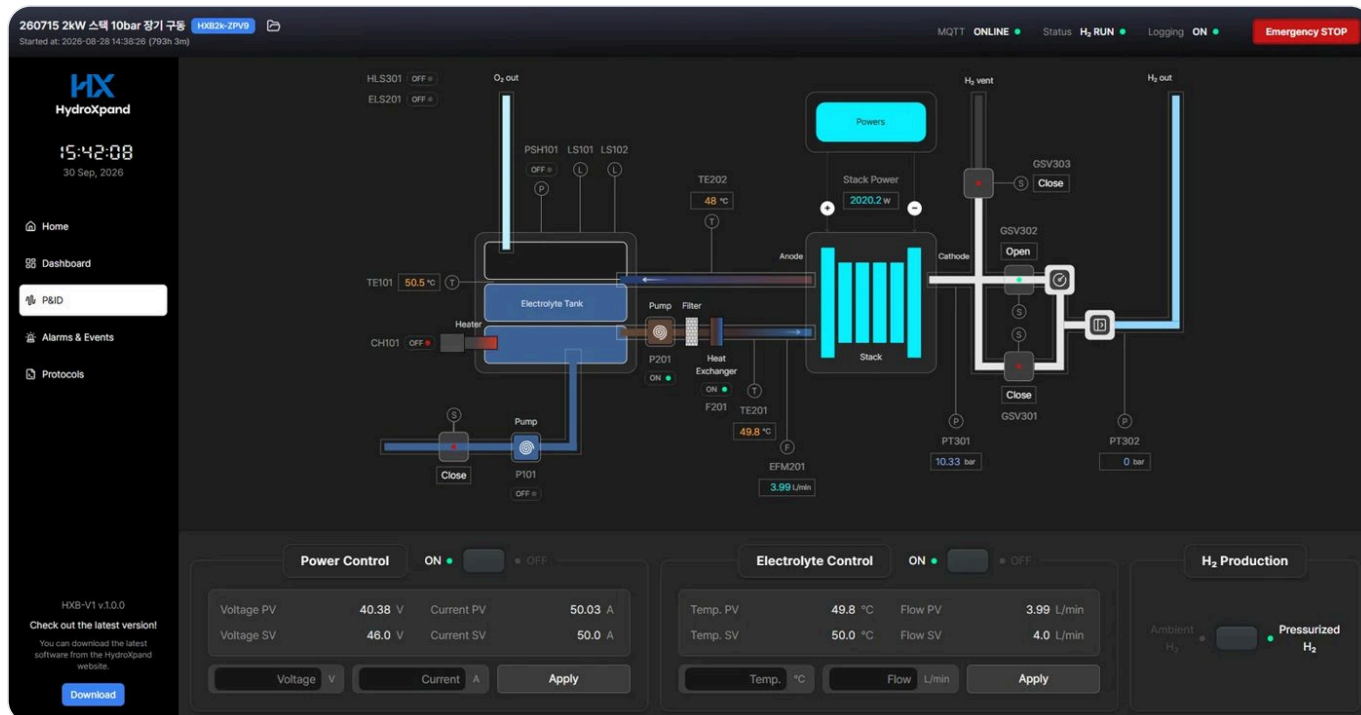


Figure 11-5 The P&ID screen in the control app. Live readings appear at each point.

Specifications

The specifications below are the same values as the product page and datasheet. They are beginning-of-life values unless stated otherwise.

