Online – Oil analysis
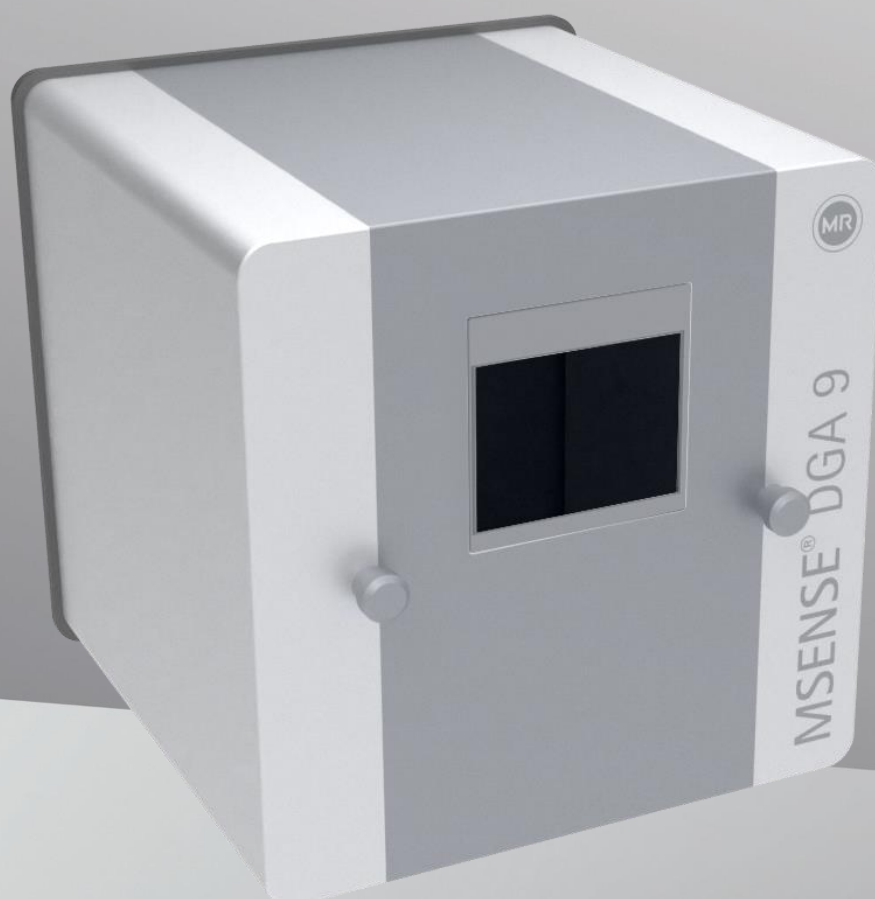# MSENSE® **DGA 9**

Installation and Operating Instructions

Your contact for all inquiries about the MSENSE® DGA 9:

MR Service & Complaint
Maschinenfabrik Reinhausen GmbH

Falkensteinstraße 8
93059 Regensburg
Germany

service@reinhausen.com

complaint@reinhausen.com

If required, you will receive at this address
more information about the product and issues
this technical document.

The MSENSE® DGA 9 will be available for the

Maschinenfabrik Reinhausen GmbH manufactured by:

EMH Energie-Messtechnik GmbH
Vor dem Hassel 2
D-21438 Brackel
Germany

MTE Meter Test Equipment AG
Landis + Gyr-Strasse 1
CH-6300 Zug
Switzerland

List of contents

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 9:

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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 9 (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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> complaint@reinhausen.com

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 9. 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 MSESNE DGA 9 device is a permanently installed multiple "gas-in-oil" analysis system. It enables the individual measurement of oil moisture (H_2O) and the key gases dissolved in the oil: hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), acetylene (C_2H_2), ethylene (C_2H_4), ethane (C_2H_6) and oxygen (O_2).

While hydrogen (H_2) 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 presence of or increase in acetylene (C_2H_2) and ethylene (C_2H_4) serves to classify faults such as overheating, partial discharge or high energy arcing.

Oxygen (O_2) is an indicator of damage to the sealing of hermetically sealed transformers.

The key advantages

- Individual measurements of hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), acetylene (C_2H_2), ethylene (C_2H_4), ethane (C_2H_6) and oxygen (O_2).

- Measurement of oil moisture (H_2O)

- 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.

This device may only be used in accordance with the instructions in this manual.

If this device is used in a way not specified by the manufacturer, the guarantee can expire and impair the protection to be determined by the measuring device.

The device manufacturer does not accept any liability for property damage or personal injury resulting from improper use or non-observance of the safety instructions.

4. Mountinginstructions

4.1 Installation position

The installation location is very important for the correct function of the MSENSE® DGA 9. There are three possible installation locations in the case of a typical transformer:
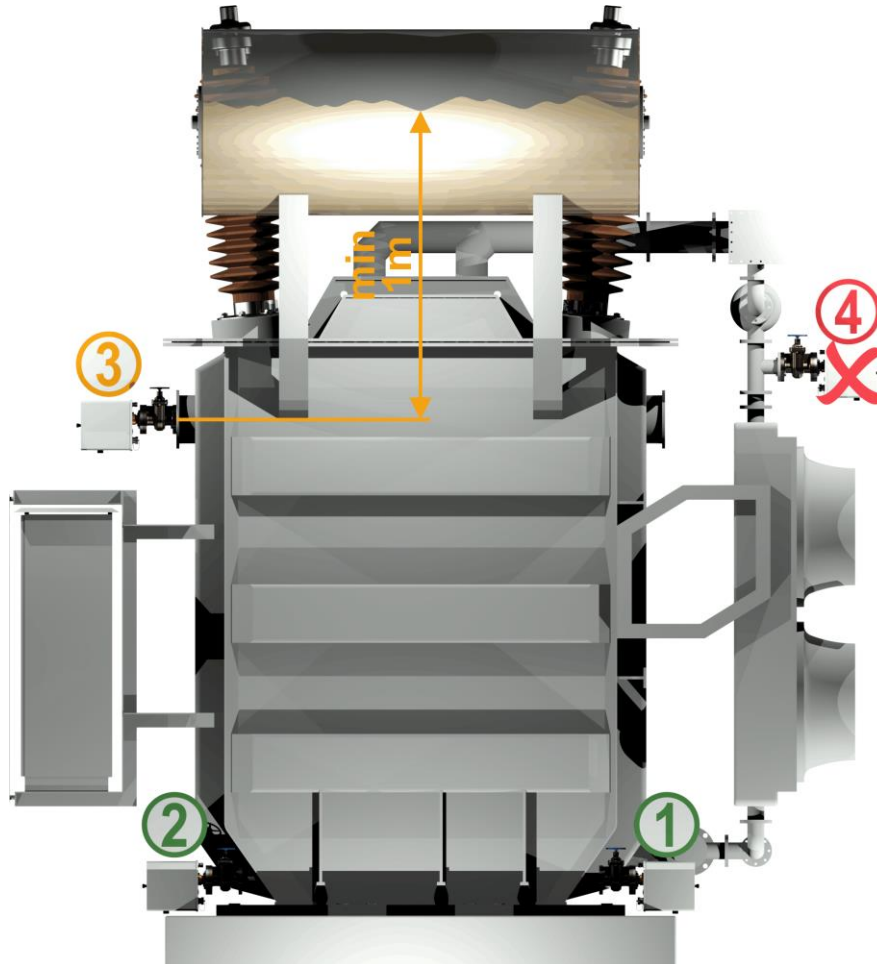
Pos. 1 **Cooler return line:**

Install the MSENSE® DGA 9 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 9 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 device in this position.

Pos. 4 **Never install the MSENSE® DGA 9 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.

Device cap
Only trained personnel may remove the device protective cover; the power supply must be switched off before the device protective cover is removed! Danger due to hazardous voltage.

Heating
Do not lay external cables above the heating units, as in this case, temperatures of up to approx. 80°C can occur in the event of a fault! Danger through heat.

Never close the ventilation opening for the oxygen supply. 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 9 with solvent, as the gases severely affect the measurement accuracy and sensitivity of the sensors. **Use only a dry cloth to clean this device!**

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 9 from the transformer valve. Alternatively, you can close the transformer valve.

Never operate the MSENSE® DGA 9 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 9 on a knee pipe or pipe bend on the intake side of the cooling system pump!!

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

Never mount the MSENSE® DGA 9 on galvanised connections or valves.

Never use a high-pressure cleaner to clean the MSENSE® DGA 9.

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 9.

High pressure cleaners used to clean the transformer could cause serious damage to the MSENSE® DGA 9.

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.

The device may only be mounted and operated in restricted working areas which are not freely accessible!

 Safety gloves must be worn during mounting of the device.
If the unit is to be installed over 1 m, the use of personal protective equipment to prevent falling and specially trained personnel are necessary.

 The high weight means two people are required for mounting the unit. Use lifting equipment. This avoids undesired movement during installation

 The device may only be mounted by a specialist

 During mounting and removal leakage of any hazardous substances to the environment must be avoided. Collect pollutants directly at the outlet points.

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 9 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 9 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 9 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.
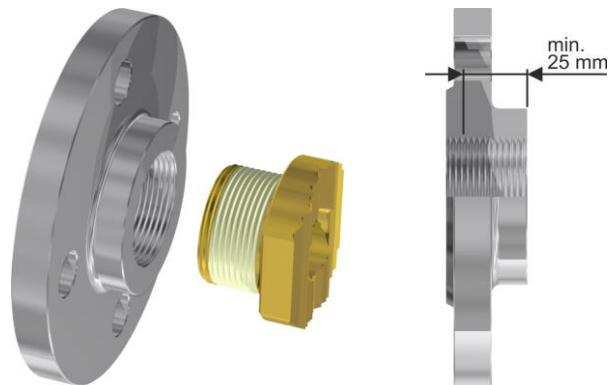
Remark: The thread depth of the threaded flange or the connecting adapter should be at least 25 mm.

4.3.1.2 Threaded joint

We recommend connecting the MSENSE® DGA 9 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.
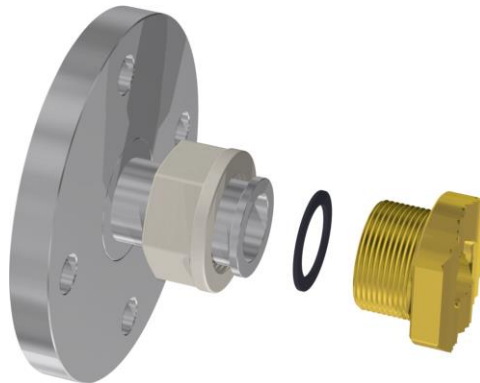
Remark: Some ball valves also have union nuts (pump ball valve).

4.3.2   Supply voltage connection

The MSENSE® DGA 9 is available in 4 different voltage versions (please ensure to specify when ordering). Depending on which nominal voltage version is being used, the following alternating or direct current connection (in the form of a 3-pin mains connection cable) must be present near to the device:

Nominal voltage version MSENSE® DGA 9	Supply voltage
120 V -20% +15% **AC** 50…60Hz	96 V_{min} … 138 V_{max} AC 50…60Hz
230 V -20% +15% **AC** 50…60Hz	184 V_{min} … 264 V_{max} AC 50…60Hz
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 9 is max. 600 VA.

Fuse: 120V:T6,3A   230V: T3, 15A

4.3.3   Tools required

The mechanical and electrical installation of the MSENSE® DGA 9 device can be carried out using the following tools/aids:

Tool / aids	Use
Long hexagon key size 4	Vent screw
Digital multimeter	Check supply voltage
Screwdriver no. 2	Supply voltage
Brass brush	Connecting unit
M55 open-ended spanner and/or 1½" adjustable spanner	Connecting unit
Bucket, oil absorbent, cloth, paper towels	Absorbing leaking oil
Plastic sheet	Catching parts which fall or are dropped

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 9 connecting unit. We recommend the use of a Teflon tape for coarse threads (100g/m^2).

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 9 connecting unit.

  Note!!!
Please note the specifications and safety instructions 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.
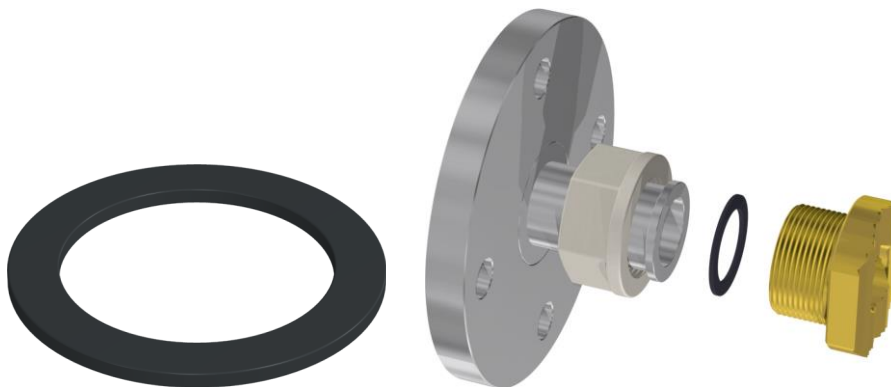
4.4   Installation

Once installation preparations have been completed, the MSENSE® DGA 9 can be installed. Installation is divided into 3 steps:

- Mechanical installation   [4.4.1]
- Electrical connection   [4.4.2]
- Initial start-up   (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, strain should be relieved using a support.

4.4.1.1   Direct mounting

In the case of direct mounting, the MSENSE® DGA 9 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   [0]
- Direct mounting with thread adhesive   [4.4.1.1.2]

<div align="center">

Note !!!

**Do not remove the protective cap (by turning it slowly) until
you are ready to install the MSENSE® DGA 9
at the connecting valve/gate valve!**

</div>

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.
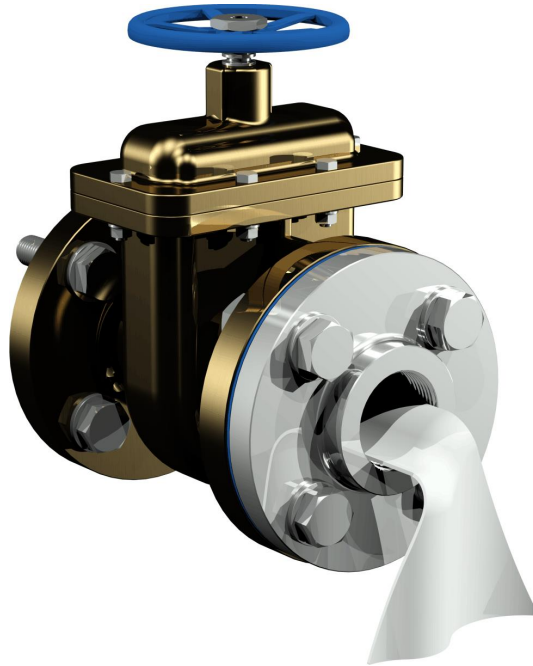
- Use a dry cloth / paper towel to clean the external thread of the connecting unit. Remove any residual thread sealing tape completely from the external thread. A brass brush or spirit can be used for stubborn soiling. The spirit must be completely dry before work can continue.

- 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 9. The first thread groove should remain free.
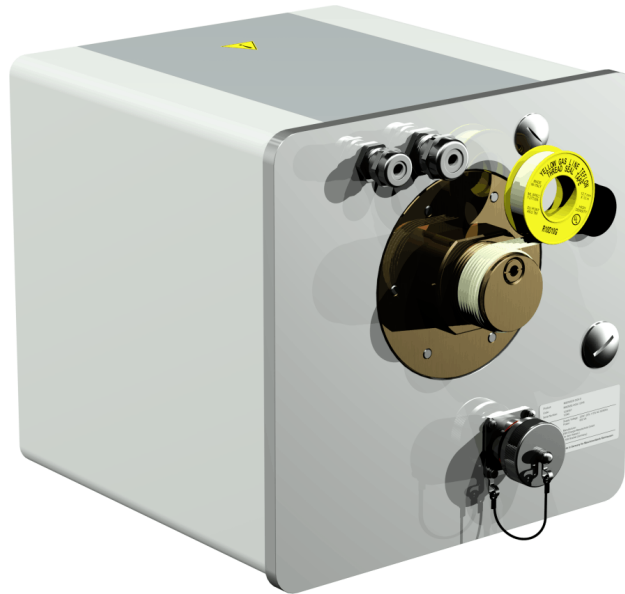
- Place the MSENSE® DGA 9 horizontally onto the threaded flange. Make sure the device does not twist.

- Screw the MSENSE® DGA 9 2 or 3 times clockwise by hand into the threaded flange.
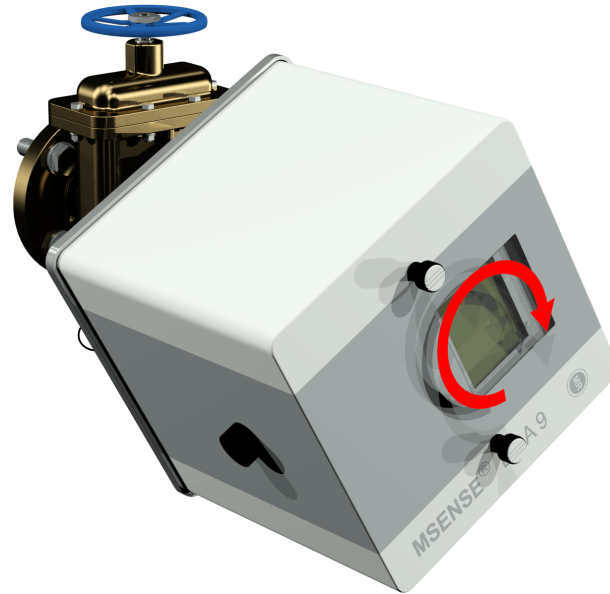
- Now use an M55 open-ended spanner or a 1 ½" adjustable spanner to screw the MSENSE® DGA 9 by a further 5 or 6 turns clockwise into the threaded flange and stop when the vent screw is in the 9 o'clock position.

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 MSENSE® DGA 9 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.

Position of aeration screw
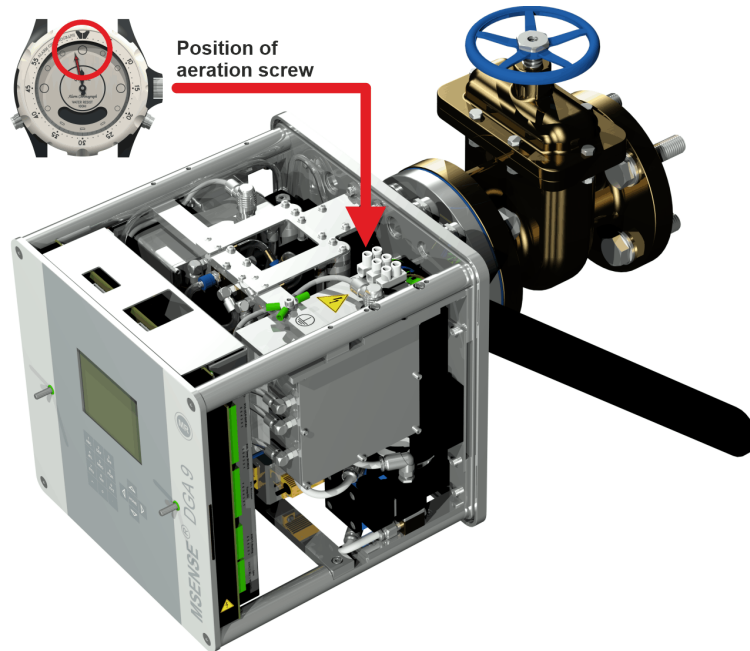
Remark: The device may only be aligned by turning clockwise. As soon as the device is turned anti-clockwise for alignment, mounting must be carried out again!

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

- 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

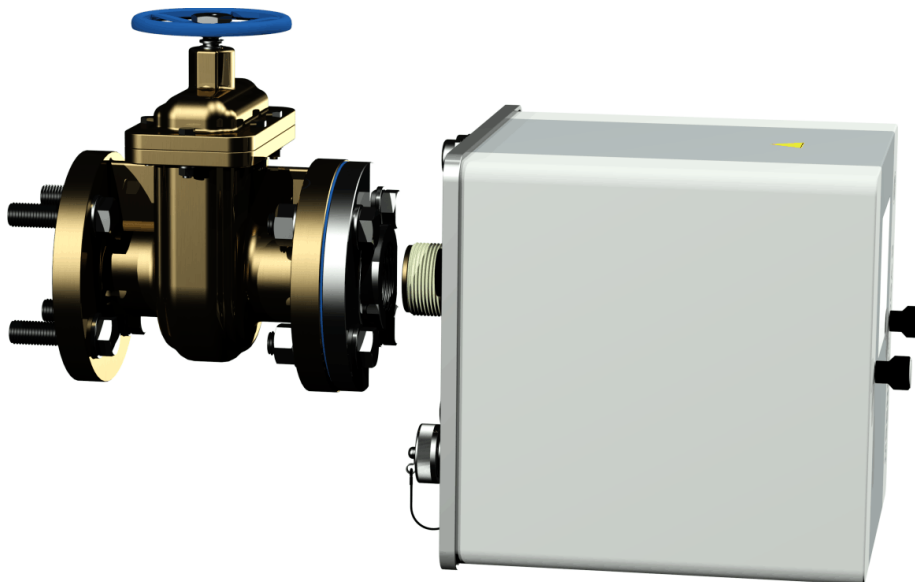- Use a dry cloth / paper towel to clean the inside of the threaded flange.
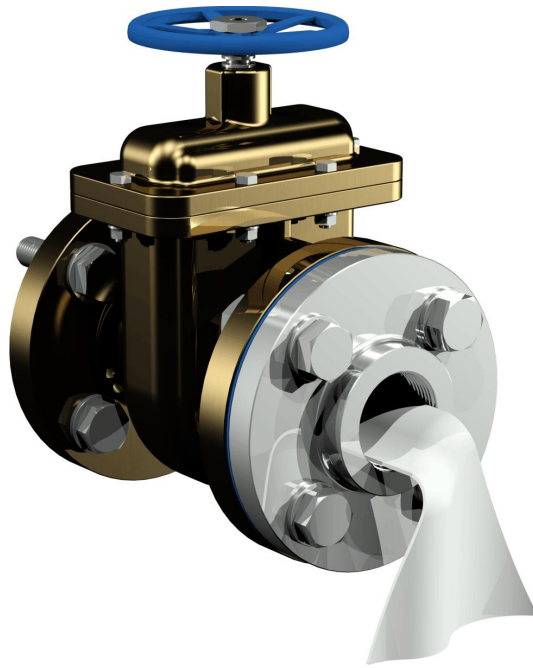
Use a dry cloth / paper towel to clean the external thread of the connecting unit. Remove any residual thread sealing tape completely from the external thread. A brass brush or spirit can be used for stubborn soiling. The spirit must be completely dry before work can continue.

- Apply LOCTITE® 7471 (activator) by spraying or brushing it onto both sealing faces. During spraying, the openings (transformer gate valve and MSENSE® DGA 9) 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.

- Use suitable gloves so that you can apply the adhesive to the bottom of the thread groove, filling the intermediate spaces well.

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

- Place the MSENSE® DGA 9 horizontally onto the threaded flange. Make sure the device does not twist.

- Screw the MSENSE® DGA 9 2 or 3 times clockwise by hand into the threaded flange.
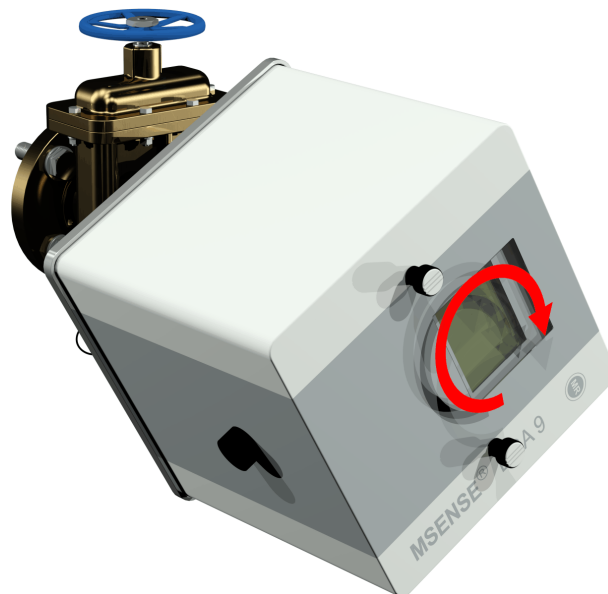
- Now use an M55 open-ended spanner or a 1½" adjustable spanner to screw the MSENSE® DGA 9 by a further 5 or 6 turns clockwise into the threaded flange and stop when the vent screw is in the 9 o'clock position.


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.

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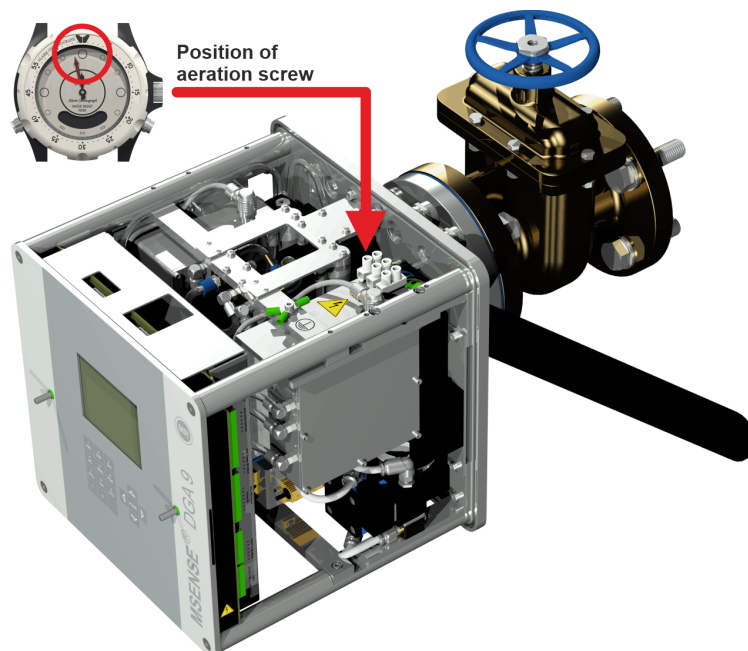
- We recommend that you wait for 30 minutes before you continue with the further installation steps. The thread adhesive only cures under pressure i.e. in the thread grooves of the pipe connection. For this reason, any excessive thread adhesive should be removed using a clean cloth.

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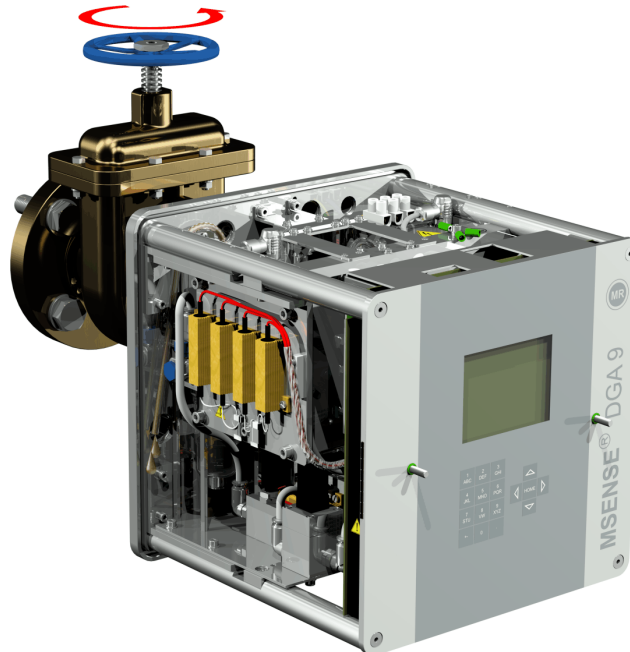

Note!!!

