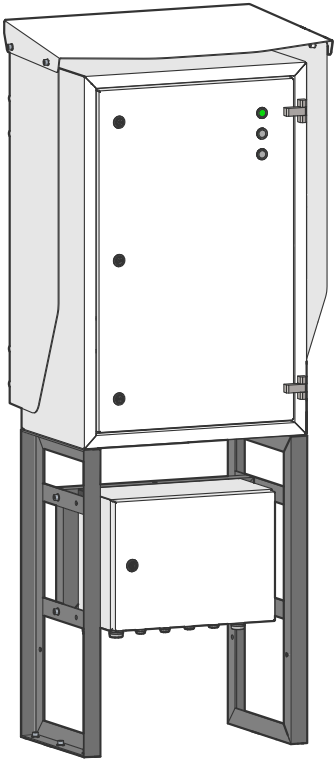
M211857EN-R

Installation Guide

Vaisala Optimus™ DGA Monitor for power transformers

OPT100



VAISALA

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1. About this document

1.1 Version information

This document provides installation instructions for Vaisala Optimus™ DGA Monitor OPT100.

Table 1 Document versions (English)

Document code	Date	Description
M211857EN-R	October 2022	Applicable from software version 1.17.0 onwards. Added sections: • Connecting auxiliary communication devices (page 57) Updated sections: • Connecting mains power (page 59) • OPTPSU cable glands and connectors (page 40) • Interior parts (page 41)
M211857EN-P	June 2022	Applicable from software version 1.16.0 onwards. Added sections: • Installing oil lines with flexible hoses (page 35) Updated sections: • Required materials (page 12) • OPTPSU cable glands and connectors (page 40) • Interior parts (page 41) • Connecting OPTPSU power to DGA monitor (page 43) • Connecting mains power (page 59) • Connecting Ethernet (page 52)
M211857EN-M	November 2021	Applicable from software version 1.15.0 onwards. Added sections: • Installation weather (page 15) Updated sections: • Installing oil lines (page 32) • Connecting relays (page 54)

1.2 Related manuals

For the latest versions of these documents, see docs.vaisala.com.

Table 2 Related manuals

Document code	Name
M211858EN	OPT100 User Guide
M212595EN	Spare part instruction: Replacing MHT411 internal multigas transmitter
M212759EN	Spare part instruction: Replacing OPT100 solenoid valves

1.3 Documentation conventions

WARNING! Warning alerts you to a serious hazard. If you do not read and follow instructions carefully at this point, there is a risk of injury or even death.

CAUTION! Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.

Note highlights important information on using the product.

Tip gives information for using the product more efficiently.

Lists tools needed to perform the task.

Indicates that you need to take some notes during the task.

1.4 Trademarks

Vaisala® is a registered trademark of Vaisala Oyj.

OPTIMUS™ is a trademark of Vaisala Oyj.

2. Planning the installation

2.1 Installation safety

WARNING! Read the product documentation carefully before installing or operating the product. If you encounter the following marking during installation or operation, consult product documentation to find out the nature of the potential hazards and any actions which have to be taken to avoid them:

WARNING! Only licensed experts may install electrical components. They must adhere to local and state legislation and regulations.

WARNING! Make sure that you prepare and connect only de-energized wires.

WARNING! Keep away from live circuits. Operating personnel must observe safety regulations at all times.

WARNING! Ground the DGA monitor cabinets as instructed in the wiring instructions. Verify the grounding before and after performing maintenance on the unit.

CAUTION! Do not modify the DGA monitor or use it in ways not described in the documentation. Modifications may lead to safety hazards, equipment damage, failure to perform according to specification, or decreased equipment lifetime.

CAUTION! Surfaces inside DGA monitor that are marked with the symbol below heat up during normal operation. Avoid touching hot surfaces and wear protective gloves when working inside the cabinet. Whenever possible, allow the DGA monitor to cool down before starting the work.

Wear protective eyewear and gloves.

Follow the safety regulations of the installation site.

The safety of any system incorporating this equipment is the responsibility of the assembler.

2.2 Installation phases

Perform the installation of the DGA monitor in the following phases:

- Planning
- Mechanical installation
- Electrical installation
- Commissioning
- Installation reporting

These phases correspond to chapters of the Installation Guide. Post-installation checklist is included as part of the installation report template.

More information

- Post-installation checklist (page 89)

2.3 Required personnel

Installation of the DGA monitor requires two persons. While most of the installation and commissioning tasks can be done by a single person, safe carrying and lifting of the DGA monitor requires two persons.

Installers must have the necessary training to legally perform all required tasks. For example, connecting the DGA monitor to mains power must be done by a licensed electrician.

Applicable legislation and site safety guidelines may require additional personnel to be present in the installation.

2.4 Required materials

In addition to the items delivered by Vaisala, installation of the DGA monitor requires various materials that you must supply yourself.

Items delivered by Vaisala

- DGA Monitor (Vaisala item OPT100)
  - DGA Monitor cabinet
  - Swagelok® plugs for oil connector fittings (2 pcs, Swagelok part no. SS-10M0-P (316 Stainless Steel Plug for 10-mm Swagelok Tube Fitting))
  - Protection shell for RJ45 Ethernet connector
  - Relay control cable (marked **RELAY**, Vaisala cable CBL210539)
  - Cabinet key
- Power Supply Unit (Vaisala item OPTPSU1 or OPTPSU2)
  - Power Supply Unit cabinet
  - Instrument power cable (Vaisala cable CBL210544)
  - Cabinet key

Optional items (must have either Wall Mounting Set or Ground Mounting Set):

- Wall Mounting Set (Vaisala item OPTMSET1)
  - Installation beam (2 pcs)
  - Cradle for Power Supply Unit
  - Screws and washers
- Ground Mounting Set (Vaisala item OPTMSET2)
  - Mounting stand (delivered in three parts)
  - Wedge anchors (6 pcs) for securing the mounting stand to ground
  - Screws, washers, and nuts
- Weather Shield (Vaisala item OPTSHLD1)
  - Weather shield (delivered in three parts)
  - Screws and washers
- Tubing adapter, 10-mm to 3/8″ (2 pcs, Vaisala item ASM213275SP)
- Tubing adapter, 10-mm to 1/4″ (2 pcs, Vaisala item ASM213274SP)

DGA monitor installation and commissioning

Not supplied by Vaisala.

- Grounding cable with 4 … 16-mm^2 (12 … 5 AWG) conductor. Enough to reach from the DGA monitor and the power supply unit to the grounding point(s).
- Mains power cable with 2.5-mm^2 (14 AWG) conductor and 9 … 16-mm (0.35 … 0.63 in) external diameter. Must be compliant with local regulations for mains power cables.

- Relay cable with 0.14 … 4-mm^2 (26 … 12 AWG) conductors and 7 … 12-mm (0.28 … 0.47 in) external diameter for connecting external devices to the relays. Verify that the required current carrying capacity matches the specification of the cable.
- RS-485 cable
- Shielded outdoor Ethernet cable with a RJ45 connector for the permanent Ethernet connection
- Laptop computer with:
  - RJ45 Ethernet connector
  - Web browser (Google Chrome, Microsoft Edge, or Mozilla Firefox)
- Ethernet cable with RJ45 connectors for temporary use

Oil pipe construction

Not supplied by Vaisala.

The amount of required oil pipe construction materials depends on the intended pipe length. Two pipes are needed, one for intake and one for returning the oil. Using the recommended pipe material, the maximum allowed length of a single pipe is 10 m (33 ft). If you are using a smaller pipe (minimum inner diameter 4 mm (0.157 in)), the maximum length is 5 m (16 ft).

- Recommended oil pipe material: stainless steel tubing with 10-mm (0.39-in) outer diameter and 1 … 1.5-mm (0.039 … 0.059 in) wall thickness. Enough to connect the oil intake and return valves to the DGA monitor.
- Adapters for connecting the oil pipes to the valves on the transformer
- Adapters for connecting the oil pipes to the DGA monitor, if not using the recommended tubing size (10-mm (0.39-in) outer diameter). Optional accessories for connecting 3/8″ and 1/4″ outer diameter tubing are available from Vaisala.
- Pipe fittings for joining pipe sections
- Pipe supports
- Oil pipe insulation (if necessary due to cold climate)
- Oil absorption material for controlling possible leaks
- Rags for wiping off oil

Mounting using Wall Mounting Set

Not supplied by Vaisala.

- M8 anchors or bolts (suitable for wall material)

Other

Not supplied by Vaisala.

- Personal safety equipment as required by installation site and applicable legislation

2.5 Recommended tools

Hand tools

- Slotted and crosshead screwdrivers

- Wrenches of various sizes
- Socket wrench and socket set
- Allen keys
- Cutting tools
- Cable stripping tool
- Metal file
- Measuring tape
- Impact drill and bits
- Spirit level
- Multimeter

Tools for oil pipe construction

- Pipe bending tool
- Pipe cutting tool
- Pipe deburring tool
- Pressurized air, either a bottle or a compressor
- Container for waste oil with at least 5 liter (1.3 gallon) capacity

2.6 Storing and transporting DGA monitor

Keep the DGA monitor and any installation accessories in their original packaging during storage and transport. Keep the items dry and in conditions allowed by the storage specification. Follow any handling instructions marked on the outside of the packaging.

After installation, store the packaging in a dry place. You can reuse it for storage and transport later.

2.7 Reinstalling DGA monitor

If you want to relocate an already installed DGA monitor, you must prepare it for transport and reinstallation by following the uninstallation procedure.

See OPT100 User Guide (M211858EN) for details.