Production performance

H₂ production 500 L/h (approx. 1 kg/day)

Energy use (kW) 2.4 kW (BOL · 2.0 stack + 0.4 BoP)

Energy use (kWh/Nm³) 4.8 (BOL)

Energy use (kWh/kg-H₂) Stack 44 · system 54 (the difference, about 10 kWh/kg, is the BoP)

Operating current 15–67 A (50 A recommended)

Hydrogen purity & pressure

H₂ purity @ 0 barg 98–99% (no dryer) · ≥ 99.999% (with dryer)

H₂ purity @ 10 barg 99% (no dryer) · ≥ 99.999% (with dryer)

H₂ pressure 0 or 10 barg · chosen at order (relief valve); 35 barg by agreement

Power & water

Power supply	200-240 V AC · 50/60 Hz · single phase
Water conductivity	Recommended ASTM D1193 Type II ($\leq 1.0 \mu\text{S}/\text{cm}$) · in-service $\leq 30 \mu\text{S}/\text{cm}$
Water consumption	0.55 L/h (50 A · 60 °C)
Feed water top-up	Built-in gear pump refills automatically
Electrolyte	KOH 0.1-1 M · circulation 2-5 L/min

Installation

Ambient temp	5-45 °C
IP rating	IP 20
Dimensions	482 × 647 × 266 mm (6U)
Weight	51.3 kg
Fluid connections	H ₂ O · H ₂ · O ₂ · VENT · DRAIN 1/4" double-ferrule
Power inlet	C20 AC inlet (C19 cable)
Installation clearance	Front ≥ 300 mm · rear ≥ 400 mm

Controls & communications

Control	Desktop app (MQTT/Ethernet)
Direct control	Voltage · current · electrolyte temperature · electrolyte flow
Stack handling	Removable · disassemblable · replaceable
Telemetry	1 s interval · 8 external control variables · Modbus TCP supported (not RTU)

Safety & warranty

Safety	H ₂ detection · emergency stop (control app) · interlocks · electrolyte tank pressure switch auto-stop
--------	---

Warranty	12 months from shipment, or from acceptance where an acceptance procedure applies (consumables excluded)
----------	--

Electrical ratings and environment

Rated supply	200-240 V AC · 50/60 Hz · single phase · 2.4 kW
Power connection	IEC 60320 C20 inlet (16 A) · C19 power cord
Protection class	Class I. Plug into an earthed outlet.
Enclosure rating	IP20
Location	Indoor use only, non-condensing
Ambient temperature	5–45 °C
Altitude	Up to 2,000 m
Overvoltage category · pollution degree	Overvoltage category II · pollution degree 2
CE conformity	Self-declared to the Low Voltage (2014/35/EU), EMC (2014/30/EU) and RoHS (2011/65/EU) directives, applying EN 61010-1, EN 61326-1 and EN IEC 63000. Download the declaration under “Sources for this chapter” below.

Labels on the unit

	General warning Beside H2 OUT and H2 VENT, where hydrogen comes out. Follow the hydrogen section of the safety chapter.
	Do not obstruct the outlet Beside H2 OUT and H2 VENT. Never block the outlets or stack things in front of them.
	Electric shock hazard Beside the power switch and C20 inlet. Always disconnect from the mains before opening any cover.

Terms

TERM	MEANING
AEM	Anion exchange membrane: a membrane that passes hydroxide ions (OH ⁻).

TERM	MEANING
KOH	Potassium hydroxide, used as a 0.1 M solution for the electrolyte.
DI water	Deionised water. Quality is judged by conductivity ($\mu\text{S}/\text{cm}$ at 25 °C).
MEA	Membrane electrode assembly: the electrodes and membrane that make up the heart of a cell.
BoP	Balance of plant: everything around the stack, such as power, pumps, tank, heat exchanger, piping, sensors and controls.
barg	Gauge pressure in bar, relative to atmosphere.
NL/h	Gas volume per hour in litres at standard conditions (0 °C, 1 atm).
BOL	Beginning of life. Specifications are BOL values unless stated otherwise.
SDS	Safety data sheet. Check it before handling KOH.
P&ID	Piping and instrumentation diagram. The P&ID screen in the control app shows the flow and measuring points inside the unit.
PSU	The power supply that feeds DC to the stack.

Manufacturer

Manufacturer	HydroXpand Inc.
Address	3F, 59 Dongtansandan 6-gil, Hwaseong-si, Gyeonggi-do 18487, Republic of Korea
Contact	+82 70-4110-1201 · info@hydroxpand.com · hydroxpand.com

Serial numbers take the form HXB-V1-YYMM-#### (year and month of manufacture, then a sequence number). Quote the serial number or Device ID from the label when you contact us.