The following steps must be carried out in accordance with company procedures. Work carefully and prevent air getting into the transformer. Use a container to collect any leaking oil.
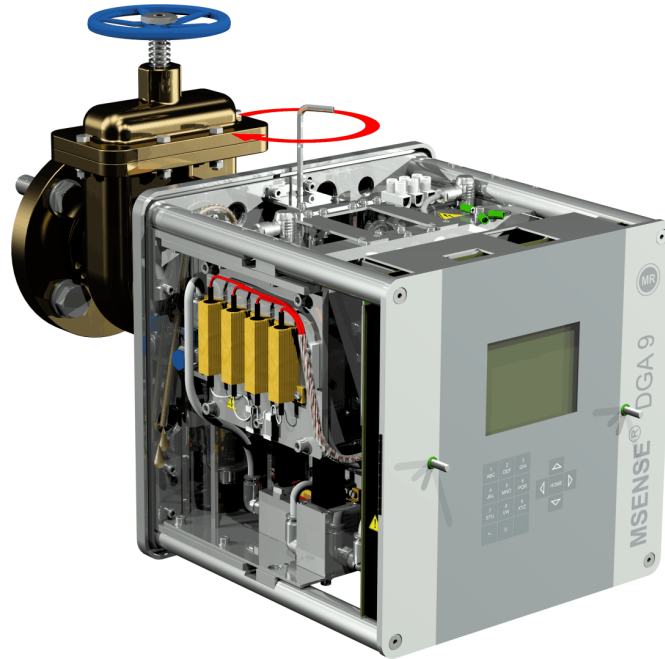
- Unscrew the vent screw by 3 or 4 turns anti-clockwise using the long size 4 hexagon key (venting is active).
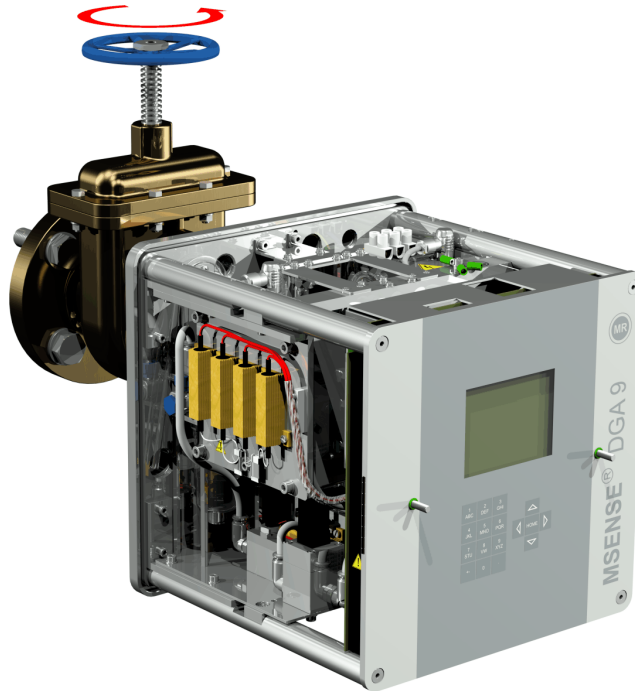

- Open the transformer gate valve very carefully until oil runs out of the sample hose. Allow the escaping oil to run into a container.
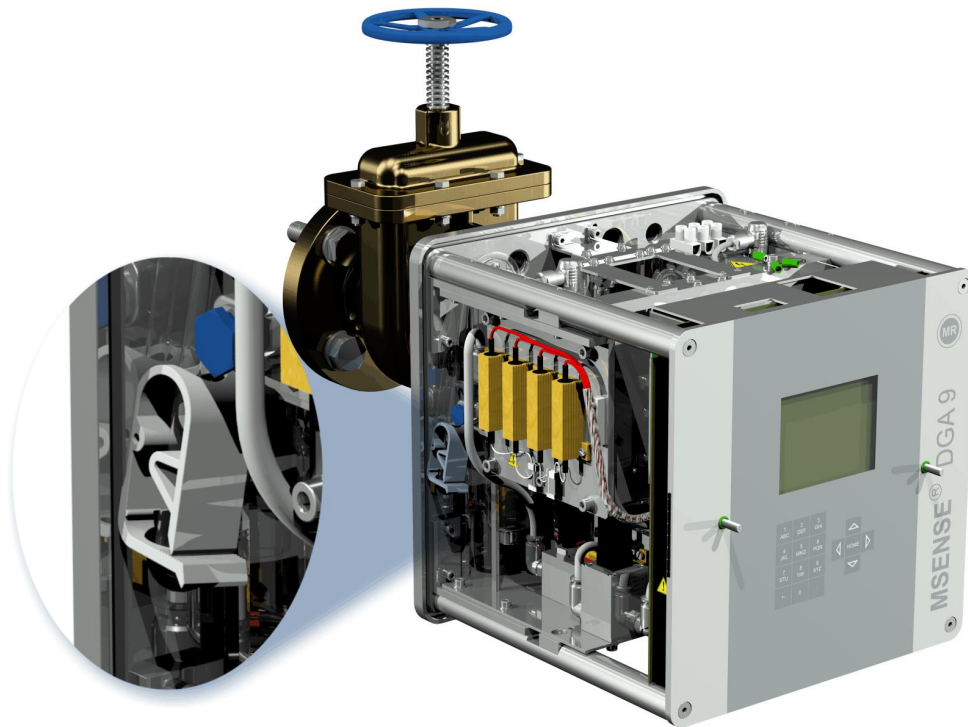
- Close the vent screw as soon as there are no more air bubbles escaping from the sample hose.
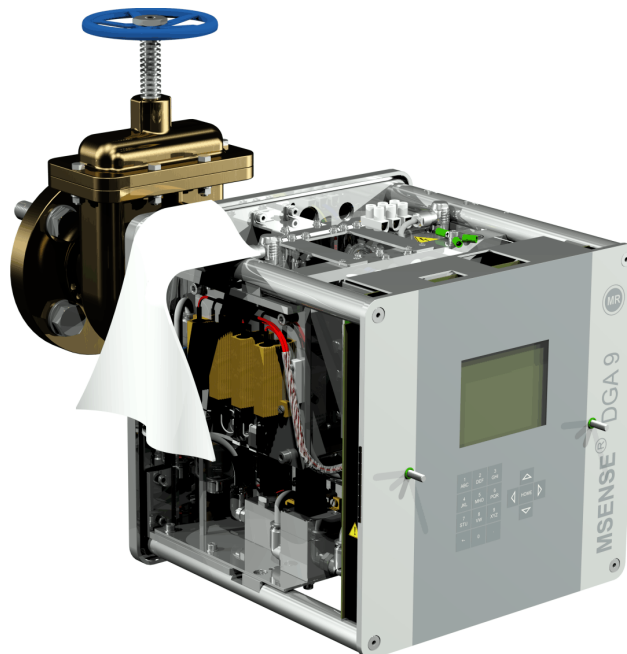

.

- Now open the gate valve/ball valve completely.

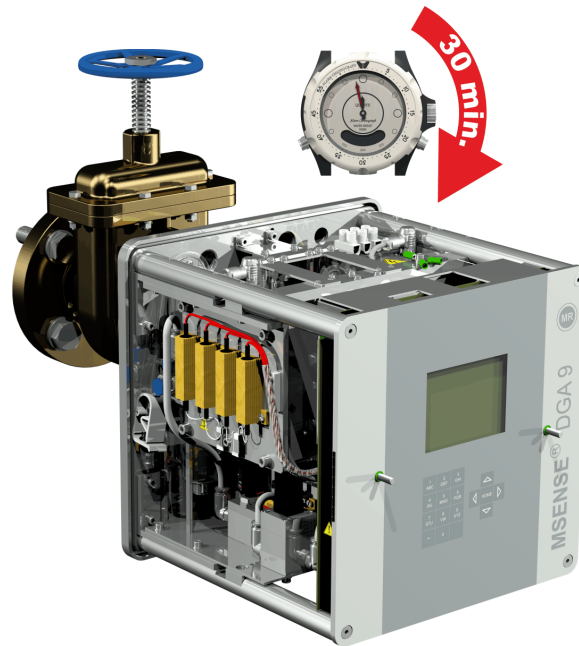- Secure the end of the sample hose using a hose clip

- 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 9 is fixed in place by screwing the union nut on the threaded joint. A flat gasket is used as a thread seal here.

<table>
<tr>
<td>⚠️</td>
<td align="center"><strong style="color:red">Note!!!
<strong style="color:red">Do not remove the protective cap (by turning it slowly) until you are ready to install the MSENSE® DGA 9 at the connecting valve/gate valve!</td>
<td>⚠️</td>
</tr>
</table>

- 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.
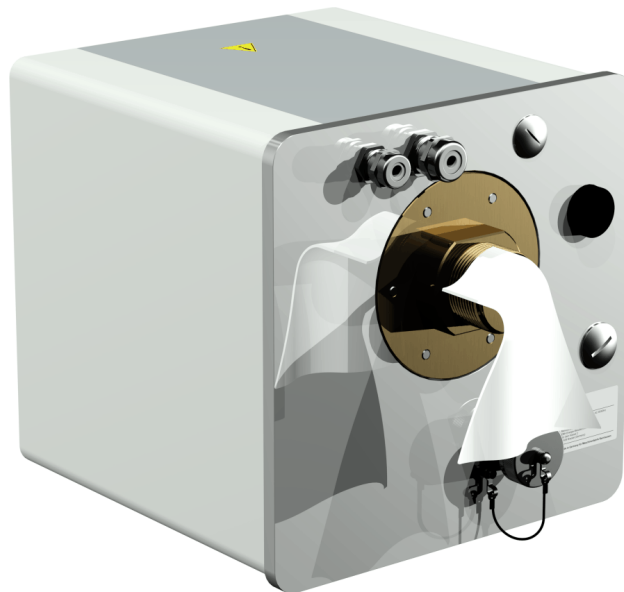
- Place the MSENSE® DGA 9 horizontally onto the threaded joint. Make sure the device does not twist.

Note!!!
Make sure that the gasket has been inserted between
MSENSE® DGA 9 and the screw connection.
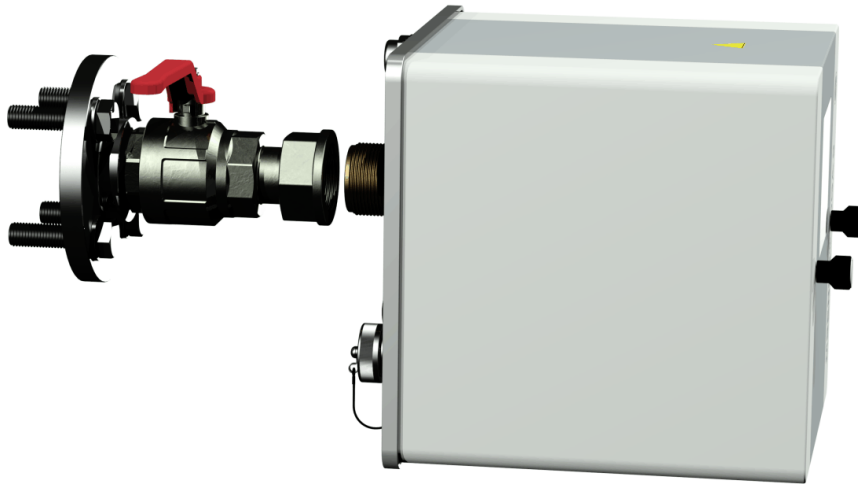
- Turn the union nut by hand onto the external thread of the connection unit until it stops.
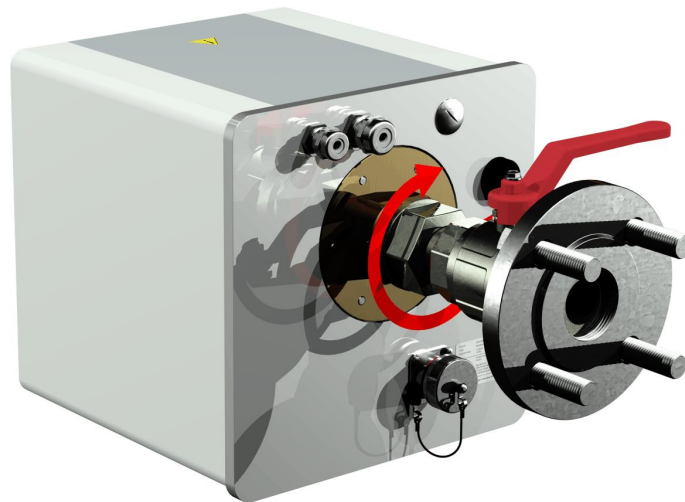
- Remove the two knurled screws and the device protective cover.
- Now align the device by turning it clockwise until the vent screw is at the 12 o'clock position at the top.
- Use a M55 open-ended spanner or 1½" adjustable spanner to tighten the union nut until the connection is a firm fit. Make sure 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.

Position of aeration screw

Note!!!

The following steps must be carried out in accordance with company procedures. Work carefully and prevent air getting into the transformer. Use a container 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

⚠️ **Note!**
There must be a 10A overcurrent protective device available in the installation ⚠️

⚠️ **Note!**
A disconnecting device must be available for the device, easy to reach for the user and identifiable as a disconnecting device for this device. ⚠️

Use reinforced pipes as protection for all cables and connect these to the respective connections in the device. 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 9 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.
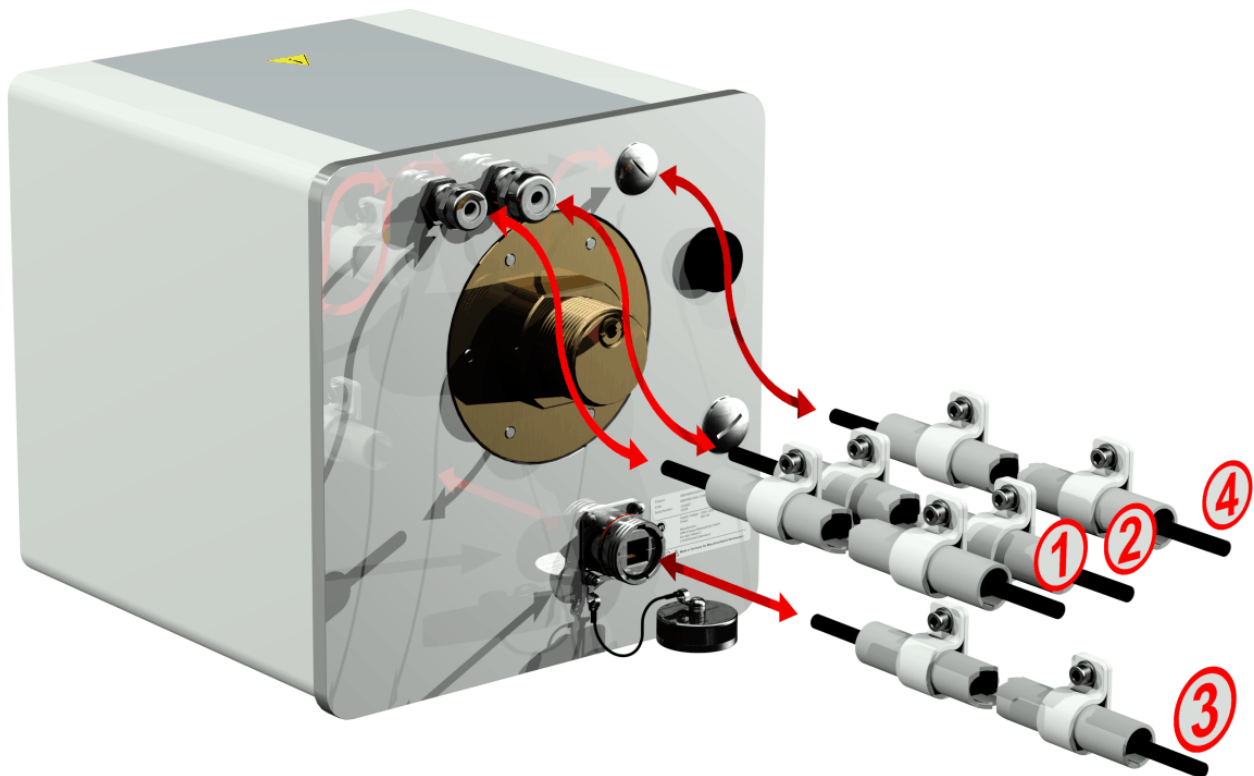
① **Mains connection:**

Recommendation for the mains connection cable:

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

Cable diameter ⌀:   8.1 mm

Cable cross-section ⊗:   1.5 mm^2 (of the 3 individual wires)

Minimum cross-section: 0.75 mm² (maximum cable length at 120V: 25m, at 230V: 50m

② **Modem communication:**
(Exclusively for service purposes)

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 ⌀:   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 ⌀:   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 ⌀:   13.3 mm
Cable cross-section ⊗:   0.5 mm^2 (of the 16 individual wires)

Do not route external wiring over the heaters.
Danger through heat.
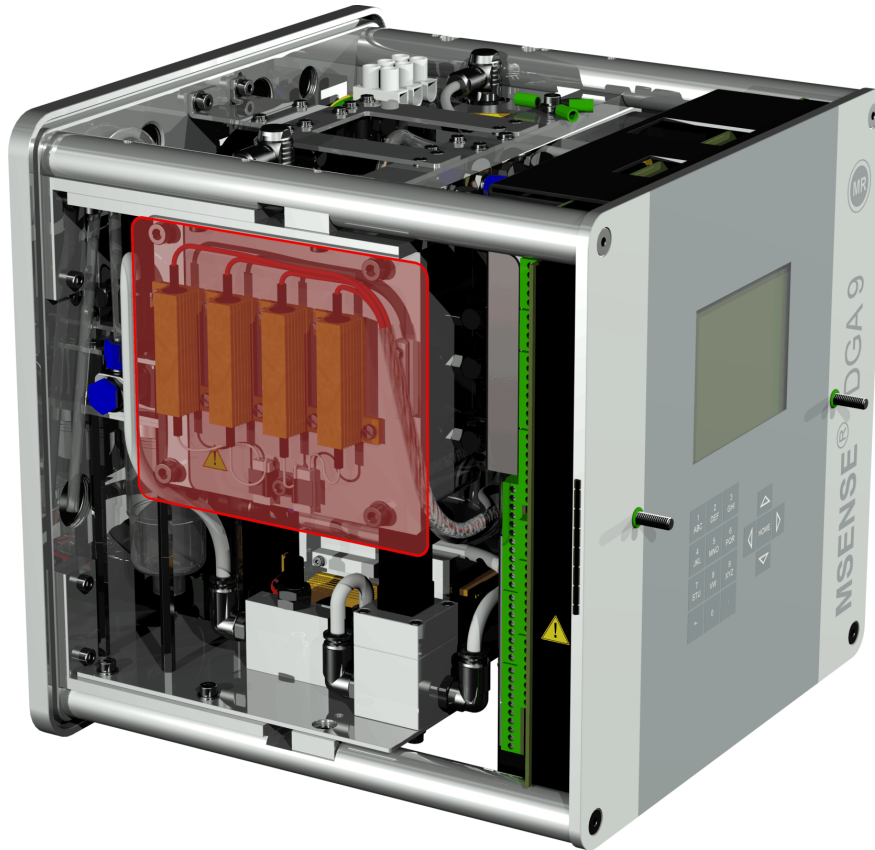
When connecting external cables, please note the following: The red-rimmed area can reach temperatures of up to 80 ° C in the event of a fault. Do not lay cables over this area!

4.4.3 Initial start-up

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.

Setting the time and date under "Device Settings"

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

To enter the sub-menu "Date, time, clock settings", please select the following sub-menu symbols.
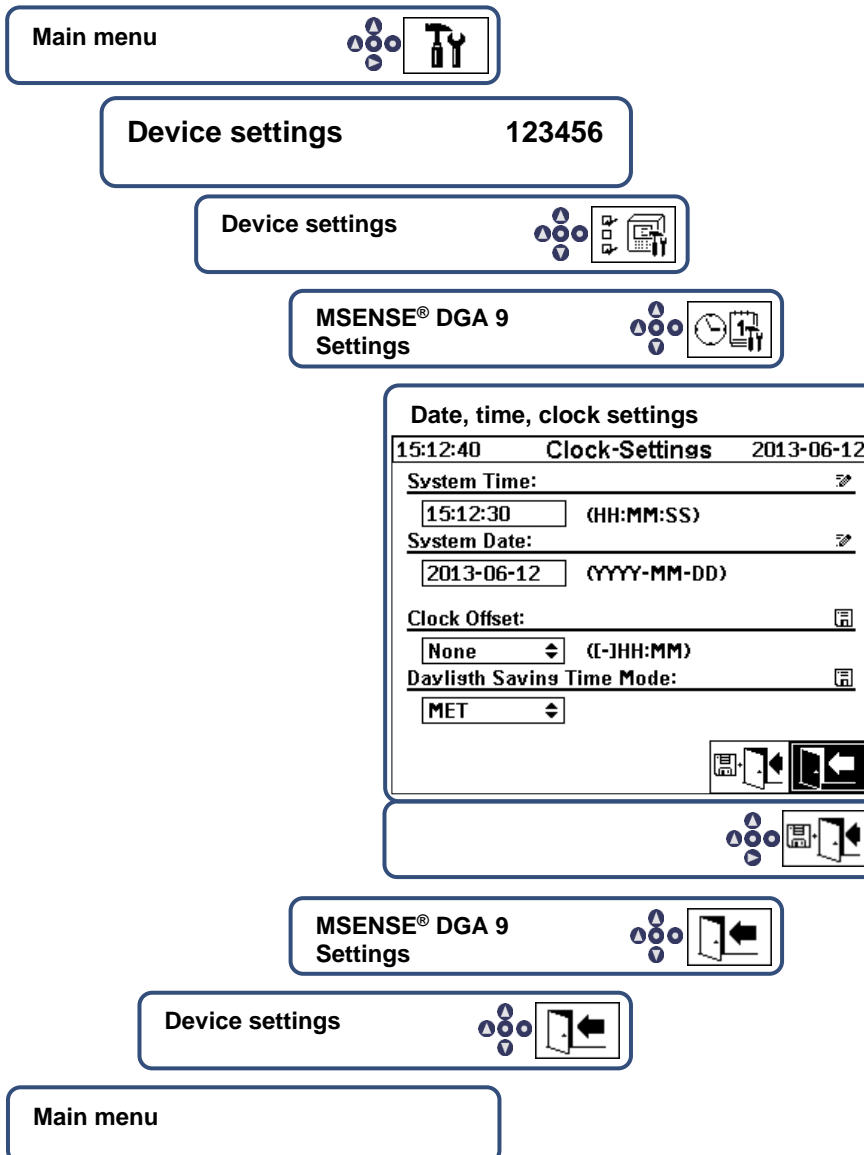
The time and date are entered using the device keyboard. It consists of an alphanumeric keypad, the arrow and the enter key. The numbers must be entered completely with separators (e.g. 15:12:30). The colon is entered using the ⊖ key and the minus sign is entered using the ⊕ key. The entry is then completed with the Enter key (6.10.4.4).

Finish making the entries by pressing the "Save and exit menu" key

 Activate / initialise device under extraction status

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

Main menu	

Extraction status
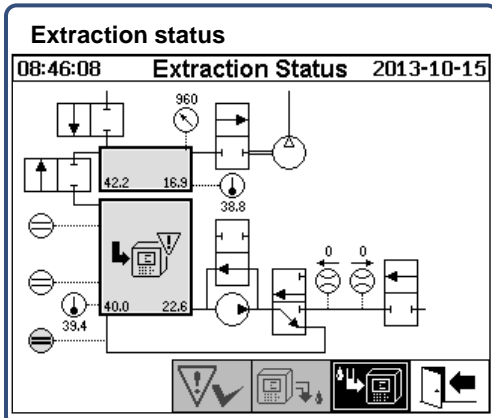
The MSENSE® DGA 9 does not automatically start the measurement cycle after installation and the application of the supply voltage (exception: after a power failure while the device is running). A warning symbol in the picture indicates this status. The activation must be done explicitly by the operator!

Device activation
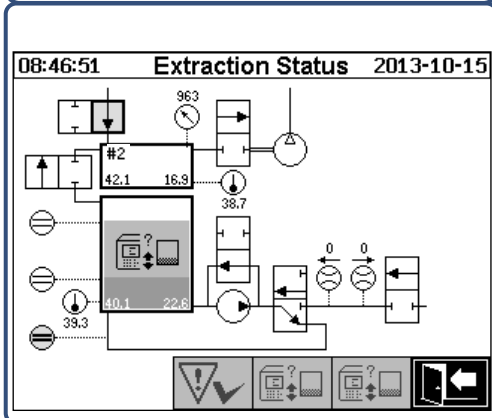
The initialisation cycle detects the device's current state and establishes a defined state of the system.
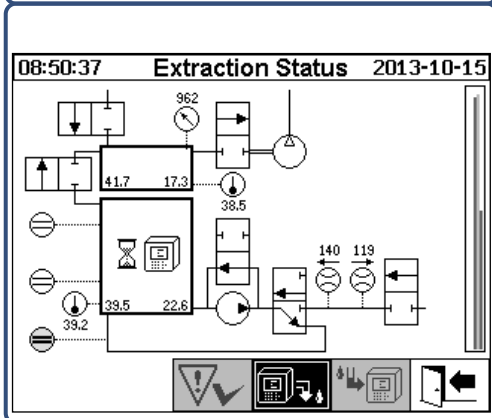
Following successful initialisation, the device's state changes to the "Wait" process step until the next measuring cycle is started.

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. A measuring cycle lasts at least 15 .... 18 minutes.

Note: Activation / initialisation of the MSENSE® DGA 9 device typically uses the term "mount".

4.4.4 Turn off the device

⚠️ **Note!!!**

The device must always be 🔲⬇ **taken out of operation using the "de-activation" key, before it becomes de-energised and can then be disassembled!!!!** ⚠️

🧪 **Deactivate device under extraction status**

Main menu	⬠⬆⬇ 🧪

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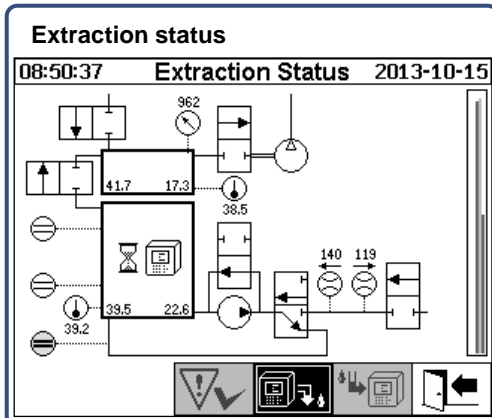
The device's deactivation has to be done explicitly by the user and can be done at any time.

⬠⬆⬇ 🔲⬇

Device deactivation
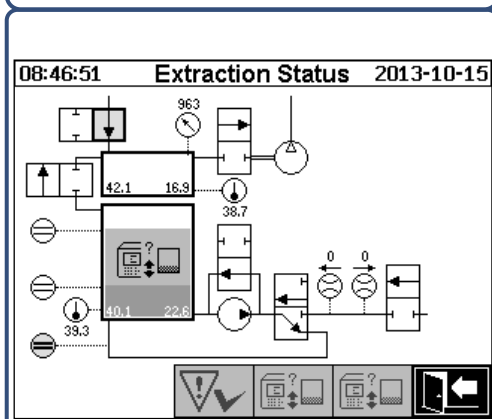
By deactivating the device, the current process step is stopped and a controlled draining is triggered.
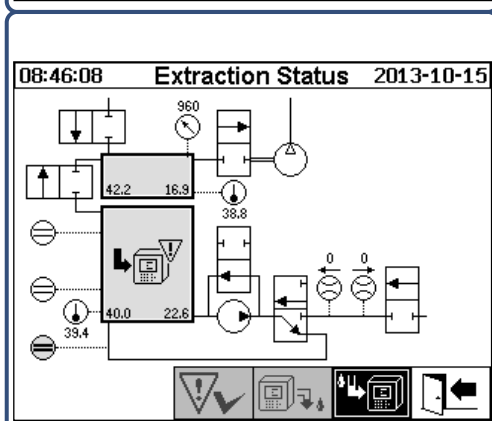
Following its successful deactivation, the device is inactive. A warning symbol indicates this status.

⬠⬆⬇ 🚪⬅

Exit menu

Main menu

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

Note: In order to deactivate the MSENSE® DGA 9, the term "unmount" is typically used.

4.4.5 Automatic activation following the interruption of the supply voltage

If a device 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 [STOP] key within 30 seconds and to manually activate the device at a later point in time (4.4.3).

