

Electrolyzer Test Station

ETS-1

(PEM - lead stage)

Data sheet

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Product key: ETS-1-S2-PEM-WA-C2A-T95-AC-PA10-PC50-BPM-PP0-1D

Datasheet stage: Lead

Cathode line

Primary condensate separator	<p>Volume pending engineering acceptance protocol Max pressure: 50 barg, automatic draining</p> <p>Pressure relief valve set to 55 barg, control mechanism is sealed to avoid manipulation</p> <p>Level measurement by differential pressure sensor and two safety sensors (Critical-high and Critical-low)</p> <p>The water level needs to be above the critical-low level (LL), otherwise the test station cannot be operated</p>
Pressure control	<p>Pressure range 0...50 barg</p> <p>Manual backpressure regulation</p> <p>Manometer pressure range 0...60 barg</p> <p>Pressure sensors 0...60 barg ($\pm 0.5\%$ FS)</p> <p>If pressure exceeds 51 barg, a warning is triggered. If pressure exceeds 53 barg, an emergency shutdown is triggered</p> <p>No prepressurizing option</p>
Condensate separation	<p>Automatic draining</p>
Safety	<p>Line volume pending engineering acceptance protocol</p> <p>Integrated nitrogen emergency flush cylinder, volume 3.0 l</p> <p>Inertization flowrate regulated by manually controlled rotameter in range 1.0...10.0 NI/min</p>
Electrolyte sharing	<p>Cathode to anode recycle, possible when pressure in cathode vessel is at least 1 bar above pressure in anode vessel</p>
Electrolyte temperature control	<p>No cathode electrolyte circulation</p>

Anode line

Primary condensate separator	<p>Volume pending engineering acceptance protocol Max pressure: 10 barg, automatic draining</p> <p>Pressure relief valve set to 15 barg, control mechanism is sealed to avoid manipulation</p> <p>Level measurement by three level sensors (Critical-high, Setpoint, Critical-low) The water level needs to be above the critical-low level (LL), otherwise the test station cannot be operated</p>
Pressure control	<p>Pressure range 0...10 barg Manual backpressure regulation Manometer pressure range 0...16 barg Pressure sensors 0...16 barg ($\pm 0.5\%$ FS) If pressure exceeds 11 barg, a warning is triggered. If pressure exceeds 13 barg, an emergency shutdown is triggered No prepressurizing option</p>
Condensate separation	<p>Automatic draining</p>
Oxygen-in-Hydrogen sensor	<p>0.0...5.0 %vol O₂ in H₂ (± 0.3 %vol) Values are representative after a certain period of time since inertization process affects the measurement outcome</p>
Safety	<p>Line volume pending engineering acceptance protocol Integrated nitrogen emergency flush cylinder, volume 3.0 l</p> <p>Inertization flowrate regulated by manually controlled rotameter in range 1.0...10.0 Nl/min</p>
Electrolyte sharing	<p>Cathode to anode recycle, possible when pressure in cathode vessel is at least 1 bar above pressure in anode vessel</p>
Electrolyte temperature control	<p>Thermocouple Type K for temperature measurement ($\pm 1,5$ °C) Inline circulation heater, power 1.38 kW DUT inlet temperature control up to 95 °C Heat exchanger for temperature reduction in case of low-temperature operation</p>
Electrolyte circulation	<p>Gear pump with servomotor with flowrate up to 1.5 l/min (minimal flowrate depends on operating temperature, 0.05 l/min at 70 °C)</p> <p>Inline turbine flow meter, measuring range 0.05...1.50 l/min ($\pm 0,1$ % FS @ 20 °C)</p> <p>Conductivity measurement 0,04..1000,00 μS/cm ($\pm 0,03$ μS/cm), Inline Ion trap for conductivity reduction</p>

Supplied Media

Nitrogen

Interface: Compression tube fitting, female port for 6 mm outer diameter pipe
Interface label: N2 SUPPLY
Required supply pressure 6...8 barg
Reccomended purity: 5.0
Pressure sensor 0...16 barg ($\pm 0.5\%$ FS)

DI water

Interface: 8 mm
Interface label: DI WATER SUPPLY
Required supply pressure 1...4 barg
Reccomended purity water conductivity $< 1 \mu\text{S/cm}$

Low water level/pressure alarm
Pressurized vessel refill flow rate 0.13 l/min @ < 10 barg

Chilled water/Chiller

Interface: Compression tube fitting, female port for 8 mm outer diameter pipe
Interface label: CHILLER SUPPLY
Required supply pressure 1...5 barg (must stay above 0.5 barg)
Inlet temperature 15...25 °C

Discharged Media

Hydrogen

Interface: Compression tube fitting, female port for 6 mm outer diameter pipe

Interface label: H2 EXHAUST

Gas can have high relative humidity on the outlet, please, take downstream condensation into consideration.