Troubleshooting

HXB-V1 · updated 2026-09-30

The order in which to work through an abnormal condition, plus causes and actions for four symptoms. Following it lets you capture the information that matters before shutting down, and then move on to checks that are safe to make.

For most symptoms the cause is not inside the stack but in electrolyte condition, flow or water make-up. Start there.

FIRST Judge the hazard · record · stop SYMPTOMS Four USUAL CAUSE Electrolyte condition · flow · water make-up

HOW TO READ THIS CHAPTER

First time

Follow the checklist from the top exactly as written. Of the four symptoms, read only the one you are seeing.

Done this before

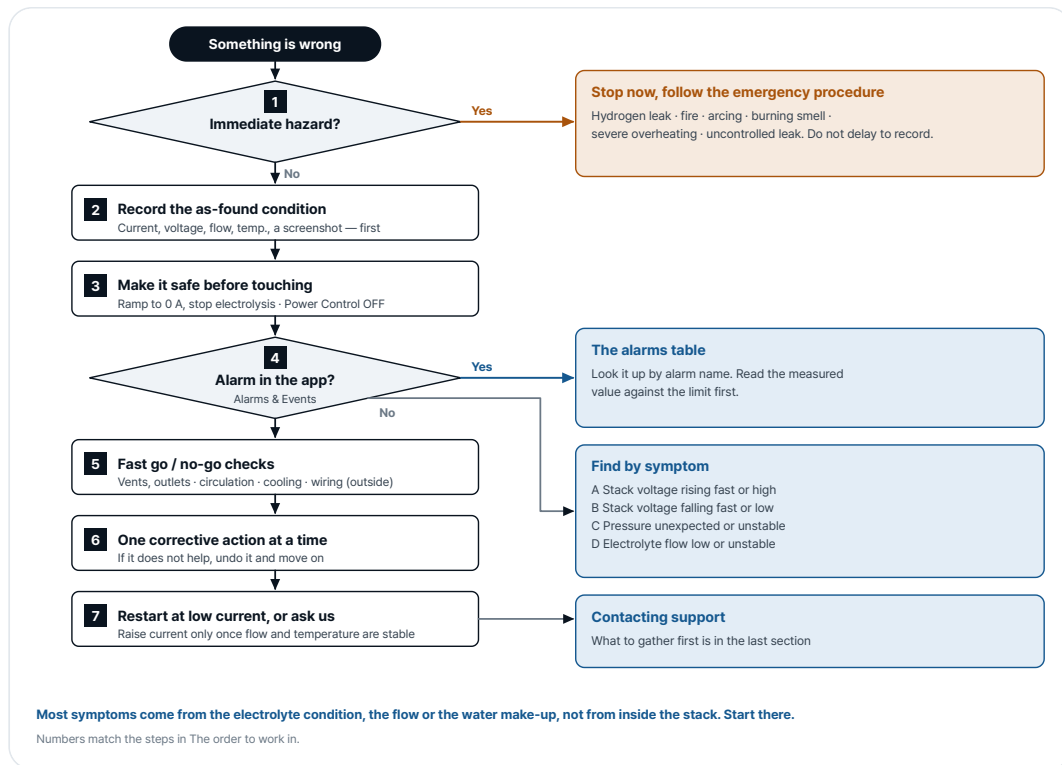
Go straight to the symptom sections. The last section lists what to gather before contacting us.

The order to work in

 DANGER

At any sign of a hydrogen leak, fire, arcing, a burning smell, severe overheating or uncontrolled electrolyte leakage, stop operating at once and follow your emergency procedure.

- If you suspect an immediate hazard, do not delay shutdown to collect data.



Troubleshooting flow. Numbers match the steps below. With an immediate hazard, stopping comes before recording.

