USER MANUAL

GMP

Gas and Moisture Sensor

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1.1 Legal information

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1.1.1 Disclaimer

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1.2 Presentation

This manual presents all the recommendations and instructions for installation, operation and maintenance of the Gas and moisture specialist sensor - GMP.

1.3 Typographical conventions

Throughout this text, the following typographical conventions were adopted:

Bold: Symbols, terms and words that are in bold have greater contextual importance. Therefore, pay attention to these terms.
Italics: Terms in foreign language, alternative or with their use outside the formal situation are written in italics.
Underlined: References to external documents.

1.4 General and safety information

This section presents relevant aspects of safety, installation and maintenance of the GMP.

1.4.1 Safety symbols

This manual uses three types of risk classification, as shown below:

Warning:
This symbol is used to alert the user of potentially dangerous operating or maintenance procedures in which higher caution must be taken. Minor or moderate injuries may occur, as well as damage to the equipment.

Caution
This symbol is used to alert the user of a potentially dangerous operating or maintenance procedure which demands extreme caution in its conduction. There may occur serious injuries or even death. Possible damages to the equipment may be irreparable.

Risk of electric shock
This symbol is used to alert the user of an operating or maintenance procedure that may result in electric shock if not strictly overseen. There may be minor, moderate, serious injuries or death.

1.4.2 General symbols

This manual uses the following general symbols:

Important
This symbol is used to highlight important information.

Tip
This symbol represents instructions to facilitate GMP usage and accesses to its information.

1.4.3 Minimum profile recommended for GMP operator and maintainer

Installation, maintenance and operation of equipment in electric power substations require special cares and, therefore, all recommendations of this manual, applicable standards, safety procedures, safe work practices and good judgment must be used during all handling stage of Gas and Moisture Specialist Sensor - GMP.

Only authorized and trained staff – operators and maintainers – should handle this equipment.

To handle GMP, the operator should:

1. The operator or maintainer must be trained and authorized to operate, ground, turn on and turn off the GMP, following maintenance procedures according to the safety practices established, under the sole responsibility of the GMP operator and maintainer;
2. Be trained in the use of PPEs, CPEs and first-aid;
3. Be trained in the working principles of the GMP, as well as its configuration;
4. Follow regulatory recommendations regarding interventions in any type of equipment included in an electric power system.

1.4.4 Environmental and voltage conditions required to installation and operation of the GMP

The table below lists important information on the environmental and voltage requirements.

Table 1 - Operation conditions

Application	Equipment for outdoor use in substations, industrial and similar environments.
Indoor/outdoor use	Outdoor use
Protection level (IEC 60529)	IP66 (NEMA4)
Altitude* (IEC EN 61010-1)	Up to 2000 m
Temperature (IEC EN 61010-1)	
Operation	-40...+85 °C
Process	-10...+90 °C
Storage	-50...+95 °C
Relative humidity (IEC EN 61010-1)	
Operation	0...100 % - condensed or Uncondensed
Storage	0...100 % - condensed or Uncondensed
Supply voltage fluctuation (IEC EN 61010-1)	Up to ±10 % of rated voltage
Overvoltage (IEC EN 61010-1)	Category II
Pollution level (IEC EN 61010-1)	level 3
Atmospheric pressure** (IEC EN 61010-1)	80...110 kPa

*Altitudes above 2000 m already have successful applications.
**Pressure below 80 kPa already have successful applications.

1.4.5 Test and installation instructions

This manual must be available for those responsible for installation, maintenance and users of the Gas and Moisture Specialist Sensor- GMP.

To ensure user safety, equipment protection and correct operation, the following minimum precautions must be followed during the GMP installation and maintenance.

1 Read this manual carefully before installing, operating or performing maintenance on the GMP. Errors in installation, maintenance or in the GMP adjustments can cause undue alarms, fail to issue relevant alarms and thus, cause misunderstanding of the actual state of health and functioning of the transformer.

2 Installation, adjustments and operation of the GMP must be done by trained personnel familiar with power transformers insulated with mineral or vegetable oil, control devices and control circuits of substation equipment.

3 Special attention must be given to the installation of the GMP, including the type and gauge of cables, installation location and commissioning, including the correct parameterization of the equipment.

GMP can be installed outdoor (exposed to weather) as long as the temperature does not overpass the one specified for the equipment.

Prioritize GMP installation in places with high oil flow and lowest temperature possible. Stagnant or poorly circulating oil can compromise the sensor's reading accuracy, while high temperatures will reduce its useful life. See topic **Error! Reference source not found.** to learn more about representativeness in measurements.

1.4.6 Cleaning and decontamination instructions

By having IP66 protection, cleaning the GMP can be done easily. You can use a cloth with soap, detergent diluted in water or even ethyl alcohol to clean the entire surface of the equipment. However, avoid the use of aggressive and corrosive chemical solvents that could damage the polycarbonate front of the equipment.

1.4.7 Inspection and maintenance instructions

For GMP inspection and maintenance, the following observations must be followed:

Do not open the equipment. There are no parts to be repaired by the user inside it. This procedure must be done only by Treetech technical support, or professionals certified by Treetech.
This equipment is completely maintenance free, and visual and operational inspections, periodic or not, can be done by the user. These inspections are not mandatory.

Opening the GMP at any time will lead to product warranty loss. In case of inappropriate opening, Treetech can not ensure the product correct functioning, regardless of whether the warranty period has expired or not.

Do not try to access the equipment's factory menu (FACT). When trying to access this menu with the wrong password, the display will show the message VOID. After a few attempts, it will completely block access to the equipment's menus and will void the warranty.

All parts of this equipment must be supplied by Treetech, or by one of its accredited suppliers, according to its specifications. If the users wish to acquire them in another way, they must strictly follow Treetech's specifications for this purpose. Thus, performance and safety for the user and the equipment will not be compromised. If these specifications are not followed, the user and the equipment may be exposed to unforeseen risks.

1.5 Technical support

Treetech has a wiki where several frequent asked questions and guides are available to help customers. It is worthy to check it through the link bellow.

Wiki
wiki.treetech.com.br

If you do not find an answer, by accessing our service desk it is possible to open a service call for our SOS team to support you.

Service Desk
sac.treetech.com.br

In some cases, it is recommended to send the equipment to our technical support. To do so, follow the steps described in our wiki.

Procedure to sending IED to technical support
treetech.atlassian.net/wiki/x/AgCuNQ

For more information, talk to us through the contacts available at the link bellow.

Contact
treetech.com.br/contato/assistencia-tecnica/

1.6 Warranty terms and conditions

The Gas and Moisture Specialist Sensor – GMP will be guaranteed by Treetech for a period of 2 (two) years, counted from the date of purchase, exclusively against any manufacturing or quality defects that cause it to be improper for regular use.
The warranty will not cover product damage suffered as result of accidents, mistreatment, incorrect handling, incorrect installation and application, inadequate testing or in case of breach of the warranty seal.
Any need for technical assistance must be communicated to Treetech or its authorized representative, with the presentation of the equipment along with the respective proof of purchase.
No express or implied warranties other than those mentioned above are provided by Treetech.
Treetech does not provide any guarantee of suitability of the GMP for a particular application. Seller shall not be liable for any damage to property or for any loss and damage arising out of, connected with, or resulting from the purchase of the equipment, its performance or any services possibly provided along with the GMP. In no event shall the seller be liable for damages incurred, including, but not limited to: loss of profits or income, impossibility of using the GMP or any associated equipment, capital costs, costs of purchased energy, costs of equipment, facilities or substitute services, downtime costs, complaints from buyers' customers or employees, regardless of whether such damages, claims or damages are based on contract, warranty, negligence, tort or otherwise. Under no circumstances will the seller be liable for any personal injury of any kind.

2 Introduction

Figure 1 - Gas and Moisture Specialist Sensor

Insulating oils are applied in high and extra high voltage equipment as a dielectric medium, given the high potential differences to which they are subjected, and as a heat transport element, increasing the efficiency of cooling systems. Other solid cellulose-based insulating materials, such as paper, cardboard and wood, are often used in conjunction with the insulating oil. Some of the most common application examples are power and current transformers and shunt reactors.

Since such equipment plays essential roles in electrical power systems, eventual failures can cause great losses, not only due to damage to the equipment, but also due to loss of revenue, contractual fines and reduced reliability of the power system. In this context, the monitoring of gases dissolved in the oil plays a fundamental role in diagnosing the status of the equipment, being able, in many cases, to detect failures in their incipient phase, in addition to pointing out possible causes.

Abnormal operating conditions, such as hot spots, partial discharges or electrical arcs lead to decomposition of the insulating oil and/or cellulose, with the formation of combustible gases that dissolve in the oil. The gases formed and their concentrations depend on the temperature and energy of the fault and the materials involved, including H_2, CO, CO_2 and low molecular weight hydrocarbons such as CH_4, C_2H_6, C_2H_4 e C_2H_2. As hydrogen (H_2) is formed by the decomposition of oil at all fault temperatures, the increase in its concentration is considered a universal indicator of the presence of an equipment failure.

For this reason, Treetech's GMP performs online monitoring of hydrogen dissolved in the insulating oil, since it is considered a key gas for defect detection in equipment immersed in oil. GMP performs the measurement without cross interference from other gases, such as methane (CH_4) for example, in order to obtain maximum sensitivity in detecting defects, without alterations in hydrogen being covered up by constant and high concentrations of these other gases.

In addition, GMP also monitors the moisture in the oil, a factor that can influence the dielectric strength of the oil, cellulosic insulation and the rate of aging of these insulators. To ensure monitoring and enable good moisture control, the GMP measures two important factors: water content and relative saturation. The water content does not depend on the temperature, type or condition of the oil, but together with the constant value of water solubility in oil, the GMP shows the so-called relative saturation, which is the result between the division of the absolute content for solubility.

In summary, monitoring the relative saturation is an important factor, as the water dissolved in the oil reduces the insulating capacity, may cause bubbles and accelerate the aging of insulating media, while monitoring hydrogen (H_2) can indicate defects and malfunction of the asset.

2.1 Characteristics and functions

COMPACT AND VERSATILE

The GMP has compact dimensions, providing space and installation cost savings. It also has a valve or small thread, which increases the number of options for installing the sensor, facilitating the ideal installation in places with large oil flow.

ROBUST HARDWARE

The GMP design exceeds EMC (Electromagnetic Compatibility) standards to withstand severe substation electromagnetic conditions and operating temperature from -40 to 85 °C. It also has IP66 protection, withstanding harsh installation and weather conditions.

SELF-SUFFICIENCY

The equipment has a LED screen for displaying measurements and alarms. Its parameterization can also be done directly from the front using the touch-sensitive keys. The use of other interfaces is optional.