Exhaust gas can also contain nitrogen, trace amounts of oxygen (due to crossover), and possibly other gases introduced into the system.

Oxygen

Interface: Compression tube fitting, female port for 6 mm outer diameter pipe

Interface label: O2 EXHAUST

Gas can have high relative humidity on the outlet, please, take downstream condensation into consideration.

Exhaust gas can also contain nitrogen, trace amounts of hydrogen (due to crossover), and possibly other gases introduced into the system.

Condensate

Interface: Male hose adapter for DN12 hoses

Interface label: CONDENSATE DRAIN

DI water that contains trace amounts of dissolved gases

Chilled water/Chiller

Interface: Compression tube fitting, female port for 8 mm outer diameter pipe

Interface label: CHILLER RETURN

Outlet temperature depends on operation. Expect 5 °C above inlet temperature

DUT Connectivity

Cell voltage monitoring	8-channel analog input, multi-function, ± 5 V, $\pm 0.0055\%$ FS (± 0.3 mV), 24 bit, burst sampling 1 ksps
Auxiliary temperature sensors	4x thermocouple Type K, Type Kminiature sockets on the front panel (± 1.5 °C)
DUT mechanical interface	3x Compression tube fittings, female ports for 6mm outer diameter pipe (2x anode circuit, 1x cathode circuit)

Electrical Parameters

Power supply	3 phases, 400 V, 50 Hz; nominal current 16 A Min cross section of power supply cable 5x2.5 mm ² Fixed connection to the terminals inside the electrical cabinet It is the responsibility of the test station owner to provide a suitable power supply cable that meets the required specifications and local safety standards Required circuit breaker 3x16 A, tripping characteristics B or C, recommended short circuit rating 10 kA
Control circuits voltage	24 VDC

Control system

Sampling Frequency	10 Hz
Database	PostgreSQL
Hard drive	1TB SSD
Scripting	Python 3.10 API, in-house (LEANCAT) developed library
Integration with 3rd party devices	OPC UA protocol
Remote access	TeamViewer, requires internet connection
Operating systém	Microsoft Windows 10 IOT 2021 LTSC, English
Operating systém	Wireless keyboard and mouse set, 24" monitor

Safety

Emergency stop	An emergency stop mushroom button is located on the right door of the test station and is marked clearly with yellow label "EMERGENCY STOP". Pressing the button triggers a safety error and a safe controlled shutdown of category 1 according to EN 60204-1, section 9.2.2.
Safety controller	Beckhoff TwinSAFE
Inertization	Nitrogen flush with nitrogen stored in internal tanks in case of a power loss or triggering of a safety function
Explosion protection	To be installed in a safe (non hazardous) area only.
Ventilation	Integrated ventilator inside the process technology cabinet, flow 44 m ³ /h The test station must be operated in a well-ventilated room. The ventilator inside the process technology cabinet actively circulates and replaces the air within the cabinet, effectively removing any potentially dangerous gas mixtures.

Dimensions and Weigth

Width	850 mm (max. 985 mm, including buttons, handles etc.)
Length	1330 mm (max. 1400 mm, including buttons, handles etc.)
Height	1610 mm (max. 1635 mm, including buttons, handles etc.)
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Height of working area	1000 mm
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Weigth	297 kg

Operating conditions

The categories of external influences according to IEC 60364-5-51 are summarized in the table below. External influences include factors like temperature, humidity, water, dust, and mechanical impacts that can affect the safety and performance of installations. Adhering to these categories prevents hazards, ensures installation longevity and reliability, and guarantees compliance with safety regulations. Properly accounting for these influences keeps the test station operating safely and minimizes risks of malfunctions or accidents.

Influence	Code	Value
Ambient temperature	AA5	5...40 °C
Atmospheric humidity	AB5	5...85% RH
Max. altitude	AC1	2000 m
Presence of water	AD1	Negligible, IPX0
Presence of foreign solid bodies or dust	AE1	Negligible, IP0X
Presence of corrosive or polluting substances	AF1	Negligible
Mechanical shock	AG1	Low severity
Vibrations	AH1	Low severity

Materials and Conformity

Wetted materials	Stainless steel 1.4404 (AISI 316L) or equivalent
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CE marking	Low voltage Directive 2014/35/EU Electromagnetic compatibility Directive 2014/30/EU Pressure Equipment Directive 2014/68/EU RoHS Directive 2011/65/EU

Block diagramme