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:
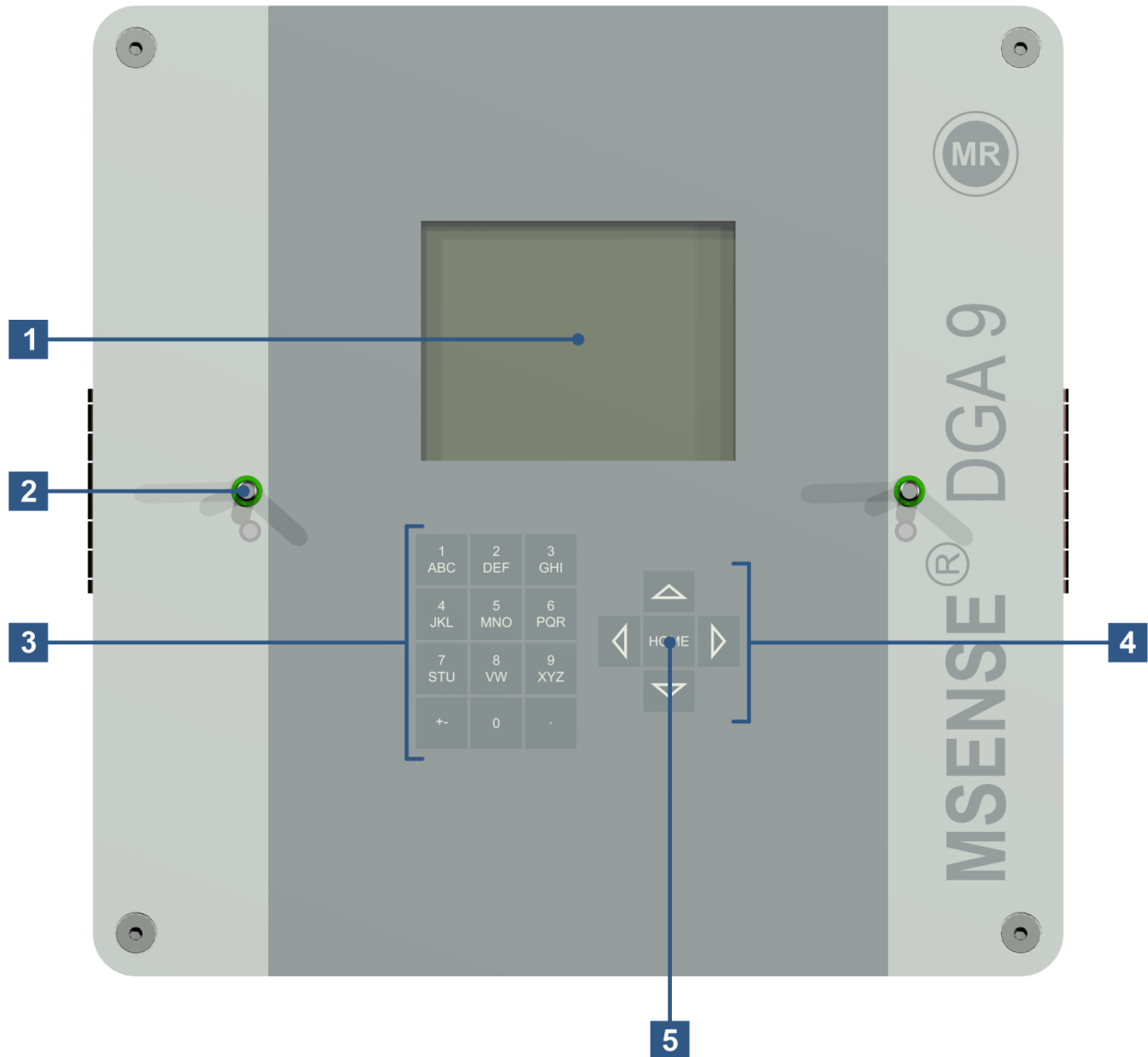
[1] **LCD-Display** with 320 x 240 pixels
[2] **Threaded bolt** for the attachment of the device protective cap
[3] **Alphanumeric keypad** for entering numbers and text
[4] **Arrow keys** for navigation in menus and data entry

[5] **Enter key** to activate and confirm functions and data entry

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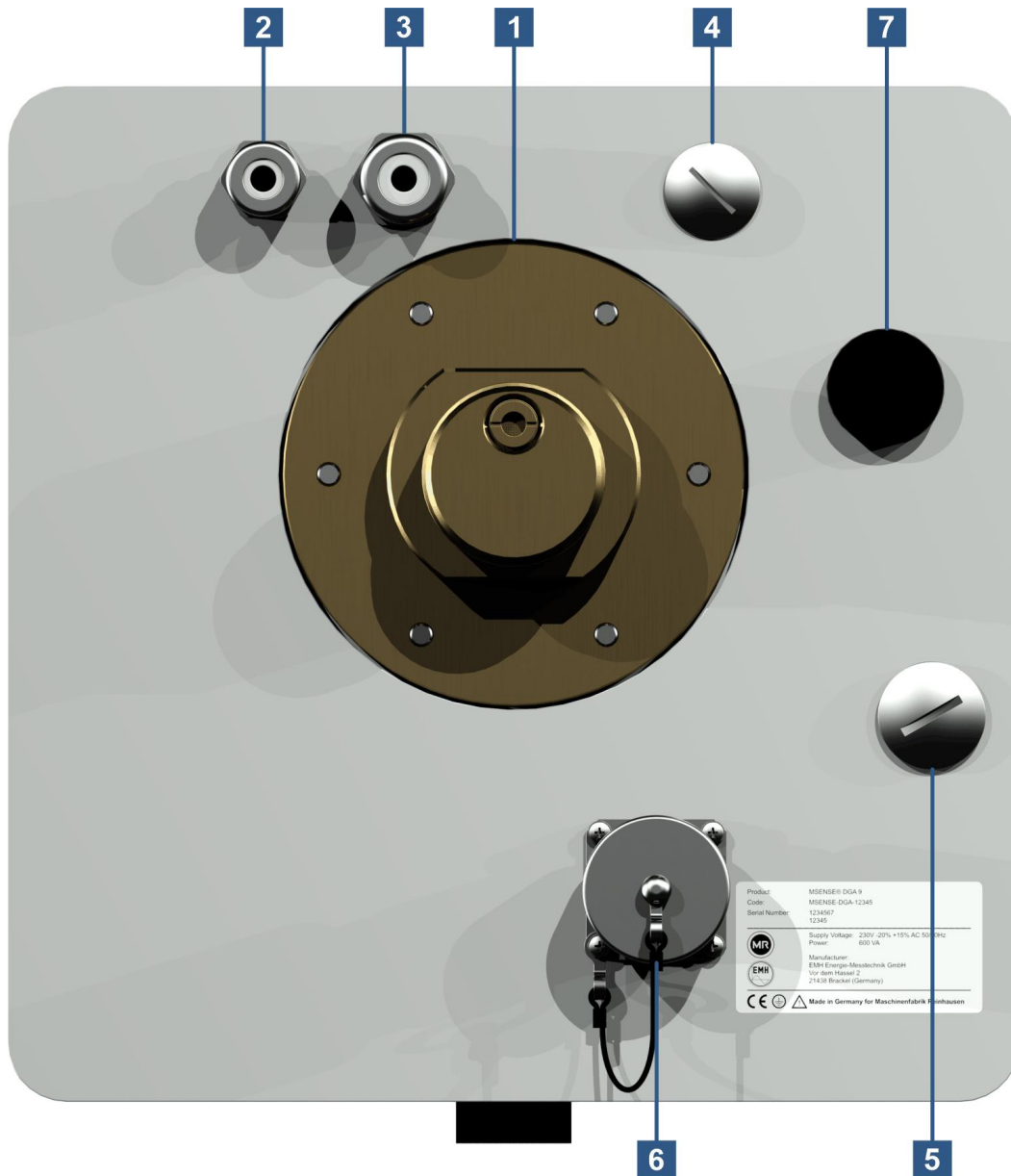
[1]   **Connecting unit** with external thread
G 1½" DIN ISO 228-1 or 1½" NPT ANSI B 1.20.1

[2] **Mains connection** with SKINTOP® threaded joint M16

Nominal voltages:	120 V -20% +15% AC 50/60Hz [1] or
	230 V -20% +15% AC 50/60Hz [1] or
	120 V -20% +15% DC [1] or
	230 V -20% +15% DC [1]
	Other nominal voltages upon request

Power consumption: max. 600 VA

Fuse for 120V: T6, 3 A

Fuse for 230V: T3, 15 A

Connect the power cable as follows:

AC version		**DC version**	
Phase:	L	Plus conductor:	+
Neutral conductor:	N	Minus conductor:	–
Protective earth: PE		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
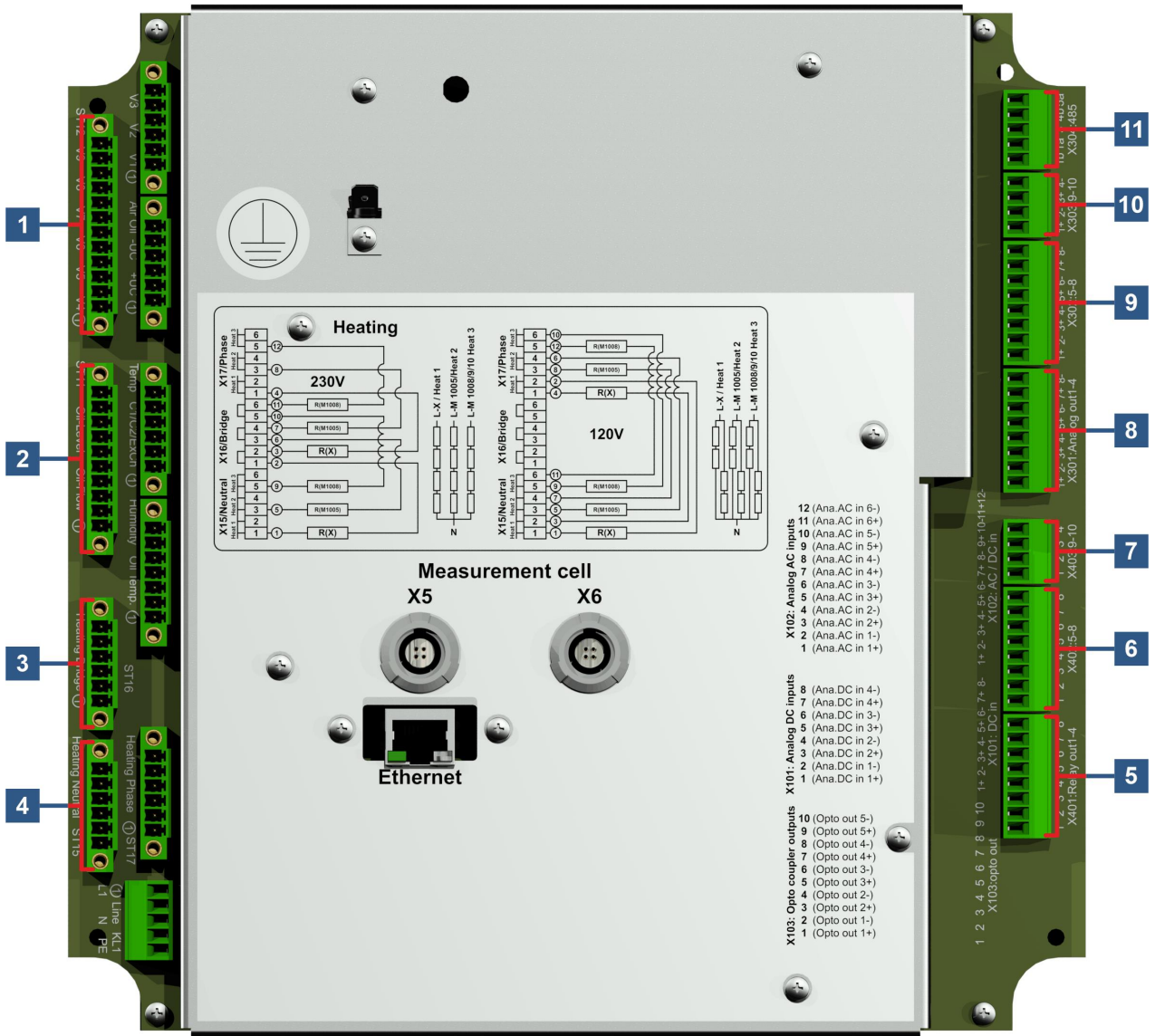
[1]   Connector plug X12: Valve control V4 ... V9 [Valve Control V4-V9]

Connection for ventilation, bypass, measurement cell switching, vacuum and

inlet / outlet valve.
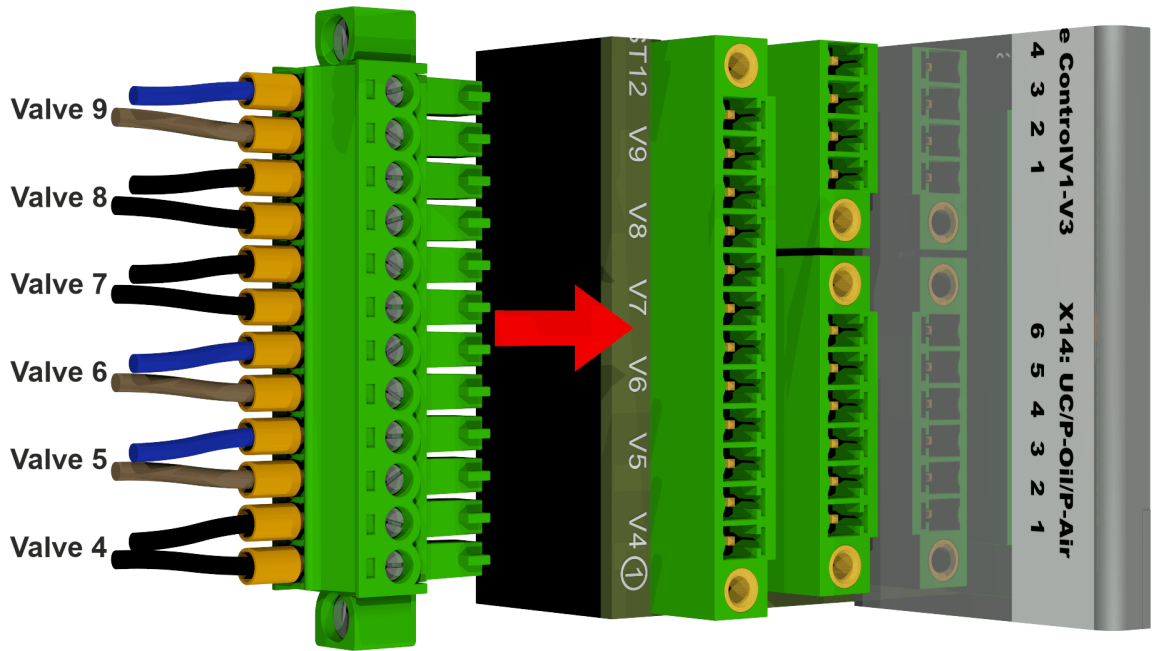
X12:12	⇨ V9 ⊖	⇨ Inlet / outlet valve
X12:11	⇨ V9 ⊕	⇨ Inlet / outlet valve
X12:10	⇨ V8 ⊖	⇨ Vent valve for measurement cell 2
X12:9	⇨ V8 ⊕	⇨ Vent valve for measurement cell 2
X12:8	⇨ V7 ⊖	⇨ Vacuum valve for measurement cell 2
X12:7	⇨ V7 ⊕	⇨ Vacuum valve for measurement cell 2
X12:6	⇨ V6 ⊖	⇨ Measurement cell switching valve
X12:5	⇨ V6 ⊕	⇨ Measurement cell switching valve
X12:4	⇨ V5 ⊖	⇨ Bypass valve oil pump
X12:3	⇨ V5 ⊕	⇨ Bypass valve oil pump
X12:2	⇨ V4 ⊖	⇨ Vent valve for measurement cell 1
X12:1	⇨ V4 ⊕	⇨ Vent valve for measurement cell 1

[2]   Connector plug X11: Filling level / Flow [Oil-Level Oil-Flow]

Connection for filling levels and flow
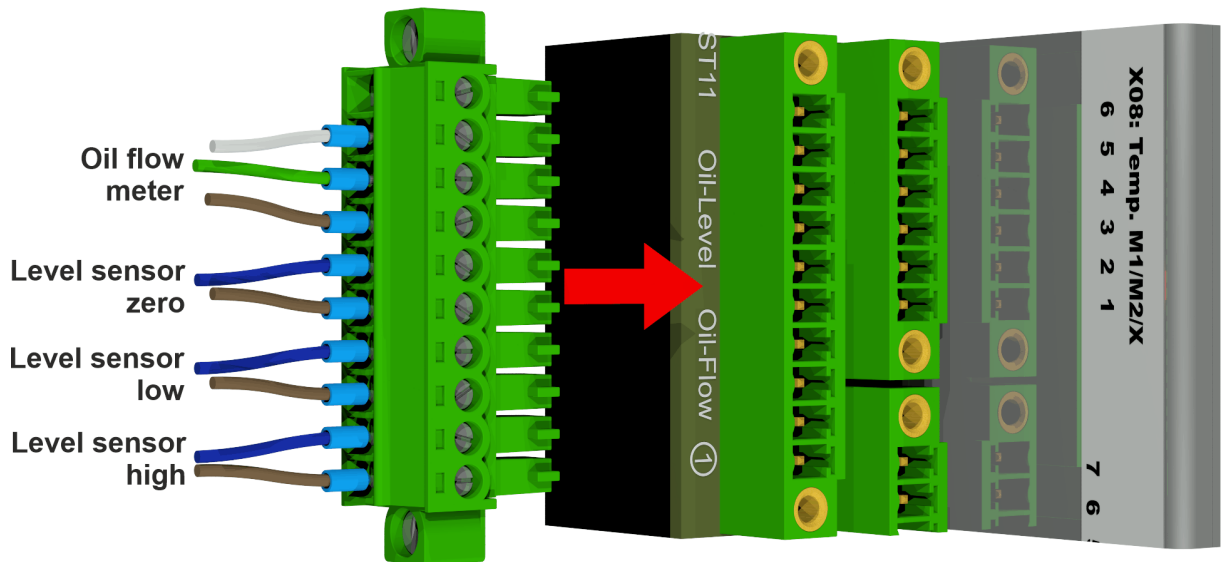
X11:10	⇨	⇨	(not connected)
X11:9	⇨ F1 ⊖	⇨	Flow meter
X11:8	⇨ F1 $_{Impulse}$	⇨	Flow meter
X11:7	⇨ F1 ⊕	⇨	Flow meter
X11:6	⇨ L0 $_{out}$	⇨	Filling level sensor zero acknowledgement
X11:5	⇨ L0 ⊕	⇨	Filling level sensor zero acknowledgement
X11:4	⇨ L1 $_{out}$	⇨	Filling level sensor low
X11:3	⇨ L1 ⊕	⇨	Filling level sensor low
X11:2	⇨ L2 $_{out}$	⇨	Filling level sensor high
X11:1	⇨ L2 ⊕	⇨	Filling level sensor high

[3]   Connector plug X16: Heating Bridge

Connection of the heating resistors with a supply voltage of 230 V
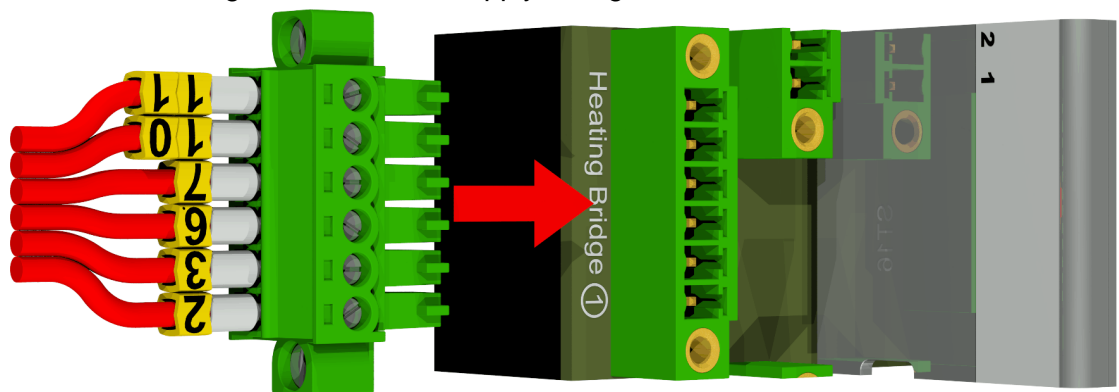
X16:6	⇨ ⌐	⇨	**11**	Heating measurement cell 2
X16:5	⇨ ∟	⇨	**10**	Heating measurement cell 2
X16:4	⇨ ⌐	⇨	**7**	Heating measurement cell 1
X16:3	⇨ ∟	⇨	**6**	Heating measurement cell 1
X16:2	⇨ ⌐	⇨	**3**	Heating extraction chamber
X16:1	⇨ ∟	⇨	**2**	Heating extraction chamber

Connection of the heating resistors with a supply voltage of 120 V
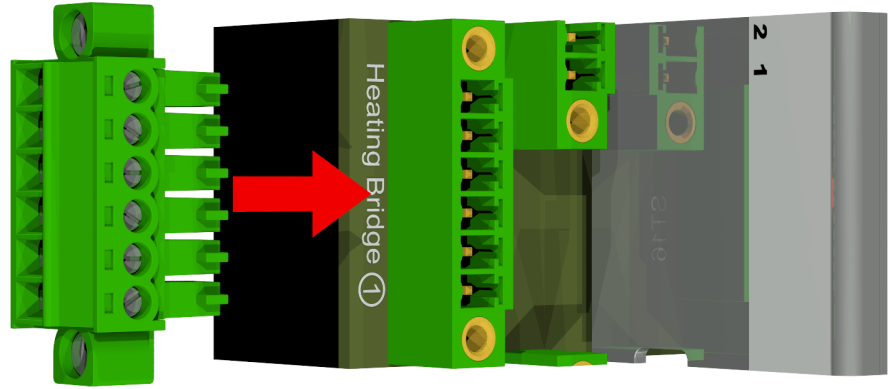
X16:6	⇨		⇨ (not connected)
X16:5	⇨	[	⇨ (not connected)
X16:4	⇨		⇨ (not connected)
X16:3	⇨	[	⇨ (not connected)
X16:2	⇨		⇨ (not connected)
X16:1	⇨	[	⇨ (not connected)

[4] Connector plug X15: Heating Neutral

Connection of the heating resistors with a supply voltage of 230 V
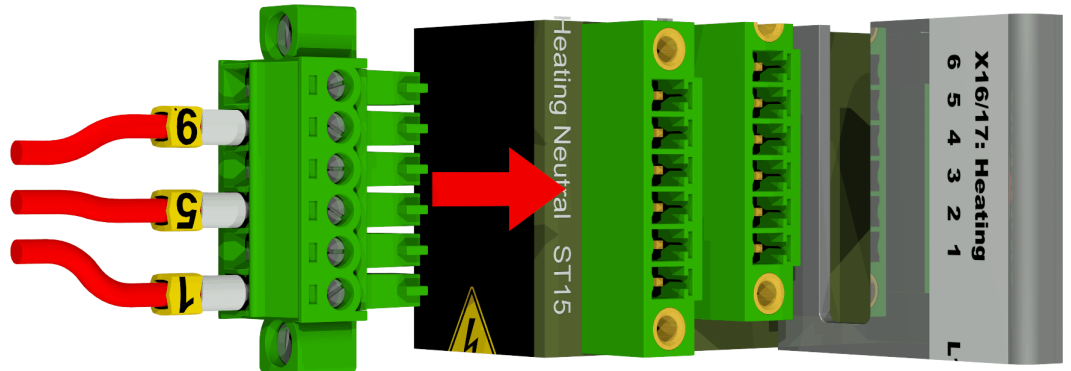
X15:6	⇨ N	⇨		(not connected)
X15:5	⇨ N	⇨	**9**	Heating measurement cell 2
X15:4	⇨ N	⇨		(not connected)
X15:3	⇨ N	⇨	**5**	Heating measurement cell 1
X15:2	⇨ N	⇨		(not connected)
X15:1	⇨ N	⇨	**1**	Heating extraction chamber

Connection of the heating resistors with a supply voltage of 120 V
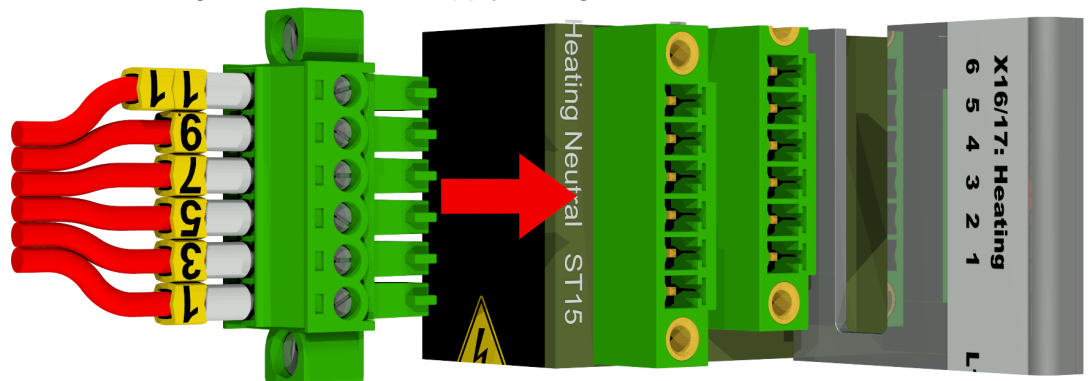
X15:6	⇨	N	⇨	**11**	Heating measurement cell 2
X15:5	⇨	N	⇨	**9**	Heating measurement cell 2
X15:4	⇨	N	⇨	**7**	Heating measurement cell 1
X15:3	⇨	N	⇨	**5**	Heating measurement cell 1
X15:2	⇨	N	⇨	**3**	Heating extraction chamber
X15:1	⇨	N	⇨	**1**	Heating extraction chamber

[5] **Connection terminals X401: Relay outputs 1 ... 4 [4 x Relay-out X401]**

Connection for relay outputs 1 ... 4 (220 VDC/VAC / 2 A / 60 W)

Relays Output 4

Relays Output 3

Relays Output 2

Relays Output 1

Relay contacts
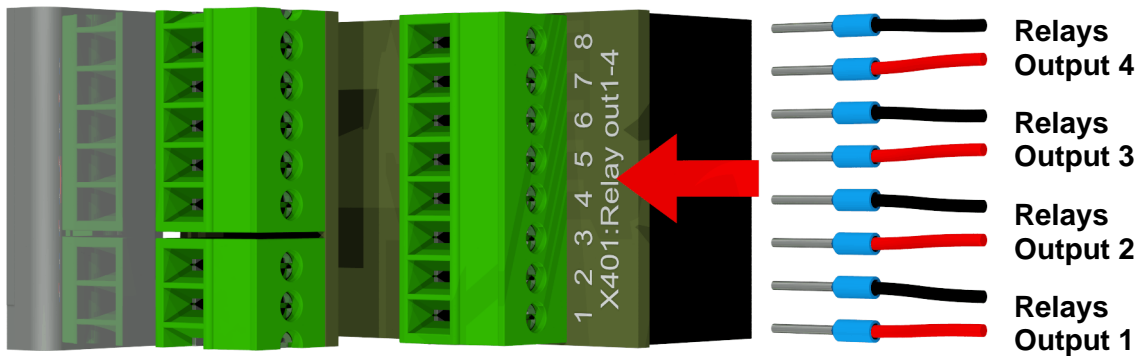
X401:8	⇨ DOR4	⇨ Relay output 4
X401:7	⇨ DOR4	⇨ Relay output 4
X401:6	⇨ DOR3	⇨ Relay output 3
X401:5	⇨ DOR3	⇨ Relay output 3
X401:4	⇨ DOR2	⇨ Relay output 2
X401:3	⇨ DOR2	⇨ Relay output 2
X401:2	⇨ DOR1	⇨ Relay output 1
X401:1	⇨ DOR1	⇨ Relay output 1

or (J1: see also 5.3.1)
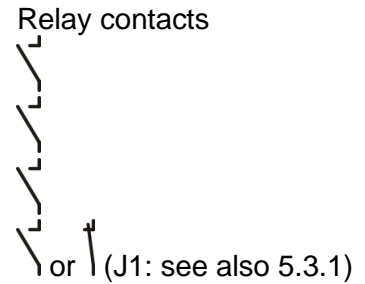
5.3.1 Configuration of relay output 1 with coding bridge 1 (J1)

If coding bridge 1 is inserted as shown in the following figure, relay output 1 is configured so that the contact is closed during the device's operation. In the event of a fault, the contact opens.

