



Online – Oil analysis
MSENSE® DGA 5

Installation and Operating Instructions

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












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



The greatest care has
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1 Introduction

This technical file contains detailed descriptions to safely and properly install, connect, commission, and monitor the product.

The target group of this technical document is exclusively specially trained and authorized specialist personnel.

1.1 Contact

Your contact for all inquiries about the MSENSE® DGA 5:

MR Service & Complaint

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Vor dem Hassel 2
D-21438 Brackel
Germany

MTE Meter Test Equipment AG
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Switzerland

1.2 Revision Rights

The information contained in this technical document is the technical specifications released at the time of printing. Significant changes will be reflected in a new edition of the technical file.

Document name and version number of this technical document can be found in the footer.

1.3 Completeness

This technical document is only complete together with the other applicable documents.

The following documents apply to this product:

- Installation and Operating Instructions MSENSE® DGA 5 (this document)
- Operating Instructions MSET DGA Software
- Test report

1.4 Legal provisions

Trademark

Microsoft, Microsoft Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and / or other countries.

All other trademarks, registered trademarks, service marks and trade names are the property of their respective owners.

Disclaimer

After the editorial deadline of this documentation, the product may have changed. The information in this document is subject to change without notice and does not constitute an obligation of Maschinenfabrik Reinhausen GmbH.

Changes to the technical data or design changes and changes to the scope of delivery are expressly reserved. The data and illustrations contained in this document, which expressly refer to third-party devices and equipment, are not binding. In principle, the information and agreements reached when processing the respective offers and orders are binding. The original operating instructions were created in German.

Maschinenfabrik Reinhausen GmbH assumes no responsibility for any errors that may occur in this operating manual prepared by the manufacturer. If you have suggestions for improvement or changes or have found errors in this manual, please inform us. No part of this document may be reproduced in any form or by any means, electronic or mechanical, including photocopying, without the express written permission of Maschinenfabrik Reinhausen GmbH and the manufacturer. All rights reserved.

1.5 Safety Guidelines

This manual contains notices that you must observe in the interests of your own personal safety and to avoid damage to property. The instructions for your personal safety are marked by a warning triangle. Those who only refer to the prevention of property damage have no warning triangle. The warnings are displayed in decreasing order of severity according to the respective hazard level.



Death or serious injury will result if proper precautions are not taken. Property damage can occur if the appropriate precautionary measure is not taken. An undesirable result or condition may occur if the corresponding note is ignored.

In cases where two or more levels of danger apply, only the most severe level warning is used on its own. A warning with a warning triangle refers primarily to possible personal injury. But it can also mean property damage at the same time.

For the personal safety of the installation and operating personnel, please observe and follow the safety instructions in the chapter of this manual!

2 Safety

This technical file contains detailed descriptions to safely and properly install, connect, commission, and monitor the product.

- Read this technical document carefully to familiarize yourself with the product.
- This technical document is part of the product.
- Read and pay special attention to the safety instructions in this chapter.
- Observe the warnings in this technical file in order to avoid dangers arising from the operation.
- The product is manufactured according to the state of the art. Nonetheless, dangers to the life and limb of the user or impairments of the product and other material assets may occur due to functional use.

2.1 Intended Use

The MSENSE® DGA is intended exclusively for use in systems and facilities of electrical power engineering. It is used for the early detection and reporting of evolving, potentially harmful trends in the monitored equipment (e.g., transformer) by measuring the concentration of gases and moisture in the equipment's insulating oil.

The device is not designed and is not capable of detecting very fast developing faults and thus not intended to protect the device from such faults (e.g., by shutting down). For this purpose, please use safety devices designed for this purpose.

Proper use and compliance with the conditions and conditions specified in this technical file as well as the warnings contained in this technical documentation and on the product do not pose a risk to persons, property and equipment

Environment. This applies over the entire service life, from delivery to assembly and operation to disassembly and disposal.

The intended use is as follows:

- Operate the product according to this technical document, the agreed terms of delivery and the technical data.
- Make sure that all necessary work is done by qualified personnel only.
- Use the devices supplied only for the intended purpose and in accordance with the specifications of this technical document.
- Observe the notes in this technical document for electromagnetic compatibility and the technical data. Safety

2.2 Basic safety instructions

In order to prevent accidents, breakdowns, accidents and environmental damage, the person responsible for the transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure that:

Personal protective equipment

Loosely worn or unsuitable clothing increases the risk of being caught or wound on rotating parts and the danger of getting caught on protruding parts. This poses a danger to life and limb.

- All necessary equipment as well as the personal protective equipment required for the respective activity such. As a helmet, protective work shoes, etc. wear. Observe the section "Personal protective equipment".
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces and other jewellery.
- For long hair wear hairnet.

Workspace

Disarray and unlit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure the work area is well lit.
- Comply with applicable accident prevention legislation in the country.

Explosion protection

Highly flammable or explosive gases, vapours and dusts can lead to severe explosions and fire.

- Do not mount and operate the product in potentially explosive atmospheres.

safety information

Warning labels and safety labels are safety labels on the product. They are an important part of the security concept. Safety markings are shown and described in the chapter "Product description".

- Observe all safety labels on the product.
- Keep all safety labels on the product complete and legible.
- Replace damaged or obsolete safety markings.

Environmental conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe specified operating conditions and site installation requirements.

Changes and conversions

Unauthorized or improper modifications of the product may result in personal injury, property damage or malfunction.

- Change product only after consultation with Maschinenfabrik Reinhausen.

Spare Parts

Spare parts not approved by Maschinenfabrik Reinhausen can lead to personal injury and property damage to the product.

- Use only replacement parts approved by the manufacturer.
- Contact Maschinenfabrik Reinhausen.

Working in the company

The product may only be operated in perfect working order. Otherwise there is danger to life and limb.

- Check safety devices regularly for their functionality.
- The inspection work described in this technical file
- perform regularly.

2.3 Qualification of the staff

The person responsible for installation, commissioning, operation, maintenance and inspection must ensure adequate qualification of the personnel.

Electrician

The qualified electrician has knowledge and experience as well as knowledge of the relevant standards and regulations due to their professional training. In addition, the electrician has the following skills:

- The electrician independently identifies possible dangers and is able to avoid them.
- The electrician is able to carry out work on electrical installations.
- The electrician is specially trained for the working environment in which she works.
- The electrician must comply with the provisions of the applicable accident prevention legislation.

Electrically trained persons

A person trained in electrical engineering is instructed and instructed by a qualified electrician about the tasks assigned to him and possible dangers of improper behaviour, as well as protective devices and protective measures. The person trained in electrical engineering works exclusively under the direction and supervision of a qualified electrician.

Operator

The operator uses and operates the product within the scope of this technical document. He is informed and trained by the operator about the special tasks and the possible dangers of improper behaviour.

Technical service

It is strongly recommended that installations, maintenance, repairs and retrofits be carried out by our technical service. This ensures the professional execution of all work. If work is not carried out by the Maschinenfabrik Reinhausen technical service, it must be ensured that the personnel are trained and authorized by Maschinenfabrik Reinhausen.

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2.4 Personal protective equipment






At work, personal protective equipment is required to minimize health hazards.

- Always wear the necessary protective equipment during work.
- Never wear damaged protective equipment.
- Follow instructions in the work area for personal protective equipment.

Basically to be worn protective equipment

	Protective clothing Close-fitting work wear with low tear resistance, with tight sleeves and no protruding parts. It is mainly used to protect against being caught by moving machine parts.
	Safety shoes To protect against heavy falling parts and slipping on slippery surfaces.

Special protective equipment in special ambient conditions

	Safety goggles To protect the eyes from flying parts and liquid splashes.
	Face Shield To protect the face from flying parts and liquid splashes or other dangerous substances.
	Helmet To protect against falling and flying parts and materials.
	Ear protection To protect against hearing damage.
	Protective gloves For protection against mechanical, thermal and electrical hazards.

2.5 IT security

Observe the following recommendations for the safe operation of the product.

- Make sure that only authorized persons have access to the device.
- Use the device only within an electronic security perimeter (ESP).
- Make sure that the device is operated only by trained personnel who are sensitized to IT security.
- All protocol interfaces (Modbus, DNP3 and IEC 61850) have read-only access to the MSENSE® DGA 5. A change of parameters or data is not possible.
- Access to the parameterisation via the MSET parameterisation software can be protected by passwords. Change the passwords on a regular basis.

Observe the notes on access authorisations, user levels and password settings in the operating instructions for the MSET parameterisation software.

3 General information

The MSENSE® DGA 5 is a permanently installed, multi-gas online DGA analysis system. It enables the individual measurement of moisture-in-oil (H₂O) as well as the four key gases dissolved in oil: **hydrogen** (H₂), **carbon monoxide** (CO), **acetylene** (C₂H₂) and **ethylene** (C₂H₄).

While hydrogen (H₂) occurs in almost every fault in the insulation system of power transformers and carbon monoxide (CO) is a sign of problems with cellulose / paper insulation, the awareness of a presence of (or increase in) acetylene (C₂H₂) and ethylene (C₂H₄) serves to classify faults such as overheating, partial discharge or high energy arcing.

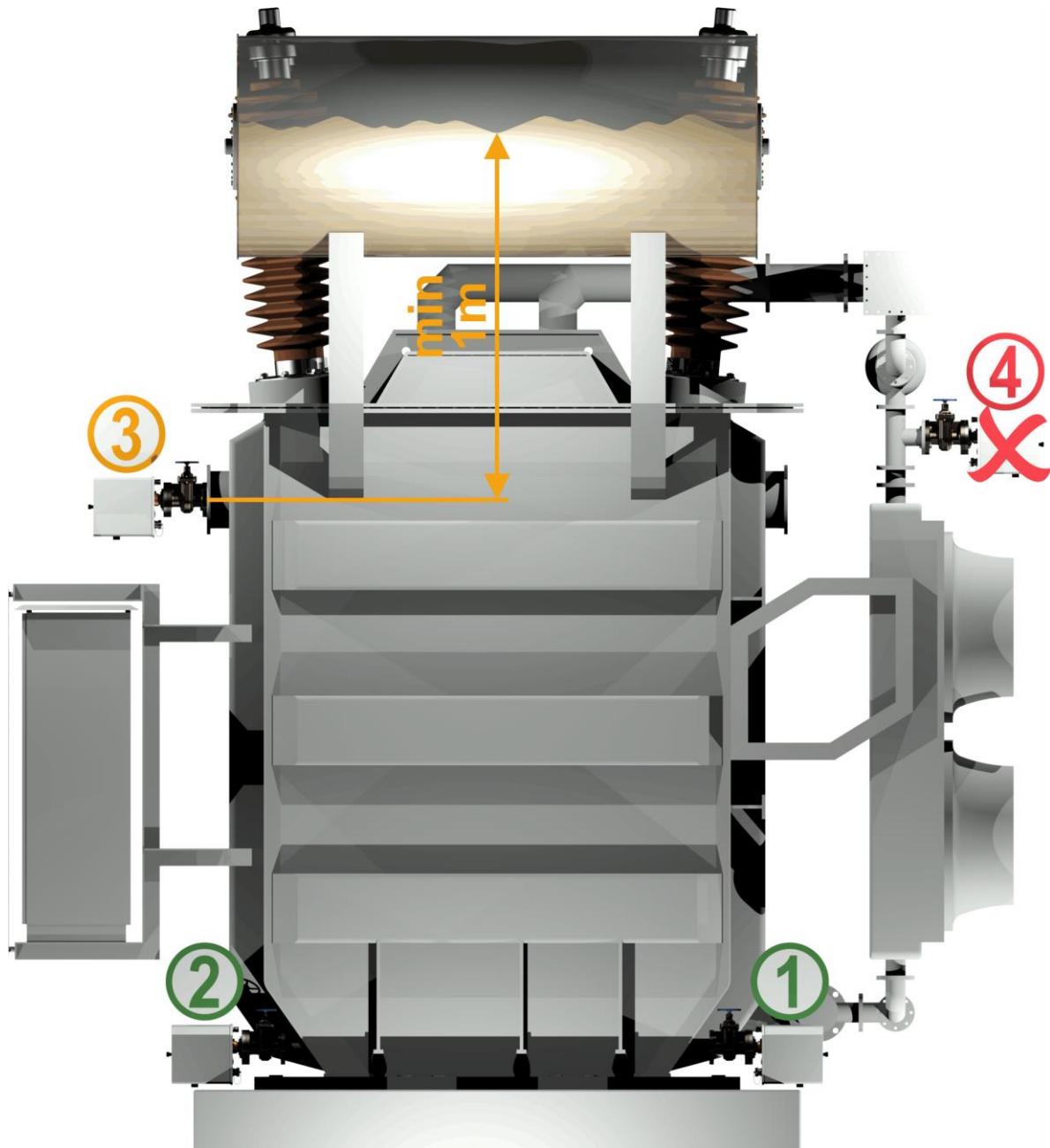
The key advantages

- The individual measurement of gas concentrations: hydrogen (H₂), carbon monoxide (CO), acetylene (C₂H₂) and ethylene (C₂H₄)
- Measurement of moisture-in-oil (H₂O)
- Output of the current gas concentration per type of gas, as well as the moisture in the oil via one analogue output for each type
- Automatic warning and alarm triggered when individually definable absolute values and / or rates of increase are exceeded – via configurable relay outputs and / or protocol communication
- Communication interfaces ETHERNET 10/100 Mbit / s (copper / RJ45 or fibre optic / SC duplex) and RS485 to support the transmission protocols MODBUS® RTU / ASCII, MODBUS® TCP as well as the proprietary protocol.
- Optional on-board DNP3 serial modem for connection to a process control system (SCADA) using communication protocol DNP3.
- Optional on-board IEC 61850 modem for communication with substations by means of communication protocol IEC 61850.

4 Mounting instructions

4.1 Installation position

The installation location is very important for the correct function of the MSENSE® DGA 5. There are three possible installation locations in the case of a typical transformer:



Pos. 1 Cooler return line:

Install the MSENSE® DGA 5 on a straight pipe section at the connection between the underside of the cooler and the transformer tank. To avoid **vacuum** the device must **always be mounted on the discharge side** (beyond the elbow) of the circulation pump.

Remark: Only choose this location if constant oil flow through the cooling system is guaranteed.

Pos. 2 Drain valve transformer tank:

The flange of the drain valve must be fitted at a minimum height of 40 cm for the MSENSE® DGA 5 to be installed.

Pos. 3 Upper filling valve:

This position may only be used if the oil level is at least 100 cm higher than the centre of the device flange. However, it is not recommended since it is difficult to operate or read the MSENSE® DGA 5 in this position.

Pos. 4 Never install the MSENSE® DGA 5 above the cooler or on the intake side of the pump!

Remark: There must be good and constant oil circulation available at the installation location.

4.2 Safety notes on installation

The following safety notes must be strictly followed during installation. Otherwise no warranty claims can be made.

Never remove the protective cap of the connecting thread before you are ready to install the device at the transformer valve.



This cap protects the connection unit from damage by dust and other foreign matter. In addition, it protects the connecting thread and/or the adapter.



Remark: Use the protective cap provided after you have dismantled the device as well.



Never close the ventilation openings for the oxygen supply because oxygen must be supplied through it. These are located on the underside of the device's protective hood and on the device's back plate.



Never use and / or store hydro-carbonaceous compounds in the vicinity of the measurement cell.



Never clean the MSENSE® DGA 5 with solvent, as the gases severely affect the measurement accuracy and sensitivity of the sensors.



Never expose the connecting unit to vacuum.
A vacuum can cause problems during the filling process.





Before every gas release or filling of the transformer, remove the MSENSE® DGA 5 from the transformer valve. Alternatively, you can close the transformer valve.



Never operate the MSENSE® DGA 5 on a close transformer valve for longer periods. Please remove the device if this can not be prevented. Always heed the removal instructions.



Never install the MSENSE® DGA 5 on the intake side of the cooling system pump!!



The MSENSE® DGA 5 may only be installed at a position that is at least 100 cm below the oil filling level.



Never install the MSENSE® DGA 5 on a knee pipe or pipe bend.



Turbulence in pipe bends can result in a vacuum that can cause problems on the device.



Never mount the MSENSE® DGA 5 on galvanised connections or valves.



Never use a high-pressure cleaner to clean the MSENSE® DGA 5.



Galvanised connections or valves can react with the oil, which can lead to erroneous readings.



High-pressure cleaners that are used to clean the transformer can cause serious damage to the MSENSE® DGA 5.



High pressure cleaners used to clean the transformer could cause serious damage to the MSENSE® DGA 5.



Never use multiple slip-joint pliers.



The use of such tools can damage the surfaces of the connection unit and those of the connecting thread. Use an M55 open-ended spanner or a 1½" adjustable spanner.





Note!!!

Incorrect or improper handling of the connection unit, such as vacuum, paint or solvent, will lead to expiry of the warranty claim.



4.3 Preparing installation

A visual inspection must be carried out on the device before installation. For this purpose, unscrew the two knurled screws and then remove the device protective cover. All the connector plugs, cables and hoses must be connected.

4.3.1 Mechanical connection

The connection device of the MSENSE[®] DGA 5 has an external thread of the type G 1½" ISO DIN 228-1 or 1½" NPT ANSI B 1.20.1 (must be specified on the order).

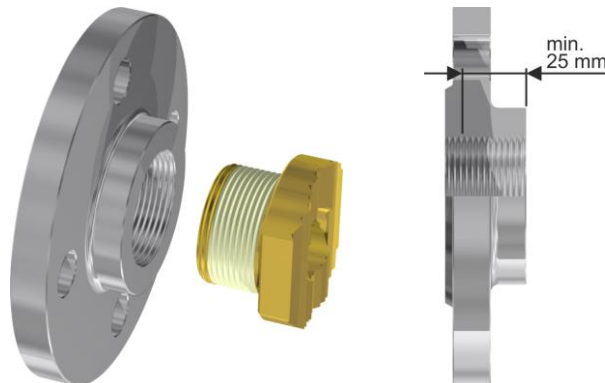
The MSENSE[®] DGA 5 should be installed on a gate valve with full passage or on a ball valve on the transformer.

These stop valves usually have a blind flange fitted. For this reason, they must be retrofitted before installation with a suitable threaded flange, connecting adapter or threaded joint.

This results in 2 different types of installation.

4.3.1.1 Flange connection

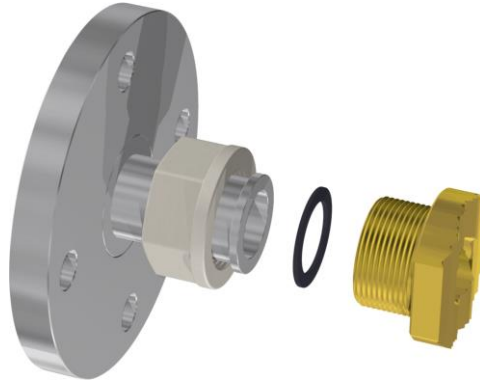
The MSENSE[®] DGA 5 is screwed directly to the threaded flange, i.e. the device is turned around its own axis in order to be fixed in place. This type of installation requires free space measuring 430 mm in diameter around the centre of the connecting flange.



Remark: The thread depth of the threaded flange or the connecting adapter should be at least 25 mm.

4.3.1.2 Threaded joint

We recommend connecting the MSENSE® DGA 5 by a threaded joint (flat sealing) on the gate valve/ball valve. This threaded joint, also known as a fitting, is made up of a threaded flange, a flat-sealing insert and a union nut. In this case, the device is not turned during installation, rather the union nut is turned to fix the device in place. A flat gasket is used for this. Additional sealing of the thread using thread sealing tape or thread adhesive is not necessary in this case, or only rarely.



Remark: Some ball valves also have union nuts (pump ball valve).

4.3.2 Supply voltage connection

The MSENSE® DGA 5 is available in 4 different voltage versions (please ensure to specify when ordering). Depending on which version is being used, the following alternating or direct current connection in the form of a 3-pin mains connection cable (4.4.2) must be present near to the device:

Nominal voltage version	Supply voltage
120 V -20% +15% AC 50...60 Hz	96 V _{min} ... 138 V _{max} AC 50...60 Hz
230 V -20% +15% AC 50...60 Hz	184 V _{min} ... 264 V _{max} AC 50...60 Hz
120 V -20% +15% DC	96 V _{min} ... 138 V _{max} DC
230 V -20% +15% DC	184 V _{min} ... 264 V _{max} DC

The power consumption of MSENSE® DGA 5 is max. 400 VA.

Fuse: 120 V: T4A 230 V: T2A

4.3.3 Required tools and aids

The mechanical and electrical installation of the MSENSE® DGA 5 can be carried out using the following tools/aids:

Tool / aids

Long hexagon key size 4
Digital multimeter
Screwdriver no. 2
Brass brush

Use

Bleed screw
Control supply voltage
Supply voltage
Connection unit

M55 open-ended spanner and / or 1½" adjustable spanner

Bucket, oil absorber, rags, paper towels

Plastic sheet / tarpaulin

Connection unit

Collection tray for leaking oil

Collection tray for falling parts

4.3.4 Sealing of the connecting thread

The connecting thread can be secured and sealed in different ways.

Either a thread sealing tape or a thread adhesive should be used:

4.3.4.1 Thread sealing tape

The thread sealing tape, also known as Teflon tape or PTFE tape (polytetrafluoroethylene) is wound tightly around the external thread of the MSENSE® DGA 5 connecting unit. We recommend the use of a Teflon tape for coarse threads (100 g/m²).



Note!!!



If you use Teflon for sealing the connecting thread, no connections are possible later.

!!!! Leak hazard !!!!



4.3.4.2 Thread adhesive

We recommend the two Henkel products LOCTITE® 7471 (activator) and LOCTITE® 577 (seal and securing) in combination. The activator LOCTITE® 7471 increases curing speed and is used before the actual thread adhesive LOCTITE® 577 is applied to 3 or 4 turns of the external thread on the MSENSE® DGA 5 connecting unit.



Note!!!

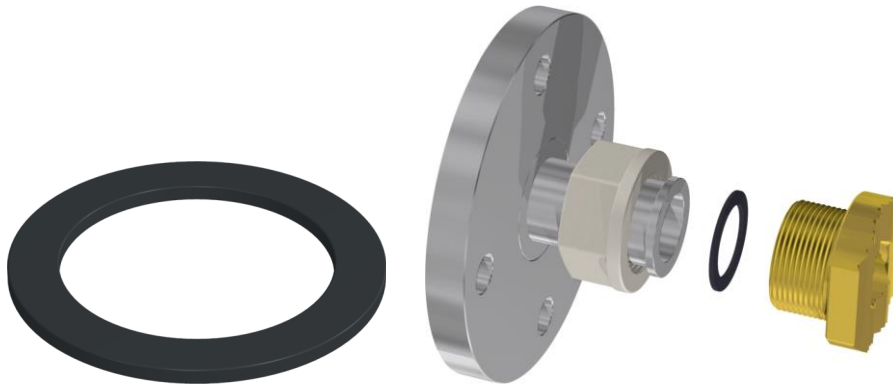


Please note the specifications provided by the manufacturer!!!



4.3.4.3 Flat gasket

When a threaded joint is used, there is no need to seal and secure the connection using thread sealing tape or thread adhesive. In this case, the flat gasket seals and the union nut secures the connection.



4.4 Installation

Once installation preparations have been completed, the MSENSE® DGA 5 can be installed.

Installation is carried out in 3 steps:

- Mechanical installation [4.4.1]
- Electrical connection [4.4.2]
- Completion of the installation [4.4.3]

4.4.1 Mechanical installation

The sequence for mechanical installation depends on the connection on the transformer side. There are 2 basic types of mechanical installation:

- Direct mounting [4.4.1.1]
- Indirect mounting [4.4.1.2]

Remark: In the event of heavy vibrations at the installation valve/gate valve, the strain should be relieved by way of an additional support.

4.4.1.1 Direct mounting

In the case of direct mounting, the MSENSE® DGA 5 is screwed directly to the threaded flange, i.e. the device is turned around its own axis in order to be fixed in place. This type of installation requires free space measuring 430 mm in diameter around the centre of the connecting flange.



The threaded joint can be sealed and fixed in place using thread sealing tape or thread adhesive.

- Direct mounting with thread sealing tape [4.4.1.1.1]
- Direct mounting with thread adhesive [4.4.1.1.2]

Note!!!

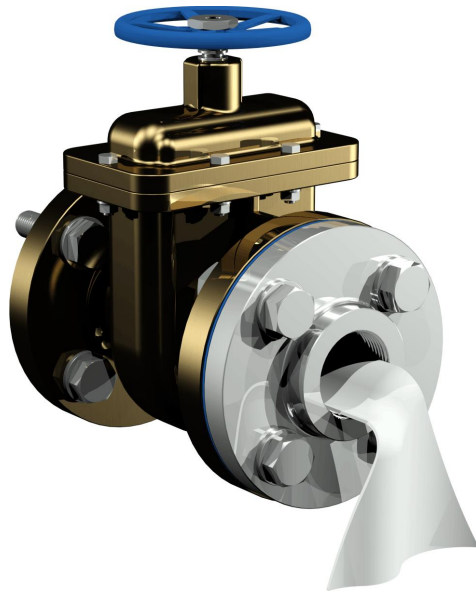


Only remove the protective cap (by turning it slowly) when you are ready to use the MSENSE® DGA 5 to be installed on the connecting valve / gate valve!



4.4.1.1.1 Direct mounting with thread sealing tape

- Use a dry cloth / paper towel to clean the inside of the threaded flange.



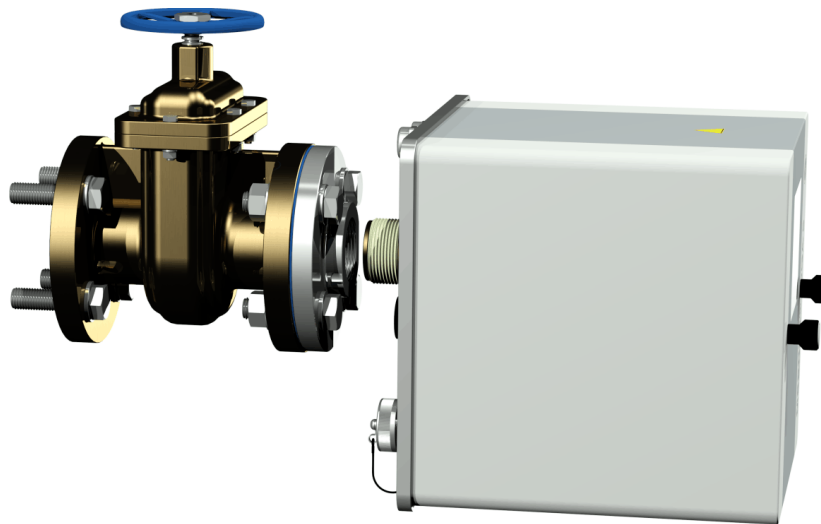
- Use a dry cloth / paper towel to clean the external thread of the connecting unit. Remove any residual thread sealing tape completely from the external thread.



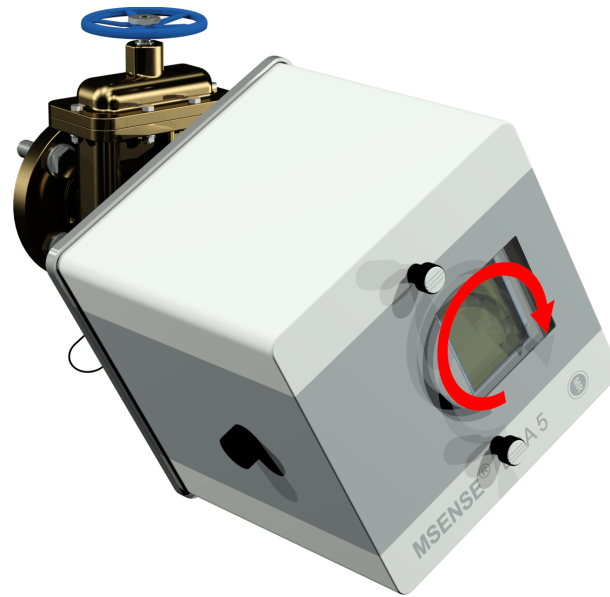
- Wind 3 to 15 layers of thread sealing tape (depending on the thread's characteristics) tightly in the clockwise direction (seen from the back) around the connecting thread of the MSENSE® DGA 5. The first thread groove should remain free.



- Place the MSENSE® DGA 5 horizontally onto the threaded flange. Make sure the device does not twist.



- Screw the MSENSE® DGA 5 2 or 3 times clockwise by hand into the threaded flange.

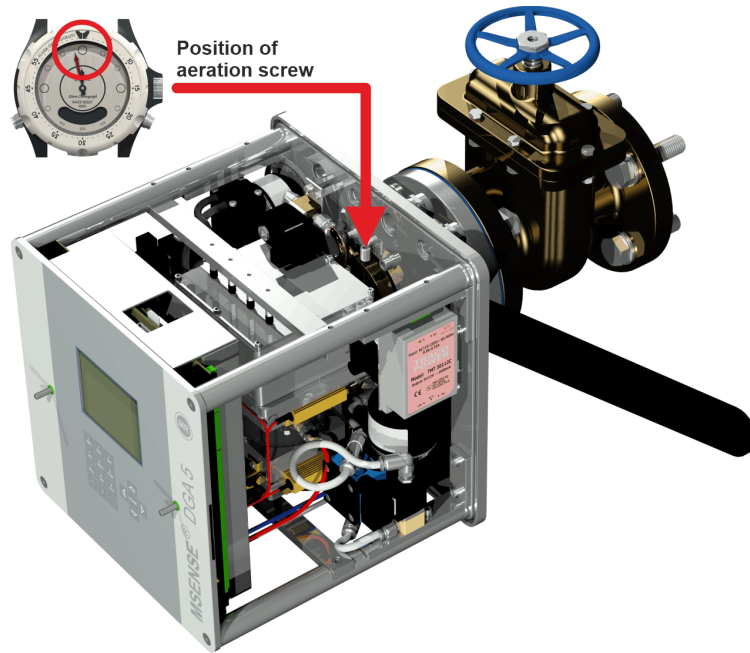


- Now use an M55 open-ended spanner or a 1½" adjustable spanner to screw the MSENSE® DGA 5 by a further 5 or 6 turns clockwise into the threaded flange and stop when the vent screw is in the 9 o'clock position.



Remark: If the unit can be screwed in without a great deal of effort being necessary, too little thread sealing tape has been used. The device has to be screwed off again, the thread sealing tape removed completely and the mounting procedure then repeated.

- Remove the two knurled screws and the device protective cover.
- Now align the device by turning it clockwise until the vent screw is at the 12 o'clock position at the top. Make sure the device is fitted firmly in this final position.



Remark: The MSENSE® DGA 5 may only be aligned by turning clockwise. As soon as the device is turned anti-clockwise for alignment, mounting must be carried out again!

Note!!!



When thread sealing tape is used, screwing the device beyond the 12 o'clock position results in the device having to be screwed back off again, the thread sealing tape being removed completely and mounting being carried out again



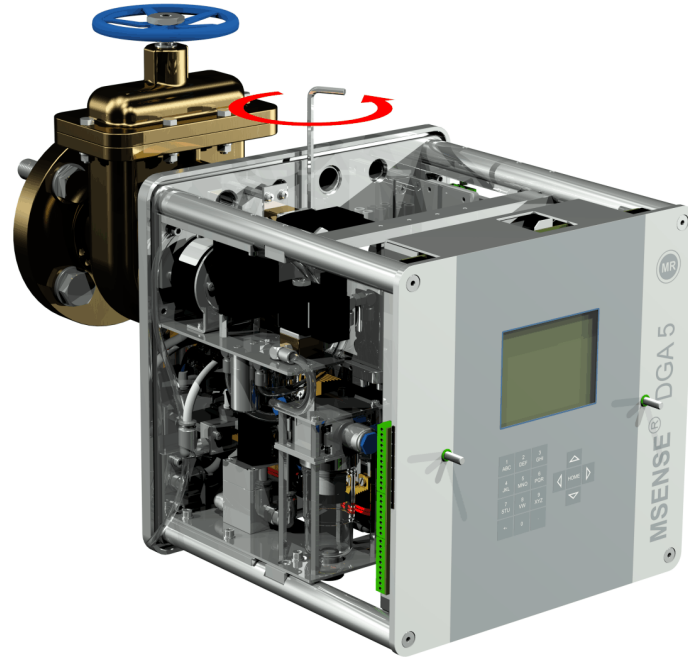
Note!!!



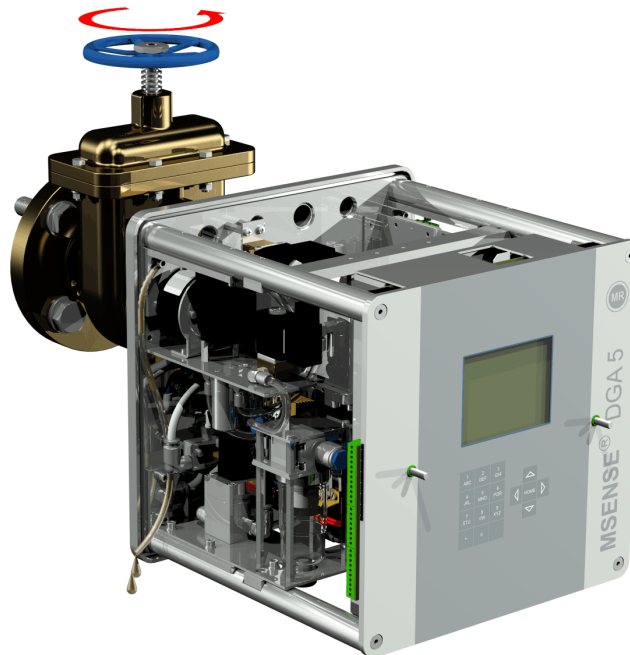
The following steps must be carried out in accordance with company procedures. Work carefully and prevent air getting into the transformer. Use a bucket to collect any leaking oil.



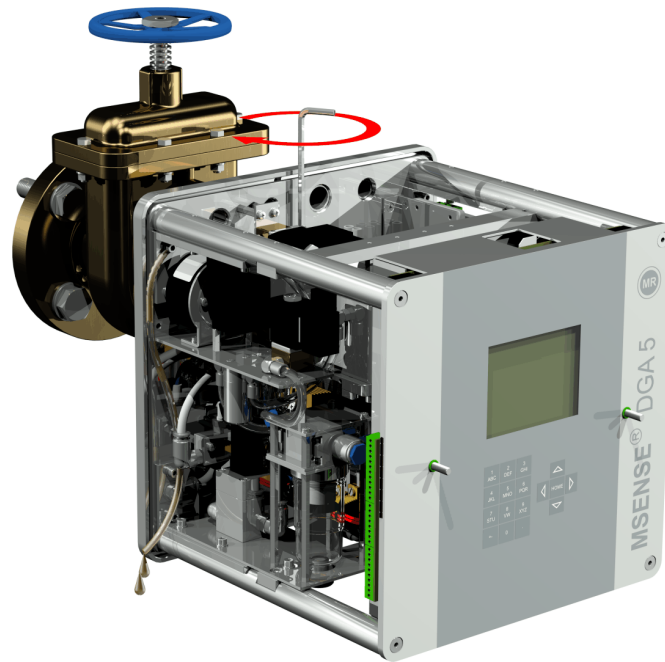
- Unscrew the vent screw by 3 or 4 turns anti-clockwise using the long size 4 hexagon key (venting is active).



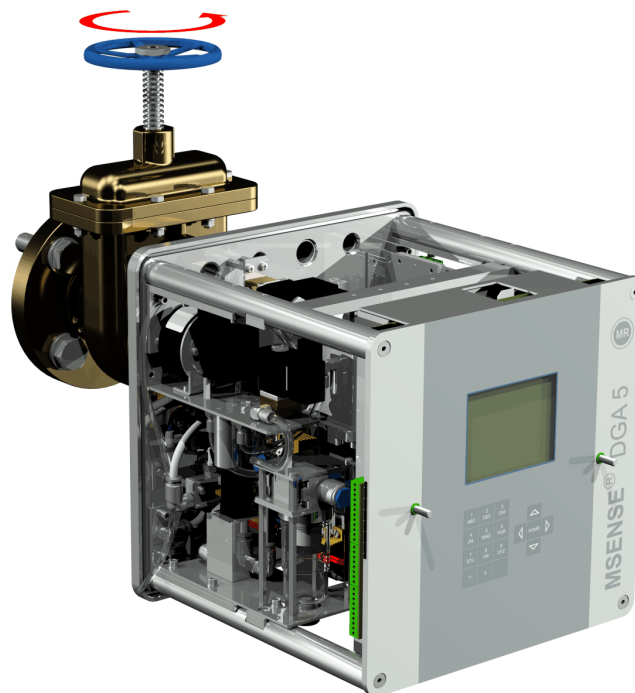
- Open the transformer gate valve very carefully until oil runs out of the sample hose. Allow the escaping oil to run into a container.