MEASUREMENT AND INDICATION OF H_2 AND H_2O

It performs the real-time measurement and indication of the hydrogen dissolved in the oil, its evolution trend and the time forecast, in days, to reach the alarm levels. Likewise, the equipment also indicates the values of relative saturation (%) and content (ppm) of water in oil.

INDICATION ALARMS FOR DE H_2 AND H_2O CONCENTRATION

High and very high indication alarms are issued for H_2 and H_2O concentrations. Alarms are also issued for trends in the evolution of these values.

REAL TIME INDICATION OF OIL TEMPERATURE

As well as measuring gas and humidity, the oil temperature is also monitored and displayed in real time.

PROGRAMMABLE OUTPUT RELAYS

4 configurable relays are available which, operating normally open or normally closed, can be actuated simultaneously with the desired alarms.

CURRENT LOOP OUTPUTS

Two current loop outputs are available. Each output can provide measurement data for any of the 10 monitored variables. The output current range is also configurable.

SELF-DIAGNOSIS

The equipment has a system to detect internal failures or lack of power. Bringing greater reliability in your measurements and linked controls.

OPEN COMMUNICATION

A RS-485 port is available for communication with monitoring or supervisory systems. Communication protocols are open - Modbus® RTU and DNP3.

2.2 Basic functioning philosophy

2.2.1 Periodic analysis of dissolved gases

The analysis of gases dissolved in oil (DGA - Dissolved Gas Analysis) has been used and recognized worldwide as an efficient tool for the analysis and diagnosis of incipient failures in transformers and high voltage equipment immersed in oil. It has also been widely used by transformer manufacturers as a tool for evaluating the performance of their products and by users of this equipment in preventive maintenance programs.

Despite this success, DGA is, in most cases, a laboratory method based on a program of manual collection of oil samples periodically carried out on the equipment, with the frequency defined accordingly to the relative importance of the equipment and any suspected defects. As a result, failure with rapid gas evolution may not be detected in a first sampling and become excessively worse until detected in the next sampling, or, in the worst case, lead to equipment failure before the next analysis is carried out.

In addition to the main inconvenience presented above, periodic DGA also presents the risk of error due to failure in the sample collection and transport processes to the laboratory and the operation of the analysis equipment, thus requiring specialized labor.

2.2.2 Continuous monitoring of dissolved gases in oil

The DGA in oil is, as mentioned above, a tool of indisputable importance for diagnosing the status of equipment immersed in insulating oil, and its continuous performance enhances this tool even more, eliminating the presented inconveniences. Obviously, this continuous monitoring through the collection of oil samples is not feasible in practice or financially when it is necessary to supervise dozens or hundreds of pieces of equipment.

On the other hand, it is currently not financially viable, in most applications, to install equipment that performs the online measurement of all the combustible gases present in the oil, as done in the laboratory with periodic samples. At first, this fact may lead us to believe in the impossibility of continuous monitoring dissolved gases, which is not reality.

Work carried out by several researchers demonstrated that hydrogen is present, alone or accompanied by other gases, in all insulating oil decomposition processes, constituting, therefore, a kind of “universal indicator” of failures. Since the evolution of this key gas is continuously monitored, it is possible to detect any problem that may develop in the equipment at any time, although this measurement alone does not allow for an accurate diagnosis of what is occurring.

Once the suspicion of an equipment problem is raised from the increase in the H_2 level, this can be confirmed (or discarded) and investigated in depth by laboratory analysis of oil samples. In this way, the time interval in which the equipment remains unsupervised is eliminated, and the identification of incipient failure in a timely manner allows the user to plan the steps necessary for its identification and take corrective actions, when necessary.

2.2.3 Methodology for online monitoring of dissolved gases on oil

Online monitoring of dissolved hydrogen as the key gas for fault detection in oil-immersed equipment fills the gap in periodic DGA.
Treetech's GMP measures the concentration of H_2 in the oil, in order to continuously monitor the evolution of this gas and detect elevations that indicate the existence of a possible defect in the high voltage equipment.

2.2.3.1 Measurement of the hydrogen concentration

The sensors used by the GMP to measure gas and humidity concentrations work with a technology using semiconductors, which eliminates cross-sensitivity to other combustible gases. Once energized, the GMP initializes the gas sensors for a period of 1 hour before actually starting this measurement.
Since the phenomena of generation and dispersion of gases in high voltage equipment have long time constants, the GMP response to changes in the concentration of hydrogen in the oil has a time constant of approximately 8 hours.

2.2.3.2 Representativeness on the measurement

For the entire process of measuring dissolved hydrogen as described above to be effective for the equipment diagnosis, it is necessary that the oil in contact with the GMP sensor (and consequently the dissolved hydrogen in it) is representative of the general situation of the transformer.
The natural circulation of oil inside the tank contributes to this condition, due to convection currents, caused by temperature differences between heat sources inside the equipment and heat dissipation points, such as radiators and side walls.
For this reason, the ideal is that the gas monitor to be installed in a place where there is a lot of oil movement, such as some of the side walls of the transformer or the inlet/outlet pipes of the radiators. Please visit the following link to view possible GMP installation locations in order of priority.

Locations for installing the GMP
treetech.atlassian.net/wiki/x/AQCSSg

3 Project and installation

3.1 System topology

The Gas and Moisture Specialist Sensor works autonomously, allowing few modules in your system and easy installation.

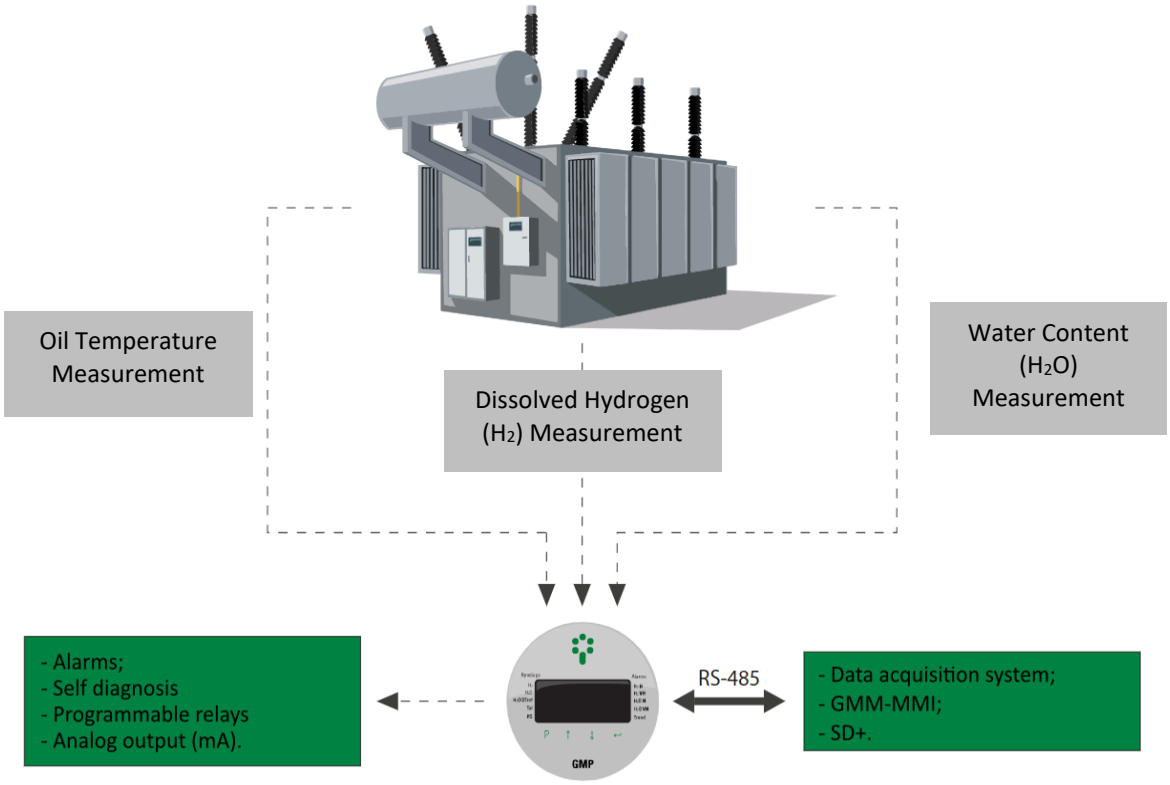


Figure 2 - Composition of the gas and humidity monitoring system

The items required for the installation and operation of the Gas and Moisture Specialist Sensor - GMP are:

- Gas and Moisture Specialist Sensor - GMP;
- Cables for auxiliary power and alarm contacts (if used);
- Shielded twisted-pair cable for RS-485 serial communication (if used);
- Shielded twisted 3-way cable for analog outputs (if used);
- Free flow valve (ball or gate) for GMP access to insulating oil.

Optional items for system composition:

- GMM-MMI remote interface module, used if the GMP is installed in a difficult-to-access location, making it difficult to read the measurements on its local display, or SD+ for expanding the output or communication interfaces.

3.2 Mechanical installation

The Gas and Moisture Specialist Sensor - GMP must be installed in a place with good oil circulation, such as radiator or heat exchanger piping, in a valve of at least 1/2" diameter with free flow, ball type or gate, in order to allow the insertion of the GMP rod through the valve, placing the tip of the rod in a place with oil circulation. This avoids the measurement of gas in oil stagnant inside the valve. Thus, valves that do not allow free flow, such as the "globe" type, should not be used.

The GMP has a 288 mm rod for connection. The free length of the rod for insertion of the GMP into the oil flow is approximately 218 mm. Thus, the total distance from the valve tip to the interior of the pipe or tank must be less than 218 mm, as shown in Figure 4, to ensure that the end of the rod is inserted into the oil flow.

It should also be noted that the GMP operating temperature ranges from -40 to +85 °C.