PRACTICAL NOTES

Why you record before you fix

- The readings from that moment disappear once you stop the system. One screenshot can save days of looking for the cause later.
- If you contact us after fixing it, we cannot tell what was different either. Record first, then act.
- That said, if you suspect an immediate hazard, abandon the recording and stop at once. That judgement comes first.

1

Judge the hazard level first.

2

Record the as-found condition.

- If it is safe to observe for a moment, record before you change anything.
- Always capture stack current and voltage, and electrolyte flow and temperature.
- If you measure them, add hydrogen flow, pressure and purity, and oxygen purity.
- Write down what you saw and heard too: pump noise or cavitation, gurgling, an unstable wet return at the outlet, odd vent behaviour, visible leakage.

3

Make it safe before touching anything.

- Ramp stack current to 0 A and stop electrolysis from the app.
- Set Power Control OFF before touching any electrical connection.

4**Read the alarm entry.**

- Open the relevant entry in Alarms & Events and copy the values as shown.
 - Read the limit against the measured value first: it tells you which threshold was reached and by how much.
 - If the log shows the system reduced load or stopped by itself, treat it as safety-related until the cause is known.
-

5**Run the fast go / no-go checks.**

- Vent and outlets: confirm H2 OUT, H2 VENT and O2 OUT are not blocked, kinked or covered, and that no downstream valve was closed by accident.
 - Electrolyte circulation: kinked tubing, visible blockage, signs of trapped air such as bubbles or surging, abnormal pump behaviour. If flow was low or unstable, fix that first, because it quickly turns into abnormal temperature and voltage.
 - Cooling: confirm the fans and heat-exchanger airflow paths are clear, and clean them if needed.
 - Electrical: visual inspection only. Loose cables or connectors, discolouration or overheating marks, an unusual smell. Do not open enclosures unless qualified.
-

6**Apply one corrective action at a time.**

- Make one change and check whether it improves. If it does not, undo it and move to the next likely cause. Never change several settings or parts at once.
-

7**Restart carefully, or ask us.**

- If you restart, begin at low current and increase only after flow and temperatures are stable.
-

Alarms: meaning and action

The English text below is the message exactly as the control app's alarm table shows it; wording can differ slightly between app versions. What the three levels mean is in the Alarms and events section of the Operation and control chapter. If the same alarm returns after you have acted, send us the alarm entry as it is.

280715 2kW 스택 10bar 장기 구동

HXB-V1

Started at: 2026-08-28 14:38:26 (793h 4m)

MQTT ONLINE

Status H₂ RUN

Logging ON

Emergency STOP

HX

HydroXpand

15:42:31

30 Sep, 2026

Home

Dashboard

P&ID

Alarms & Events

Protocols

HXB-V1 v1.0.0

Check out the latest version!

You can download the latest software from the HydroXpand website.

Download

Alarms

2 active alarms

Clear All Resolved

ID	Time	Category	Label / Message	Value / Limit	Status
13365	2026-09-29 18:50:52	PROC	PT301 H2 Production pressure high	10.0 bar 10 bar	Active
13362	2026-09-29 18:14:34	PROC	PT301 H2 Production pressure high	1.4 bar 1 bar	Active
13364	2026-09-29 18:41:12	PROC	PT301 H2 Production pressure high	10.0 bar 10 bar	Resolved
13363	2026-09-29 18:14:51	PROC	PT301 H2 Production pressure high	10.2 bar 10 bar	Resolved
13361	2026-09-29 18:02:50	PROC	TE201 Electrolyte temperature high	78.78 °C 80.0 °C	Resolved
13360	2026-09-29 17:39:53	PROC	EFM201 Electrolyte flowrate low	0.1 slm 3.2 slm	Resolved
13359	2026-09-29 17:26:43	SAF	LS102 Electrolyte tank level abnormally high	Unsafe condition	Resolved
13358	2026-09-29 17:20:46	PROC	EFM201 Electrolyte flowrate low	0.5 slm 3.2 slm	Resolved
13357	2026-09-29 17:19:47	EQUIP	PS01 Electrolyte makeup pump fault detected	Actuator fault detected	Resolved