Mess- und Controllerkarte

KL 401   KL 402   KL 403   KL 301
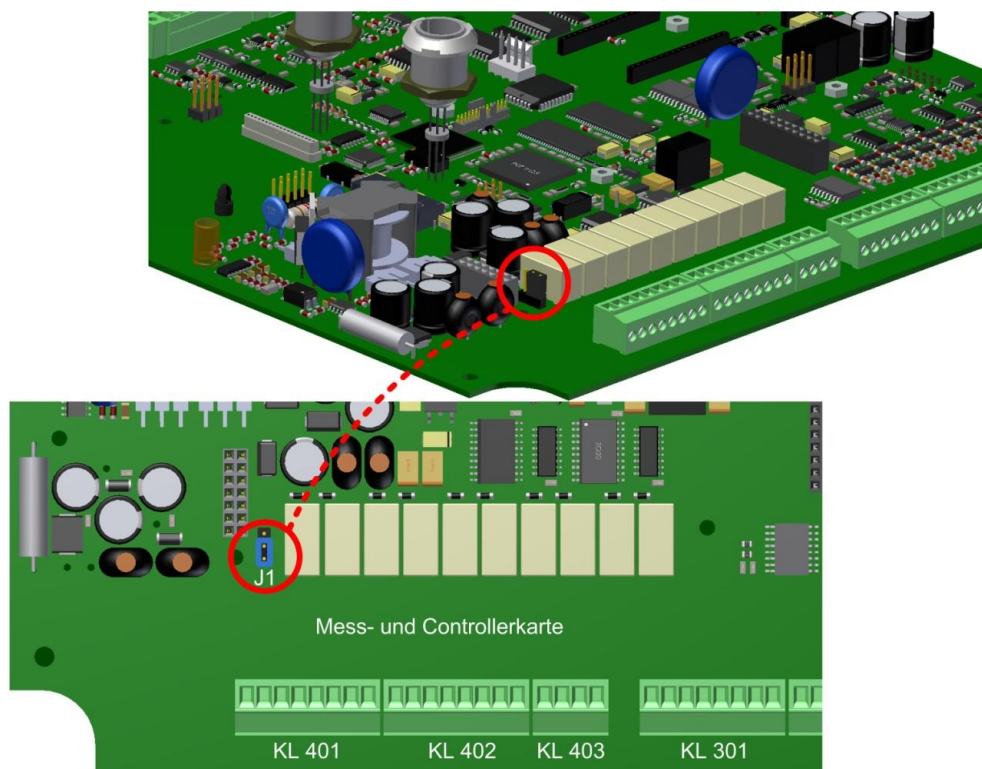
Coding bridge 1 for configuring relay contact 1 (X401 / KL401)

[6] **Connection terminals X402: Relay outputs 5 ... 8 [4 x Relay-out X402]**

Connection for relay outputs 5 ... 8 (220 VDC/VAC / 2 A / 60 W)
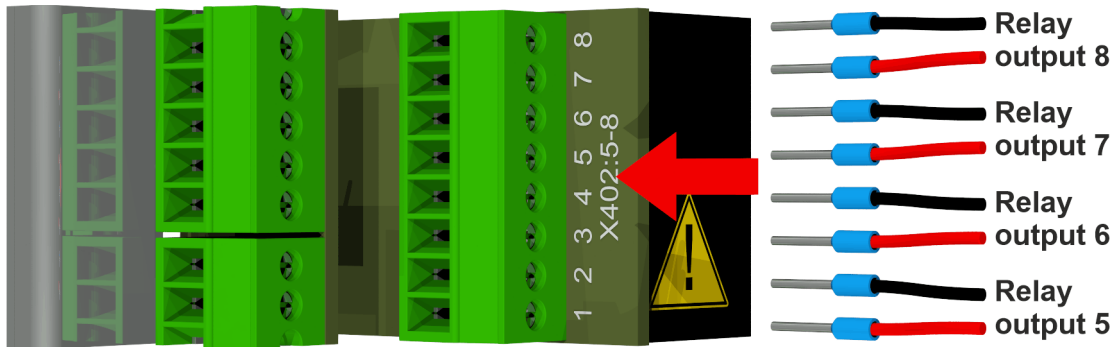
X402:8	⇨ DOR8	⇨ Relay output 8
X402:7	⇨ DOR8	⇨ Relay output 8
X402:6	⇨ DOR7	⇨ Relay output 7
X402:5	⇨ DOR7	⇨ Relay output 7
X402:4	⇨ DOR6	⇨ Relay output 6
X402:3	⇨ DOR6	⇨ Relay output 6
X402:2	⇨ DOR5	⇨ Relay output 5
X402:1	⇨ DOR5	⇨ Relay output 5

[7] **Connection terminals X403: Relay outputs 9 ... 10 [2 x Relay-out X403]**

Connection for relay outputs 9 ... 10 (220 VDC/VAC / 2 A / 60 W)
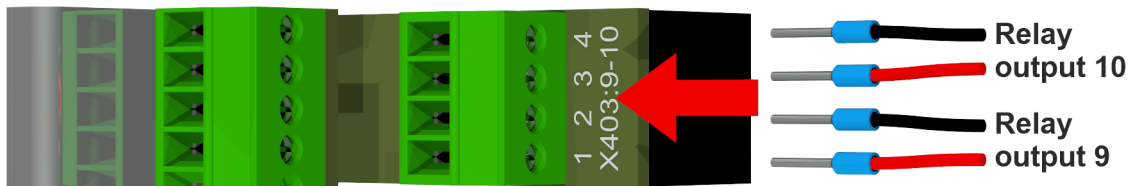
X403:4	⇨ DOR10	⇨ Relay output 10
X403:3	⇨ DOR10	⇨ Relay output 10
X403:2	⇨ DOR9	⇨ Relay output 9
X403:1	⇨ DOR9	⇨ Relay output 9

[8] **Connection terminals X301: Relay outputs 1 ... 4 [Analogue output 1-4]**

Connection for analogue outputs 1 ... 4 (0 / 4…. 20 mA DC)
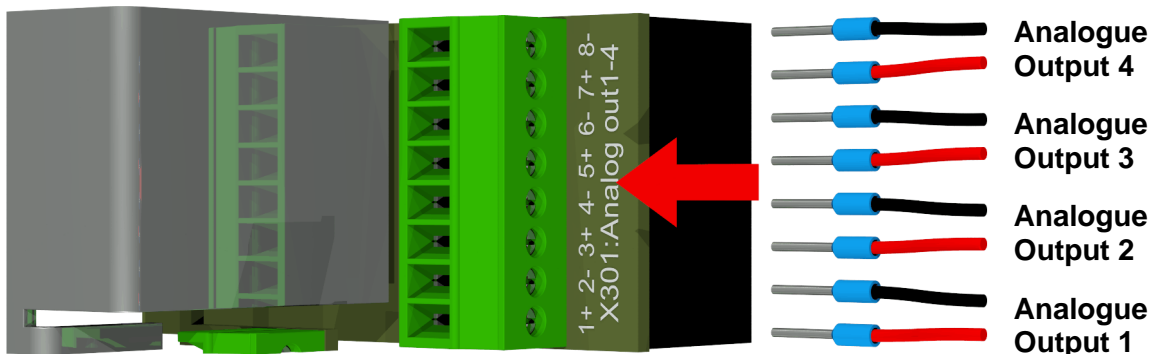
X301:8	⇨ AO4⊖	⇨ Analogue output 4
X301:7	⇨ AO4⊕	⇨ Analogue output 4
X301:6	⇨ AO3⊖	⇨ Analogue output 3
X301:5	⇨ AO3⊕	⇨ Analogue output 3
X301:4	⇨ AO2⊖	⇨ Analogue output 2
X301:3	⇨ AO2⊕	⇨ Analogue output 2

X301:2	⇨ AO1⊖	⇨ Analogue output 1
X301:1	⇨ AO1⊕	⇨ Analogue output 1

[9] **Connection terminals X302: Relay outputs 5 ... 8 [Analogue output 5-8]**

Connection for analogue outputs 5 ... 8 (0 / 4…. 20 mA DC)
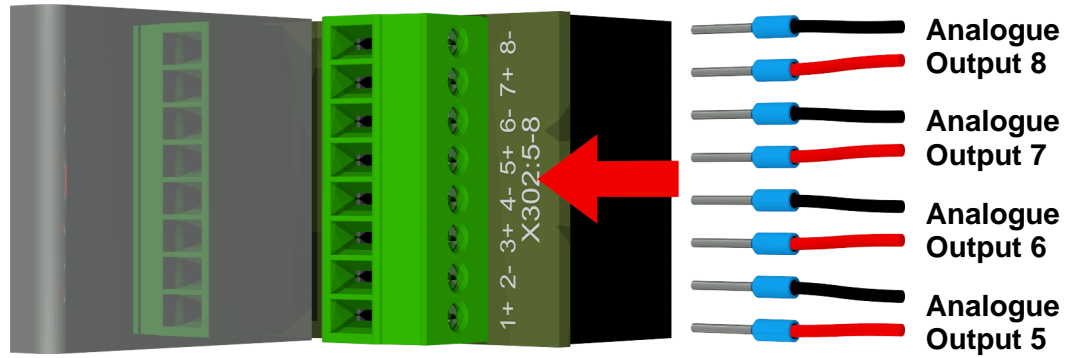
X302:8	⇨ AO8⊖	⇨ Analogue output 8
X302:7	⇨ AO8⊕	⇨ Analogue output 8
X302:6	⇨ AO7⊖	⇨ Analogue output 7
X302:5	⇨ AO7⊕	⇨ Analogue output 7
X302:4	⇨ AO6⊖	⇨ Analogue output 6
X302:3	⇨ AO6⊕	⇨ Analogue output 6
X302:2	⇨ AO5⊖	⇨ Analogue output 5
X302:1	⇨ AO5⊕	⇨ Analogue output 5

[10] **Connection terminals X303: Relay outputs 9 ... 10 [Analogue output 9-10]**

Connection for analogue outputs 9 ... 10 (0 / 4…. 20 mA DC)
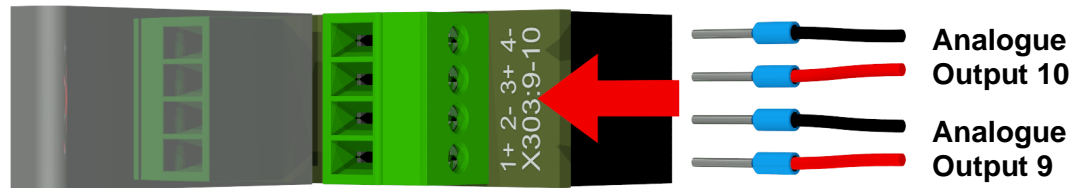
X303:4	⇨ AO10⊖	⇨ Analogue output 10
X303:3	⇨ AO10⊕	⇨ Analogue output 10
X303:2	⇨ AO9⊖	⇨ Analogue output 9
X303:1	⇨ AO9⊕	⇨ Analogue output 9

[11] **Connection terminals X304: RS485 interface**

Connection for RS485 interface
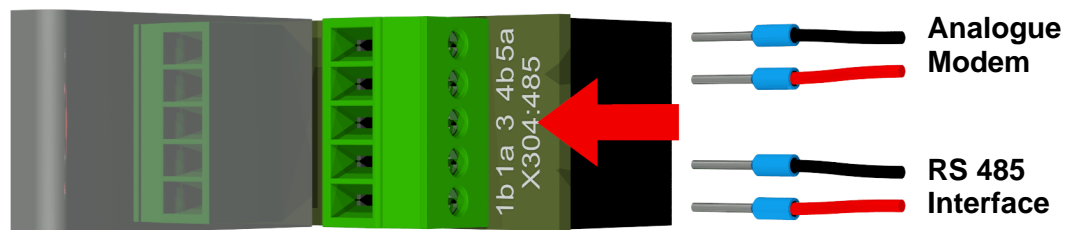
X304:5	⇨	Phone A	⇨	Analogue modem (exclusively for service purposes)
X304:4	⇨	Phone B	⇨	Analogue modem (exclusively for service purposes)
X304:3	⇨	GND IO	⇨	RS-485 interface
X304:2	⇨	OUT A ⊖	⇨	RS-485 interface
X304:1	⇨	OUT B ⊕	⇨	RS-485 interface

The following labels appear on the circuit board diagram:

Left side connectors: [12], [13], [14], [15], [16], [17]

Labels: ST2, V9, V8, V7, V6, V5, V4, ST11, Oil-Level, Oil-Flow, Heating Bridge, ST16, Heating Neutral ST15, Heating Phase ST17, L1 LINE, L11 N.L1, PE

Heating diagram:

X17/Phase — Heat 1, Heat 2, Heat 3 — 6 5 4 3 2 1 / 12 8 4
X16/Bridge — 6 11 10 3 6 2 1 2 — R(M1008), R(M1005), R(X)
X15/Neutral — Heat 1, Heat 2, Heat 3 — 6 5 4 3 2 1 — 9 5 1 — R(M1008), R(M1005), R(X)

Heating 230V

L-X / Heat 1, L-M 1005/Heat 2, L-M 1008/9/10 Heat 3 — N

X17/Phase — Heat 1, Heat 2, Heat 3 — 6 5 4 3 2 1 / 10 12 8 4 — R(M1008), R(M1005), R(X)
120V
X16/Bridge — 6 5 4 3 2 1 — 11 9 7 3 — R(M1008), R(M1005), R(X)
X15/Neutral — Heat 1, Heat 2, Heat 3 — 6 5 4 3 2 1
L-X / Heat 1, L-M 1005/Heat 2, L-M 1008/9/10 Heat 3 — N

Measurement cell

X5   X6

Ethernet

[18], [19], [20]

Right side:

X102: Analog AC inputs
12 (Ana.AC in 6-)
11 (Ana.AC in 6+)
10 (Ana.AC in 5-)
9 (Ana.AC in 5+)
8 (Ana.AC in 4-)
7 (Ana.AC in 4+)
6 (Ana.AC in 3-)
5 (Ana.AC in 3+)
4 (Ana.AC in 2-)
3 (Ana.AC in 2+)
2 (Ana.AC in 1-)
1 (Ana.AC in 1+)

X101: Analog DC inputs
8 (Ana.DC in 4-)
7 (Ana.DC in 4+)
6 (Ana.DC in 3-)
5 (Ana.DC in 3+)
4 (Ana.DC in 2-)
3 (Ana.DC in 2+)
2 (Ana.DC in 1-)
1 (Ana.DC in 1+)

X103: Opto coupler outputs
10 (Opto out 5-)
9 (Opto out 5+)
8 (Opto out 4-)
7 (Opto out 4+)
6 (Opto out 3-)
5 (Opto out 3+)
4 (Opto out 2-)
3 (Opto out 2+)
2 (Opto out 1-)
1 (Opto out 1+)

Right connector labels: 1b1a 3 4b5a X304:485, 1+ 2- 3+ 4- X303:9-10, 1+ 2- 3+ 4- 5+ 6- 7+ 8- X302:5-8, 1+ 2- 3+ 4- 5+ 6- 7+ 8- X301:Analog out1-4, X403:9-10, X102:AC / DC in, X101:DC in, X402:5-8, X401:Relay out1-4, X103:opto out

[12]   Connector plug X13: Valve control V1 ... V3 [Valve Control V1-V3]

Connection for degassing, measurement cell separation and vacuum MZ1 - valve

Valve 3, Valve 2, Valve 1
ST12, V9, V8, V3
X13: Valve Control V1-V3 — 6 5 4 3 2 1
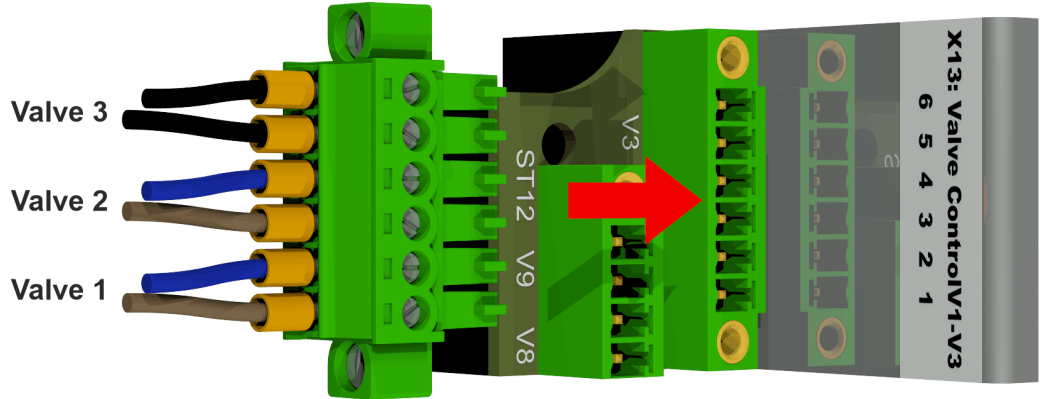
X13:6	⇨ V3 ⊖	⇨ Vacuum value for measurement cell 1
X13:5	⇨ V3 ⊕	⇨ Vacuum value for measurement cell 1
X13:4	⇨ V2 ⊖	⇨ Measurement cell isolation valve
X13:3	⇨ V2 ⊕	⇨ Measurement cell isolation valve
X13:2	⇨ V1 ⊖	⇨ Degassing valve
X13:1	⇨ V1 ⊕	⇨ Degassing valve

[13]   Connector plug X14: Voltage 12VDC / Pump / Compressor [UC / P-Oil / P-Air]

Connection for voltage 12VDC, oil pump and compressor

Depression compressor K1

Oil pump P1

Supply voltage UC-/UC+
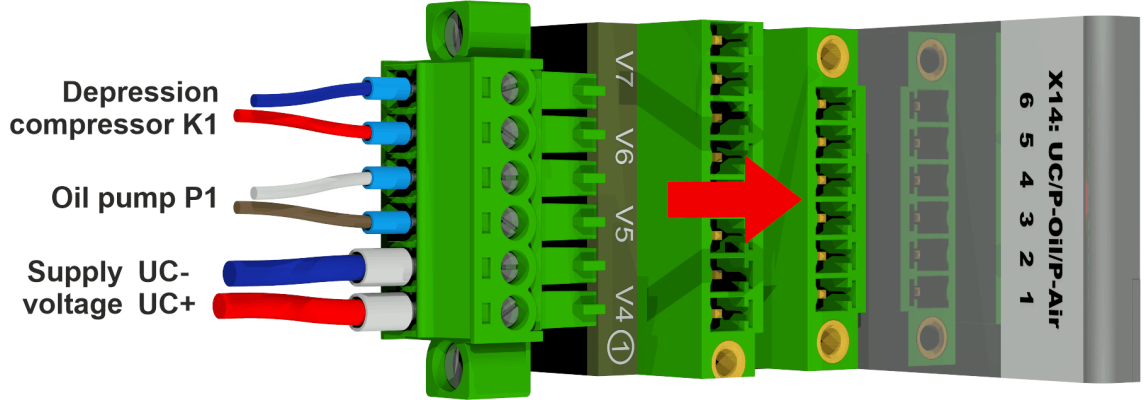
X14:6	⇨	K1 ⊖	⇨	Compressor
X14:5	⇨	K1 ⊕	⇨	Compressor
X14:4	⇨	P1 ⊖	⇨	Pump
X14:3	⇨	P1 ⊕	⇨	Pump
X14:2	⇨	UC ⊖	⇨	Voltage 12 VDC
X14:1	⇨	UC ⊕	⇨	Voltage 12 VDC

[14]   Connector plug X8: Temperature heating [Temp. HeatX]

Connection for temperature sensors – heating

Temperature Sensor $T_{X-Chmbr}$

Temperature Sensor T_{MC2}

Temperature Sensor T_{MC1}
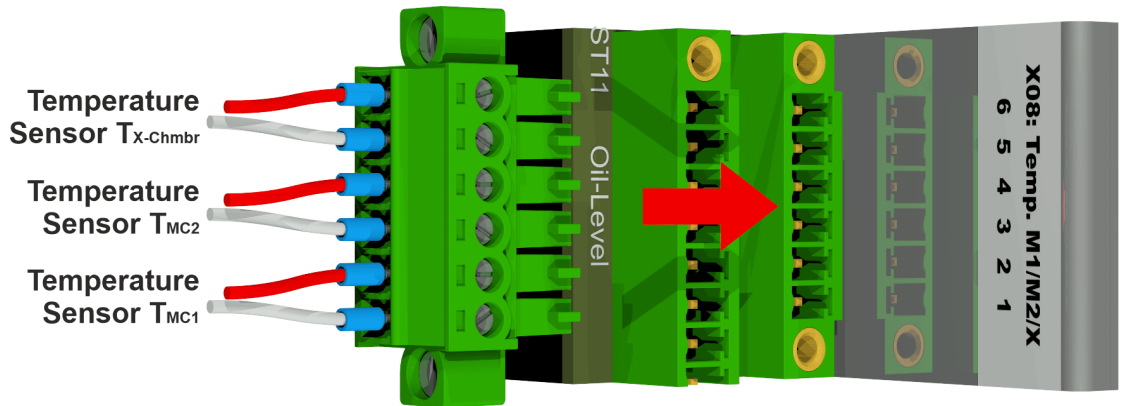
X8:6	⇨ $T_{X-Chmbr}$	⇨ Temperature sensor extraction chamber
X8:5	⇨ $T_{X-Chmbr}$	⇨ Temperature sensor extraction chamber
X8:4	⇨ T_{MC2}	⇨ Temperature sensor measurement cell 2
X8:3	⇨ T_{MC2}	⇨ Temperature sensor measurement cell 2
X8:2	⇨ T_{MC1}	⇨ Temperature sensor measurement cell 1
X8:1	⇨ T_{MC1}	⇨ Temperature sensor measurement cell 1

[15]   Connector plug X3: Moisture in oil / oil temperature Oil]

Connection for the moisture in oil sensor and oil temperature sensor
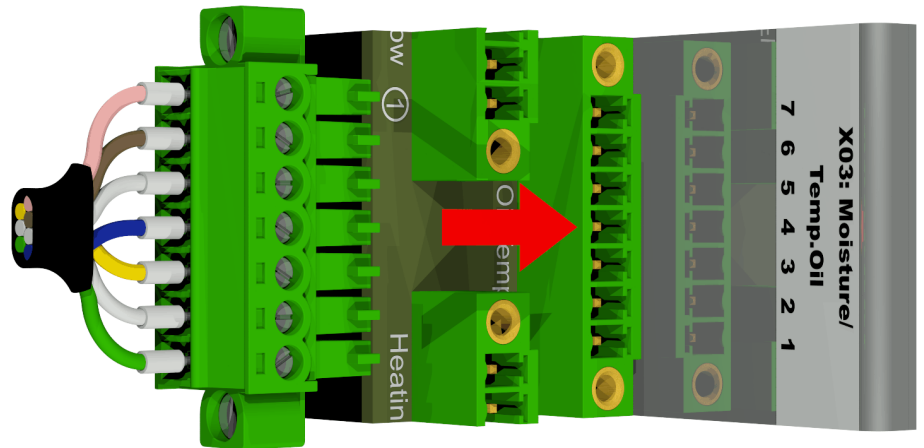
X3:7	⇨ T2	⇨ Oil temperature sensor extraction chamber
X3:6	⇨ T2	⇨ Oil temperature sensor extraction chamber
X3:5	⇨ M1$_{GND}$	⇨ Moisture in oil sensor extraction chamber
X3:4	⇨ M1$\oplus$	⇨ Moisture in oil sensor extraction chamber
X3:3	⇨ M1$\ominus$	⇨ Moisture in oil sensor extraction chamber
X3:2	⇨ M1$_{out}$	⇨ Moisture in oil sensor extraction chamber
X3:1	⇨ M1$_{in}$	⇨ Moisture in oil sensor extraction chamber

[16]   Connector plug X17: Heating Phase

Connection of the heating resistors with a supply voltage of 230 V
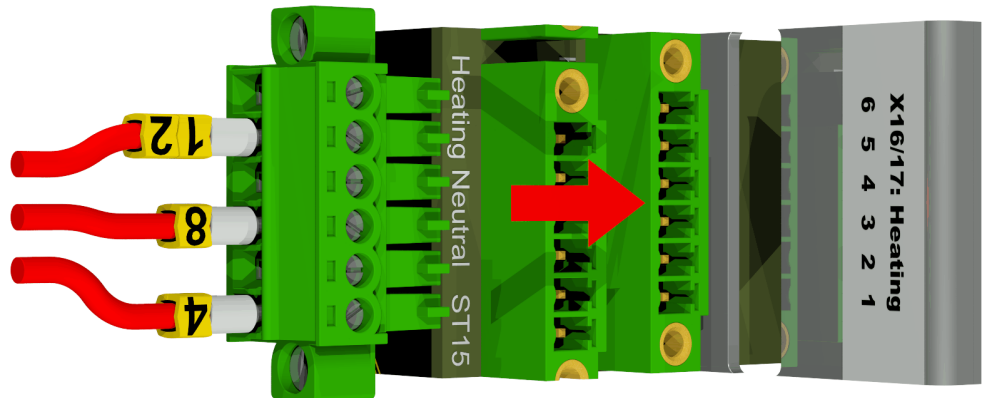
X17:6	⇨ N	⇨ (not connected)
X17:5	⇨ N	⇨ **1 2** Heating measurement cell 2
X17:4	⇨ N	⇨ (not connected)
X17:3	⇨ N	⇨ **8** Heating measurement cell 1
X17:2	⇨ N	⇨ (not connected)
X17:1	⇨ N	⇨ **4** Heating extraction chamber

Connection of the heating resistors with a supply voltage of 120 V
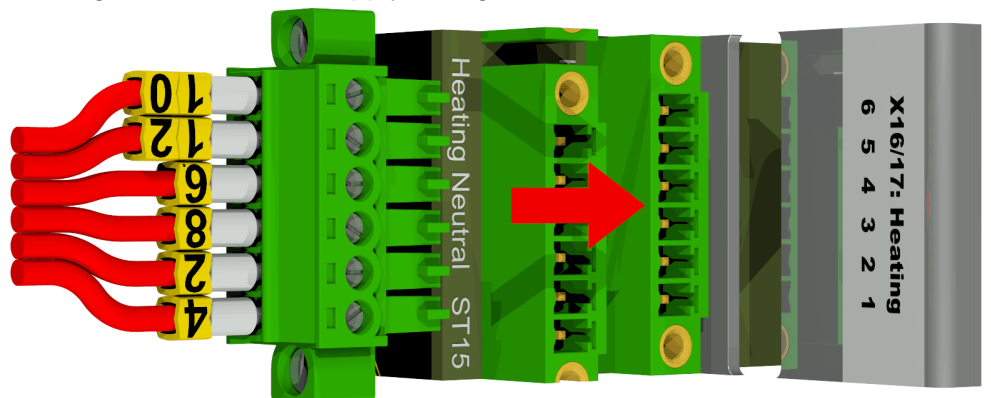
X17:6	⇨ N	⇨ **1 0**	Heating measurement cell 2
X17:5	⇨ N	⇨ **1 2**	Heating measurement cell 2
X17:4	⇨ N	⇨ **6**	Heating measurement cell 1
X17:3	⇨ N	⇨ **8**	Heating measurement cell 1
X17:2	⇨ N	⇨ **2**	Heating extraction chamber
X17:1	⇨ N	⇨ **4**	Heating extraction chamber

[17] Connection terminals X1: Power supply

Connection power supply
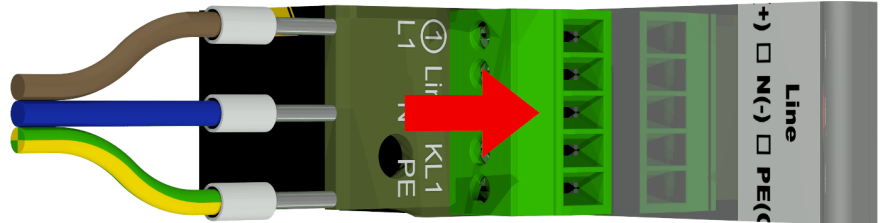
Connector X1: 1 is connected to the fuse carrier supplied by the main connector.