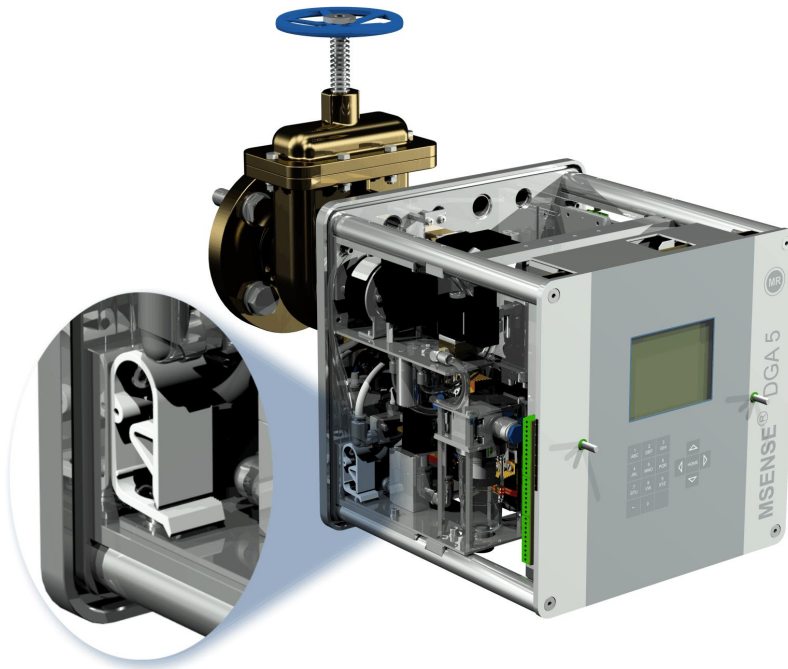
- Close the vent screw as soon as there are no more air bubbles escaping from the sample hose.



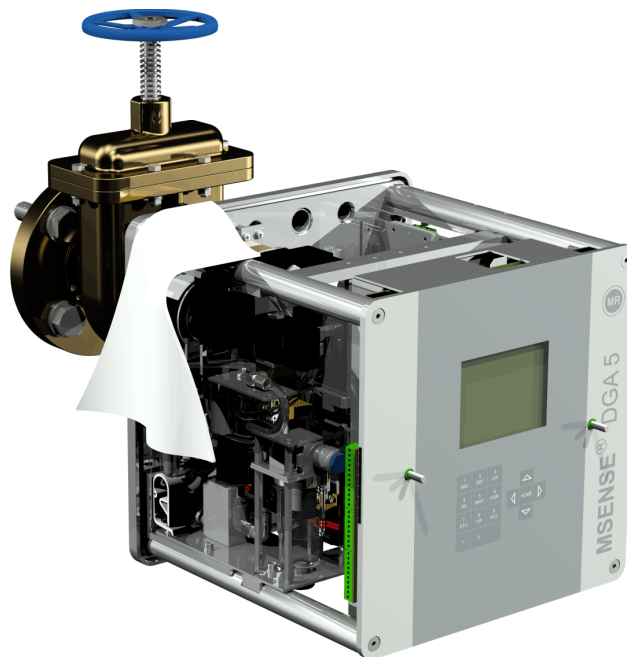
- Now open the gate valve/ball valve completely.



- Secure the end of the sample hose using a hose clip



- Use a dry cloth / paper towel to remove oil residues thoroughly from the device.

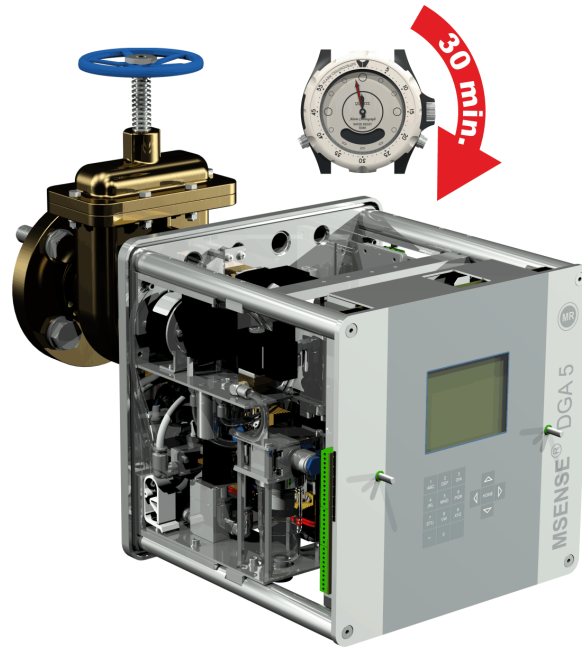


Note!!!

Do not use solvents for cleaning!

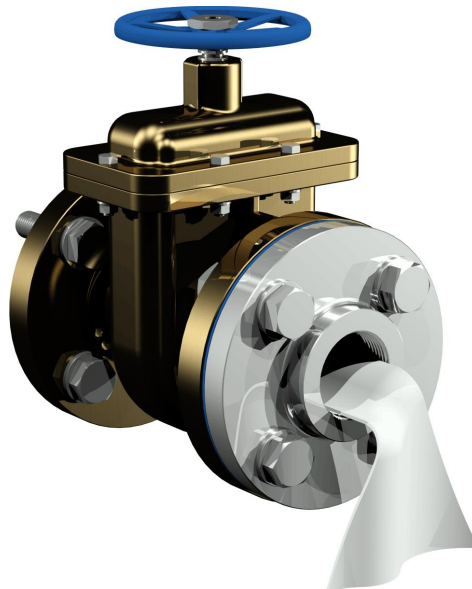


- Check every 30 minutes whether the thread connection is leak-proof.



4.4.1.1.2 Direct mounting with thread adhesive

- Use a dry cloth / paper towel to clean the inside of the threaded flange.



- Use a dry cloth / paper towel to clean the external thread of the connecting unit.



- Apply LOCTITE® 7471 (activator) by spraying or brushing it onto both sealing faces. During spraying, the openings (transformer gate valve and MSENSE® DGA 5) must be covered/sealed by a clean cloth / paper towel.



- Allow the activator to flash off completely in a well ventilated room until the surface is completely dry.

Remark: After activation, the thread connection should be glued within 7 days at the latest. Soiling should be avoided before gluing.

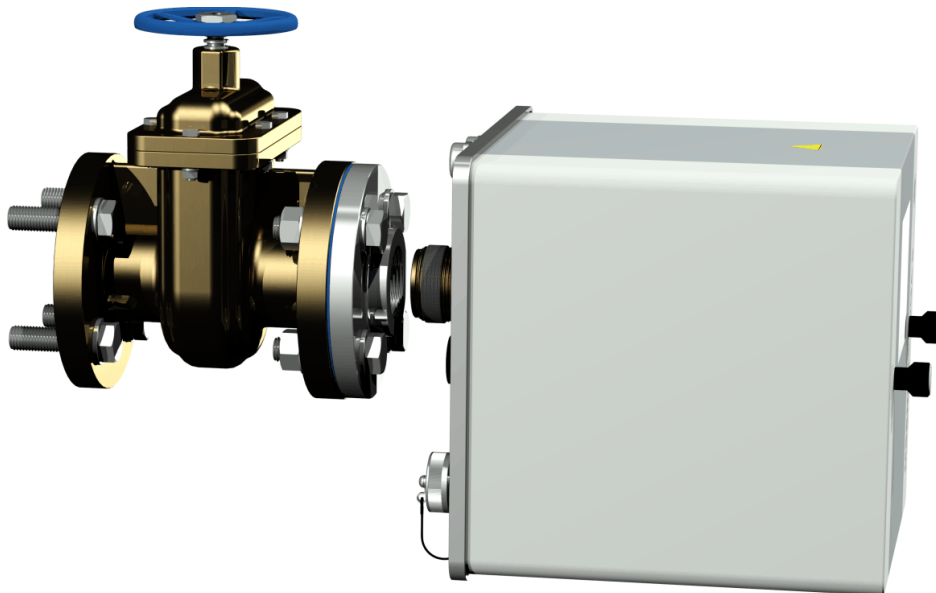
- Apply LOCTITE® 577 (adhesive) 360° in a ring shape on 3 to 4 thread grooves of the external thread, leaving the first thread groove clear.



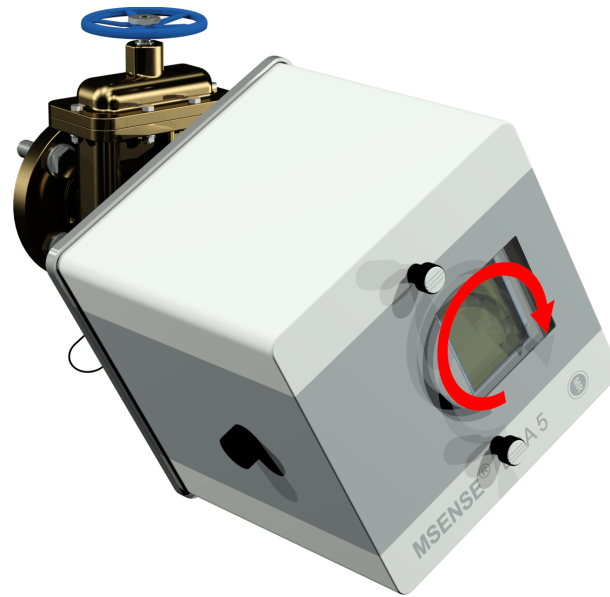
- Apply adhesive to the bottom of the thread by using suitable gloves, in order to fill in the gaps.

Remark: Adapt the adhesive quantity accordingly in the case of larger intermediate spaces.

- Place the MSENSE® DGA 5 horizontally onto the threaded flange. Make sure the device does not twist.



- Screw the MSENSE® DGA 5 2 or 3 times clockwise by hand into the threaded flange.



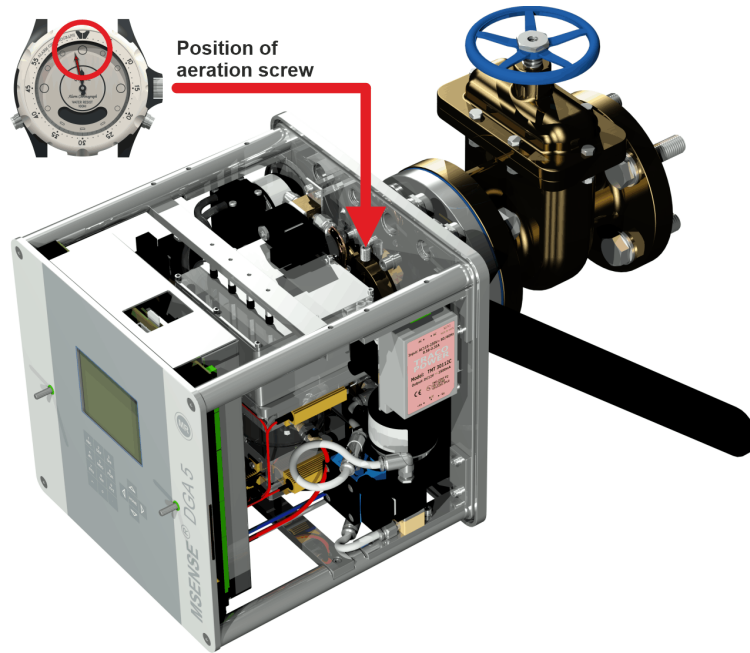
- Now use an M55 open-ended spanner or a 1½" adjustable spanner to screw the MSENSE® DGA 5 by a further 5 or 6 turns clockwise into the threaded flange and stop when the vent screw is in the 9 o'clock position.

Remark: If the unit can be screwed in without a great deal of effort being necessary, too little thread sealing adhesive has been used. The device has to be unscrewed again, the thread sealant has to be completely removed with a brass brush and the mounting has to be carried out again.



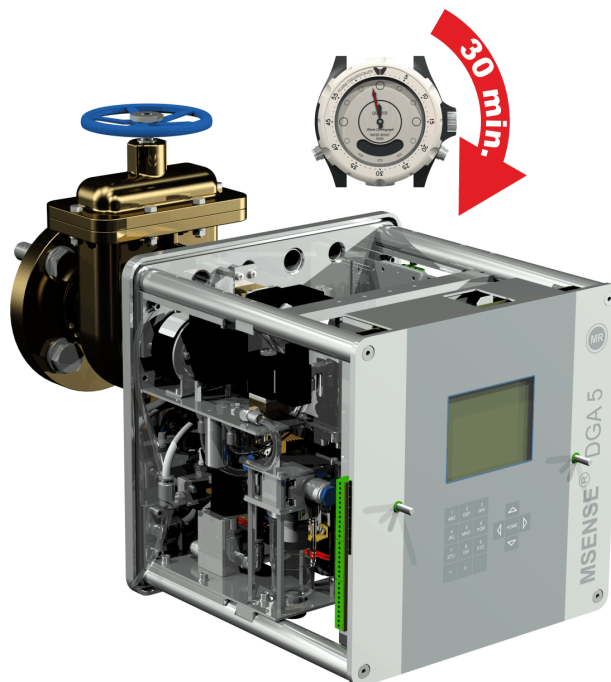
- Remove the two knurled screws and the device protective cover.

- Now align the device by turning it clockwise until the vent screw is at the 12 o'clock position at the top. Make sure the device is fitted firmly in this final position.



- We recommend that you wait for 30 minutes before you continue with the further installation steps. The thread adhesive only cures under pressure i.e. in the thread grooves of the pipe connection. For this reason, any excessive thread adhesive should be removed using a clean cloth.

Remark: The adhesive has completely cured and achieved resistance against environmental influences after one week.



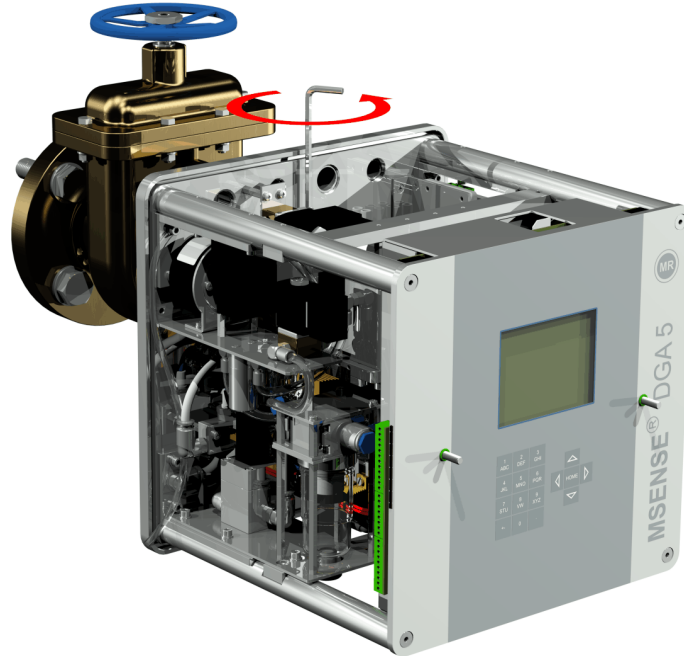
Note!!!



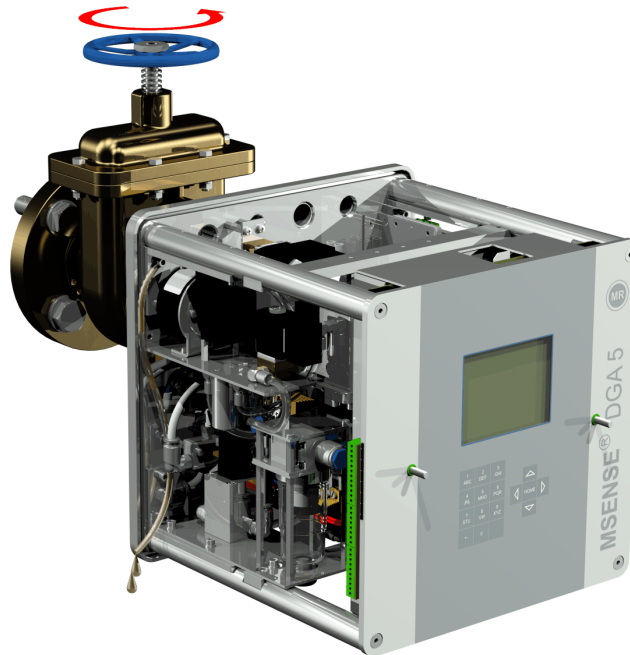
The following steps must be carried out in accordance with company procedures. Work carefully and prevent air getting into the transformer. Use a bucket to collect any leaking oil.



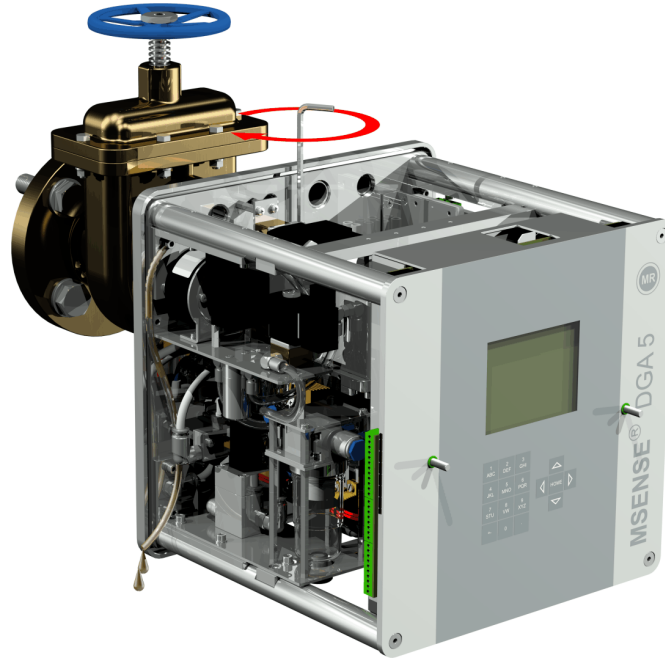
- Unscrew the vent screw by 3 or 4 turns anti-clockwise using the long size 4 hexagon key (venting is active).



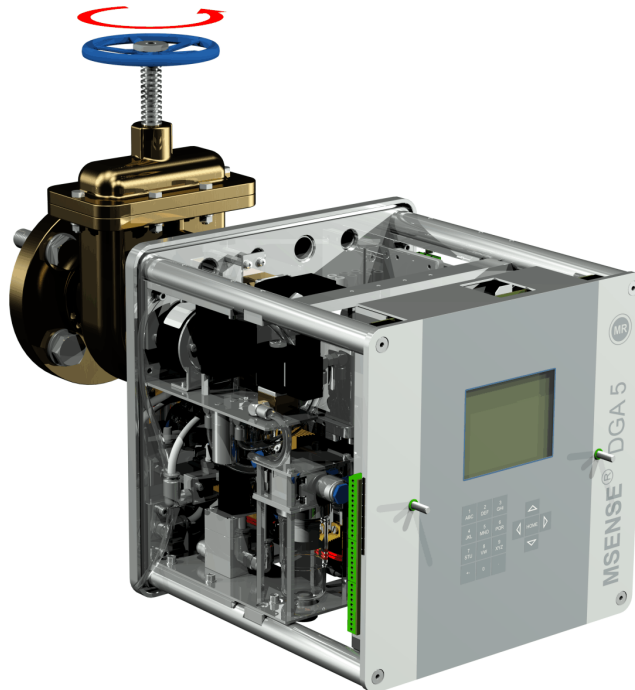
- Open the transformer gate valve very carefully until oil runs out of the sample hose. Allow the escaping oil to run into a container.



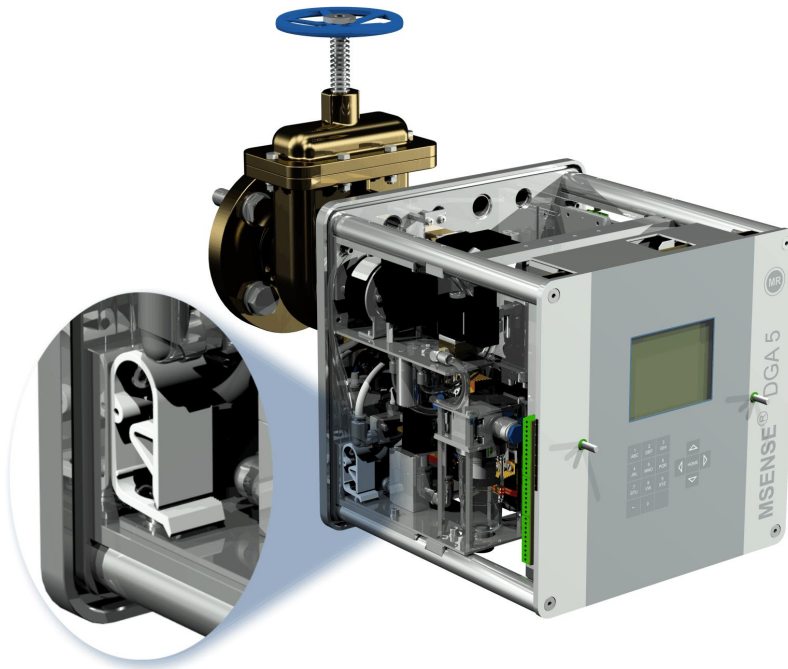
- Close the vent screw as soon as there are no more air bubbles escaping from the sample hose.



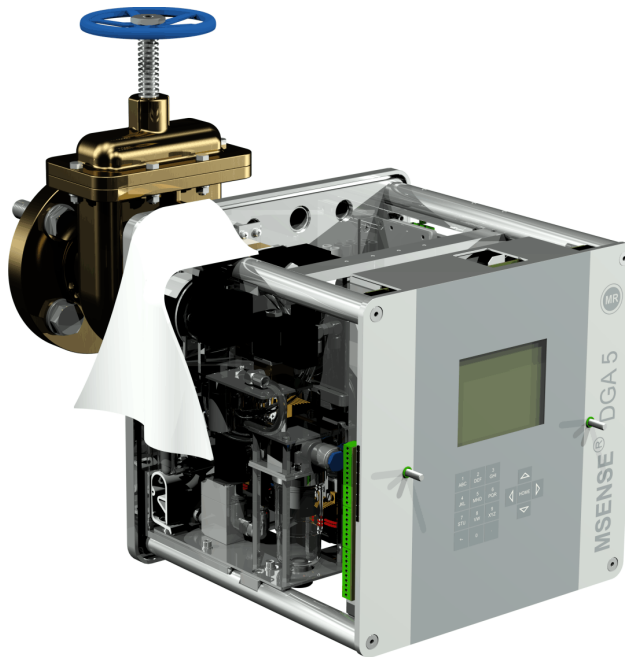
- Now open the gate valve/ball valve completely.



- Secure the end of the sample hose using a hose clip



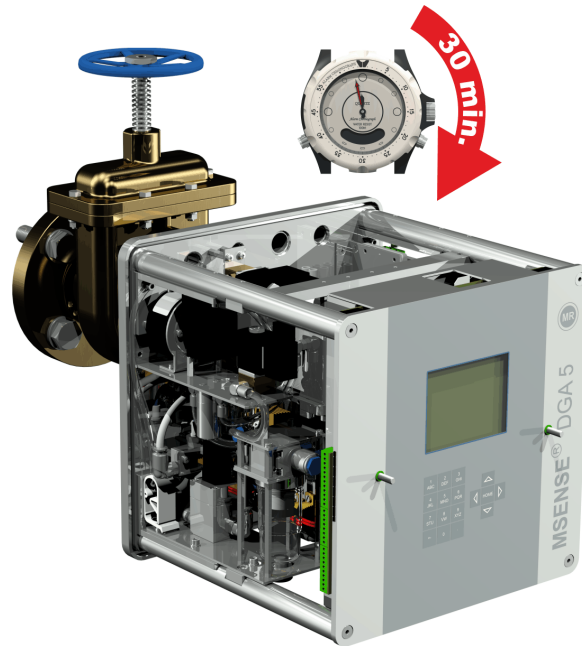
- Use a dry cloth / paper towel to remove oil residues thoroughly from the device.



Note!!!
Do not use solvents for cleaning!



- Check every 30 minutes whether the thread connection is leak-proof.



4.4.1.2 Indirect mounting

In the case of indirect mounting, the MSENSE® DGA 5 is fixed in place by screwing the union nut on the threaded joint. A flat gasket is used as a thread seal here.

Note!!!



Only remove the protective cap (by turning it slowly) when you are ready to use the MSENSE® DGA 5 to be installed on the connecting valve / gate valve!



- Use a dry cloth / paper towel to clean the inside of the union nut.



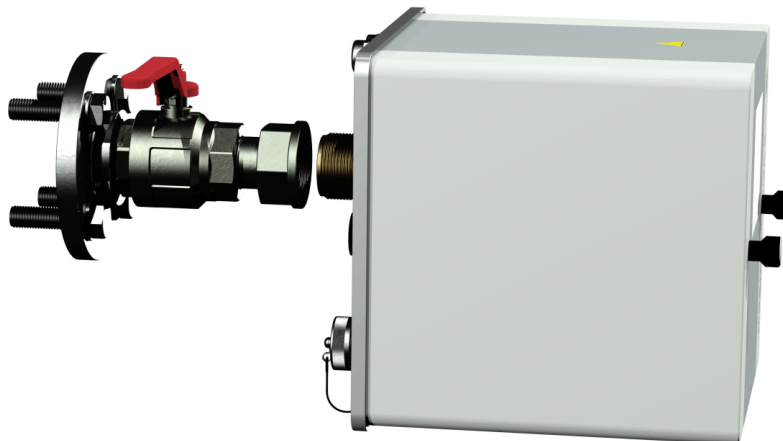
- Use a dry cloth / paper towel to clean the external thread of the connecting unit. Completely remove any soiling from the external thread with a brass brush.



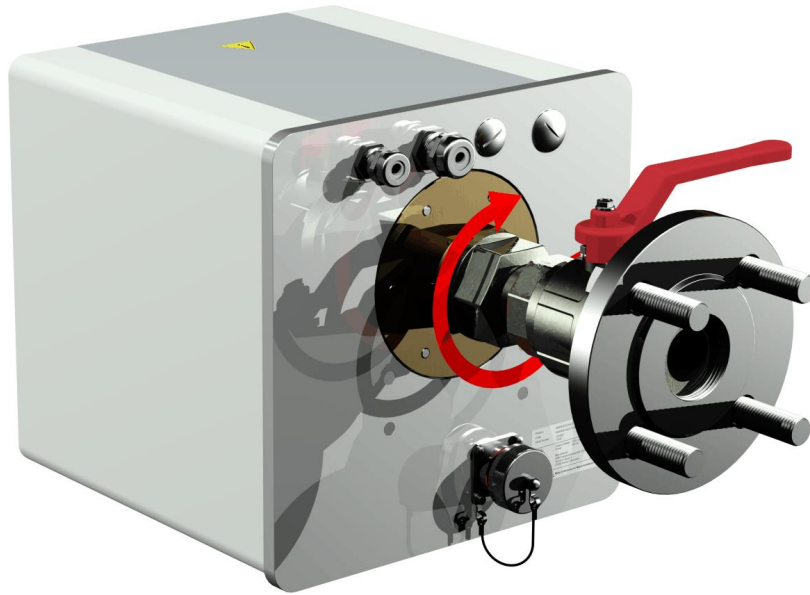
- Place the MSENSE® DGA 5 horizontally onto the threaded joint. Make sure the device does not twist.

Note!!!

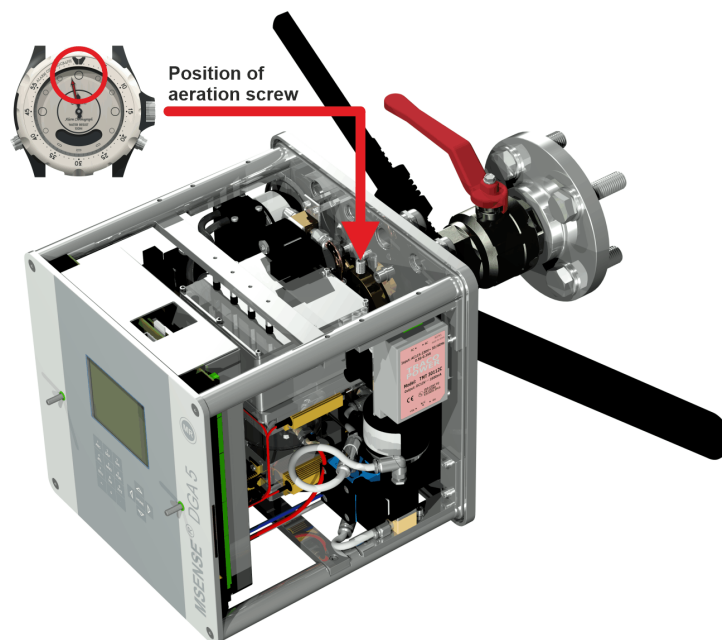
**Please ensure that the flat gasket is correctly screwed in position
between
MSENSE® DGA 5 and threaded joint.**



- Turn the union nut by hand onto the external thread of the connection unit until it stops.



- Remove the two knurled screws and the device protective cover.
- Now align the device by turning it clockwise until the vent screw is at the 12 o'clock position at the top.
- Use a M55 open-ended spanner or 1½" adjustable spanner to tighten the union nut until the connection is a firm fit. Make sure that the 12 o'clock alignment is not displaced. Use an additional M55 open-ended spanner or a 1½" to lock the device during tightening and hold it in position.

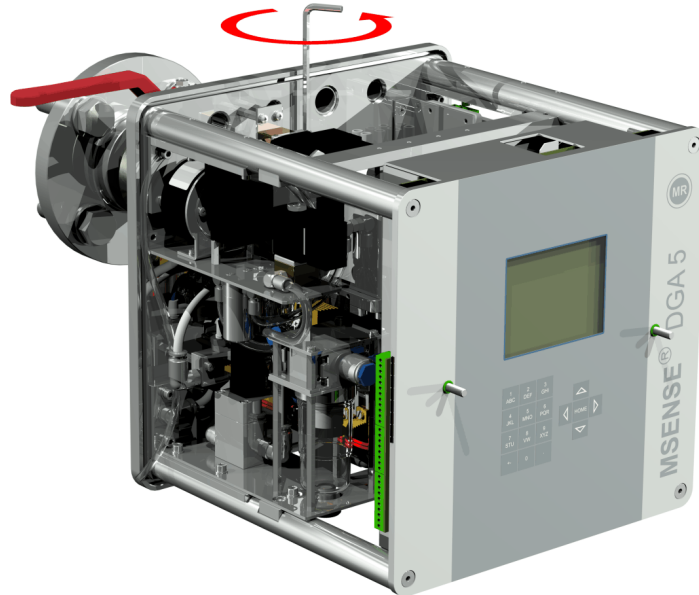


Note!!!

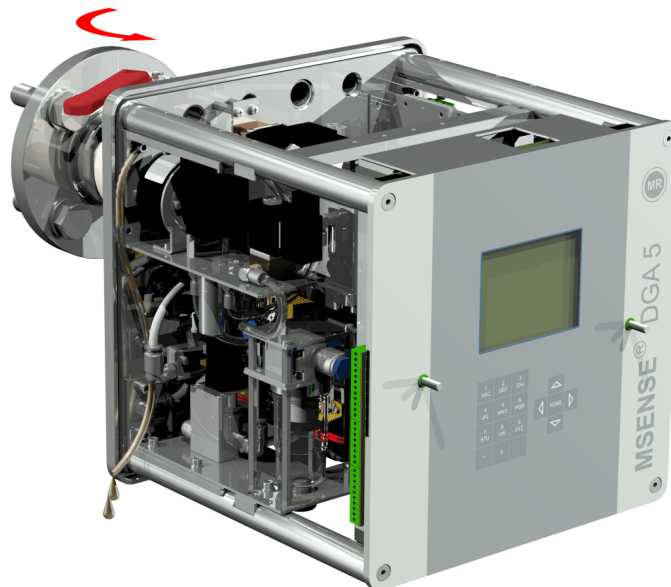


The following steps must be carried out in accordance with company procedures. Work carefully and prevent air getting into the transformer. Use a bucket to collect any leaking oil.

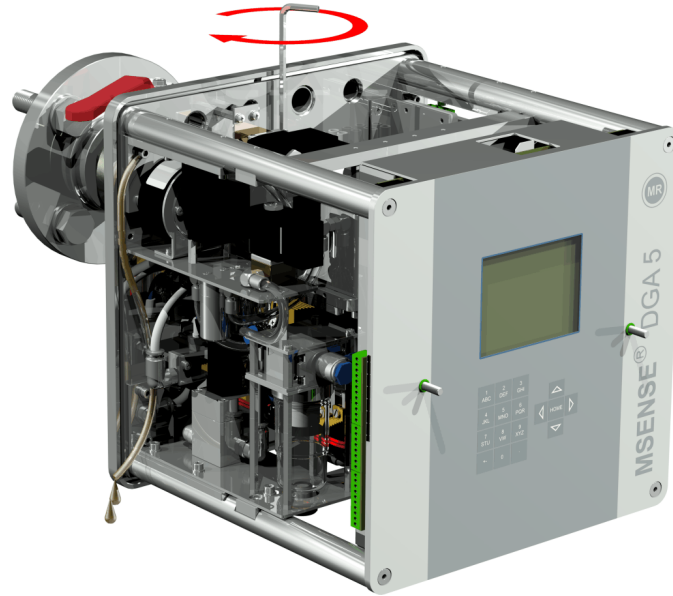
- Unscrew the vent screw by 3 or 4 turns anti-clockwise using the long size 4 hexagon key (venting is active).



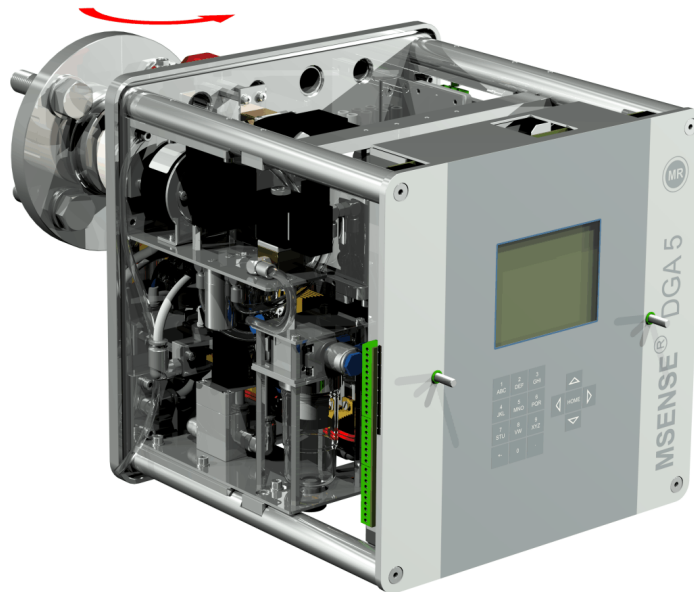
- Open the transformer gate valve very carefully until oil runs out of the sample hose. Allow the escaping oil to run into a container.



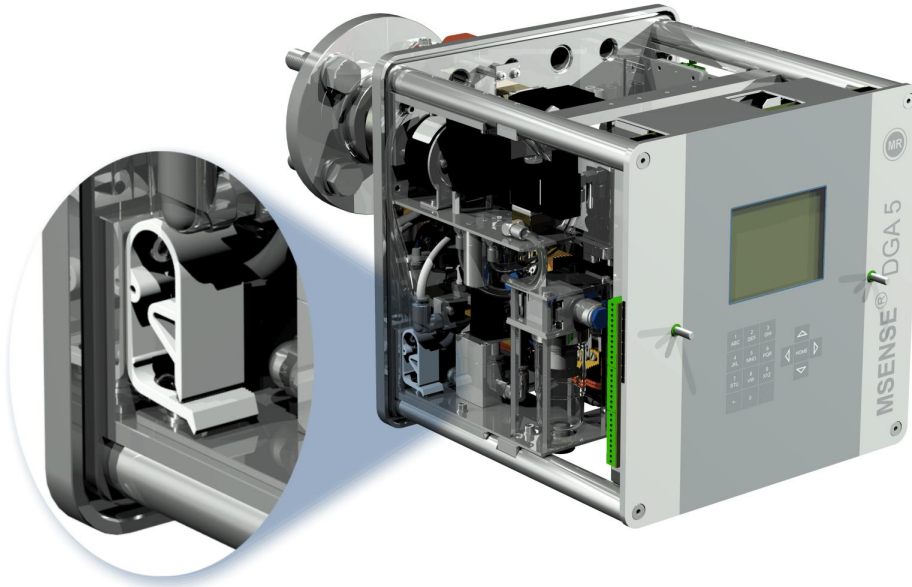
- Close the vent screw as soon as there are no more air bubbles escaping from the sample hose.