2.8 Installation site requirements

DGA monitor can be installed and successfully operated in a wide variety of environments. Note the following special considerations:

- **Cold environments**: Trace heating elements and thermal insulation may need to be placed over the exposed sections of the oil pipes. Required heating power and insulation thickness depends on the pour point of the transformer oil that is used. Temperature of the oil in the lines must exceed the pour point with a reasonable margin in order to keep the oil flowing normally during operation.
- **Hot environments**: Weather shield installation option will reduce the solar radiation load on the DGA monitor. Consider placing the DGA monitor in a location that is not exposed to direct sunlight.

- **Operating altitude**: DGA monitor is intended for use in altitude range -1000 ... 3000 m.

If you have any questions, contact Vaisala for more information.

Performing a site inspection in person is a good idea. Take photographs of the intended installation location, oil connections, and electrical connections. Measure the amount of cable and oil pipe needed.

2.8.1 Installation location of DGA monitor

DGA monitor can be attached to the transformer chassis or to its immediate vicinity. The location must fulfill the following requirements:

- The location must be close to the oil connections to minimize the length of the oil lines. The maximum length of the lines is 10 m (33 ft) each.
- The location must be safely accessible from the floor without the need to climb or reach.
- There must be enough room and suitable supporting structures to install the DGA monitor in a vertical orientation. The DGA monitor must not be tilted more than 5 degrees.
- If the Ground Mounting Set is used, there must be a level concrete surface that is at least 100 mm thick.

If you have many suitable locations, prefer the following:

- Locations that are protected from rain and solar radiation.
- Locations where the vibration and heat from the transformer are not directly conducted to the DGA monitor.

2.8.2 Installation weather

If the installation site is outdoors and not protected from the effects of weather, make sure you can keep the equipment clean and dry during installation and service activities:

- Avoid working on the DGA monitor in rain or any kind of storm, and in temperatures below −20 °C (−4 °F).
- Keep equipment off the ground, especially if the ground is wet.
- Cover any tools and parts that are not being used. **It is especially important to keep the oil pipes and oil connectors clean and dry.**
- Keep the cabinet doors closed when not working inside the cabinets. This is important for keeping the inside of the DGA monitor clean and the measurement environment stable.

2.8.3 Recommended locations of oil connections

DGA monitor needs to pump oil out of the transformer and return it after each measurement cycle. It is important that the oil is clean and from a representative location in the transformer, and the same oil volume is not measured repeatedly.

The oil volume needed for a single measurement cycle is slightly more than one liter. To make it possible to pump a new sample and return the measured oil without mixing them up, you must build two oil lines between the DGA monitor and the transformer. Consider the following when selecting the locations of the oil connections in the transformer and preparing for the installation:

- The recommended arrangement is to use two valves in different locations on the transformer. This improves oil circulation inside the transformer and prevents the returned oil from immediately mixing with the next sample.
- Use the same valve for oil intake that has been previously used to take oil samples. This makes the measurements results of the DGA monitor more comparable with previous laboratory analysis results. After the oil lines are connected, you will not be able to take oil samples from the valves. Consider adding a new sampling valve to the intake oil line if you need to continue taking oil samples.
- Check if the transformer circulates its oil by forced convection. Oil flow inside the transformer makes the sampled oil more representative of the overall oil volume. It is also useful if you have to use two valves that are close together, as it carries the returned oil away from the valve.
- It is possible to use a T-joint to connect both lines to a single valve but the T-joint must be close to the transformer – no farther than one meter (3 ft) from the valve. If a T-joint is used, the transformer should be of a type that circulates its oil.
- Check the type of connection thread on the valves, and make sure you have appropriate adapters for connecting the oil lines to the valves.
- The maximum allowed length of an oil line is 10 m (33 ft).

Some typically available locations of oil connections are presented in Figure 1 (page 17).

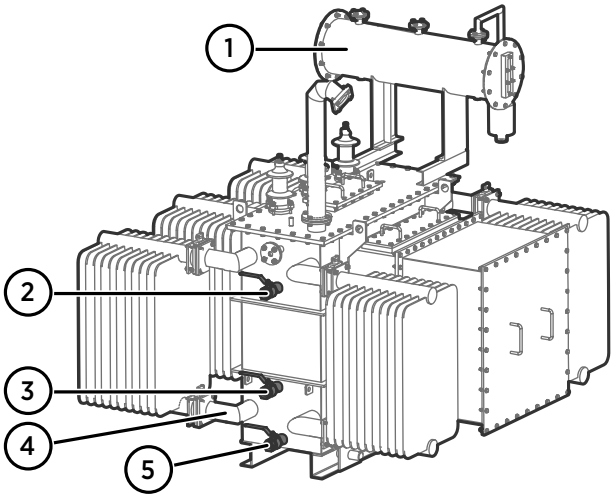


Figure 1 Possible locations of oil connections

1 Oil reservoir. Do not use.
2 Side of the oil tank, top level. Suitable location for oil connection if the valve is under oil level at all times.
3 Side of the oil tank, high enough from the bottom to enable proper oil movement. Suitable location for oil connection.
4 Radiator and its pipes. Suitable location if there is guaranteed continuous oil flow in the radiator. Not recommended if there is no forced circulation or circulation is not continuous.
5 Drain valve of the oil tank. Not recommended due to risk of sludge and free water. Measurement from the bottom of the tank is also not representative for moisture measurement.

CAUTION! Operate the selected valves and make sure the oil is clean with no sludge or free water present.

DGA monitor needs to pump oil in both directions during initialization and maintenance. To make sure this is possible, check that:
- Intake and return valves are both **below oil level** in the transformer. There should be no risk of drawing gas into the oil lines even when the flow is reversed.
- There are no flow direction control valves on the oil lines.

More information

- Installing oil lines with flexible hoses (page 35)

2.8.4 Network security

DGA monitor is intended to be connected to a secure SCADA network that is appropriately protected against security threats. Do not connect the DGA monitor directly to the Internet.

The second Ethernet port of the DGA monitor (marked **ETH1**) is for temporary local use only.

2.9 Regulatory compliances

OPT100 Optimus DGA monitor is in conformity with the provisions of the following EU directives:

- EMC Directive
- Low Voltage Directive

OPT100 is specifically designed to be installed as part of another type of equipment that is excluded from the RoHS directive (2011/65/EU) scope.

The conformity is declared with using the following standards:

- EN 61326-1: Electrical equipment for measurement, control, and laboratory use – EMC requirements – intended for use in industrial locations.
- EN 55032: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.
- EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements.

2.9.1 FCC Part 15 compliance statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CAUTION! Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.9.2 Canada ICES-003 compliance statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numerique de la classe A est conforme a la norme NMB-003 du Canada.

3. Mechanical installation

3.1 Unpacking DGA monitor

- Wire cutters

Two persons are required to lift the DGA monitor out of the packaging.

1. Cut the packing straps and remove the cover.
2. Remove the top padding from the box.
3. Lift the DGA monitor out of the box and set it down on a stable surface so that the door side is on top.

CAUTION! The cable glands and oil connections of the DGA monitor are located on the bottom of the cabinet. When unpacking and moving the DGA monitor, avoid putting the bottom of the DGA monitor on the ground. Putting the weight of the unit on the cable glands and oil connections may damage them. Keep the oil connections clean to ensure tight connections and to prevent dirt from getting into the oil circulation.

3.2 Mounting with Ground Mounting Set

- Ground Mounting Set (Vaisala item OPTMSET2)
  - Mounting stand (delivered in three parts)
  - Wedge anchors (6 pcs) for securing the mounting stand to ground
  - Screws, washers, and nuts
- 6-mm Allen key
- 13-mm wrench
- Impact drill and bits

Use the Ground Mounting Set when a free standing installation of the DGA monitor is needed. The mounting surface must allow the use of wedge anchors to secure the mounting stand. A concrete surface that is at least 100 mm thick is recommended.

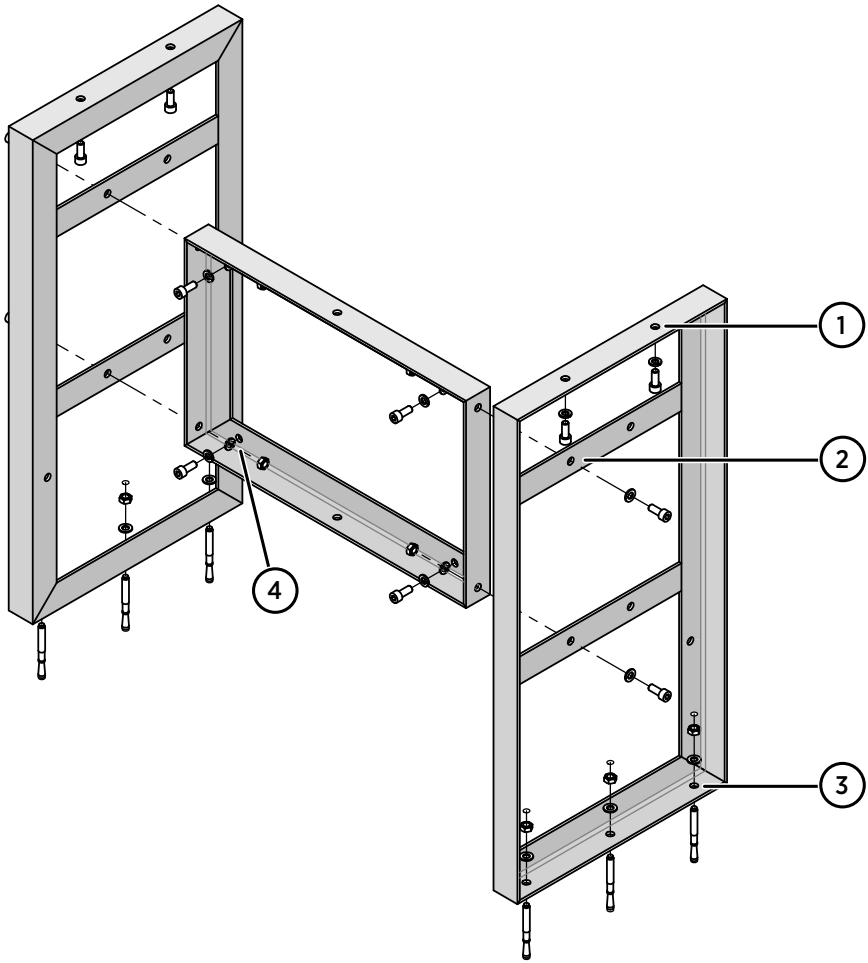


Figure 2 Assembly of the mounting stand

1 Mounting holes on the top are for attaching the DGA monitor.
2 Mounting holes on the side join the parts of the mounting stand together.
3 Holes on the bottom (three on each side) are for anchoring the mounting stand to the ground.
4 Attach the power supply unit to the middle part using these four holes.