Events

Clear All

ID	Time	Type	Action	Status
123	2026-09-29 18:14:31	Command	High-P Production: On	Applied
122	2026-09-29 17:55:32	Command	Power: On	Applied
121	2026-09-29 17:55:30	Command	Voltage: 46 V, Current: 50 A	Applied
120	2026-09-29 17:41:55	Command	Temperature: 50 °C, Flow Rate: 4 SLM	Applied
119	2026-09-29 17:39:54	Command	Temperature: 25 °C, Flow Rate: 4 SLM	Applied
118	2026-09-29 17:38:59	Command	Electrolyte Control: On	Applied
117	2026-09-29 17:26:45	Emergency	Emergency Stop	Applied

When an alarm comes up, read the measured value against the limit on this screen first. Which threshold was crossed, and by how much, narrows down the cause.

Emergency stop

APP MESSAGE	LABEL	MEANING	WHAT TO DO
Hydrogen leak detected	HLS301	Hydrogen was detected inside the unit.	Keep away and ventilate. Remove ignition sources nearby and follow the emergency response in the Safety chapter. Do not restart until the cause is found.
Electrolyte leak detected	ELS201	Electrolyte was detected at the base of the unit.	Put on PPE, switch off, then find the leak. Deal with spilled electrolyte as the electrolyte section of the Safety chapter describes. If it leaks inside the enclosure, contact us.
Electrolyte tank pressure higher than 60 psi	PSH101	Electrolyte tank pressure exceeded its limit.	Check that the O2 OUT line is not blocked, kinked or submerged at its end. Gas leaves the tank this way.
Electrolyte tank level abnormally high	LS102	The tank filled up to the overfill switch.	Check whether too much electrolyte was filled or the make-up pump keeps running. Heavy foaming can also trip it. Drain the excess back to normal level, then clear the stop.

APP MESSAGE	LABEL	MEANING	WHAT TO DO
Electrolyte flow critically low (pump failure)	EFM201	There is almost no circulation flow. The circulation pump has most likely stopped.	Check that the tubing is not blocked or kinked and the level is sufficient. If nothing is wrong and it recurs, contact us. See Symptom D .
H2 production pressure critical high	PT301	Hydrogen pressure rose to a critical level.	A closed downstream valve or a blocked line is the likely cause. Confirm pressure has been relieved, then check from H2 OUT to the end of your line. See Symptom C.
H2 outlet pressure critical high	PT302		
DISCONNECTED	—	The link to the control app was lost for longer than allowed. It shows as a flashing red front LED rather than as an alarm entry.	Check the LAN cable and the PC. Set the PC so sleep or update restarts do not interrupt it, and restart the app.

Fault stop

APP MESSAGE	LABEL	MEANING	WHAT TO DO
Electrolyte refill failure	LS101	Water make-up has not succeeded for too long.	See When make-up starts to fail under Water make-up in the Operation and control chapter.
Electrolyte circulation lost	EFM201	Electrolyte circulation flow stayed far below the setpoint.	First bring the current to 0 A (Power Control OFF). Then look for kinked tubing, trapped air or a pump problem. See Symptom D .
Electrolyte tank temperature high (stop)	TE101	Electrolyte temperature stayed far above the setpoint.	Check that fan and heat-exchanger airflow is not blocked, the ambient temperature is within the installation limits and circulation flow is normal. Let it cool, remove the cause, then start.
Stack inlet temperature high (stop)	TE201		
Stack outlet temperature high (stop)	TE202		
Unsafe operating temperature	TE101/201/202	A temperature that cannot occur in normal operation, at freezing or boiling level.	If it may have frozen, do not operate; contact us. In any other case, contact us too.