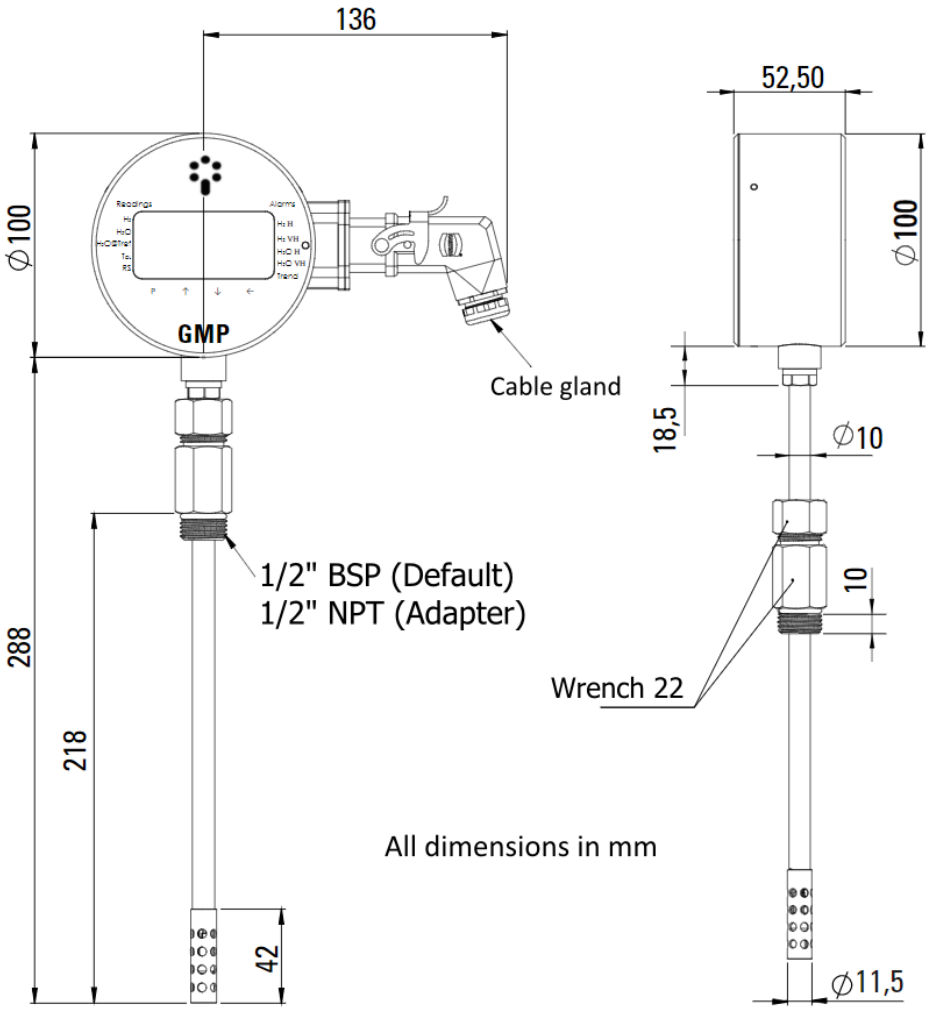


Figure 3 - Equipment dimensions

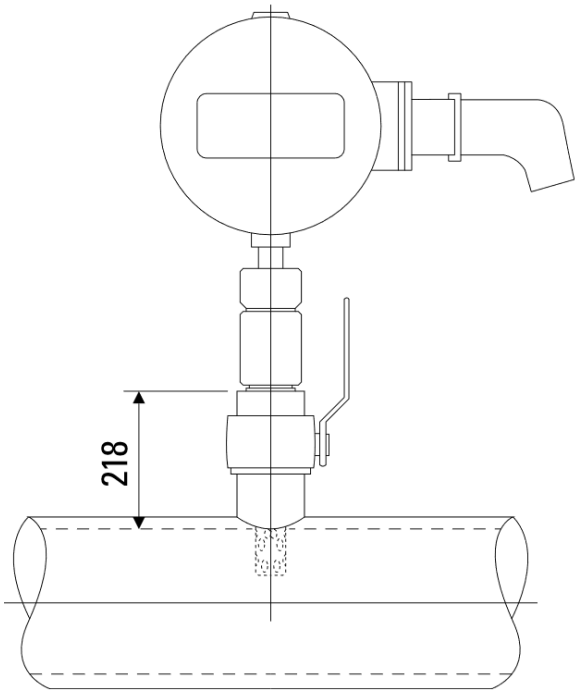
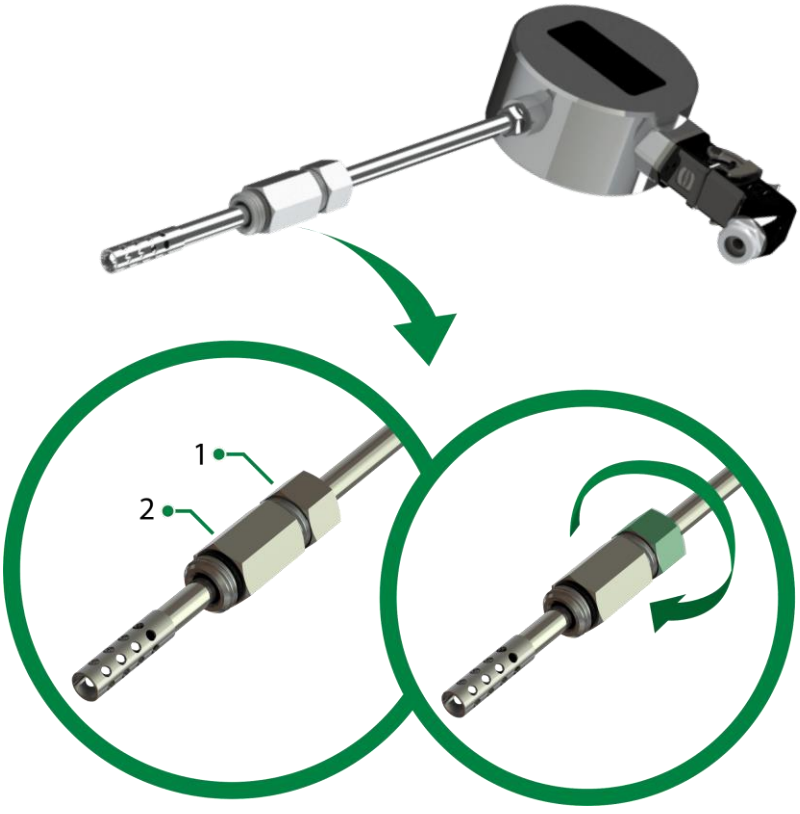


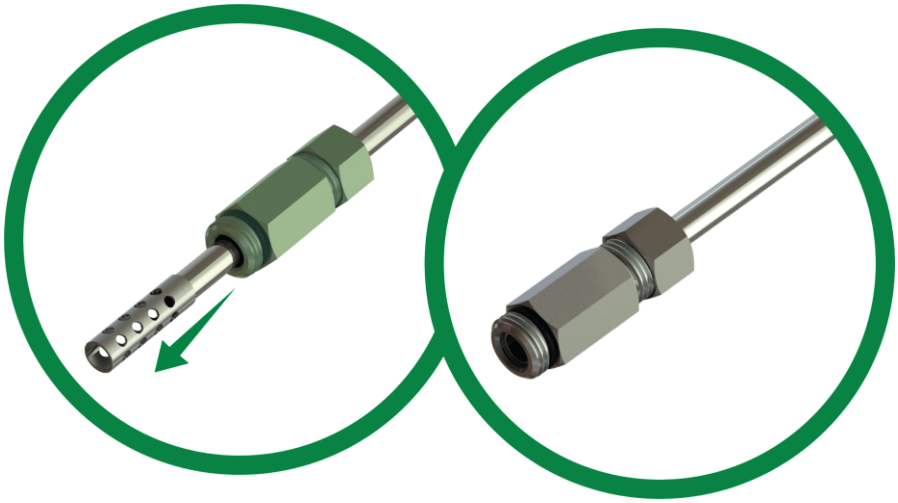
Figure 4 - Distance for sensor installation

3.2.1 Mechanical installation procedure

a) Remove the plastic cover that protects the end of the rod during transport.
b) Loosen the nut (1) of the fastening element (2).

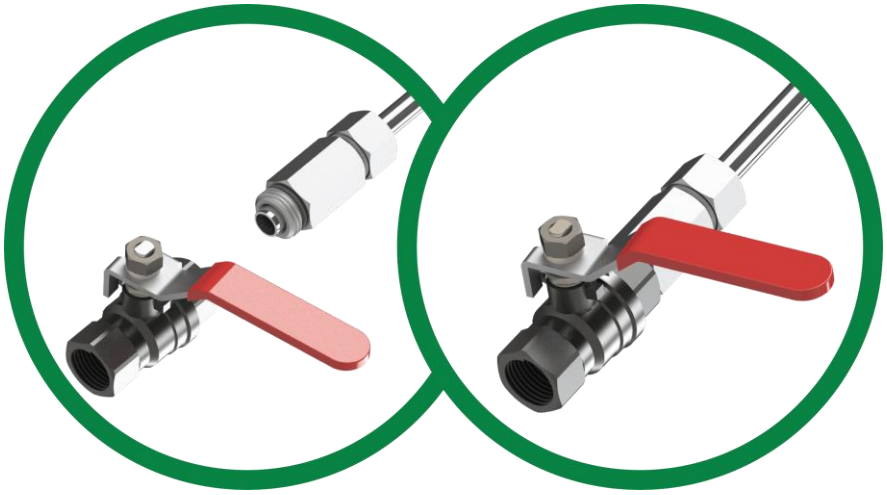


c) Push the fastening element (2) towards the lower end of the rod as illustrated below.

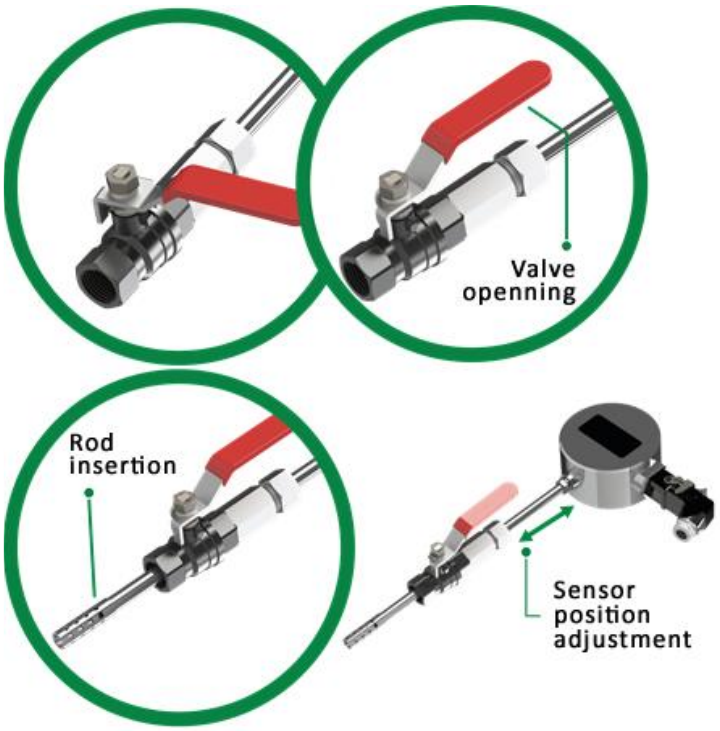


d) Using a size 22 wrench, screw and tighten the fastening element (2) on the transformer valve. It is not necessary to use Teflon tape, as the sealing is performed by the sealing ring (o-ring) of the equipment.