1. Assemble the mounting stand. Tighten the screws to finger tightness at this point, not all the way.

2. Using the assembled mounting stand as the template, mark the locations of the six anchors on the mounting surface. If the mounting location is at the edge of a concrete slab, leave at least 10 cm (4 in) clearance to the edge.

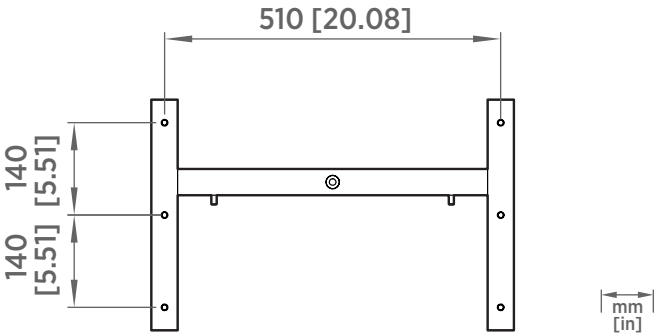


Figure 3 Anchoring holes on the mounting stand

3. Drill holes for the anchors using an impact drill and an 8 mm (.315 in) drill bit. The holes must be 60 mm (2.36 in) deep.
4. Install the anchors in the holes.
5. Attach the mounting stand to the anchors.
6. Verify that the mounting stand is securely anchored.
7. Attach DGA monitor to the top of the mounting stand.
8. Tighten the screws to 20 Nm tightness.

3.2.1 Parts with Ground Mounting Set

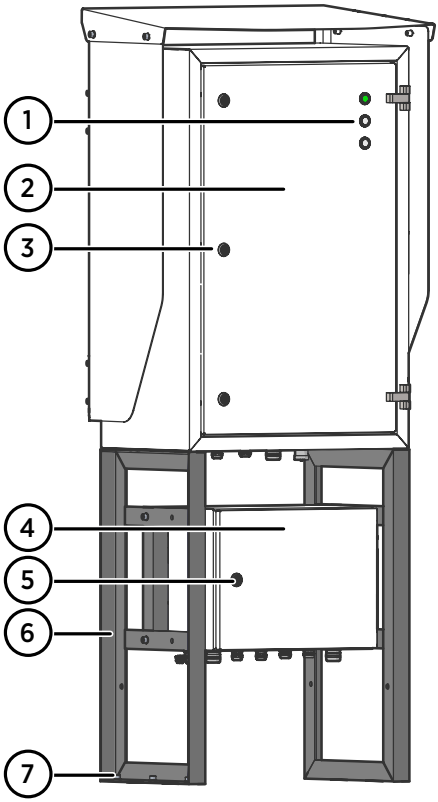


Figure 4 OPT100 front parts with Ground Mounting Set

1 Status LEDs
2 OPT100 DGA Monitor
3 Door lock (3 pcs)
4 Power supply unit (OPTPSU)
5 Door lock
6 Mounting stand
7 Wedge anchors (6 pcs)

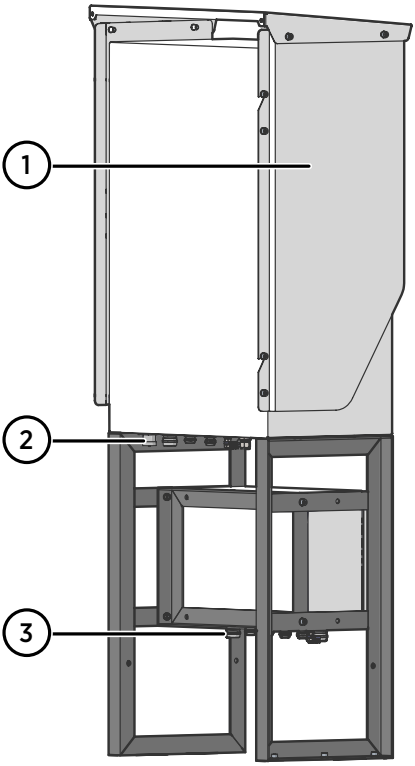


Figure 5 OPT100 rear parts with Ground Mounting Set

1 Weather shield
2 Cable glands and oil connections for DGA Monitor
3 Cable glands for power supply unit

3.2.2 Dimensions with Ground Mounting Set

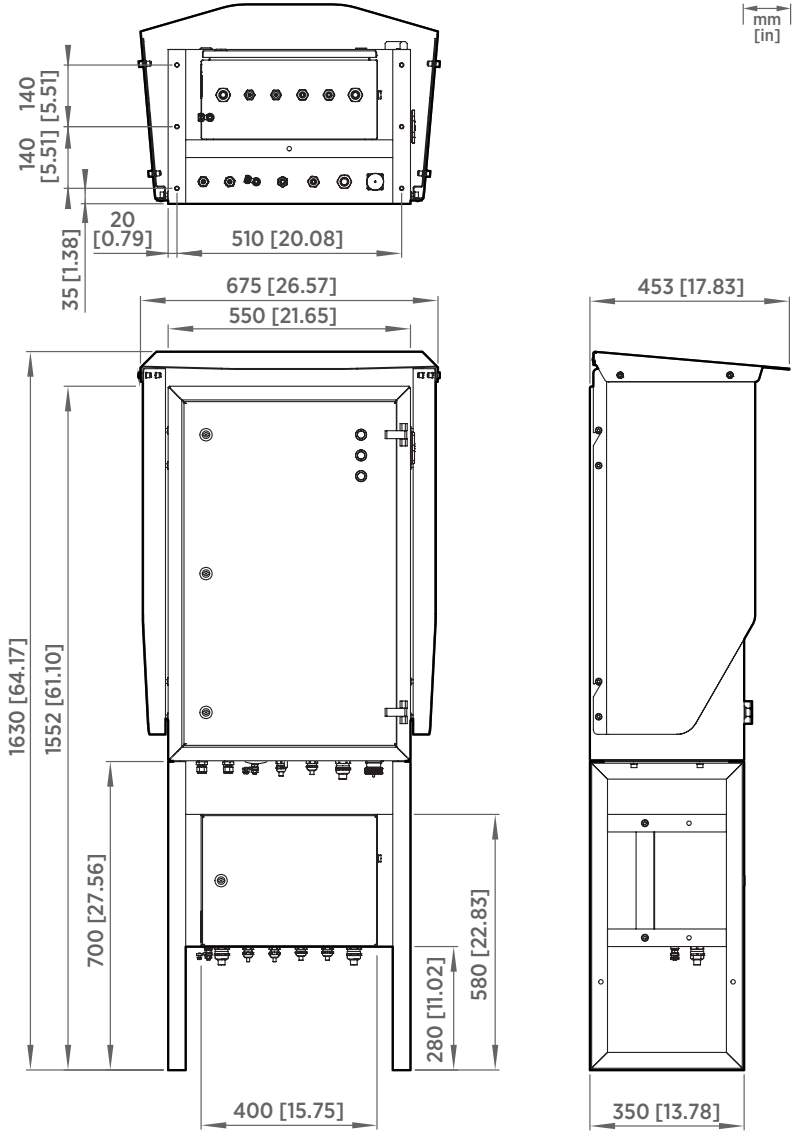


Figure 6 OPT100 dimensions with Ground Mounting Set

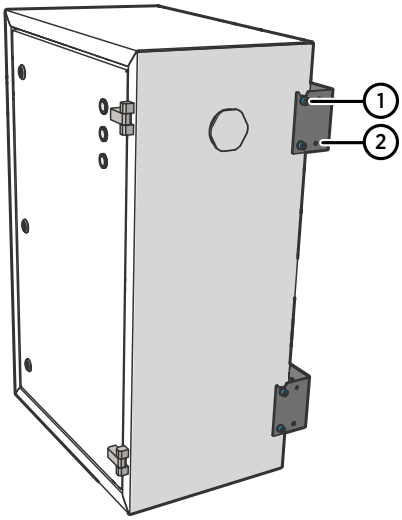
3.3 Mounting with Wall Mounting Set

- Wall Mounting Set (Vaisala item OPTMSET1)
  - Installation beam (2 pcs)
  - Cradle for Power Supply Unit
  - Screws and washers
- M8 anchors or bolts (suitable for wall material)
- 6-mm Allen key

CAUTION! Use enough anchors or bolts to fill local safety factor requirements. Also account for possible vibrations and other sources of additional mechanical stress.
Use anchors or bolts that are suitable for the wall material at the installation location. Note that they are not included with the Wall Mounting Set.