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

[18] Connection ETHERNET communication [Ethernet]

Communication port via Ethernet
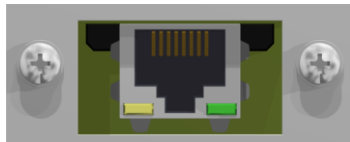
Copper cable   or   **fibre optic cable**
(RJ45)   **(SC-Duplex)**

[19] Connection socket X5: Measurement cell 1 [Measurement cell 1 1005 / X5]

Connection for the measurement cell 1 via REDEL panel jack 4-pole 0° coded

X5:2   **X5:3**

X5:1   **X5:4**
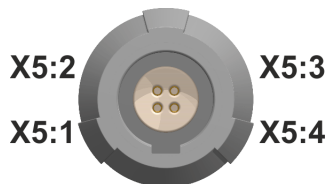
X5:4	⇨ Tx$_{SENS}$	⇨	Measurement cell 1 transmission signal
X5:3	⇨ Rx$_{SENS}$	⇨	Measurement cell 1 reception signal
X5:2	⇨ GND	⇨	8 Volt supply
X5:1	⇨ 8V⊕	⇨	8 Volt supply

[20] Connection socket X6: Measurement cell 2 [Measurement cell 2 1009 / X6]

Connection for the measurement cell 2 via REDEL panel jack 4-pole 0° coded

X6:2   **X6:3**

X6:1   **X6:4**
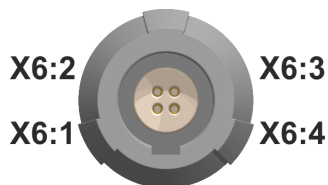
X6:4	⇨ Tx$_{SENS}$	⇨	Measurement cell 2 transmission signal
X6:3	⇨ Rx$_{SENS}$	⇨	Measurement cell 2 reception signal
X6:2	⇨ GND	⇨	8 Volt supply
X6:1	⇨ 8V⊕	⇨	8 Volt supply

5.4   Extraction menu
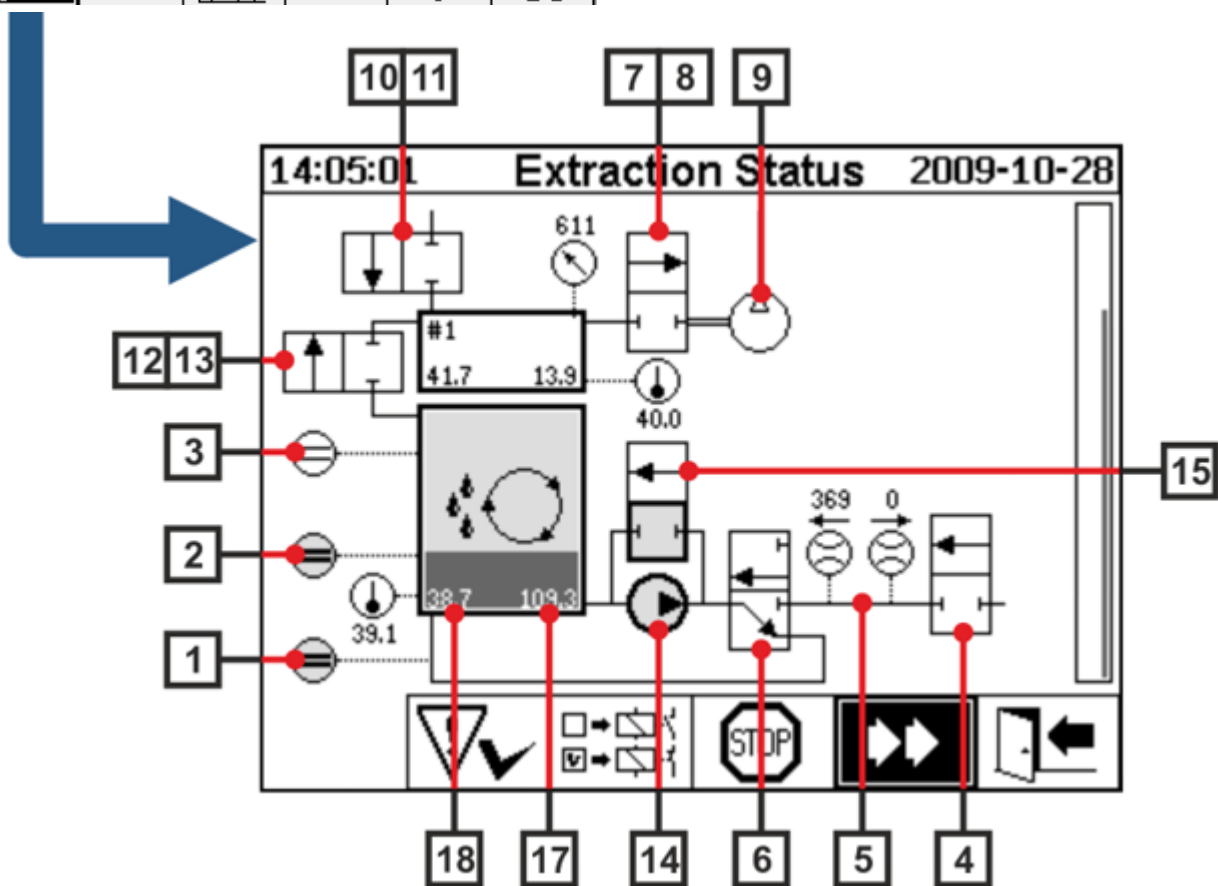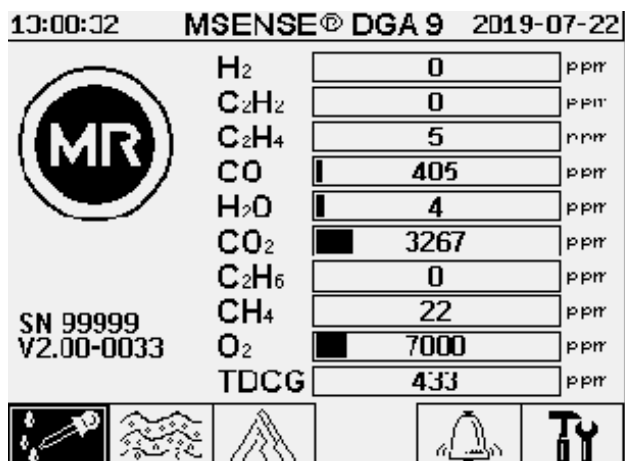
5.4.1   Hardware components

[1]   **Filling level sensor L0** (L0 zero acknowledgement)

[2]   **Filling level sensor L1** (L1 extraction chamber)

[3]   **Filling level sensor L2** (L2 extraction chamber)

[4]   **Valve V9** (safety)

[5]   **Flow measurement** (fill / drain flow)

[6]   **Valve V1** (filling / draining, circulation)

[7]   **Valve V3** (vacuum MZ1)

[8]   **Valve V7** (vacuum MZ2)

[9]   **Compressor K1**

[10] **Valve V4** (ventilation MZ1)

[11] **Valve V8** (ventilation MZ2)

[12] **Valve V2** (measurement cell separation, oil from gas)

[13] **Valve V6** (switching between MZ1 and MZ2)

[14] **Oil pump P1**

[15] **Valve V5** (bypass filling)

[16] **Oil separator**

[17] **Oil-moisture extraction chamber**

[18] **Oil temperature extraction chamber**
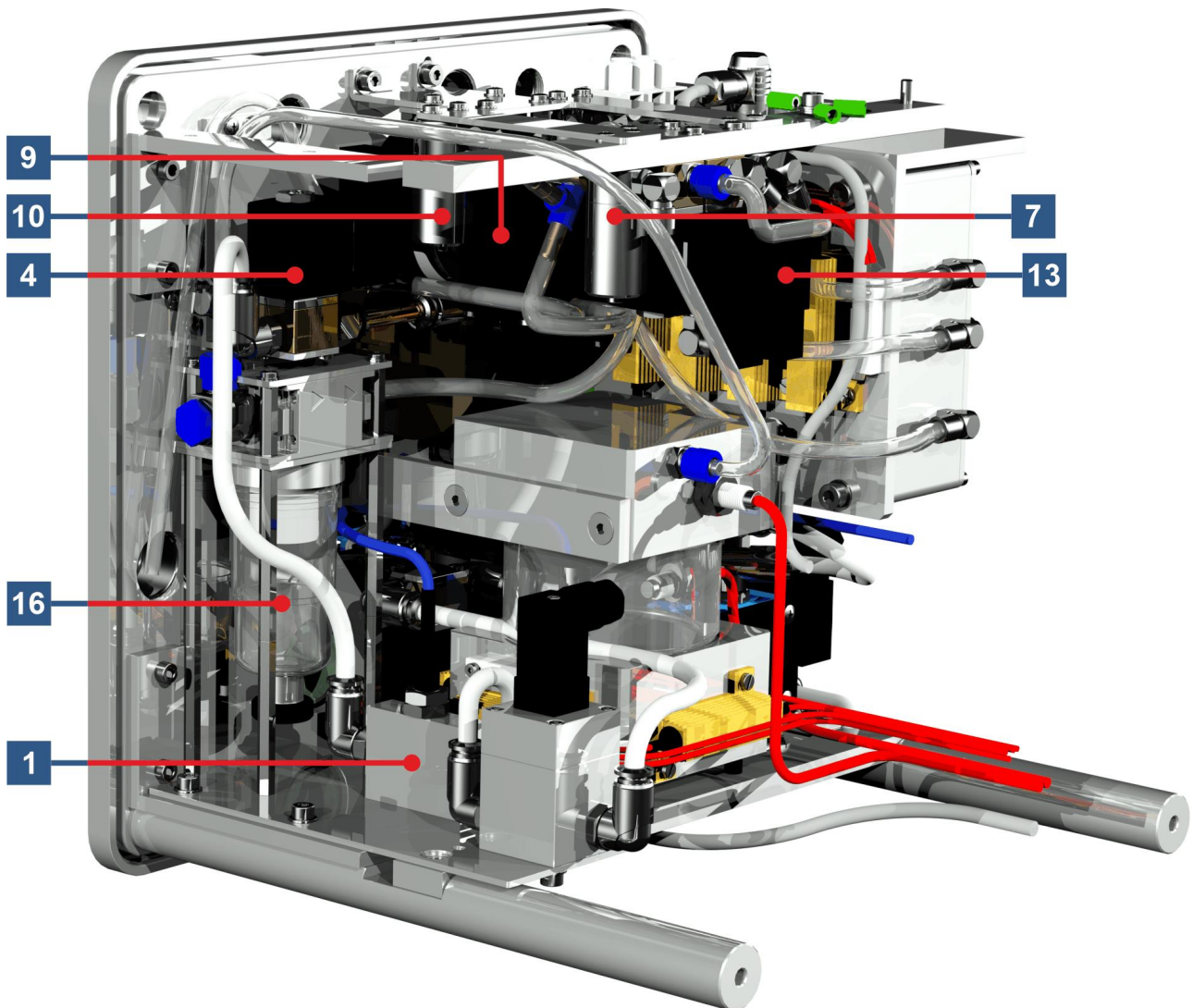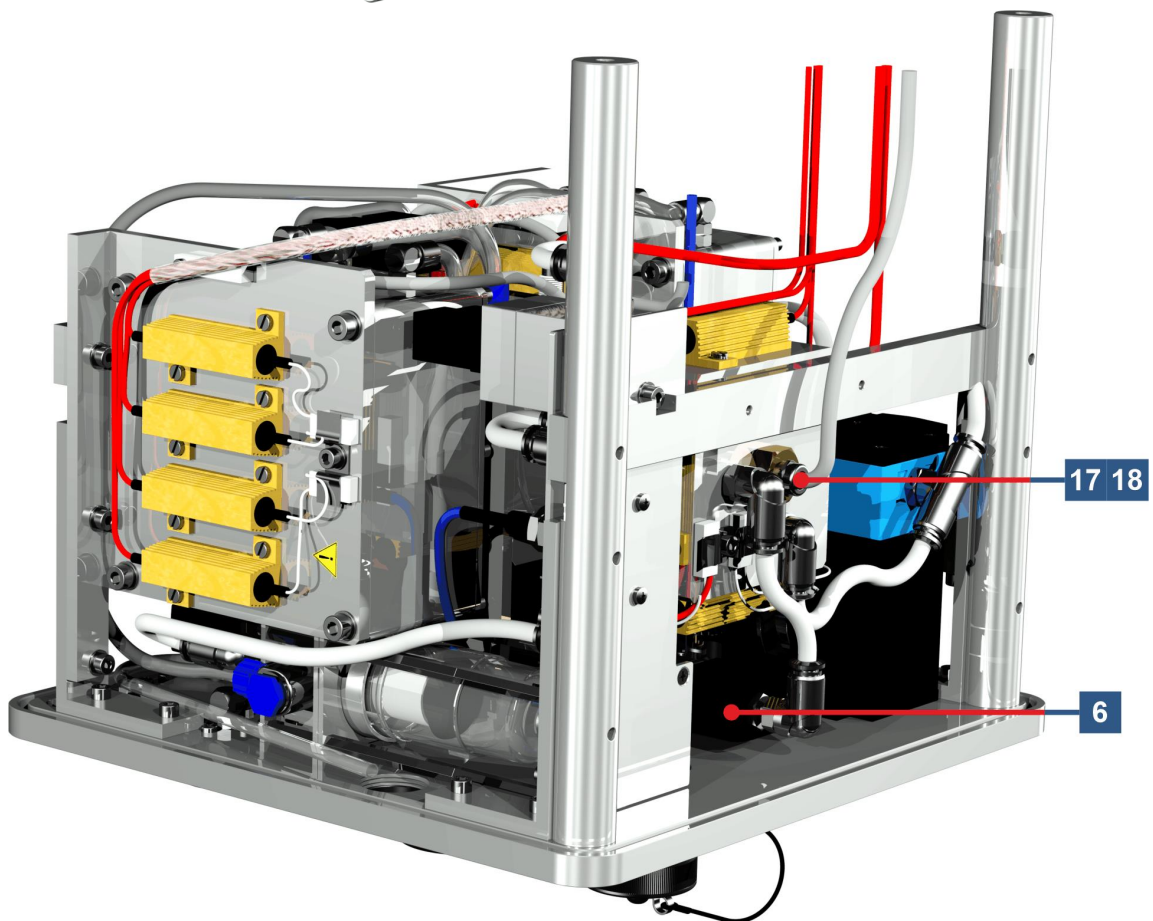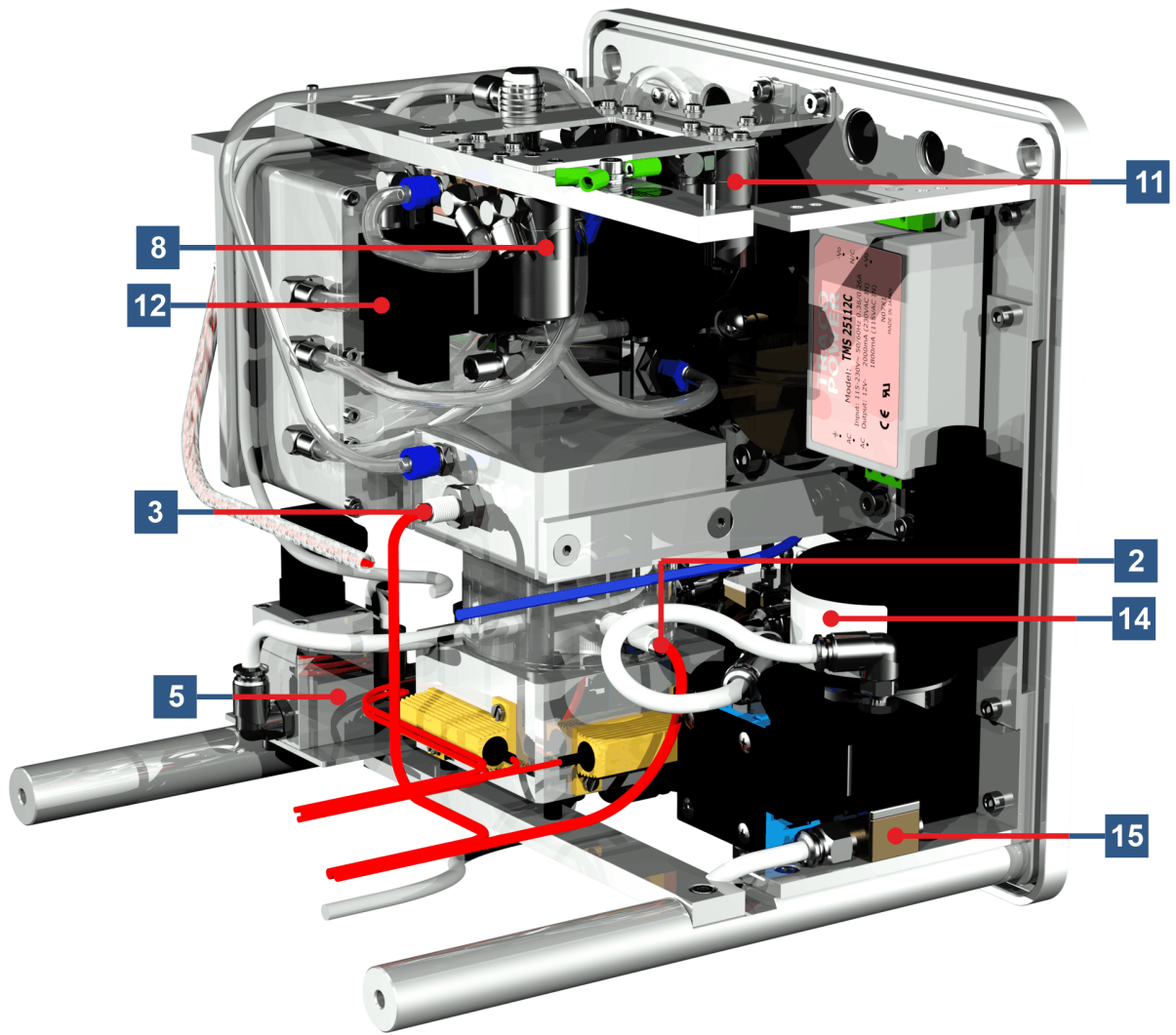
6. Device firmware

6.1 General information

The "gas-in-oil" analysis system MSENSE® DGA 9 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 10 years.

After that, the oldest data are overwritten by the current measured values. When using analogue sensors, memory capacity is reduced. When using additional sensors, the storage capacity depends on the number of sensors and the chosen storage interval. The following calculation formula can be used to determine the storage capacity:

$$Speichertiefe[Tage] \approx \frac{128 \cdot 2^{20}[Byte]}{23000\,[Byte/Tag] + \sum_{n=1}^{12} 288\,[Byte/Tag] \cdot Sensorspeicher_n[1/Std]}$$

With an additional sensor and a storage interval of 5 minutes, the result is as follows:

$$Speichertiefe[days] \approx \frac{128 \cdot 2^{20}[Byte]}{2300\,Tag + 3456\,[Byte/Tag]} \approx \frac{128 \cdot 2^{20}[Byte]}{26456\,[Byte/Tag]} \approx 2500\,[Tage]$$

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 MR MSET DGA software.

6.1.1 Main screen
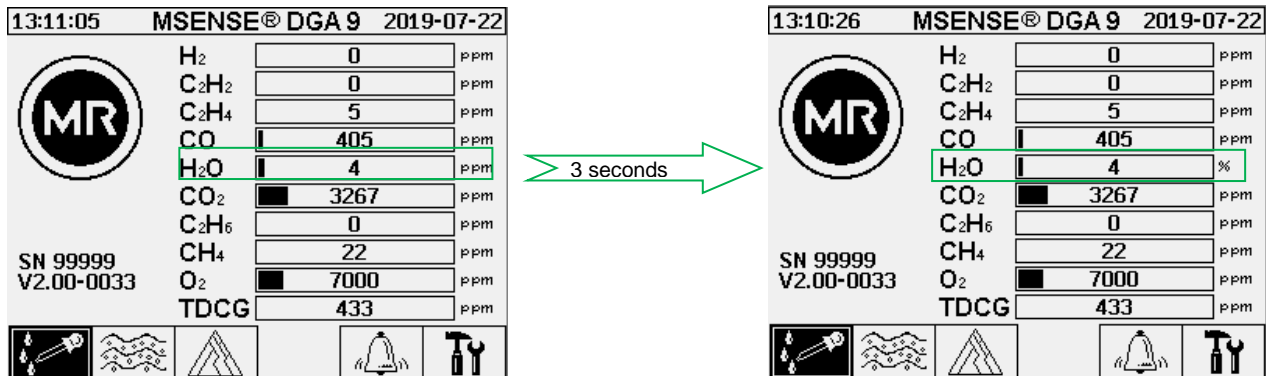
The relative moisture of the oil is displayed on the main screen in alternating fashion between the absolute and relative oil moisture. The bar for the oil moisture changes between its absolute and relative moisture (3s change interval).

6.2 Process flow

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

Remarks: The valve V6 for switching between the measurement cells is not listed in the graphs. The fact is that it switches through to measurement cell 1 when de-energised.

6.2.1 Zero measurement

In this process step, the zero measurement is executed.

Legend	Condition of components
[1]	**Filling level L0** "not reached"
[2]	**Filling level L1** "not reached"
[3]	**Filling level L2** "not reached"
[4]	**Valve V9** "closed"
[5]	**Flow F1** "not available"
[6]	**Valve V1** "degassing"
[7]	**Valve V3/ V7** "closed"
[8]	**Compressor K1** "standstill"
[9]	**Valve V4/ V8** "closed"
[10]	**Valve V2** "closed"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"

Safety functions and fault detection Zero measurement

Monitored components	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline
Pressure sensor in measurement cell	Pressure unstable

6.2.2 Vacuum generation

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

Legend	Condition of components
[1]	**Filling level L0** "not reached"
[2]	**Filling level L1** "not reached"
[3]	**Filling level L2** "not reached"
[4]	**Valve V9** "closed"
[5]	**Flow F1** "not available"
[6]	**Valve V1** "degassing"
[7]	**Valve V3/ V7** "open"
[8]	**Compressor K1** "operation"
[9]	**Valve V4/ V8** "closed"
[10]	**Valve V2** "closed"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"

Safety functions and fault detection Vacuum generation

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

6.2.3 Leak testing

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

Legend	Condition of components
[1]	**Filling level L0** "not reached"
[2]	**Filling level L1** "not reached"
[3]	**Filling level L2** "not reached"
[4]	**Valve V9** "closed"
[5]	**Flow F1** "not available"
[6]	**Valve V1** "filling - draining"
[7]	**Valve V3/ V7** "closed"
[8]	**Compressor K1** "standstill"
[9]	**Valve V4/ V8** "closed"
[10]	**Valve V2** "open"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"

Safety functions and fault detection Leakage test

Monitored components	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0, L1 or L2 reached
Measurement cell	Measurement cell offline
Pressure sensor in measurement cell	Pressure drop
Flow measurement	Valve V9 does not close properly

6.2.4 Filling level L1

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

Legend	Condition of components
[1]	**Filling level L0** "reached"
[2]	**Filling level L1** "reached"
[3]	**Filling level L2** "not reached"
[4]	**Valve V9** "open"
[5]	**Flow F1** "present - filling"
[6]	**Valve V1** "filling - draining"
[7]	**Valve V3/ V7** "closed"
[8]	**Compressor K1** "standstill"
[9]	**Valve V4/ V8** "closed"
[10]	**Valve V2** "open"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"
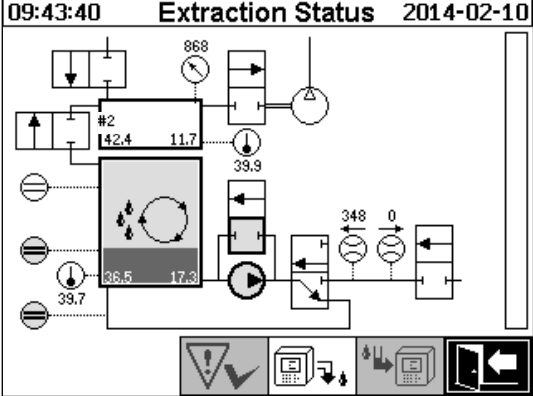
Safety functions and fault detection Filling level L1

Monitored components	Detectable errors
Filling sensors zero acknowledgement, low and high	Filling level L0 or L1 not reached Filling level L2 reached
Filling sensors zero acknowledgement, low and high Flow measurement Time monitoring	Filling level drops Filling stagnates Filling time exceeded
Measurement cell	Measurement cell offline
Pressure sensor in measurement cell	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 components	
[1]	**Filling level L0** "reached"	
[2]	**Filling level L1** "reached"	
[3]	**Filling level L2** "not reached"	
[4]	**Valve V9** "closed"	
[5]	**Flow F1** "not available"	
[6]	**Valve V1** "degassing"	
[7]	**Valve V3/ V7** "closed"	
[8]	**Compressor K1** "standstill"	
[9]	**Valve V4/ V8** "closed"	
[10]	**Valve V2** "closed"	
[11]	**Pump P1** "Operation"	
[12]	**Valve V5** "closed"	

Safety functions and fault detection Degassing

Monitored components	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 sensor in measurement cell	• 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 components	
[1]	**Filling level L0** "reached"	
[2]	**Filling level L1** "reached"	
[3]	**Filling level L2** "reached"	
[4]	**Valve V9** "open"	
[5]	**Flow F1** "present - filling"	
[6]	**Valve V1** "filling - draining"	
[7]	**Valve V3/ V7** "closed"	
[8]	**Compressor K1** "standstill"	
[9]	**Valve V4/ V8** "closed"	
[10]	**Valve V2** "open"	
[11]	**Pump P1** "standstill"	
[12]	**Valve V5** "open"	

Safety functions and fault detection Filling level L2

Monitored components	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	• 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 components
[1]	**Filling level L0** "reached"
[2]	**Filling level L1** "reached"
[3]	**Filling level L2** "reached"
[4]	**Valve V9** "closed"
[5]	**Flow F1** "not available"
[6]	**Valve V1** "degassing"
[7]	**Valve V3/ V7** "closed"
[8]	**Compressor K1** "standstill"
[9]	**Valve V4/ V8** "closed"
[10]	**Valve V2** "closed"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"

Safety functions and fault detection Gas measurement

Monitored components	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 components
[1]	**Filling level L0** "reached"
[2]	**Filling level L1** "reached"
[3]	**Filling level L2** "reached"
[4]	**Valve V9** "closed"
[5]	**Flow F1** "not available"
[6]	**Valve V1** "degassing"
[7]	**Valve V3/ V7** "open"
[8]	**Compressor K1** "operation"
[9]	**Valve V4/ V8** "open"
[10]	**Valve V2** "closed"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"

Safety functions and fault detection Ventilation

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

6.2.9 Draining

This process step drains the extraction chamber. The oil is pumped back into the transformer.

Legend	Condition of components
[1]	**Filling level L0** "reached"
[2]	**Filling level L1** "reached"
[3]	**Filling level L2** "reached"
[4]	**Valve V9** "open"
[5]	**Flow F1** "present - draining"
[6]	**Valve V1** "filling - draining"
[7]	**Valve V3/ V7** "open"
[8]	**Compressor K1** "operation"
[9]	**Valve V4/ V8** "open"
[10]	**Valve V2** "open"
[11]	**Pump P1** "Operation"
[12]	**Valve V5** "closed"

Safety functions and fault detection Draining

Monitored components	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	• Flow stops • Fill the flow • Filling level timeout (prevents the ingress of air into the transformer)
Measurement cell	Measurement cell offline
Pressure sensor in measurement cell	No pressure drop

6.2.10 Ventilation

After draining, the measurement cell is then re-ventilated as per 6.2.8.

6.2.11 Waiting (only when switching from measurement cell # 2 to measurement cell # 1)

This process step sets the system for waiting / standby until the start of the next measurement cycle. Valve V6 is switched after waiting.

Legend	Condition of components
[1]	**Filling level L0** "not reached"
[2]	**Filling level L1** "not reached"
[3]	**Filling level L2** "not reached"
[4]	**Valve V9** "closed"
[5]	**Flow F1** "not available"
[6]	**Valve V1** "degassing"
[7]	**Valve V3/ V7** "closed"
[8]	**Compressor K1** "standstill"
[9]	**Valve V4/ V8** "closed"
[10]	**Valve V2** "closed"
[11]	**Pump P1** "standstill"
[12]	**Valve V5** "open"

Safety functions and fault detection Wait

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

6.3 Operation by means of device keyboard

The MSENSE® DGA 9 can be used while in operation via the built-in alphanumeric keypad, the arrow keys and the enter 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**	
	Capital letters	**Lowercase letters**	**Numbers**	
	ABC	abc123	123ABC	
1 ABC	ABC1	abc1	1	
2 DEF	DEF2	def2	2	
3 GHI	GHI3	ghi3	3	
4 JKL	JKL4	jkl4	4	
5 MNO	MNO5	mno5	5	
6 PQR	PQR6	pqr6	6	
7 STU	STU7	stu7	7	
8 VW	VW8	vw8	8	
9 XYZ	XYZ9	xyz9	9	
0	ˍ0@{}()<>[]	ˍ0@{}()<>[]	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 arrow keys while the main menu is active.
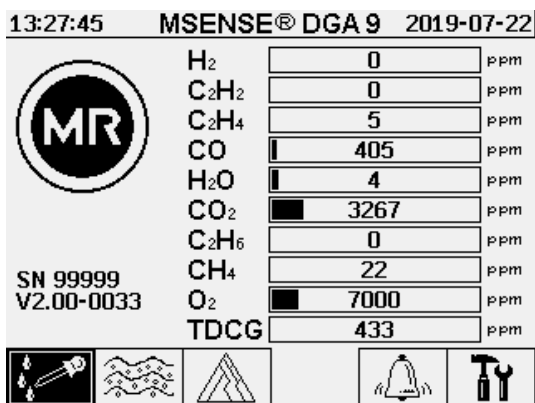
6.4   Main menu

After the MSENSE® DGA 9 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 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)

    Duval triangle (6.7)

    Alarm / Alarm history (6.8)

    Device settings (6.10)

- In the main menu you will find the device's serial number (e.g. SN99999), the installed firmware version (e.g. V 2.00-0033), 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 9 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):
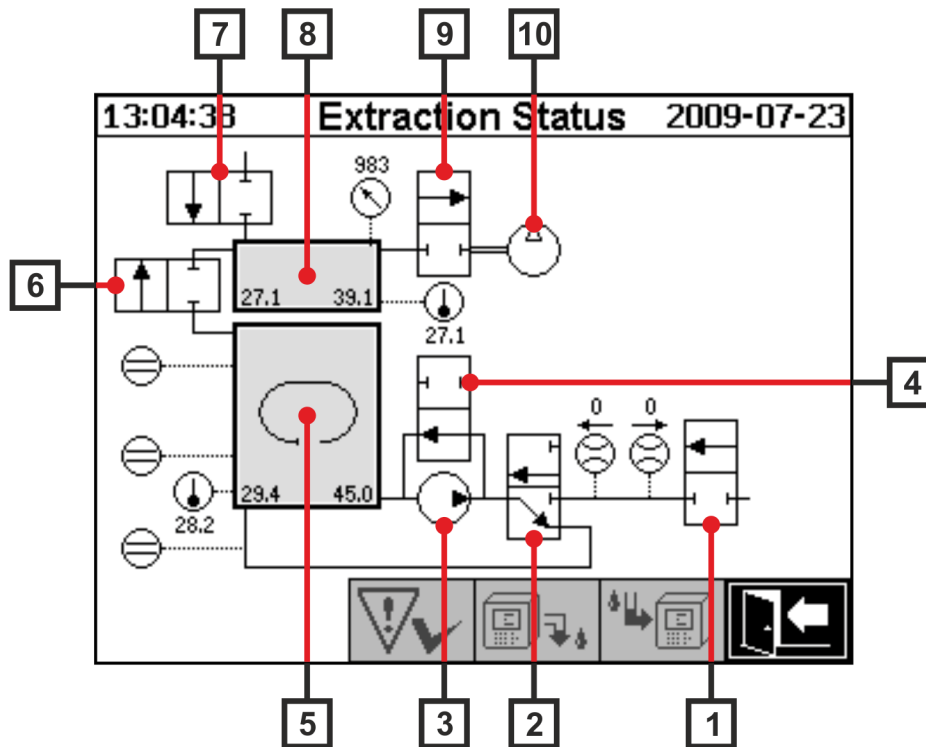
Legend	Name	Short designation	Valve function
[1]	Safety valve	V9	(NC)
[2]	Degassing	V1	(NC)
[3]	Oil pump	P1	-
[4]	Bypass valve oil pump	V5	(NO)
[5]	Extraction chamber	-	-
[6]	Measurement cell isolation valve	V2	(NC)
[7]	Ventilation valve	V4 / V8	(NC)
[8]	Measurement cell	-	-
[9]	Vacuum valve	V3 / V7	(NC)
[10]	Compressor	K1	-

(NC): Valve normally closed (Normally Closed)

