UPC·MARATHON

H2SMART™
Intelligent Hydrogen Sampling System
USER MANUAL

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MANUAL #: 003

Revision #	Revision Date	Revision Description
020	March 27, 2020	Updated Process Connection in Specification table; revised bottom view schematic to feature IN and OUT connectors; added adapter to front and side views; inserted Filter Plate Option section; expanded Communications section to include Profibus Registers
019	September 18, 2019	

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Declaration of incorporation according to EC Machinery Directive 2006/42 / EC, Annex II B

Hereby we declare that the incomplete machine

H2Smart™

Due to its design and construction, as well as in the design it places on the market, as far as the scope of supply allows, it complies with the following basic requirements:

2014/30/EU	Electromagnetic Compatibility Directive
Harmonized standards:	
EN 61000-6-2:2008	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-4:2008+A1:2012	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

2006/95/EC Low-Voltage Directive

EN 61010-1:2011	Safety requirements of electrical equipment for measurement, control and laboratory use. Part1: General requirements

Compliant with 2002/95/EC RoHS Directive
Recycling: per 2002/96/EC W.E.E.E Directive

We declare that the special technical documentation in accordance with Annex VII, Part B has been prepared for this incomplete machine and we undertake to transmit it to the supervisory authorities in digital form on request.

For the purpose of the Machinery Directive 2006/42/EC, the partly completed machinery may not be put into service until it has been determined that the machine in which it is to be installed complies with the provisions of this Directive, provided that this Directive applies to this machinery.

We would like to point out that the following actions may affect the above attested conformity and the characteristics of the product:

- Installation and operating errors or failure to observe the instructions in the operating instructions supplied with the product.
- Replacement of parts or original accessories by unauthorized persons or replacement with parts that are not approved by the manufacturer.

To ensure EMC compliance, the device must always be connected to protective earth. This connection is made via the M12 connector.

AMS Conformity (North America)

This product conforms to SAE Aerospace Material Specifications AMS 2759/10 for nitriding and 2759/12 for nitrocarburizing.

TECHNICAL ASSISTANCE

For all questions or concerns regarding the operation of the *H2Smart*™, please consult the last page of this manual for contact information.

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1 INTRODUCTION

The *H2Smart*™ is an integrated thermal conductivity sampling system designed to measure the concentration of a gas sample in binary or quasi-binary mixtures. It is especially suitable to measure hydrogen content or dissociation level with high accuracy in nitriding and nitrocarburizing atmospheres and to calculate the parameters necessary for nitriding process control. A unique measuring cell design and advanced electronics eliminate the need for a reference gas cell, thus simplifying the installation.

It includes an integrated sampling pump with variable output and a flow monitoring circuit with pump saturation warning and flow alarm. The pump provides a continuously controlled flow despite possible sampling line obstructions or filter contaminations, thus assuring accurate measurements and better process control.

The measuring block is maintained at a preset temperature with high accuracy to provide stable measuring conditions and protect the system from moisture formation and cell contamination during nitrocarburizing.

The system status and measured results are displayed on a large, easy to read alphanumerical display.

2 SPECIFICATIONS

2.1 PHYSICAL

Width (including mounting bracket):	170 mm / (6.7”)
Height:	190 mm / (7.5”)
Depth:	140 mm / (5.5”)
Weight:	4 kg / (8.8 lbs)
Process Connection:	1/4" Swagelok tubing connector, 6mm adaptor available

2.2 PERFORMANCE

Accuracy:	+/- 0.5% of reading plus +/- 0.3% of full scale
Linearity:	< 0.5% of full scale
Repeatability:	< 0.5% of full scale
Zero drift:	< 0.5% of full scale per month
Sampling flow:	0.5 lpm / (1 cfh) controlled
Response time:	95% in 30 sec @ 0.5 lpm / (1 cfh)

2.3 OPERATING

Power requirements:	24VDC, 2.5 Amps max. Use only well-regulated power supply
Outputs:	2 x analog, sourcing, individually isolated, 4 – 20 mA (R<500 Ohm) 4 x digital OUT, 24 VDC, 0.7 A max.
Inputs:	1 x analog, dedicated temperature sensor (optional) 2 x digital, 24 VDC
Working pressure:	ambient +/- 70mbar (1PSI)
Ambient Temperature:	< 57°C (<135°F)
Sampling pump:	Maximum Continuous Vacuum generated 350mbar - abs (5 psi) Maximum Continuous Pressure generated 1.4barg / (20 psig)

2.4 RECOMMENDED CALIBRATION

Polynomial calibration	12 months

3 INSTALLATION

3.1 OVERVIEW

The *H2Smart*™ unit is to be installed away from the furnace and the sample gases are tapped from the exhaust lines. Ensure that the source and dump lines are at the same pressure. Do not install spanning an oil/water bubbler or other pressure control valves.

CAUTION

The sampling gas temperature entering the *H2Smart*™ must be < 90°C (195F°). Usually this condition is easily accomplished by selecting the proper length and heat dissipation condition of the sampling supply line. Necessary heat dissipation for the sampling flow of 0.5 lpm (1 cfh) and temperature difference 500°C (932°F) is less than 10 W (35 Btu/hr) and depend on the sampling gas composition.

CAUTION

Handle with care, do not drop. The sensor is susceptible to shock, and it is a static sensitive device, use proper handling procedures

 **CAUTION**

Installations with dirty exhausts (powder residues, injections, Malcomizing, masking, furnaces with oil seals) require a supplementary pre-filter. We suggest a 5µm (or as required for your particular condition) with a surface area of not less than 200 cm^2 (30 in^2).

For ferritic nitrocarburizing, we suggest that this pre-filter is also heat traced.

End user must ensure that gases entering the unit are free of contaminants such as water, oil or other.

Always purge the chamber when possible. Consider to “sample” when the furnace is purging to limit the precipitate in the chamber.