1. Attach one of the installation beams to the mounting location, at a height where you want the top of the OPT100 cabinet to be. Make sure it is securely attached from at least two points, and can bear the full weight of the DGA monitor.
2. Attach the second installation beam at the height of the second set of mounting holes.
3. Attach screws with washers to the top mounting holes of each pair on the sides of the OPT100 cabinet (four screws in total). Tighten them enough to safely bear the weight of the cabinet but not all the way in. The second hole of each set must remain free at this point.
4. With two people lifting, lift the OPT100 cabinet up and hang it from installation beams by the screws. If the lower installation beam is not at the correct height, re-attach it at the correct height before attempting this step again.
5. Tighten the four screws to secure the cabinet in place.

6. Add a second screw (with washer) below each of the installed screws, and tighten them. The cabinet is now secured to the installation beams by a total of eight screws.



1 Installation beam mounting screws.
2 Leave second set of mounting holes free for weather shield installation.

3.3.1 Parts with Wall Mounting Set

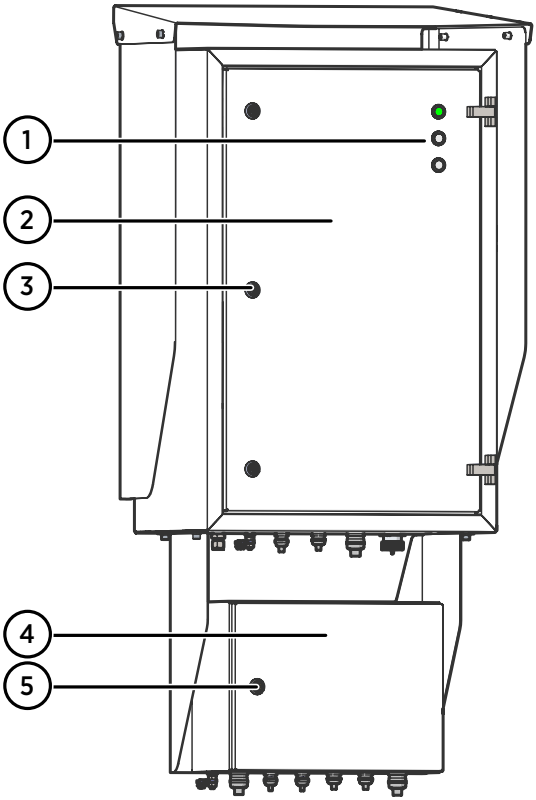


Figure 7 OPT100 front parts with Wall Mounting Set

1 Status LEDs
2 OPT100 DGA Monitor
3 Door lock (3 pcs)
4 Power supply unit
5 Door lock

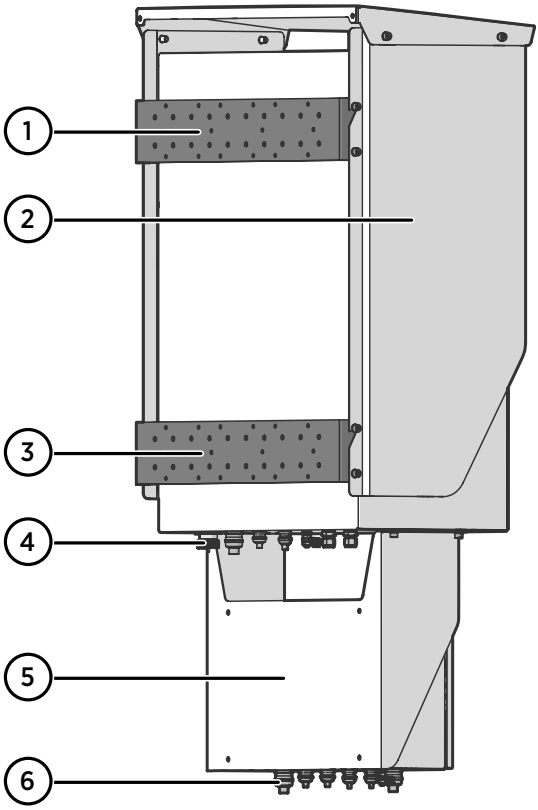


Figure 8 OPT100 rear parts with Wall Mounting Set

1 Installation beam (upper)
2 Weather shield
3 Installation beam (lower)
4 Cable glands for DGA Monitor
5 Cradle for power supply unit
6 Cable glands for power supply unit