(NO): Valve normally open (Normally Open)
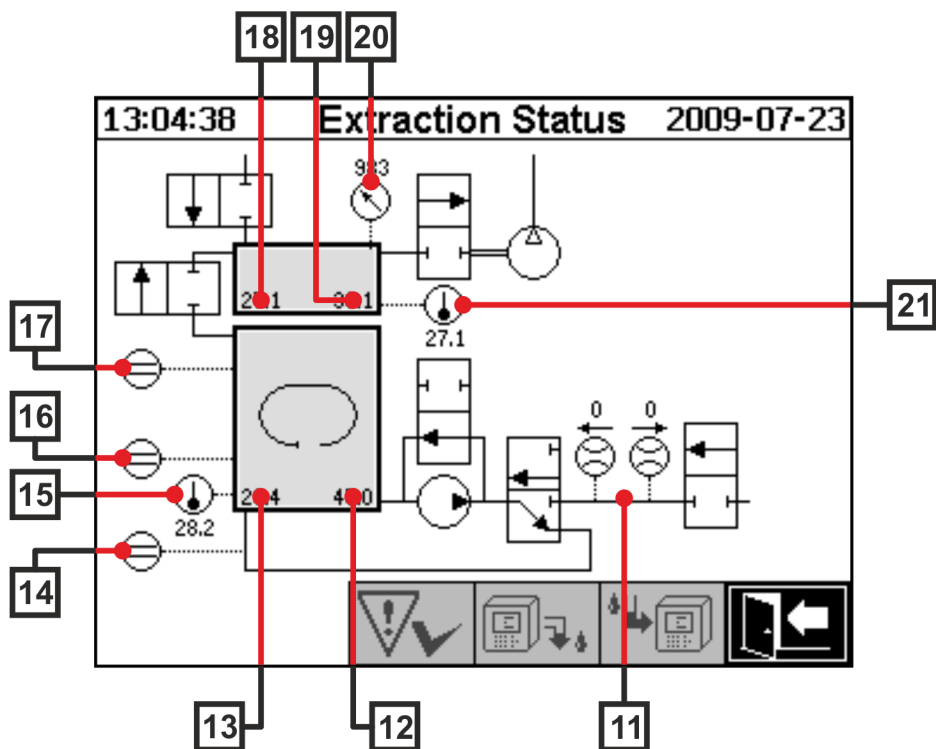
Legend	Name	Short designation	(Valve function)
[11]	Flow measurement oil	Flow F1	
[12]	Moisture in oil	Moisture in oil H_2O	
[13]	Oil temperature	Temperature T2	
[14]	Filling level sensor zero acknowledgement	Filling level L0	
[15]	Temperature heating extraction chamber	-	
[16]	Filling level sensor low 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	-	

Overview of possible states:

MSENSE® DGA 9 inactive (un-mounted)

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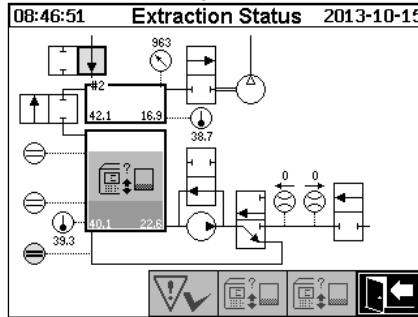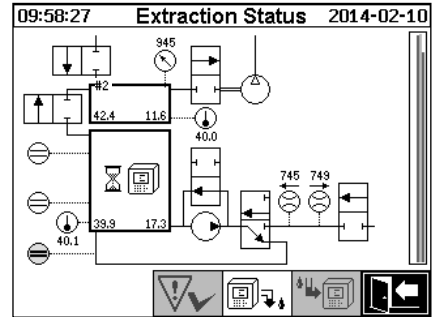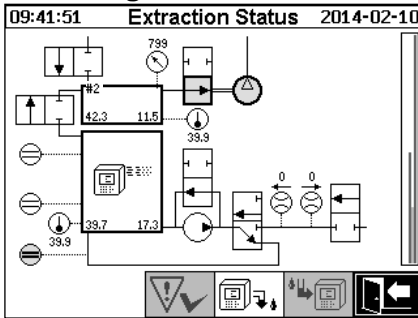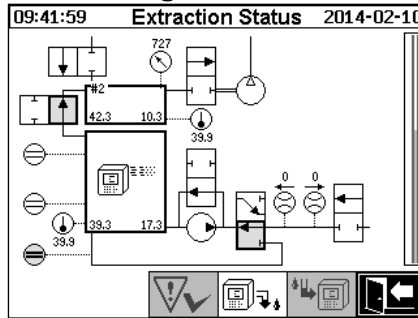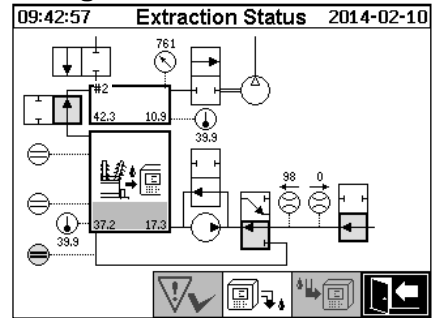
08:46:51 Extraction Status 2013-10-15

Zero measurement

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

Vacuum generation

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

Leak testing

09:41:59 Extraction Status 2014-02-10

Filling level L1

09:42:57 Extraction Status 2014-02-10

Degasing

09:43:40 Extraction Status 2014-02-10

Filling level L2

09:48:52 Extraction Status 2014-02-10

Gas measurement

09:53:15 Extraction Status 2014-02-10

Ventilation

09:54:23 Extraction Status 2014-02-10

Draining

09:54:57 Extraction Status 2014-02-10
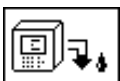
Waiting

09:58:27 Extraction Status 2014-02-10
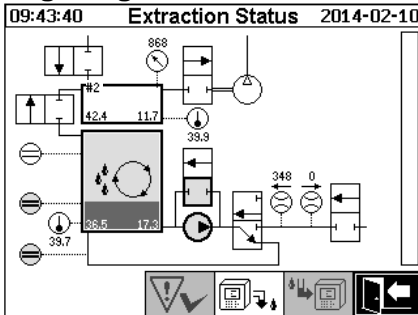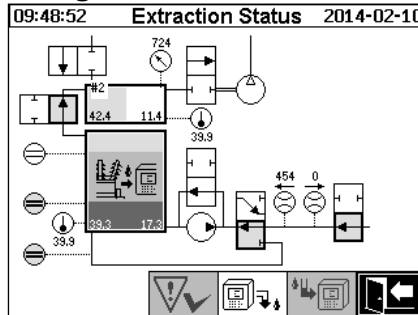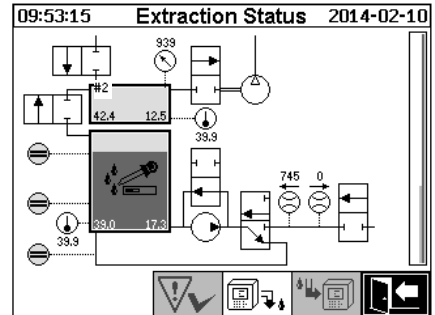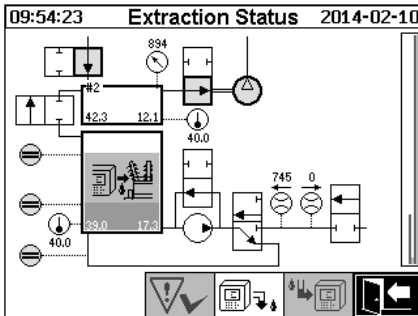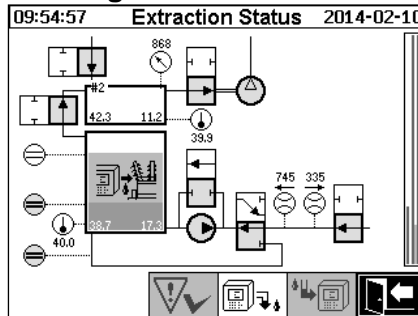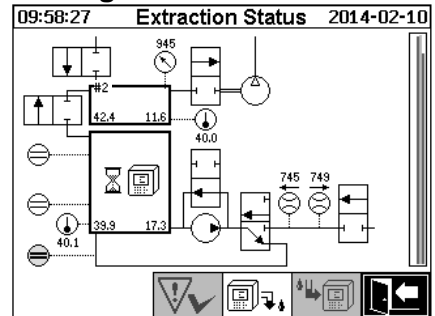
The following functions are available in the extraction status menu:

Fault acknowledgement (6.5.1)
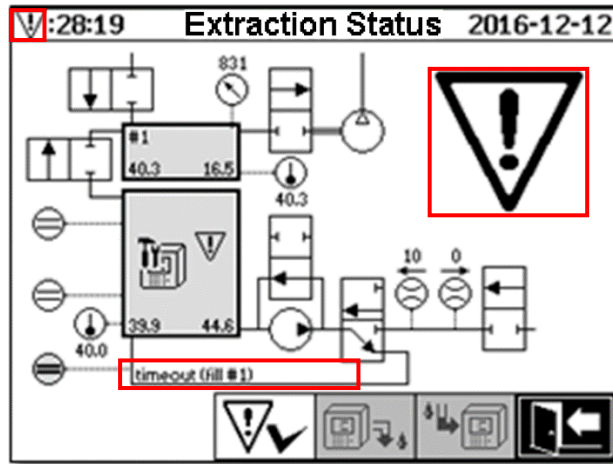
Deactivate device (6.5.2)

Activate device (6.5.3)

Exit menu

6.5.1 ⓥ✓ Acknowledge fault

After a 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 "Fault – Extraction status menu" (9.1.6.4).

6.5.2 🖥⬇ Deactivate device ("unmount")

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 "Commissioning" (4.4.3).

6.5.3 ⬆🖥 Activating the device ("mount")

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.
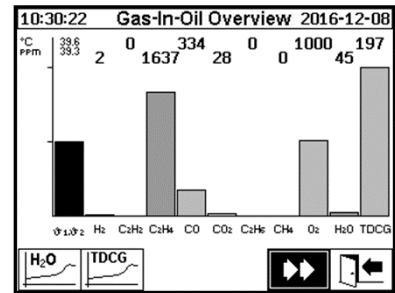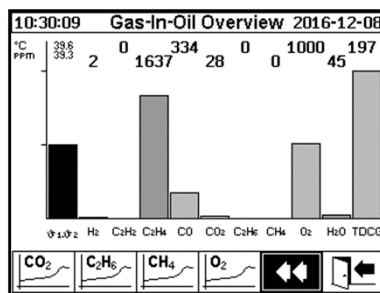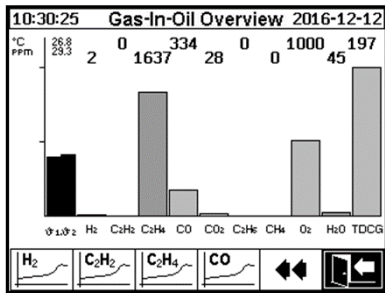
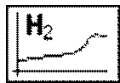The activation procedure can be found in the chapter on "Commissioning" (4.4.3).
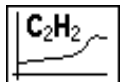
6.6 ⬛ Gas-in-oil measurements

In the menu "Gas-in-oil measurements", an overview of the measured gases is displayed as a bar chart. The measurements C_2H_2, C_2H_4, CO, CO_2, C_2H_6, CH_4, H_2O, O_2 and TDCG (**T**otal **d**issolved **c**ombustible **G**as) each show the current gas content in the oil.
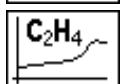

The following values are available with this MSENSE® DGA 9 device:
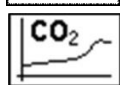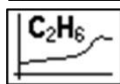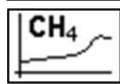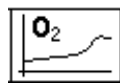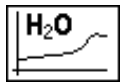
H_2 graph	Hydrogen
C_2H_2 graph	Acetylene
C_2H_4 graph	Ethylene
CO graph	Carbon monoxide
CO_2 graph	Carbon dioxide
C_2H_6 graph	Ethane
CH_4 graph	Methane
O_2 graph	Oxygen
H_2O graph	Moisture in oil
TDCG graph	TDCG (Total Dissolved Combustible Gas)

6.6.1 ⬚ Graph view

After selecting the measurement variable to be displayed, its graphic time history is displayed.
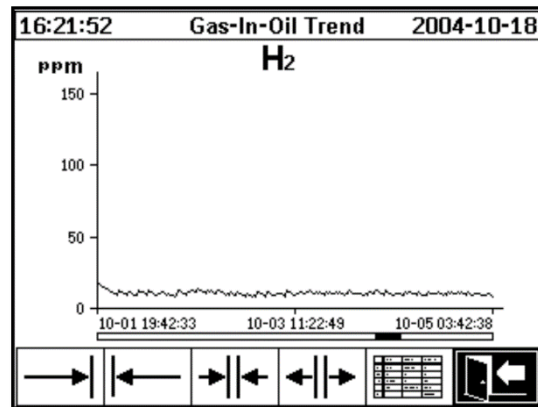
The following functions are available in the time line display:
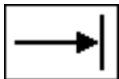
⬚	Scroll to the right on the time line (future)
⬚	Scroll to the left on the time line (past)
⬚	Expand presentation. The smallest resolution is 3 days / page
⬚	Zoom out. The largest resolution is 8 hours / page
⬚	Switch to tabular display
⬚	Exit menu
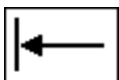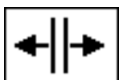
6.6.2 ⊞ Table view

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.

The following functions are available in the table view:
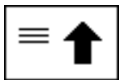
≡⬆	Scroll one line up
📄⬆	Scroll one page up
📄⬇	Scroll one page down
≡⬇	Scroll one line down
H₂	Switch to the time line view
🚪⬅	Exit menu
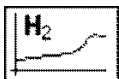
6.7 ⚠️ Duval triangle
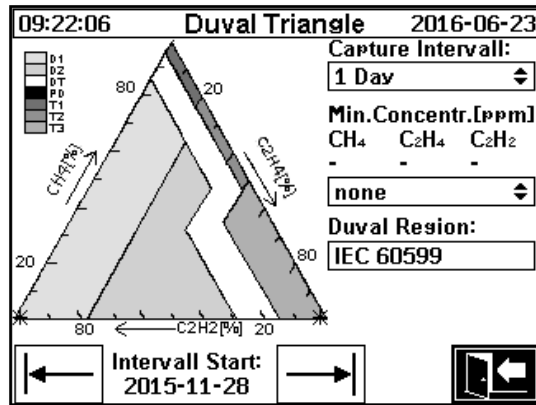
- **Capture interval:** Time span of the data displayed in the Duval triangle
- **Min Concentration (ppm)**: Blanking threshold for data to be displayed.
  Possible setting:
  - ➢ none: No threshold
  - ➢ low: 1-1-1
  - ➢ high: 10-10-10
- **Duval region**: Duval region defined for IEC 60599, can not be changed.
- **Interval start:** Start date from capture interval,

is selected with arrow keys [⇤] and [⇥].

6.8 🔔 Alarm / Alarm history

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

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.

- o There is a date entry: There was an alarm in the past for this measurement variable, which was confirmed at the time shown.
- o 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:**
  - o ⚠⚠ **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.
 - o ⚠🖹 **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:
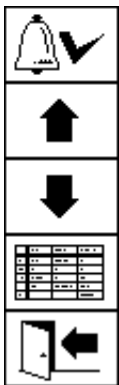
🔔✓	Acknowledge selected alarm (6.8.1)
⬆	Scroll one line up
⬇	Scroll one line down
▦	Alarm settings of the selected alarm (6.8.2)
🚪←	Exit menu

6.8.1   ⌂✓   Alarm acknowledegement

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 enter key, the alarm is acknowledged.

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

6.8.2   ⊞   Alarm settings of the selected alarm

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

Details regarding the corresponding alarm settings can be found in chapter (6.10.3).

6.10 ⚒ Device settings

The user language can be selected on the MSENSE® DGA 9. The following languages are available: English, German, French, Russian, Turkish, Spanish and Polish.

Select the language selection field using the arrow key. By repeatedly pressing the Enter 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 arrow 🔲 and confirmed with the Enter key. The ✔ symbol indicates the selected language.

Before changes can be made to the device settings, the password is requested first (standard password 123456).
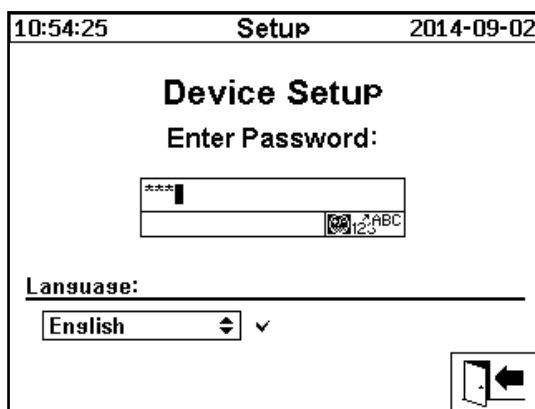
After entering the corresponding password using the alphanumeric keyboard and confirming with the enter key, the "Device settings" menu is opened.
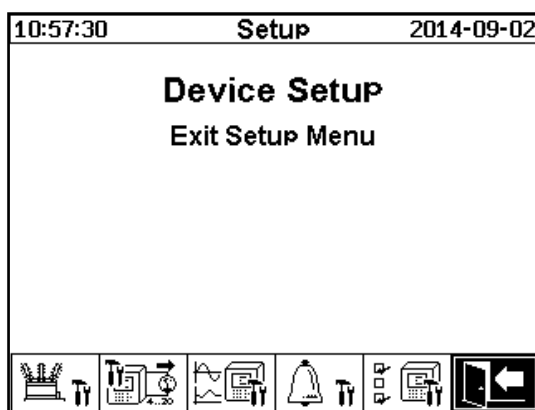
The following sub-menus can be selected in the menu "Device settings":

　　Transformer-related settings (6.10.1)

　　Settings analogue outputs (6.10.2)

		Alarm settings (6.10.3)
		MSENSE® DGA settings (6.10.4)
		Exit settings menu

6.10.1 Transformer-related settings

Transformer-specific information can only be entered and managed using the MSET DGA programme. However, this information is not absolutely necessary in order to operate the device.
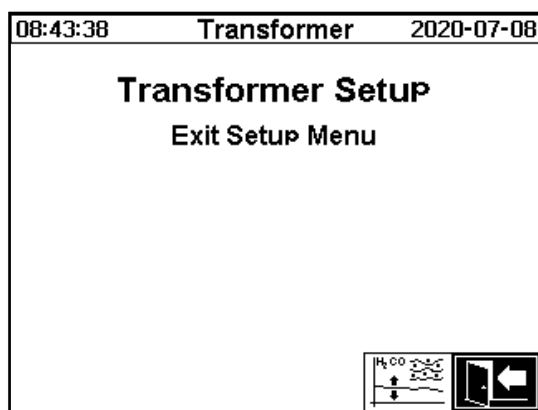
The following sub-menus can be selected in the "Transformer-related settings" menu:
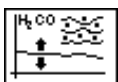
	DGA adjustment (6.10.1.1)
	Exit settings menu

6.10.1.1 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 9 are then determined and displayed in the "MSENSE® DGA 9 value" fields. After the results of the laboratory analysis have been entered in the "Laboratory value" fields for H_2, C2H2, C_2H_4, CO, CO_2, C_2H_6, CH_4 and O_2, 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."

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.

6.10.2 Settings – analogue outputs

This MSENSE® DGA 9 device has 10 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, oil moisture, temperatures and for all additional sensors.

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_2H_2 concentration
Output #3:	Mode: 4 ... 20 mA	Sensor: C_2H_4 concentration
Output #4:	Mode: 4 ... 20 mA	Sensor: CO concentration
Output #5:	Mode: 4 ... 20 mA	Sensor: H_2O concentration
Output #6:	Mode: 4 ... 20 mA	Sensor: CO_2 concentration
Output #7:	Mode: 4 ... 20 mA	Sensor: C_2H_6 concentration
Output #8:	Mode: 4 ... 20 mA	Sensor: CH_4 concentration
Output #9:	Mode: 4 ... 20 mA	Sensor: O_2 concentration
Output #10:	Mode: 4 ... 20 mA	Sensor: TDCG 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.
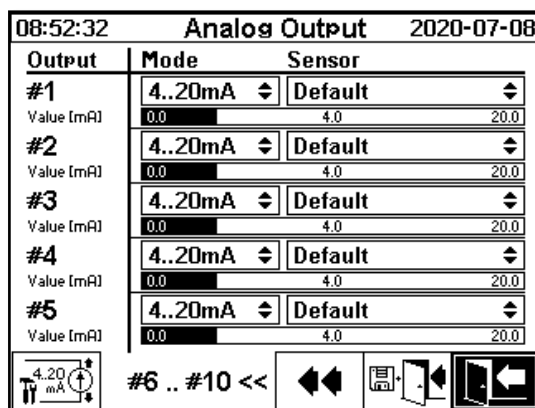
Analogue output 1 - X301:1(+) & 2(-)

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

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

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

Analogue output 5 - X302:1(+) & 2(-)
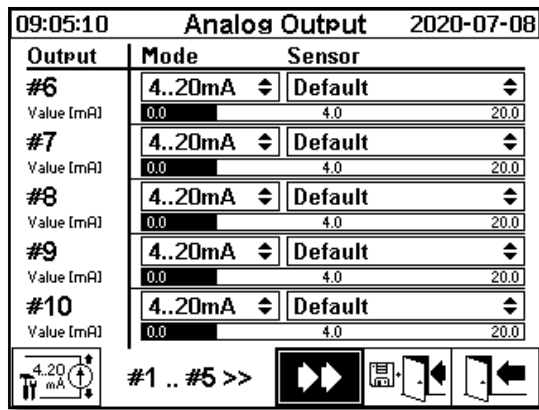
Analogue output 6 - X302:3(+) & 4(-)

Analogue output 7 - X302:5(+) & 6(-)

Analogue output 8 - X302:7(+) & 8(-)

Analogue output 9 - X303:1(+) & 2(-)

Analogue output 10 - X303:3(+) & 4(-)

In the Sensor column, a selection of the following options can be made:

- Standard
- Gas H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2 concentration
- TDCG - concentration
- Temperature   T1 (ϑ1 Gas temperature measurement cell)

  Temperature   T2 (ϑ2 Oil temperature extraction chamber)
- Moisture in oil H_2O - concentration
- Trend H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2 Daily trend
- Trend H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2 Weekly trend
- All under additional sensors (with the associated defined sizes)

The following selection can be made in the Mode column:

- Off
- 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 Enter 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 .

6.10.3 ⌂ 🔧 Alarm limits and alarm sources

With this MSENSE® DGA 9 you have the possibility to configure 16 different alarms. The alarms can be applied to internal or external measurements and can be issued in different ways. One of these is the issuance to the digital outputs. The MSENSE® DGA 9 contains 13 digital alarm outputs. The first 10 (relay – terminal X401:1 ... 8, relay – terminal X402:1 ... 8, and relay – terminal X403:1 ... 4) are 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 coding bridge on the measuring and controller card (see 5.3.1).

Remark: The system fault can be individually set to one of the outputs (standard: relay output 1) (6.10.4.2). This may not be additionally occupied by one of the 16 alarms!

The alarm summary table contains the following information:

#	Number:	1 ... 16
Type	Type:	Gas / Temp. / Hum. / Trend / Ext.
Name	Name:	Free naming - e.g. oil temperature high
Unit	Unit:	Depending on the measurement variable and - e.g. ppm / ° C / A / mA / V / kV, etc.
Alert	Output:	LOG entry / exit with number

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

Icon	Function
⚠🔧✉	Alarm SMS settings (not available)
⬆	Highlight upwards
⬇	Highlight downwards
⌂❄	Create new alarm (6.10.3.1)
🔧	Alarm settings (6.10.3.2)
🚪←	Exit menu (without saving)

6.10.3.1 ⬜ Create new alarm

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

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.

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

- Gas H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4- O_2 concentration
- --   TDCG concentration
- Temp.   T1 (ϑ1 gas temperature measurement cell)
            T2 (ϑ2 oil temperature extraction chamber)
- Hum.   Moisture in oil H_2O– concentration
- Trend H_2O Daily trend
- Trend H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2 Daily trend
- Trend H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2 Weekly trend

Once you have selected the desired measurement variable, use the arrow key to switch to the ⬜ key.

6.10.3.2 ⚒ Alarm settings

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

🗑	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
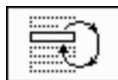
6.10.3.2.1 Alarm setting – Mode

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.

6.10.3.2.2 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   Gas concentration H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2
- °C   Temp.   Temperatures T1 - T2
- ppm   Moisture in oil Concentration H_2O
- ppm/d   Trend   Gas concentration – Daily trend H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2
- ppm/w   Trend   Gas concentration – Weekly trend H_2 - C_2H_2 - C_2H_4 - CO - CO_2 - C_2H_6 - CH_4 – O_2

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

- 0 ... 5,000 ppm   Gas concentration CH_4
- 0 ... 10,000 ppm   Gas concentration H_2 - C_2H_2 - C_2H_4 - CO - C_2H_6
- 0 ... 20,000 ppm   Gas concentration CO_2
- 0 ... 50,000 ppm   Gas concentration O_2
- 0 ... 100 ppm   Moisture in oil H_2O
- -20 ... 100 ° C temperature T1, T2

6.10.3.2.3 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 "dot" key. After confirming the data using the Enter key, the input value is displayed in the format [Hours]: [Minutes]: [Seconds].

Example: CO alarm is set as follows:

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

CO "Gas-in-Oil" Contents
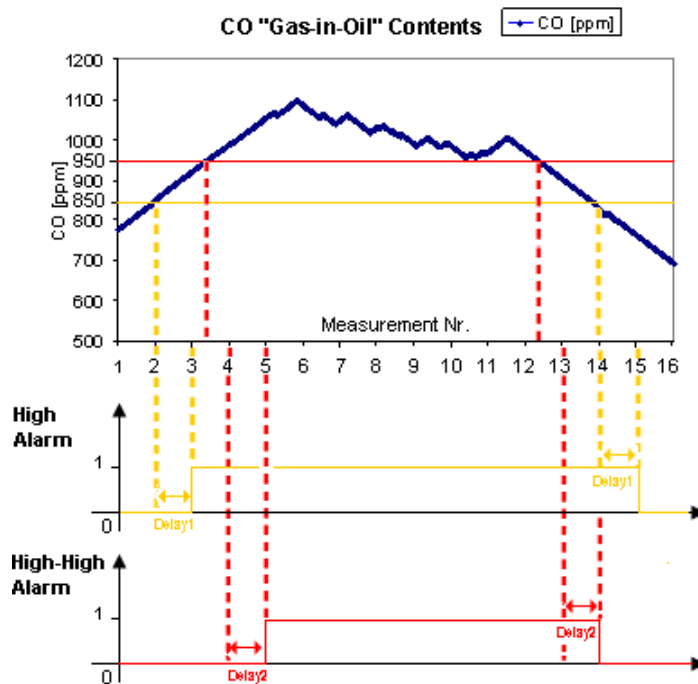
Remark: The standard measurement interval of the "gas-in-oil" measurement lasts 60 min.

6.10.3.2.4 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 & SMS** 🗎**:** A status change is saved in the alarm history, this must be acknowledged. In addition, an SMS is sent to the pre-defined recipients. (Option not available)
- **Output & SMS** ⇧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, and an SMS is sent to the pre-defined recipients. (Option not available)
- **Output held & SMS** ⇧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. Furthermore, an SMS is sent to the pre-defined recipients. (Option not available)

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.

6.10.4   **MSENSE® DGA Settings**

16:03:22   MSENSE® DGA   2019-09-23

MSENSE® DGA Setup

DGA Measure-Cycle Interval
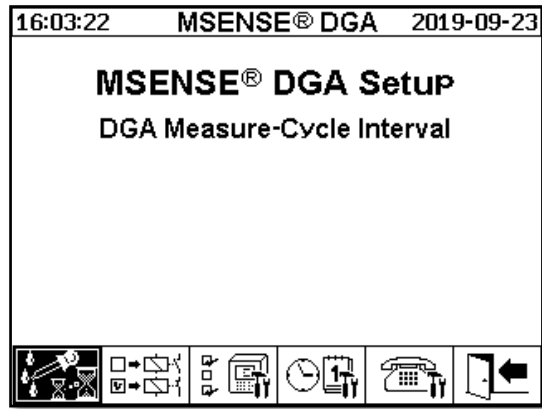
The following sub-menus can be selected in the MSENSE® DGA 9 settings:

DGA measurement cycle interval (6.10.4.1)
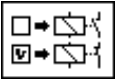
Digital outputs (6.10.4.2)

Device options (6.10.4.3)

Date, time, clock settings (6.10.4.4)

Communication / Interfaces (6.10.4.5)

Exit settings menu

6.10.4.1 ⚗️⏳ 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 9 starts the measurement cycles in a standard interval of 60 minutes. The measurement cycle starts synchronously with the time either at xx: 00, xx: 20 or xx: 40.

Instead of the standard 60-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.
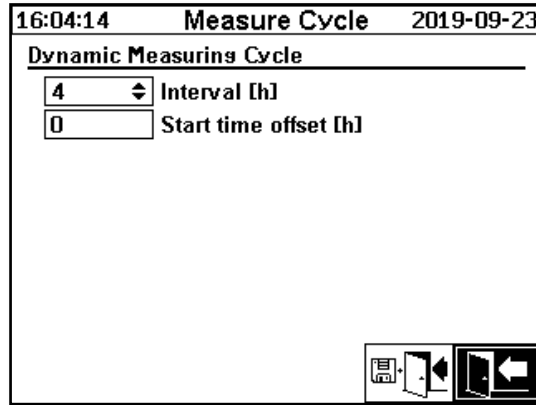
Interval [h]

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

 - (* Deactivated*) - Standard interval every 60 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 / 01:00 / 02:00 / 03:00 / 04:00 / 05:00 / 06:00 / ....
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 60 minutes after the start of the measurement.