APP MESSAGE	LABEL	MEANING	WHAT TO DO
Temperature sensor fail	TE	A sensor reading went outside its measurable range. The sensor or its wiring has failed.	Send us the alarm entry as it is and contact us. Do not open the enclosure.
Current sensor fail	CT201		
Voltage sensor fail	PSU48		
Pressure sensor fail	PT301/302		
Makeup pump fault	P101	The make-up pump was commanded on but draws no current.	Contact us. Without make-up the level soon falls.
Circulation pump fault	P201	The circulation pump was commanded on but draws no current.	Bring the current to 0 A at once (Power Control OFF); running current without circulation damages the stack. Then contact us.
Hydrogen solenoid valve 1 / 2 fault detected	GSV301/302	A valve was commanded on but draws no current.	Contact us. These valves serve pressurised operation and the emergency vent.
Solenoid valve 3 fault	GSV303		
Magnetic contactor fault detected	MC401	The stack power contactor does not close as commanded.	Contact us.

Warning

APP MESSAGE	LABEL	MEANING	WHAT TO DO
Electrolyte tank temperature high · Electrolyte temperature high	TE101 TE201 TE202	Electrolyte temperature is starting to rise above the setpoint.	Check cooling airflow and ambient temperature. If it keeps rising, it becomes a fault stop.
Electrolyte flowrate low	EFM201	Circulation flow is below the setpoint.	Look for kinked tubing and trapped air. If it persists, see Symptom D .
H2 Production pressure high	PT301	Hydrogen pressure is above the normal range.	Check for back pressure downstream. See Do not create back pressure in the Upstream and downstream chapter .
H2 Outlet pressure high	PT302		

APP MESSAGE	LABEL	MEANING	WHAT TO DO
Electrolyte cooling fan fault detected	F201	A fan was commanded on but is not turning.	Check for debris or blockage around the fan. Left alone it leads to overheating. If it persists, contact us.
Axial fan fault detected	F401		
Cartridge heater falt detected	CH101	The heater was commanded on but draws no current.	Warm-up will not happen or will be slow. Contact us.

Symptom A. Stack voltage rises quickly or sits unusually high

Electrolyte temperature too low

Check the electrolyte temperature and its setpoint in the app. If there is no upward trend toward the setpoint, or the heater status looks abnormal, stop operating and contact us.

Electrolyte concentration too low

Confirm the electrolyte is 0.1 M KOH and review the recent water make-up history. If dilution is suspected, stop and replace it with fresh 0.1 M KOH. Restart at low current, confirm the voltage trend is stable, then ramp up. If it is still abnormal with fresh electrolyte, contact us.

Internal crossover or membrane damage suspected

Stop operating. Keep the electrolyte level trend, the make-up events and the stack current and voltage as evidence, and contact us.

Electrolyte flow insufficient or unstable

Check the flow indication and any related alarms in the app. If the pump is on but there is no flow, if it does not start reliably, or if its behaviour is abnormal, stop operating and contact us.

Current drops although no setting was changed

When stack voltage reaches the power supply's voltage limit, the supply lowers the current by itself. In that case the voltage of a single cell inside the stack has often risen sharply. The control app shows only total stack voltage, so on screen the voltage sits at the limit while the current falls. In our tests a slow rise of stack voltage at the same current appeared first, 10-24 hours before the stop. Stop operating and do not restart repeatedly. Keep the current and voltage trends and contact us.

Symptom B. Stack voltage falls quickly or sits unusually low

Electrolyte temperature too high

Check the electrolyte temperature and its setpoint in the app. If it does not come down toward the expected range, or cooling-related status looks abnormal, stop operating and contact us.

Electrolyte concentration too high

Check the electrolyte level and confirm water make-up is working. Bring the electrolyte back to the 0.1 M KOH specification following your site procedure. Restart at low current, confirm the voltage trend is stable, then ramp up.

Electrolyte flow insufficient or unstable

Check the electrolyte level, confirm make-up is enabled and active, and see whether the level rises as expected. If make-up appears to run but the level does not recover, the DI water source is empty or not supplying. If refilling does not raise the level, stop operating and contact us.

Membrane damage in the stack

If voltage is still unusually low after temperature, concentration and flow are restored, stop operating. Keep the stack current and voltage trend, electrolyte temperature and flow, and recent service history as evidence, and contact us.