3.3.2 Dimensions with Wall Mounting Set

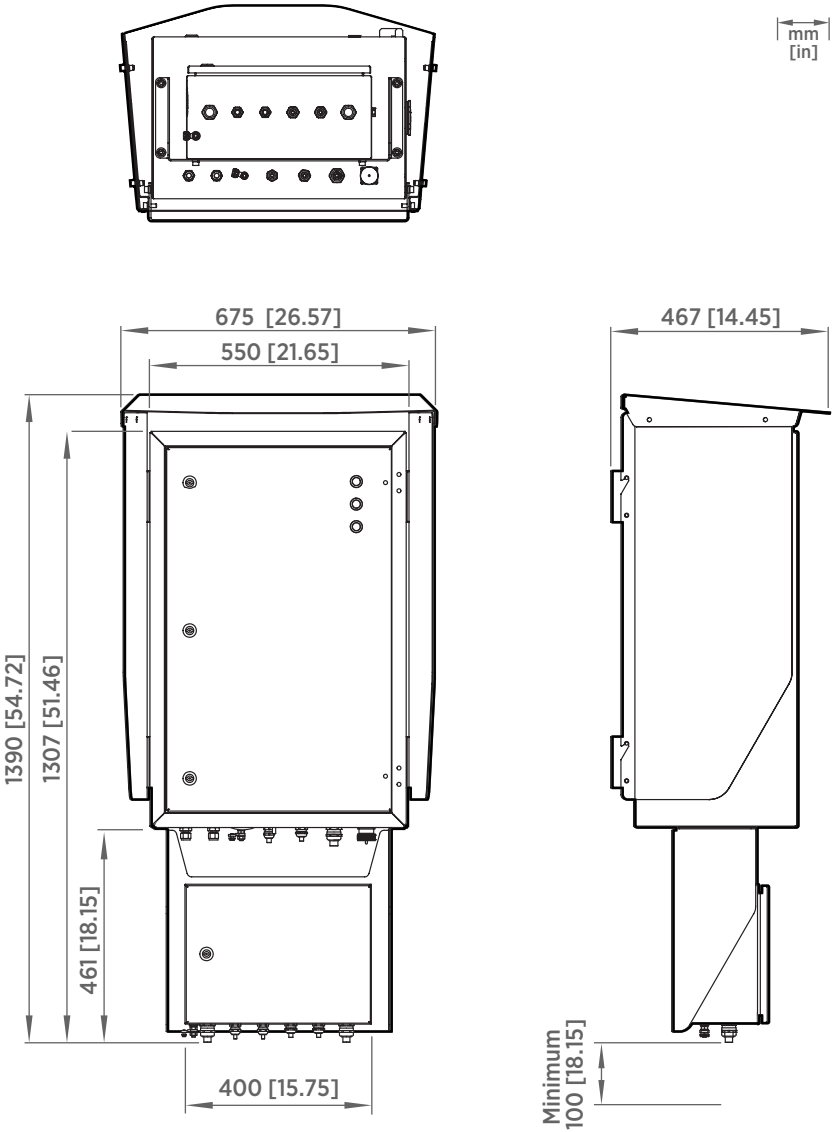


Figure 9 OPT100 dimensions with Wall Mounting Set

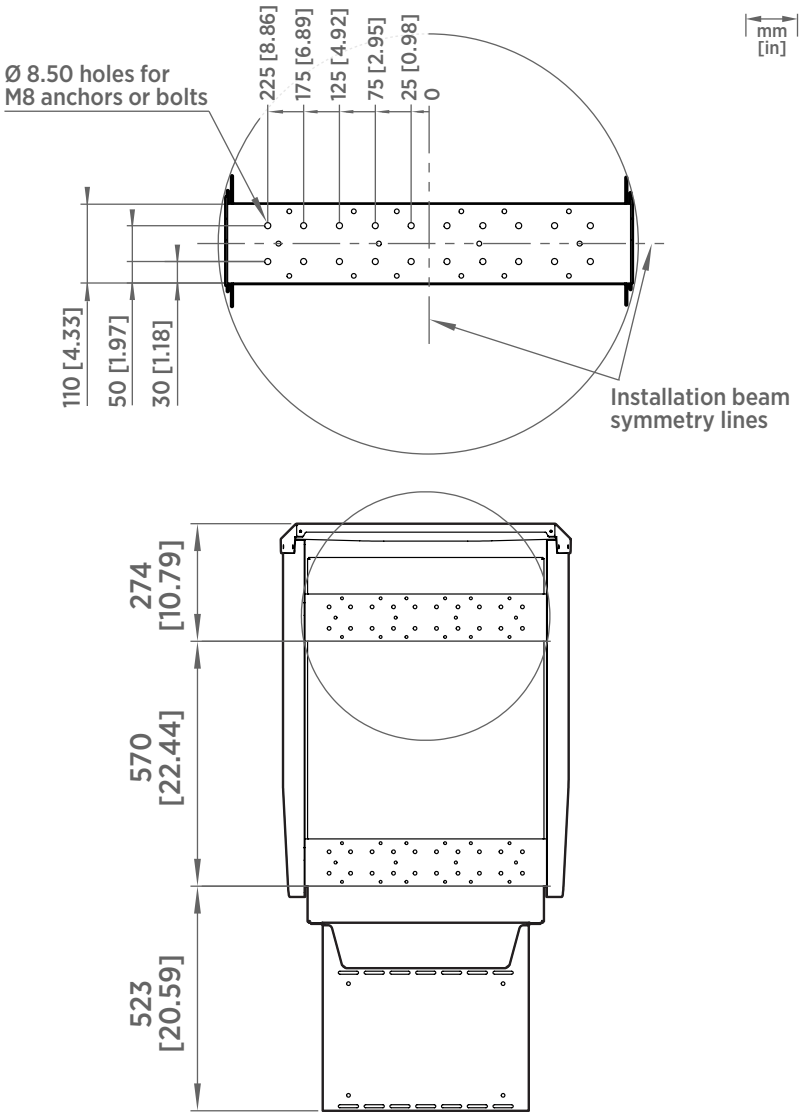


Figure 10 Mounting dimensions of installation beams

3.4 Installing oil lines

- Adapters for connecting the oil pipes to the valves on the transformer
- Adapters for connecting the oil pipes to the DGA monitor, if not using the recommended tubing size (10-mm (0.39-in) outer diameter). Optional accessories for connecting 3/8″ and 1/4″ outer diameter tubing are available from Vaisala.
- Recommended oil pipe material: stainless steel tubing with 10-mm (0.39-in) outer diameter and 1 … 1.5-mm (0.039 … 0.059 in) wall thickness. Enough to connect the oil intake and return valves to the DGA monitor.
- Pipe fittings for joining pipe sections
- Pipe supports
- Pipe bending tool
- Pipe cutting tool
- Pipe deburring tool
- Pressurized air, either a bottle or a compressor
- Wrenches of various sizes
- Container for waste oil with at least 5 liter (1.3 gallon) capacity

CAUTION! When working with oil pipes, hoses, fittings, and adapters:

- **Keep parts and tools clean and off the ground.** Dirty parts may contaminate the transformer oil or cause connections to leak.
- **Oil pipes, hoses and connection adapters must be dry**, without any free water residue inside. Water inside the oil lines can cause issues with the OPT100 measurement and water may be carried with the oil to the connected transformer.
- **Use new Swagelok® adapters** (nuts and ferrules) when making new connections. Do not use third party adapters or used parts from a different connection. Opening and retightening existing oil line connections without changing the nuts and ferrules is OK as long as the parts appear intact and you can verify the connections do not leak. Swagelok part code for the included 10-mm pipe adapters is SS-10M0-NFSET.
- If you are unsure about the proper use of fittings and adapters, refer to their manufacturer's instructions online.

If the DGA monitor is mounted using the wall mounting set, the power supply unit will be attached by a mounting cradle. Make sure you are not routing the oil lines so that they will obstruct the power supply unit attachment.

Wear protective eyewear and gloves.

Before starting to install the oil lines, see oil connection location recommendations for important information.

1. Inspect and prepare the selected inlet and outlet oil valves on the transformer:
   a. Remove any previously installed flow direction control valves. The DGA monitor needs to pump oil in both directions during initialization, and will not work if there are flow direction controllers in the oil lines.
   b. Clean any loose dirt from the outside and inside of the oil valves on the transformer.
   c. Drain some oil from the selected valves into the waste oil container. Verify that the oil is clean and there is no sludge coming out with the oil. If there is sludge, do not use that valve to connect the DGA monitor.
2. Install the adapters to the inlet and outlet valves on the transformer to match them to the size of the oil pipe material.
3. Measure the distance from the oil valves to the DGA monitor, and plan the length and shape of the oil pipe sections. Minimize the amount of joints.

CAUTION! Make sure that both oil connections on the transformer are below oil level. There must be no risk of drawing gas into the oil lines even when the flow is reversed.

4. Cut and bend the oil pipe to appropriate sections for building the oil lines.
5. Remove any sharp edges from the cut surfaces.
6. Clean any metal shavings from inside the pipes using pressurized air.
7. Build the oil lines between the valves and the oil connections on the DGA monitor marked **Oil In** and **Oil Out**.
8. Remove the plugs from the pipe fittings on the DGA monitor and store them for possible later use. Check that the fittings are clean.

9. Connect both oil lines to the fittings on the DGA monitor. Use the supplied Swagelok® adapters (delivered in a separate bag).
   a. Insert the nut of the adapter over the oil pipe or hose.
   b. Insert the two ferrules over the pipe or hose. Make sure they are in the order and orientation shown in Figure 11 (page 34).
   c. Push the pipe or hose into the fitting on the DGA monitor and rotate the nut finger-tight.
   d. Mark the nut position.
   e. Hold the base of the oil fitting with a second wrench to keep it from turning when tightening.
   f. Tighten the nut 1 1/4 turns with a wrench.

If you are not using the recommended oil pipe size, install adapters into the oil connections first. Then connect the oil pipe to the adapter.

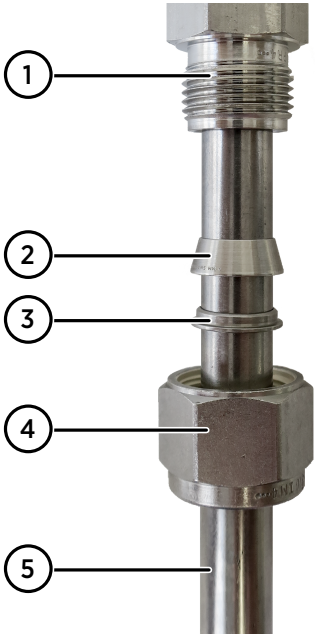


Figure 11 Pipe or hose connection fitting order

1 Oil fitting on the DGA monitor
2 Front ferrule
3 Back ferrule
4 Nut of the adapter
5 Oil pipe

10. Install pipe supports where necessary to support the pipe mechanically. The pipe should be supported at least every 2 meters (6 feet).
11. If necessary due to cold climate, install insulation over the oil pipes.

To verify that the oil connections are tight, check for leaks during commissioning when the DGA monitor is pumping oil. Ideally, check the connections again after the DGA monitor has been running for some time (for example, the next day).

More information

- Recommended locations of oil connections (page 15)
- Attaching power supply unit (page 37)

3.4.1 Installing oil lines with flexible hoses

- 14-mm wrench (2 pcs)
- 19-mm wrench
- 22-mm wrench
- Flex hose kit, 2 x 10 m (Vaisala item ASM214666SP)
- Adapter kit, ½″ NPT (Vaisala item ASM214667SP)
- Adapter kit, 1″ NPT (Vaisala item ASM214668SP)
- Adapter kit, 2″ NPT (Vaisala item ASM214669SP)
- Optional pipeline valve kit, 10-mm (Vaisala item ASM214670SP)
- Pressurized air, either a bottle or a compressor
- Container for waste oil with at least 5 liter (1.3 gallon) capacity

Follow these instructions to install oil lines with flexible hoses. The flex hose kit and adapters are not delivered with the standard DGA monitor delivery.

CAUTION! When working with oil pipes, hoses, fittings, and adapters:

- **Keep parts and tools clean and off the ground.** Dirty parts may contaminate the transformer oil or cause connections to leak.
- **Oil pipes, hoses and connection adapters must be dry**, without any free water residue inside. Water inside the oil lines can cause issues with the OPT100 measurement and water may be carried with the oil to the connected transformer.
- **Use new Swagelok® adapters** (nuts and ferrules) when making new connections. Do not use third party adapters or used parts from a different connection. Opening and retightening existing oil line connections without changing the nuts and ferrules is OK as long as the parts appear intact and you can verify the connections do not leak.
- If you are unsure about the proper use of fittings and adapters, refer to their manufacturer's instructions online.

Wear protective eyewear and gloves.

If the DGA monitor is mounted using the wall mounting set, the power supply unit will be attached by a mounting cradle. Make sure you are not routing the oil lines so that they will obstruct the power supply unit attachment.

Before starting to install the oil lines, see oil connection location recommendations for important information.

Minimum bending radius from center line for the flexible hoses is 3.05 cm (1.20 inches).

Do not bend flexible hoses close to the fitting connection to avoid strain.

1. Inspect and prepare the selected inlet and outlet oil valves on the transformer:
   a. Remove any previously installed flow direction control valves. The DGA monitor needs to pump oil in both directions during initialization, and will not work if there are flow direction controllers in the oil lines.
   b. Clean any loose dirt from the outside and inside of the oil valves on the transformer.
   c. Drain some oil from the selected valves into the waste oil container. Verify that the oil is clean and there is no sludge coming out with the oil. If there is sludge, do not use that valve to connect the DGA monitor.
2. Install the adapters to the inlet and outlet valves on the transformer to match them to the size of the flexible hose connectors.
3. Measure the distance from the oil valves to the DGA monitor, and plan the shape of the oil line installation.
   a. Use pipe supports every 1 meters (3 feet).
   b. Do not coil excess flexible hoses. Loop the hoses away from the DGA monitor along the cable guides or other protection structures. Mind the minimum bending radius.
   c. Make sure the flexible tubing is parallel to the ground to avoid air traps during bleeding.
   d. Make sure the flexible hoses are not under constant strain after installation.

   CAUTION! Make sure that both oil connections on the transformer are below oil level. There must be no risk of drawing gas into the oil lines even when the flow is reversed.

4. Build the oil lines between the valves and the oil connections on the DGA monitor marked **Oil In** and **Oil Out**.

5. Remove the plugs from the pipe fittings on the DGA monitor and store them for possible later use. Check that the fittings are clean.
6. Connect both oil lines to the fittings on the DGA monitor. Use the supplied Swagelok® adapters (delivered in a separate bag). See Installing oil lines (page 32), step 9 and manufacturer's instructions for more information on tightening the fittings.
7. Install pipe supports for the flexible hose. Do not leave the flexible hose on the ground where it can be stepped over.
8. Ground the flexible tubing and the support materials according to local regulations.