3.2 PHYSICAL CHARACTERISTICS

BOTTOM VIEW

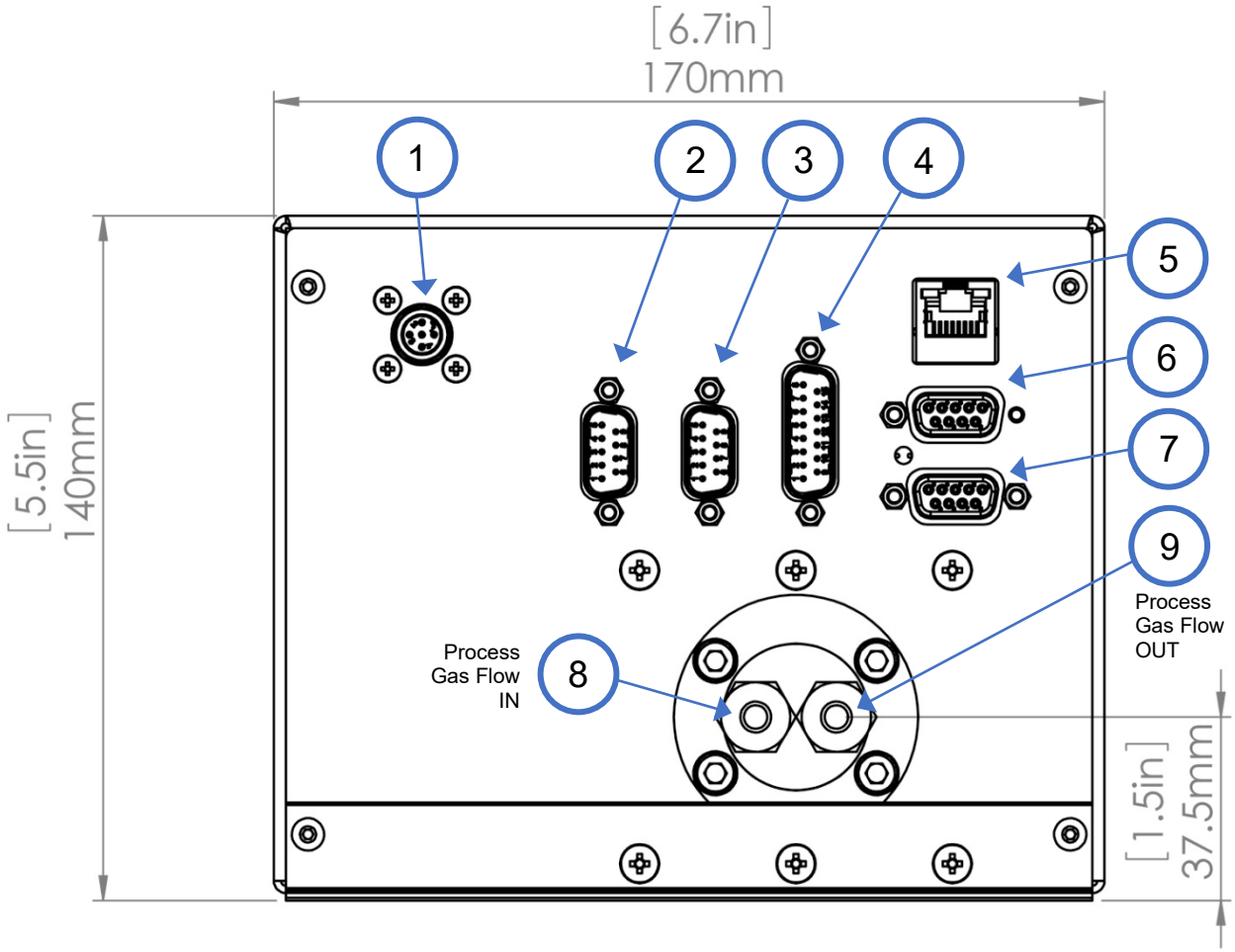


Figure 1 - Bottom View

1	Power
2	Oxygen Probe (EMK + TC)
3	Taux (temp sensor)
4	Digital I/O
5	Ethernet

6	Optional Communications
7	Analog Out
8	IN Connector, 1/4" Swagelok tubing
9	OUT Connector, 1/4" Swagelok tubing

FRONT VIEW

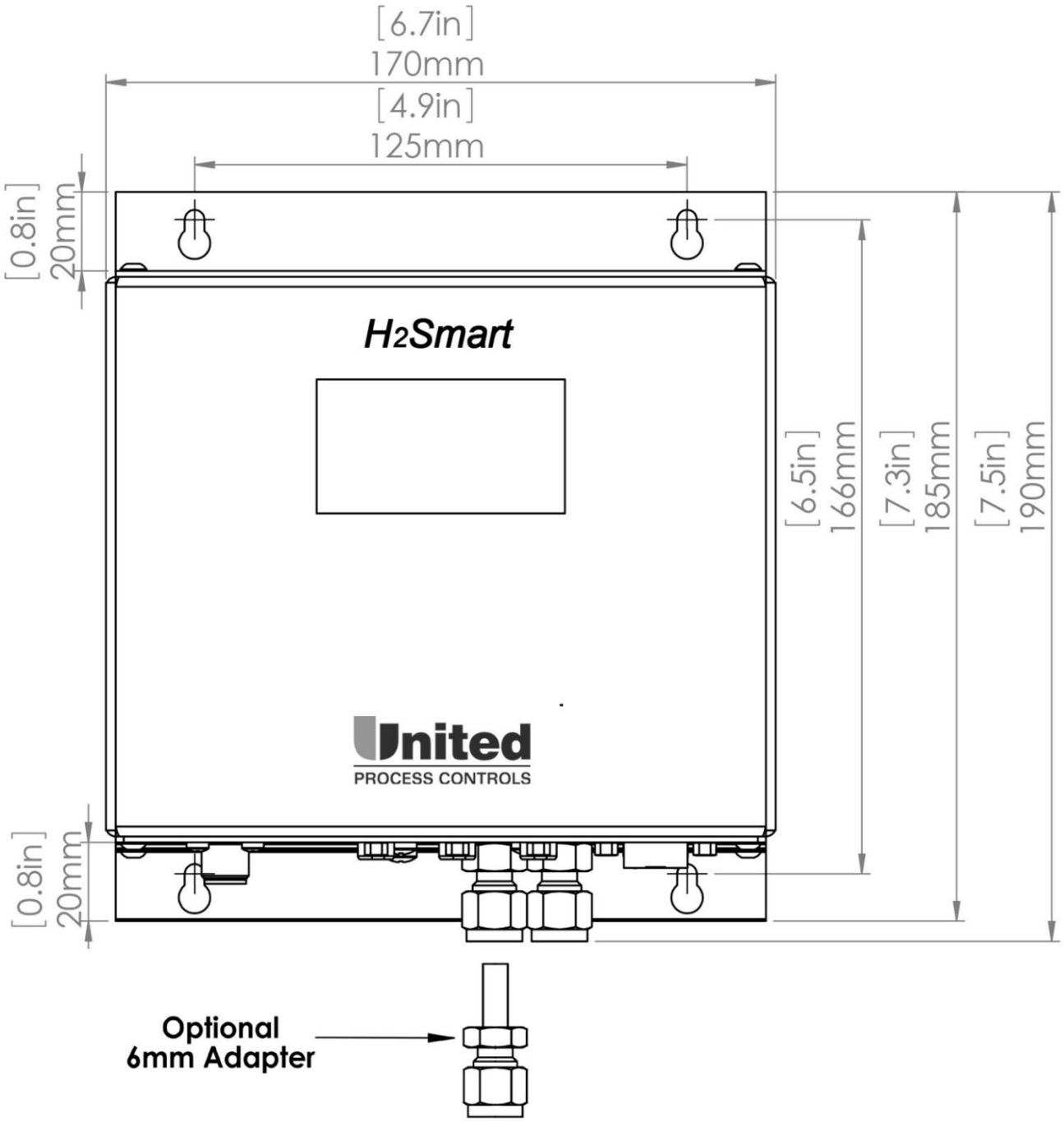


Figure 2 - Front View

SIDE VIEW

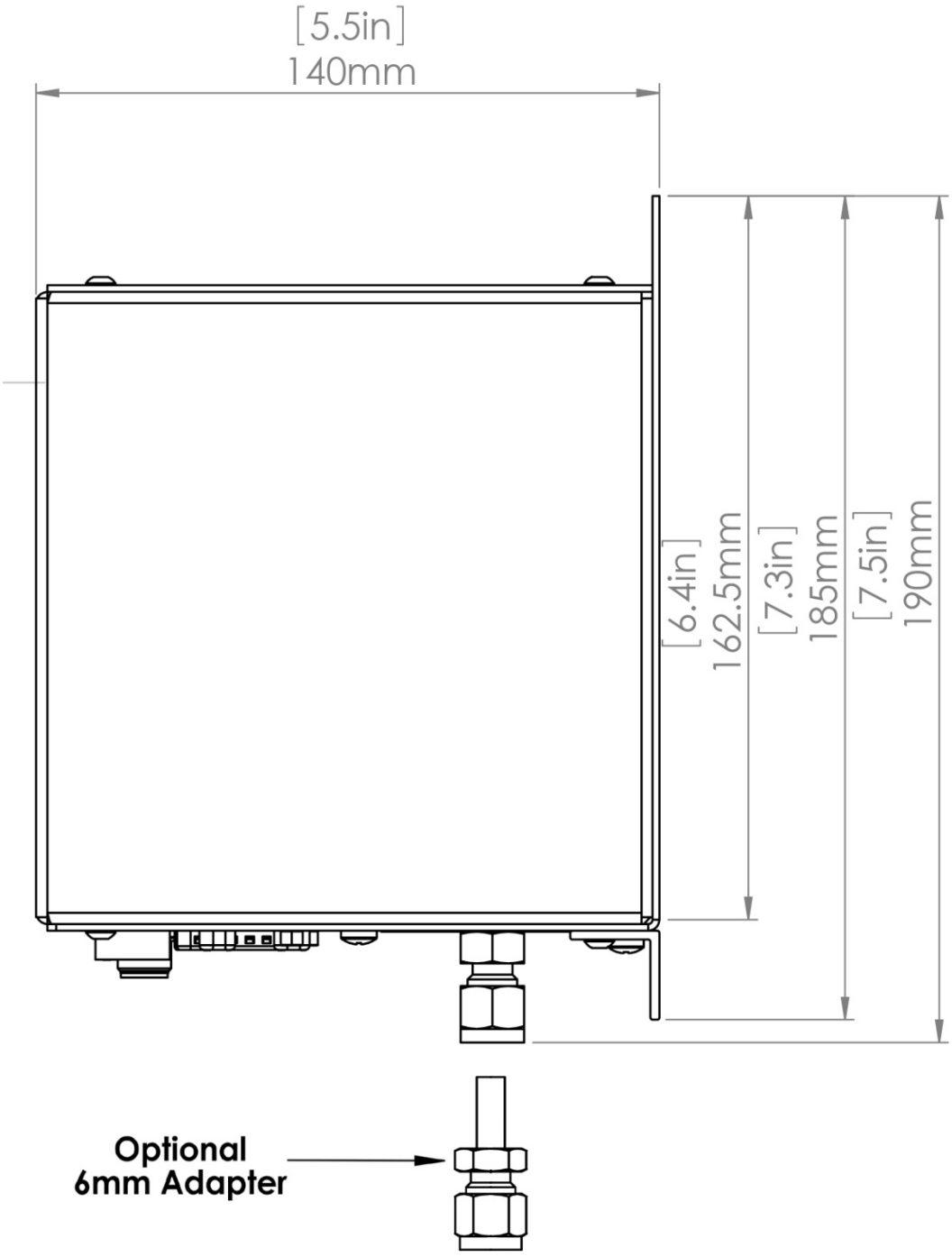


Figure 3 - Side View

3.3 INSTALLATIONS STEPS

3.3.1 Step 1

Two support brackets and four screws are used to secure the *H2Smart*™ unit. Attach unit to a panel wall using four #10 (M5) screws

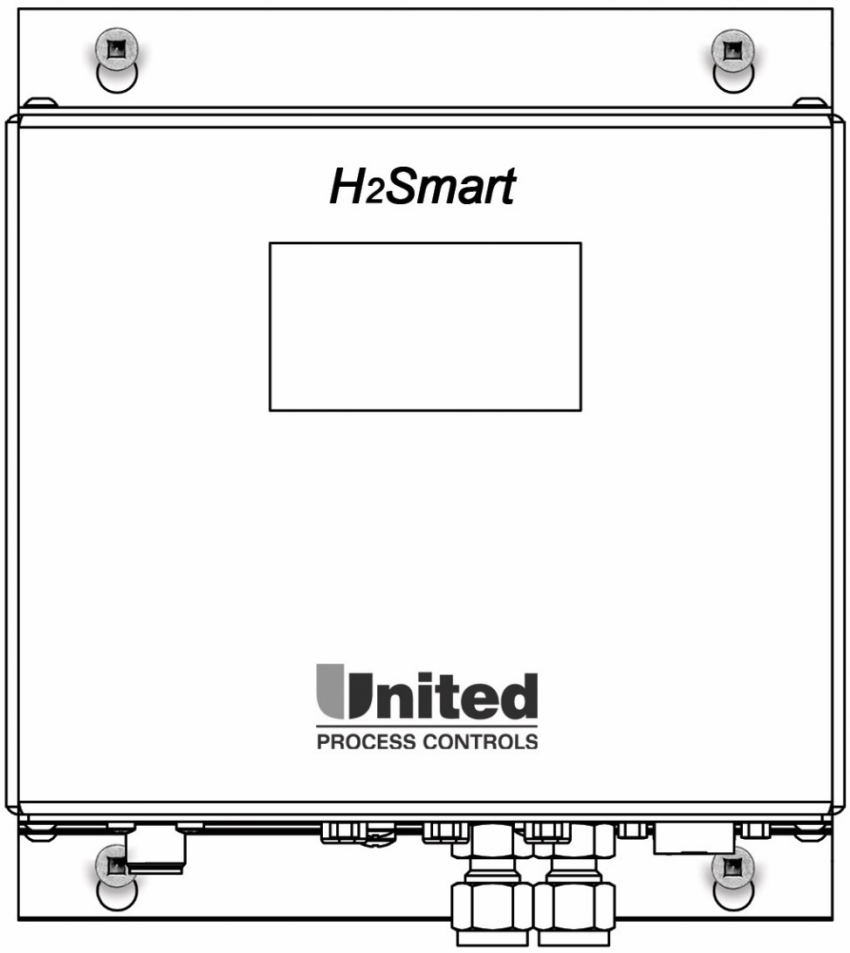


Figure 4 - Step 1

3.3.2 Step 2

Pre-measure and bend the tubing accordingly.

Pre-swage Swagelok ferrules to the tubing's using Swagelok Pre-swaging tool or spare Swagelok fitting

CAUTION

Do not swage the tubing in the *H2Smart*™ connectors!