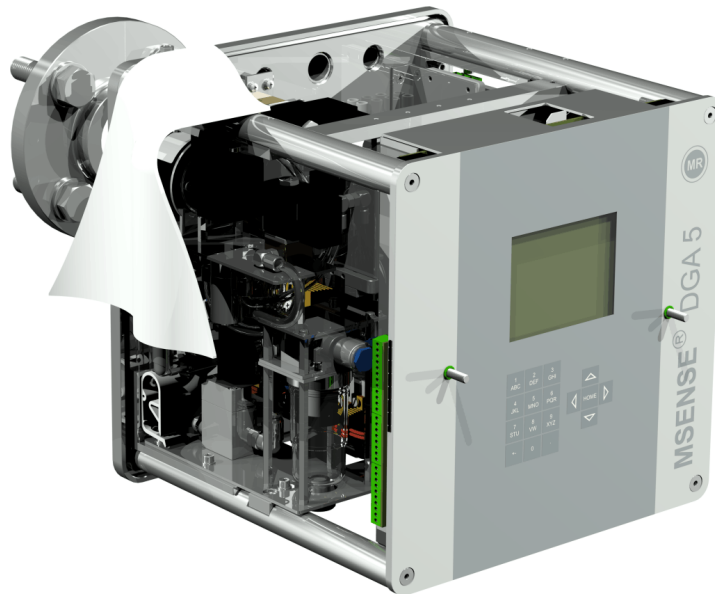
- Now open the gate valve/ball valve completely.



- Secure the end of the sample hose using a hose clip



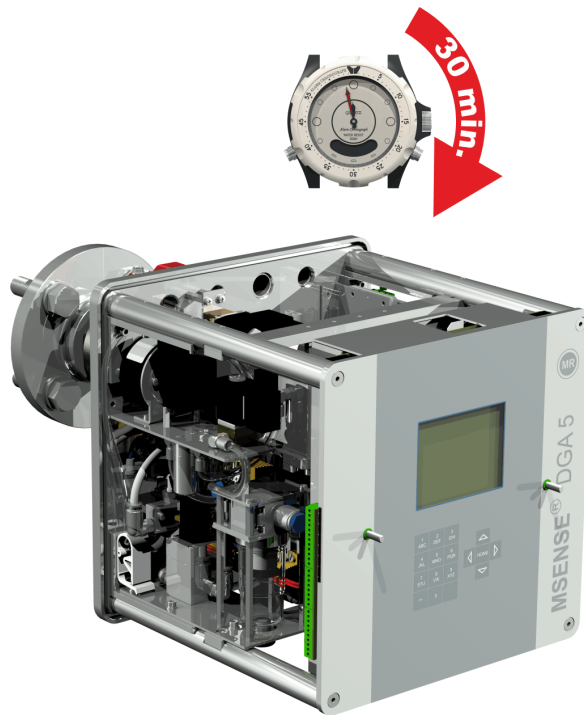
- Use a dry cloth / paper towel to remove oil residues thoroughly from the device.



Note!!!
Do not use solvents for cleaning!



- Check every 30 minutes whether the thread connection is leak-proof.



4.4.2 Electrical connection

Use reinforced pipes as protection for all cables and connect these to the respective connections in the device (5.3). All the cables must be provided by the customer.

The following versions are available for the electrical connections:

- 1 x M16 SKINTOP® threaded joint (clamping range 4.5 ... 10.0 mm)
- 2 x M20 SKINTOP® threaded joint (clamping range 7.0 ... 13.0 mm)
- 1 x M25 SKINTOP® threaded joint (clamping range 9.0 ... 17.0 mm)

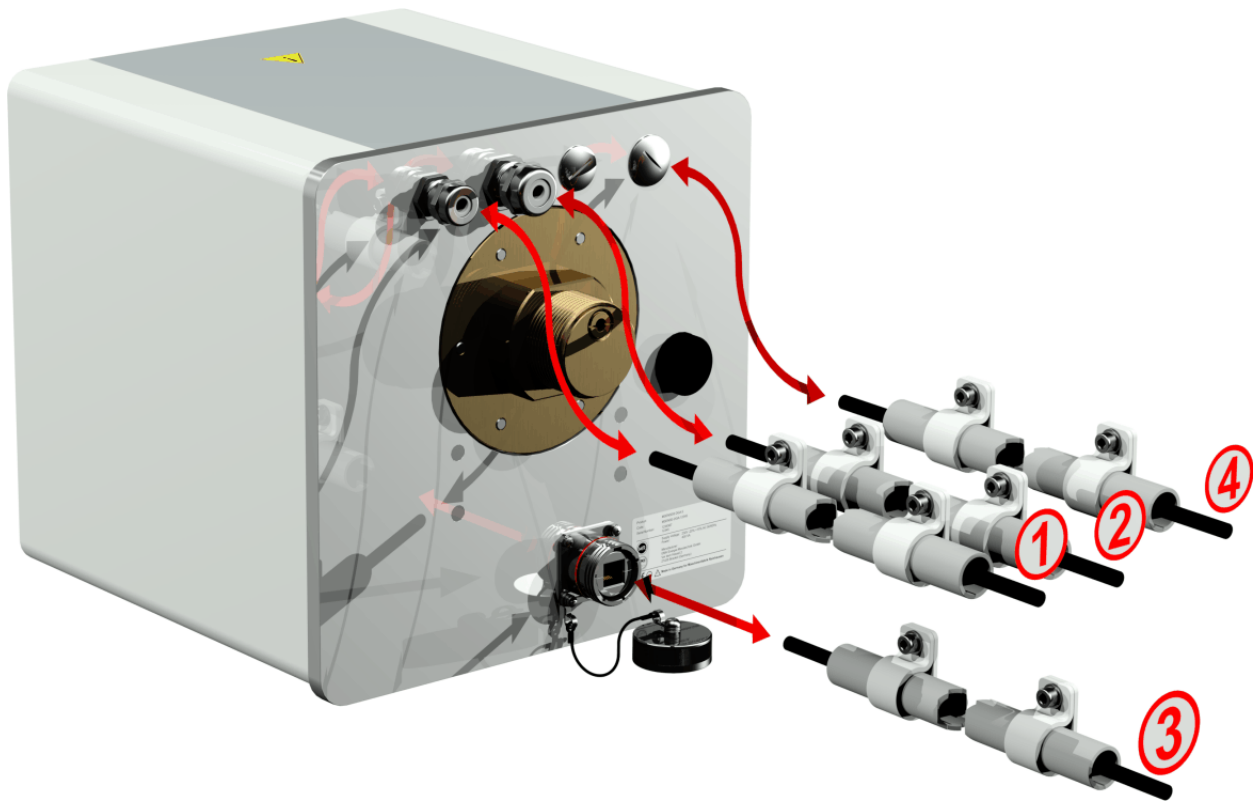
Note!!!



Where smaller cable diameters are involved, appropriate reducing seal inserts must be used to guarantee clamping and tightness of the cable gland!



Remark: The MSENSE® DGA 5 is delivered with 2 SKINTOP® threaded joints M16 and M20 from the factory! The four remaining ducts are sealed with blind plugs M20 and M25.



① Mains connection:

Recommendation for the mains connection cable:

Cable type: PUR-PUR CEE JB 3x1.50 (or similar)

Cable diameter Ø: 8.1 mm

Cable cross-section ⊗: 1.5 mm² (of the 3 individual wires)

② Modem communication:

Analogue line:

Recommendation for the analogue line cable:

Cable type: U72 1x4x0.5 (or similar)

Cable diameter Ø: 3.8 mm

Cable cross-section ⊗: 0.5 mm² (of the 4 single wires)

③ Ethernet communication:

Ethernet communication can be connected by copper cable (RJ45) or fibre optic cable (SC-Duplex) (please state when placing your order). For the copper variant, the connection socket (RJF 544) is located directly on the back of the device. The connection for the fibre optic version must be routed through the cable gland and connected directly on the inside of the device.

Copper cable:

Recommendation for the Ethernet communication cable (copper):

Cable type: Ethernet cable Cat. 5e with RJ45 connector (RJF 544 6)

Cable diameter Ø: 6.3 mm

Fibre optic cable:

Recommendation for the Ethernet communication cable (light waves):

Cable type: HITRONIC® HQN 1000 multi-mode G4 62.5/125 with SC-Duplex connector
Cable diameter Ø: 6.5 mm
Bending radius: min. 15 x Ø

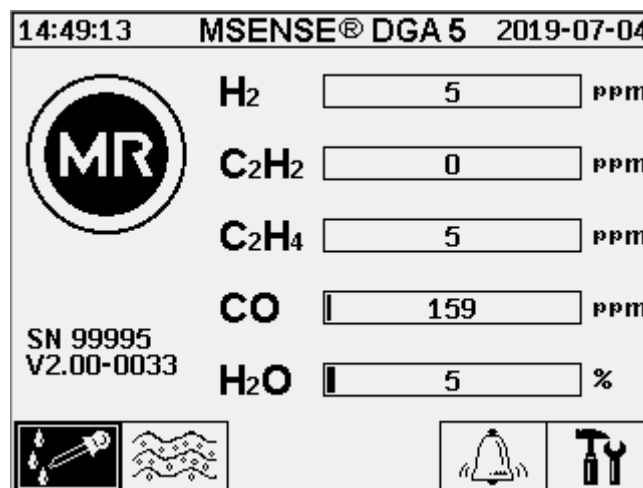
④ Alarm outputs:

Recommendation for the analogue line cable:

Cable type: ÖLFLEX® FD855CP (or similar)
Cable diameter Ø: 13.3 mm
Cable cross-section ⊗: 0.5 mm² (of the 16 individual wires)

4.4.3 Completion of the installation

As soon as the device is connected to a power source, a short beep will sound and the LCD screen will show the main menu after a brief moment. To begin with, the time and date have to be set and then the device must be activated / initialized by the operator.



4.4.3.1

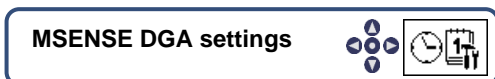


Setting the time and date under “Device Settings”



The user can navigate through the individual menus by using the Cursor keys. The active field / menu is highlighted in black and can be selected by pressing the Home key.

To enter the sub-menu “Date, time, clock settings”, please select the following sub-menu symbols.



Date, time, clock settings

15:12:40 Clock-Settings 2013-06-12

System Time: (HH:MM:SS)

System Date: (YYYY-MM-DD)

Clock Offset: (L-JHH:MM)

Daylight Saving Time Mode:

The time and date are entered using the device keyboard. It consists of an alphanumeric keypad, the Cursor and the “Home” key (0). The numbers must be entered completely with separators (e.g. 15:12:30). The colon is entered using the “.” key and the minus sign is entered using the “+/-” key. The entry is then completed with the “Home” key (0).

Finish making the entries by pressing the “Save and exit menu” key.



4.4.3.2



Activate / initialise device under extraction status

To enter the sub-menu “Extraction status”, please select the following sub-menu symbols.

Main menu

Extraction status
08:46:08 Extraction Status 2013-10-15

08:46:51 Extraction Status 2013-10-15

08:50:37 Extraction Status 2013-10-15

The MSENSE® DGA 5 does not automatically start the measurement cycle after installation and the application of the supply voltage (exception: after a power failure while the device is running). A warning symbol in the picture indicates this status. The activation must be done explicitly by the operator!

Device activation

The initialisation cycle detects the device's current state and establishes a defined state of the system.

Following successful initialisation, the device's state changes to the “Wait” process step until the next measuring cycle is started.

Exit menu

Main menu

- If the function is correct, you can reinstall the protective hood and fix it with the two knurled screws.
- Every 20 minutes, a measurement is started. The start of the measurement is synchronised with the time (xx: 00, xx: 20 and xx: 40). A measuring cycle lasts at least 15 18 minutes.


See also section 6.8.4.1.1.

Note: Activation / initialisation of the MSENSE® DGA 5 device typically uses the term “mount”.

4.4.4 Turn off the device



Note!!!

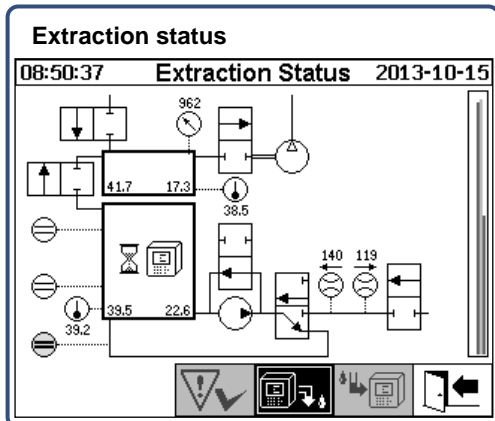
Always press the “Deactivation” key ,
before switching off the supply voltage
and removing the MSENSE® DGA 5 !!!





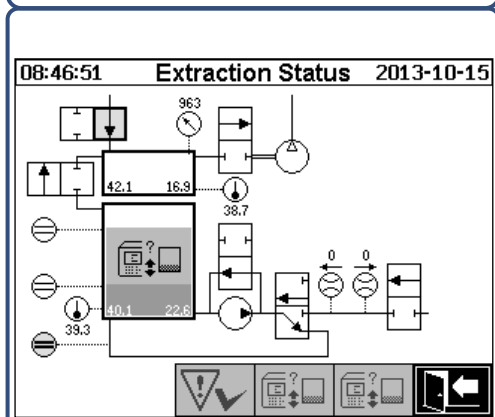
Deactivate device under extraction status

Main menu

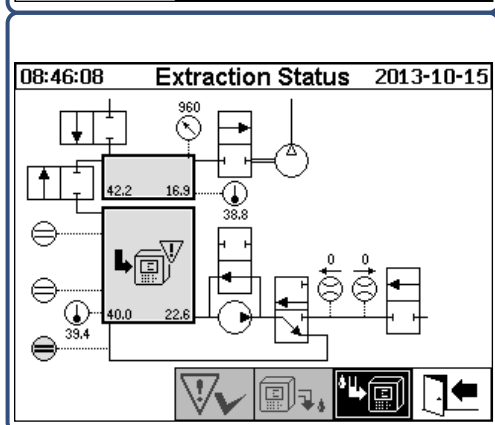


The device's deactivation has to be done explicitly by the user and can be done at any time.

Device deactivation



By deactivating the device, the current process step is stopped and a controlled draining is triggered.



Following its successful deactivation, the device is inactive. A warning symbol indicates this status.

Exit menu



Main menu

- The device can now be de-energised and disassembled.


Note: In order to deactivate the MSENSE® DGA 5, the term “unmount” is typically used.

4.4.5 Automatic activation following the interruption of the supply voltage

If the MSENSE® DGA 5 has already been activated, the automatic activation will be started after the supply voltage is interrupted. You will hear a short beep sound and, after a brief moment, the screen will show the special menu item “Extraction chamber (Pollution warning! - Indication of pollution!)”.



The waiting time until automatic activation is then started. This is shown with a second-by-second countdown timer. Furthermore, short beeps are audible (the first 25 seconds is a short beep tone every 5 seconds and a short beep tone is then heard every second for the last 5 seconds).

There is the option to cancel the automatic activation with the  key within 30 seconds and to manually activate the device at a later point in time (4.4.3.2).

Once the waiting time has elapsed, the automatic activation will start and the LCD will show the main menu.



Cancel the device's automatic activation



Initial position of the cursor (the key has no stored function)



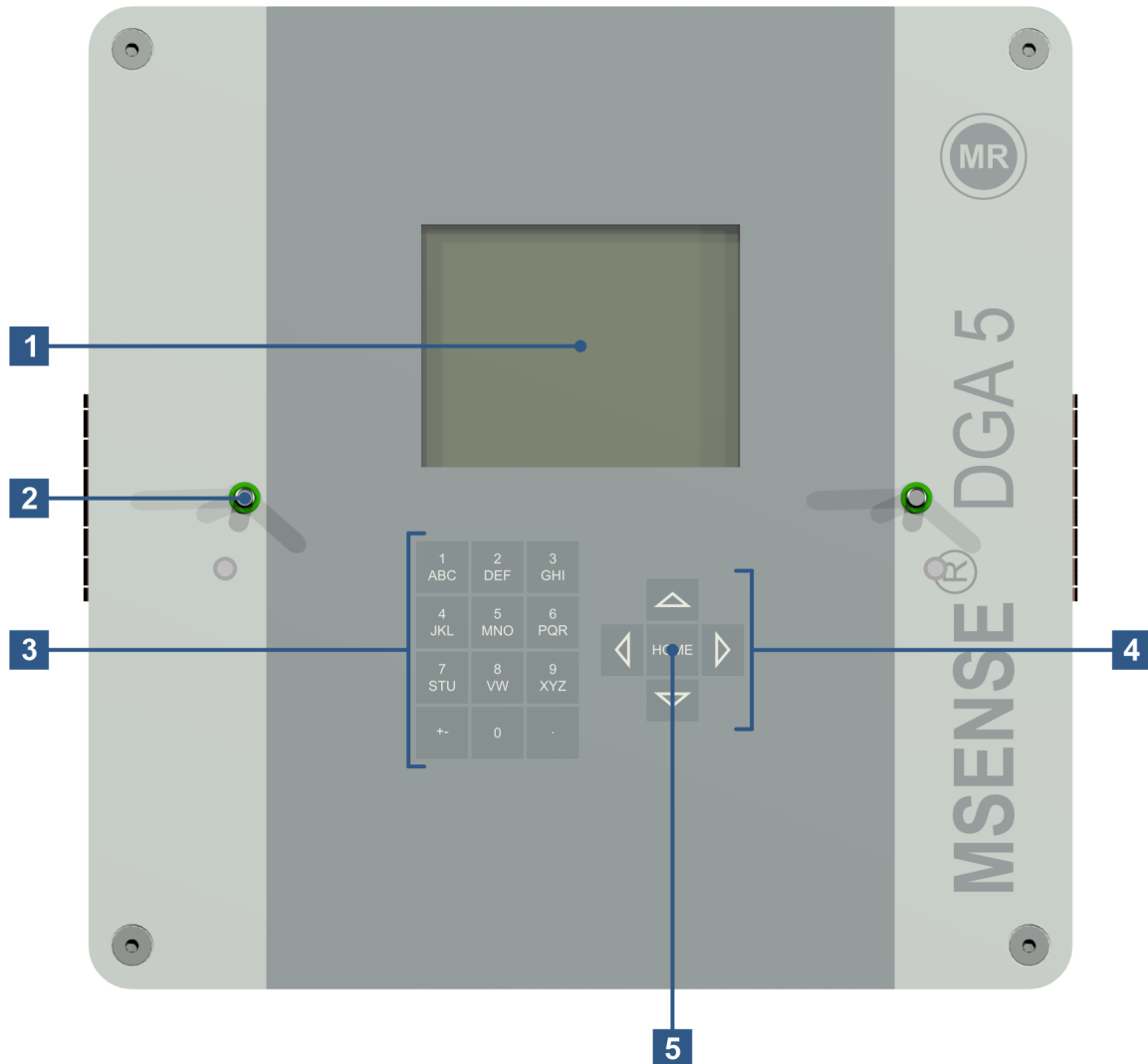
Exit menu

Remark: After leaving the initial position, this can no longer be reached.

5 Hardware components

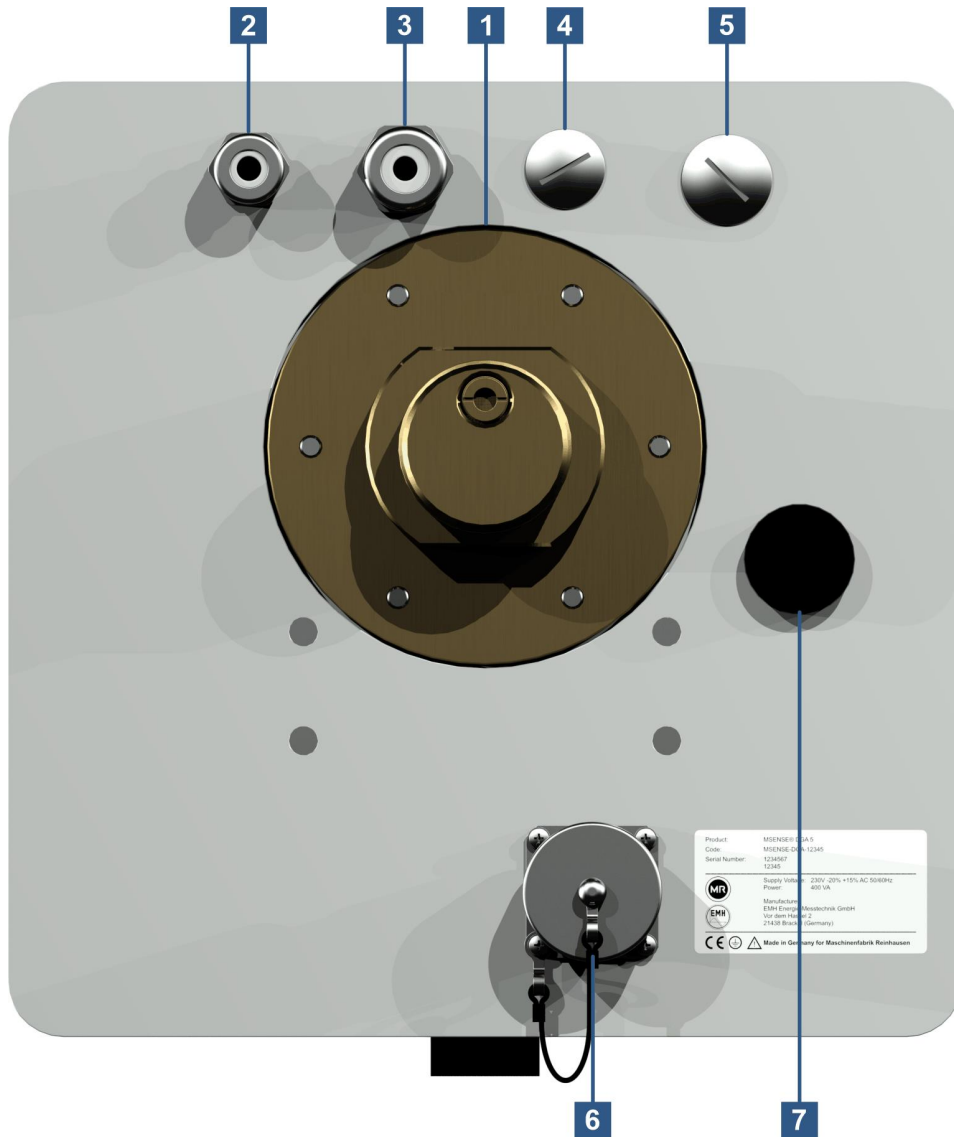
5.1 Internal front view with controls

After removing the housing's protective hood, the inner front section and its operating elements become visible. This comprises the following components:



- [1] **LCD touch display** with 320 x 240 pixels
- [2] **Threaded bolt** for the attachment of the device protective cap
- [3] **Alphanumeric keypad** for entering numbers and text
- [4] **Cursor keys** to navigate the menus and enter data
- [5] **“Home” key** to activate and confirm functions and the data entered

5.2 View of rear



- [1] **Connecting unit** with external thread
G 1½" DIN ISO 228-1 or 1½" NPT ANSI B 1.20.1

[2] Mains connection with SKINTOP® threaded joint M16

Nominal voltages: 120 V -20% +15% AC 50/60 Hz ¹⁾ or
230 V -20% +15% AC 50/60 Hz ¹⁾ or
120 V -20% +15% DC ¹⁾ or
230 V -20% +15% DC ¹⁾

Power consumption: max. 400 VA

Fuse for 120 V: T4A

Fuse for 230 V: T2A

Connect the power cable as follows:

AC version

Phase: L

Neutral conductor: N

Protective earth: PE

DC version

Plus conductor: +

Minus conductor: -

Protective earth: PE



Remark ¹⁾:

120 V ⇒ 120 V -20% = **96 V_{min}** 120 V +15% = **138 V_{max}**
230 V ⇒ 230 V -20% = **184 V_{min}** 230 V +15% = **264 V_{max}**

[3] System connection with SKINTOP® threaded joint M20

Communication / alarms and additional sensors:

[4] Implementation with SKINTOP® blind threaded joint M20

-

[5] Implementation with SKINTOP® blind threaded joint M25

-

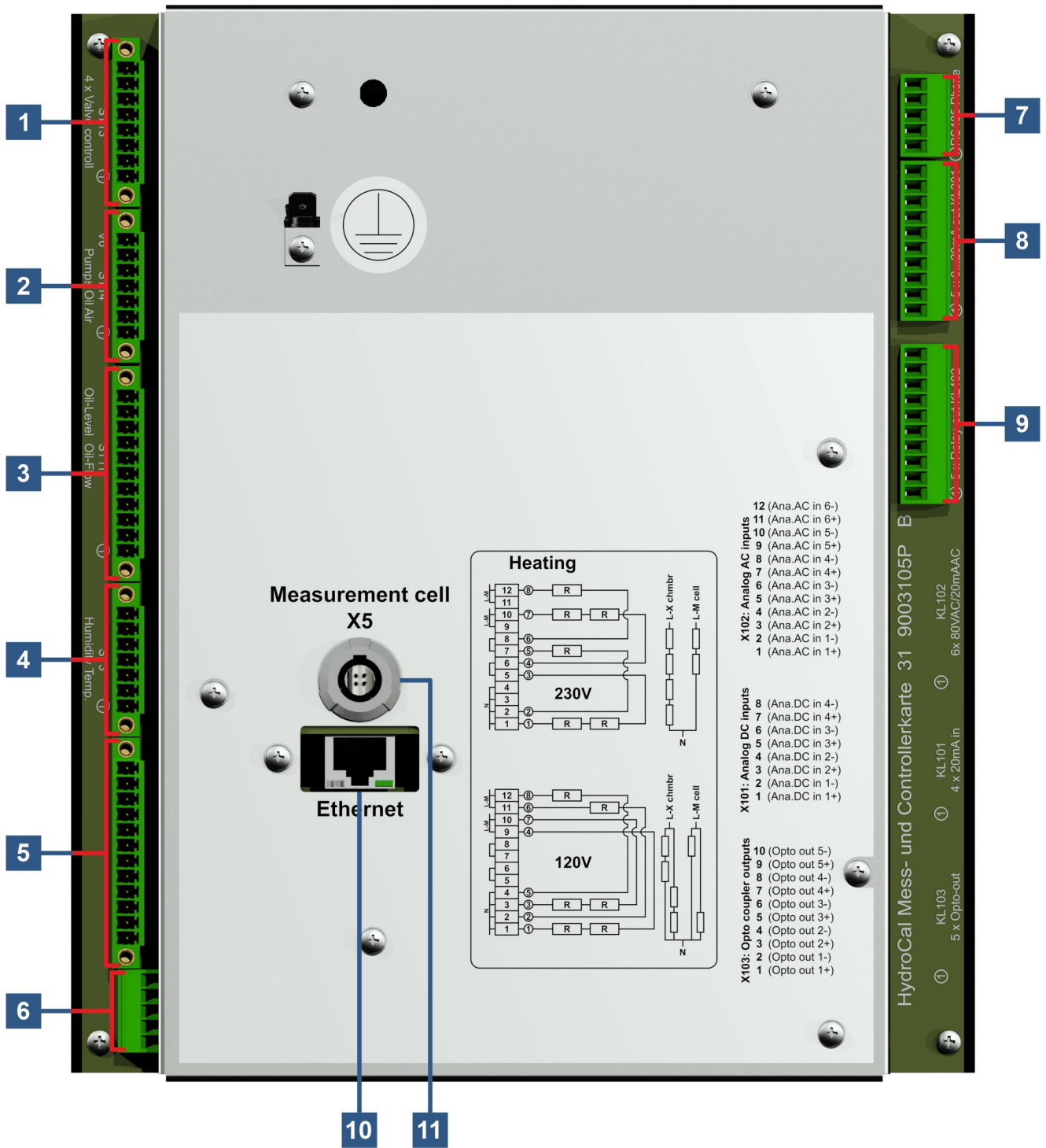
[6] ETHERNET communication port with RJ45 socket (RJF TV Type: 2)

Communication interface ETHERNET 10/100 Mbit for copper cable

[7] Vent opening

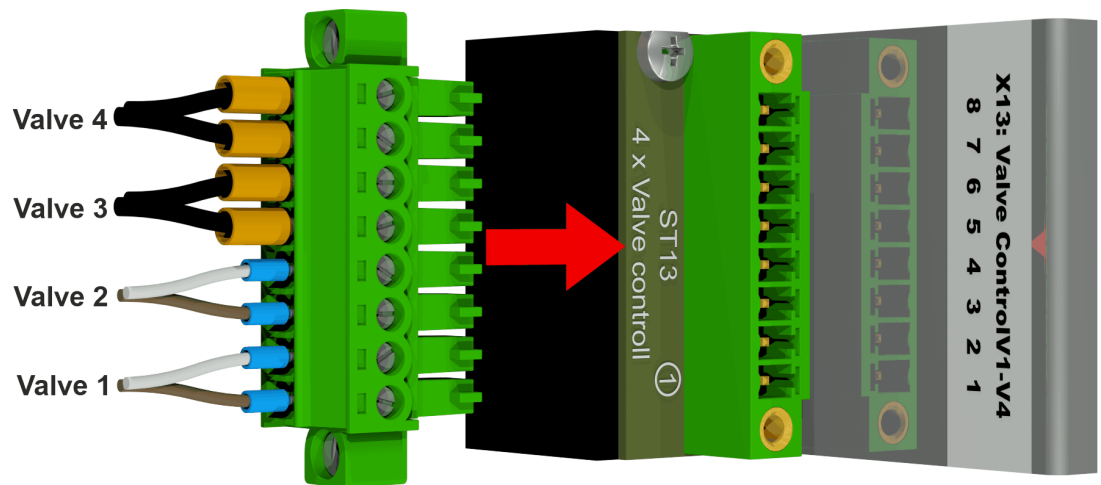
Used as an output for the vacuum compressor (gas/air mixture of the measurement cell)

5.3 Connections for the measuring and controller card



[1] Connector plug X13: Valve Control

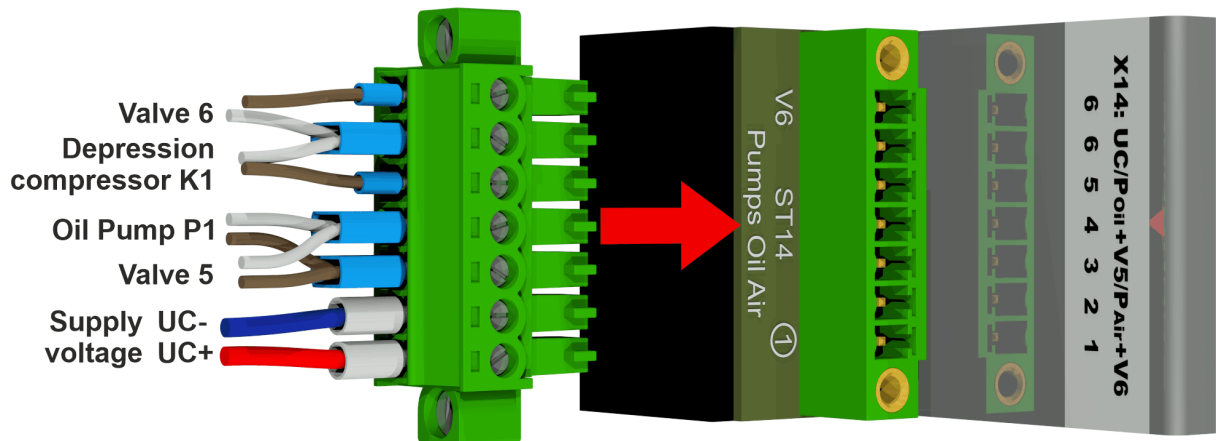
Connection for degassing, measurement cell separation, vacuum and ventilation valve



X13:8	⇒ V4 ⊖	⇒ Ventilation valve
X13:7	⇒ V4 ⊕	⇒ ventilation valve
X13:6	⇒ V3 ⊖	⇒ Vacuum valve
X13:5	⇒ V3 ⊕	⇒ Vacuum valve
X13:4	⇒ V2 ⊖	⇒ Cell separator valve
X13:3	⇒ V2 ⊕	⇒ Cell separator valve
X13:2	⇒ V1 ⊖	⇒ Degassing valve
X13:1	⇒ V1 ⊕	⇒ Degassing valve

[2] Connector plug X14: Pump / Compressor / Valve

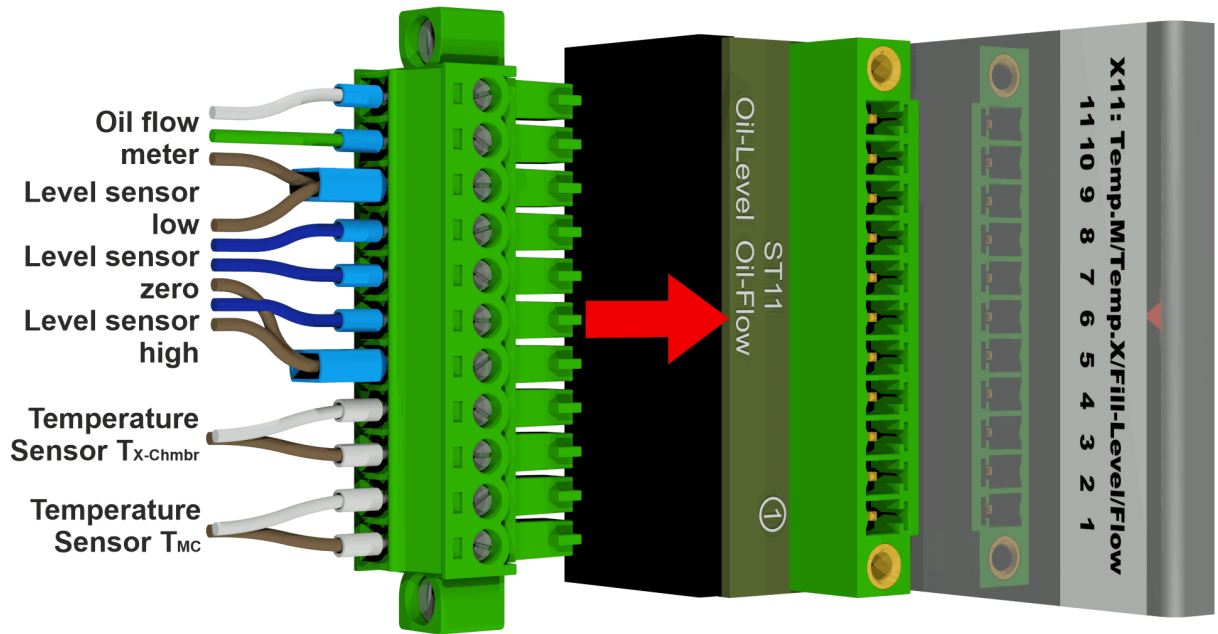
Connection for low voltage, oil pump, vacuum compressor and inlet / outlet valve



X14:7	⇒ V6 ⊕	⇒ Inlet / outlet valve
X14:6	⇒ K1/V6 ⊖	⇒ Vacuum compressor and inlet / outlet valve
X14:5	⇒ K1 ⊕	⇒ Vacuum compressor
X14:4	⇒ P1/V5 ⊖	⇒ Oil pump and bypass valve oil pump
X14:3	⇒ P1/V5 ⊕	⇒ Oil pump and bypass valve oil pump
X14:2	⇒ UC ⊖	⇒ Low voltage
X14:1	⇒ UC ⊕	⇒ Low voltage

[3] Connector plug X11: H-Temp./Level/Flow

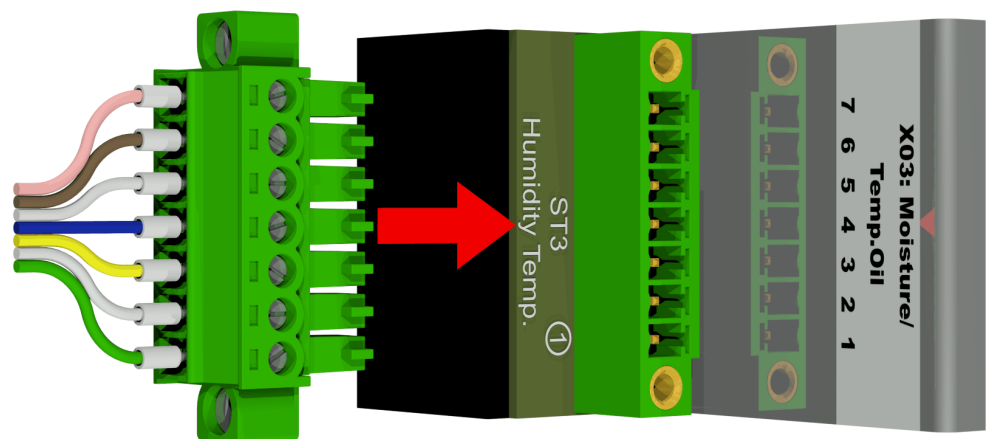
Connection for heating temperature sensors, filling levels and flow