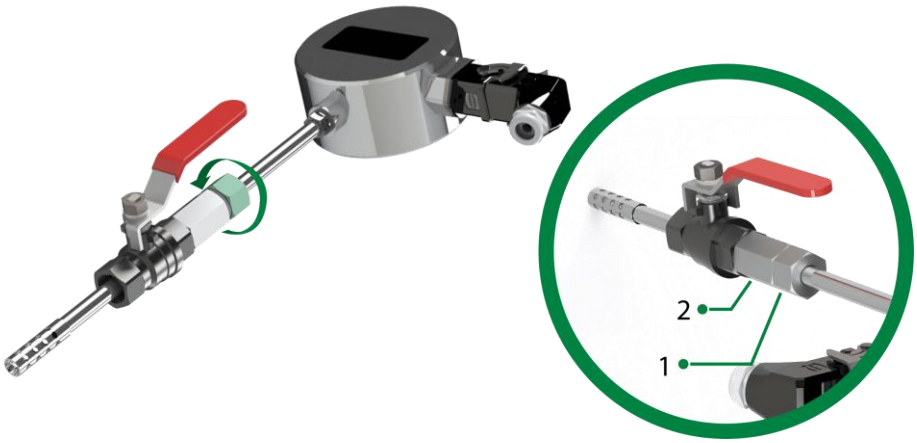
e)



f) Carefully open the valve and insert the rod, adjusting its position until the sensor tip is in contact with the oil flow.



g) Using a size 22 open-end wrench, tighten the nut (1) onto the fastening element (2), preventing undue displacement of the rod.



h) Proceed with the electrical installation, as described in the following topic.

3.3 Electric installation

This equipment operates at dangerous supply voltage levels, which could result in death or serious injury to the operator or service provider.

Some special precautions must be followed for the design and installation of the GMP, as described below.

A circuit breaker must be used immediately before the power input (Universal powering of 38 to 265 Vdc or 85 to 265 Vac, ≤ 8 W, 50/60 Hz), which corresponds to pins 1 and 2 of the GMP. This circuit breaker must have the number of poles corresponding to the number of phases used in the supply – the poles must only interrupt the phases, and never the neutral or ground – and provide thermal and electrical protection to the conductors that supply the equipment.
The circuit breaker must be close to the equipment and easily maneuvered by the operator. Additionally, it must have an indelible identification showing that it is the GMP electrical disconnect device.

The following circuit breaker specification is recommended when used exclusively for GMP:
AC/CC Powering, Phase-Neutral: Monopolar circuit breaker, 1 A ≤ In ≤ 2 A, curve B or C, standards NBR/IEC 60947-2, NBR/IEC 60898 or IEEE 1015:2006;
AC/CC Powering, Phase-phase: bipolar circuit breaker, 1 A ≤ In ≤ 2 A, curve B or C, standards NBR/IEC 60947-2, NBR/IEC 60898 or IEEE 1015:2006.

The standard schematic diagram of GMP connections shows all the possibilities of connections that GMP provides, identifying them as shown in figures 5 and 6.

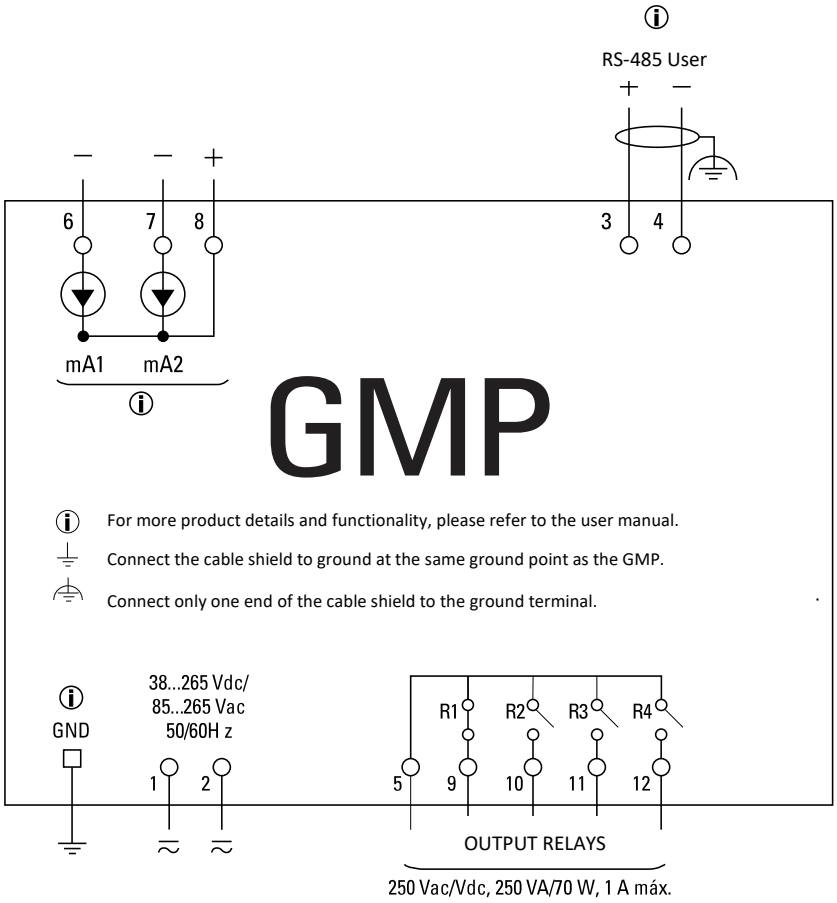


Figure 5 - GMP electrical connection diagram

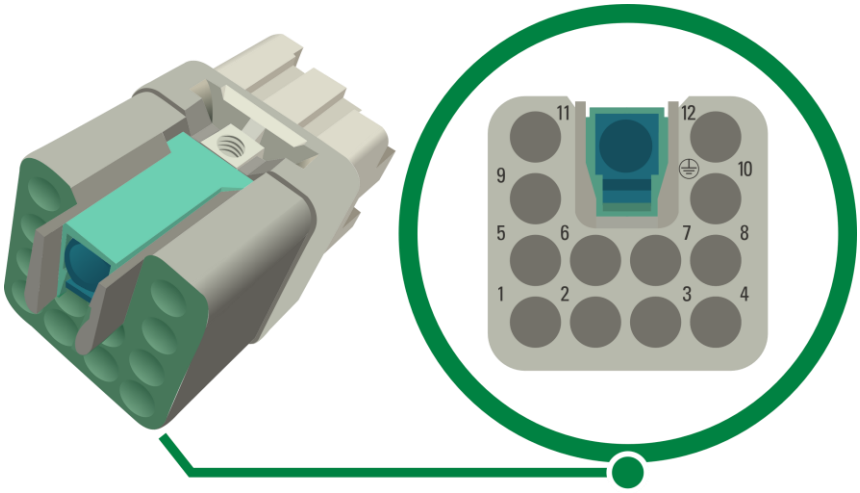


Figure 6 - GMP socket with numbered terminals

Special attention must be paid to the correct connection of components to the GMP at all stages of installation. Errors in connecting the equipment can cause risks or even irreversible damage to the operator. Damage from misuse is not covered under the warranty.

In the following sections, the connections and functions of the equipment's inputs, outputs and communication will be presented in more detail.

3.3.1 Input and output terminals

Table 2 - Input and output terminals

Entradas	Terminals
POWER AND GROUND Inputs for universal power 35 to 265 Vdc or 85 to 265Vac, 50/60 Hz, ≤ 8 W.	1 - dc/ac 2 - dc/ac GND - ground
SERIAL COMMUNICATION ***RS-485 serial communication port available to the user for connection to the monitoring or supervisory system, using Modbus® RTU or DNP3 protocols, via shielded twisted-pair cable.***	3 – (+) 4 – (-)
PROGRAMMABLE OUTPUT RELAYS Four programmable relays, 1 normally closed (NC) and three normally open (NO) to indicate any alarms and/or self-diagnosis according to parameterization of the RLAY submenu, see topic *Error! Reference source not found.*.	5 – common 9 – relay 1 (NC) 10 – relay 2 (NO) 11 – relay 3 (NO) 12 – relay 4 (NO)
CURRENT LOOP OUTPUTS Two current loop outputs (mA) are available for remote indication of measurements. Each output can indicate the value of a variable in a certain current range, according to the parameterization of the ANOU menu, see topic 5.8.4.	6 – output 1 7 – output 2 8 – common

POWER AND GROUND

The GMP has a universal power input (38 to 265Vdc or 85 to 265Vac, 50/60 Hz). Powering the GMP through the substation's auxiliary services is advisable, particularly when it is integrated into a serial communication network for data collection purposes for supervisory or monitoring systems.

SERIAL COMMUNICATION NETWORK

Communication with data acquisition systems can be done through an RS-485 serial network, using Modbus® RTU or DNP 3.0 protocols, as parameterized in the PRT parameter, see topic **Error! Reference source not found.**.

This interconnection must be made using shielded twisted-pair cable, keeping the mesh uninterrupted throughout. If there is a need for intermediate terminals for interconnecting the serial communication, also pass the cable shielding through a terminal, avoiding interruption. The unshielded cable run due to splicing should be as short as possible, and it is advisable that the cable shield be grounded at only one end. It is advisable to use a 120 Ω terminating resistor at each end of the serial communication network to attenuate signal reflections. In conjunction with the termination resistors, pull-up and pull-down resistors must be used at only one point of the network, as indicated in figure 7 below. The 5V direct voltage for supplying the pull-up and pull-down resistors can be internal to the data acquisition system. Note that some communication equipment may already have these resistors installed internally, dispensing with the use of external resistors. The maximum distance of 1200 m between the ends of the communication network must be obeyed. It is also worth noting that up to 31 devices are allowed on the RS-485 network.