To verify that the oil connections are tight, check for leaks during commissioning when the DGA monitor is pumping oil. Ideally, check the connections again after the DGA monitor has been running for some time (for example, the next day).

More information

- Recommended locations of oil connections (page 15)
- Attaching power supply unit (page 37)

3.5 Attaching power supply unit

- 6-mm Allen key

1. If the Ground Mounting Set is used:
   a. Attach the power supply unit to the middle of the mounting stand.
2. If the Wall Mounting Set is used:
   a. Attach the power supply unit to the cradle.
   b. Support the power supply unit and cradle and attach them to the bottom of the OPT100 cabinet.

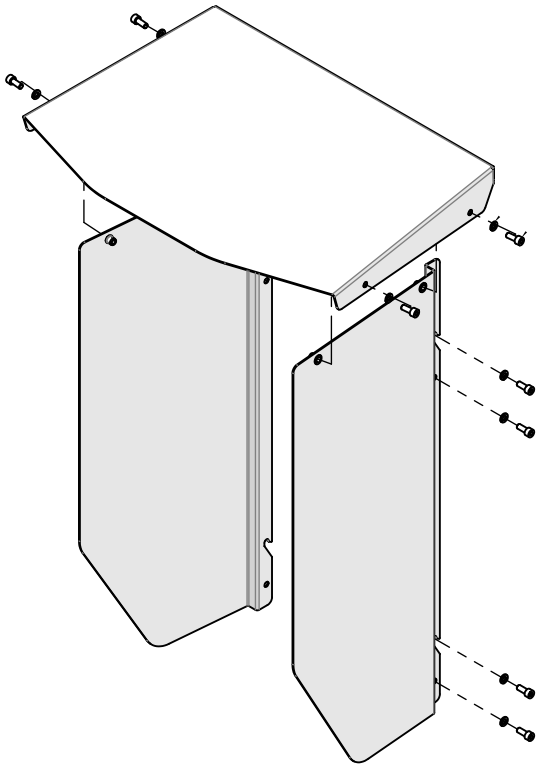
More information

- Installing oil lines with flexible hoses (page 35)

3.6 Attaching weather shield

- Weather Shield (Vaisala item OPTSHLD1)
  - Weather shield (delivered in three parts)
  - Screws and washers

1. Attach the weather shield to the OPT100 cabinet:



   a. Attach the left side panel. Note that the panels have an assigned side, they are not identical.
   b. Attach the right side panel.
   c. Verify that all screws holding the side panels of the weather shield are tight.
   d. Attach the top panel.

4. Electrical installation

4.1 OPT100 cable glands and connectors

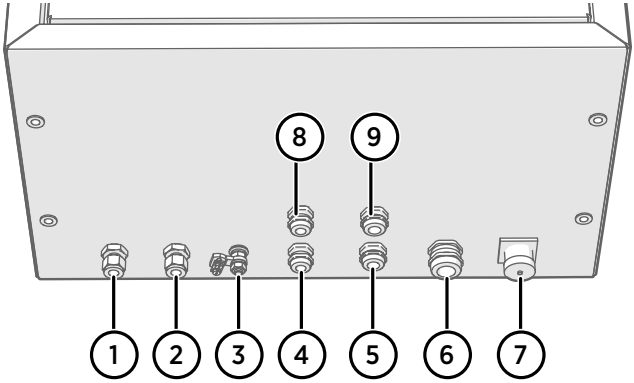


Figure 12 Cable glands and connectors on OPT100 cabinet

#	Label	Description	Cable/pipe diameter	Wrench size
1	**Oil Out**	Oil return to transformer.	10 mm (0.39 in)	19 mm
2	**Oil In**	Oil intake from transformer.	10 mm (0.39 in)	19 mm
3	⏚	Ground connection.	4 ... 16 mm^2 (12 ... 5 AWG) conductor	13 mm
4	**RS-485**	RS-485 connection.	5 ... 10 mm (0.20 ... 0.39 in)	20 mm
5	**Relay control out**	Relay control to OPTPSU. Use Vaisala cable CBL210539.	7 ... 12 mm (0.28 ... 0.47 in)	24 mm
6	**DC in**	DC input from OPTPSU. Use Vaisala cable CBL210544.	9 ... 16 mm (0.35 ... 0.63 in)	30 mm
7	**Ethernet**	Ethernet connection. Use shielded outdoor Ethernet cable. Assemble the included protection shell on the RJ45 connector.	-	-
8	**Spare**	Not reserved.	5 ... 10 mm (0.20 ... 0.39 in)	20 mm
9	**Spare**	Not reserved.	7 ... 12 mm (0.28 ... 0.47 in)	24 mm

4.2 OPTPSU cable glands and connectors

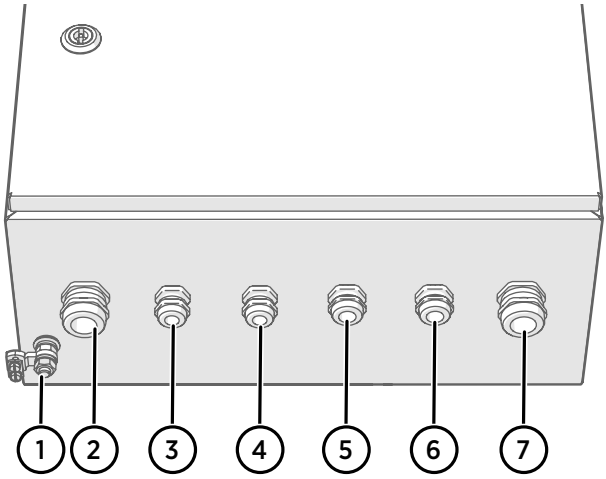


Figure 13 Cable glands and connectors on OPTPSU power supply unit

#	Label	Description	Cable diameter	Wrench size
1	⏚	Ground connection.	4 ... 16 mm^2 (12 ... 5 AWG) conductor	13 mm
2	**AC in** (OPTPSU1)	Mains power input. 100 ... 240 V AC, 50 ... 60 Hz, 10 A.	9 ... 16 mm (0.35 ... 0.63 in) 0.5 ... 10mm^2 (24 ... 6 AWG) conductor	30 mm
	DC in (OPTPSU2)	Mains power input. 110 ... 220 V DC, 6.3 ... 2.5 A.	9 ... 16 mm (0.35 ... 0.63 in) 0.5 ... 10mm^2 (24 ... 6 AWG) conductor	30 mm
3	**Spare**	Not reserved.	5 ... 10 mm (0.20 ... 0.39 in)	20 mm
4	**Spare**	Not reserved.	5 ... 10 mm (0.20 ... 0.39 in)	20 mm
5	**Relay out**	Relay output, max 250 V AC, 10 A.	7 ... 12 mm (0.28 ... 0.47 in)	24 mm

#	Label	Description	Cable diameter	Wrench size
6	**Relay control in**	Relay control from DGA monitor. Use Vaisala cable CBL210539.	7 ... 12 mm (0.28 ... 0.47 in)	24 mm
7	**DC out**	DC output to DGA monitor, 24 V DC, 20 A. Use Vaisala cable CBL210544.	9 ... 16 mm (0.35 ... 0.63 in)	30 mm

4.3 Interior parts

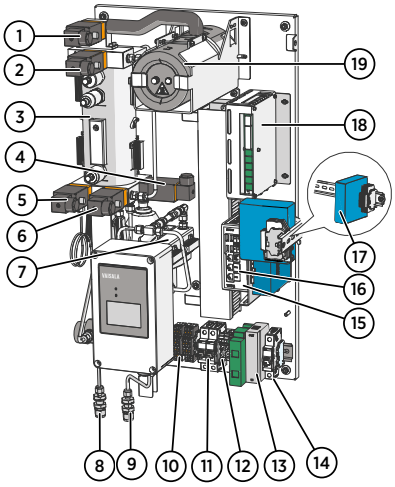


Figure 14 Inside DGA monitor cabinet

1 Valve 5 (bleed valve). Must be manually accessed during initialization and uninstallation.
2 Valve 4
3 Oil block
4 Valve 2
5 Valve 3
6 Valve 1
7 In-oil measurement of hydrogen and moisture
8 Oil out
9 Oil in
10 Terminal blocks for RS-485 output (Y1) and relay control (Y2)
11 Circuit breakers: main breaker (F2) and breaker for heating power (F1)
12 Terminal block for DC in (Y3)
13 Surge arresters
14 Circuit breaker for auxiliary device (F3) (Y4)
15 Processing unit
16 Ethernet connectors:
   - ETH0 Connection for SCADA, wired to external Ethernet connector
   - ETH1 Service port for temporary local use, with IP address 192.168.28.2
17 Auxiliary device and terminal blocks (Y5)
18 Control unit
19 Optical measurement module for extracted gases

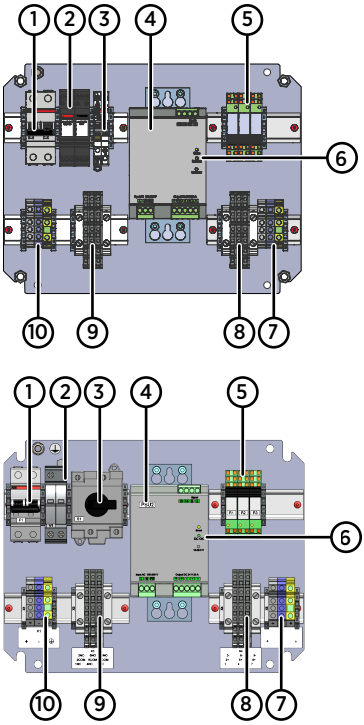


Figure 15 Inside Power Supply Unit cabinet (OPTPSU1 and OPTPSU2)

1 Circuit breaker for AC or DC power (F1)
2 Surge arresters
3 Power switch (S1)
4 Power supply
5 Relays (3 pcs). Each relay has a LED that is lit when the relay is active.
6 DC OK LED. If flashing, check DC output wiring.
7 DC out terminal block (X5)
8 Relay control terminal block (X4)
9 Relay output terminal block (X3)
10 Mains power in terminal block (X1)

4.4 Grounding DGA monitor

- Grounding cable with 4 ... 16-mm^2 (12 ... 5 AWG) conductor. Enough to reach from the DGA monitor and the power supply unit to the grounding point(s).
- Cable stripping tool
- Crosshead screwdriver
- Metal file
- Multimeter

1. Locate the ground terminals on the underside of the DGA monitor and the power supply unit, and find a good grounding point on the transformer or the surrounding structures.
2. Clean the grounding point of rust for a good connection.