- | | | |
|---------------|------------------------|---|
| X11:11 | ⇒ F1 ⊖ | ⇒ Flow measurement oil |
| X11:10 | ⇒ F1 Impulse | ⇒ Flow measurement oil |
| X11:9 | ⇒ L1/F1 ⊕ | ⇒ Filling level sensor low / flow measurement oil |
| X11:8 | ⇒ L1 out | ⇒ Filling level sensor low |
| X11:7 | ⇒ L0 out | ⇒ Filling level sensor zero acknowledgement |
| X11:6 | ⇒ L2 out | ⇒ Filling level sensor high |
| X11:5 | ⇒ L2/L0 ⊕ | ⇒ Filling level sensor high / Filling level sensor zero acknowledgement |
| X11:4 | ⇒ T _{X-Chmbr} | ⇒ Temperature sensor heating extraction chamber |
| X11:3 | ⇒ T _{X-Chmbr} | ⇒ Temperature sensor heating extraction chamber |
| X11:2 | ⇒ T _{MC} | ⇒ Temperature sensor heating measurement cell |
| X11:1 | ⇒ T _{MC} | ⇒ Temperature sensor heating measurement cell |

[4] Connector plug X3: Oil-Moisture / Temp

Connection for moisture and oil temperature measurement in the extraction chamber

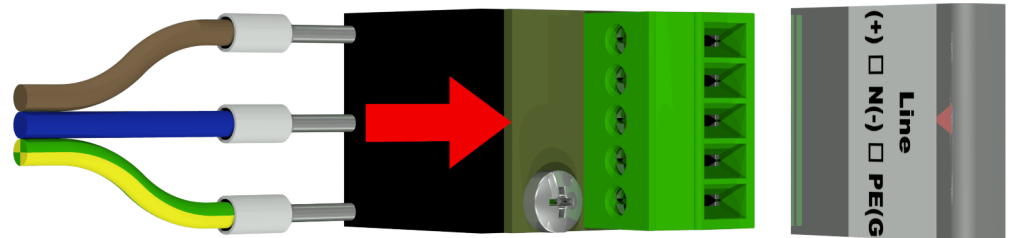


- | | | |
|-------------|------|--------------------------|
| X3:7 | ⇒ T2 | ⇒ Oil temperature sensor |
| X3:6 | ⇒ T2 | ⇒ Oil temperature sensor |

X3:5	⇒ M1 _{GND}	⇒ Moisture in oil sensor
X3:4	⇒ M1 ⁺	⇒ Moisture in oil sensor
X3:3	⇒ M1 ⁻	⇒ Moisture in oil sensor
X3:2	⇒ M1 _{out}	⇒ Moisture in oil sensor
X3:1	⇒ M1 _{in}	⇒ Moisture in oil sensor

[5] Connection terminal X1: Power supply

Connection for mains voltage

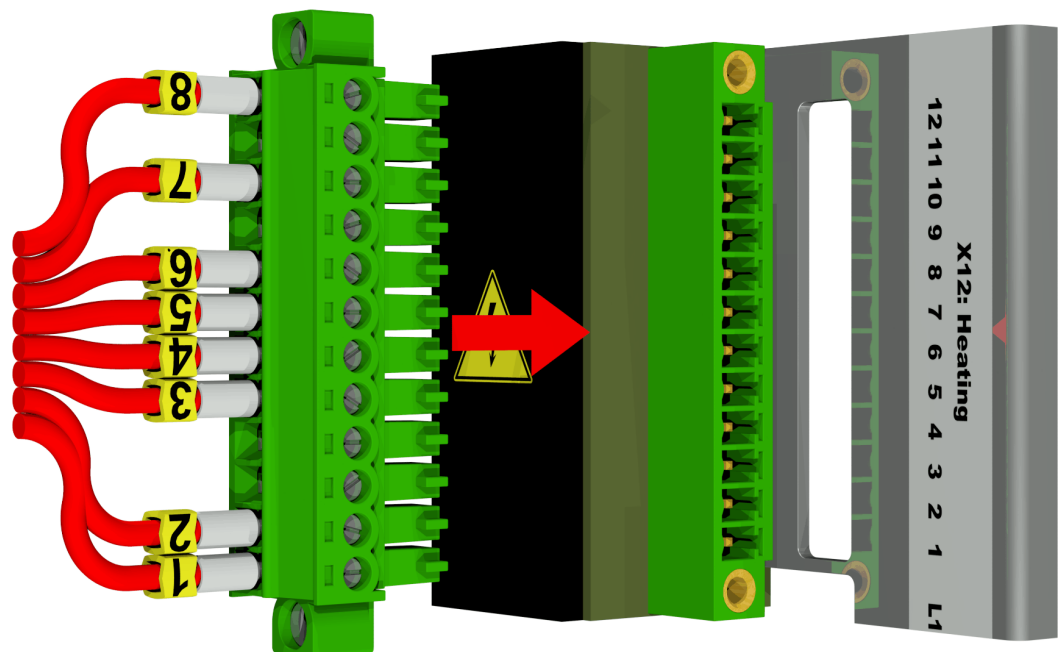


Connector X1: 1 (L) is connected to the fuse carrier supplied by the main connector.

X1:1	⇒ L	⇒ Phase AC / Plus conductor ⁺ DC
X1:2	⇒ -	
X1:3	⇒ N	⇒ Neutral AC / Minus conductor ⁻ DC
X1:4	⇒ -	
X1:5	⇒ PE	⇒ Protective earth / Protective earth

[6] Connector plug X12: Heating

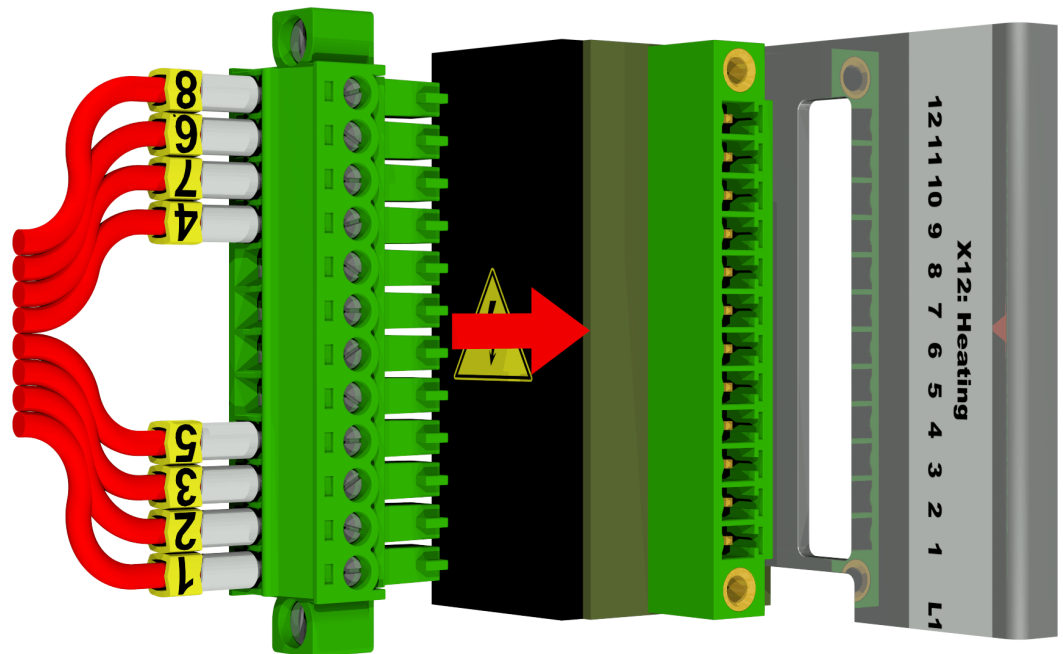
Connection of the heating resistors with a supply voltage of 230 V



X12:12	⇒ L	⇒ 8 Heating measurement cell
X12:11	⇒ L	⇒
X12:10	⇒ L	⇒ 7 Heating extraction chamber
X12:9	⇒ L	⇒
X12:8	⇒ L	⇒ 6 Heating measurement cell
X12:7	⇒ L	⇒ 5 Heating measurement cell

X12:6	⇒	┌	⇒	4	Heating extraction chamber
X12:5	⇒	└	⇒	3	Heating extraction chamber
X12:4	⇒	N	⇒		
X12:3	⇒	N	⇒		
X12:2	⇒	N	⇒	2	Heating measurement cell
X12:1	⇒	N	⇒	1	Heating extraction chamber

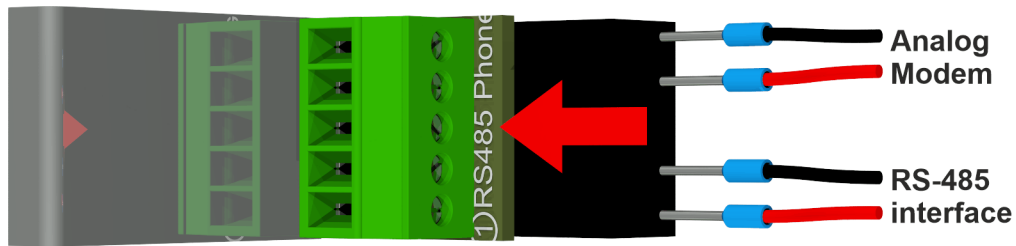
Connection of the heating resistors with a supply voltage of 120 V



X12:12	⇒	L	⇒	8	Heating measurement cell
X12:11	⇒	L	⇒	6	Heating measurement cell
X12:10	⇒	L	⇒	7	Heating extraction chamber
X12:9	⇒	L	⇒	4	Heating extraction chamber
X12:8	⇒	┌	⇒		
X12:7	⇒	└	⇒		
X12:6	⇒	┌	⇒		
X12:5	⇒	└	⇒		
X12:4	⇒	N	⇒	5	Heating measurement cell
X12:3	⇒	N	⇒	3	Heating extraction chamber
X12:2	⇒	N	⇒	2	Heating measurement cell
X12:1	⇒	N	⇒	1	Heating extraction chamber

[7] Connection terminals X302: RS485 interface

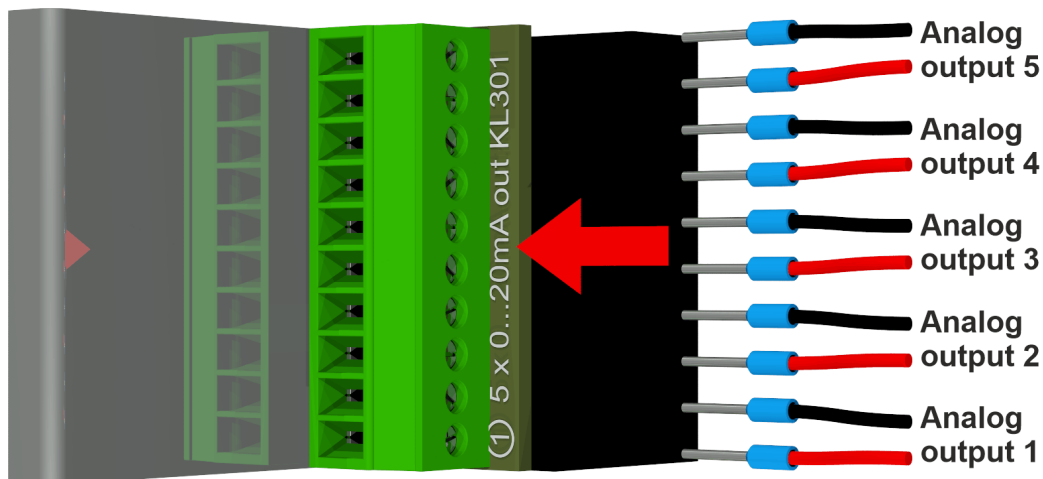
Connection for RS485 interface



X302:5	⇒ Amt A	⇒ Analogue modem (not available)
X302:4	⇒ Amt B	⇒ Analogue modem (not available)
X302:3	⇒ GND	⇒ RS485 interface
X302:2	⇒ OUT A ⊖	⇒ RS485 interface
X302:1	⇒ OUT B ⊕	⇒ RS485 interface

[8] Connection terminals X301: Analogue outputs

Connection for the analogue outputs (0/4 20 mA DC)



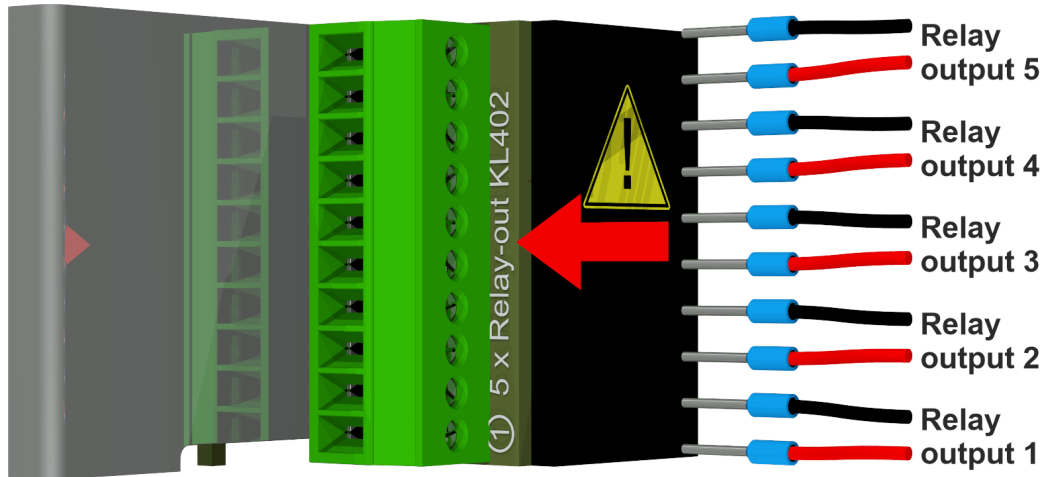
X301:10	⇒ AO5⊖	⇒ Analogue output 5
X301:9	⇒ AO5⊕	⇒ Analogue output 5
X301:8	⇒ AO4⊖	⇒ Analogue output 4
X301:7	⇒ AO4⊕	⇒ Analogue output 4
X301:6	⇒ AO3⊖	⇒ Analogue output 3
X301:5	⇒ AO3⊕	⇒ Analogue output 3
X301:4	⇒ AO2⊖	⇒ Analogue output 2
X301:3	⇒ AO2⊕	⇒ Analogue output 2
X301:2	⇒ AO1⊖	⇒ Analogue output 1
X301:1	⇒ AO1⊕	⇒ Analogue output 1

Firmware identifier

⇒ Output # 5
⇒ Output # 5
⇒ Output # 4
⇒ Output # 4
⇒ Output # 3
⇒ Output # 3
⇒ Output # 2
⇒ Output # 2
⇒ Output # 1
⇒ Output # 1

[9] Connection terminals X402: Relay outputs

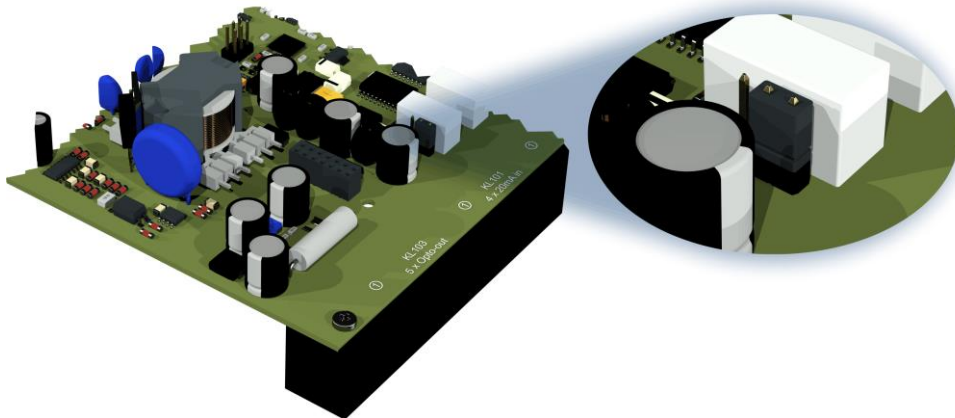
Connection for the relay outputs (220 VDC / VAC / 2 A / 60 W)



X402:ID	DOR	Relay output	Firmware identifier	Relay contacts
X402:10	⇒ DOR5	⇒ Relay output 5	⇒ Term. 5 relay	
X402:9	⇒ DOR5	⇒ Relay output 5	⇒ Term. 5 relay	
X402:8	⇒ DOR4	⇒ Relay output 4	⇒ Term. 4 relay	
X402:7	⇒ DOR4	⇒ Relay output 4	⇒ Term. 4 relay	
X402:6	⇒ DOR3	⇒ Relay output 3	⇒ Term. 3 relay	
X402:5	⇒ DOR3	⇒ Relay output 3	⇒ Term. 3 relay	
X402:4	⇒ DOR2	⇒ Relay output 2	⇒ Term. 2 relay	
X402:3	⇒ DOR2	⇒ Relay output 2	⇒ Term. 2 relay	
X402:2	⇒ DOR1	⇒ Relay output 1	⇒ Term. 1 relay	
X402:1	⇒ DOR1	⇒ Relay output 1	⇒ Term. 1 relay	

Configuration of relay output 1 with coding bridge 1 (J1)

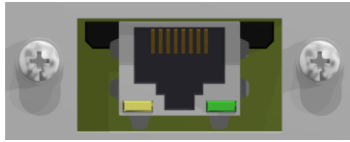
If the coding bridge 1 is inserted as shown in the following figure, the relay output 1 is configured so that the contact is open during operation of the device. The contact closes in case of an error.



Coding bridge 1 for configuring relay contact 1 (X402 / KL402)

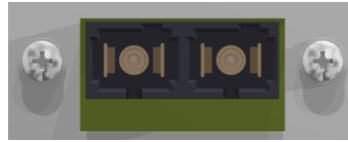
[10] Connection ETHERNET communication [Ethernet]

Ethernet communication port



**Copper cable
(RJ45)**

or

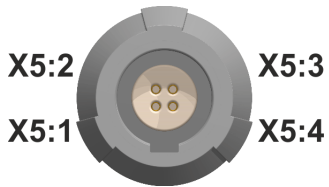


**fibre optic cable
(SC-Duplex)**

The connectors are connected to the motherboard (measuring and controller card).
The fibre optic connection can be ordered as an optional extra.

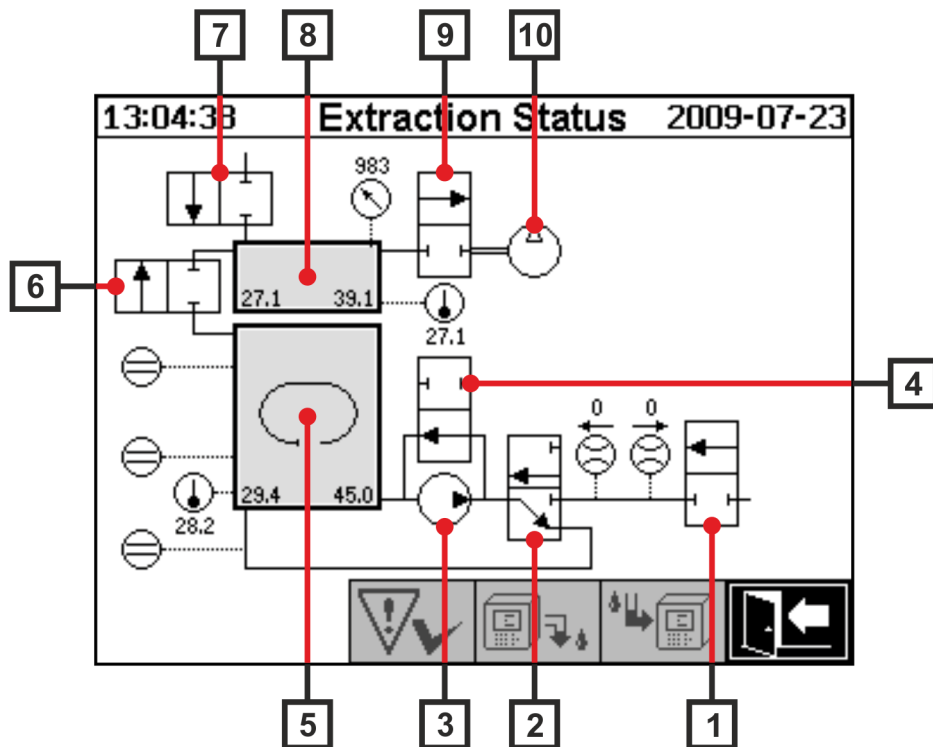
[11] Connection socket X5: Measurement cell

Connection for the measurement cell via REDEL panel jack 4-pole 0° coded



X5:4	⇒ TX _{SENS}	⇒ Measurement cell transmission signal
X5:3	⇒ RX _{SENS}	⇒ Measurement cell reception signal
X5:2	⇒ GND	⇒ 8 Volt supply
X5:1	⇒ 8V [⊕]	⇒ 8 Volt supply

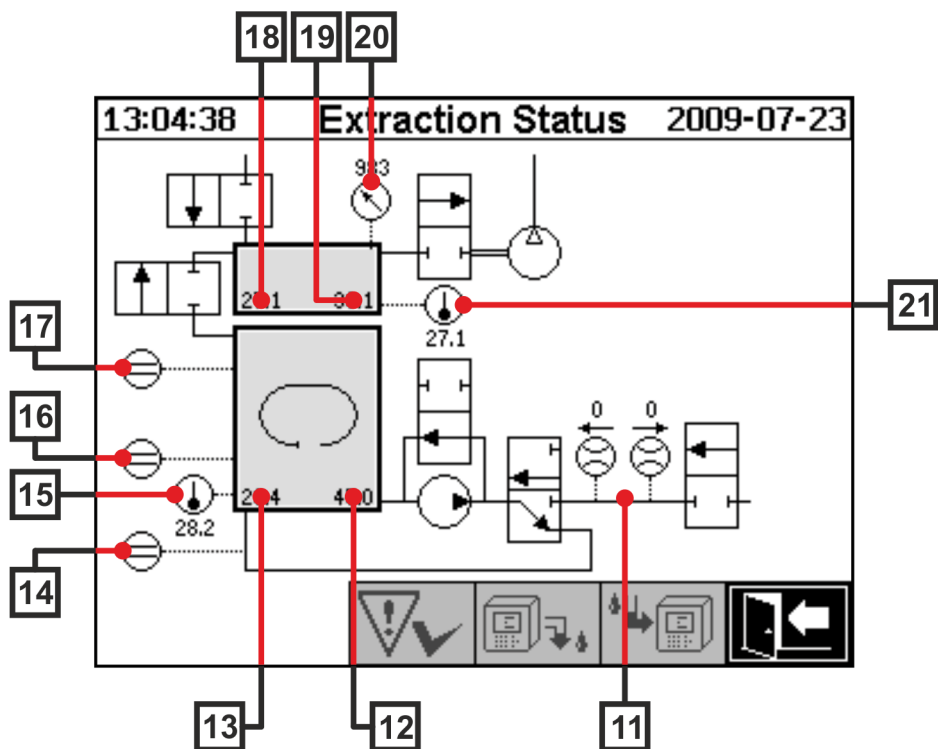
5.4 Gas extraction and measuring components



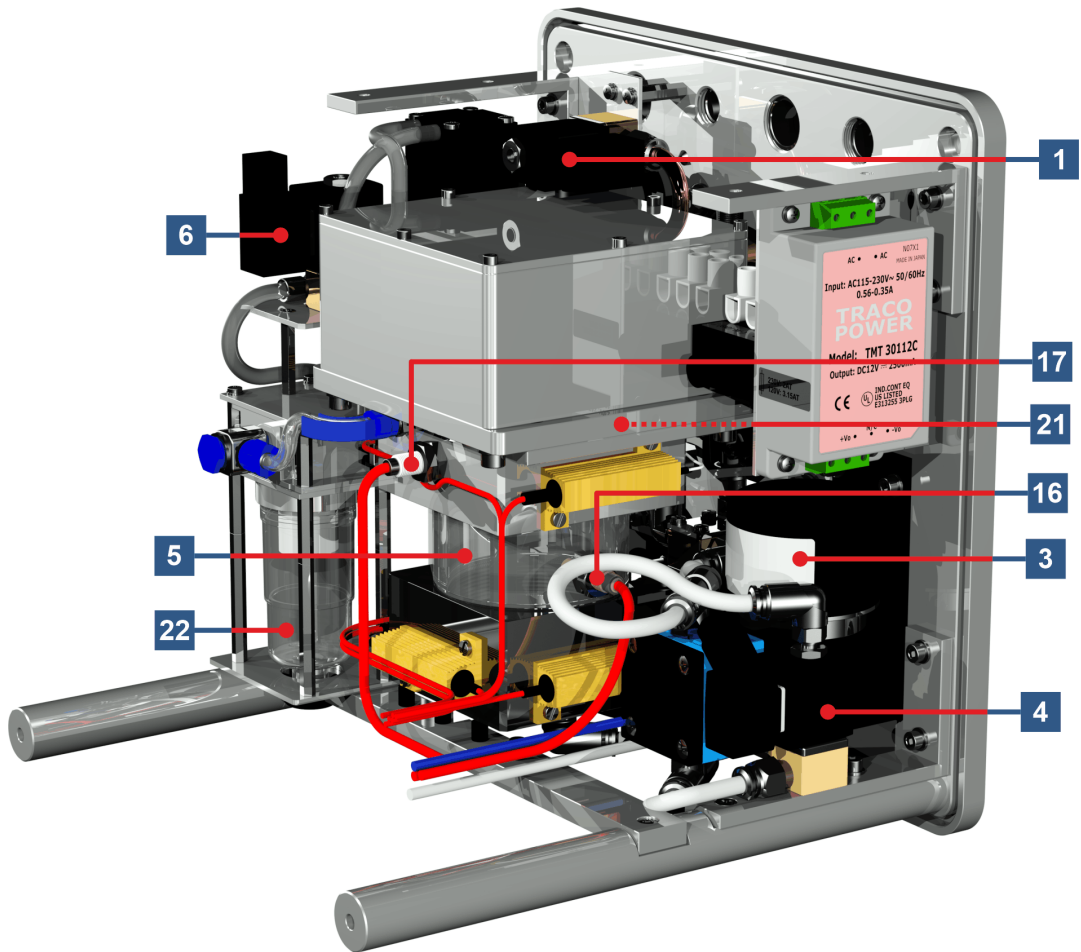
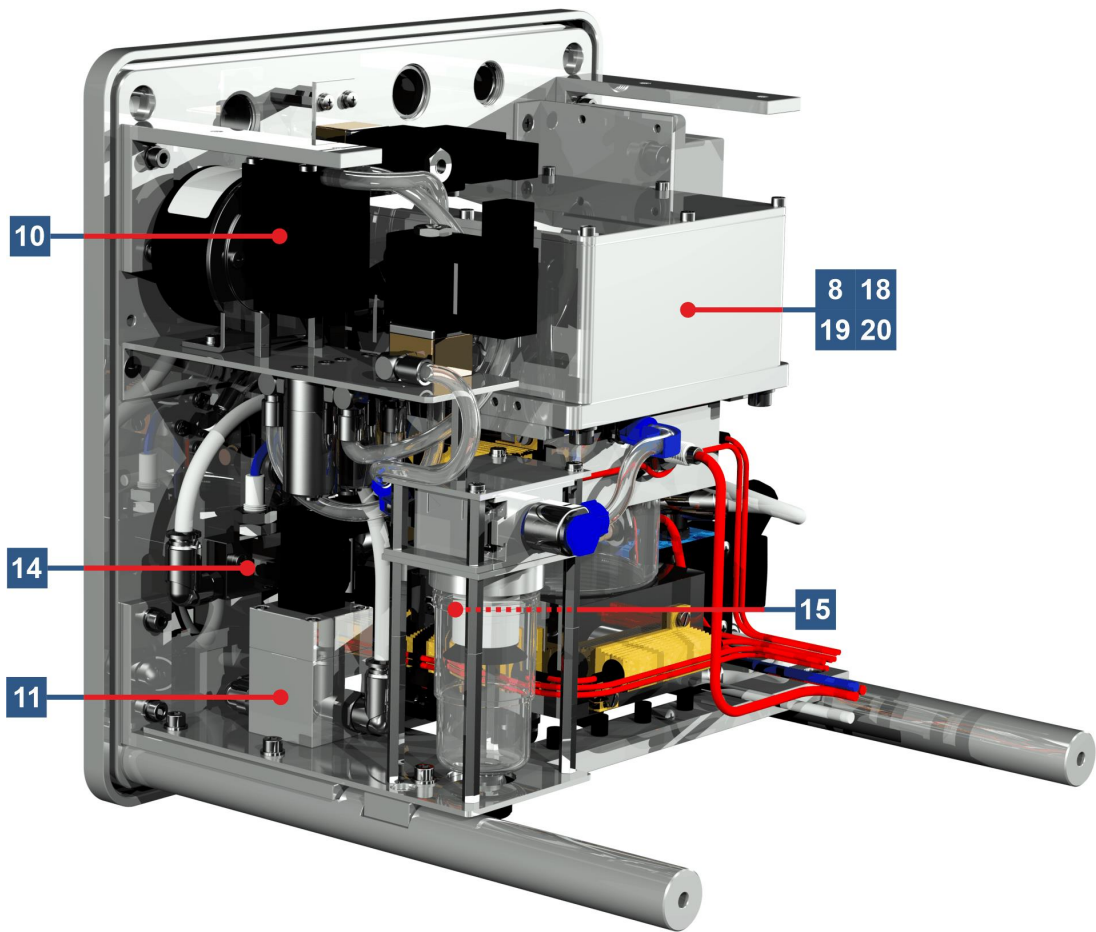
Legend	Name	Short designation	(Valve function)
[1]	Inlet / outlet valve	Valve V6	(NC)
[2]	Degassing	Valve V1	(NC)
[3]	Oil pump	Pump P1:	-
[4]	Bypass valve oil pump	Valve V5	(NO)
[5]	Extraction chamber	-	-
[6]	Measurement cell isolation valve	Valve V2	(NC)
[7]	Ventilation valve	Valve V4	(NC)
[8]	Measurement cell	-	-
[9]	Vacuum valve	Valve V3	(NC)
[10]	Vacuum compressor	Compressor K1	-

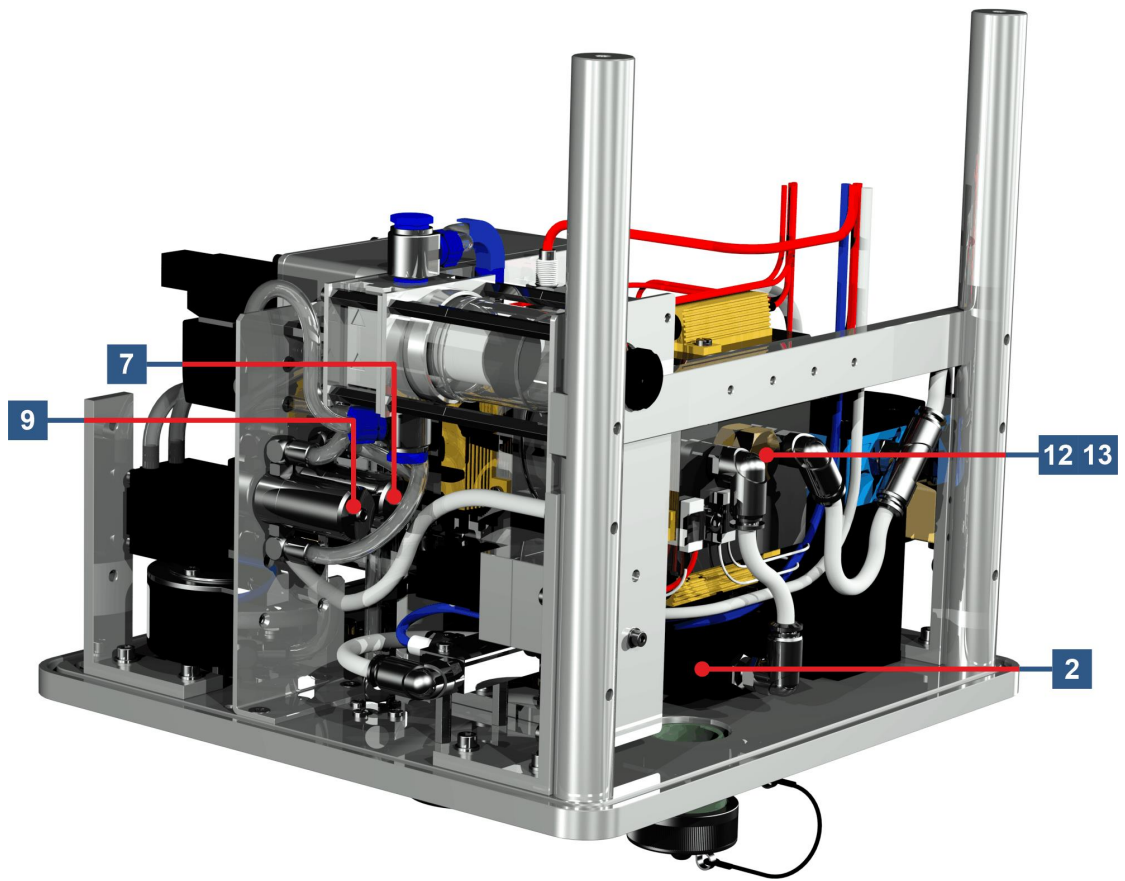
(NC): Valve normally closed (Normally Closed)

(NO): Valve normally open (Normally Open)



Legend	Name	Short designation	(Valve function)
[11]	Flow measurement oil	Flow F1	
[12]	Moisture in oil	Moisture in oil H ₂ O	
[13]	Oil temperature	Temperature T2	
[14]	Filling level sensor zero acknowledgement	Filling level L0	
[15]	Temperature heating extraction chamber	-	
[16]	Filling level sensor low extraction chamber	Filling level L1	
[17]	Filling level sensor high extraction chamber	Filling level L2	
[18]	Gas temperature measurement cell	Temperature T1	
[19]	Gas-moisture measurement cell	-	
[20]	Pressure sensor measurement cell	-	
[21]	Temperature heating measurement cell	-	
[22]	Oil separator	-	





6 Device firmware

6.1 General information

The “gas-in-oil” analysis system of the MSENSE® DGA 5 is based on microprocessor control. A 32-bit “Coldfire” processor with a processor cycle frequency of 240 MHz is used. The device software was developed in programming language “C”. The system has a flash memory of 128 Mbyte capacity for saving the measured data. This corresponds to a memory capacity for measured data for about 16 years. After that, the oldest data are overwritten by the current measured values.

The storage capacity depends on the selected storage interval. The following calculation formula can be used to determine the storage capacity:

$$Memorydepth[days] \approx \frac{128 \cdot 2^{20} [Byte]}{23000 [Byte / day] + \sum_{n=1}^{12} 288 [Byte / day] \cdot Sensorstorages_n [1/Std]}$$

The defined alarms also affect the storage capacity. Each alarm status change requires 12 bytes of space.



Note!!!

To avoid data loss, the measured values should be read out regularly using the Windows-based MSET DGA software.



6.2 Process sequence Gas extraction and gas measurement

This chapter contains a description of the individual process steps and the information regarding safety and the associated functions. In the event of a fault, the process is interrupted and the system is set to a defined state (pump and compressor standstill, all valves closed).

Colour	Aggregate	State
White	Pump: compressor: Level: Flow:	Standstill Standstill not reached not available
Green	Pump: Compressor: Level: Flow: 2/2-way valve: 3/2-way valve:	Operation Operation reached available A-P open A-R closed / A-P open
Yellow	2/2-way valve: 3/2-way valve:	A-P closed A-R open / A-P closed

6.2.1 Zero measurement

In this process step, the zero measurement is executed.

Legend	Condition of the aggregates
[1]	Filling level L0 "not reached"
[2]	Filling level L1 "not reached"
[3]	Filling level L2 "not reached"
[4]	Valve V6 "closed"
[5]	Flow F1 "not available"
[6]	Valve V1 "degassing"
[7]	Valve V3 "closed"
[8]	Compressor K1 "standstill"
[9]	Valve V4 "closed"
[10]	Valve V2 "closed"
[11]	Pump P1 "standstill"
[12]	Valve V5 "open"

09:58:27 Extraction Status 2014-02-10

Safety functions and error detection Zero measurement

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline
Pressure switch	Pressure unstable

6.2.2 Vacuum generation

In this process step, a vacuum is generated in the measurement cell.