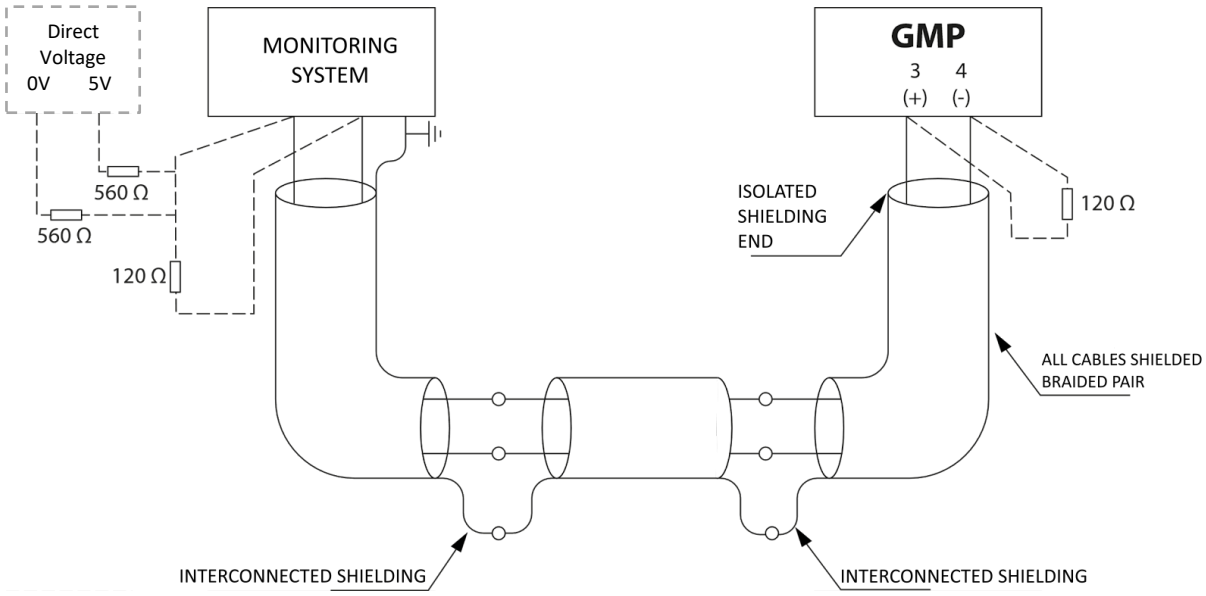


Figure 7 - Connections and grounding in the RS-485 communication network

PROGRAMMABLE OUTPUT RELAYS

Output contacts can receive one or more alarms as a condition to change their state. Likewise, these four relays can be linked with the self-diagnosis to be actuated and, in this way, indicate any anomaly verified by the GMP.

Relays 2, 3 and 4 are physically of the NO (normally open) type and relay 1 is of the NC (normally closed) type. The operation logic of the relays can be inverted when parameterizing the equipment (parameter MODE, see topic **Error! Reference source not found.**), however, in cases of power failure, the physical configuration will prevail.

All relays can switch resistive loads with a maximum power of 70 W or 250 VA at up to 250 Vdc/Vac. The thermal conduction capacity (limit due to the Joule effect) of each individual relay is 1 A, but the total current at terminal 5 (common point) must not exceed 2 A.

CURRENT LOOP OUTPUTS

The analog outputs provide the values of the measurements carried out, such as hydrogen concentration, water content and others that can be consulted in the AV1 and AV2 parameter, as described in topic 5.8.4. The current range can also be adjusted according to the options of the AOR parameter, described in the same topic. The maximum load of the current loop output is 10V, which results in the maximum loads in ohms shown below:

Table 3 - Maximum load of analog output options

Output options	Maximum load
0...1 mA	10000 Ω
0...5 mA	2000 Ω
0...10 mA	1000 Ω
0...20 mA	500 Ω
4...20 mA	500 Ω

The values of the variable selected for indication on the analog output corresponding to the beginning and end of its scale are programmable in parameters bOS1/bOS2 and EOS1/EOS2 (see topic 5.8.4), according to the measurement selected for indication. To minimize interference and induction, it is advisable to use a shielded twisted cable, grounded at only one end, to connect the analog outputs to the measurement system.

4 Operation

All operations on the Gas and Moisture Specialist Sensor - GMP can be performed through the keyboard on its front panel. The measurements of H_2, H_2O, temperature and alarm conditions are indicated on the display by the signaling LEDs.

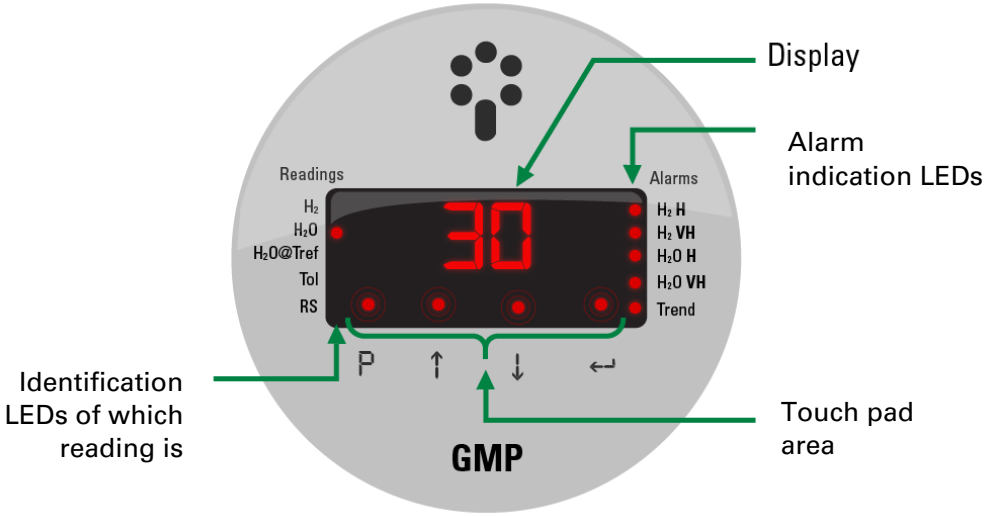


Figure 8 - GMP front display

4.1 Readout and display LEDs

As shown in figure 8, there are 5 LEDs on the left of the equipment front, each one representing a variable read by the equipment, as follows:

- **H_2** – Hydrogen, in parts per million (ppm);
- **H_2O** – Water content, in ppm;
- **H_2O@Tref** – Water content converted at 20 °C, in ppm;
- **Tol** – Oil temperature at measuring point, in °C;
- **RS** – Relative saturation of water in oil, in %.

In the central part we have the display, which shows the measurement value referring to the variable indicated by the readout LED.

4.2 Key functions

To navigate between measurements, access menus and parameters, simply use the keyboard located at the bottom of the display.

Table 4 - GMP key functions

Key	Function
P	**Programming**: allows access to the password to enter the configuration menus. In these, it leaves the current menu and returns to the previous level menu. If activated while changing a parameter, it returns to the previous level menu without saving the change made.
↑	**Up**: navigation to menus and increment programmed values.
↓	**Down**: navigation to menus and decrease programmed values.
↵	**Enter**: selects the menu option and parameters shown on the display, saves programmed values.

4.3 Alarm LEDs

There are 5 LEDs on the right side, whose states represent that a certain alarm was triggered, they are:

- **H_2 H** – H_2 level high;
- **H_2 VH** – H_2 level very high;
- **H_2O H** – H_2O level high;
- **H_2O VH** – H_2O level very high;
- **Trend** – Trend of evolution of H_2 and or H_2O.

To access the alarm memory, simply press P (P) and ↑ (up arrow) simultaneously. The display will alternately indicate the abbreviation "MALx" and the self-diagnosis codes. To clear self-diagnoses that are no longer active, just hold ↵ (enter) for 5 seconds. Note that **only non-active alarms will be cleared from memory.**
Press P (P) to exit the alarm memory screen.

4.4 Auxiliary indications

When the GMP is in the initial menu, it is possible to consult auxiliary indications on the display by pressing the ↵ (enter) key. These are the indications in sequence, it is possible to navigate between them using the arrows:

- **INT1** – Internal temperature measurement 1 (GMP), in °C;
- **INT2** – Internal temperature measurement 2 (Sensor board);
- **H2T** – H_2 evolution trend, in ppm/day;
- **DH2H** – Days to reach high H_2 level according to evolution trend;
- **DH2V** – Days to reach very high H_2 level according to evolution trend;
- **RSTR** – Relative saturation (%) converted to parameterized reference temperature (TREF);
- **H2OT** – Trend of evolution of H_2O content, in ppm/day;
- **H2OH** – Days to reach high water content level according to evolution trend;
- **H2OV** – Days to reach very high water content level according to evolution trend;
- **W20T** – Evolution trend of converted H_2O content at 20 °C, in ppm/day;
- **D20H** – Days to reach high level of converted H_2O content at 20 °C according to evolution trend;
- **D20V** – Days to reach very high level of converted H_2O content at 20 °C according to evolution trend;
- **HOUR** – Current hour;
- **MIN** – Current minute;
- **SEC** – Current second
- **DAY** – Current day;
- **MON** – Current month;
- **YEAR** – Current year;
- **UTC** – Value set for UTC time zone.

4.5 Self-diagnostics

The GMP has a self-diagnosis system that allows the equipment to detect and indicate, through specific circuits and algorithms, the presence of any anomaly in its operation, alerting the user of the need for intervention, facilitating the diagnosis of the occurrence, thus increasing the reliability of the information provided by the equipment.

If any anomaly occurs, the self-diagnosis contact is activated for remote indication and the local display alternately indicates the abbreviation “DIAG'' and the corresponding self-diagnosis number, as shown in Figure 9 - Self-diagnosis display. The meaning of this code and the recommended action can be found in topic 6.1.

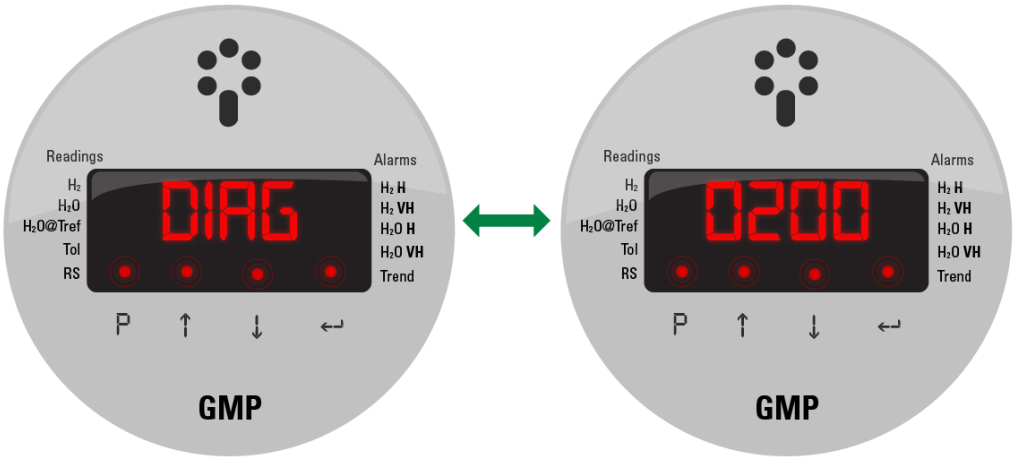


Figure 9 - Self-diagnosis display

To access the self-diagnosis memory, simply press P (P) and ↓ (down arrow) simultaneously. The display will alternately indicate the abbreviation "MDIA" and the self-diagnosis codes. To clear self-diagnoses that are no longer active, just hold ↵ (enter) for 5 seconds. Note that **only non-active self-diagnoses will be cleared from memory**.
Press P (P) to exit the self-diagnosis memory screen.