Attach tubing to Exhaust

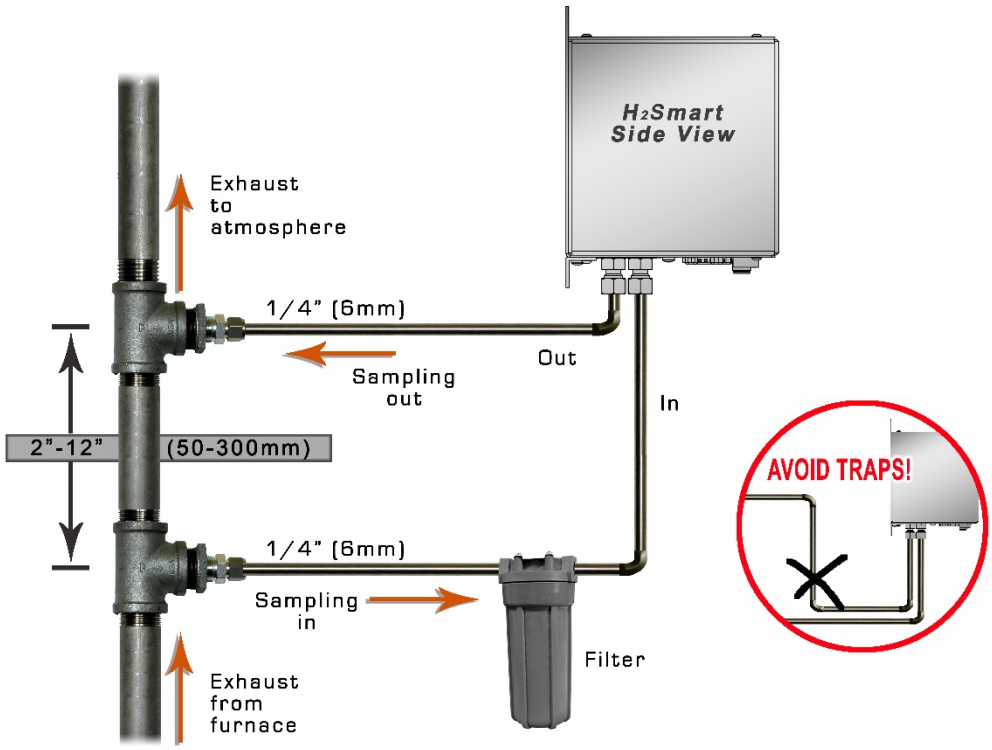


Figure 5 - Step 2

3.3.3 Step 3

Connect 1/4" tubing to Swagelok connector using a 9/16" wrench or metric equivalent - **do not over tighten**

* **Follow Swagelok instruction to assemble piping with tube fitting.**

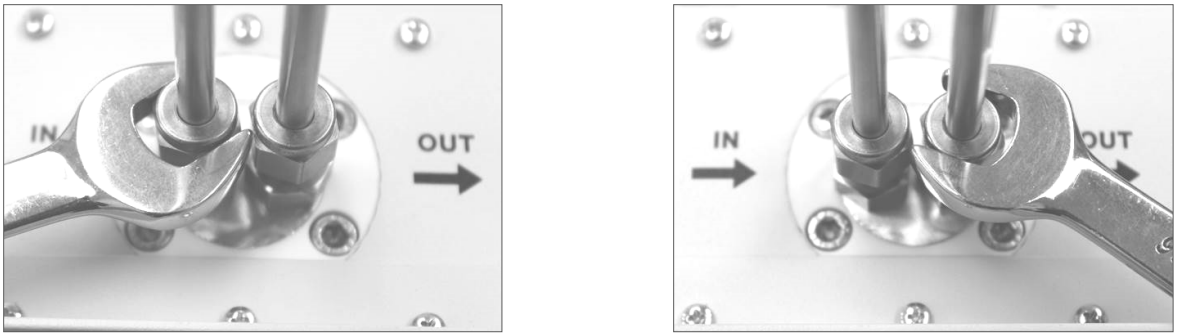


Figure 6 - Step 3

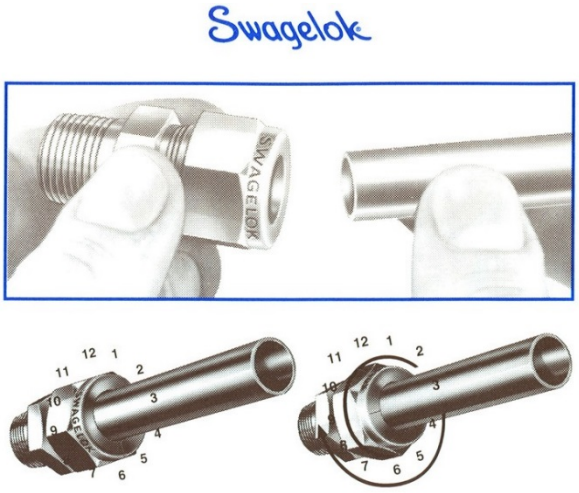


Figure 7 - Step 3

Assembly Instructions

a. Insert tubing into the Swagelok tube fitting
b. Make sure that tubing rests firmly on the shoulder of the tube fitting body and that the nut is finger-tight
c. Scribe the nut at 6 o'clock position
d. While holding fitting body steady, tighten the nut 1 1/4 turns to the 9 o'clock position

Reassembly Instructions

a. Insert tubing with pre-swaged ferrules into fitting body until the front ferrule seats.
b. Rotate the nut with a wrench to the previously pulled-up position. At this point, a significant increase in resistance will be encountered.
c. Tighten slightly with the wrench. Note: don't use the gap inspection gauge with reassembled fittings.

3.3.4 Step 4

Heat tracing the sample gas tubes for Ferritic Nitrocarburizing furnace

In order to avoid clogging of the sample gas tubes by ammonium carbonate and condensation, the sample tubing / piping should be kept at temperatures within the range of 85 – 90ºC (185 - 195°F) by external heat tracing. For this purpose, typically, a heat trace cable is run close to

Figure 8 - Step 4

the tube bundle, tightly pressed against the tubes by appropriate cable ties. The whole assembly is then wrapped in thermal insulation material.

Use pipe insulation whenever you run heat tracing!

Try to run the in and out tubing side by side such that the heat tracing sensor and the cable all fit nicely in one tightly packed bundle. This will ease the installation of the insulation and maximize efficiency.

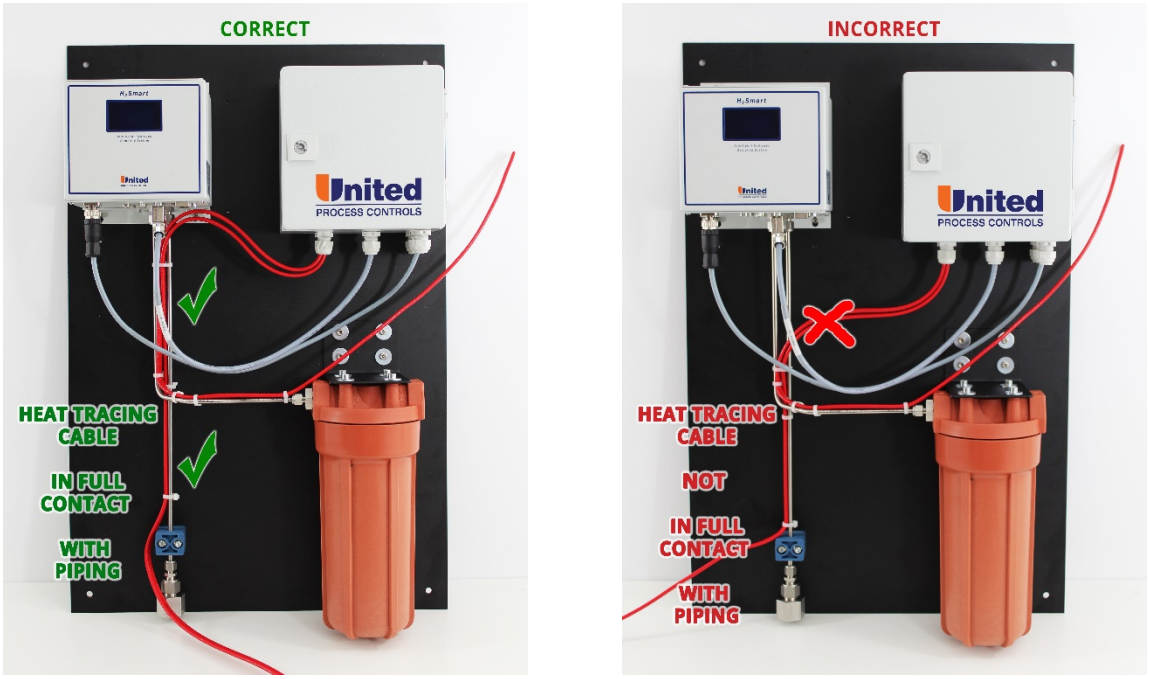
Mount the optional heat tracing temperature sensor to the tube bundle inside the thermal insulation, at a distance of 30 - 60 cm / (1 - 2 ft) from the *H2Smart*™ connectors.
Use an appropriate solid-state relay controlled by the heat tracing control output to switch power to the heat tracing cable.

Due to the high probability of “dirty gas”, sharp bends in the piping should be avoided. Try to keep the piping as smooth and as straight as possible as this will aid in the heat tracing / insulation later. Avoid unnecessary **loops, fittings or traps in piping**.

See the wiring diagram section for more information.
The *H2Smart*™ will regulate the heat tracing temperature to 203°F (95°C) as long as it is powered up without further user action.

Important consideration

- Digital I/O’s and *H2Smart*™ main power shall be powered from the same source
- Arrange the heat tracing cables and the temperature sensor as shown
- 15 W/foot (45 W/meter) is good for typical installations with average insulation
- Heating cable has to be placed up to the inlets plate of the *H2Smart*™
- Cable has to heat both (inlet and outlet) connectors
- Thermal insulation shall be **in contact** with inlets plate and be **properly sealed**
- No gap shall exist between inlets plate and the insulation
- Temperature sensor has to be attached to the tubing only, it should not touch the heating cable



Note: Heat tracing insulation not shown
Figure 9 - Heat trace cable installation

4 ELECTRICAL INSTALLATION

Connect the system to a well-regulated 24VDC power supply capable of supplying 2.5A minimum (3A typical).

Connect power cable to 24 V power supply

Figure 10 - Electrical Installation

CAUTION

The *H2Smart*™ will be permanently damaged if connected to 115 or 230VAC

Within the specified limits, the value of the supply voltage will not influence the accuracy, but a power supply with bad stability may increase measurement noise of the system. Use a well-regulated power supply and do not operate other heavy loads from the same supply.
The specified power consumption is only true during start-up, after operating temperature is reached, the power consumption will decrease to 20% - 40% of the specified value, depending on ambient temperature.

4.1 POWER AND ELECTRICAL CONNECTIONS

Power 24 VDC - M12-5 connector		
Pin	**Description**	**Cable***
1	+24 VDC	BRN
2	NOT USED	WHT
3	COM	BLU
4	NOT USED	BLK
5	GND	YEL/GRN

Digital I/O – DB15 Male connector		
Pin	**Description**	**Cable***
1	DI1 +	1
2	DI1 -	2

Digital I/O – DB15 Male connector		
Pin	**Description**	**Cable***
3	DI2 +	-
4	DI2 -	2
5	DO 3	4
6	DO 2	5
7	DO 1	6
8, 15	24 V COM	2
9, 10, 11	NOT USED	-
12	DO 4	-
13, 14	+24 VDC	3
NC		Green/Yellow

Analog Out - DB9 Female		
Pin	**Description**	**Cable***
1	AO1 +	Brown
2	AO1 -	White
3	AO2 +	Yellow
4	AO2 -	Green
6, 7, 8, 9	NOT USED	-
5	GND	Shield

Taux (Heat Trace Sensor) – DB9 Male	
Pin	**Description**
7	SENSOR SIGNAL
8	SENSOR VCC
3	GND
1, 2, 4, 5, 6, 9	NOT USED

Opt. Communication – DB9 PROFIBUS	
Pin	**Description**
1	SHIELD
2	NC
3	RX/TX+
4	RTS
5	BUS GND

* Color designation of the cables supplied by UPC-Marathon

Opt. Communication – DB9 PROFIBUS	
Pin	**Description**
6	BUS VCC
7	NC
8	RX/TX-
9	NC

Opt. Communication – DB9 MODBUS RTU	
Pin	**Description**
1	SHIELD
2	NC
3	RX/TX+
4	NC
5	BUS GND
6	BUS VCC
7	NC
8	RX/TX-
9	NC

Opt. Communication – DB9 CANBUS	
Pin	**Description**
1	NC
2	CAN L
3	BUS GND
4	NC
5	SHIELD
6	BUS GND
7	CAN H
8	NC
9	BUS VCC

Ethernet - RJ-45 STD connector

4.2 OXYGEN PROBE CONNECTOR (OPTIONAL FEATURE – CONNECTOR AND ADD-ON CARD)

The optional oxygen probe card with high impedance input comes with a user-friendly DB9 connector where you can terminate the mV and TC signal from the oxygen probe using only a precision screwdriver. Move the slider to the right to release, left to grip (as shown in the drawing below).