Legend	Condition of the aggregates
[1]	Filling level L0 "not reached"
[2]	Filling level L1 "not reached"
[3]	Filling level L2 "not reached"
[4]	Valve V6 "closed"
[5]	Flow F1 "not available"
[6]	Valve V1 "degassing"
[7]	Valve V3 "open"
[8]	Compressor K1 "operation"
[9]	Valve V4 "closed"
[10]	Valve V2 "closed"
[11]	Pump P1 "standstill"
[12]	Valve V5 "open"

09:41:51 **Extraction Status** 2014-02-10

Safety functions and fault detection Vacuum generation

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline
Pressure switch	No pressure drop

6.2.3 Leak testing

This process step checks the pressure stability of the whole system.

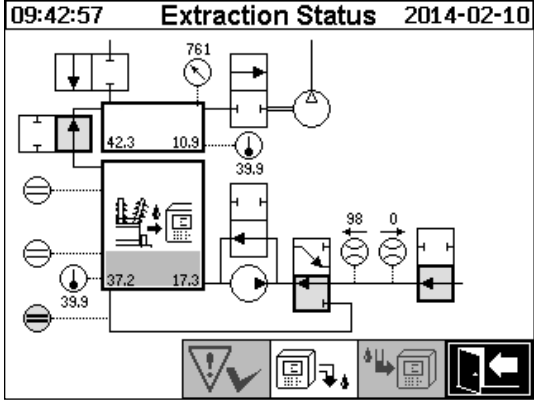
Legend	Condition of the aggregates	
[1]	Filling level L0 "not reached"	
[2]	Filling level L1 "not reached"	
[3]	Filling level L2 "not reached"	
[4]	Valve V6 "closed"	
[5]	Flow F1 "not available"	
[6]	Valve V1 "filling - draining"	
[7]	Valve V3 "closed"	
[8]	Compressor K1 "standstill"	
[9]	Valve V4 "closed"	
[10]	Valve V2 "open"	
[11]	Pump P1 "standstill"	
[12]	Valve V5 "open"	

Safety functions and fault detection Leakage test

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline
Pressure switch	Pressure drop
Flow measurement	Valve V6 does not close properly

6.2.4 Filling level L1

In this process step, the extraction chamber is filled with oil up to filling level L1.

Legend	Condition of the aggregates	
[1]	Filling level L0 "reached"	 <p>09:42:57 Extraction Status 2014-02-10</p> <p>The screenshot shows a process control interface for an extraction system. It features a central diagram of the extraction chamber with various sensors and valves. Numerical values are displayed: 76.1 at the top, 42.3 and 10.9 on the left side, 39.9 on the right side, 37.2 and 17.3 at the bottom left, and 98 and 0 on the right side. The interface includes several icons at the bottom, such as a warning sign, a computer monitor, a printer, and a back arrow.</p>
[2]	Filling level L1 "reached"	
[3]	Filling level L2 "not reached"	
[4]	Valve V6 "open"	
[5]	Flow F1 "present - filling"	
[6]	Valve V1 "filling - draining"	
[7]	Valve V3 "closed"	
[8]	Compressor K1 "standstill"	
[9]	Valve V4 "closed"	
[10]	Valve V2 "open"	
[11]	Pump P1 "standstill"	
[12]	Valve V5 "open"	

Safety functions and fault detection Filling Filling level L1

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L1 or L1 not reached Filling level L2 reached
Filling sensors zero acknowledgement, low and high Flow measurement Time monitoring	<ul style="list-style-type: none"> • Filling level drops • Filling stagnates • Filling timeout
Measurement cell	Measurement cell offline
Pressure switch	<ul style="list-style-type: none"> • Pressure drop • Flow stops

6.2.5 Degasing

In this process step, the gases dissolved in oil are released by way of circulation into the air in the extraction chamber (headspace principle). This results in a balance being achieved in the proportionate quantities of gas between oil and air.

Legend	Condition of the aggregates	
[1]	Filling level L0 "reached"	
[2]	Filling level L1 "reached"	
[3]	Filling level L2 "not reached"	
[4]	Valve V6 "closed"	
[5]	Flow F1 "not available"	
[6]	Valve V1 "degassing"	
[7]	Valve V3 "closed"	
[8]	Compressor K1 "standstill"	
[9]	Valve V4 "closed"	
[10]	Valve V2 "closed"	
[11]	Pump P1 "Operation"	
[12]	Valve V5 "closed"	

Safety functions and fault detection Degassing

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L1 or L1 not reached Filling level L2 reached
Filling sensors zero acknowledgement, low and high	Filling level drops
Measurement cell	Measurement cell offline
Pressure switch	<ul style="list-style-type: none"> Pressure drop Valve V4 does not close properly
Flow measurement	Valve V6 does not close properly

6.2.6 Filling level L2

In this process step, the extraction chamber is filled with oil up to filling level L2 and the gaseous air is forced from the extraction chamber into the measurement cell.

Legend	Condition of the aggregates	
[1]	Filling level L0 "reached"	
[2]	Filling level L1 "reached"	
[3]	Filling level L2 "reached"	
[4]	Valve V6 "open"	
[5]	Flow F1 "present - filling"	
[6]	Valve V1 "filling - draining"	
[7]	Valve V3 "closed"	
[8]	Compressor K1 "standstill"	
[9]	Valve V4 "closed"	
[10]	Valve V2 "open"	
[11]	Pump P1 "standstill"	
[12]	Valve V5 "open"	

Safety functions and fault detection Filling Filling level L2

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Filling sensors zero acknowledgement, low and high Flow measurement Time monitoring	<ul style="list-style-type: none"> Flow stops Drain the flow Filling level timeout (prevents the flooding of the measurement cell)
Measurement cell	Measurement cell offline
Pressure switch	No pressure increase

6.2.7 Gas measurement

In this process step, the gas contents of the air in the measurement cell are measured.

Legend	Condition of the aggregates	
[1]	Filling level L0 "reached"	
[2]	Filling level L1 "reached"	
[3]	Filling level L2 "reached"	
[4]	Valve V6 "closed"	
[5]	Flow F1 "not available"	
[6]	Valve V1 "degassing"	
[7]	Valve V3 "closed"	
[8]	Compressor K1 "standstill"	
[9]	Valve V4 "closed"	
[10]	Valve V2 "closed"	
[11]	Pump P1 "standstill"	
[12]	Valve V5 "open"	

Safety functions and fault detectionGas measurement

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline

6.2.8 Ventilation

This process step is used to ventilate the measurement cell with fresh air.

Legend	Condition of the aggregates	
[1]	Filling level L0 "reached"	
[2]	Filling level L1 "reached"	
[3]	Filling level L2 "reached"	
[4]	Valve V6 "closed"	
[5]	Flow F1 "not available"	
[6]	Valve V1 "degassing"	
[7]	Valve V3 "open"	
[8]	Compressor K1 "operation"	
[9]	Valve V4 "open"	
[10]	Valve V2 "closed"	
[11]	Pump P1 "standstill"	
[12]	Valve V5 "open"	

Safety functions and fault detection Ventilation

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline
Pressure switch	No pressure drop

6.2.9 Draining

This process step is used to drain the extraction chamber. The existing oil is pumped back to the transformer.

Legend	Condition of the aggregates	
[1]	Filling level L0 "reached"	
[2]	Filling level L1 "reached"	
[3]	Filling level L2 "reached"	
[4]	Valve V6 "open"	
[5]	Flow F1 "present - draining"	
[6]	Valve V1 "filling - draining"	
[7]	Valve V3 "open"	
[8]	Compressor K1 "operation"	
[9]	Valve V4 "open"	
[10]	Valve V2 "open"	
[11]	Pump P1 "Operation"	
[12]	Valve V5 "closed"	

Safety functions and fault detection Draining

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Filling sensors zero acknowledgement, low and high Flow measurement Time monitoring	<ul style="list-style-type: none"> Flow stops Fill the flow Filling level timeout (prevents the ingress of air into the transformer)
Measurement cell	Measurement cell offline
Pressure switch	No pressure drop

6.2.10 Waiting

This process step sets the system for waiting / standby until the start of the next measurement cycle.

Legend	Condition of the aggregates	
[1]	Filling level L0 "not reached"	
[2]	Filling level L1 "not reached"	
[3]	Filling level L2 "not reached"	
[4]	Valve V6 "closed"	
[5]	Flow F1 "not available"	
[6]	Valve V1 "degassing"	
[7]	Valve V3 "closed"	
[8]	Compressor K1 "standstill"	
[9]	Valve V4 "closed"	
[10]	Valve V2 "closed"	
[11]	Pump P1 "standstill"	
[12]	Valve V5 "open"	

Safety functions and fault detectionMaintenance

Monitored aggregates	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline

6.3 Operation via the device keyboard

The MSENSE® DGA 5 can be used while in operation via the built-in alphanumeric keypad, the cursor keys and the “Home” key. To do so, the protective hood must be removed. Loosen the knurled screws on the front of the device and carefully remove the protective cover.



6.3.1 Cursor keys

Functions of the cursor keys:



Use the left / right cursor keys to move the cursor horizontally. Entries can be deleted with the left cursor key.



Use the up / down cursor keys to move the cursor vertically or to adjust the contrast of the LCD display when the main menu is active.

6.3.2 “Home” key

Functions of the “Home” key:



Pressing the “Home” key activates or exits the selected function or accesses a sub-menu.

6.3.3 Alphanumeric keypad

Functions of the alphanumeric keypad:



Alphanumeric keypad for customer-specific inputs.

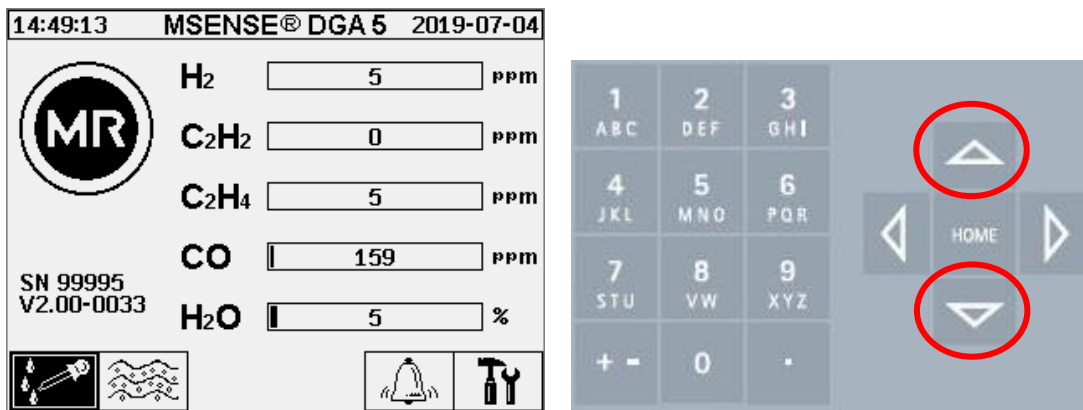
This input is based on the same principle as with mobile phones (not smartphones). By repeatedly pressing the respective alphanumeric key, the corresponding numbers or characters can be entered. The following table shows which key can be used to enter which numbers and characters in the corresponding input format:

Key	 - Choice of input format		
	Uppercase 	Lowercase letters 	Numbers 
	ABC1	abc1	1
	DEF2	def2	2
	GHI3	ghi3	3
	JKL4	jkl4	4
	MNO5	mno5	5
	PQR6	pqr6	6
	STU7	stu7	7
	VW8	vw8	8
	XYZ9	xyz9	9
	_0@{}()<>[]	_0@{}()<>[]	0
	.+*/_#,:;	.+*/_#,:;	.

Remark: After a capital letter is entered, the firmware will automatically switch the format to lowercase.

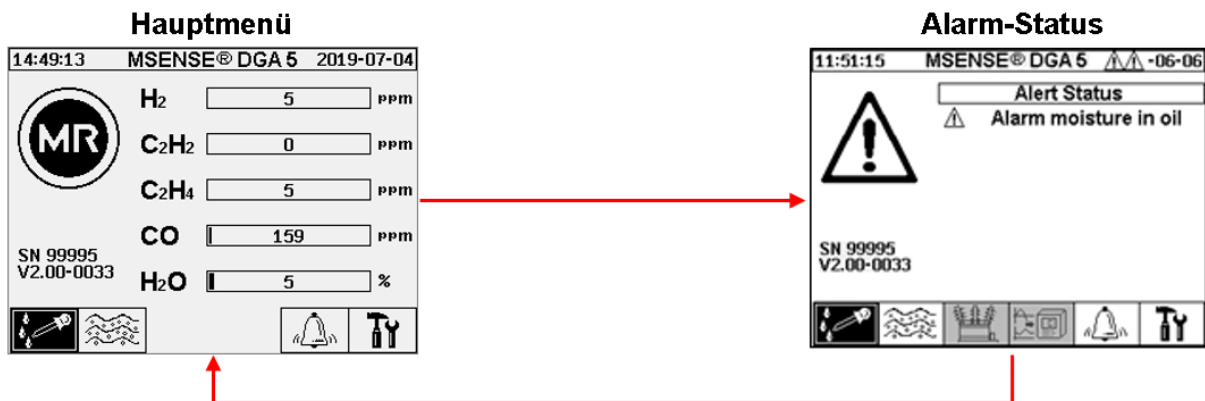
6.3.4 Contrast settings

The contrast of the LCD display can be adjusted using the up / down cursor keys while the main menu is active.







6.4 Main menu



After the MSENSE® DGA 5 has been connected to the supply voltage, a short beep will sound and, after a short period of time, the main menu will appear on the LCD display. The current measurement values of the corresponding gas concentrations and the oil moisture are then displayed. If unconfirmed alarms are present, the display switches periodically every 5 seconds (6.8.4.3) between the main menu and alarm status.



The following sub-menus can be selected from the main menu:

-  Extraction status (6.5)
-  Gas-in-oil measurements (6.6)
-  Alarm / Alarm history (0)
-  Device settings (6.8)

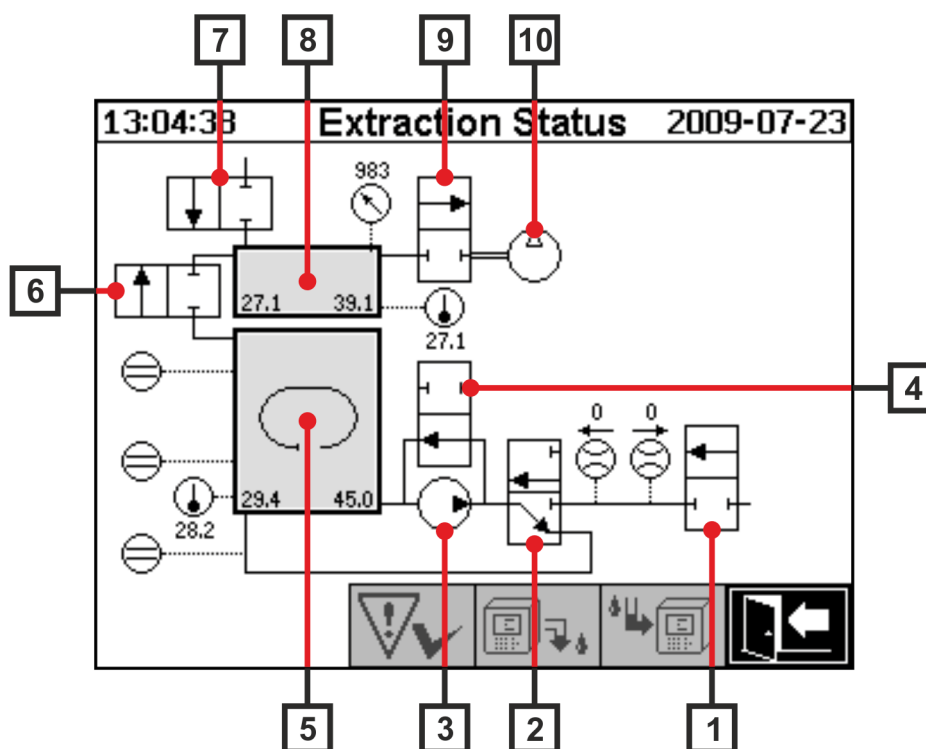
Remark:

- In the main menu you will find the device's serial number (e.g. SN 99995), the installed firmware version (e.g. V 1.00-0859), and the device's IP number (e.g. @ 10.166.1.77) when the Ethernet connection is active.
- To access the "Main menu" screen directly, press the key 
- To access the "Alarm status" screen directly, press the key 

6.5 Extraction status

The extraction status menu displays the measuring and sampling components of the MSENSE® DGA 5 in the form of a hydraulic function diagram. These are displayed actively (shaded grey) and change their status according to the current process step (6.2):

Removal components:



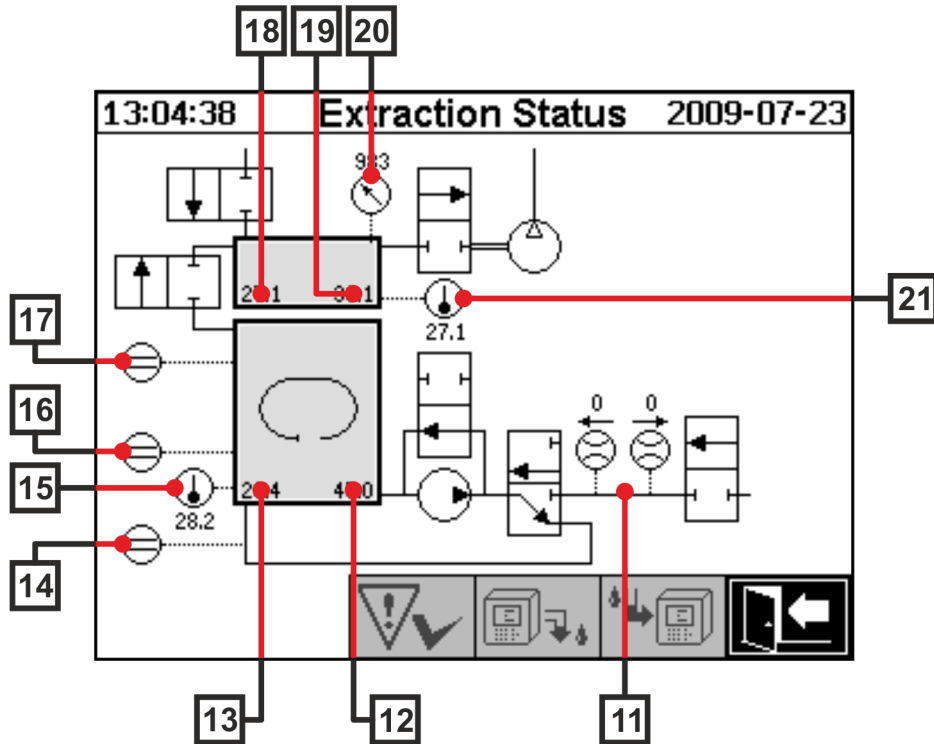
Legend	Name	Short designation	(Valve function)
[1]	Inlet / outlet valve	Valve V6	(NC)
[2]	Degassing	Valve V1	(NC)
[3]	Oil pump	Pump P1:	-
[4]	Bypass valve oil pump	Valve V5	(NO)
[5]	Extraction chamber	-	-
[6]	Measurement cell isolation valve	Valve V2	(NC)
[7]	Ventilation valve	Valve V4	(NC)
[8]	Measurement cell	-	-

[9]	Vacuum valve	Valve V3	(NC)
[10]	Vacuum compressor	Compressor K1	-

(NC): Valve normally closed (Normally Closed)

(NO): Valve normally open (Normally Open)

Measuring components:

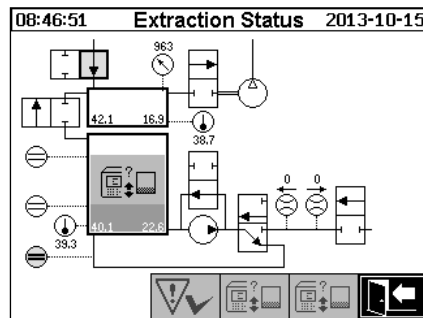


Legend	Name	Short designation	(Valve function)
[11]	Flow measurement oil	Flow F1	
[12]	Moisture in oil	Moisture in oil H ₂ O	
[13]	Oil temperature	Temperature T2	
[14]	Filling level sensor zero acknowledgement	Filling level L0	
[15]	Temperature heating extraction chamber	-	
[16]	Filling level sensor low extraction chamber	Filling level L1	
[17]	Filling level sensor high extraction chamber	Filling level L2	
[18]	Gas temperature measurement cell	Temperature T1	
[19]	Gas-moisture measurement cell	-	
[20]	Pressure sensor measurement cell	-	

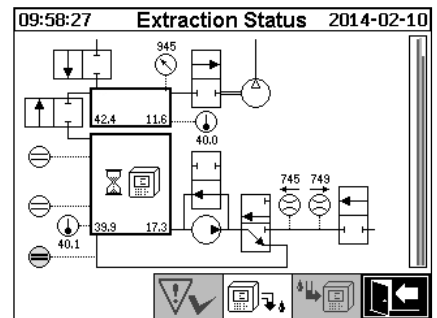
Overview of possible states:

MSENSE® DGA 5 inactive
(deactivated)

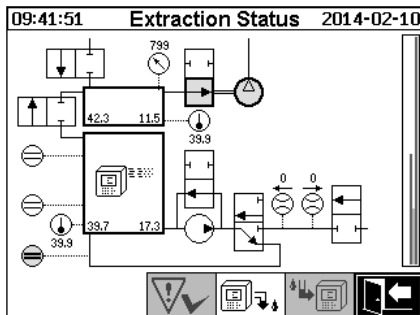
Initialisation cycle



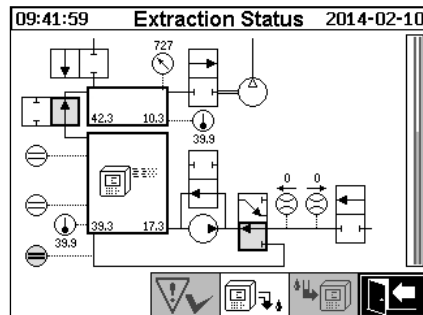
Zero measurement



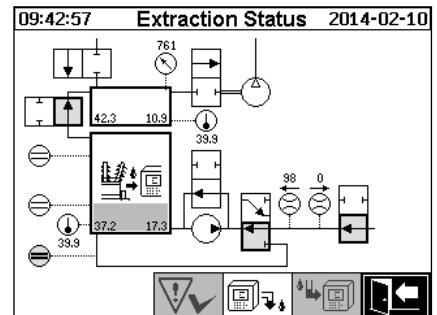
Vacuum generation



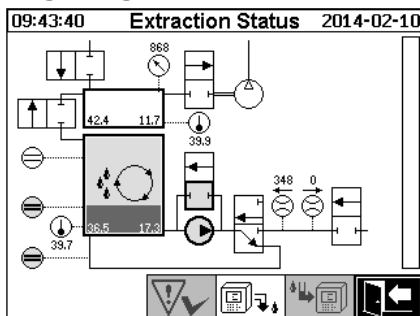
Leak testing



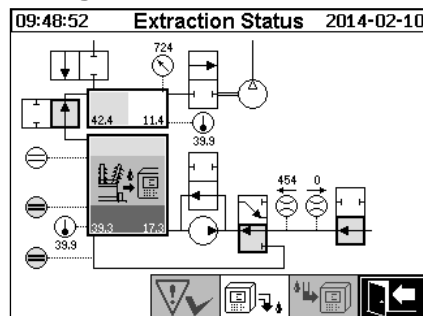
Filling level 1



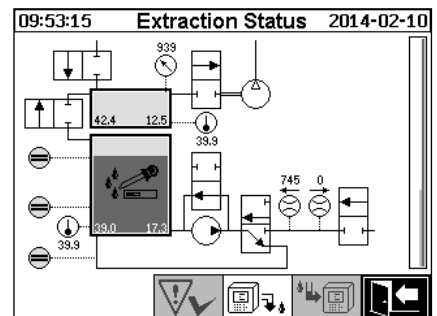
Degasing



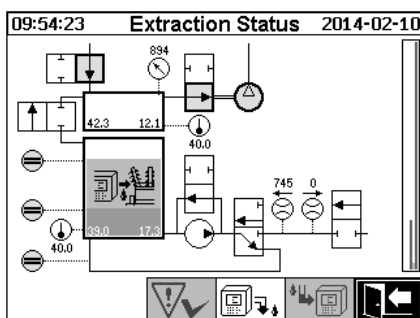
Filling level 2



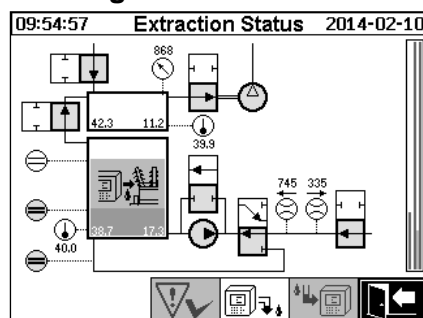
Gas measurement



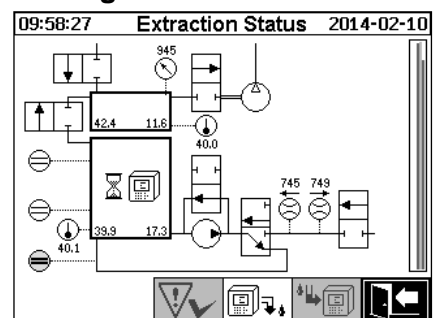
Ventilation



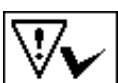
Draining



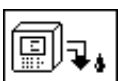
Waiting



The following functions are available in the extraction status menu:



Acknowledgement of extraction fault (6.5.1)



Deactivate device (6.5.2)




Activate device (6.5.3)

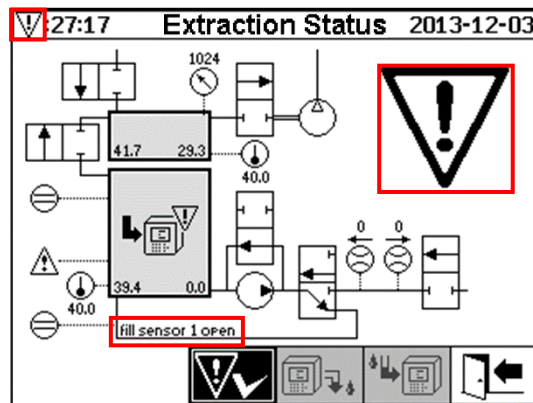


Exit menu

6.5.1 Acknowledge extraction fault

After an extraction fault has occurred and this has once again been corrected, it can be acknowledged with the key .


The fault is visualised with an additional information line (below the extraction chamber) and warning symbols (header and to the right of the compressor).



Remark: The large warning symbol is also visualised in the main menu. The small warning symbol is visualised in every menu.


Further information on individual faults can be found in the chapter “Extraction fault – Extraction status menu” (9.1.6.4).

6.5.2 Deactivate device

The key  deactivates the device (often the term “unmount” is used). Afterwards, the device can be de-energised and disassembled.

The deactivation procedure can be found in the chapter on “Finishing the installation” (4.4.3).

6.5.3 Activate device

The key  activates the device (the term “mount” is often used). The initialisation cycle is then started. This detects the device’s current state and establishes a defined state of the system.

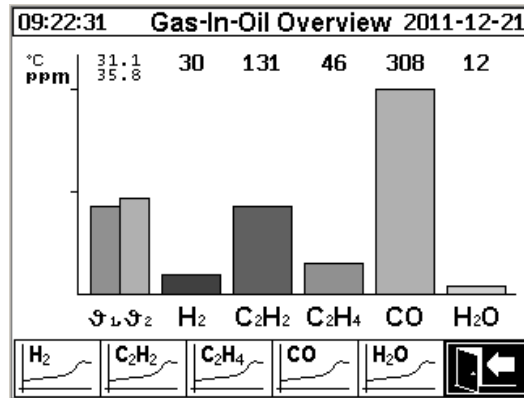
The activation procedure can be found in the chapter on “Finishing the installation” (4.4.3).

6.6

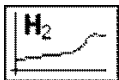


Gas-in-oil measurements

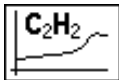
In the menu “Gas-in-oil measurements”, an overview of the measured gases is displayed as a bar chart. The measurement values H_2 , C_2H_2 , C_2H_4 , CO and H_2O each show the current gas content found in the oil. In the picture below, the proportions are shown as follows: H_2 30 ppm, C_2H_2 131 ppm, C_2H_4 46 ppm, CO 308 ppm and H_2O 12 ppm. The double bar on the left of the picture shows the temperatures ϑ_1 at 31.1 ° C (gas temperature measurement cell T1) and ϑ_2 at 35.8 ° C (oil temperature extraction chamber T2).



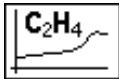
The following values are available with this MSENSE® DGA 5 device:



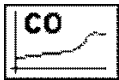
Hydrogen



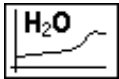
Acetylene



Ethylene



Carbon monoxide



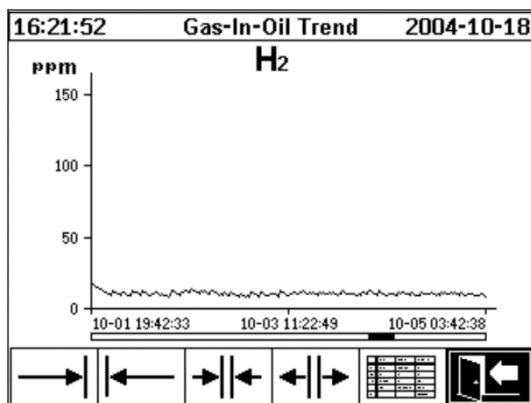
Moisture in oil



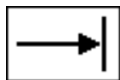
temperatures: - ϑ_1 Gas temperature measuring cell (T1)
- ϑ_2 Oil temperature extraction chamber (T2)

6.6.1 Graphical display

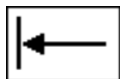
After selecting the measurement variable to be displayed, its graphic time history is displayed.



The following functions are available in the time line display:



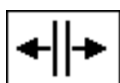
Scroll to the right on the time line (future)



Scroll to the left on the time line (past)



Expand presentation. The smallest resolution is 3 days / page



Zoom out. The largest resolution is 8 hours / page



Switch to tabular display



Exit menu

6.6.2

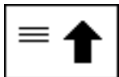


Tabular display

The tabular display shows the measured values together with the record number, date and time. The presentation is chronological and the last measurement is always inserted at the top.

11:06:01		Gas-In-Oil Data		2014-08-22	
No.	Time	H ₂			
9780	01-20 09:36:00	7			
9779	01-20 09:16:00	7			
9778	01-20 08:56:00	7			
9777	01-20 08:36:00	7			
9776	01-20 08:16:00	7			
9775	01-20 07:56:00	7			
9774	01-20 07:36:00	7			
9773	01-20 07:16:00	7			
9772	01-20 06:56:00	7			
9771	01-20 06:36:00	7			
9770	01-20 06:16:00	7			
9769	01-20 05:56:00	7			
9768	01-20 05:36:00	7			
9767	01-20 05:16:00	7			
9766	01-20 04:56:00	7			

The following functions are available in the tabular display:



Scroll one line up



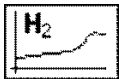
Scroll one page up



Scroll one page down



Scroll one line down



Switch to the time line view





Exit menu






6.7



Alarm / Alarm history






In the menu “Alarm / Alarm history” all configured alarms are displayed in tabular form.

14:40:58 Alert Overview  -06-06			
Selection of Alert			
#	Name	Date/Time	Status
1	Alarm moisture in oil	06-06 11:36	
2	H2-Alarm	06-06 14:36	✓
3	CO-Alarm	06-06 14:36	✓
4	Alarm oil temperat...	06-06 14:36	✓

All configured alarms are displayed with the corresponding status information. The “Date / Time” column shows the time of the most recent status change.

The symbols in the “Status” column mean the following:

- **✓ Symbol - OK:** There is no active alarm for this measurement variable.
 - There is a date entry: There was an alarm in the past for this measurement variable, which was confirmed at the time shown.
 - There is no date entry: There was no alarm for this measurement variable in the past.
- ** Symbol - One-level threshold limit breach active:** The defined threshold value “Threshold 1” is currently exceeded. The threshold value was breached at the point in time shown.
- ** Symbol - One-level threshold limit breach inactive:** The defined threshold value “Threshold 1” was exceeded in the past. The threshold value “Threshold 1” was breached again at the point in time shown.
- **Two-level threshold limit breach active:**
 - ** Symbol:** The defined threshold values “Threshold 1” and “Threshold 2” are currently exceeded. The threshold value “Threshold 2” was breached at the point in time shown.
 - ** Symbol:** The defined threshold values “Threshold 1” and “Threshold 2” were exceeded in the past. The threshold value “Threshold 2” was again undershot at the time shown, but is still above the threshold value “Threshold 1”.
- ** Symbol - Two-level threshold limit breach inactive:** The defined threshold values “Threshold 1” and “Threshold 2” were exceeded in the past. The threshold value “Threshold 1” was breached again at the point in time shown.

The following functions are available in the “Alarm / Alarm history” menu:



Acknowledge selected alarm (6.7.1)



Scroll one line up



Scroll one line down



Alarm settings of the selected alarm (6.7.2)



Exit menu

6.7.1 Alarm acknowledgement

Password entry is required to acknowledge the selected alarm (standard password: 123456)



After entering the corresponding password using the alphanumeric keyboard and confirming with the “Home” key, the alarm is acknowledged.

Remark: Every alarm must be acknowledged individually in the firmware.

6.7.2 Alarm settings of the selected alarm

In the sub-menu “Alarm settings” the detailed information of the selected alarm is displayed.

14:43:42 Alert ⚠️⚠️ -06-06		
Alarm moisture in oil		
Alert #1. Sensor= H2O		
Settins	Value	Unit
Mode	High	
Level 1	20	ppm
Delay 1	0:20:00	s
Action 1	Output	
Clamp 1	Out 2	Relay

Details regarding the corresponding alarm settings can be found in chapter (0).




6.8



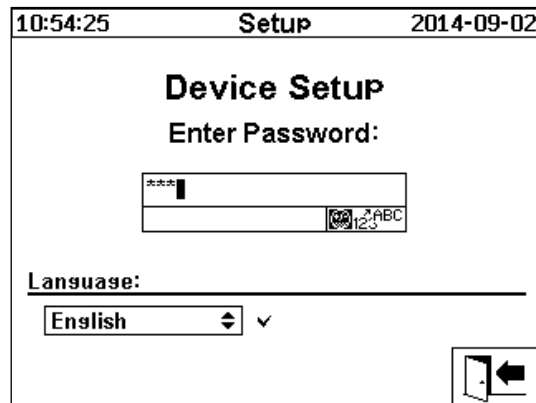
Device settings

The user language can be selected on the MSENSE® DGA 5. The following languages are available: English, German, French, Russian, Turkish, Spanish, Portuguese and Polish.

Select the language selection field using the cursor key. By repeatedly pressing the “Home” key you can select the desired language.

If the language is changed, the  icon appears to the right of the language selection box. This must be selected using the cursor  and confirmed with the “Home” key. The  symbol indicates the selected language.

Before changes can be made to the device settings, the password is requested first (standard password 123456).



After entering the corresponding password using the alphanumeric keyboard and confirming with the “Home” key, the “Device settings” menu is opened.



The following sub-menus can be selected in the menu “Device settings”:



Transformer-related settings (6.8.1)



Settings analogue outputs (6.8.2)



Alarm settings (0)



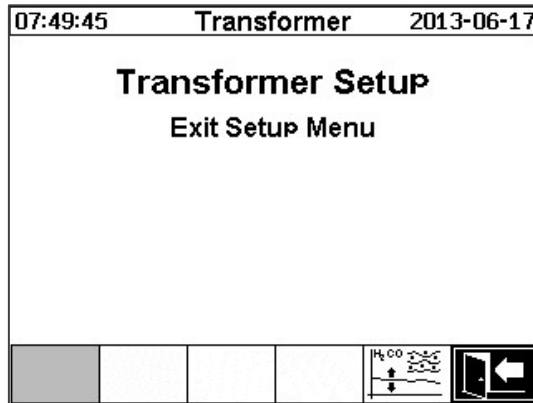
MSENSE® DGA 5 settings (6.8.46.8.4)



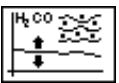
Exit settings menu

6.8.1 Transformer-related settings

Transformer-specific information can only be entered and managed on the PC using the MSET DGA programme. However, this information is not absolutely necessary in order to operate the device.