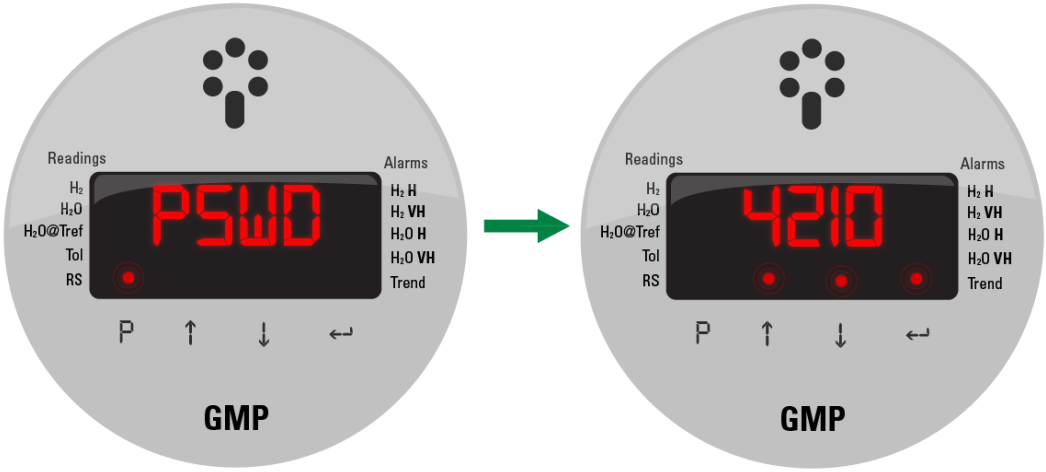
5 Parameterization

5.1 Access to parameterization menus

To guarantee the correct monitoring of gas and humidity, some operating parameters must be adjusted in the GMP, providing the equipment with the information necessary for its operation. Adjustments can be made via its front panel or via RS-485 serial communication.

To access the parameterization menu from the GMP front, follow the procedure shown below:

a) Keep P (P) pressed for 3 seconds until PSWD appears on the display. The GMP will ask for a 4-digit password to access the menu, enter the password using the arrow keys and press ↵ (enter) to confirm.



b) If the password is correct, the GMP will display the first submenu (CLCK) of the programming menu.

All GMPs are shipped with the default password of 0 (zero). After the first access, the user can customize the password in the equipment's configuration menu.
In case the new adjusted password is lost or forgotten, Treetech can assist in the recovery if the number shown on the screen is informed when the equipment requests the password.

5.2 Structure of parameterization menus

When adjusted from the front panel, the parameters are divided into menus and submenus, organized as shown in Figure 10 – Structure of menus and submenus.

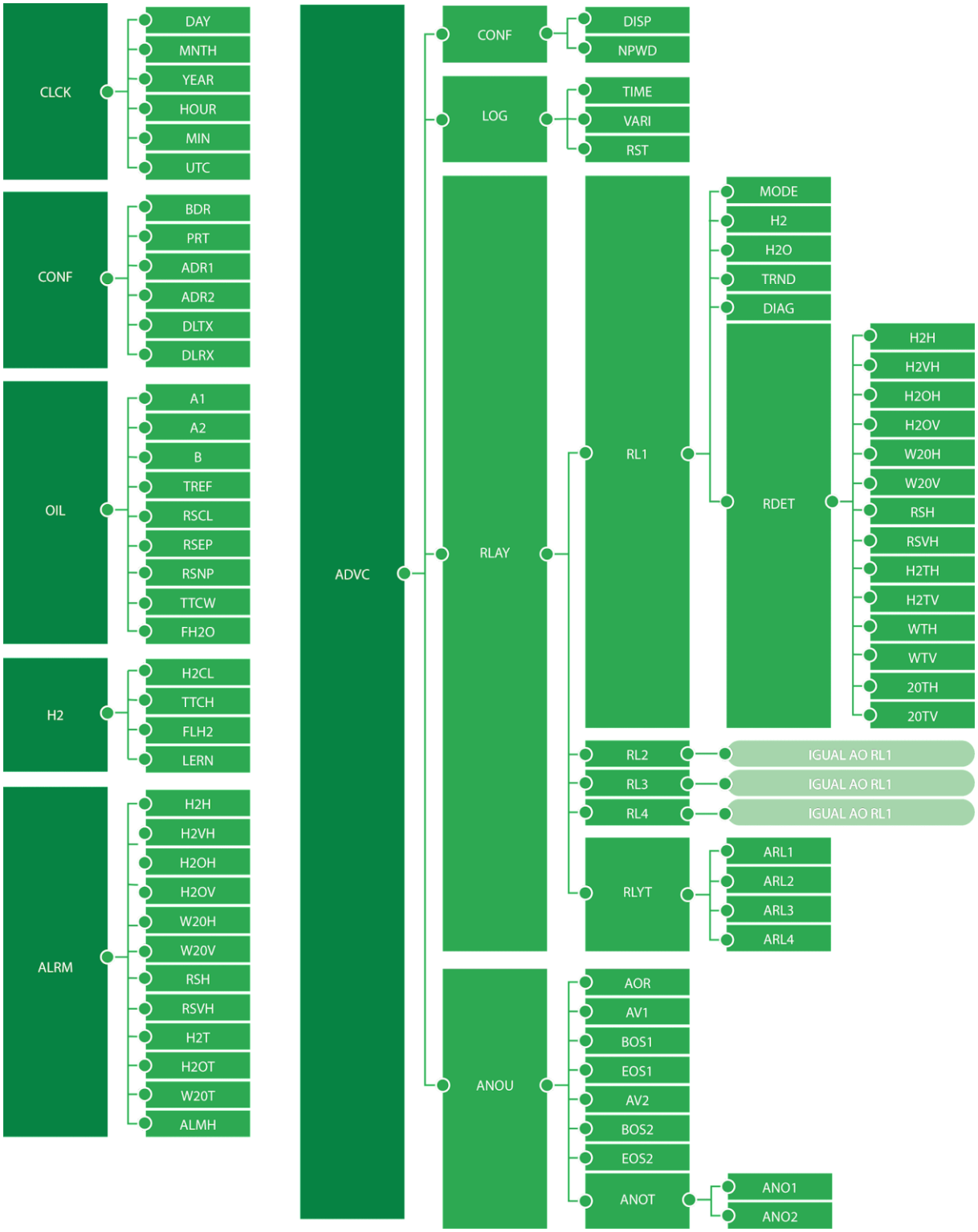


Figure 10 – Structure of menus and submenus

5.3 CLCK menu

The CLCK menu stores date, time and time zone parameters, which enable the correct identification of measurements and events of alarms and self-diagnosis.

DAY:
Select the current day.
ADJUSTMENT RANGE: 1 to 31, in steps of 1.
DEFAULT VALUE: N/A

MNTH:
Select the current month.
ADJUSTMENT RANGE: 1 to 12, in steps of 1.
DEFAULT VALUE: N/A

YEAR:
Select the current year.
ADJUSTMENT RANGE: 0 to 37 (2000 to 2037), in steps of 1.
DEFAULT VALUE: N/A

HOUR:
Select the current time.
ADJUSTMENT RANGE: 0 to 23, in steps of 1.
DEFAULT VALUE: N/A

MIN:
Select the current minute.
ADJUSTMENT RANGE: 0 to 59, in steps of 1.
DEFAULT VALUE: N/A

UTC:
Select the UTC time zone.
ADJUSTMENT RANGE: -12 to 12 hours, in steps of 1 h.
DEFAULT VALUE: -3 hours.

5.4 CONF menu

In the CONF menu, all the configurations referring to the communication available through the RS-485 serial port are located.

BDR:
Select the communication baud rate.
ADJUSTMENT RANGE: 4.8 – 9.6 – 19.2 – 38.4 – 57.6 – 115.2 kbps.
DEFAULT VALUE: 9.6 kbps.

PRT:
Select the communication protocol, Modbus® (MDB) or DNP3 (DNP).
ADJUSTMENT RANGE: MDB – DNP.
DEFAULT VALUE: MDB.

ADR1 or ADR:
Select the GMP address on the communication network. When the PRT parameter is set to DNP (DNP3), the value of ADR1 sets the high bytes of the address. When PRT is configured in MDB (modbus), the ADR value represents the complete address.
ADJUSTMENT RANGE: 1 to 247 (when PRT = MDB), 1 to 65 (when PRT = DNP), in steps of 1.
DEFAULT VALUE: 247 for when PRT = MDB, 0 when PRT = DNP.

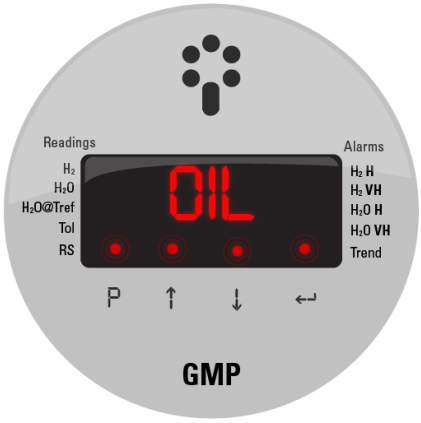
ADR2:
Only available when PRT = DNP. Select the least significant 3 digits of the address.
ADJUSTMENT RANGE: 0 to 999 if END1 < 65; 0 to 519 if END1 = 65, in steps of 1.
DEFAULT VALUE: 247.

DLTX:
Parameter responsible for defining the interframe waiting time for data transmission.
ADJUSTMENT RANGE: 5 to 255 milliseconds, in steps of 1 millisecond.
DEFAULT VALUE: 25 milliseconds.

DLRX:
Parameter responsible for defining the interframe waiting time for receiving data.
ADJUSTMENT RANGE: 5 to 255 milliseconds, in steps of 1 millisecond.
DEFAULT VALUE: 5 milliseconds.

5.5 OIL menu

The OIL menu displays the parameters related to the type of oil used, reference temperature, among others.



A1:
Parameters A1 and A2 represent the value of the water-in-oil solubility constant A. Typical values can be set, according to the type of oil, as shown in the table below, or values obtained in tests.

The final solubility value will be the concatenation of the parameters A1 and A2, so the value of A1 represents only the unit and the tenth of the value, while the value of A2 represents the hundredths. Example: A1 = 7.0 and A2 = 895 → Solubility = 7.0895.