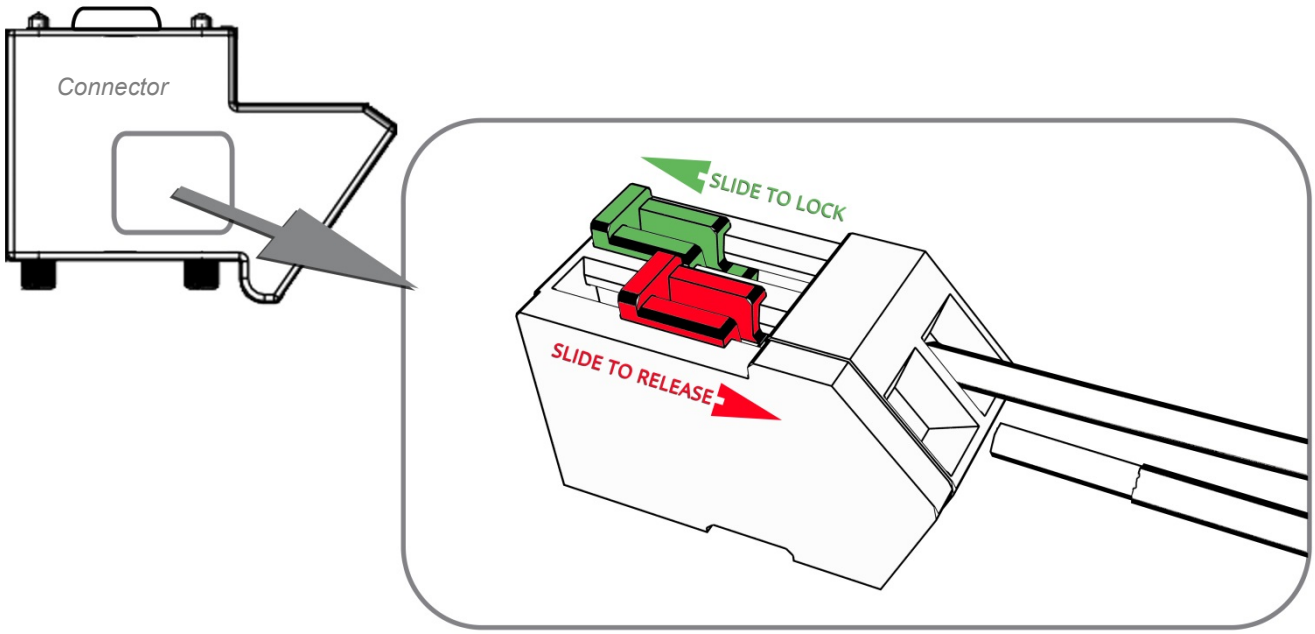


Figure 11 - Probe Connector

PIN	O_2 Probe db9 connector
RED	Probe mV (+)
BLK	Probe mV (-)
GRN	Probe TC (+)
WHT	Probe TC (-)

Note that the *H2Smart*™ Oxygen Probe card's thermocouple input can be configured as type K or S. It is crucial to use the webserver to select the appropriate setting.

5 OPERATING INSTRUCTIONS

Connect the system to a well-regulated 24VDC power supply capable of supplying 2.5A. Once power is applied, the system heats up the measuring cell to operational temperatures. Flow measurement is disabled, and the sampling pump is off during heat up to avoid contamination of the system with condensation. Depending on ambient temperature, heat up takes about 30 minutes. Full accuracy is reached after 1h. It is always recommended to keep the system powered up and use the "Sampling enable" digital input or digital communication to activate or deactivate the sampling flow.

When the operating temperature is reached, the "Sampling enable" digital input or digital communication command must be active to start sample gas pump, enable sampling flow control and gas composition measurement.

Display

The display shows the following information, depending on the system status:

Display shows:	**Status**
Process Variable i.e. % diss., $\%H_2$	Sampling enabled; value is displayed
O_2 Probe mV + Temperature, K_N, Alarms (in order of priority)	If enabled, the mV and temperature is displayed
Ticker	Information such as IP address, FW version and up time.
Wrench symbol	Maintenance is due. See webserver.

K_N and K_C Calculation

The K_N and K_C calculations run internally in the unit based on the furnace volume, the inlet gas flows, and the reading from the *H2Smart*™ sensor. To ensure a correct furnace atmosphere calculation, the process flows into the furnace must be updated whenever they are changed. The updates must be made at all times during the recipe, even during non-nitriding stages. These changes can be made via the communication adaptor (MODBUS, ProfiBus or CANBus). The communication data register assignments can be found in this manual. The furnace atmosphere is continually updated based on the flow rates and the stored furnace volume.

Valid K_N and K_C calculated values require the furnace to be at nitriding temperature, as well as the *H2Smart*™ sampling enabled. When the sampling is disabled, the K_N and K_C calculations are disabled and will return a 0.00 value. If sampling is enabled under non nitriding conditions, the K_N and K_C calculations will not return valid K_N and K_C values.

6 PREVENTIVE CARE

All maintenance and preventive care must be carried out by trained personal only in compliance with the applicable safety standards.

6.1 SAMPLE GAS PUMP

Maintenance period	The life time of the sample gas pump is dependent on the composition of the gas.
Action	Send the unit in for service in case of a pump failure.

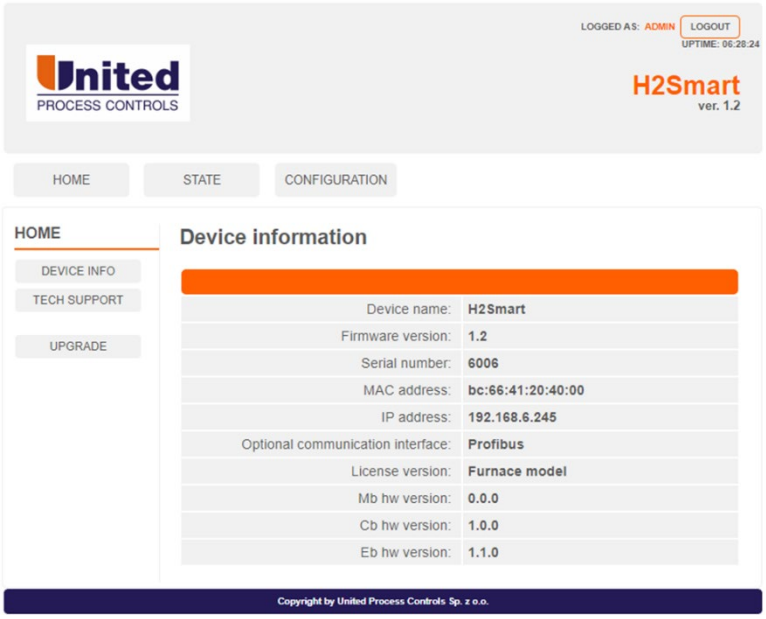
WARNING
Prevent liquids such as water or oil from entering the sampling line.

WARNING
Never use sharp objects (wire, screwdriver, etc.) to check or unblock the *H2Smart*™ sampling Swagelok connectors and internal lines. Never use compressed air to clean the *H2Smart*™.
This may create a health hazard and permanent instrument damage.

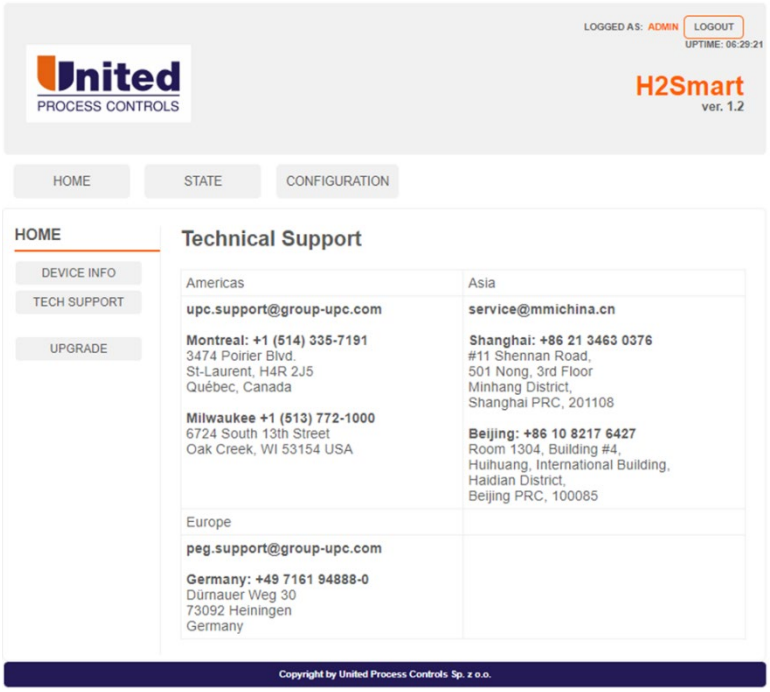
7 CONFIGURATION (INTEGRATED WEB SERVER)

Using a web browser, navigate to the IP address of the H2Smart. Many parameters can be set / adjusted such as IP address, alarm details, and other user accessible variables. The default access is: u: admin / pw: ammonia