The following sub-menus can be selected in the “Transformer-related settings” menu:



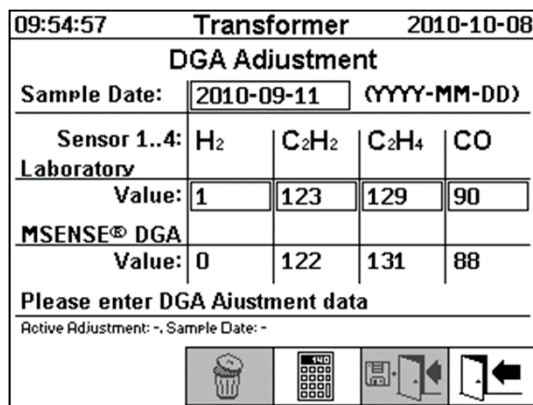
DGA adjustment (6.8.1.1)




Exit settings menu


6.8.1.1 DGA adjustment





In the menu “DGA adjustment”, results from laboratory analyses can be entered. These can then be used to calculate correction factors, which are then applied to determine the gas content.








To enter results from laboratory analyses, the date of the analysis should first be entered in the “Sample date” field. The daily average gas concentrations of the MSENSE® DGA 5 are then determined and

displayed in the “MSENSE® DGA 5 value” fields. After the results of the laboratory analysis have been entered in the “Laboratory value” fields for H₂, C₂H₂, C₂H₄, and CO the  key is rendered active.

After pressing the  key, the new correction factors are calculated. Following a short calculation time, as indicated by the hourglass symbol, the following message appears on the LCD display: “Determination of DGA adjustment successful.”

09:54:57		Transformer		2010-10-08	
DGA Adjustment					
Sample Date:	2010-09-11	(YYYY-MM-DD)			
Sensor 1..4:	H ₂	C ₂ H ₂	C ₂ H ₄	CO	
Laboratory					
Value:	1	123	129	90	
MSENSE® DGA					
Value:	0	122	131	88	
Active Adjustment: -, Sample Date: -					
   					

The new values are saved and activated by leaving the menu using the “Save and exit” key . The new correction factors are now applied to the following measured values.

09:54:57		Transformer		2010-10-08	
DGA Adjustment					
Sample Date:	2010-09-11	(YYYY-MM-DD)			
Sensor 1..4:	H ₂	C ₂ H ₂	C ₂ H ₄	CO	
Laboratory					
Value:	1	123	129	90	
MSENSE® DGA					
Value:	0	122	131	88	
Active Adjustment: -, Sample Date: -					
   					

6.8.2 Settings – analogue outputs

The MSENSE® DGA 5 device has 5 analogue current outputs, which can be operated with 0 ... 20 mA or 4 ... 20 mA. These can be used as outputs for the gas-in-oil concentration and the moisture-in-oil.

The standard factory setting / assignment is as follows:

Output #1:	Mode: 4 ... 20 mA	Sensor: H ₂ concentration
Output #2:	Mode: 4 ... 20 mA	Sensor: C ₂ H ₂ concentration
Output #3:	Mode: 4 ... 20 mA	Sensor: C ₂ H ₄ concentration
Output #4:	Mode: 4 ... 20 mA	Sensor: CO concentration
Output #5:	Mode: 4 ... 20 mA	Sensor: H ₂ O concentration

In the menu, test currents can be set which override the current values. These are used for checking the installation. When exiting the menu, the current values are then re-issued.

14:30:08			Analog Output		2013-12-04	
Output	Mode	Sensor				
#1	4..20mA	Default				
Value [mA]	0.0	4.1				20.0
#2	4..20mA	Default				
Value [mA]	0.0	4.0				20.0
#3	4..20mA	Default				
Value [mA]	0.0	4.0				20.0
#4	4..20mA	Default				
Value [mA]	0.0	4.0				20.0
#5	4..20mA	Default				
Value [mA]	0.0	5.4				20.0

Analogue output 1 - X301:1(+) & 2(-)

Analogue output 2 - X301:3(+) & 4(-)

Analogue output 3 - X301:5(+) & 6(-)

Analogue output 4 - X301:7(+) & 8(-)

Analogue output 5 - X301:9(+) & 10(-)

The following selection can be made in the Sensor column:

- Standard
- H₂ - C₂H₂ - C₂H₄ - CO - H₂O concentration
- H₂ - C₂H₂ - C₂H₄ - CO - H₂O daily trend
- H₂ - C₂H₂ - C₂H₄ - CO - H₂O weekly trend
- Temperature ϑ1 (T1 Gas temperature measuring cell)
- Temperature ϑ2 (T2 Oil temperature extraction chamber)

The following selection can be made in the Mode column:


- Out
- 0...20 mA
- 4...20 mA
- Test

For simulation and test purposes, a current of between 0 and 20 mA can be activated at the outputs. To do so, the selection “Test” must be made for the corresponding analogue output in the Mode column and the cursor must be in the “Sensor” column. By repeatedly pressing the “Home” key, you can switch between the following current values:

0, 1, 3, 4, 5, 10, 15, 19 and 20 mA.

Remark: When exiting the menu, the test signals are automatically switched off and the corresponding configured sensor is reassigned to the output.

At the end, all entered values are saved and activated by pressing the “Save and exit menu” key 

. If you do not want to save the values, simply exit the menu using the “exit menu” key .

6.8.3 Alarm limits and alarm sources

With this MSENSE® DGA 5 you have the possibility to configure 16 different alarms. The alarms can be issued to the relay outputs. When the status is “On” the contact is closed, when the status is “Off” the contact is open (with output # 1 the function can be inverted by means of a “Jumper” on the measuring and controller card (see 5.3).






Remark: The system fault can be individually set to one of the outputs (standard: relay output 1) (6.8.4.2). This may not be additionally occupied by one of the 16 alarms!

12:43:38		Alert		2013-06-07	
Setup / Edit Alert					
#	Type	Name	Unit	Alert	
1	Hum.	Alarm moisture in...	ppm	☒ 2	
2	Gas	H2-Alarm	ppm	☒ 2	
3	Gas	CO-Alarm	ppm	☒ 2	
4	Temp.	Alarm oil temper...	°C	☒ 2	
5	--	--			
6	--	--			
7	--	--			
8	--	--			
9	--	--			
10	--	--			

The alarm summary table contains the following information:

#	Number:	1 ... 16
Type	Type:	Gas / Temp. / Hum. / Trend
Name	Name:	Free naming - e.g. oil temperature high
Unit	Unit:	Depending on the measurement variable – e.g. ppm / ° C
Alert	Output:	LOG entry / exit with number - e.g. ☒, ☒ 2, ☒ 2.6 etc.

The following functions / sub-menus are available in the alarm summary table

-  Highlight upwards
-  Highlight downwards
-  Create new alarm (6.8.3.1)
-  Alarm settings (6.8.3.2)
-  Exit menu (without saving)



6.8.3.1




Create new alarm

To create a new alarm, use the cursor keys to select the desired free alarm number:


14:58:00		Alert		-06-11	
Setup / Edit Alert					
#	Type	Name	Unit	Alert	
1	Hum.	Alarm moisture in...	ppm	☒ 2	
2	Gas	H2-Alarm	ppm	☒ 2	
3	Gas	CO-Alarm	ppm	☐	
4	Temp.	Alarm oil temper...	°C	☐	
5	--	--			
6	--	--			
7	--	--			
8	--	--			
9	--	--			
10	--	--			

As soon as the  key is pressed, the  key appears in its place and the desired measurement variable can be selected by pressing it several times.

15:03:53		Alert		2013-06-11	
Setup / Edit Alert					
#	Type	Name	Unit	Alert	
1	Hum.	Alarm moisture in...	ppm	☒ 2	
2	Gas	H2-Alarm	ppm	☒ 2	
3	Gas	CO-Alarm	ppm	☐	
4	Temp.	Alarm oil temper...	°C	☐	
5	--	--			
6	--	--			
7	Gas	**H2	ppm	**	
8	--	--			
9	--	--			
10	--	--			

The following measurement variables are available by pressing the  key several times:

- Gas H₂ - C₂H₂ - C₂H₄ - CO - concentration
- Temp. T1 (ϑ1 gas temperature measurement cell)
T2 (ϑ2 oil temperature extraction chamber)
- Hum. H₂O - concentration
- Trend H₂ - C₂H₂ - C₂H₄ - CO - daily trend
- Trend H₂ - C₂H₂ - C₂H₄ - CO - weekly trend

Once you have selected the desired measurement variable, use the cursor key to switch to the  key (6.8.3.2).

6.8.3.2



Alarm settings

After creating a new alarm and by selecting it with the key, the following functions are available:

12:53:12	Alert	2006-11-10
CO-Alert(#2)		
Alert #2, Sensor= CO		
Settings	Value	Unit
Mode	High-High	
Level 1	850	ppm
Delay 1	0:10:00	s
Action 1	Output	
Clamp 1	Out 1	Relay
Level 2	950	ppm
Delay 2	0:20:00	s
Action 2	Output	
Clamp 2	Out 2	Relay



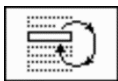
Delete alarm



Highlight upwards



Highlight downwards



Switches between the existing selections in the lines:
Mode, action 1/2 and output 1/2 (if an output was selected during the action)



Activates the entry from the alphanumeric keypad for the lines:
Threshold value 1/2 and delay 1/2



Save and exit menu



Exit menu


6.8.3.2.1 Alarm settings – Mode

In the line mode, the following selection can be made by pressing the key:

- **High:** An alarm is triggered when threshold 1 is exceeded.
- **High - High:** A two-level alarm is triggered. The first stage of the alarm is triggered after threshold 1 has been exceeded, while the second stage is triggered when threshold 2 has been exceeded.
- **Low:** An alarm is triggered when threshold 1 is undershot.
- **Low - low:** A two-level alarm is triggered. The first stage of the alarm is triggered after threshold 1 has been undershot, while the second stage is triggered when threshold 2 has been undershot.

- **Low - High:** A two-level alarm is triggered if the measured value is outside the range. The first stage of the alarm is triggered after threshold 1 has been undershot, while the second stage is triggered when threshold 2 has been exceeded.
- **Area:** An alarm is triggered if the measurement value is within the range defined by Threshold Value 1 and Threshold Value 2.

6.8.3.2.2 Alarm settings – Threshold

The alarm settings can be edited using the  key, the arrow keys and the alphanumeric keypad.

The unit is defined by the measurement variable:

- ppm Gas Concentration H₂ - C₂H₂ - C₂H₄ - CO
- °C Temp. Temperatures T1 - T2
- ppm Hum. Concentration H₂O
- ppm/d Trend Gas concentration – daily trend H₂, C₂H₂, C₂H₄, CO
- ppm/w Trend Gas concentration – weekly trend H₂, C₂H₂, C₂H₄, CO

The alarm limits (threshold 1/2) must be within the respective measurement ranges.

These are:







- 0 ... 2,000 ppm Gas concentration H₂ - C₂H₂ - C₂H₄
- 0 ... 5,000 ppm Gas concentration CO
- 0 ... 100 ppm Moisture in oil H₂O
- -20 ... 100 ° C Temperature T1, T2

6.8.3.2.3 Alarm settings – Delay

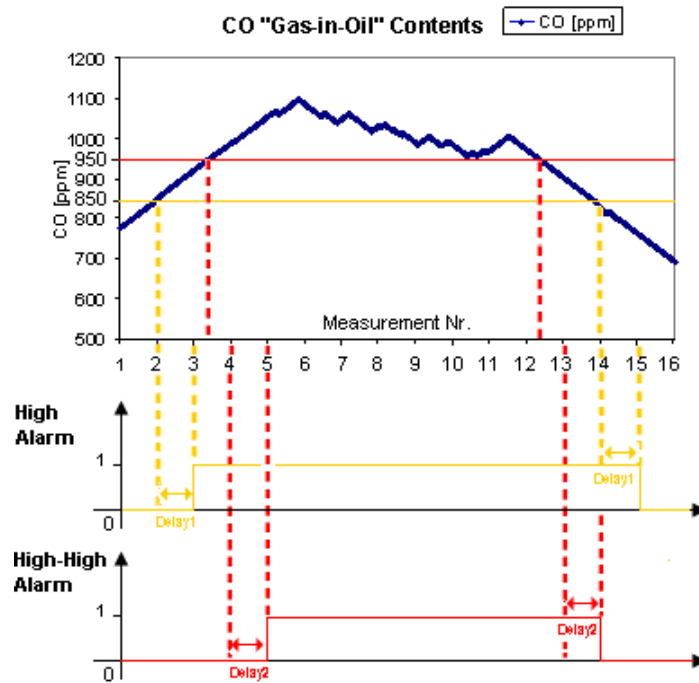
The delays are used to suppress the alarm that has been triggered in situations where the threshold is briefly exceeded or undershot.

The delay can be entered in seconds or in hours - minutes - seconds. To enter the colon, please use the "0" key. After confirming the entry using the Enter key, the input value is displayed in the format [Hours]: [Minutes]: [Seconds].

Example: CO alarm is set as follows:


12:53:12	Alert	2006-11-10
CO-Alert(#2)		
Alert #2, Sensor= CO		
Settings	Value	Unit
Mode	High-High	
Level 1	850	ppm
Delay 1	0:10:00	s
Action 1	Output	
Clamp 1	Out 1	Relay
Level 2	950	ppm
Delay 2	0:20:00	s
Action 2	Output	
Clamp 2	Out 2	Relay
     		







If the threshold is exceeded, the following sequence of events occurs:



Remark: The measurement interval of the “gas-in-oil” measurement lasts 20 min.

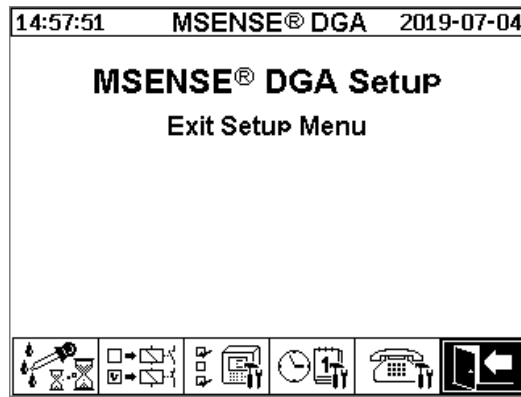
6.8.3.2.4 Alarm settings – Action

When in the line action, the following selection can be made by pressing the  key:

- **Entry** : A status change is saved in the alarm history, this must be acknowledged.
- **Output**  2: A status change is saved in the alarm history, this must be acknowledged. In addition, an output is set depending on the selected mode when the threshold is breached either upwards or downwards. This output is reset as soon as the alarm is no longer pending.
- **Output held**  2: A status change is saved in the alarm history, this must be acknowledged. In addition, an output is set depending on the selected mode when the threshold is breached either upwards or downwards. When leaving the alarm condition, the output remains switched on until it is acknowledged manually.
- **Entry** : A status change is saved in the alarm history, this must be acknowledged.
- **Output**  2: A status change is saved in the alarm history, this must be acknowledged. In addition, an output is set depending on the selected mode when the threshold is breached either upwards or downwards.
- **Output held**  2: A status change is saved in the alarm history, this must be acknowledged. In addition, an output is set depending on the selected mode when the threshold is breached either upwards or downwards. When leaving the alarm condition, the output remains switched on until it is acknowledged manually.

Remark: The entry in the alarm history is always active as soon as an alarm has been defined!!!

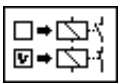
It is possible to assign different alarms to the same output, in order that so-called “collective alarms” can be defined.



The following sub-menus can be selected in the MSENSE® DGA 5 settings:



DGA measurement cycle interval (6.8.4.1)



Test relay outputs (6.8.4.2)



Device options (6.8.4.3)



Date, time, clock settings (6.8.4.4)



Communication / Interfaces (6.8.4.5)



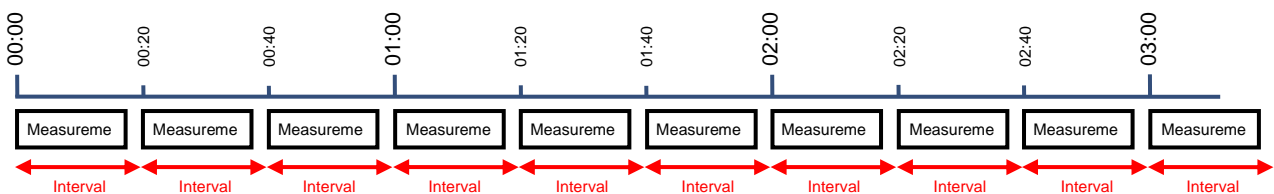
Exit settings menu

6.8.4.1

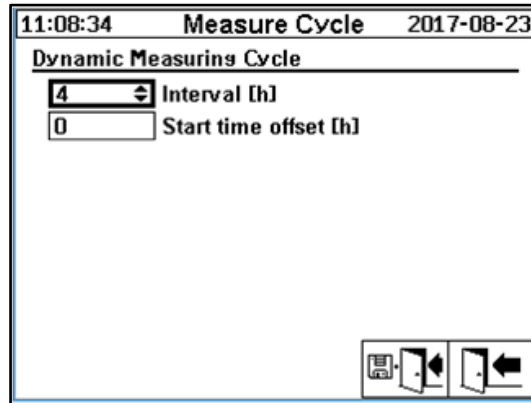


DGA measurement cycle interval

The DGA measurement cycle interval defines the time range between the start of the measurement and the start of the following measurement cycle. As per the factory settings, the MSENSE® DGA 5 starts the measurement cycles in a standard interval of 20 minutes. The measurement cycle starts synchronously with the time either at xx: 00, xx: 20 or xx: 40 and lasts at least 15 ... 18 minutes. The duration of the measurement cycle can not be changed.



Instead of the standard 20-minute interval, the DGA measurement cycle interval can be increased to 2, 4, 8, 12 or 24 hours. The measurement cycle begins synchronously with the time (full hour). The starting reference is 00:00.



Interval [h]

In the Interval [h] selection field, the following interval values can be selected:

- - (* Deactivated*) - Standard interval every 20 minutes
- 2, 4 (factory setting), 8, 12 or 24

Start time offset [h]

Using the start time offset [h] option, the start time of an interval can be shifted by whole hours.

- Input range: 0 ... (Interval - 1) [h]

Example:

Interval [h]	Start offset [h]	Start of the measurement by
--	(Not selectable)	00:00 / 00:20 / 00:40 / 01:00 / 01:20 / 01:40 / 02:00 / ...
2	0	00:00 / 02:00 / 04:00 / 06:00 / 08:00 / 10:00 / 11:00 / ...
2	1	01:00 / 03:00 / 05:00 / 07:00 / 09:00 / 11:00 / 13:00 / ...
4	2	02:00 / 06:00 / 10:00 / 14:00 / 18:00 / 22:00 / 02:00 / ...
8	0	00:00 / 08:00 / 16:00 / 00:00 / 08:00 / 16:00 / 00:00 / ...
8	3	03:00 / 11:00 / 19:00 / 03:00 / 11:00 / 19:00 / 03:00 / ...

Start reference

Remark: The measurement values are available no later than 20 minutes after the start of the measurement.

6.8.4.1.1 Dynamic DGA measurement cycle interval

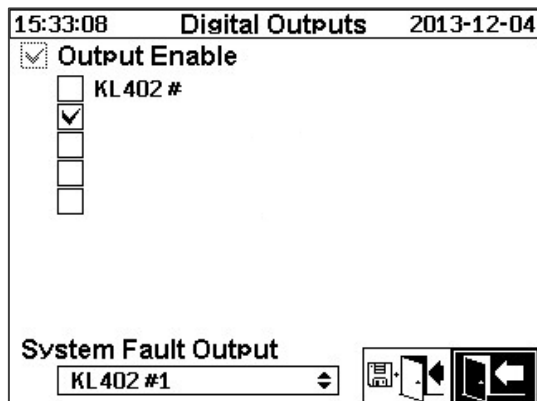
The desired time span can be set by the user (standard setting 4 hours).

Switching to a slower measurement cycle takes place automatically when a stable measurement is detected. The slow measurement cycle also automatically switches to the fast / normal measurement when a significant change in the measurements is detected.

6.8.4.2 Test relay outputs

In order to test the outputs and their peripherals, the alarm outputs in this menu can be set manually. Use the cursor keys to select the desired output and then the "Home" key to switch the output on and off.

5 relay outputs are labelled KL402 # (see chapter 5.3) [9] - X402:1 ... 5).



6.8.4.2.1 System fault

The MSENSE® DGA 5 boasts a system monitoring function with fault notification, which can be issued via a digital output.

The following internal sources of fault are monitored:

- Loss of time
- Data storage not ready
- RTC not ready for operation (buffer capacitor empty)

The system fault can be individually set to one of the 5 outputs (standard: relay output 1). The selection can be made in the field system fault output:

- KL402 #1 X402:1&2 (Relay output 1)
- KL402 #2 X402:3&4 (Relay output 2)
- KL402 #3 X402:5&6 (Relay output 3)
- KL402 #4 X402:7&8 (Relay output 4)
- KL402 #5 X402:9&10 (Relay output 5)
- - (no assignment of the system fault to an output)

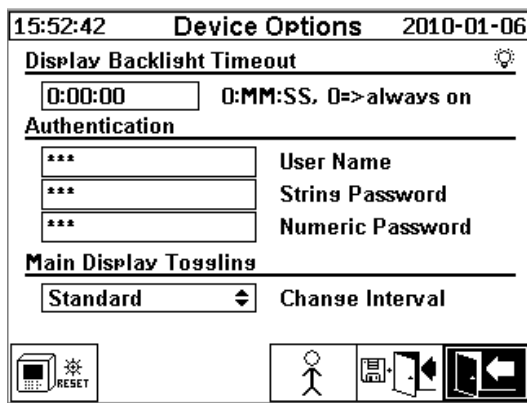
If the output has already been allocated an alarm, the terminal number is displayed with an exclamation mark (e.g.: ! KL402 #2).

When in a fault-free state, the contact is closed or the output circuit is switched through. In the event of a fault, the contact is open or the output circuit is open.

Remark: With the relay output 1 (KL402 # 1), the function can be inverted by means of Jumper J1 on the measuring and controller card (5.3).

6.8.4.3 Device options

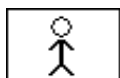
In this menu the display lighting time, the authentication and the change of the main screen display (main menu) can be set:



The following sub-menus can be selected in the “Device options” menu:



Pressing the reset key performs a software reset in the device.



Customer data settings (6.8.4.3.1)




Save and exit menu



Exit menu

Display lighting time

The delayed switch off of the display lighting, following active operation, can be entered in seconds or in hours - minutes - seconds. To enter the colon, please use the "0" key. After confirming the entry using the Enter key, the input value is displayed in the format [Hours]: [Minutes]: [Seconds].

Remark: With the setting 0:00:00 the display lighting remains permanently switched on. When the  symbol is selected and the “Home” key is pressed, the display light turns off manually.

Remark: The display lighting is also switched on when communicating with the MSENSE® DGA 5 device via the serial interface RS232 (for service purposes only).

Authentication

Some settings and operations of the MSENSE® DGA 5 are protected by way of a user name and password:

- User name (standard user name: MR Service)
- Password sign (standard password sign: MRDGA)
- Password digits (standard password digits: 123456)
 - Device settings
 - Customer data settings
 - Acknowledgement of alarms

Changing the main screen display – Main menu

The content of the main menu display changes in a defined cycle. The following selection can be made by pressing the “Home” key in the “Change interval” field:

- Standard Change every 5 seconds
- Slow Change every 15 seconds
- Very slow Change every 25 seconds

6.8.4.3.1



Customer data settings

15:11:13 Customer Data 2013-06-12



Customer Data Setup

Customer

Station

Transformer

Comment

The desired field is selected by using the Cursor and “Home” key. The entry is made using the alphanumeric keypad and the cursor keys and is completed by pressing the “Home” key. The input field allows you to enter a maximum of 26 characters. In the main menu, however, only 10 characters are displayed.



Save and exit menu



Exit menu

6.8.4.4



Date, time, clock settings

The MSENSE® DGA 5 has a sub-menu in which the system time, system date, time offset and daylight saving time mode can be set.

15:12:40	Clock-Settings	2013-06-12
System Time:		
<input type="text" value="15:12:30"/>	(HH:MM:SS)	
System Date:		
<input type="text" value="2013-06-12"/>	(YYYY-MM-DD)	
Clock Offset:		
<input type="text" value="None"/>	([-]HH:MM)	
Daylisth Savins Time Mode:		
<input type="text" value="MET"/>		

The following input formats are to be considered for the system time and date:

System time: [Hours]:[minutes]:[seconds] (enter the colon using the “.” key)

System date: [Year]-[Month]-[Day] (Enter the minus using the “+/-” key)

15:16:58	Clock-Settings	2013-06-12
System Time:		
<input type="text" value="15:17:00"/>	(HH:MM:SS)	
System Date:		
<input type="text" value="2013-06-12"/>	(YYYY-MM-DD)	
Clock Offset:		
<input type="text" value="Custom"/>	<input type="text" value="01:30"/>	([-]HH:MM)
Daylisth Savins Time Mode:		
<input type="text" value="MET"/>		

Time offset

The time offset can be used to set the time with respect to Greenwich Mean Time (GMT). The following settings can be made with the “Home” key:

- None
- +01:00 to +06:00
- Users
- -06:00 to -01:00

With the User setting, the desired time shift can be entered in the right-hand field in [Hours]:[Minutes]. As a colon, the “.” key is used.

Remark: “None” means that the synchronisation is not active on GMT time. This setting is recommended.

DST mode

For the DST mode the following selections are possible using the “Home” key:

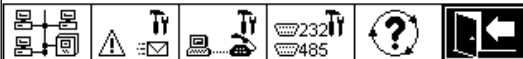
- MET (Middle European Time): The summer and winter time is automatically changed.
- None: The function is switched off

Remark: The time change for summer refers to the time zone MET
(Last Sunday in March – last Sunday in October)!

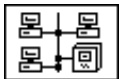
6.8.4.5 Communication / Interfaces

In the Communication menu, the interfaces are configured and the current status information of the corresponding interfaces (RS232, RS485, modem and Ethernet) is displayed.

15:30:28 Communication 2013-06-12	
Communication Status	
RS 232 :	19200-8N1. No Handshake RTS: 1. CTS: 0. @RS 232. PC: 0
RS 485 :	19200-8N1. Half-Duplex
Modem :	None PwR: 0. DTR: 1
Ethernet :	Cable connected MAC 00:1f:58:01:01:b0 IP: 10.166.1.77 NET: 255.255.255.0. 10.166.1.44 TCP: 49152



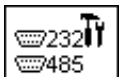
The following sub-menus can be selected in the “Communication” menu:



Network settings (6.8.4.5.1)



Modem settings (0)



RS232 / 485 settings (6.8.4.5.3)



Updating the status information



Exit menu

6.8.4.5.1 Network settings

The MSENSE® DGA 5 is equipped with an Ethernet interface. It can be integrated into a TCP / IP network and supports both static and dynamic integration. The way in which the device is to be integrated into the network on site remains the responsibility of the respective network administrator.

6.8.4.5.1.1 Static IP

The network administrator must provide the following information. This must then be entered in the corresponding fields in the network sub-menu:

- IP address
- Network mask
- Standard gateway

When selecting IEC 61850 modem, in addition:

- IP address IEC 61850

15:31:34 Network 2013-06-12	
Ethernet Port	
Port Setup	Static IP
IP-Address	10.166.1.77
Network-Mask	255.255.255.0
Default Gateway	10.166.1.44
Proprietary Connection via	
TCP-Port Number	49152
<small>Cable connected MAC:00:1f:58:01:01:b0</small>	

14:33:37 Network 2014-08-22	
Ethernet Port	
Port Setup	Static IP
IP-Address	10.166.1.77
Network-Mask	255.255.255.0
Default Gateway	10.166.1.44
IP-Adr. IEC 61850	10.166.1.78
Proprietary Connection via	
TCP-Port Number	49152
<small>Cable connected MAC:00:1f:58:01:01:b0</small>	

6.8.4.5.1.2 DHCP Client

The network administrator must allow automatic TCP / IP address assignment for MSENSE® DGA 5 in the network.

Normal view:

15:15:29 Network 2009-10-01	
Ethernet Port	
Port Setup	DHCP Client
IP-Address	via DHCP
Network-Mask	via DHCP
Default Gateway	via DHCP
Proprietary Connection via	
TCP-Port Number	49152
<small>*not connected*</small> <small>MAC:00:1f:58:00:00:02</small>	

When selecting IEC 61850 modem:

14:30:05 Network 2014-08-22	
Ethernet Port	
Port Setup	DHCP Client
IP-Address	via DHCP
Network-Mask	via DHCP
Default Gateway	via DHCP
IP-Adr. IEC 61850	via DHCP
Proprietary Connection via	
TCP-Port Number	49152
<small>Cable connected MAC:00:1f:58:01:01:b0</small>	

6.8.4.5.1.3 DHCP Server

For testing purposes, a DHCP server can be activated on the device. However, this setting should only be used during start-up, in order to connect to a Windows based laptop.

Remark: The device is not designed as a DHCP Server for a genuine network.

13:24:31		Network		2014-08-22	
Ethernet Port					
Port Setup	DHCP Server				
IP-Adresse	10.166.1.77				
Netzwerkmaske	255.255.255.0				
Standard Gateway	10.166.1.44				
DHCP Client IP from	10.166.1.33				
DHCP Client IP to	10.166.1.48				
Proprietary Connection via					
TCP-Port Nummer	49152				
Cable connected MAC:00:1f:58:01:01:b0					

6.8.4.5.1.4 TCP port number

The TCP port number should also be determined by the network administrator. The free area for TCP port number is: 49152 ... 65535. The standard factory setting is 49152.

Theoretically, the device allows the following settings: 1 ... 65535. However, several TCP port numbers are reserved for other applications, e.g. HTTP, FTP, Mail, etc.

6.8.4.5.1.5 Network settings with integrated IEC 61850-Stack (option)

With the option “integrated IEC 61850 Stack”, the general network setting is extended by the input field (IED Name & Device). The IED Name of the device can be entered here.

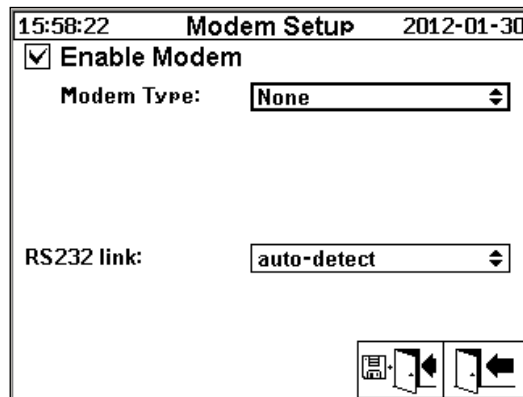
09:48:50		Network		2020-01-10	
Ethernet Port					
Port Setup	DHCP Client				
IP-Address	via DHCP				
Network-Mask	via DHCP				
Default Gateway	via DHCP				
IED Name & Device:					
IEC_MSENSE_1234567					
LDevice1					
Proprietary Connection via					
TCP-Port Nummer	49152				
not connected					
MAC:01:02:03:04:05:06					

6.8.4.5.2



Modem settings

If an on-board DNP3 modem is present in the MSENSE® DGA 5, the modem settings are configured here:



The following functions are available:



Save and exit menu



Exit menu

In the “Modem type” field, the following modem selection can be made using the “Home” key:

- **None**
- **DNP3-GW (internal) (0)**
- **IEC61850-GW (int.) (0)**

In the field RS232 link the following selection can be made using the “Home” key:

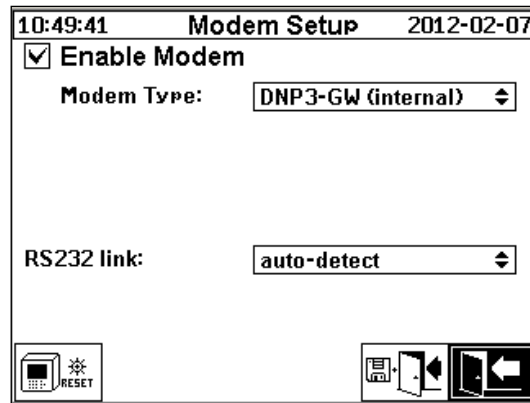
The RS232 link function is used for the internal switching of the RS232 interface to:

- **RS232 socket:** Real RS232 interface on ST4 of the measuring and controller card. Today, this interface is hardly needed any more, given that the MSENSE® DGA 5 has an Ethernet interface.
- **Modem socket:** On-board modem (BU4 and ST6). The plug ST6 on the measuring and controller card is for MR service purposes only!

Remark: As standard, the “automatic detection” setting must be selected!

6.8.4.5.2.1 DNP3 Modem

When selecting DNP3-GW (internal), the following appears on the LCD display:



No additional settings can be made here.

The following functions are available:



Modem reset (temporarily breaks the modem's supply voltage)



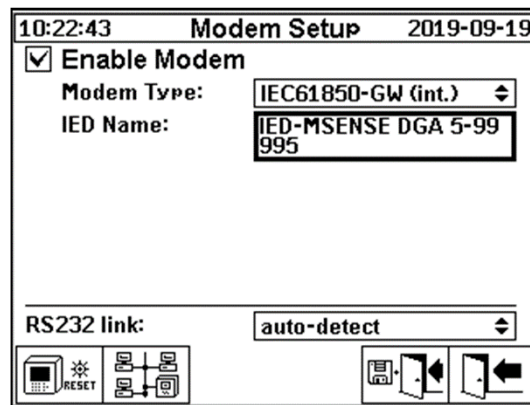
Save and exit menu



Exit menu

6.8.4.5.2.2 IEC 61850 modem

When selecting IEC61850-GW (int.), the following appears on the LCD display:



IED name

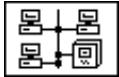
This input field is used to name the MSENSE® DGA 5 device in the IEC 61850 name space. As with other input fields, the input is made via the device's alphanumeric keyboard. Without any input, the name is set automatically as follows:

“IED-MSENSE DGA” <MSENSE-DGA Type Number> “-” <Serial Number>, e.g.: IED-MSENSE DGA 5-99995

The following functions are available:



Modem reset (temporarily breaks the modem's supply voltage)



Network settings (6.8.4.5.1)



Save and exit menu



Exit menu

Remark: The RS232 interface should be configured for the IEC 61850 modem as follows:
Baud rate: 57600

Network settings with IEC 61850-GW (int.)

The general network settings are extended by the input field (IP address IEC 61850). In the event of a static address being entered, the IEC 61850 network address can be entered there. When DHCP Client is selected, the address assignment is generated automatically. The selection “DHCP server” is for testing purposes only.

16:22:40	Network	2020-01-09	16:21:08	Network	2020-01-09
Ethernet Port			Ethernet Port		
Port Setup			Port Setup		
Static IP			DHCP Client		
IP-Address			via DHCP		
192.168.1.32			via DHCP		
Network-Mask			via DHCP		
255.255.255.0			via DHCP		
Default Gateway			via DHCP		
192.168.1.1			via DHCP		
IP-Adr. IEC 61850			via DHCP		
192.168.1.40					
Proprietary Connection via			Proprietary Connection via		
TCP-Port Number			TCP-Port Number		
49152			49152		
* not connected * MAC:00:00:00:00:00:00			* not connected * MAC:00:00:00:00:00:00		

Remark: The device is not designed as a DHCP Server for a genuine network.

6.8.4.5.3 RS232 / RS485 Settings

The settings for the serial interface are made via the following menus:

14:01:25	RS232/485 Setup	2019-07-03	15:20:08	MODBUS	2009-10-01
Bus Communication Setup			MODBUS Configuration		
Mode:			Mode:		
MODBUS			Off		
Address:			Address:		
1			0		
Answer Delay [ms]:			Baudrate:		
70			57600		
Current Settings. Default Settings			Data Bits:		
Baudrate			8		
RS 232			Parity:		
57600			None		
RS 485			Stop Bits:		
19200			1		
Handshake			Answer Delay [ms]:		
RS 232			0		
No Handshake					
ART					
RS 485					
<input checked="" type="checkbox"/>					

This section shows different ways of communicating with the MSENSE® DGA 5.

Point-to-point

Direct connection between PC and MSENSE® DGA 5 via RS232, RS485.

- **Bus node**

Connection between PC and several MSENSE® DGA 5 via RS485 bus.

- **Bus bridge**

Connection between PC and several MSENSE® DGA 5 via RS485 bus. A MENSE® DGA 5 serves as gateway, i.e. it has an RS232 connection to a PC.

- **MODBUS**

Connection between the process control system and one or more MSENSE® DGA 5.