Table 5 - Typical values of water solubility in oil types (A)

Oil type	Typical value of A
Mineral	7.0895
Silicone	6.2906
Envirotemp FR3	5.3318

ADJUSTMENT RANGE: 1.0 to 9.9, in steps of 0.1.
DEFAULT VALUE: 7.0.

A2:
Complement of parameter A1, to compose the typical value.
ADJUSTMENT RANGE: 0 to 999, in steps of 1.
DEFAULT VALUE: 895.

B:
The value of B represents the water-in-oil solubility constant B. As well as parameters A1 and A2, it can also be set with a typical value, according to the type of oil, or with values obtained from tests.

Table 6 - Typical values of water solubility in oil types (B)

Oil type	Typical value of B
Mineral	1567
Silicone	1187
Envirotemp FR3	687

ADJUSTMENT RANGE: 0 to 9999, in steps of 1.
DEFAULT VALUE: 1567.

TREF:
This parameter represents the reference temperature used in the calculation of relative saturation converted to reference temperature (RSTR).
ADJUSTMENT RANGE: -55 to 200 °C, in steps of 1 °C.
DEFAULT VALUE: 25 °C.

RSCL:
The adjusted value will be added to the relative saturation % calculated by the GMP, allowing a fine adjustment of the measurement in the form of an offset.
ADJUSTMENT RANGE: 0 to 10 %, in steps of 0.1 %
DEFAULT VALUE: 2.0 %.

RSEP:
Limit value for applying the relative saturation filter
ADJUSTMENT RANGE: 2 to 100 %, in steps of 0.1 %.
DEFAULT VALUE: 10.0 %.

RSNP:
Nominal point of relative saturation filter equal to measurement offset.
ADJUSTMENT RANGE: 0 to 8 %, in steps of 0.1 %.
DEFAULT VALUE: 0.0 %.

TTCW:
Time constant used in low-pass filters to calculate the evolution trend of H_2O.
ADJUSTMENT RANGE: 1 to 720 hours, in steps of 1.
DEFAULT VALUE: 168 hours.

FH2O:
Moving average filter intensity applied in H_2O concentration and oil temperature. VLOW = Very Low, LOW = Low, DFLT = Default, HIGH = High, VHIGH = Very High.
ADJUSTMENT RANGE: VLOW, LOW, DFLT, HIGH, VHIGH.
DEFAULT VALUE: DFLT.

In our Wiki, we have a detailed explanation of how the moving average filter works, applied in GMP. Access: treetech.atlassian.net/wiki/x/AYBqZ

5.6 Menu H2

The H2 menu contains the command for automatic learning and parameter for fine-tuning the measurement values of H_2.

H2CL:
The adjusted value will be added to the H_2 concentration calculated by the GMP, allowing a fine adjustment of the indication in the form of an offset.
ADJUSTMENT RANGE: -25 a +25, in steps of 1 ppm.
DEFAULT VALUE: 0 ppm.

TTCH:
Time constant used in low-pass filters to calculate the evolution trend of H_2.
ADJUSTMENT RANGE: 1 to 720 hours, in steps of 1 h.
VALOR PADRÃO: 168 hours.

FLH2:
Moving average filter intensity applied in measuring H_2 concentration. VLOW = Very Low, LOW = Low, DFLT = Default, HIGH = High, VHIGH = Very High.
ADJUSTMENT RANGE: VLOW, LOW, DFLT, HIGH, VHIGH.
DEFAULT VALUE: DFLT.

LERN:
The GMP must learn the measurement of H_2.
The parameter LERN allows the command to start learning, which must happen whenever a new installation or change of installation location is performed.
ADJUSTMENT RANGE: YES – NO
DEFAULT VALUE: N/A

5.7 ALARM menu

Values related to hydrogen and moisture measurements are parameterized within the ALARM menu. These values may vary depending on oil type, manufacturer and application. In the absence of data provided by manufacturers for these values, some standards provide reference values.

Indication for alarm values
treetech.atlassian.net/wiki/x/F4AeCQ

H2H:
Value for issuing the alarm for high concentration of hydrogen in oil.
ADJUSTMENT RANGE: 30 to 5000 ppm, in steps of 1 ppm.
DEFAULT VALUE: 200 ppm.

H2VH:
Value for issuing the alarm for very high concentration of hydrogen in oil.
ADJUSTMENT RANGE: 30 to 5000 ppm, in steps of 1 ppm.
DEFAULT VALUE: 300 ppm.

H2OH:
Value for issuing the alarm for high water content.
ADJUSTMENT RANGE: 0 to 500 ppm, in steps of 1 ppm.
DEFAULT VALUE: 25 ppm.

H2OV:
Value for issuing the alarm for very high water content.
ADJUSTMENT RANGE: 0 to 500 ppm, in steps of 1 ppm.
DEFAULT VALUE: 35 ppm.

W20H:
Value for issuing the alarm for high converted water content at 20 °C.
ADJUSTMENT RANGE: 0 to 500 ppm, in steps of 1 ppm.
DEFAULT VALUE: 20 ppm.

W20V:
Value for issuing the alarm for very high converted water content at 20 °C.
ADJUSTMENT RANGE: 0 to 500 ppm, in steps of 1 ppm.
DEFAULT VALUE: 25 ppm.

RSH:
Value for issuing the alarm for high water relative saturation.
ADJUSTMENT RANGE: 0 to 100 %, in steps of 1 %.
DEFAULT VALUE: 40 %.

RSVH:
Value for issuing the alarm for very high water relative saturation.
ADJUSTMENT RANGE: 0 to 100 %, in steps of 1 %.
DEFAULT VALUE: 50 %.

H2T:
Value for issuing the alarm for trend of evolution of H_2 levels.
ADJUSTMENT RANGE: 1 to 90 days in steps of 1 day.
DEFAULT VALUE: 14 days.

H20T:
Value for issuing the alarm for trend of evolution of water content.
ADJUSTMENT RANGE: 1 to 90 days in steps of 1 day.
DEFAULT VALUE: 14 days.

W20T:
Value for issuing the alarm for trend of evolution of H_2O at 20 °C.
ADJUSTMENT RANGE: 1 to 90 days in steps of 1 day.
DEFAULT VALUE: 14 days.

ALMH:
Determines a hysteresis value for the alarms, preventing their states from being affected by small fluctuations in the variables.
ADJUSTMENT RANGE: 0 to 20 % in steps of 1 %.
DEFAULT VALUE: 10 %.

5.8 ADVC menu

Relays, analog outputs, log and usability settings are available in the ADVC menu. As this is a more extensive menu, its parameters have been divided into its submenus.

5.8.1 CONF submenu

DISP:
The DISP parameter defines the display mode of measurements on the GMP front.
ADJUSTMENT RANGE: SCRL – FIX (SCRL automatically switches between measurements – FIX indicates the same measurement until it is changed by the device keyboard).
DEFAULT VALUE: SCRL.

NPWD:
Defines a new input password to the parameter menu.
ADJUSTMENT RANGE: 0 to 8191.
DEFAULT VALUE: 0.

5.8.2 LOG submenu

TIME:
Defines a time interval for recording LOG measurements in non-volatile memory. The shorter the time, the greater the amount of data and LOG resolution, however, at the end of memory, the oldest data will start to be overwritten. Pay attention to the duration of data in memory as a function of the TIME parameter, see the memory information table in topic 8.1 for more information.
ADJUSTMENT RANGE: 1 to 1440 minutes, in steps of 1 minute.
DEFAULT VALUE: 60 minutes.

VARI:
Parameter that configures the minimum measurement variation to be recorded in memory.
ADJUSTMENT RANGE: 1 to 20 %, in steps of 1 %.
DEFAULT VALUE: 10 %.

RST:
Command that resets the log, erasing all measurements saved in the LOG memory.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: N/A

5.8.3 RLAY submenu

5.8.3.1 RL1 to RL4 submenus

MODE:
The MODE parameter adjusts the relays' actuation mode at a logical level, so that they can act normally or inversely to their physical structure. It is important to point out that, in absence of power to the equipment, the modes defined by their physical structure prevail (RL1 NC and RL2 to RL4 NO).
ADJUSTMENT RANGE: NORM - INVE.
DEFAULT VALUE: NORM.

H2:
Assigns all alarms related to variable H_2 as a condition for relay actuation.
ADJUSTMENT RANGE: YES – NO – ADVC.
DEFAULT VALUE: NO

H2O:
Assigns all alarms related to variable H_2O as a condition for relay actuation.
ADJUSTMENT RANGE: YES – NO – ADVC
DEFAULT VALUE: NO

TRND:
Assigns all alarms related to the evolution trend as a condition for relay actuation.
ADJUSTMENT RANGE: YES – NO – ADVC
DEFAULT VALUE: NO

DIAG:
Defines the self-diagnosis indications as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 1, NO for other relays.

5.8.3.1.1 RDET – Detailed relays

H2H:
Defines the alarm for high H_2 concentration as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 2, NO for other relays.

H2VH:
Defines the alarm for very high H_2 concentration as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 2, NO for other relays.

H2OH:
Defines the alarm for high H_2O content as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 3, NO for other relays.

H2OV:
Defines the alarm for very high H_2O content as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 3, NO for other relays.

W20H:
Defines the alarm for high H_2O content converted at 20 °C as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 3, NO for other relays.

W20V:
Defines the alarm for very high H_2O content converted at 20 °C as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 3, NO for other relays.

RSH:
Defines the alarm for high relative saturation as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 3, NO for other relays.

RSVH:
Defines the alarm for very high relative saturation as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: YES for relay 3, NO for other relays.

H2TH:
Defines the alarm for high evolution trend of H_2 as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: NO.

H2TV:
Defines the alarm for very high evolution trend of H_2 as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: NO

WTH:
Defines the alarm for high water content trend as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: NO.

WTV:
Defines the alarm for very high water content trend as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: NO.

20TH:
Defines the alarm for high water content trend at 20 °C as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: NO.

20TV:
Defines the alarm for very high water content trend at 20 °C as one of the variables that actuate the relay.
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: NO.

5.8.3.2 RLYT submenu

ALR1 to ALR4:
The values from ALR1 to ALR4 are the commands for testing relays 1 to 4. To test the relay by changing its state, use the keys. To navigate between relays, press ⇜↵ (enter).
ADJUSTMENT RANGE: YES – NO.
DEFAULT VALUE: OFF.

5.8.4 ANOU submenu

AOR:
The AOR parameter defines the current range (mA) of current loop outputs 1 and 2.
ADJUSTMENT RANGE: 0 - 1, 0 - 5, 0 - 10, 0 - 20 or 4 - 20 mA.
DEFAULT VALUE: 4 - 20 mA.

AV1 and AV2:
Defines which monitored variable will be transmitted by analog outputs 1 (AV1) and 2 (AV2).
ADJUSTMENT RANGE: H2, H2T, TOIL, INT1, INT2, H2O, TH2O, W20, WT20 ou RS.
DEFAULT VALUE: H2.