Symptom C. Pressure is not as expected or is unstable

Pressure does not match the ordered specification

The unit's hydrogen pressure is set by the relief valve chosen when you ordered (0 barg or 10 barg). If a 10 barg unit cannot build to that pressure or is unstable, stop operating and contact us.

Relief valve malfunction suspected

If pressure cannot build to 10 barg, or drops quickly during pressurised operation, relief valve leakage may be the cause. Stop operating and contact us.

Pressure sensor malfunction suspected

If the reading jumps suddenly, sticks at one value, or is simply implausible, suspect the sensor. Stop operating and contact us.

Hydrogen outlet path blocked

The moisture that leaves with the hydrogen carries alkaline residue, which can build up as deposits in valve orifices and narrow tubing as it dries. Suspect this if hydrogen pressure creeps up or fluctuates although no setting was changed. Stop operating, depressurise, then check the tubing and valves from H2 OUT to the end of your downstream line. Do not dismantle valves inside the unit yourself; contact us.

Membrane damage in the stack

If pressure stays unstable or cannot be held on a 10 barg unit while temperature and flow behave normally, suspect an internal stack issue. Stop operating and do not keep restarting. Keep the pressure trend, the current and voltage trend and the relevant alarm entry as evidence, and contact us.

Symptom D. Electrolyte flow is low or unstable

Electrolyte level too low

There is not enough liquid for stable circulation. Check the level in the app and confirm make-up is working and DI water is available. If the level does not recover as expected, stop operating and contact us.

Circulation pump malfunction suspected

Check the flow indication and any related alarms in the app. If the pump is on but there is no flow, flow is unstable, or its behaviour is abnormal, stop operating and contact us.

Make-up takes longer than usual or the level recovers slowly

The make-up pump is not drawing water properly. Check that the DI water reservoir is not empty, the H2O IN hose is submerged, the reservoir is not too far below the unit, and the hose is not full of air. Left alone, make-up stops and circulation flow falls. Keep electrolysis stopped while you find the cause.

Make-up is more frequent than usual and liquid comes out of O2 OUT

The electrolyte is foaming and being carried out through O2 OUT. Make-up runs more often to replace it, and cell voltages may rise with it. Stop electrolysis, drain all the electrolyte and refill with fresh (Maintenance, Changing the electrolyte). If it comes back after the refill, contact us.

Make-up is overdue and has not run at all

If the usual make-up interval has passed and make-up has not run once, the level reading may be at fault. Stop electrolysis and contact us even if no alarm has appeared yet. Left alone, the level falls and circulation and temperature control fail.

Membrane damage in the stack

If flow stays unstable or cannot be held, suspect an internal stack issue. Stop operating and do not keep restarting. Keep the pressure trend, the current and voltage trend and the relevant alarm entry as evidence, and contact us.

Contacting support

When to ask us

- Stack voltage behaviour stays abnormal after you have checked and corrected level and condition, flow and temperature.

- The same problem recurs under normal operating conditions and the symptom guide above does not resolve it.
- You are planning non-standard operation and want the safe limits and recommended practice confirmed.
- A high-severity alarm persists or returns after the basic checks.
- You see behaviour the symptom guide does not explain, such as erratic readings or unexplained mode changes.

Send these and diagnosis is faster

- The full alarm entry: time, category, label, message, measured value against the limit, and status.
- The stack current and voltage and the electrolyte flow and temperature trends across the abnormal period.
- The electrolyte specification and the date it was last replaced.
- Any recent change: a new stack, new electrolyte, piping modification, a replaced component.
- Accumulated run hours and the number of start-stop cycles.

NOTICE

Repair and replacement of site equipment is the customer's responsibility.

- That covers the DI water supply, downstream hydrogen equipment, and the external piping and valves connected to H2 OUT. We help interpret the alarms and operating trends to judge the system's behaviour, and tell you whether factory service or replacement is needed.
- Returns for inspection or service go ahead only after we confirm them. Do not ship without prior confirmation.