6.8.4.5.3.1 General

The RS232 interface is needed for service purposes only. This requires a special connection cable. The following chapters show how to configure MSENSE® DGA 5 and the MSET DGA software. Some comments and tips relate to the screen shots.

The device settings must be read out manually.

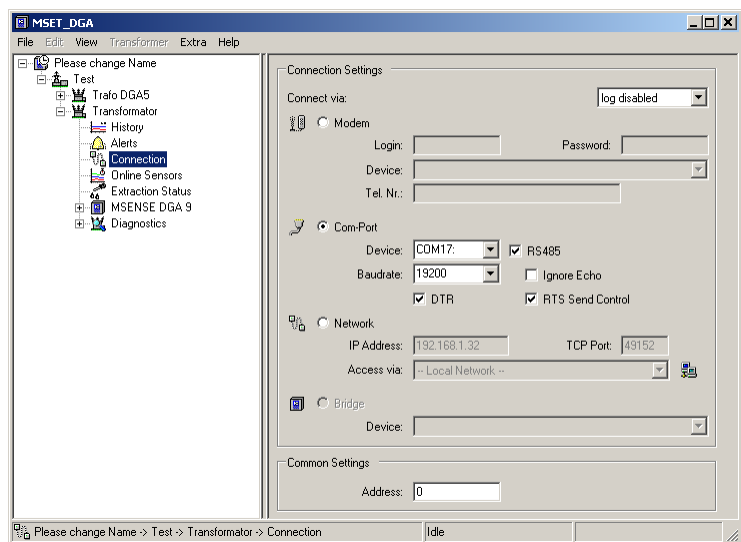
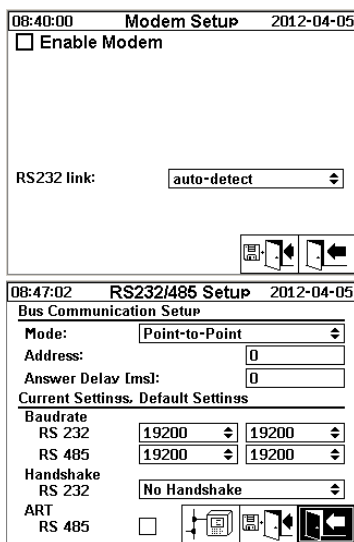
Remark: The MSET DGA software is described in detail in separate operating instructions.

6.8.4.5.3.2 Point-to-point

The point-to-point connection has the simplest setting. The PC is connected directly to a device. For this connection, the RS232 interface (for service purposes only), the RS485 interface or the modem can be used. The point-to-point connection is the standard setting for MSENSE® DGA 5 and MSET DGA.

Point-to-point – RS485

The RS485 interface can be used for long connections (up to 1,000 m). This consists of a two-wire interface with half-duplex and software handshake.



Please ensure that the baud rate and the COM interface in MSET DGA are set correctly and that, when necessary, ART RS485 is selected in the "Settings – Bus communication" menu (in the standard settings, ART is not selected). An RS485 adapter may require additional settings in the MSET DGA "Connection" menu (ignore echo, RTS Transmit Control).

ART

The hardware found in the MSENSE® DGA 5 supports ART (Automatic Receive Transmit Control). ART is a special RS485 protocol which simply sends the data and turns off the transmission mode of the corresponding device immediately after the last character has been transmitted. For this type of protocol, the RS485 communication bus must be equipped with special terminating resistors.

RS485 PC adapter

In order to be able to connect a PC to the RS485 interface of the MSENSE® DGA 5, an adapter (interface converter) is normally required. Given the characteristics of the RS485 adapter in use, this must be configured accordingly in MSET DGA.

For RS485 communication with MSENSE® DGA 5, only a 2-wire half-duplex mode is available. This mode requires transmit and receive control, which is guided by manual control (e.g. via RTS signal) or by ART (Automatic Receive Transmit Control). The adapter should confirm the data sent (echo).

The two check boxes in the MSET DGA dialogue box must match the adapter properties:

- Ignore echo

Must be selected if the adapter sends a response.

- RTS transmit control

Must be selected if the adapter requires manual transmit-receive control via the RTS signal.

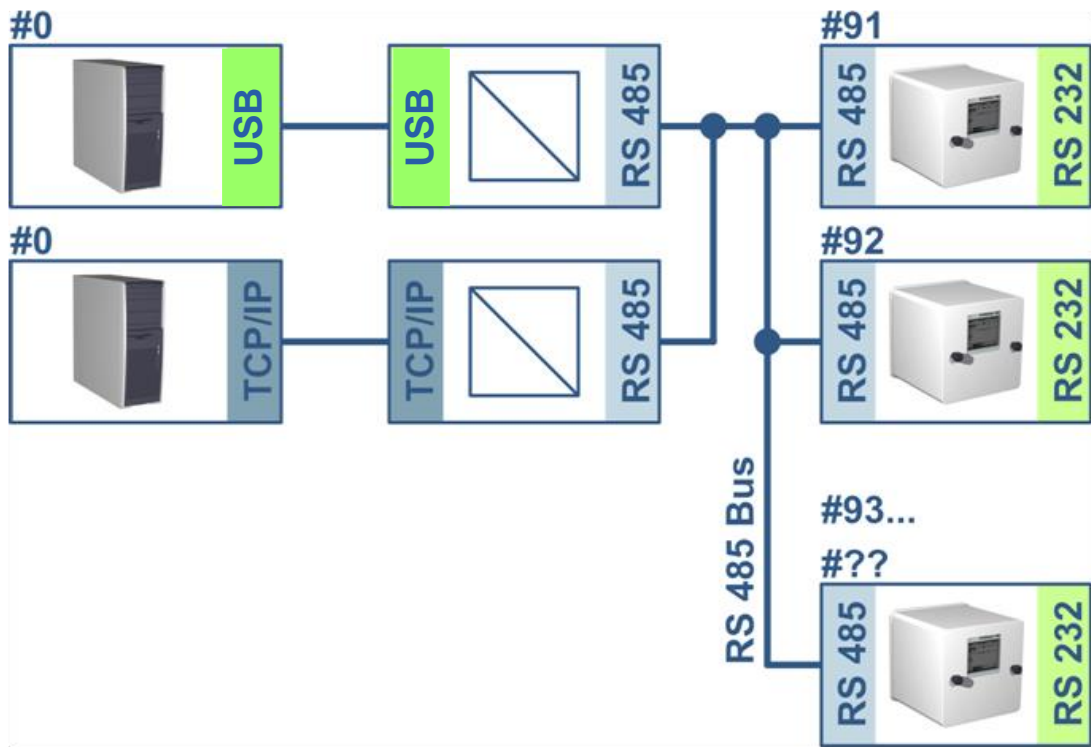
Response delay

If an adapter with RTS transmit control is used, everything is configured correctly and the communication still does not work, this may be due to the transmit-receive control. If the adapter does not release the transmitter quickly enough when sending the data, the response of the MSENSE® DGA 5 is only partially detected by the adapter (or not at all). Therefore, a response delay should be entered in MSENSE® DGA 5 (0 ... 2550 ms), in order to counteract this problem.

RS485 Bus node

When using the RS485 interface, multiple MSENSE® DGA 5 devices can be connected to one host. However, it is only possible to communicate with one device at this time. The following figure shows the schematic topology.

Remark: Naturally, only one host PC is permitted! The host PC with the TCP / IP connection is only presented as an alternative way of connecting to an RS485 bus. Various third-party vendors have such network-to-serial adapters in their product range.



11:11:32 RS232/485 Setup 2012-04-05

Bus Communication Setup

Mode:

Address:

Answer Delay (ms):

Current Settings. Default Settings

Baudrate

RS 232

RS 485

Handshake

RS 232

ART

RS 485

11:12:42 MODBUS 2012-04-05

MODBUS Configuration

Mode:

Address:

Baudrate:

Data Bits:

Parity:

Stop Bits:

Answer Delay (ms):

MSET_DGA

File Edit View Transformer Extra Help

Please change Name

- Test
 - Trafo DGA5
 - Transformer
 - History
 - Alerts
 - Connection
 - Online Sensors
 - Extraction Status
 - MSENSE DGA 9
 - Diagnostics

Connection Settings

Connect via:

Modem

Login: Password:

Device:

Tel. Nr.:

Com-Port

Device: RS485

Baudrate: Ignore Echo

DTR RTS Send Control

Network

IP Address: TCP Port:

Access via:

Bridge

Device:

Common Settings

Address:

Please change Name -> Test -> Transformer -> Connection Idle

Bus communication settings in the MSENSE® DGA 5 device:

- Set mode to “Bus node”
- One-to-one address (1 ... 254) for each device in the RS485 bus.

Remark: There can currently be up to 32 devices in the same RS485 bus.

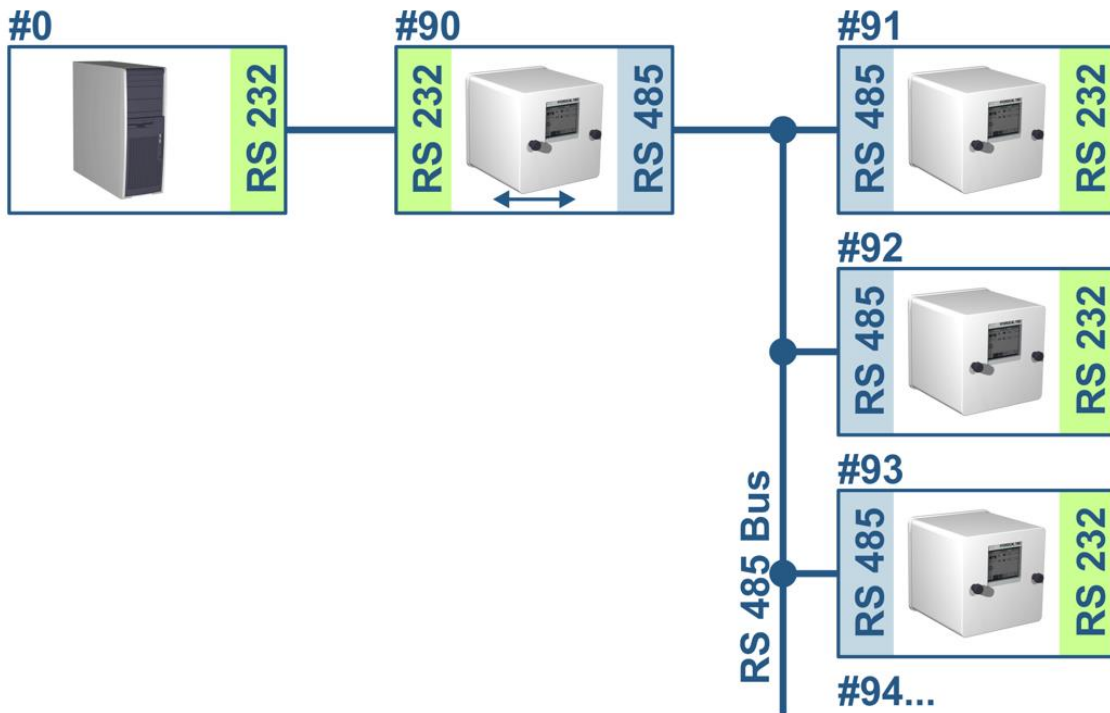
- Enter “Response delay” based on the adapter specifications.
- Baud rate RS485 (300 ... 115200) (current setting)
- Set MODBUS mode to “Off”

Connection settings in MSET DGA:

- Connect via: Serial
- Set correct connection
- Select check box RS485
- Configure baud rate RS485 (same as with the device)
- Ignore echo check boxes & select RTS transmit control according to the adapter specification
- General settings: Enter the correct address (own Bus address)

RS485 Bus Bridge

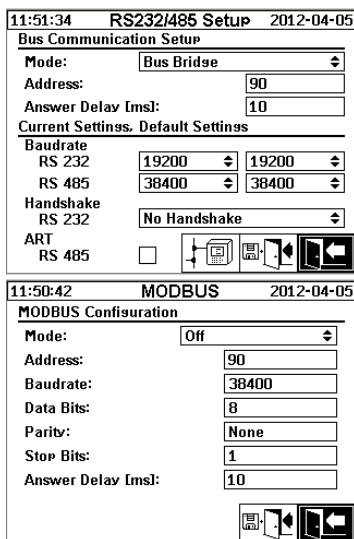
The RS485 bus bridge is an extension that allows communication with an RS485 network in which several MSENSE® DGA 5 devices are present. In this configuration, the host PC is connected via a modem or RS232 to a MSENSE® DGA 5 device, which serves as a communication gateway.



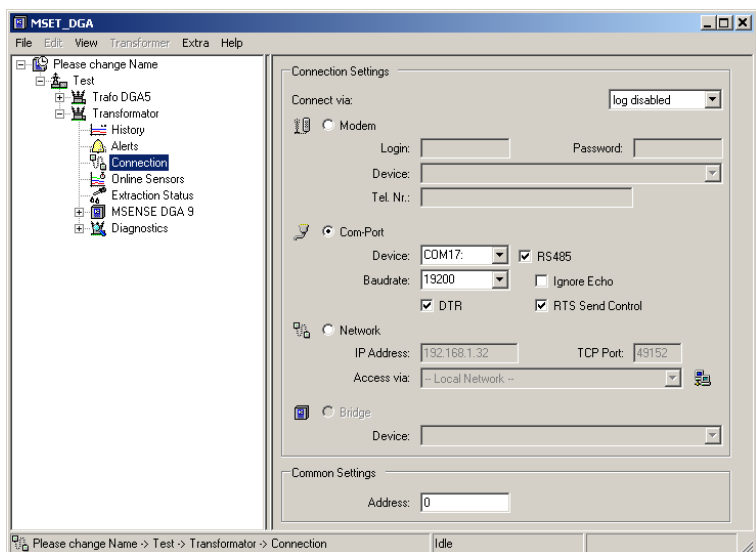
The settings correspond exactly to those of the RS485 bus node settings, but with one exception: The device with the gateway function must be in the Bus communication settings in “Bus bridge” mode.

Bus Bridge – Gateway Device Settings

MSENSE® DGA 5



MSET DGA



Bus communication settings in the MSENSE® DGA 5 device:

- Set mode to “Bus bridge”
- One-to-one address (1 ... 254) for each device in the RS485 bus.

Remark: There can currently be up to 32 devices in the same RS485 bus.

- “Response delay” (0 ... 2550) (recommended value: 0).
- Baud rate RS485 (300 ... 115200) (current setting)
- Baud rate RS232 (300 ... 115200) (current setting)

- Set MODBUS mode to “Off”

Connection settings in MSET DGA:

- Connect via: Serial
- Set correct connection
- Check box RS485 must not be selected!
- Configure baud rate RS232 (same as with the gateway device)
- General settings: Enter the correct address (own Bus address)

Bus Bridge – BusDevice Settings

MSENSE® DGA 5

11:11:32 RS232/485 Setup 2012-04-05

Bus Communication Setup

Mode: **Bus Node**

Address: **91**

Answer Delay [ms]: **10**

Current Settings, Default Settings

Baudrate

RS 232: **19200** / **19200**

RS 485: **38400** / **38400**

Handshake

RS 232: **No Handshake**

ART

RS 485:

11:12:42 MODBUS 2012-04-05

MODBUS Configuration

Mode: **Off**

Address: **91**

Baudrate: **38400**

Data Bits: **8**

Parity: **None**

Stop Bits: **1**

Answer Delay [ms]: **10**

MSET DGA

MSET DGA

File Edit View Transformer Extra Help

Please change Name

- Test
 - Trafo DGA5
 - Transformer
 - History
 - Alerts
 - Connection
 - Online Sensors
 - Extraction Status
 - MSENSE DGA 9
 - Diagnostics

Connection Settings

Connect via: **log disabled**

Modem

Login: Password:

Device:

Tel. Nr.:

Com-Port

Device: **COM17** RS485

Baudrate: **19200** Ignore Echo

DTR RTS Send Control

Network

IP Address: **192.168.1.32** TCP Port: **49152**

Access via: **Local Network**

Bridge

Device:

Common Settings

Address: **0**

Please change Name -> Test -> Transformer -> Connection Idle

Bus communication settings in the MSENSE® DGA 5 device:

- Set mode to “Bus node”
 - One-to-one address (1 ... 254) assigned to each device in the RS485 bus
- Remark:** There can currently be up to 32 devices in the same RS485 bus.
- “Response delay” (0 ... 2550) (recommended value: 0).
 - Baud rate RS485 (300 ... 115200) (current setting)
 - Set MODBUS mode to “Off”

Connection settings in MSET DGA:

- Connect via: Bridge
- Device: Selection of the MSENSE® DGA 5, which serves as communication gateway
- General settings: Enter correct address (own Bus address)



The connection of several MSENSE® DGA 5 to a control system can be realised with MODBUS.

MSENSE® DGA 5

14:24:01 RS232/485 Setup 2019-07-03	
Bus Communication Setup	
Mode:	MODBUS
Address:	1
Answer Delay (ms):	70
Current Settings, Default Settings	
Baudrate	
RS 232	57600
RS 485	19200
Handshake	
RS 232	No Handshake
ART	
RS 485	<input checked="" type="checkbox"/>

14:22:56 MODBUS 2019-07-03	
MODBUS Configuration	
Mode:	RS485 / RTU
Address:	1
Baudrate:	19200
Data Bits:	8
Parity:	Even
Stop Bits:	1
Answer Delay (ms):	70

←=→ 0 → 0 ← 0 #10

Settings MODBUS configuration in MSENSE® DGA 5:

- Selection of the necessary mode:
 - RS485 RTU
 - RS485 ASCII
 - RS232 RTU (for service purposes only)
 - RS232 ASCII (for service purposes only)
- One-to-one address (1 ... 254) assigned to each device in the RS485 bus

Remark: There can currently be up to 32 devices in the same RS485 bus.

- Setting the baud rate (2400, 4800, 9600, 19200, 38400, 57600 or 115200))
- Set data bits (7 or 8)
- Set parity (none, odd or even)
- Set stop bits (1 or 2)
- Enter response delay if necessary (0 ... 2550 ms)

6.8.4.5.3.4 MODBUS configuration

Using the “Home” key, the following selection can be made in the field mode:

14:22:56 MODBUS 2019-07-03

MODBUS Configuration

Mode: RS485 / RTU

Address: 1

Baudrate: 19200

Data Bits: 8

Parity: Even

Stop Bits: 1

Answer Delay [ms]: 70

<==> 0 -> 0 <- 0 #! 0

- **Mode**

Off / RS485 RTU / RS485 ASCII / RS232 RTU / RS232 ASCII (for service purposes only)

- **Address**

- The device address is entered in the address field. For the MODBUS communication, addresses in the range of 1 ... 247 are permissible. For the MSENSE DGA 5 proprietary protocol, addresses in the range of 1 ... 254 will be issued.

Remark: There can currently be up to 32 devices in the same RS485 bus.

- **Baud rate, data bits, parity and stop bits**

These input fields can be used to set the format coding for the serial MODBUS protocol.

Remark:

- Changing the mode does not automatically adjust the format coding. The format coding must be entered manually according to the mode.
- Only the baud rate setting is used for the MSENSE DGA 5 proprietary protocol. The remaining format coding settings are ignored and the fixed values (8 data bits / no parity / 1 stop bit) are adopted.
- **Response delay**

Should communication problems occur, a response delay (0 ... 2550 ms)

Test options with MSENSE[®] DGA 5

In the lower left corner of the LCD display there is an image of the MODBUS statistics:

- <==> 0; Counter of all MODBUS messages
- > 0 ; Counter of all received MODBUS messages
- <- 0 ; Counter of all transmitted MODBUS messages
- #! 0 ; Counter of all parity and framing faults in the interface

6.8.4.5.3.5 MODBUS / TCP via network

The MODBUS communication can be implemented in a network. MODBUS / TCP is available on the device and uses the default port number 502. This is independent of the serial MODBUS configuration. The functions, registers and address display are identical to the serial port implementation. Two MODBUS / TCP connections are possible at the same time. MODBUS/TCP is always switched on.

7 Modbus Function, register and address mapping

The following MODBUS functions, register and address areas are used:

Modbus function Code	Modbus address Dec. / Hex	Register Address ¹⁾ (5 digit dec.)	MSENSE® DGA 5
0x02 Read discrete Input	1000 / 3E8 ... 1015 / 3F7	11001 ... 11016	Alarm status Alarm #1 ... Alarm #16 Only the state of the alarm is reported. The alarm threshold (e.g. high, high-high) is not transmitted.
0x04 Read Input Register	1000 / 3E8 ... 1029 / 405	31001 ... 31030	Sensor value Sensor #1 ... Sensor #16 The sensor value is transmitted as a signed integer value. Before the value is transmitted, the real value is multiplied by a factor of 10 (to achieve an accuracy of 1 digit). In other words, in order to achieve the real value on the opposite side, the value has to be divided by the factor of 10. An open input is transmitted with a sensor value of -32768 (0x8000).
0x04 Read Input Register	2000 / 7D0 2002 / 7D2 2004 / 7D4 ... 2058 / 7EE	32001 32003 32005 ... 32031	Sensor value Sensor #1 Sensor #2 Sensor #3 ... Sensor #16 The sensor value is transmitted as a floating-point number (32 bit, big endian). An open input is transmitted with a sensor value of NAN (0x7FFFFFFF).
0x04 Read Input Register	3000 / BB8 ... 3015 / BC7	33001 ... 33016	Alarm status Alarm #1 ... Alarm #16 The complete alarm status is transmitted. 0 No alarm 1 Threshold 1 alarm (not active) 2 Threshold 2 alarm (not active)

Modbus function Code	Modbus address Dec. / Hex	Register Address ¹⁾ (5 digit dec.)	MSENSE® DGA 5
			3 Threshold 1 alarm (active) 4 Threshold 2 alarm (active)
0x04 Read Input Register	4000 / FA0 ... 4001 / FA1 4002 / FA2 ... 4003 / FA3	34001 ... 34002 34003 ... 34004	Query ageing rate Operating time reduction [s] Operating time [s] The values are transferred in each case to two MODBUS register addresses as an unsigned, 32-bit integer value.
0x04 Read Input Register	5000/1388- 5001/1389 5002/138A- 5003/138B	35001 - 35002 35003 - 35004	Query system status register System fault Extraction chamber There are 2 freely configurable registers available to test the write functions. A value of 0 (zero) indicates proper operation.
0x06 Write Single Register	0 / 0 ... 1 / 1	40001 ... 40002	Holding register Test register #1, #2 There are 2 freely configurable registers available to test the write functions. (The reset initialisation values of the two registers are 0xA5A5 and 0x5A5A.)
0x06 Write Single Register	1000 / 3E8	41001	Alarm acknowledgement Alarm status #16 .. #1 The alarm acknowledgements are summarised in a register as a coded alarm field. (Alarm #16 -> 0x8000, Alarm #1 -> 0x0001). If a zero is written in the corresponding position the active alarm is acknowledged. If the register is written '0000' all the alarms are acknowledged.
0x06 Write Single	2000 / 7D0	42001	Switching off MODBUS Switching off MODBUS

Modbus function Code	Modbus address Dec. / Hex	Register Address ¹⁾ (5 digit dec.)	MSENSE® DGA 5
Register			It is possible to switch off the MODBUS protocol via MODBUS. This is done by writing 0x00FF into the register.
0x03 Read Holding Register	0 / 0 ... 1 / 1 1000 / 3E8 2000 / 7D0	40001 ... 40002 41001 42001	Holding registers 16-bit test register #1, #2 Alarm status bit-sample #16 .. #1 MODBUS protocol status Remark: The value read is always 0x0000. If the MODBUS status is switched off, this value cannot be read.

¹⁾ Modicon® PLC address schematic

The allocation of the sensor numbers (SNSR) is as follows:

1	Gas sensor H ₂	
2	Gas sensor C ₂ H ₂	
3	Gas sensor C ₂ H ₄	
4	Gas sensor CO	
5	Temperature sensor ϑ1	(T1 Gas temperature measurement cell)
6	Temperature sensor ϑ2	(T2 Oil temperature extraction chamber)
7	Moisture-in-oil sensor	(Absolute [ppm])
8	Moisture-in-oil sensor	(Relative [%])
9	Daily trend Gas sensor H ₂	
10	Daily trend Gas sensor C ₂ H ₂	
11	Daily trend Gas sensor C ₂ H ₄	
12	Daily trend Gas sensor CO	
13	Weekly trend Gas sensor H ₂	
14	Weekly trend Gas sensor C ₂ H ₂	
15	Weekly trend Gas sensor C ₂ H ₄	
16	Weekly trend Gas sensor CO	

7.1 Serial MODBUS Communication examples

The following programme and hardware were used to test the MODBUS communication with MSENSE® DGA 5. Both programmes are available for download, free of charge. Both hardware adapters are not the only application that works with MSENSE® DGA 5. These are just two examples that have been tested.

Programmes (for Microsoft® Windows):

- QuickMod Modbus® scanning tool (Windows-based)
AzeoTech, Inc. (www.azeotech.com)

- Modpoll Modbus® Polling Tool (Command Line Tool)
FOCUS Software Engineering (www.focus-sw.com)

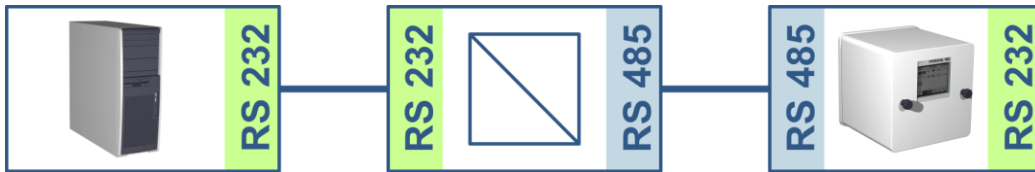
Hardware:

- Roline RS232C / RS485 converter
Roline IC-485S (12.02.1028), IC-485SI (12.02.1029), (www.rottronic.ch)
- ADAM-4572 1-port Modbus® to Ethernet Data Gateway
Advantech (www.advantech.com)

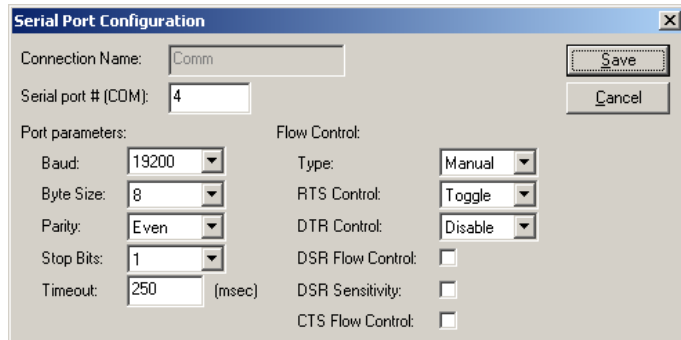
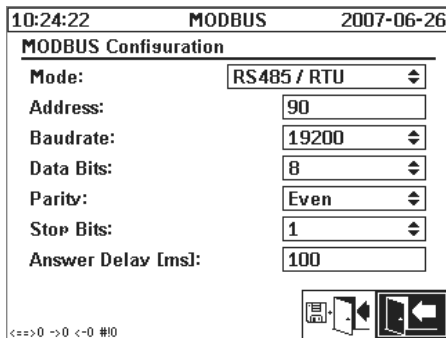
7.2 MODBUS RS485 RTU with QuickMod

This connection was achieved with QuickMod and the Roline RS232 / RS485 adapter (12.02.1028). Connection, settings and results are as follows:

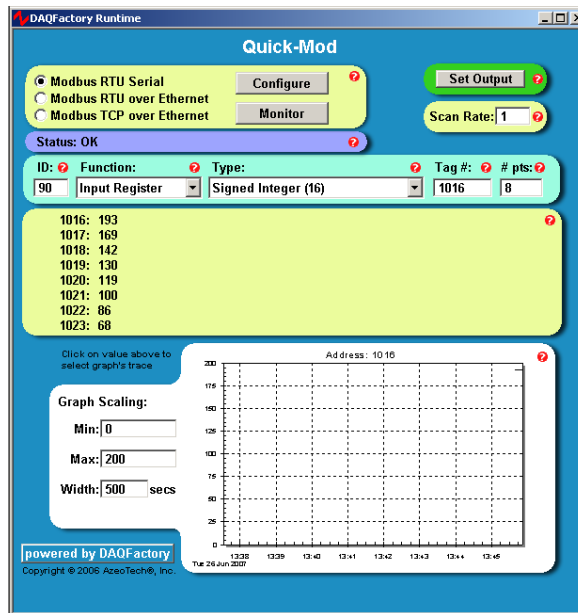
- Physical connection



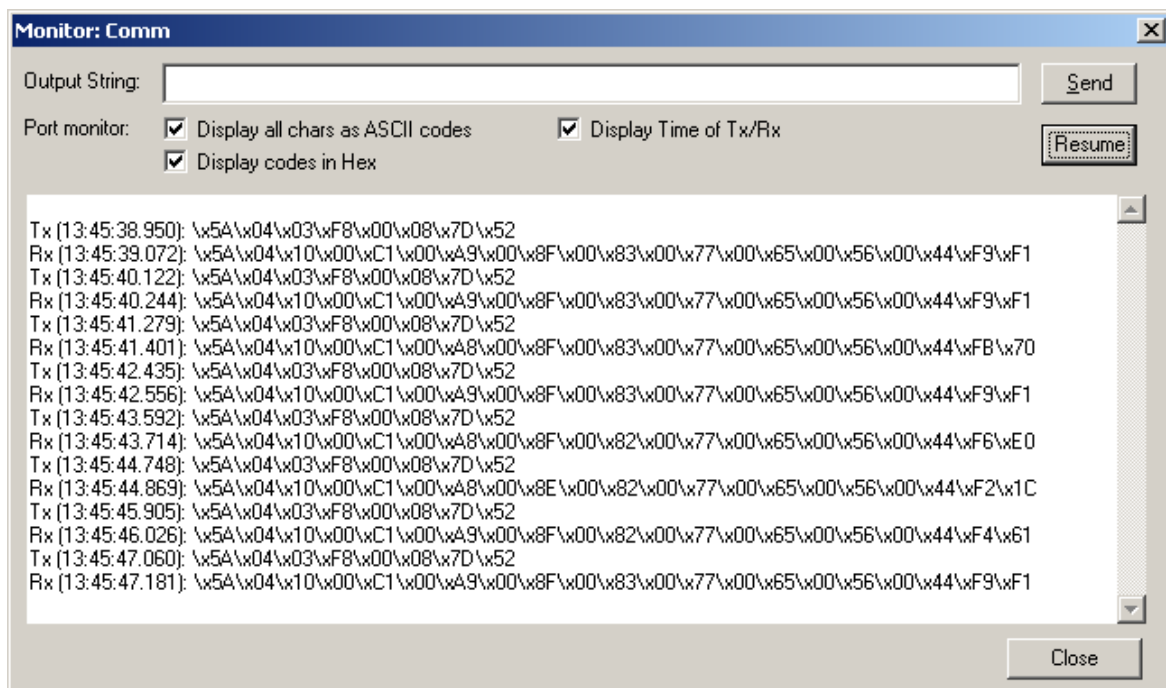
- The RS232-to-RS485 adapter is configured as a “MultiDrop half-duplex”. Connection pairs T+, R+ and T-, R- are short-circuited (connection terminals 1+4, 2+3).
- The RS232 to RS485 adapter is configured for RTS transmit / receive control (SW2 in centre position for T_{xRTS}/R_{xRTS} . The underlined text means: Signal not active).
- MSENSE® DGA 5 and QuickMod settings:



- The MSENSE® DGA 5 response delay of 100 ms gives QuickMod the time it requires to convert the RS232-to-RS485 adapter from transmit to receive.
- Through the QuickMod setting in the configuration window on RTS Control: Toggle, the adapter works according to the desired procedure.
- QuickMod Fenster:



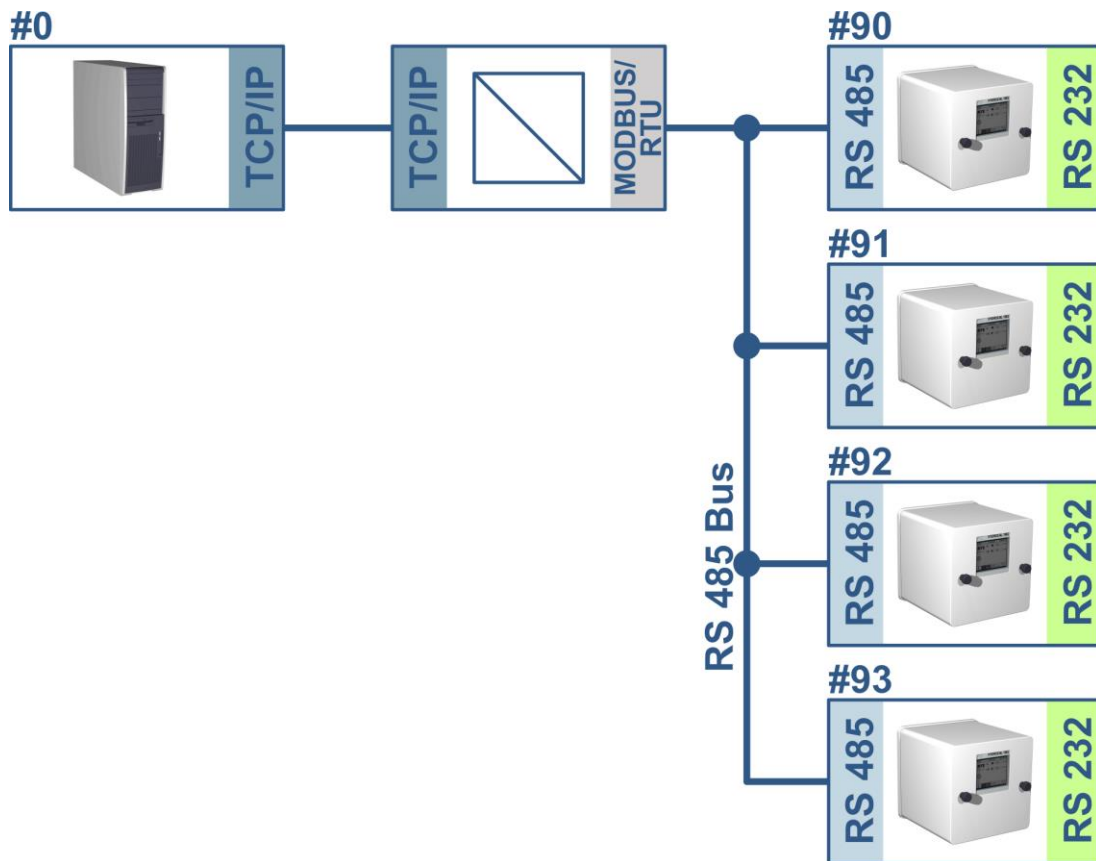
- QuickMod Monitor



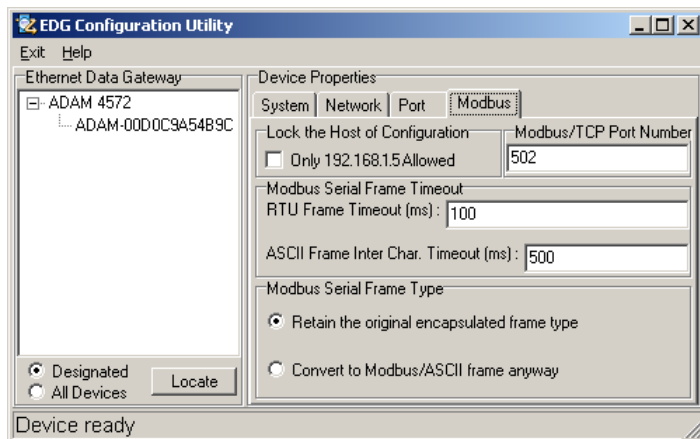
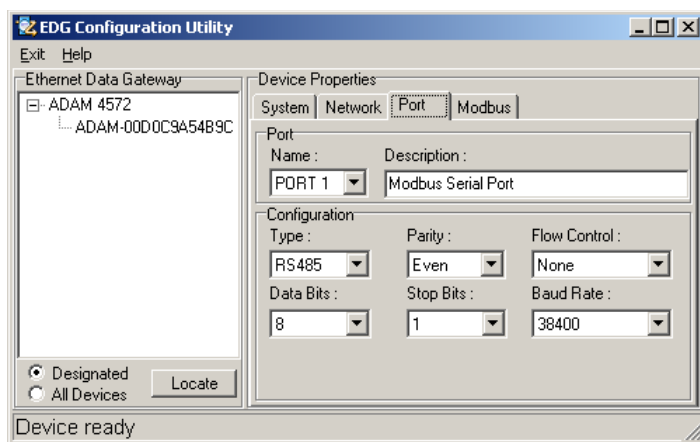
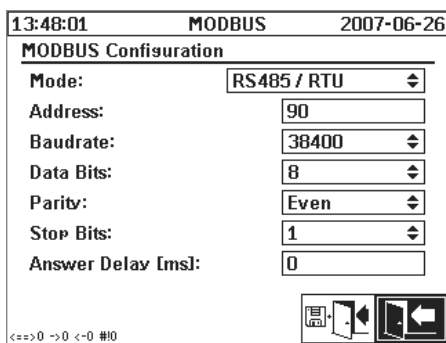
7.2.1 MODBUS RS485 RTU with Modpoll

This RTU MODBUS connection was achieved with Modpoll and the ADAM-4572 Ethernet Gateway. This includes the ability to connect multiple MSENSE® DGA 5 devices to one RS485 bus. Connection, settings and results are as follows:

- Physical connection



MSENSE® DGA 5 (only device # 90) and ADAM-4572 settings:



- MSENSE® DGA 5 does not require a response delay in this case. Every MSENSE® DGA 5 connected to the bus has its own unique address (# 90 .. # 93, # 0 reserved for host PC).