Table 7 - List of analog output parameters

Parameter	Variable
H2	H_2 Concentration
H2T	H_2 Evolution trend
TOIL	Oil temperature
INT1	Internal temperature 1 (GMP)
INT2	Internal temperature 2 (H2Scan Sensor board)
H2O	H_2O Content
TH2O	H_2O Evolution trend
W20	H_2O Content evolution at 20 °C
WT20	H_2O Content evolution trend at 20 °C
RS	Relative saturation RS%

bOS1 e bOS2:
Corresponds to the start of scale value of the variable assigned to analog output 1 (bOS1) or analog output 2 (bOS2).
ADJUSTMENT RANGE: -55 to 5000, the unit of measurement depends on the variable VA1 or VA2. When the monitored variable is equal to H2, the minimum value will be 30.
DEFAULT VALUE: 30.

EOS1 e EOS2:
Corresponds to the full scale value of the variable assigned to analog output 1 (EOS1) or analog output 2 (EOS2)
ADJUSTMENT RANGE: -55 to 5000.
DEFAULT VALUE: 5000.

5.8.4.1 ANOT submenu

ANO1 e ANO2:
Command to perform a test on the analog outputs 1 (ANO1) and 2 (ANO2). An output percentage value is set to test its match within the parameterized range.
ADJUSTMENT RANGE: 0 to 100 %.
DEFAULT VALUE: 0 %.

6 Problems resolution

6.1 Self-diagnosis

When accessing the self-diagnosis menu, as described in topic 4.4, it is possible to check, using the indicated codes, which is the self-diagnosis description. The value shown on the digit will be the sum of the value of all active alarms for that digit. If, for example, a certain digit is showing the number 3, this means that alarms 1 and 2 are active (1 + 2 = 3). In case a digit shows the letter B, for example, alarms 1, 2 and 8 are currently active, because in hexadecimal numbers B = 1 + 2 + 8.

The tables below show all GMP self-diagnosis codes and procedural recommendations for each case.

Digit 1			
Code	**Description**	**Likely cause**	**Recommended procedure**
0000	No failure	-	-
0001	Internal failure in EEPROM memory	Data inconsistency in EEPROM memory	Contact Treetech's technical support
0002	Internal failure in RTD measurement	Failure in Pt100 measurement hardware	Contact Treetech's technical support
0004	Internal failure in moisture measurement	Failure in reading moisture in oil	Contact Treetech's technical support
0008	Failure in oil RTD measurement	Failure in oil Pt100 measurement	Contact Treetech's technical support

Digit 2			
Code	**Description**	**Likely cause**	**Recommended procedure**
0000	No failure	-	-
0010	Failure in internal temperature measurement 1	Failure in reading Pt100 internal sensor	Contact Treetech's technical support
0020	Measurement overflow	Failure in reading the Pt100 internal sensor	Contact Treetech's technical support
0040	Failure in reading flash memory	Failure in flash memory	Contact Treetech's technical support
0080	-	-	-

Digit 3			
Code	**Description**	**Likely cause**	**Recommended procedure**
0000	No failure	-	-
0100	Communication failure between boards	Failure in sensor communication	Contact Treetech's technical support
0200	Failure in measuring board parameters	Failure in sensor board	Contact Treetech's technical support
0400	Required data not available on measuring board	Failure in sensor communication	Contact Treetech's technical support
0800	Board temperature greater than 105 °C	Inappropriate installation location. Device in overheating.	Contact Treetech's technical support

Digit 4			
Code	**Description**	**Likely cause**	**Recommended procedure**
0000	No failure	-	-
1000	Failure in H_2 sensor measurement	H_2 sensor inhibit fault	Contact Treetech's technical support
2000	Not used	-	-
4000	Failure in internal temperature measurement 2	Failure in reading Pt100 internal sensor	Contact Treetech's technical support
8000	Tip heating resistance	Failure in heating resistance	Contact Treetech's technical support

6.2 Resolution of problems unrelated to GMP self-diagnosis

If you encounter difficulties or problems in the operation of the GMP that are not related to any self-diagnosis situation, we suggest consulting the possible causes and simple solutions presented below.

If this information is not enough to solve the problem, please contact Treetech's technical support or its authorized representative.

Communication failure with the data acquisition system	
Likely cause	**Recommended actions**
Incorrect programming of serial communication parameters.	Check the correct programming of the following CONF menu parameters: Baud Rate – BDR Parameter; Protocol – PRT Parameter; Address – ADR Parameter.
Bad connection, disconnection or inversion of serial communication cables.	Check for bad connections, disconnections or inversions along the entire route of the communication cable, including the connection of the GMP, the passage terminals and the data acquisition system.
External interference in the communication signal.	Use shielded twisted-pair cable, connected in accordance with the recommendations in this manual.
Signal loss over long cable lengths.	If the circuit exceeds the distance of 1200 meters, it is necessary to use repeater modules or the application of optical fiber.

Incorrect indication of current loop output (mA)	
Likely cause	**Recommended actions**
Exceeded maximum load allowed for current output.	Check the maximum load allowed for each output pattern selected (*Table 3 - Maximum load of analog output options*)
Incorrect programming of mA output parameters.	Check the programming of the following parameters: Output scale - AOR Analog variable - AV1/AV2 Start of scale - bOS1/bOS2 End of scale - EOS1/EOS2
Incorrect mA output cable connection	Check the correct connection of the cables and terminals (polarity, any short circuits, open links) between the GMP and the mA output measuring system.
External interference on mA output signal	Check the use of shielded cable and grounding at a single point of the cable mesh. Incorrect grounding can allow noise and induced transients to make it impossible to measure the current loop. Check the intermediate connections, such as passage terminals, the mesh must have continuity throughout the circuit.

7 Commissioning

Once the GMP has been installed in accordance with this manual, putting it into service must follow the basic steps below.

1. Check the mechanical and electrical installations in accordance with the Project and Installation recommendations in this manual. Check correctness of electrical connections (for example, through continuity tests).
2. Energize the GMP with voltage in the range of 38 to 265 Vdc or 85 to 265 Vac, 50 or 60 Hz.
3. Carry out all the parameterization of the GMP, according to the instructions of item 5 - Parameterization contained in this manual. The parameterization performed can be noted down in the form provided on our wiki - treetech.atlassian.net/wiki/x/AYAfPg
4. Adjust the clock (Menu → CLCK)
5. Clear self-diagnosis memory (4.5 - Self-diagnosis)
6. Clear alarm memory (Topic 4.3 - Alarm LEDs)
7. Reset the equipment LOG (ADVC Menu → LOG → RST)
8. Restart H_2 learning (H2 Menu → LERN).
9. Wait for about 10 minutes and check the self-diagnosis memory one more time. If there is any self-diagnosis, check the cause and clear the memory again.

8 Technical data and type tests

8.1 Technical data

Hardware	Interval/Description
Power Supply	38...265 Vdc or 85...265 Vac, 50/60 Hz
Maximum consumption	≤ 8 W
Degree of Protection	IP66, NEMA 4
Electrical Connections - Crimp Outlet	From 0.5 to 1.5 mm². The maximum nominal section of the connections also depends on the use of cable glands or sealtube, so that, when using the cable gland, it defines the maximum thickness of the cables within the specified working range. Connections example: -Powering cables: 0.5 mm²; -Communication cables: 2x18 AWG; -Relays cables; 0.5 mm²; -Analog output cables: 3x18 AWG.
Connection to the insulating oil	½" BSP or ½" NPT (it is recommended that ball or gate valves are used)
Working temperature - environment	-40...+85 °C
Working temperature - insulating oil	-20...+85 °C
Admissible oil pressure	0.1 Mpa, full vacuum

Relay outputs	Interval/Description
Relays outputs	3 NA + 1 NF
Maximum switching power	70 W(dc)/250 VA(ac)
Maximum switching voltage	250 Vac/Vdc
Maximum conduction current	1 A, as long as the sum of the currents of the 4 relays does not exceed 2 A at the common point (terminal 5)

Analog outputs	Interval/Description
Analog outputs in current loop	2 outputs
Maximum error of analog outputs	0.5 % of the end of scale
Options (selectable) and maximum load	0...1 mA, 10 kΩ; 0...5 mA, 2 kΩ; 0...10 mA, 1 kΩ; 0...20 mA, 500 Ω; 4...20 mA, 500 Ω.

Hydrogen measurement	Interval/Description
Measurement range	30...5000 ppm
Maximum error	±20 % of measurement or ±25 ppm, whichever is greater

Water saturation percentage measurement	Interval/Description
Measurement range	0...100 % of water saturation
Maximum error	±2 % of water saturation

Temperature measurement	Interval/Description
Temperature measurement	One (Oil in the position where the GMP was installed)
Measurement range	-55...+200 °C
Maximum error at 20 °C	0.5 % of the end of the scale

Memory information	Interval/Description
Mass memory	Non-volatile FIFO (*First In First Out*)
Recording interval	1...1,440 minutes
Capacity	55,000 records – 6.2 years with a 60-minute interval; 55,000 records – 37.6 years with a 6-hour interval; 55,000 records – 50.2 years with an 8-hour interval;

Communication interface	Description
Serial communication port	1x TIA-485-A (RS-485)
Communication protocols	Modbus® RTU, DNP3 RTU

8.2 Type tests

The GMP is a device built on the Gas Monitor platform, on which the type tests presented were carried out:

Type tests (Gas platform)
Immunity to surges (IEC 60255-22-5 and IEC 61000-4-5)
Immunity to RF field induced disturbances (IEC 60255-22-6 and IEC 61000-4-6)
IP66, NEMA 4
Immunity to electrical transients (IEC 60255-22-1, IEC 61000-4-12 e IEEE C37-90-1)
Voltage pulse (IEC 60255-5)
Immunity to irradiated electro-magnetic fields (IEC 60255-22-3 e IEC 61000-4-3)
Electrostatic discharges (IEC 60255-22-2, IEC 61000-4-2 e IEEE C37-90-3)
Immunity to fast electric transients (IEC 60255-2-4, IEC 61000-4-4 e IEEE C37-90-1)
Cold weather supportability (IEC 60068-2-1)
Dry hot weather supportability (IEC 60068-2-2)
Wet hot weather supportability (IEC 60068-2-78)
Thermal cycle climatic test (IEC 60068-2-14)
Vibration response (IEC 60255-21-1)
Vibration durability (IEC 60255-21-1)

9 Purchase order specification

In the GMP purchase order, the following items must be specified:

1. **Product name**

   Gas and Moisture Specialist Sensor - GMP.

2. **Quantity**

   The number of units.

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