3. Ground the DGA monitor:
   a. Run the cable from the ground terminal to the grounding point, and secure it so it does not hang loose.
   b. Connect the cable to the grounding point on the DGA monitor.

      If necessary for good connection, you can replace the grounding connector with your own cable terminal. The bolt is M8 size.

   c. Connect the other end of the cable to the grounding point.
   d. Measure the resistance from the ground terminal to the grounding point to verify the grounding.
4. Repeat step 3 to ground the power supply unit as well.

More information

- OPT100 cable glands and connectors (page 39)
- OPTPSU cable glands and connectors (page 40)

4.5 Connecting OPTPSU power to DGA monitor

- Instrument power cable (Vaisala cable CBL210544)
- Screwdriver with 3-mm-wide (0.12-in) slotted head
- Adjustable wrench

CAUTION! If the Vaisala-supplied instrument power cable is not available, use a shielded cable with 6 mm^2 (10 AWG) wires. Maximum length of the cable is 1.2 m (3 ft 11 in).

1. Open the cable gland marked **DC in** on the DGA monitor. Remove the plug and store it for later use.
2. Insert the instrument power cable through the outer nut and the seal insert, and start inserting the cable through the cable gland. Stop when you reach the section of the cable where the metal braid is exposed.
3. Bend the cable braid over the seal insert so that it will make contact with metal when the cable gland is tightened.
4. Push the outer nut and the seal insert against the contact socket of the gland and tighten the outer nut.

5. Inside the DGA monitor, connect the wires to terminal block **Y3**:

Table 3 Terminal block Y3 wiring

Signal	Wire color Vaisala cable CBL210544	Terminal
24 V DC +	Black with red marking	+
24 V DC –	Black	–
Ground	Green/yellow	⏚

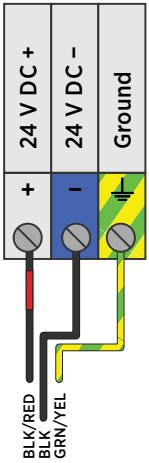


Figure 16 Terminal block Y3 wiring

6. Open the cable gland marked **DC out** on the power supply unit. Remove the plug and store it for later use.
7. Insert the instrument power cable through the outer nut and the seal insert, and start inserting the cable through the cable gland. Stop when you reach the section of the cable where the metal braid is exposed.

8. Bend the cable braid over the seal insert so that it will make contact with metal when the cable gland is tightened.

9. Push the outer nut and the seal insert against the contact socket of the gland and tighten the outer nut.

10. Inside the power supply unit, connect the wires to terminal block **X5**:

Table 4 Terminal block X5 wiring

Signal	Wire color Vaisala cable CBL210544	Terminal
24 V DC +	Black with red marking	+
24 V DC –	Black	–
Ground	Green/yellow	⏚

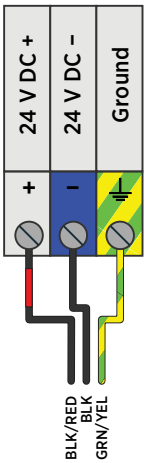


Figure 17 Terminal block X5 wiring

4.6 Connecting relay control to power supply unit

- Relay control cable (marked **RELAY**, Vaisala cable CBL210539)
- Screwdriver with 3-mm-wide (0.12-in) slotted head
- Adjustable wrench

1. Open the cable gland marked **Relay control out** on the DGA monitor. Remove the plug and store it for later use.
2. Insert the relay control cable through the outer nut and the seal insert, and start inserting the cable through the cable gland. Stop when you reach the section of the cable where the metal braid is exposed.

3. Bend the cable braid over the seal insert so that it will make contact with metal when the cable gland is tightened.
4. Push the outer nut and the seal insert against the contact socket of the gland and tighten the outer nut.
5. Inside the DGA monitor, connect the wires to terminal block **Y2**:

Table 5 Terminal block Y2 wiring

Signal	Wire color Vaisala cable CBL210539	Terminal
Relay 1 control +	White	1
Relay 1 control –	Brown	2
Relay 2 control +	Green	3
Relay 2 control –	Yellow	4
Relay 3 control +	Grey	5
Relay 3 control –	Pink	6

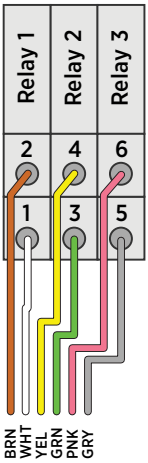


Figure 18 Terminal block Y2 wiring

6. Open the cable gland marked **Relay control in** on the power supply unit. Remove the plug and store it for later use.
7. Insert the relay control cable through the outer nut and the seal insert, and start inserting the cable through the cable gland. Stop when you reach the section of the cable where the metal braid is exposed.

8. Bend the cable braid over the seal insert so that it will make contact with metal when the cable gland is tightened.
9. Push the outer nut and the seal insert against the contact socket of the gland and tighten the outer nut.
10. Inside the power supply unit, connect the wires to terminal block **X4**:

Table 6 Terminal block X4 wiring

Signal	Wire color Vaisala cable CBL210539	Terminal
Relay 1 control +	White	2
Relay 1 control –	Brown	3
Relay 2 control +	Green	5
Relay 2 control –	Yellow	6
Relay 3 control +	Grey	8
Relay 3 control –	Pink	9

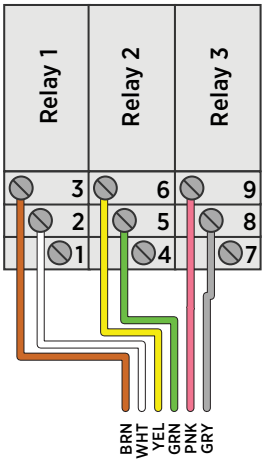


Figure 19 Terminal block X4 wiring

4.7 Connecting RS-485 serial line

- RS-485 cable
- Screwdriver with 3-mm-wide (0.12-in) slotted head
- Cable stripping tool

Default settings of the RS-485 line are;
- Baud rate: 19200
- Transmission mode: 8E1
- Modbus slave ID: 240

1. Open the cable gland marked **RS-485** on the DGA monitor. Remove the plug and store it for later use.
2. Prepare the cable for connection:
   a. Measure how much cable you need to reach from the cable gland to terminal block **Y1**.
   b. Remove the outer sheath and cable braid from the part of the cable that will be left inside the DGA monitor.
   c. Strip the ends of the individual wires to expose the conductors for 1 cm (0.4 in).
   d. Remove some more of the outer sheath to expose more cable braid. This part of the braid should be connected to the cable gland.
3. Insert the cable through the outer nut and the inner seal, and start inserting the cable through the cable gland. Stop when you reach the section of the cable where the metal braid is exposed.
4. Arrange the cable braid so that it makes contact with the cable gland when it is closed. Push the inner seal in place and tighten the outer nut.

5. Inside the DGA monitor, connect the wires to terminal block **Y1**:

> Verify the wiring colors of your cable before making any connections.

Table 7 Terminal block Y1 wiring

Signal	Terminal
RS-485 +	1
RS-485 –	3
Common	5

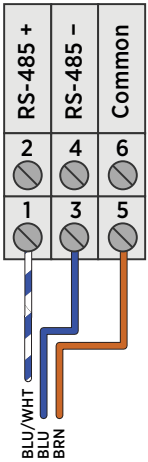


Figure 20 Terminal block Y1 wiring example

4.7.1 RS-485 termination and biasing

Use of termination and bias resistors on the RS-485 line is configured using DIP switches on the isolated RS-485 repeater. Change their configuration if necessary for your system. See Table 8 (page 52).

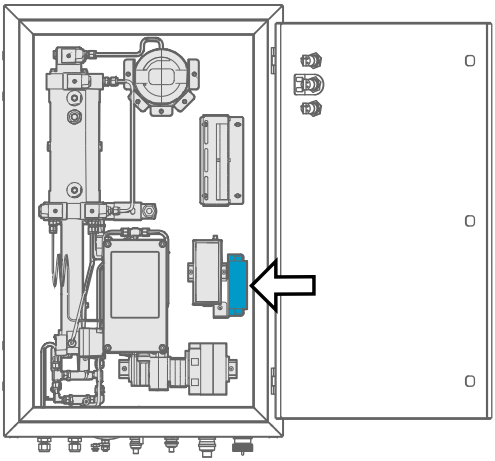


Figure 21 Location of the RS-485 repeater inside the DGA monitor cabinet

There are two banks of DIP switches on the underside of the RS-485 repeater. Switches for configuring the RS-485 output are at the front of the repeater, next to the grounding terminal (green screw).