6.10.4.1.1 Dynamic DGA measurement cycle interval

Up to version V1.50-B0001 the measurement cycle was fixed at 60 minutes. Thereafter, it is possible to switch over to a slower measuring cycle. 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.

6.10.4.2   ⊡ Test digital outputs

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

The ten relay outputs are labelled with KL401 #, KL402 # and KL403 # (see chapter 5.3) [5] - X401: 1 ... 8, [6] - X402:1 ... 8 and [7] - X403:1 ... 4).

5 optional optocouplers outputs are labelled KL103 # (see chapter 5.3) [18] - X103:1 ... 10)
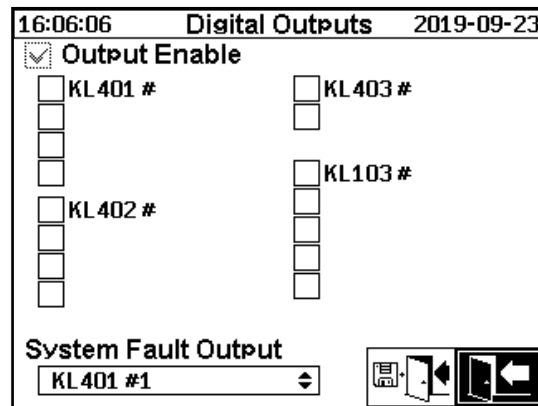
6.10.4.2.1   System fault – Output

The MSENSE® DGA 9 boasts a system monitoring function, 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 adjusted to one of the 15 digital outputs (standard: relay output 1). The selection can be made in the field system fault output:

- KL401 #1   X401:1&2   (Relay output 1)
- KL401 #2   X401:3&4   (Relay output 2)
- KL401 #3   X401:5&6   (Relay output 3)
- KL401 #4   X401:7&8   (Relay output 4)
- KL402 #1   X402:1&2   (Relay output 5)
- KL402 #2   X402:3&4   (Relay output 6)
- KL402 #3   X402:5&6   (Relay output 7)
- KL402 #4   X402:7&8   (Relay output 8)
- KL403 #1   X403:1&2   (Relay output 9)
- KL403 #2   X403:3&4   (Relay output 10)
- KL103 #1   X103:1&2   (Optical coupler output 1 optional)
- KL103 #2   X103:3&4   (Optical coupler output 2 optional)
- KL103 #3   X103:5&6   (Optical coupler output 3 optional)
- KL103 #4   X103:7&8   (Optical coupler output 4 optional)
- KL103 #5   X103:9&10   (Optical coupler output 5 optional)
- -   (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.: ! KL401 #1).

When in fault-free status (during the device's operation), the relay contact is closed or the optocoupler is connected through.

Remarks: When the device is disassembled, the system monitoring is switched in the same way as in the event of a fault. The function of relay output 1 (KL401 # 1) can be inverted. This is set with a coding bridge on the measuring and controller card. (please see 5.3.1).

6.10.4.3 [icon] Device options

In this menu the display lighting time, the authentication and the change of the main screen display (main menu) can be set:
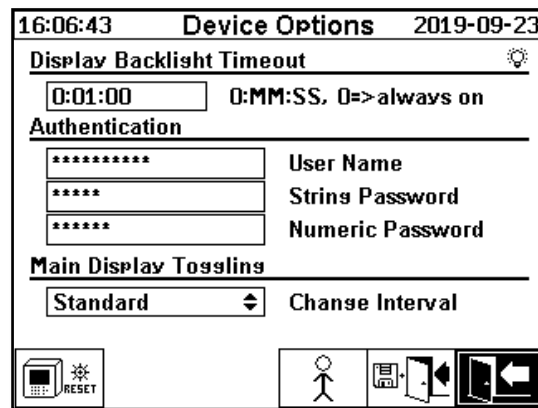
The following sub-menus can be selected in the "Device options" menu:

[icon RESET]	Pressing the reset key performs a software reset in the device.
[icon person]	Customer data settings (6.10.4.3.1)
[icon save exit]	Save and exit menu
[icon exit]	Exit menu
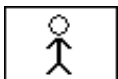
Display lighting time

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 "dot" 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 [icon] symbol is selected and the Enter key is pressed, the display light turns off manually.

Remark: The display lighting is also switched on when communicating with the MSENSE® DGA 9 device via the serial interface RS232 (for service purposes only).

Authentication

Some settings and operations of the MSENSE® DGA 9 are protected by way of a user name and password:

- User name (standard user name: Admin)
  - Modem login (for service purposes only)
- Password sign (standard password sign: MRDGA)
  - Modem login (for service purposes only)
- 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 Enter key in the "Change interval" field:

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

6.10.4.3.1   Customer data settings
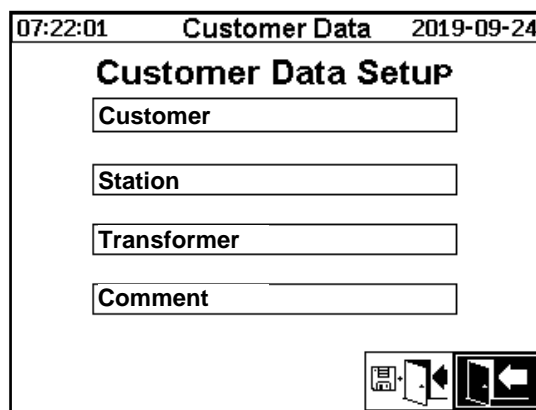
The desired field is selected by using the arrow and enter key. The entry is made using the alphanumeric keypad and the arrow keys and is completed by pressing the Enter key. The input field allows you to enter a maximum of 26 characters. In the main menu, however, only 10 characters are displayed.

	Save and exit menu

	Exit menu

6.10.4.4   Date, time, clock settings

The MSENSE® DGA 9 has a sub-menu in which the system time, system date, time offset and daylight saving time mode can be set.

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

System time: [Hours]:[minutes]:[seconds] (enter the colon using the "dot" key)

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

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 enter 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)!

6.10.4.5 📞 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.
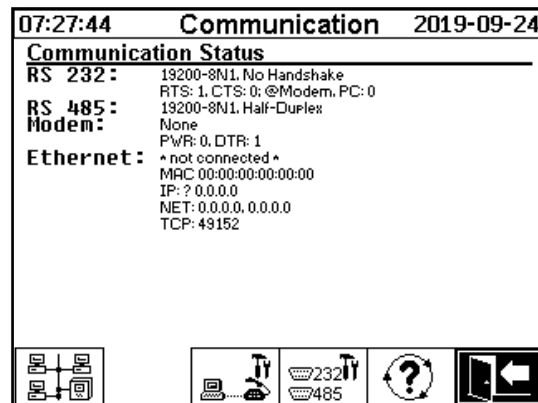
The following sub-menus can be selected in the "Communication / Interfaces" menu:
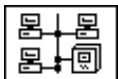
 Network settings (6.10.4.5.1)
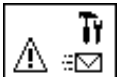
 Alarm SMS settings (not available)

 Modem settings (6.10.4.5.2)
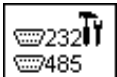
 RS232 / 485 settings (6.10.4.5.3)

 Updating the status information

 Exit menu

6.10.4.5.1 🖧 Network settings

The device 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.

6.10.4.5.1.1 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
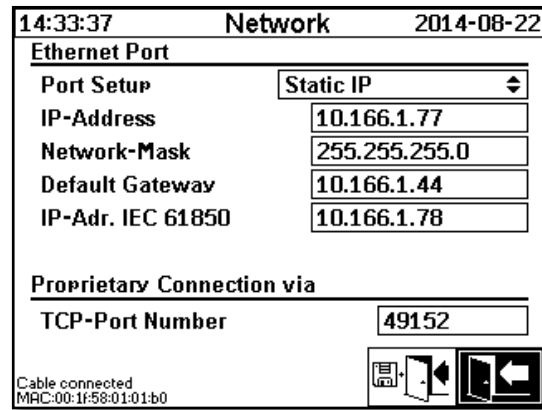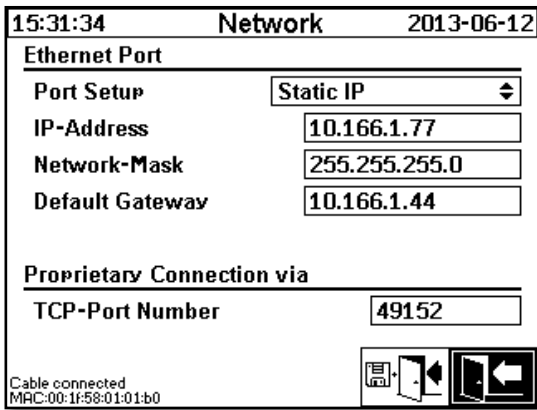
6.10.4.5.1.2   DHCP Client

The network administrator must allow automatic TCP / IP address assignment for MSENSE® DGA 9 in the network.
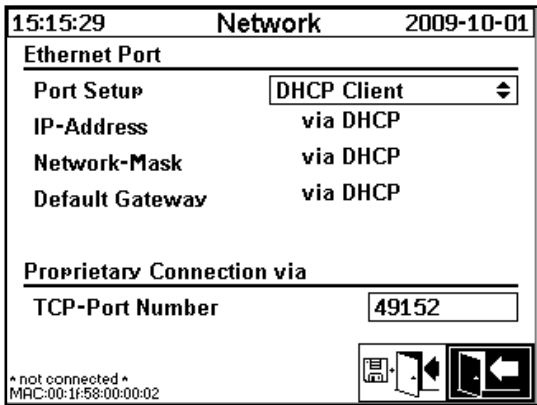
Normal view: When selecting IEC 61850 modem:
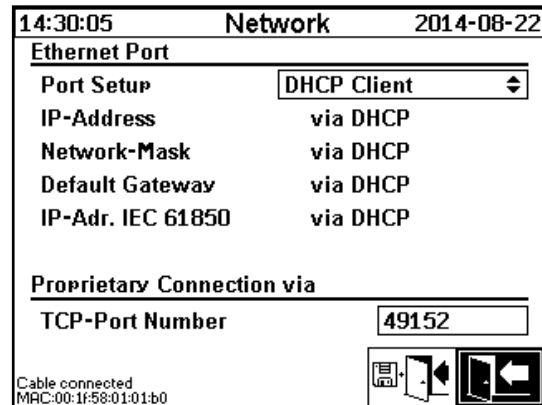
6.10.4.5.1.3   DHCP Server

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.
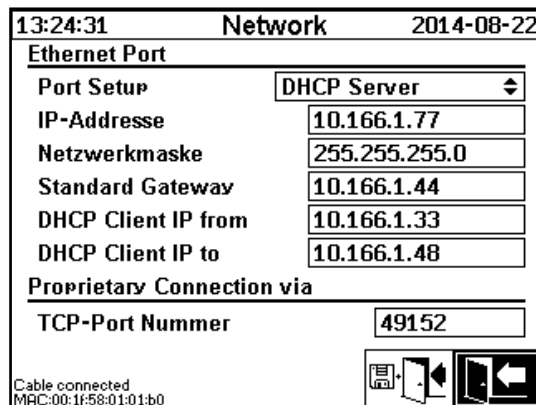
6.10.4.5.1.4 TCP port number

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.

6.10.4.5.1.5 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 Number          [49152  ]
^ not connected ^                    [💾⤓] [🚪◀]
MAC:01:02:03:04:05:06
```

6.10.4.5.2   🖥️ Modem settings

If an on-board IEC61850 or DNP3 modem is present in the MSENSE® DGA 9, the modem settings are configured here:

```
07:29:29      Modem Setup      2019-09-24
☑ Enable Modem
  Modem Type:        [None            ⇕]




RS232 link:          [auto-detect     ⇕]
                                  [💾⤓] [🚪◀]
```

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 Enter key:

- **None**
- **DNP3-GW (internal)** (6.10.4.5.2.1)
- **IEC61850-GW (int.)** (6.10.4.5.2.2)

In the field RS232 link the following selection can be made using the enter key:

- **auto-detect**
- **RS232 connector**
- **Modem socket**

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 9 has an Ethernet interface.

- **Modem socket:** On-board modem (BU4 and ST6). The plug ST6 on the measuring and control card is for MR service purposes only!

6.10.4.5.2.1   DNP3 Modem

When selecting DNP3-GW (internal), the following appears on the LCD display:
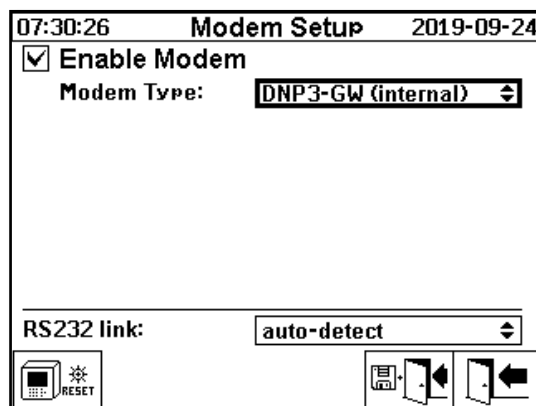
No additional settings can be made here.

The following functions are available:

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

    Save and exit menu

    Exit menu

6.10.4.5.2.2   IEC 61850 modem

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

```
07:31:10      Modem Setup     2019-09-24
☑ Enable Modem
   Modem Type:      IEC61850-GW (int.)  ⇕
   IED Name:        IED-MSENSE DGA 9-99
                    999


RS232 link:         auto-detect        ⇕
```
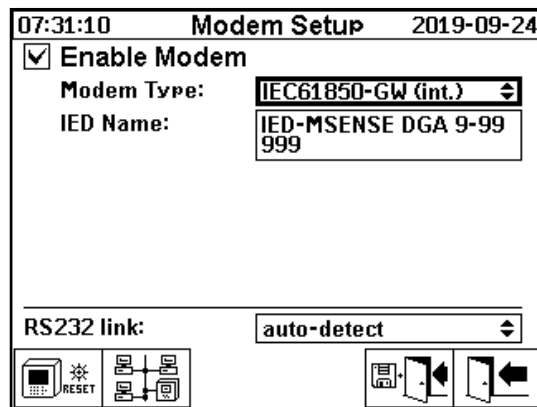
IED name
This input field is used to name the MSENSE® DGA 9 device in the IEC 61850 name space. As with other input fields, the input is made via the device's alphanumeric keyboard. Without any input, the name is set automatically as follows:
"IED-MSENSE DGA" <MSENSE-DGA Type Number> "-" <Serial Number>, e.g.: IED-MSENSE DGA 9-9999

The following functions are available:

Modem reset (temporarily breaks the modem's supply voltage)
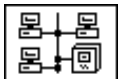
Network settings (6.10.4.5.1)

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
Ethernet Port
Port Setup — Static IP
IP-Address — 192.168.1.32
Network-Mask — 255.255.255.0
Default Gateway — 192.168.1.1
IP-Adr. IEC 61850 — 192.168.1.40
Proprietary Connection via
TCP-Port Number — 49152
^ not connected ^ MAC:00:00:00:00:00:00

16:21:08 Network 2020-01-09
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
^ not connected ^ MAC:00:00:00:00:00:00

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

6.10.4.5.3 🖳 **RS232 / RS485 settings**

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

07:32:32 RS232/485 Setup 2019-09-24
Bus Communication Setup
Mode: — Point-to-Point
Address: — 0
Answer Delay [ms]: — 0
Current Settings, Default Settings
Baudrate
RS 232 — 19200 / 19200
RS 485 — 19200 / 19200
Handshake
RS 232 — No Handshake
ART
RS 485 — ☐

07:32:53 MODBUS 2019-09-24
MODBUS Configuration
Mode: — Off
Address: — 0
Baudrate: — 19200
Data Bits: — 8
Parity: — Even
Stop Bits: — 1
Answer Delay [ms]: — 0
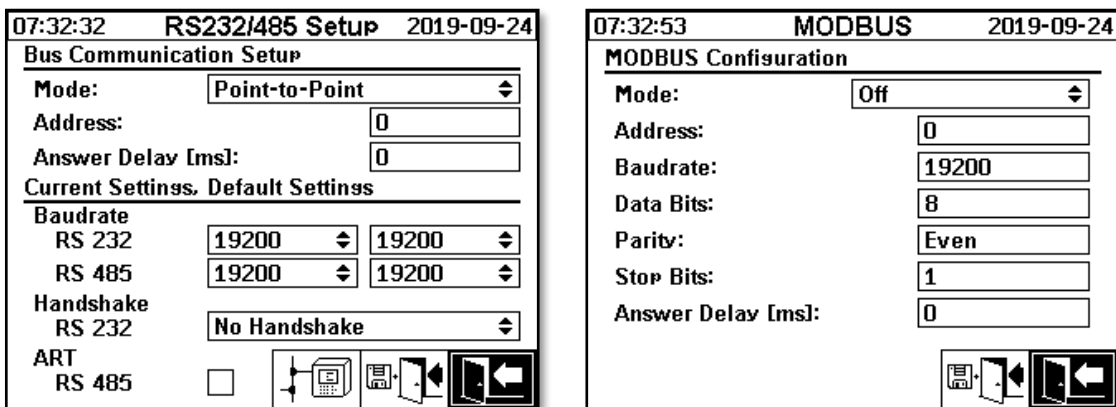
This section shows different ways of communicating with the MSENSE® DGA 9.

Point-to-point

Direct connection between PC and MSENSE® DGA 9 via RS232, RS485.

- **Bus node**

Connection between PC and several MSENSE® DGA 9 via RS485 bus.

- **Bus bridge**

Connection between PC and several MSENSE® DGA 9 via RS485 bus. On MENSE® DGA 9 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 9.

6.10.4.5.3.1 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 9 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.

6.10.4.5.3.2 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 9 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.

MSENSE® DGA 9   MSET DGA
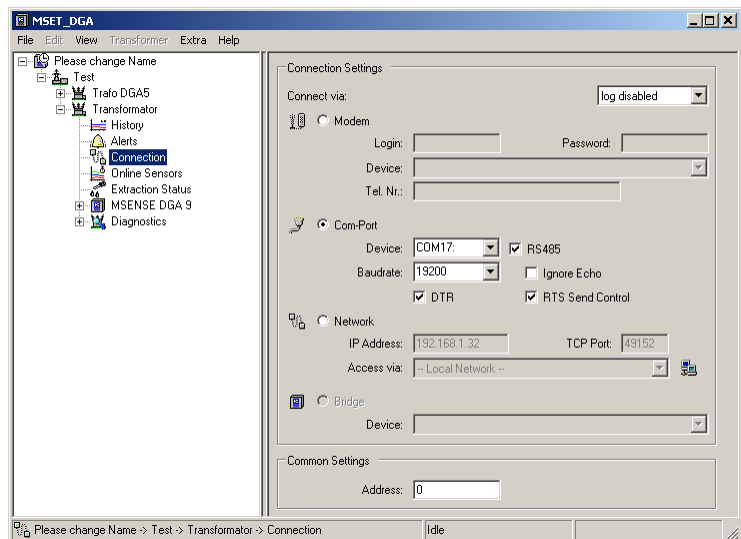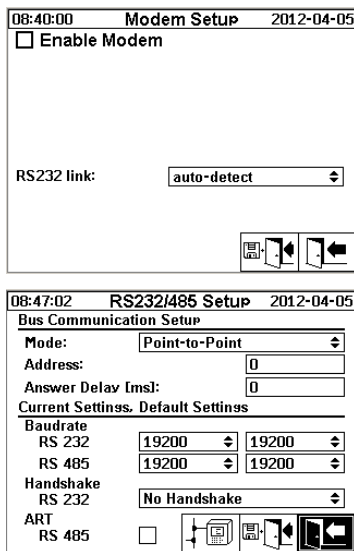
Please ensure that the baud rate and the COM interface in MR MSET DGA are set correctly and that, when necessary, ART RS485 is selected in the "Settings – Bus communication" menu (in the standard settings, ART is not selected). An RS485 adapter may require additional settings in the MR MSET DGA "Connection" menu (ignore echo, RTS Transmit Control).

ART

The hardware found in the MSENSE® DGA 9 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 9, an adapter (interface converter) is normally required. Given the characteristics of the RS485 adapter in use, this must be configured accordingly in MR MSET DGA.

For RS485 communication with MSENSE® DGA 9, 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 MR 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 9 is only partially detected by the adapter (or not at all). Therefore, a response delay should be entered in MSENSE® DGA 9 (0 ... 2550 ms), in order to counteract this problem.

RS485 Bus-mode

When using the RS485 interface, multiple MSENSE® DGA 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.
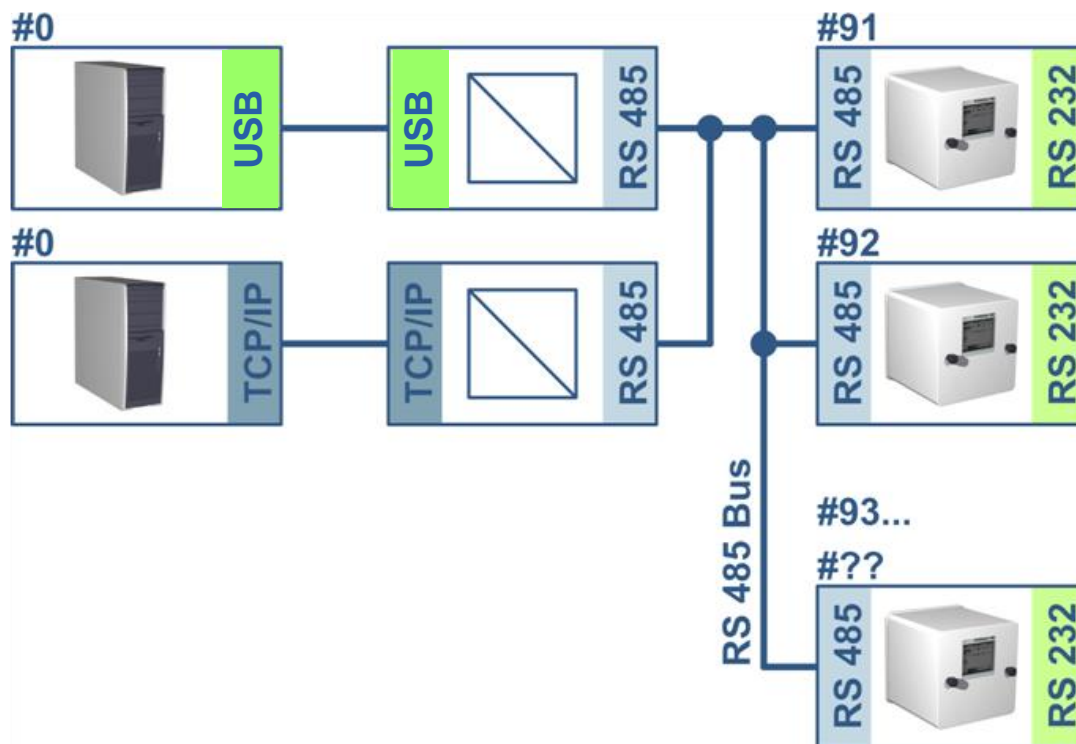
MSENSE® DGA 9	MSET DGA
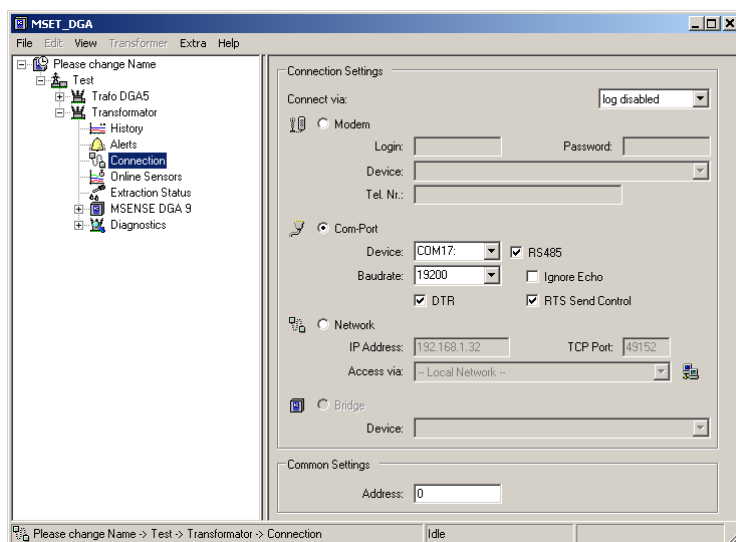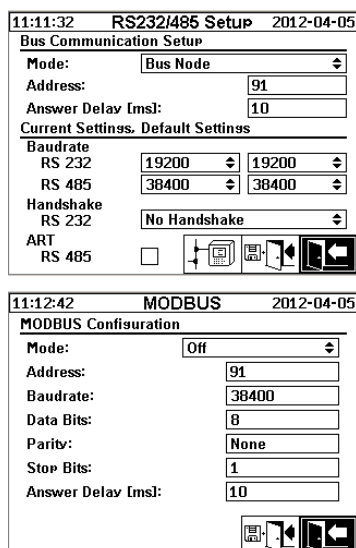
Bus communication settings in the MSENSE® DGA 9 device:

- 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 9 devices are present. In this configuration, the host PC is connected via a modem or RS232 to a MSENSE® DGA 9 device, which serves as a communication gateway.
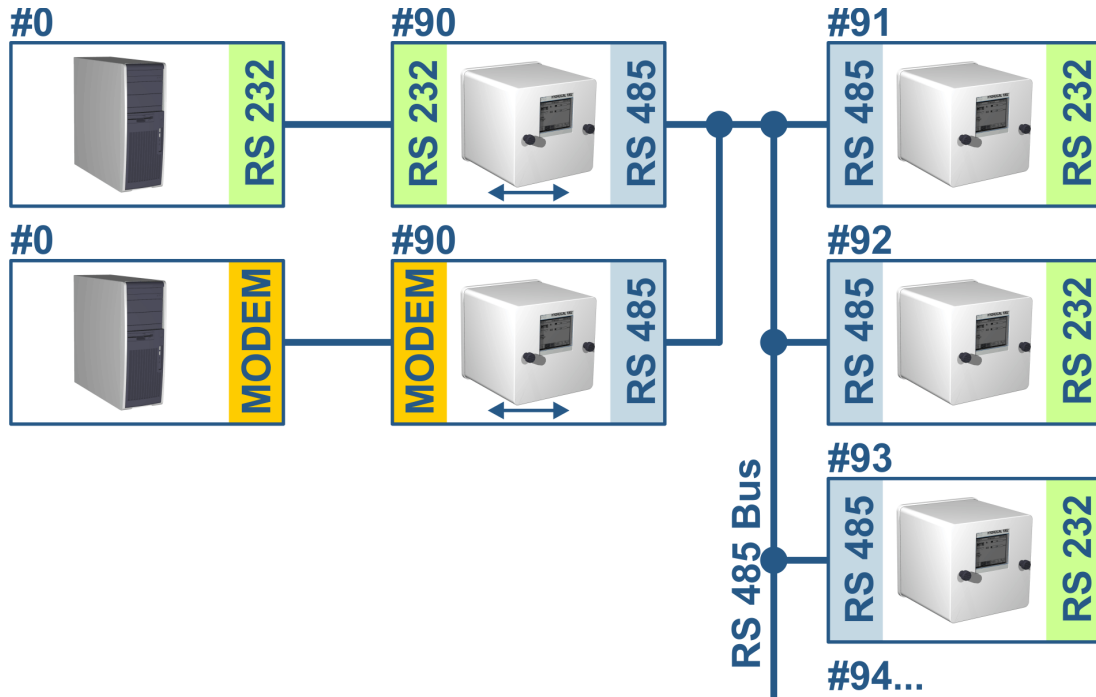
The settings correspond exactly to those of the RS485 bus node settings, but with one exception: The device with the gateway function must be in the Bus communication settings in "Bus bridge" mode.

Bus Bridge / Gateway Device Settings

MSENSE® DGA 9   MSET DGA

Bus communication settings in the MSENSE® DGA 9 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 9	MSET DGA

Bus communication settings in the MSENSE® DGA 9 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 9, which serves as communication gateway
- General settings: Enter correct address (own Bus address)

6.10.4.5.3.3 ⊞ MODBUS

The connection of several MSENSE® DGA 9s to a control system can be realised with MODBUS. A connection to the MSET DGA is not possible via MODBUS.

MODBUS configuration

Using the Enter key, the following selection can be made in the field mode:

```
┌──────────────────────────────────────┐
│ 07:34:46      MODBUS      2019-09-24  │
│ ┌──────────────────────────────────┐ │
│ │ MODBUS Configuration             │ │
│ │ Mode:            [RS485 / RTU  ↕]│ │
│ │ Address:              [91     ]  │ │
│ │ Baudrate:             [19200 ↕]  │ │
│ │ Data Bits:            [8     ↕]  │ │
│ │ Parity:               [Even  ↕]  │ │
│ │ Stop Bits:            [1     ↕]  │ │
│ │ Answer Delay [ms]:    [10    ]   │ │
│ │                                  │ │
│ │                       [💾┇◀][ ┇◀]│ │
│ └──────────────────────────────────┘ │
└──────────────────────────────────────┘
```

Settings MODBUS configuration in MSENSE® DGA 9:

- **Mode**
  - ○ RS485 RTU
  - ○ RS485 ASCII
  - ○ RS232 RTU (<u>for service purposes only</u>)
  - ○ RS232 ASCII (<u>for service purposes only</u>)

- **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 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**
  - ○ Setting the baud rate (2400, 4800, 9600, 19200, 38400, 57600 or 115200))
  - ○ The format coding of the serial MODBUS protocol can be set with these input fields:
    - ▪ Set data (7 or 8)
    - ▪ Set parity (none, odd or even)
    - ▪ Set stop bits (1 or 2)

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 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) can solve the problem in most instances.

Test options for the MSENSE DGA 9

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

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 9

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 ... 1042 / 412	31001 ... 31043	**Sensor value**
			    Sensor #1
			    ...
			    Sensor #43
			
			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
	...
	2084 / 824
		32001
		32003
		32005
		...
		32085
			Sensor value
			    Sensor #1
			    Sensor #2
			    Sensor #3
			    ...
			    Sensor #43
			
			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)
			    3 Threshold 1 alarm (active)
			    4 Threshold 2 alarm (active)

Modbus function code	Modbus address Dec. / Hex	Register Address [1] (5 digit dec.)	MSENSE® DGA 9
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 unit* The value is transmitted in 2 MB registers as 32-bit unsigned number in big endian format. The value 0 indicates the fault-free function of the device.
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 Register	2000 / 7D0	42001	**Switching off MODBUS** Switching off MODBUS It is possible to switch off the MODBUS protocol via MODBUS. This is done by writing 0x00FF into the register.

Modbus function code	Modbus address Dec. / Hex	Register Address [1] (5 digit dec.)	MSENSE® DGA 9
0x03 Read Holding Register	0 / 0 ... 1 / 1	40001 ... 40002	**Holding registers** 16-bit test register #1, #2
	1000 / 3E8	41001	Alarm status bit-sample #16 .. #1
	2000 / 7D0	42001	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

Sensor number allocation MSENSE DGA 9

The following sensor numbers are currently applicable:

1	Gas sensor H_2
2	Gas sensor C_2H_2
3	Gas sensor C_2H_4
4	Gas sensor CO
5	Gas sensor CO_2
6	Gas sensor C_2H_6
7	Gas sensor CH_4
8	Gas sensor O_2
9	Day trend gas sensor H_2
10	Day trend gas sensor C_2H_2
11	Day trend gas sensor C_2H_4
12	Day trend gas sensor CO
13	Day trend gas sensor CO_2
14	Day trend gas sensor C_2H_6
15	Day trend gas sensor CH_4
16	Day trend gas sensor O_2
17	Week trend gas sensor H_2
18	Week trend gas sensor C_2H_2
19	Week trend gas sensor C_2H_4
20	Week trend gas sensor CO
21	Week trend gas sensor CO_2
22	Week trend gas sensor C_2H_6
23	Week trend gas sensor CH_4
24	Week trend gas sensor O_2
25	Temperature sensor (gas temperature measurement cell)
26	Temperature sensor (oil temperature extraction chamber)
27	Moisture-in-oil sensor
28	Relative moisture in oil in [%]
29	TDCG

7.8 MODBUS TCP

MODBUS TCP is always available. TCP port number is 502.

7.9 MODBUS Serial Communication Adapter Example

The following programme and hardware were used to test the MODBUS communication with MSENSE® DGA 9. The programme is available for download, free of charge. The hardware adapter is not the only application that works with MSENSE® DGA 9. This is simply a tested example.

Programme (for Microsoft® Windows):

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

Hardware:

- USB / RS485 converter (FTDI chip)

7.9.1 MODBUS RS232 ASCII with Modpoll (RS232 for service purposes only)

Connection, settings and results are as follows:

- Physical connection

- MSENSE® DGA 9 settings and screenshot
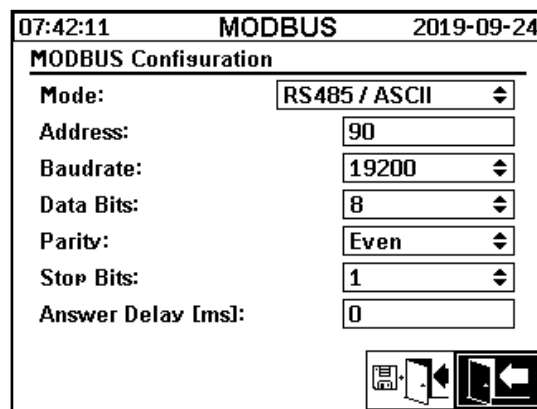
- MSENSE® DGA 9 can be operated without a response delay (due to full duplex on RS232).

```
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 ASCII
Slave configuration...: Address/Id = 90, start reference = 1017, count = 8
Communication.........: COM3, 19200, 7, 1even
Data type.............: 16-bit register, input register table

Polling slave ...
[1017]: 193
[1018]: 169
[1019]: 143
[1020]: 131
[1021]: 119
[1022]: 101
[1023]: 86
[1024]: 68

C:>_
```

Modpoll result screenshot:

- Modpoll requires the start register address 1017 to query the additional sensors 1 ... 8 (Address = 1016 ... 1023, Register = 1017 ... 1024)

7.9.2 MODBUS / RTU on RS485 bus (with Modpoll)

This test MSENSE® DGA 9 -MODBUS / RTU via RS485 bus was performed using the Modpoll application and a USB to RS485 converter. This demonstrates the ability to connect multiple MSENSE® DGA 9 devices to one RS484 bus. Connection, settings and results are shown below.

- Physical connection / RS485 bus topology

MSENSE® DGA 9 (Device # 91, # 92 only) Settings:

- MSENSE® DGA 9 Response delay setting. Each MSENSE® DGA 9 in the bus has its own address (# 90 .. # 93, # 0 is reserved for the bus master).
- Modpoll screenshot (device address 91 ... address 92, gas results)

8. RS 485 Wiring

This chapter focuses on the wiring of the RS485 connection.

8.1 RS485

The RS485 interface, which is integrated in the MSENSE® DGA 9 is designed as a 3-conductor inter-face. 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 9.

Remark: Heed polarity!!
1) OUT B ⊕ RS485
2) OUT A ⊖ RS485
3) GNDIO   Earth without screen
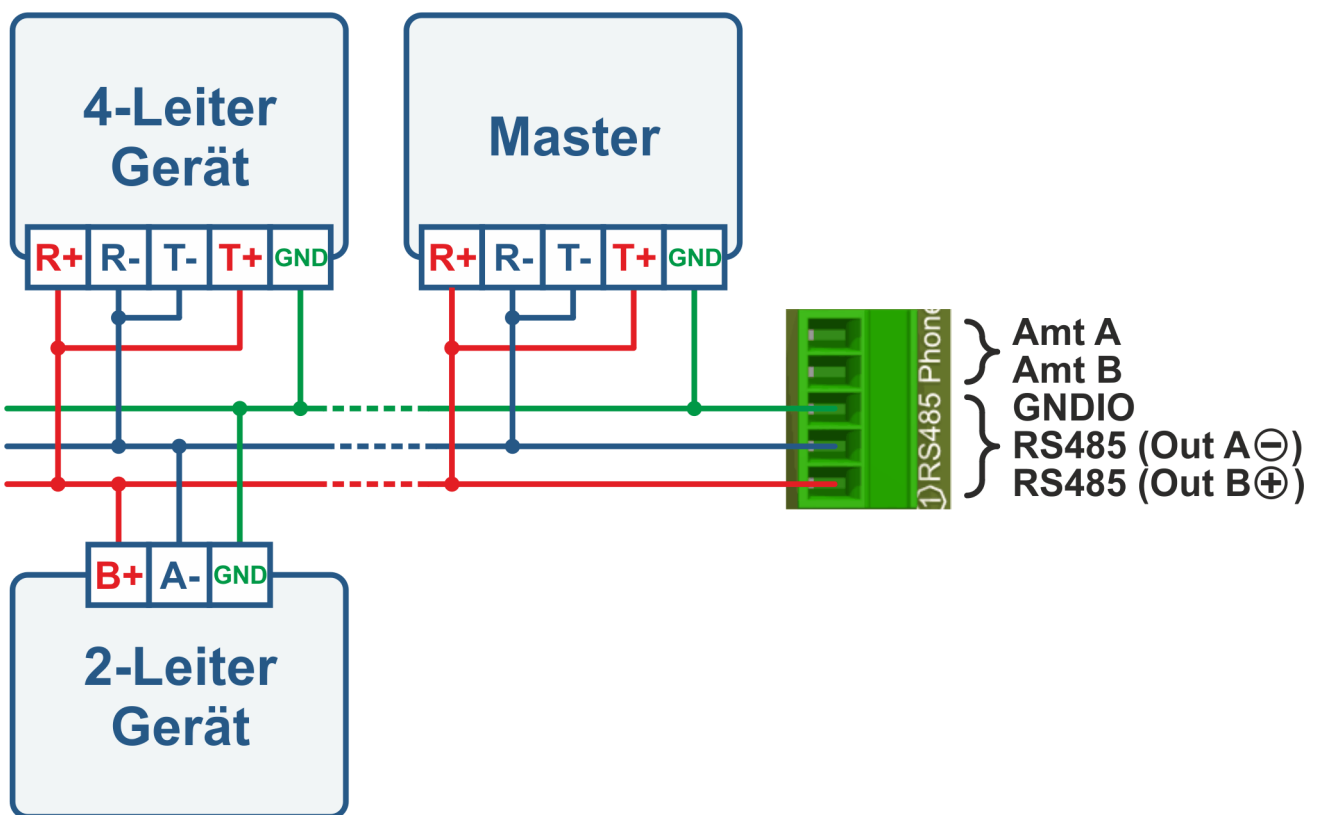
8.2 Termination, working point setting, earthing and protection of the RS485 bus

The description of termination, working point setting, earthing and protection of the RS485 bus is com-plex 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

Execute the following points in succession:

- **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 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

Execute the following points in succession:

- **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 9 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 Fault

With any complex device, there is a risk that it may fail. The same applies to the devices belonging to the MSENSE® DGA 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 <u>not</u> reset** this **fault!**

9.1.5 Fault – 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).
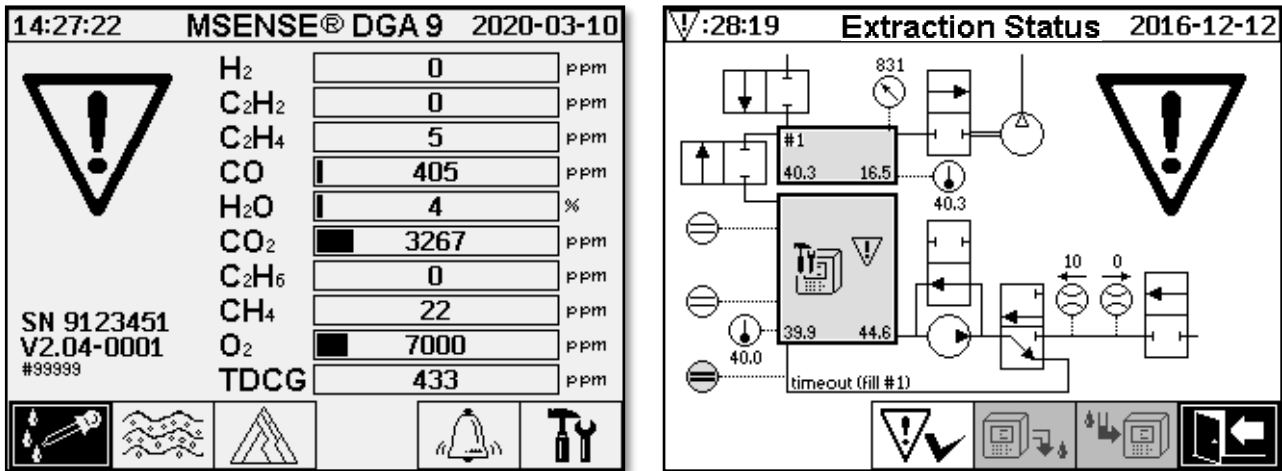
9.1.6 Faults – Analysis and acknowledgement options

A fault must be reset by the user. 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 9. 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 the MSENSE® DGA 9
- 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   On-site fault analysis

In order to be able to acknowledge a 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 device is in the "Device active" state.

9.1.6.4   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.
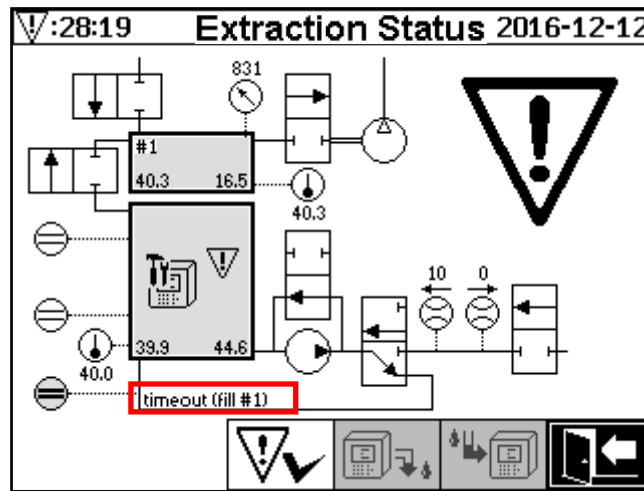
Extraction status menu with fault message

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 a 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.

Fault message	Possible reason
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   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 MSENSE® DGA 9 Service Tool . The read-out service data must be sent to the MR Service Department (see page 2) for analysis. Please now wait for the MR Service Department report before taking any further action.

9.1.6.6   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.

9.1.7   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 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.
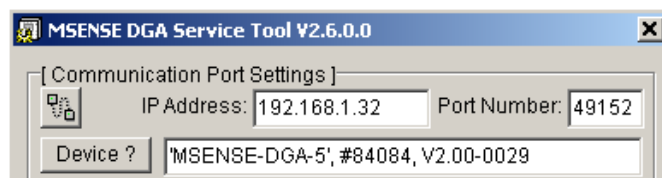

Figure: Ethernet interface selection

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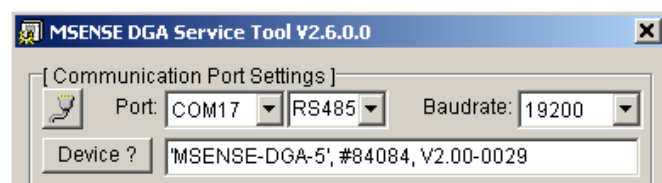

Figure: Serial interface selection (COM Port)

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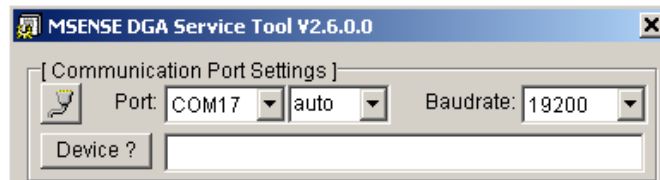
In order to start the device detection process, the PC COM Port (*Communication Port Settings*) – to which the device is connected – must be selected.

Remark: The standard baud rate of 19200 must only be changed if a different baud rate has been set on the device.
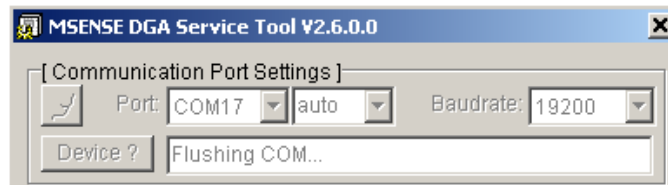
When the Device? key is pressed, the detection cycle starts.
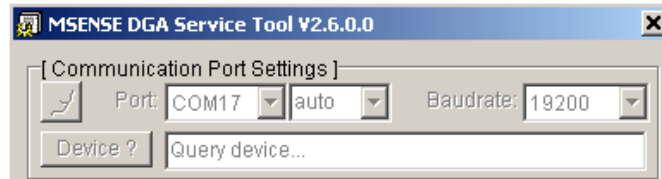
- Select COM Port and Baud Rate

- Start the device detection process

- The device detection is executed

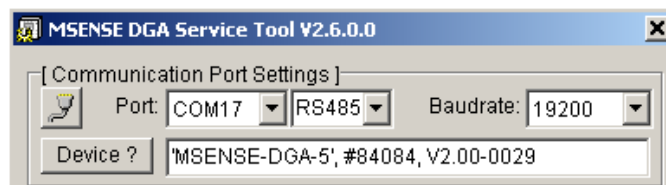- The device has been detected

Figure: Device detection sequence

- Following the successful device detection process, the text field Device? displays the following content (here using the example of MSENSE DGA 5):
- 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

Please note: In the event of a device fault a firmware update may not be carried out.
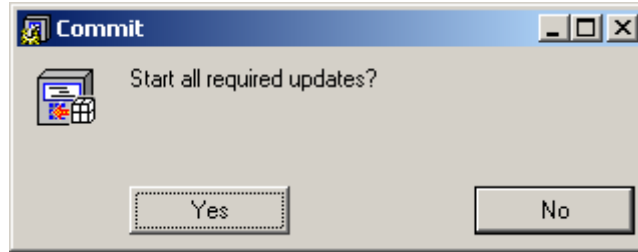
Window update request

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

If there is no fault with the device, an update can be started by clicking on the "Yes" key.

If the following message appears at the start, no update is necessary, and this message can be acknowledged with OK.
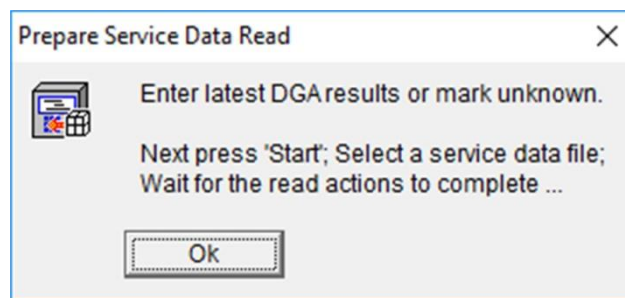
9.1.7.3.5 Service data read

In the **event of a fault** affecting the MSENSE® DGA 9, 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 must be selected.
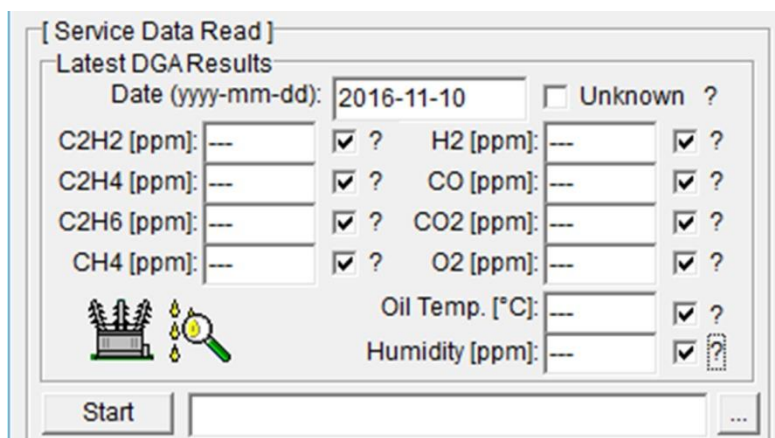

Figure: Latest DGA results

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-#86302-20190719-103030.dat). Here, a standard location is first specified. You can specify a different location.

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
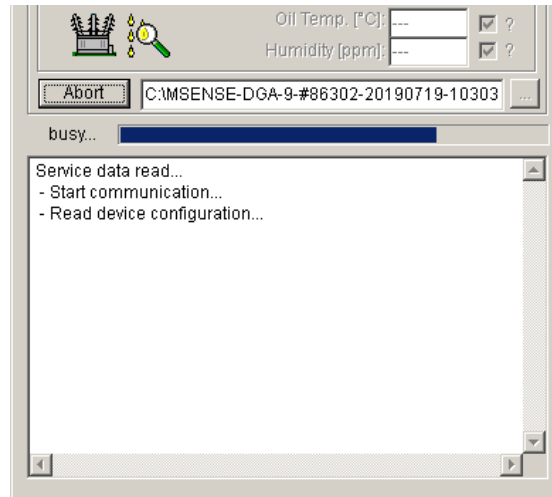
- Read-out diagnostics data
- Read-out extraction chamber data
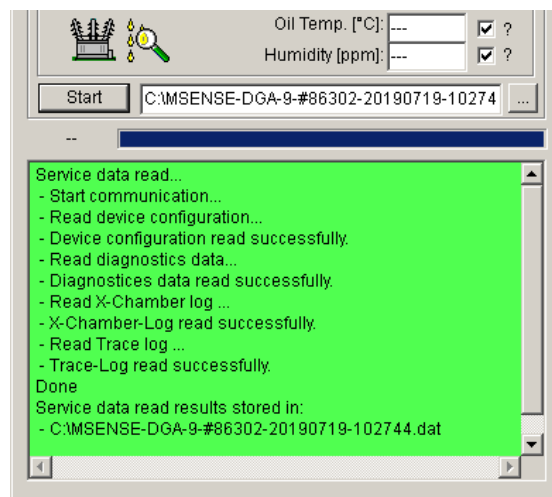- Read-out workflow tracking data

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 VAC 50/60 Hz [1] or 230 VAC 50/60 Hz [1] or 120 VDC [1] or 230 VDC [1] Other nominal voltages upon request! CAT II
Power consumption:	max. 600 VA
Housing:	Aluminium
Dimensions:	W 263 x H 274 x D 331.5 mm
Weight:	approx. 15 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
Pressure at the oil inlet:	0 - 300 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 61010-1:2002
Protection type:	IP-55

Measurements

Gas / moisture-in-oil measurement		
Quantity to be measured	Area	Precision [2] [3]
Hydrogen H_2	0 ... 10,000 ppm	± 15 %± 25 ppm
Carbon monoxide CO	0 ... 10,000 ppm	± 20 %± 25 ppm
Carbon dioxide CO_2	0 ... 20,000 ppm	± 20 %± 25 ppm
Methane CH_4	0 ... 5,000 ppm	± 20 %± 25 ppm
Acetylene C_2H_2	0 ... 10,000 ppm	± 20 %± 5 ppm
Ethylene C_2H_4	0 ... 10,000 ppm	± 20 %± 10 ppm
Ethane C_2H_6	0 ... 10,000 ppm	± 20 %± 15 ppm
Oxygen O_2	0 … 50,000 ppm	± 10 %± 1000 ppm
Moisture H_2O (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-infra-red NIR gas sensor unit for CO, CO_2, CH_4, C_2H_2, C_2H_4, C_2H_6 and O_2

- Micro-electronic gas sensor for H_2 measurement

- Capacitive thin-film humidity sensor for H_2O measurement
- Temperature sensors for oil and gas temperature measurement

Analogue and digital outputs (standard)

Digital outputs	Max. switching capacity
Type	(free assignment)
Relays	220 VDC/VAC / 2 A / 60 W potential-free

Analogue DC outputs		Standard Function	Alternative Function
Type	Area		
Current: DC	0/4 ... 20 mADC	H_2 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	C_2H_2 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	C_2H_4 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	CO Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	Moisture-in-oil Concenration.	Freely configurable
Current: DC	0/4 ... 20 mADC	CO_2 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	C_2H_6 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	CH_4 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	O_2 Concenration	Freely configurable
Current: DC	0/4 ... 20 mADC	TDCG	Freely configurable

Communication

- RS 485 (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 (optional)
- On-board IEC 61850 modem (optional)

Remarks
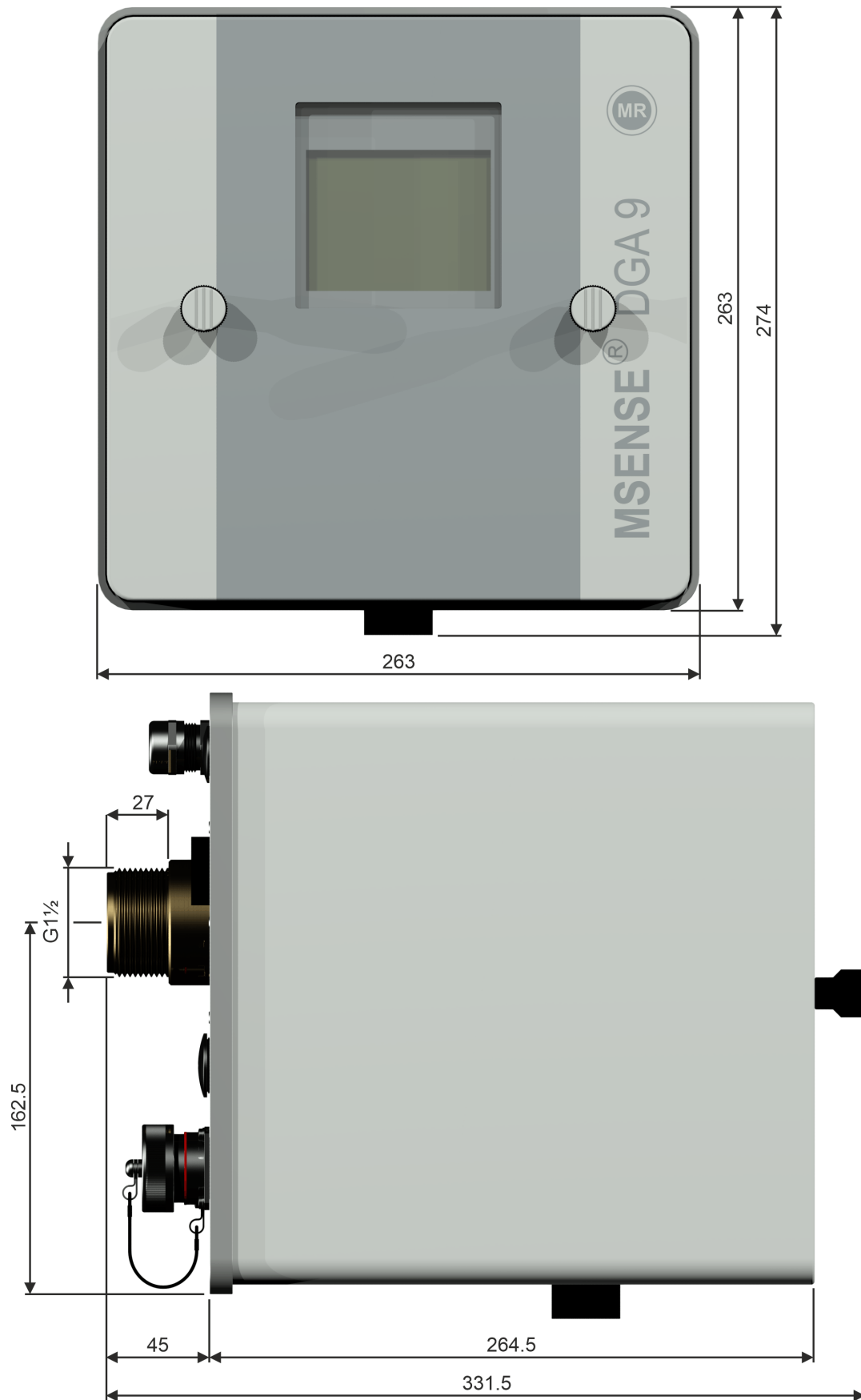[1] The nominal voltages result in the following nominal voltage ranges:
120 V ⇨ 120 V -20% = **96 V$_{min}$** 120 V +15% = **138 V$_{max}$**
230 V ⇨ 230 V -20% = **184 V$_{min}$** 230 V +15% = **264 V$_{max}$**
[2] In relation to ambient temperature +20°C and oil temperature +55°C
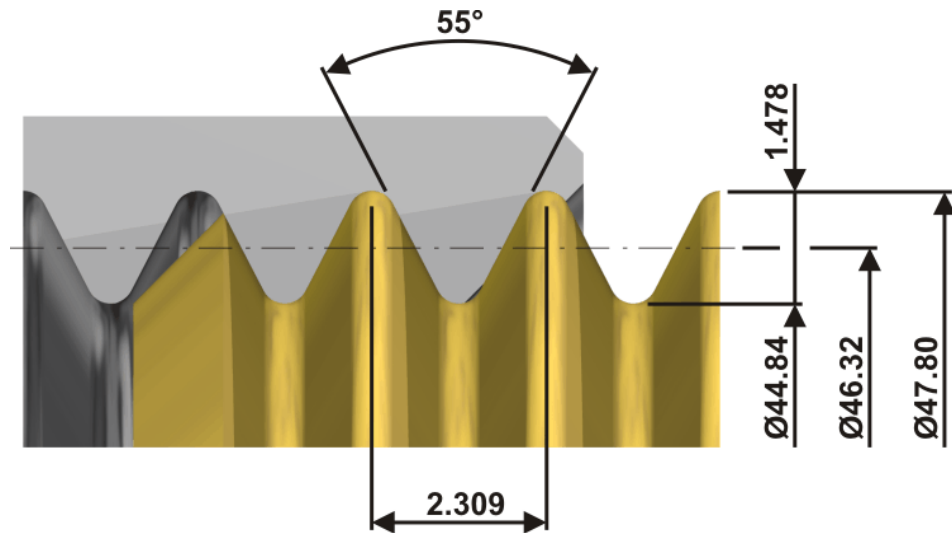[3] Moisture-in-oil accuracy H_2O only applies when used in mineral transformer oil

11. Dimensions MSENSE® DGA 9

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