- The ADAM-4572 response delay (timeout) can be small. The MSENSE® DGA 5 response arrives within 100 ms and ADAM-4572 uses ART which generates no additional delay.
- Modpoll screenshot

```
C:\WINDOWS\system32\cmd.exe
modpoll - FieldTalk(tm) Modbus(R) Polling Utility
Copyright (c) 2002-2006 FOCUS Software Engineering Pty Ltd
Visit http://www.modbusdriver.com for Modbus libraries and tools.

Protocol configuration: MODBUS/TCP
Slave configuration...: Address/Id = 90, start reference = 1017, count = 8
Communication.....: 192.168.1.1, port 502
Data type.....: 16-bit register, input register table

Polling slave ...
[1017]: 193
[1018]: 169
[1019]: 142
[1020]: 130
[1021]: 120
[1022]: 101
[1023]: 86
[1024]: 68

modpoll - FieldTalk(tm) Modbus(R) Polling Utility
Copyright (c) 2002-2006 FOCUS Software Engineering Pty Ltd
Visit http://www.modbusdriver.com for Modbus libraries and tools.

Protocol configuration: MODBUS/TCP
Slave configuration...: Address/Id = 91, start reference = 1017, count = 8
Communication.....: 192.168.1.1, port 502
Data type.....: 16-bit register, input register table

Polling slave ...
[1017]: 0
[1018]: 0
[1019]: 0
[1020]: 0
[1021]: 0
[1022]: 0
[1023]: 0
[1024]: 0
```

8 RS485 Wiring

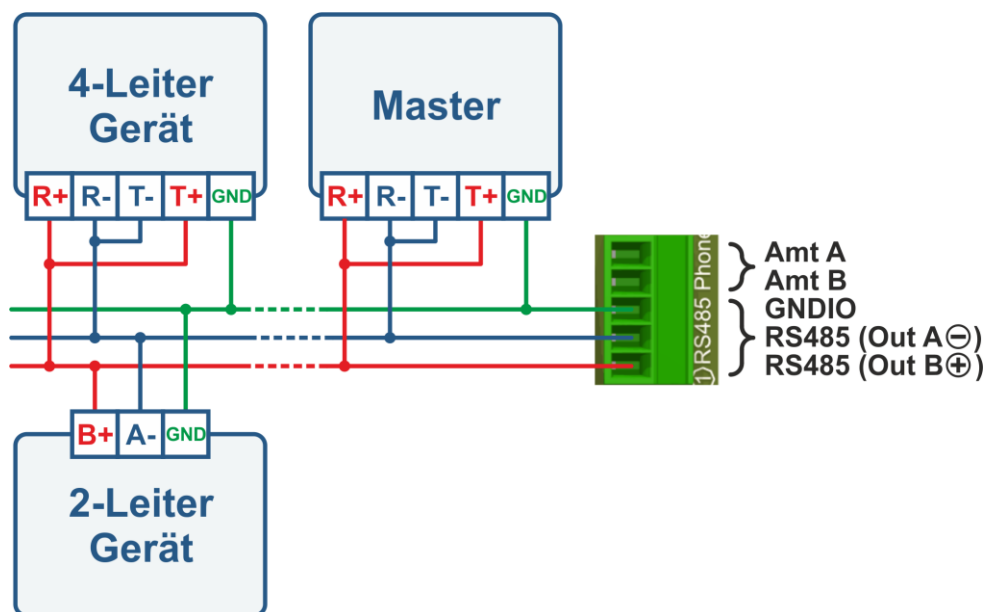
This chapter focuses on the wiring of the RS485 connection.

8.1 RS485

The RS485 interface, which is integrated in the MSENSE[®] DGA 5 is designed as a 3-conductor interface. The 3 conductors are fitted to the terminal clamps KL302 (RS485 Phone) at pin 1, 2 and 3, which are located on the measuring and controller card inside the MSENSE[®] DGA 5.

Remark: Heed polarity!!

- 1) OUT B \oplus RS485
- 2) OUT A \ominus RS485
- 3) GNDIO Earth without screen



8.2 Termination, working point setting, earthing and protection of the RS485 bus

The description of termination, working point setting, earthing and protection of the RS485 bus is complex and would breach the scope of this manual. Detailed and useful information can be found under www.bb-elec.com (see chapter "Technical information").



9 Troubleshooting

9.1 Extraction chamber fault

This chapter describes the approach to fault analysis and troubleshooting the extraction chamber. The subsequent brief instructions describe the process in short form. The following chapters describe the extraction chamber process with detailed background information on the brief instructions.

9.1.1 Brief instructions on site

Step-by-step instructions:

- **NEVER** switch the **power supply** of a **faulty device on and off** to make it work again!
- Please ensure that the “Activate device” key is active ().
- Please ensure that the external slide / ball valve has not been accidentally closed.
- Check the extraction fault status display on the main menu.
- Use the MSENSE® DGA Service Tool to read out the service data.
- Carefully remove the device's protective hood.
- Check the extraction chamber by way of visual inspection.
- Check to see if oil is found in the hood or on the device's components.
- Check if loose pneumatic connections (air white / oil yellow) can be found.
- Check for loose electrical connections.
- If necessary, repair or replace the defective components.
- If there are no faults in the device, open the Extraction Status menu.
- Acknowledge the fault in the extraction status menu using the  key.
- Monitor the device while the initialisation cycle is in progress.
- Wait for the next measurement cycle and monitor the process.
- Should a fault occur again in the device, read out the service data once again.
- Send the read out service data (ZIP file) to the MR service e-mail specified on page 2 and await a response.

9.1.2 Brief instructions by way of remote diagnosis

Step-by-step instructions:

- **NEVER** switch the **power supply** of a **faulty device on and off** to make it work again!
- Use the MSENSE® DGA Service Tool to read out the service data.
- Send the read out service data (ZIP file) to the MR service e-mail specified on page 2 and await a response.
- Should the MR Service Department identify the problem as a hardware fault, an on-site service call is required.
- The MR Service Department sends a command file which resets the device.
- Use the MSENSE® DGA Service Tool to transfer this command file to the device.

- **NEVER load an old command file**, which you obtained earlier for another device, onto the current device.
- Check the operating status after a short period.
- If the device does not work, an on-site service is required.

9.1.3 Gas extraction principle

The “gas-in-oil” analysis system MSENSE® DGA 5 is based on the so-called “headspace” principle, which extracts the erroneous gases from the transformer oil. The complete extraction and measuring device consists of the following components: Connection unit, valves, pneumatic hoses, oil pump, vacuum compressor, flow measurement, filling level sensors, pressure monitor, oil separator, extraction unit (extraction chamber with humidity and temperature sensor and heater), measurement cell with heating and front panel complete (measuring and control card with alphanumeric keyboard and display).

9.1.3.1 Extraction cycle

During the extraction cycle, the extraction chamber is partially filled with oil. To extract the erroneous gases from the oil, the oil is warmed up and circulated. Thereafter, the gas-enriched air is forced into the measurement cell by completely filling the extraction chamber with oil. After the measurement cycle has been completed, the oil is pumped back into the transformer.

9.1.3.2 Device activation

Extraction can only work if the device has been activated on the transformer or on a test device. After the device has been installed correctly, the operator must operate the device by pressing the “Activate device” key. The initialisation cycle begins and must be successfully completed for the device to be ready for operation.

The extraction status menu displays the device’s status. In the footer you will find the keys “Deactivate device” and “Activate device”. Only one key is active at any one time.

The following figure shows the status “Device inactive”. The key “Deactivate device” (grey background) can not be selected – the key “Activate device” (white background) can be selected in this case.



Deactivate device / activate device

After the “Activate device” key has been pressed, the device changes to the initialisation cycle. The two keys change as follows:



9.1.4 Extraction fault

In principle, there is a residual risk of failure with any complex device. The same applies to the devices belonging to the MSENSE® DGA 5 family.

In the event of a fault, the following hazards must be avoided:

- Environmental pollution

- Oil leakage
- Ingress of air into the transformer (Buchholz relay)

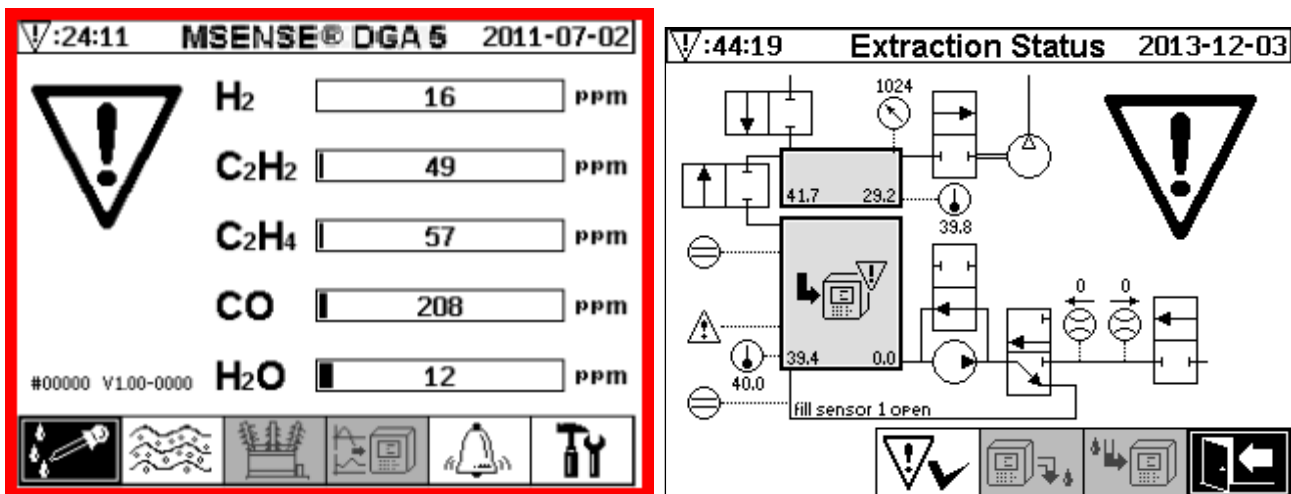
The device's control software (firmware) endeavours to avoid such hazards by means of different control and test algorithms. If the firmware still detects an abnormal or unfamiliar condition, the extraction cycle is stopped (pump and compressor "standstill", all valves "closed") and the system is set to a fault state.

This fault state can only be rectified by human intervention.

Important: A loss of power does not reset this fault!

9.1.5 Extraction error - Signalling

A fault state is indicated by a flashing, large warning symbol in the main menu and extraction status menu or by a small, flashing warning symbol in the status list (top left).



9.1.6 Faults – Analysis and acknowledgement options

This extraction fault can only be rectified by human intervention. This can be done manually on site or remotely via a firmware command.

The following chapters describe the available analysis and acknowledgement options in the event of a fault. The differences between on-site and remote access are shown. Remote analysis is only possible if remote access to the device is available.

Under no circumstances should the device be switched off and on again and no software reset may be executed! The device firmware has a large internal cache in which the activities of the extraction system are stored. The internal buffer is created in the non-remanent memory (RAM) and is therefore lost if a restart (hardware / software) is performed. Therefore, in the event of a reset, any activities also used for fault diagnosis would be lost.

The cache is read out using the MSET DGA Service Tool.



9.1.6.1 Reading out service data

If a fault occurs, all the data should be read out using the MSET DGA Service Tool before any further actions are taken. The cache data associated with the fault cycle may contain valuable information which should therefore be stored. This data is used by the service technician to locate the problem.

If the MSET DGA Service Tool is used for troubleshooting, no download of any kind may also be carried out in the meantime, since this would also reboot the MSENSE® DGA 5. The update query which the MSET DGA Service Tool suggests during device detection must be aborted. The last DGA analysis data (Service Date Read) are not required for this and can be marked as unknown (date and gases).

9.1.6.2 Brief instruction on reading out service data

This quick guide should help you to read out the service data using the MSET DGA Service Tool. Please consult the detailed description, should you require more detailed information.

- Extract the MSET DGA Service Tool in the desired directory (zip file)
- Connect MSENSE® DGA 5
- Start the MSET DGA Service Tool
- Select interface  (serial / network)
- Enter the COM port and baud rate for the serial interface
- Enter the IP address and port number for the network interface
- Press the device key 
- Cancel bootloader, firmware and parameter update and skip
- Perform service data read out only
- Enter the last DGA analysis data or mark as unknown.
- Select storage location
- Assign file name or accept automatic naming
- Start service data read out (Service Data Read)
- Wait for completion

9.1.6.3 Extraction error – on-site analysis

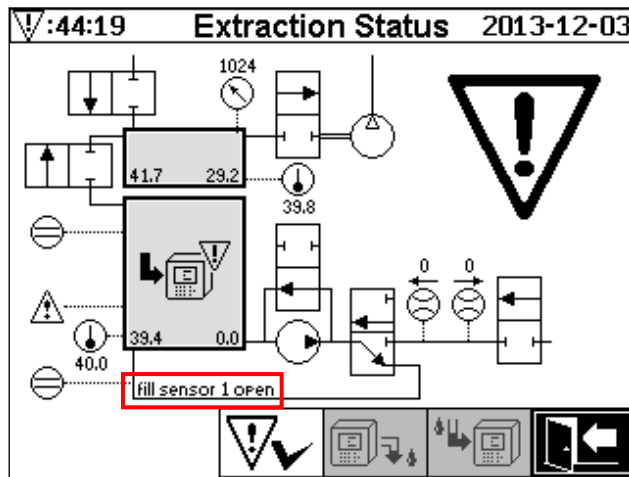
In order to be able to acknowledge an extraction fault, the device's protective hood must be removed. A check should be made as to whether the device's hood is contaminated with oil. Also, the device should be subjected to a visual inspection to make sure it is intact.

If damage to the device is detected, the corresponding parts must be repaired or replaced.

Please ensure that the slide / ball valve is fully open and that the MSENSE® DGA 5 is in the “Device active” state.

9.1.6.4 Extraction fault - Extraction status menu

The extraction status menu also indicates the fault. There may be a problem within the oil itself (debris or dirt) or in the air hose system (leak) that is not identifiable as oil contamination in the unit or the device's protective hood. The red mark in the following figure highlights the area where the fault messages are displayed in the event of a fault.





Extraction status menu and highlighting the fault message

The area designated for the fault message is too small to display the possible cause of the fault in text form. The fault message is shown in short form. The following table reveals the possible reasons for the occurrence of an extraction fault. Given that numerous components are involved in the extraction cycle, an analysis of the fault cycle's cache data for the purpose of fault detection is inevitable.

<u>Fault message</u>	<u>Possible reason</u>
fill sensor x short	Hardware failure
fill sensor x open	Hardware failure
fill level cascade	Hardware failure
fill level x bad	Hardware failure
flow stuck	Pump P1, oil hoses, valves, flow measurement
flow leak	Oil hoses and valves
m-chamber offline	Measurement cell hardware fault
no depression (drain/flush)	Air hoses, valves and compressor
level timeout (drain/flush)	Whole system
depress. timeout (fill)	All hoses, valves and compressor
depress. pressure stuck (fill)	All hoses and compressors
depress. timeout (circ)	All hoses, valves and compressor
depress. pressure stuck (circ)	All hoses, valves and compressor
depress. lost (circ)	All hoses and valves
depress. change	All hoses and valves
no pressure rise (fill #x)	All hoses and valves
timeout (fill #x)	All hoses and valves
detect overall timeout	All hoses and valves
detect amb. pres. timeout	Air hoses, valves and measurement cell
detect depres. pres. stuck	Air hoses and valves
fill level #x lost	Oil hoses and valves
leak check failure	All hoses and valves

9.1.6.5 Extraction fault – Acknowledgement by hand

As soon as the system is ready for operation, the fault can be acknowledged. This is done in the extraction status menu by pressing the  key.

After the  key has been pressed, the initialisation cycle starts. This cycle should be monitored. The device's protective hood should not yet be put back. After completing the initialisation cycle, the instrument will go into a waiting status until the next measurement cycle (every 20 minutes). The measurement cycle should also be observed without the device's protective hood, as not all components are used in the initialisation cycle.

If a fault should re-occur, the service data must be re-read out from the device by means of the MSET DGA Service Tool. The read-out service data must be sent to the MR Service Department for analysis (see page 2). Please now wait for the MR Service Department report before taking any further action.

9.1.6.6 Extraction fault – Acknowledgement via command file

An acknowledgement via a command file requires a communication connection to the device. The service data must be read out and sent to the MR Service Department for analysis.

The response by the MR Service Department can take different forms. There may be a hardware issue requiring on-site deployment, or there is the possibility that a so-called device command file may resolve the problem.

Only use the MSET DGA Service Tool to transfer this command file to the device. **NEVER load an old command file**, which you obtained earlier for another device, onto the current device without contacting the MR Service Department.

The extraction unit is very complex. Acknowledging a fault without performing a detailed analysis and executing the appropriate steps can lead to various hazards (9.1.4).

9.1.7 MSET DGA Service Tool

The MSET DGA Service Tool (MSENSE DGA Service Tool.exe) is an auxiliary software for the devices of the MSENSE® DGA family.

The software is mainly used for:

- Updating firmware and setting parameters for the MSENSE® DGA devices
- Reading out service data (configuration, parameter setting, diagnosis and measured data)

9.1.7.1 Distribution / Installation

The MSET DGA Service Tool is sent as a compressed file (zip-file).

Installation is not necessary. Simply unpack the compressed file to the required directory.

9.1.7.2 System requirements

The following system requirements must be fulfilled for the MSET DGA Service Tool:

- Personal computer (PC) with a Microsoft® Windows operating system such as Windows XP, Vista, Windows 7, Windows 8 or Windows 10.
- Ethernet interface

- Optional: RS232 communication interface (internal RS232 or USB to RS232 adapter)

9.1.7.3 Sequence diagnostics – Data read

To read out service data using the MSET DGA Service Tool, proceed as follows.

9.1.7.3.1 Connection and start

The device from the MSENSE® DGA family must be connected to the network interface via a network cable or via a serial cable to the PC's free COM interface. Next, the MSET DGA Service Tool will be opened via the start file:



MSENSE DGA Service Tool.exe

9.1.7.3.2 Interface selection

MSENSE® DGA devices can be connected via an Ethernet or serial interface. The key in the upper left corner serves as a toggle switch for the following two interface selections:

- If Ethernet is enabled, the *IP Address:* and *Port Number:* must be entered.
- The IP address depends on the network settings (fixed IP address / DHCP).
- The port number is determined by the MSENSE® DGA Ethernet device settings.

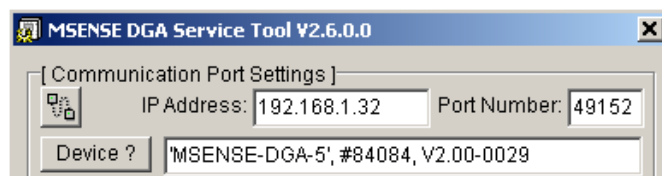


Figure: Ethernet interface selection

- If a serial connection is enabled, the COM Port and Baud Rate are set via the corresponding selection fields.

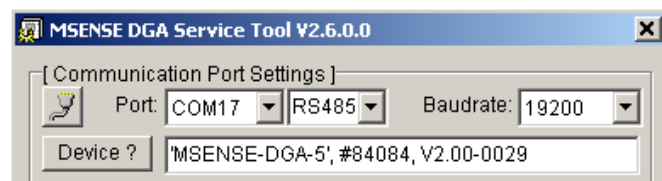


Figure: Serial interface selection (COM Port)

9.1.7.3.3 Device detection

Before you can work with the connected device, the device must be first be detected.

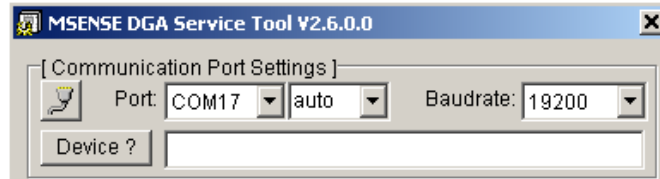
The following screenshots show the connection setup via a serial connection. Establishing an Ethernet connection follows a similar path.

In order to start the device detection process, the PC COM Port (*Communication Port Settings*) – to which the device is connected – must be selected.

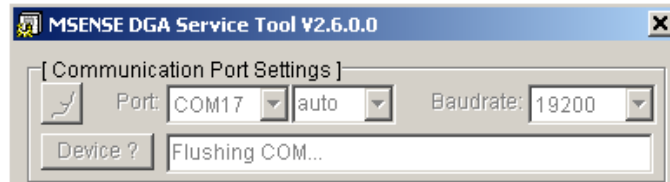
Remark: The standard baud rate of 19200 must only be changed if a different baud rate has been set on the MSENSE® DGA.

When the Device? key is pressed, the detection cycle starts.

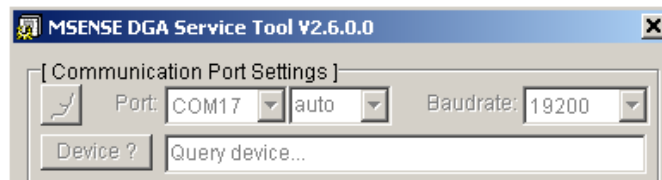
- Select COM Port and Baud Rate



- Start the device detection process



- The device detection is executed



- The device has been detected

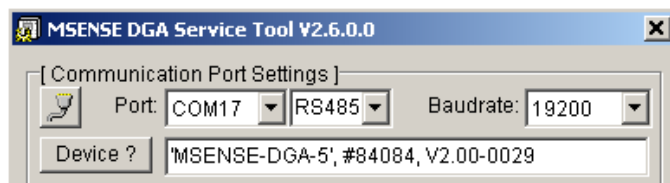


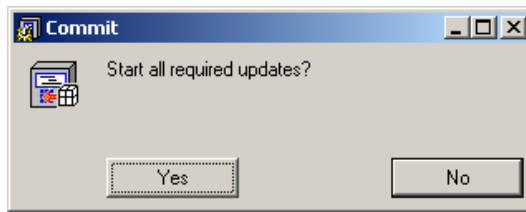
Figure: Device detection sequence

- Following the successful device detection process, the text field Device? displays the following content:
 - Device name: *MSENSE-DGA-5*
 - Serial number: *#84084*
 - Firmware version: *V2.00-B0029*

If the device has not been detected, please ensure that the port and baud rate settings are correct, and then try again. When using Ethernet, the connection to the device can be tested with a PING command. It is important to ensure that the IP address and port number are set correctly.

9.1.7.3.4 Firmware and parameter update

In the event of an extraction fault, this step must be skipped.



Window update request

In such a case, please close this dialogue box by pressing the “No” key to skip the update process.

9.1.7.3.5 Service data read

In the **event of a fault** affecting the MSENSE® DGA 5, the MSET DGA Service Tool **may only be used to read out** the service data (configuration, parameterisation, diagnostics and measurement data).

9.1.7.3.6 Latest DGA results

In order to read-out the service data using the MSET DGA Service Tool, you must first enter the results of the latest DGA analysis (Dissolved Gas Analysis), which you will have received from the laboratory. Depending on the MSENSE® DGA type in use, different reference gas values are required.

Where available, the numbers (date & reference gas values) are entered in the corresponding fields. Otherwise, the “?” selection fields, which stand for non-existent values (Unknown?), must be selected.

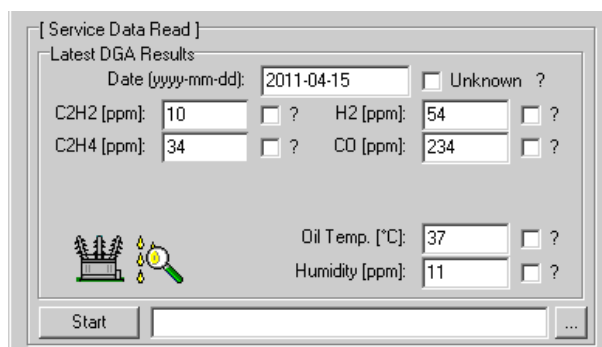


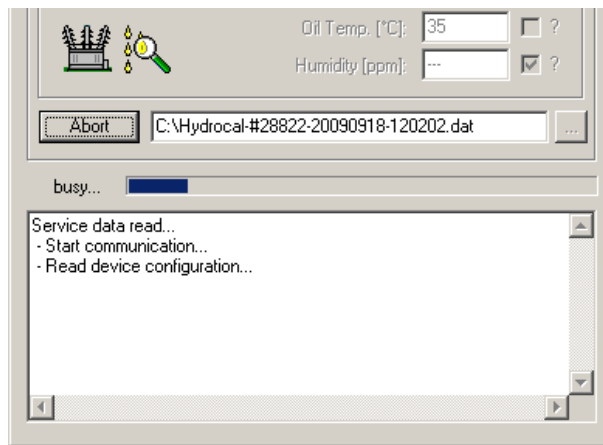
Figure: Latest DGA results

In a next step, the location and file name (under which the service data is to be stored) must be selected. To do this, press the “...” key. The standard setting proposes a file name composed of the device's name, its serial number, the read-out date (YYYYMMDD), and read-out time (hhmmss) (e.g. MSENSE-DGA-#28822-20190818-120202.dat). The standard location for the diagnostic data file is the user directory “Personal Data Storage” (“Persönliche Datenablage”).

9.1.7.3.7 Read-out the service data

By pressing the Start key, the data read-out is begun. The following steps will be performed:

- Read-out device configuration



- Read-out diagnostics data

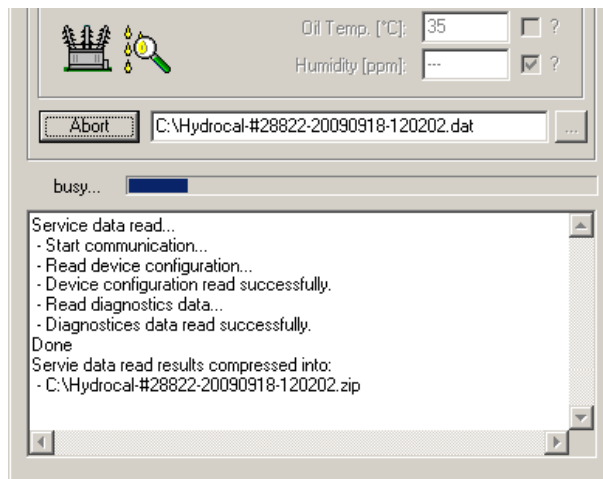


Figure: Read-out diagnostics data

At the end, the read-out data (.dat) is compressed and stored in a zip file (.zip) with the same name. The uncompressed file (.dat) is then deleted.

For the purposes of the fault analysis, please send the compressed file to the MR Service Department.

10 Technical specifications

General

Optional nominal voltages of the operating voltage:	120 V -20% +15% AC 50/60Hz ¹⁾ or 230 V -20% +15% AC 50/60Hz ¹⁾ or 120 V -20% +15% DC ¹⁾ or 230 V -20% +15% DC ¹⁾
Power consumption:	max. 400 VA
Housing:	Aluminium
Dimensions:	W 263 x H 274 x D 331.5 mm
Weight:	approx. 13.5 kg
Operating temperature: (Surroundings)	-55°C ... + 55 ° C - (below -10°C display function locked)
Oil temperature: (in the transformer)	-20°C ... +90°C
Storage temperature: (Surroundings)	-20°C ... +65°C
Oil pressure:	up to 800 kpa (negative pressure permissible)
Valve connection:	G 1½" DIN ISO 228-1 or 1½" NPT ANSI B 1.20.1

Safety

	CE-certified
Isolation protection:	IEC 61010-1:2001
Protection type:	IP55

Measurements

Gas / moisture-in-oil measurement		
Quantity to be measured	Area	Precision ^{2) 3)}
Hydrogen H ₂	0 ... 2,000 ppm	± 15 % ± 25 ppm
Carbon monoxide CO	0 ... 5,000 ppm	± 20 % ± 25 ppm
Acetylene C ₂ H ₂	0 ... 2,000 ppm	± 20 % ± 5 ppm
Ethylene C ₂ H ₄	0 ... 2,000 ppm	± 20 % ± 10 ppm
Moisture H ₂ O _(aw)	0 ... 100 %	± 3 %
Moisture-in-mineral oil	0 ... 100 ppm	± 3 % ± 3 ppm

Working principle

- Reduced gas sampling production based on the gas space principle

(no membrane, proof of vacuum)
- Patent-pending oil sampling system (EP 1 950 560 A1)
- Near-infrared NIR gas sensor unit for CO, CH₄*, C₂H₂ and C₂H₄
- Micro-electronic gas sensor for H₂ measurement
- Capacitive thin-film humidity sensor for H₂O measurement
- Temperature sensors for oil and gas temperature measurement

Analogue and digital outputs

5 x analogue DC outputs		Key functions (Free allocation)
Type	Area	
1 x current DC	0/4 ... 20 mADC	Hydrogen H ₂
1 x current DC	0/4 ... 20 mADC	Carbon monoxide CO
1 x current DC	0/4 ... 20 mADC	Acetylene C ₂ H ₂
1 x current DC	0/4 ... 20 mADC	Ethylene C ₂ H ₄
1 x current DC	0/4 ... 20 mADC	Moisture in oil H ₂ O

5 x relay outputs:		Max. switching capacity (free assignment)
Type	Control voltage	
5 x relays:	12 VDC	220 VDC/VAC / 2 A / 60 W

Communication

- RS485 (Proprietary or MODBUS® RTU / ASCII protocol)
- ETHERNET 10/100 Mbit/s copper / RJ 45 or fibre optic cable / SC Duplex (own or MODBUS® TCP protocol)
- On-board DNP3 serial modem (option) (DNP3 Protocol)
- On-board IEC 61850 modem - copper / RJ45 or fibre optic / SC duplex (option)
(IEC 61850 protocol)

Remarks

¹⁾ The nominal voltages result in the following nominal voltage ranges:

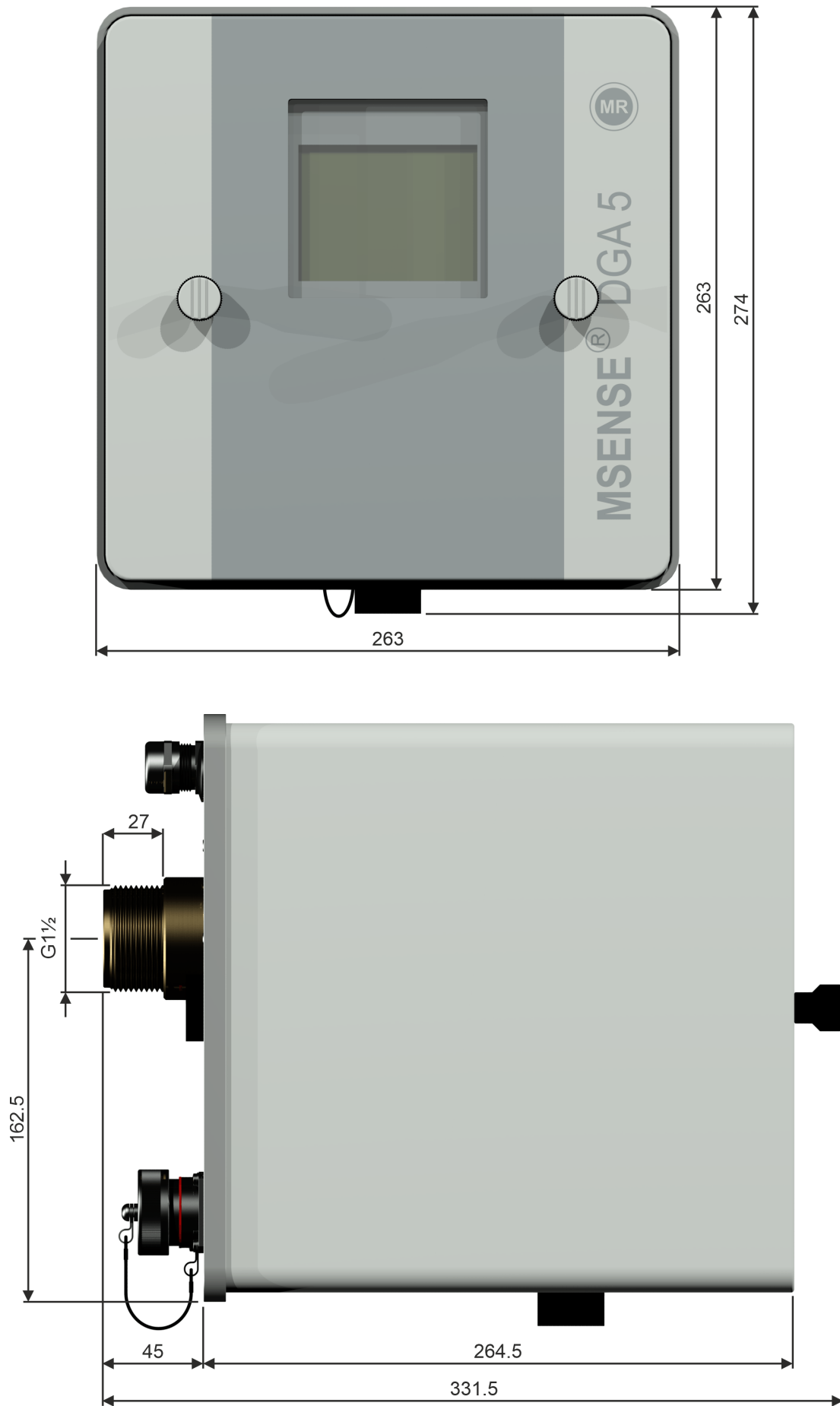
$$120 \text{ V} \quad \Rightarrow \quad 120 \text{ V} - 20\% = 96 \text{ V}_{\min} \quad 120 \text{ V} + 15\% = 138 \text{ V}_{\max}$$

$$230 \text{ V} \quad \Rightarrow \quad 230 \text{ V} - 20\% = 184 \text{ V}_{\min} \quad 230 \text{ V} + 15\% = 264 \text{ V}_{\max}$$

²⁾ With regard to ambient temperature + 20°C and oil temperature + 55°C;
total accuracy in factory calibration (includes gas extraction and gas measurement)

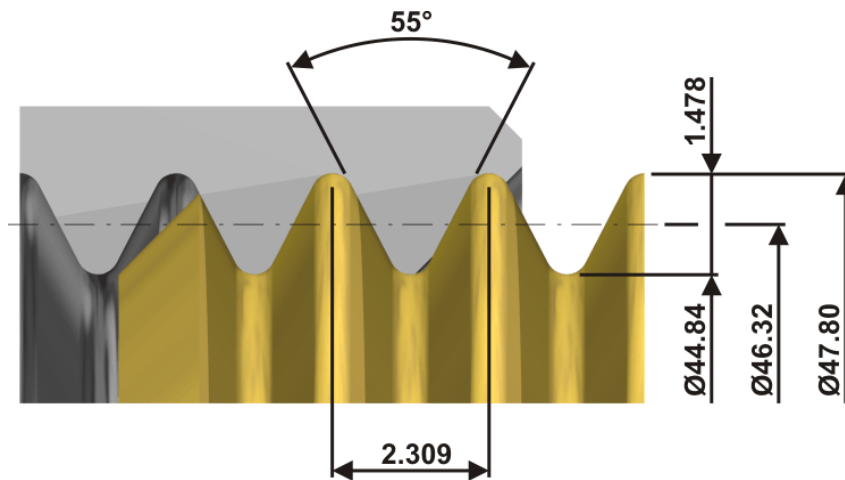
³⁾ Moisture-in-oil accuracy H₂O only applies when used in mineral transformer oil

11 Dimensions



11.1 Dimensions gate valve / ball valve connection

11.1.1 Pipe thread G 1½" DIN ISO 228-1



11.1.2 Pipe thread 1½" NPT ANSI B 1.20.1