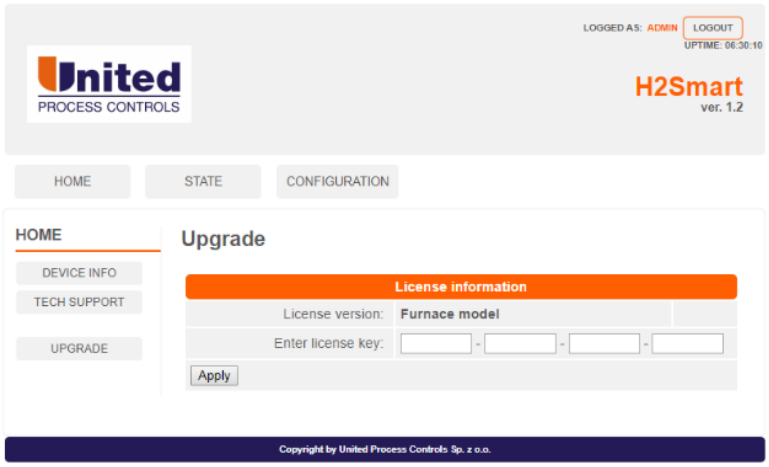
7.1 DEVICE INFORMATION



7.2 TECHNICAL SUPPORT

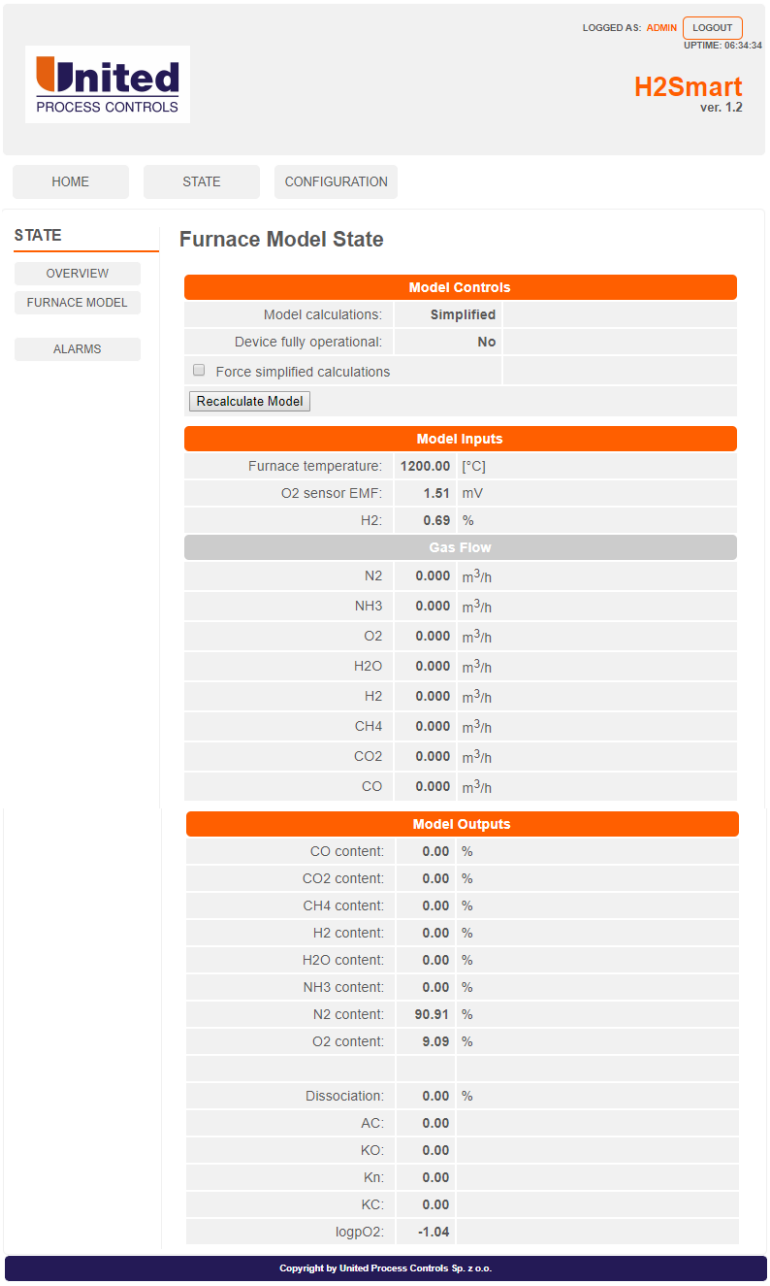


7.3 UPGRADE

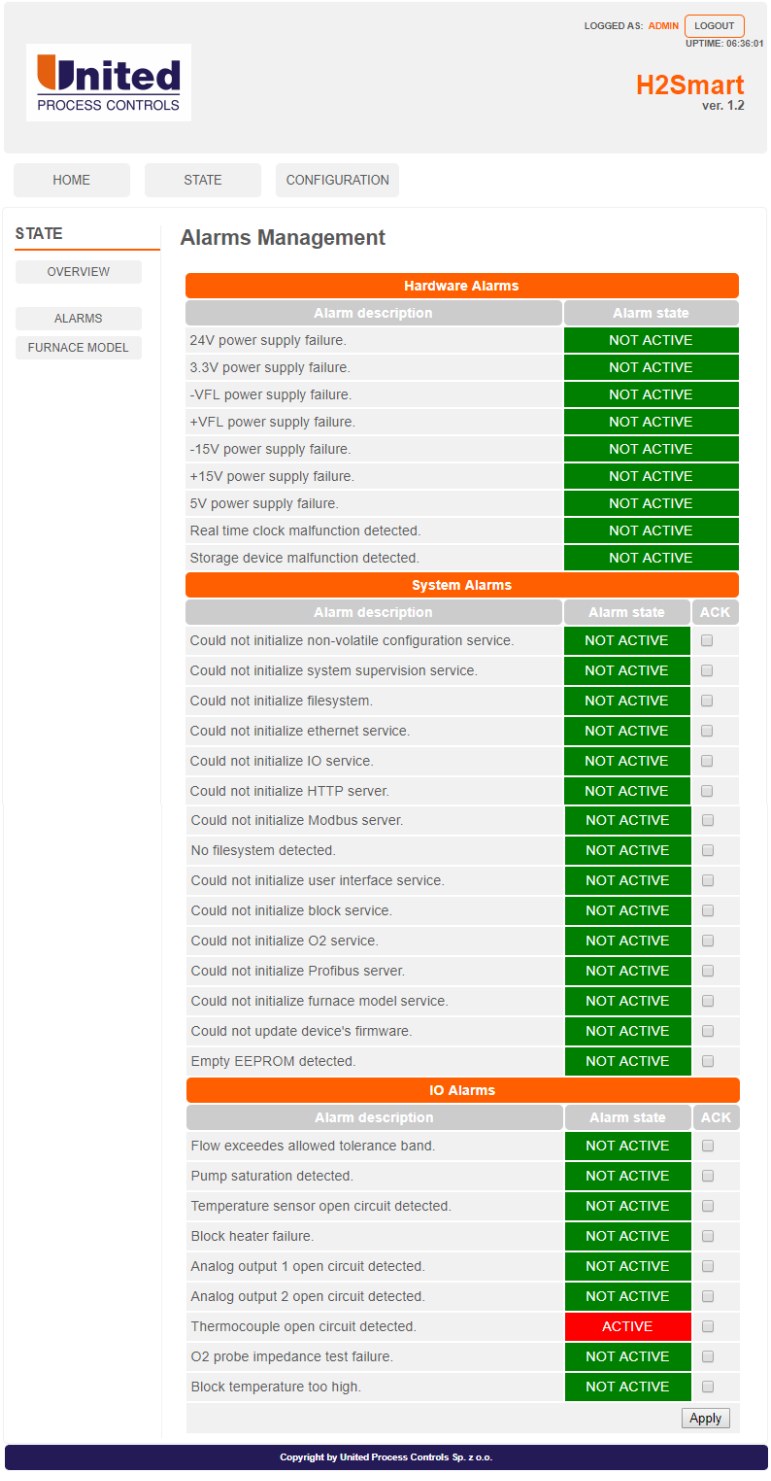


7.4 SYSTEM OVERVIEW

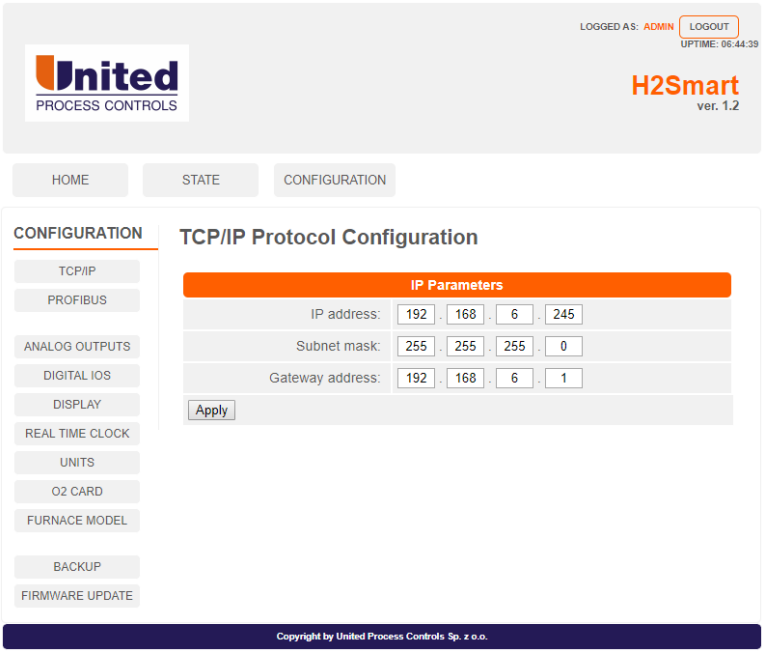
7.5 FURNACE MODEL STATE



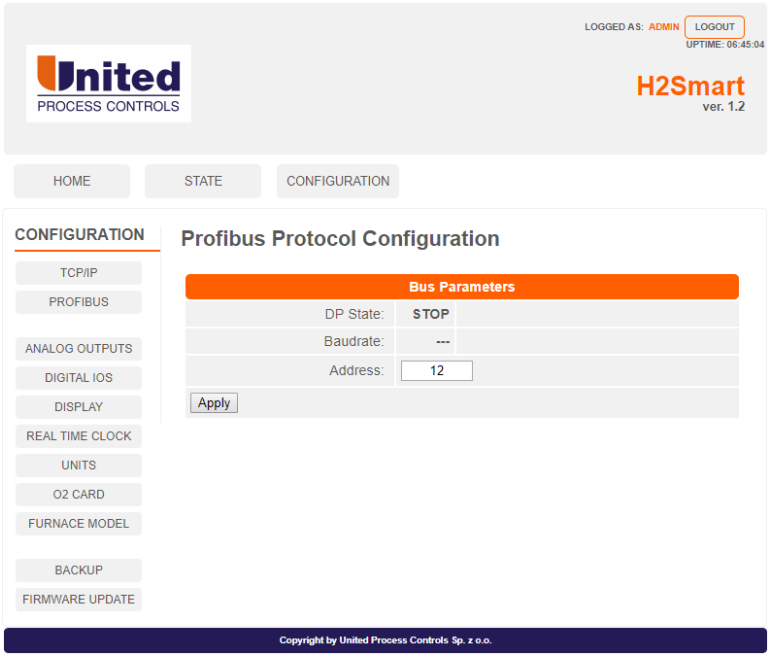
7.6 ALARMS MANAGEMENT



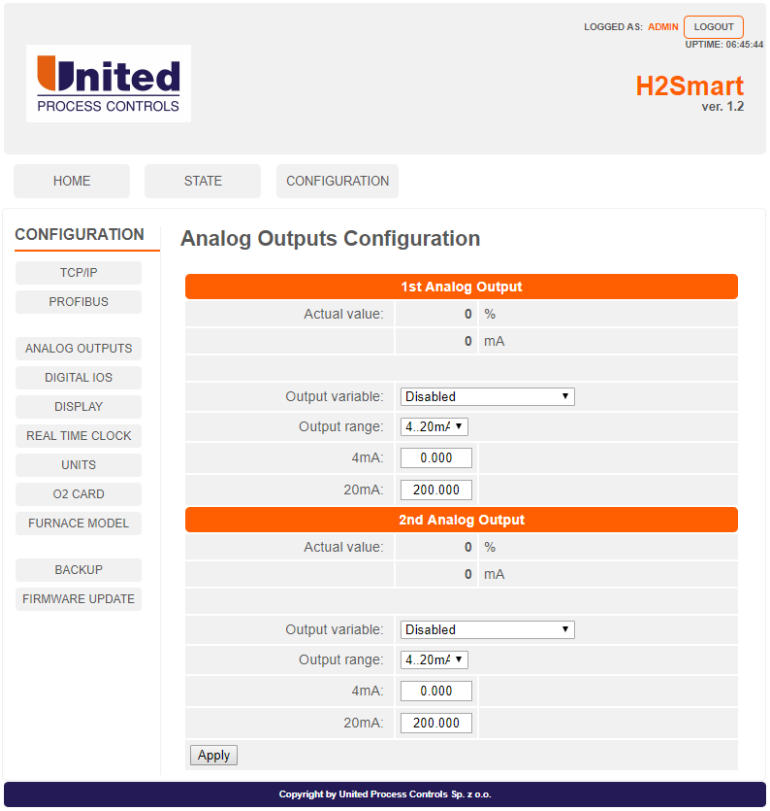
7.7 TCP I/P CONFIGURATION



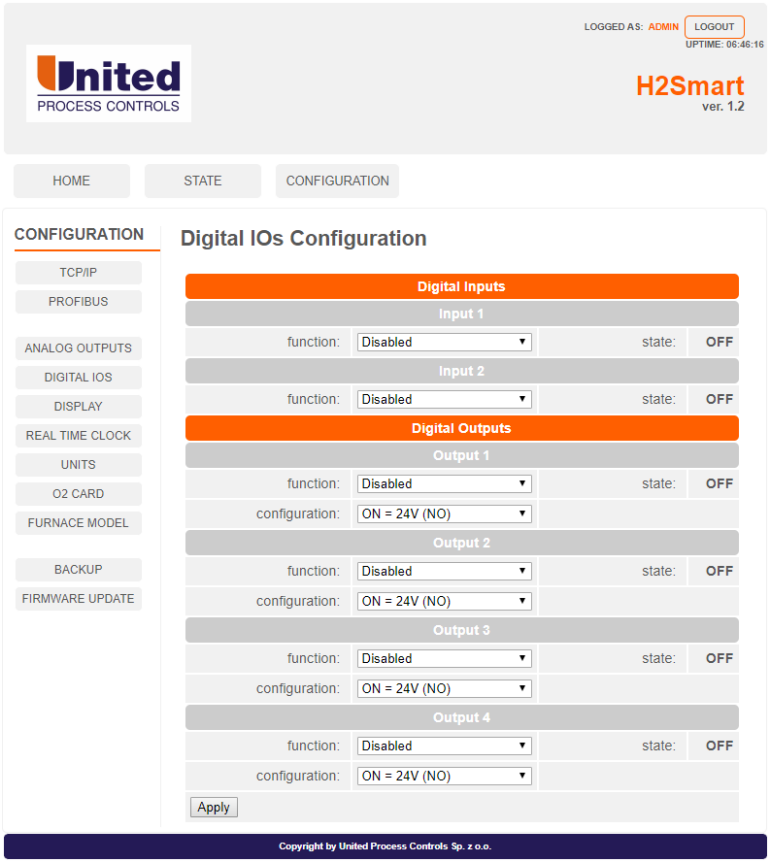
7.8 PROFIBUS CONFIGURATION



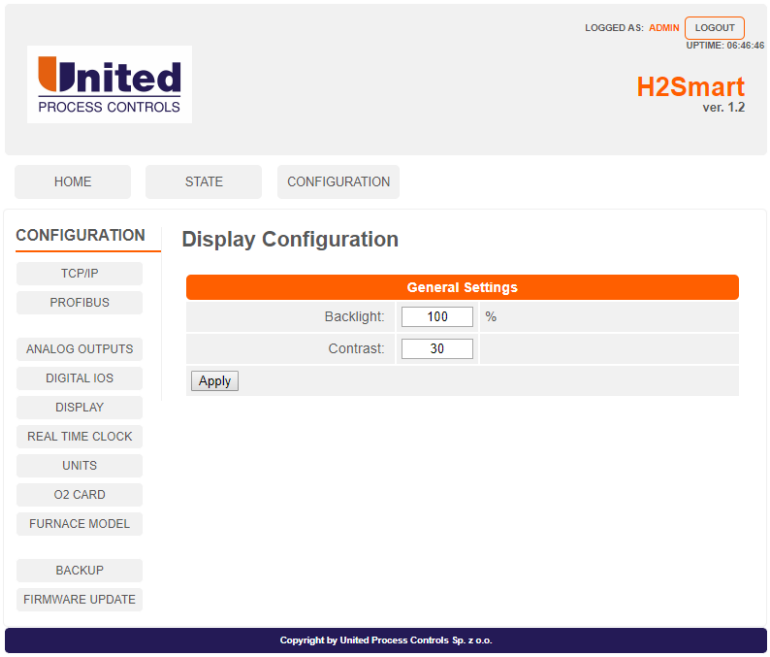
7.9 ANALOG OUTPUT CONFIGURATION



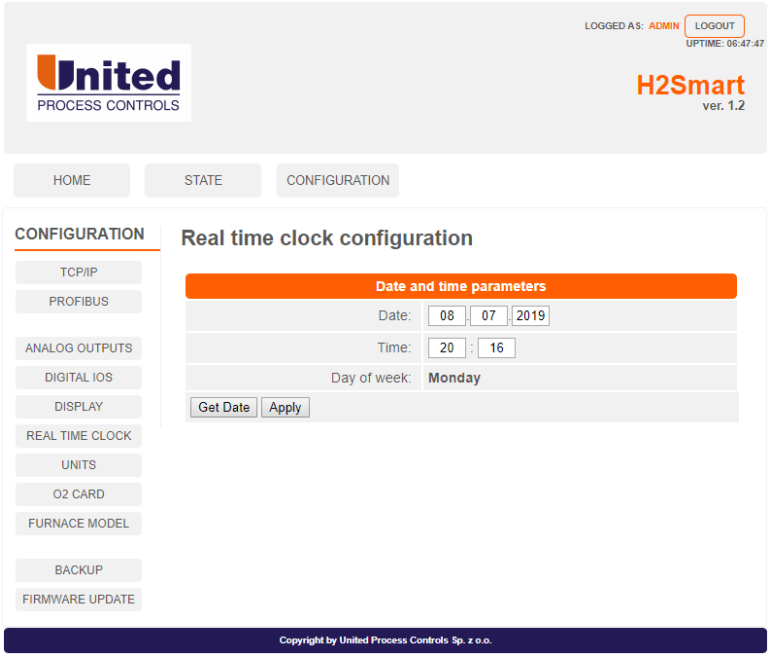
7.10 DIGITAL IO CONFIGURATION



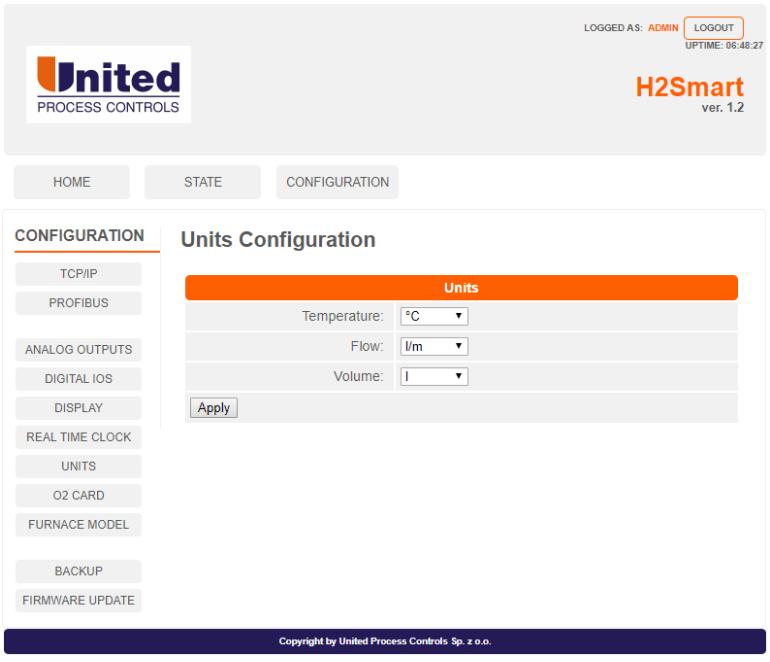
7.11 DISPLAY CONFIGURATION



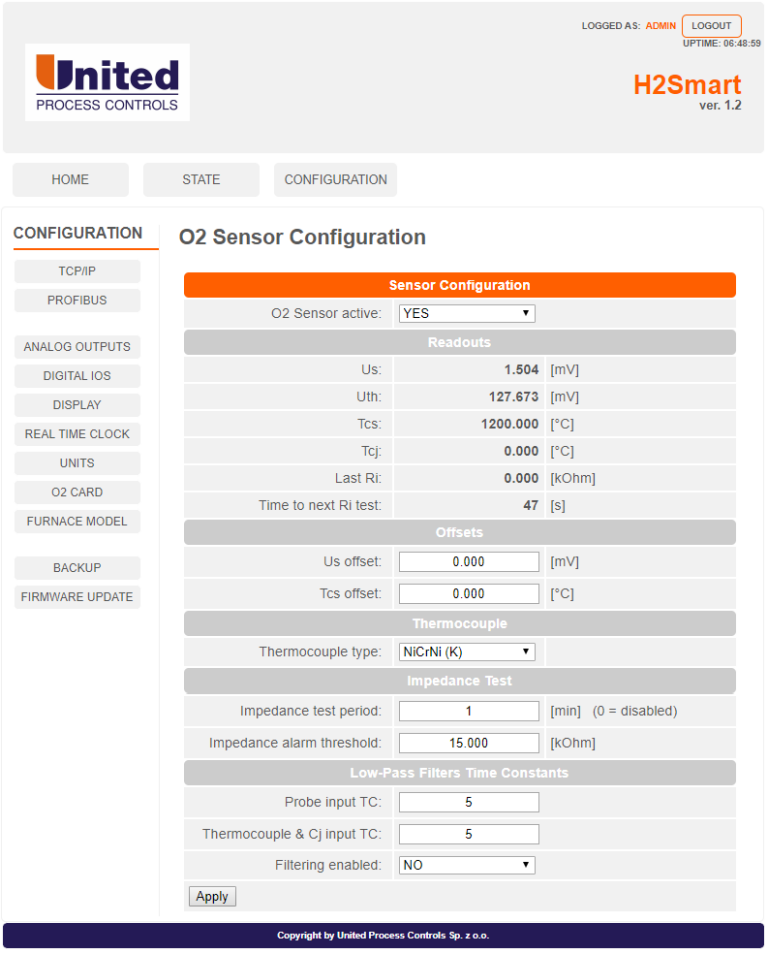
7.12 REAL TIME CLOCK CONFIGURATION



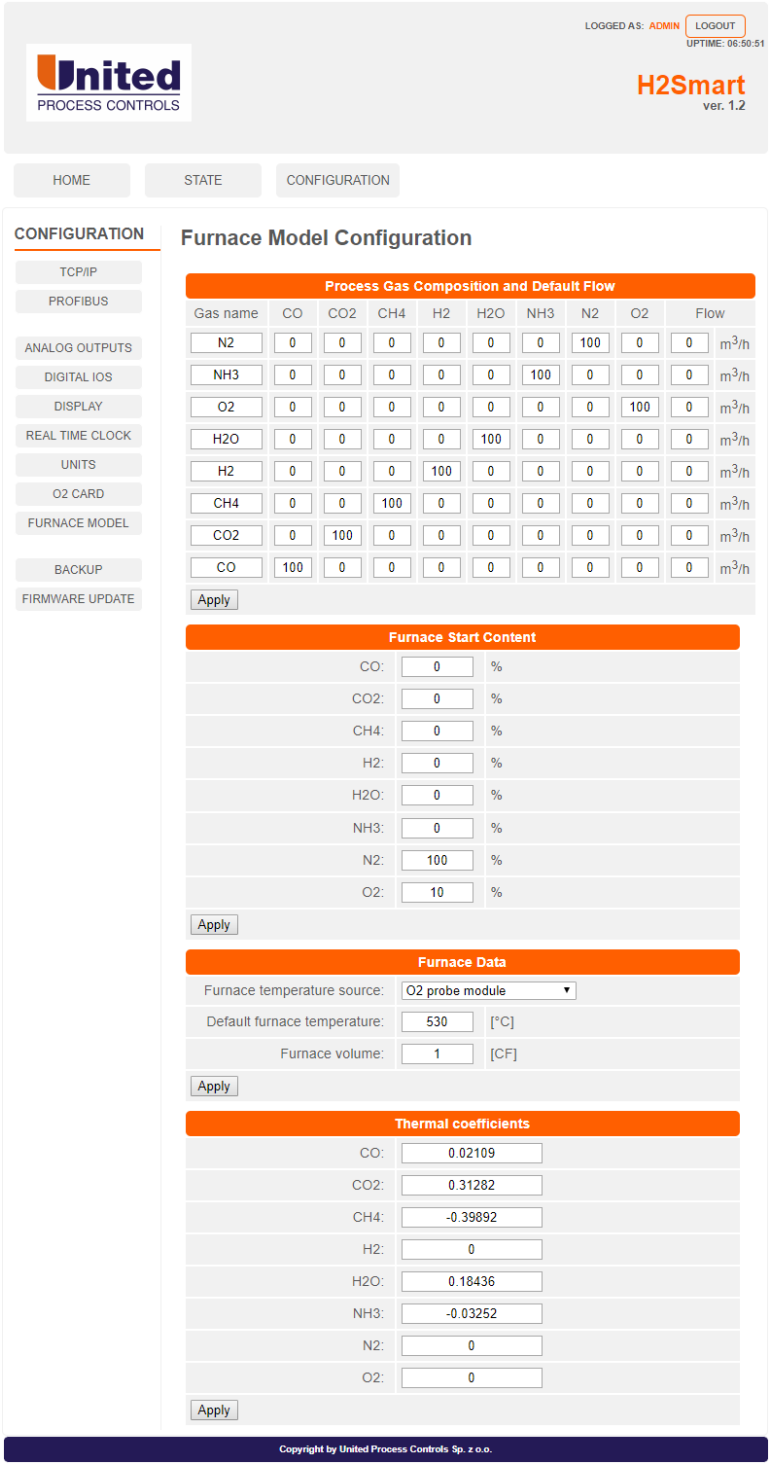
7.13 UNITS CONFIGURATION



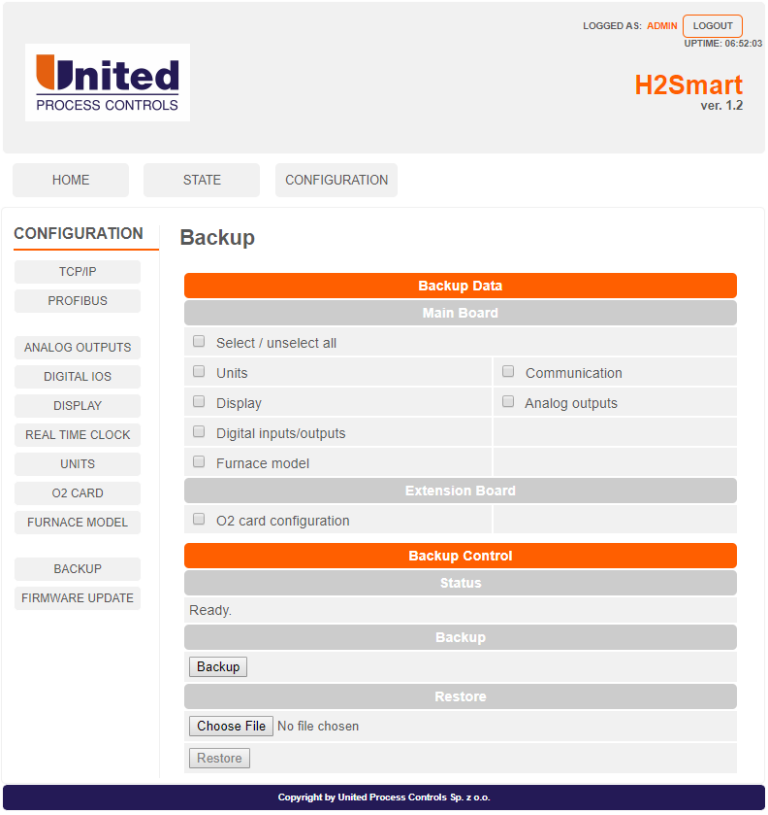
7.14 O_2 SENSOR CONFIGURATION



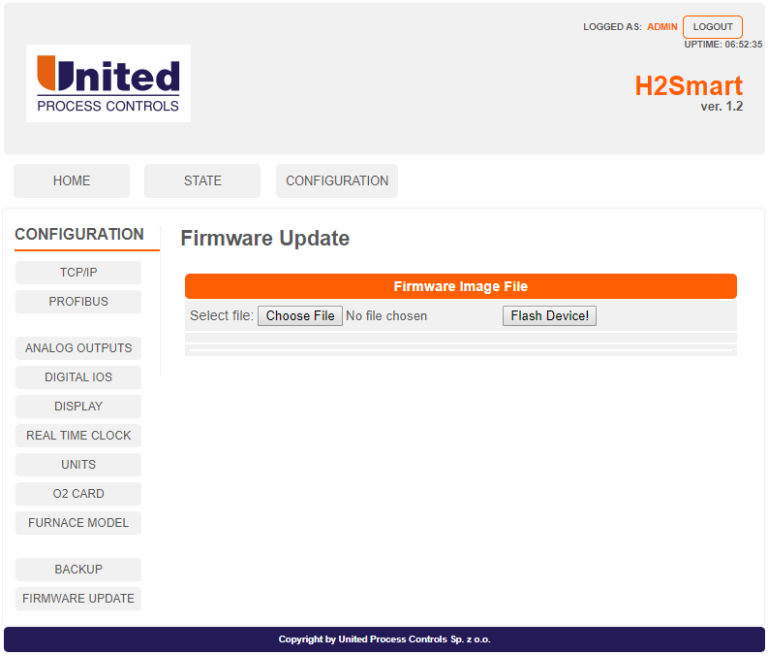
7.15 FURNACE MODEL CONFIGURATION



7.16 BACKUP



7.17 FIRMWARE UPDATE



8 FILTER PLATE OPTION

Figure 12 - Filter Plate Option

Plate dimensions: 500mm w x 750mm h

Process connections: ¾ “ NPT Female

Junction Box Electrical connections:

Pin	Description
1	24VDC + Supply
2	0VDC Supply
3	CAN L
4	CAN H
5	CAN GND

Pin	Description
6	Sampling Enable Input (24VDC)
7	Flow Alarm Output (24VDC)
8	Pump Saturation Alarm Output (24VDC)
9	Oxygen Probe mV +
10	Oxygen Probe mV -
11	Heat Tracing 230/120 VAC L
12	Heat Tracing 230/120 VAC N
13	Heat Tracing Output (230/120VAC Pulsed)

9 COMMUNICATIONS

9.1 MODBUS TCP REGISTERS

Input Register	Data	Type	Low/High Word	Details
999	test register	Ushort		always 1234 readout
1000	System State	UINT	Hi	reserved
1001			Lo	Bit0: Sampling enabled (pump on) Bit1: Block ready Bit2: Enable sampling request on digital input Bit3: Enable sampling request from web application Bit4: Enable sampling request on Profibus Bit5: Enable sampling request on Modbus Bit6: Enable sampling request on CAN
1002	Hardware Alarms	UINT	Hi	reserved
1003			Lo	Bit0: 24V power supply failure Bit1: 3V3 power supply failure Bit2: -VFL power supply failure Bit3: +VFL power supply failure Bit4: -15V power supply failure Bit5: +15V power supply failure Bit6: 5V power supply failure Bit7: Real time clock malfunction Bit8: Storage device malfunction
1004	System Alarms	UINT	Hi	reserved
1005			Lo	Bit0: Could not initialize non-volatile configuration service Bit1: Could not initialize system supervision service Bit2: Could not initialize filesystem Bit3: Could not initialize ethernet service Bit4: Could not initialize IO service Bit5: Could not initialize HTTP server Bit6: Could not initialize Modbus server Bit7: No filesystem detected Bit8: Could not initialize display service Bit9: Could not initialize measurement block service Bit10: Could not initialize O_2 card service

Input Register	Data	Type	Low/High Word	Details
				Bit11: Could not initialize Profibus server
				Bit12: Could not initialize CAN server
				*Bit13: Could not initialize furnace model service
				Bit30: Could not update device's firmware
				Bit31: Empty EEPROM detected
1006	IO Alarms	UINT	Hi	reserved
1007			Lo	Bit0: Flow off limits
				Bit1: Pump saturation
				Bit2: Temperature sensor open circuit detected
				Bit3: Block heater failure
				Bit4: Analog output 1 open circuit detected
				Bit5: Analog output 2 open circuit detected
				Bit6: Thermocouple open circuit detected
				Bit7: O_2 probe impedance test failure
1008	H_2 / Dissociation [%]	Float	Hi	
1009			Lo	
1010	Block temperature [°C]	Float	Hi	
1011			Lo	
1012	Thermocouple temperature [°C]	Float	Hi	Only if O_2 card is present
1013			Lo	
1014	O_2 probe emf [mV]	Float	Hi	
1015			Lo	
1016	K_N	Float	Hi	**
1017			Lo	
1018	Ko	Float	Hi	** Only if O_2 card is present
1019			Lo	
1020	Serial Number	Ushort		
1021	Total Working Hours	UINT	Hi	
1022			Lo	
1023	Hours to next service	Ushort		
1024	Heat tracing temperature [°C]	Float	Hi	
1025			Lo	
1026	Flow rate [l/m]	Float	Hi	
1027			Lo	
1028 - 1029 - RESERVED				
1030	FMO: CO content [%]	Float	Hi	*
1031			Lo	
1032	FMO: CO_2 content [%]	Float	Hi	*
1033			Lo	
1034	FMO: CH_4 content [%]	Float	Hi	*
1035			Lo	
1036	FMO: H_2 content [%]	Float	Hi	*
1037			Lo	
1038	FMO: H_2O content [%]	Float	Hi	*
1039			Lo	
1040	FMO: NH_3 content [%]	Float	Hi	*
1041			Lo	
1042	FMO: N_2 content [%]	Float	Hi	*
1043			Lo	

Input Register	Data	Type	Low/High Word	Details
1044	FMO: O_2 content [%]	Float	Hi	*
1045			Lo	
1046	FMO: Dissociation [%]	Float	Hi	*
1047			Lo	
1048	FMO: K_N	Float	Hi	*
1049			Lo	
1050	FMO: A_C	Float	Hi	*
1051			Lo	
1052	FMO: K_O	Float	Hi	*
1053			Lo	
1054	FMO: K_C	Float	Hi	*
1055			Lo	
1056	FMO: $LogpO_2$	Float	Hi	*
1057			Lo	
1058	Furnace model simplified calculation	Byte		* 0 = not active, 1 = active

FMO = Furnace Model Output
* = Furnace Model option needed
** = Nitriding Potential option needed

Holding Register	Data	Type	Low/High Word	Details
1000	Enable sampling request	Byte		1 = activate
1001 - 1029 Reserved				
1030	Actual gas1 inlet flow [m^3/h]	Float	Hi	* Modbus input for furnace model
1031			Lo	
1032	Actual gas2 inlet flow [m^3/h]	Float	Hi	
1033			Lo	
1034	Actual gas3 inlet flow [m^3/h]	Float	Hi	
1035			Lo	
1036	Actual gas4 inlet flow [m^3/h]	Float	Hi	
1037			Lo	
1038	Actual gas5 inlet flow [m^3/h]	Float	Hi	
1039			Lo	
1040	Actual gas6 inlet flow [m^3/h]	Float	Hi	
1041			Lo	
1042	Actual gas7 inlet flow [m^3/h]	Float	Hi	
1043			Lo	
1044	Actual gas8 inlet flow [m^3/h]	Float	Hi	
1045			Lo	
1046	Furnace temperature [°C]	Float	Hi	
1047			Lo	
1048	Reinitialize furnace model calculations	Byte		* 1 = activate
1049	Force simplified model calculations	Byte		* 1 = activate, 0 = deactivate

Supported error codes		
Error code	**Fault**	**Description**
2	illegal data address	Modbus register is not supported
3	illegal data value	Data requested to be stored in holding register is out of range
4	slave device failure	Undefined error occurred

Supported error codes		
Error code	**Fault**	**Description**
6	slave busy	Device is busy proceeding request

FMO = Furnace Model Output
* = Furnace Model option needed
** = Nitriding Potential option needed

Holding Register	Data	Type	Low/High Word	Details
1000	Enable sampling request	Byte		1 = activate
1001 - 1029 Reserved				
1030	Actual gas1 inlet flow [m^3/h]	Float	Hi	* Modbus input for furnace model
1031			Lo	
1032	Actual gas2 inlet flow [m^3/h]	Float	Hi	
1033			Lo	
1034	Actual gas3 inlet flow [m^3/h]	Float	Hi	
1035			Lo	
1036	Actual gas4 inlet flow [m^3/h]	Float	Hi	
1037			Lo	
1038	Actual gas5 inlet flow [m^3/h]	Float	Hi	
1039			Lo	
1040	Actual gas6 inlet flow [m^3/h]	Float	Hi	
1041			Lo	
1042	Actual gas7 inlet flow [m^3/h]	Float	Hi	
1043			Lo	
1044	Actual gas8 inlet flow [m^3/h]	Float	Hi	
1045			Lo	
1046	Furnace temperature [°C]	Float	Hi	
1047			Lo	
1048	Reinitialize furnace model calculations	Byte		* 1 = activate
1049	Force simplified model calculations	Byte		* 1 = activate, 0 = deactivate

Supported error codes		
Error code	**Fault**	**Description**
2	illegal data address	Modbus register is not supported
3	illegal data value	Data requested to be stored in holding register is out of range
4	slave device failure	Undefined error occurred
6	slave busy	Device is busy proceeding request

9.2 CANBUS REGISTERS

Input Register	Data	Type	Low/High Word	Details
0	System State	UINT	Hi	reserved
			Lo	Bit0: Pump Saturation Bit1: Pump Alarm reserved reserved reserved reserved

Input Register	Data	Type	Low/High Word	Details
				reserved
6	System State	UINT	Hi	reserved
			Lo	Bit0: Pump Status reserved reserved reserved reserved reserved reserved
8	Probe Temperature	Float	Hi	Probe Temperature in degrees C
9			Lo	
12	Probe mV (EMK)	Float	Hi	Probe EMK in MV
13			Lo	
24	H_2 / Dissociation [%]	INT	Hi	X 0.01
25			Lo	
26	Block temperature [°C]	UINT	Hi	X 0.01
27			Lo	
1002	Hardware Alarms	UINT	Hi	reserved

Output Register	Data	Type	Low/High Word	Details
0	System State	UINT	Hi	reserved
			Lo	Bit0: Pump Enable reserved reserved reserved reserved reserved reserved

9.3 PROFIBUS REGISTERS

Input Register	Data	Type	License required	Comments
0	System state	Uint	Standard	Bit0: Sampling enabled (pump on)
				Bit1: Block ready
				Bit2: Enable sampling request on digital input
				Bit3: Enable sampling request from web application
				Bit4: Enable sampling request on Profibus
				Bit5: Enable sampling request on Modbus
				Bit6: Enable sampling request on CAN
4	Hardware alarms	Uint	Standard	Bit0: 24V power supply failure
				Bit1: 3V3 power supply failure
				Bit2: -VFL power supply failure
				Bit3: +VFL power supply failure
				Bit4: -15V power supply failure
				Bit5: +15V power supply failure
				Bit6: 5V power supply failure
				Bit7: Real time clock malfunction

Input Register	Data	Type	License required	Comments
				Bit8: Storage device malfunction
8	System alarms	Uint	Standard	Bit0: Could not initialize non-volatile configuration service
				Bit1: Could not initialize system supervision service
				Bit2: Could not initialize filesystem
				Bit3: Could not initialize ethernet service
				Bit4: Could not initialize IO service
				Bit5: Could not initialize HTTP server
				Bit6: Could not initialize Modbus server
				Bit7: No filesystem detected
				Bit8: Could not initialize display service
				Bit9: Could not initialize measurement block service
				Bit10: Could not initialize O2 card service
				Bit11: Could not initialize Profibus server
				Bit12: Could not initialize CAN server
			Furnace model	Bit13: Could not initialize furnace model service
			Standard	Bit30: Could not update device's firmware
				Bit31: Empty EEPROM detected
12	IO alarms	Uint	Standard	Bit0: Flow off limits
				Bit1: Pump saturation
				Bit2: Temperature sensor open circuit detected
				Bit3: Block heater failure
				Bit4: Analog output 1 open circuit detected
				Bit5: Analog output 2 open circuit detected
				Bit6: Thermocouple open circuit detected
				Bit7: O2 probe impedance test failure
				Bit8: Block temperature too high
16	H2/Dissociation [%]	Float	Standard	
20	Block temperature [°C]	Float	Standard	
24	Thermocouple temperature [°C]	Float	Standard	Only if o2 card is present
28	O2 probe emf [mV]	Float	Standard	
32	Kn	Float	Nitriding potential	
36	Ko	Float	Nitriding potential	Only if o2 card is present
40	Serial number	Ushort	Standard	
42	Total working hours	Uint	Standard	
46	Hours to next service	Ushort	Standard	
48	Heat tracing temperature [°C]	Float	Standard	
52	Flow rate [l/m]	Float	Standard	
56	Reserved			Reserved
60	Furnace model output: CO content	Float	Furnace model	
64	Furnace model output: CO2 content	Float	Furnace model	
68	Furnace model output: CH4 content	Float	Furnace model	
72	Furnace model output: H2 content	Float		

Input Register	Data	Type	License required	Comments
			Furnace model	
76	Furnace model output: H2O content	Float	Furnace model	
80	Furnace model output: NH3 content	Float	Furnace model	
84	Furnace model output: N2 content	Float	Furnace model	
88	Furnace model output: O2 content	Float	Furnace model	
92	Furnace model output: Dissociation	Float	Furnace model	
96	Furnace model output: Kn	Float	Furnace model	
100	Furnace model output: Ac	Float	Furnace model	
104	Furnace model output: Ko	Float	Furnace model	
108	Furnace model output: Kc	Float	Furnace model	
112	Furnace model output: LogpO2	Float	Furnace model	
116	Furnace model simplified calculations	Byte	Furnace model	0 = not active, 1 = active

Output Register	Data	Type	License required	Comments
0	Enable sampling request	Byte	Standard	1 = activate
1	Reserved			Reserved
20	Actual gas1 inlet flow [m^3/h]	Float	Furnace model	
24	Actual gas2 inlet flow [m^3/h]	Float	Furnace model	
28	Actual gas3 inlet flow [m^3/h]	Float	Furnace model	
32	Actual gas4 inlet flow [m^3/h]	Float	Furnace model	Profibus input for furnace model
36	Actual gas5 inlet flow [m^3/h]	Float	Furnace model	
40	Actual gas6 inlet flow [m^3/h]	Float	Furnace model	
44	Actual gas7 inlet flow [m^3/h]	Float	Furnace model	
48	Actual gas8 inlet flow [m^3/h]	Float		

Output Register	Data	Type	License required	Comments
			Furnace model	
52	Furnace temperature [°C]	Float	Furnace model	
56	Reinitialize furnace model calculations	Byte	Furnace model	1 = activate
57	Force simplified model calculations	Byte	Furnace model	1 = activate, 0 = deactivate

10 CUSTOMER SUPPORT

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