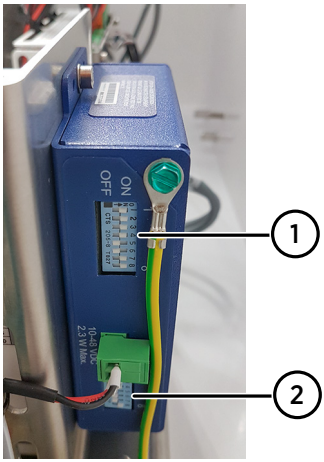


Figure 22 Location of DIP switches on the RS-485 repeater

1 DIP switches for configuring the RS-485 output.
2 DIP switches for configuring the internal serial connection. Do not change the settings of this bank.

Table 8 DIP switch configuration of RS-485 output

Switch number				Result
Switch 1	**Switch 2**	**Switch 3**	**Switch 4**	**Communication mode**
ON	ON	ON	ON	RS-485 2-wire half-duplex (default)
ON	OFF	OFF	OFF	RS-485 4-wire full-duplex
OFF	OFF	OFF	OFF	RS-422 full-duplex
Switch 5				**Termination resistor**
ON				Use built-in 120 Ω termination
OFF				Use external or no termination (default)
Switch 6				**Transmit bias resistor**
ON				Use external or no bias resistor
OFF				Use built-in 1.2 kΩ transmit bias resistor (default)
Switch 7				**Receive bias resistor**
ON				Use external or no bias resistor (default)
OFF				Use built-in 1.2 kΩ receive bias resistor

Switch 8 is not used.

CAUTION! DGA monitor is wired for 2-wire communication so do not change the communication mode.

4.8 Connecting Ethernet

- Shielded outdoor Ethernet cable with a RJ45 connector for the permanent Ethernet connection
- Protection shell for Ethernet connector

Ethernet connector **ETH1** inside the DGA monitor is intended for temporary local use only. For a permanent network connection, use the Ethernet connector under the DGA monitor.

CAUTION! Do not make a fixed Ethernet connection directly to DMU or any other ports not mentioned in these instructions. Bypassing protection components and connecting directly to other ports can damage components.

1. Assemble the protection shell over the RJ45 connector on your Ethernet cable. Assemble according to **Code A**: see instructions on top of the bag that contains the parts.

   CAUTION! You must use the protection shell to maintain the ingress protection rating of the cabinet.

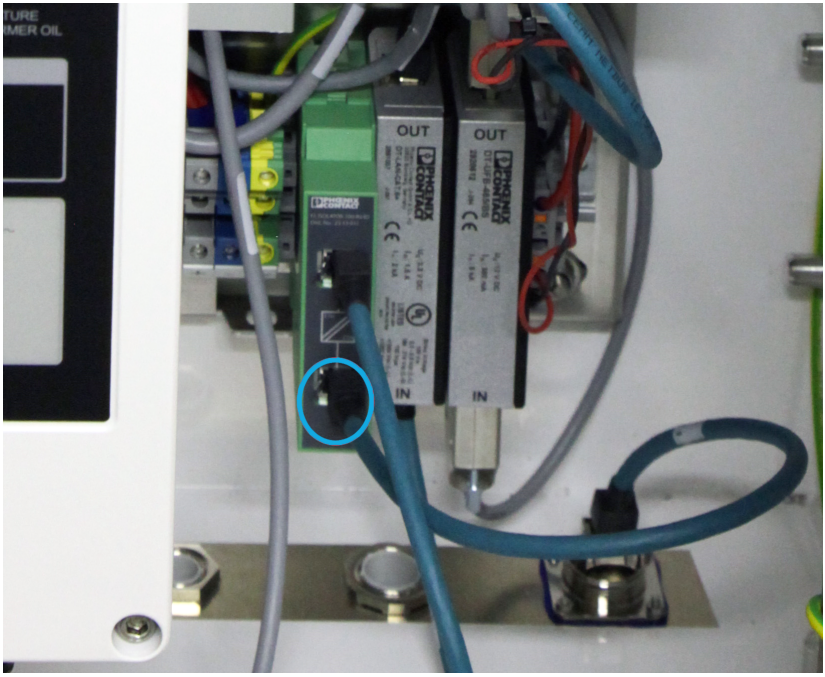
Figure 23 RJ45 connector inside the protection shell

2. Open the plug marked **Ethernet** under the DGA monitor.
3. Plug in the Ethernet cable.

4. Tighten the connector by hand.

   If you are unable to connect through the provided default port cable gland, use the green isolator port for connecting Ethernet. Replace the existing cable coming from the bottom of the DGA monitor to the port and ensure ingress protection through cable glands.

Figure 24 Alternative Ethernet connection



4.9 Connecting relays

- Relay cable with 0.14 ... 4-mm^2 (26 ... 12 AWG) conductors and 7 ... 12-mm (0.28 ... 0.47 in) external diameter for connecting external devices to the relays. Verify that the required current carrying capacity matches the specification of the cable.
- Screwdriver with 3-mm-wide (0.12-in) slotted head
- Adjustable wrench

Maximum switching current of the relays:
- 6 A (at 250 V AC)
- 2 A (at 24 V DC)
- 0.2 A (at 250 V DC)

If the diameter of your relay cable is not compatible with the cable gland marked **Relay out**, you can use either of the two cable glands marked **Spare** (diameter 5 … 10 mm (0.2 … 0.39 in)). If the **Relay out** cable gland is left unused, remember to plug it so that the cabinet remains tight.

Operation of relay outputs is available from software version 1.4.0 onwards.

1. Open the cable gland marked **Relay out** on the power supply unit. Remove the plug and store it for later use.
2. Prepare the cable for connection:
    a. Measure how much cable you need to reach from the cable gland to terminal block **X3**.
    b. Remove the outer sheath and cable braid from the part of the cable that will be left inside the power supply unit.
    c. Strip the ends of the individual wires to expose the conductors for 1 cm (0.4 in).
    d. Remove some more of the outer sheath to expose more cable braid. This part of the braid should be connected to the cable gland.
3. Insert the relay cable through the outer nut and the inner seal, and start inserting the cable through the cable gland. Stop when you reach the section of the cable where the metal braid is exposed.
4. Arrange the cable braid so that it makes contact with the cable gland when it is closed. Push the inner seal in place and tighten the outer nut.

5. Inside the power supply unit, connect the wires to terminal block **X3**. Wire the connection as **normally open (NO)** or **normally closed (NC)** according to the table below.

> Verify the wiring colors of your cable before making any connections.

Table 9 Terminal block X3 wiring

Signal	Terminal
Relay 1 NC	1
Relay 1 common	2
Relay 1 NO	3
Relay 2 NC	4
Relay 2 common	5
Relay 2 NO	6
Relay 3 NC	7
Relay 3 common	8
Relay 3 NO	9

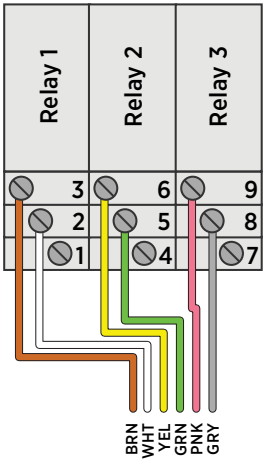


Figure 25 Terminal block X3 example wiring for normally open (NO) connection

4.10 Connecting auxiliary communication devices

CAUTION! To avoid surges to the DMU, use an isolator when connecting a data cable from the DMU to an auxiliary device that has electrical connections outside the DGA monitor.

Vaisala does not take responsibility for any disturbances to the measuring performance of Optimus DGA monitor caused by 3rd party devices.

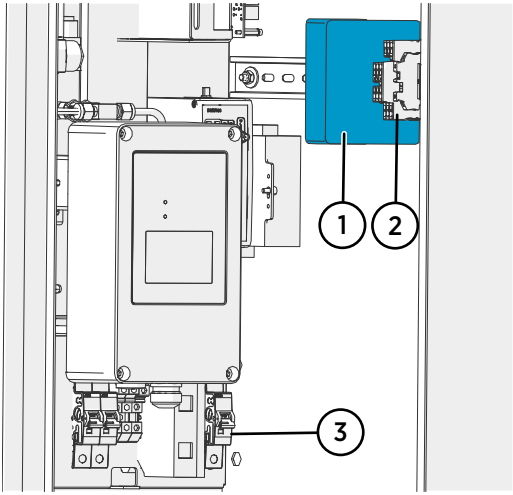
Liability for customer installed devices is not covered by Vaisala.

Only devices with 24 V DC input voltage and maximum class B electromagnetic interference (EMI) are allowed to be installed inside the DGA monitor.

Make sure the auxiliary device complies with local safety and EMC regulations.

Follow these instructions to correctly and safely connect an auxiliary connection device such as a modem or optical network unit into the DGA monitor. The maximum power rating of the auxiliary device is 48 W (2 A).

1. Install the auxiliary device into the DIN rail on the right side of the DGA monitor.



1 Auxiliary device
2 Terminal blocks (Y5)
3 Circuit breaker F3 (Y4)

Make sure the auxiliary device is not touching the existing components to avoid surges and thermal disturbances.

2. Make sure the auxiliary device is firmly in place.
3. Turn off the auxiliary device power by swiching off circuit breaker F3.

4. Connect the auxiliary device cables to terminal blocks at position Y5.

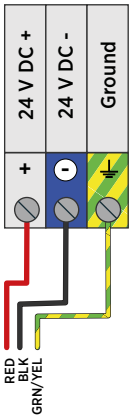


Figure 26 Terminal block Y5 wiring example

5. If you are connecting a device that has cables coming from the outside of the DGA monitor, use the free cable glands at the bottom of the DGA monitor and ground shielded cables onto the cable glands.

> **CAUTION!** Use the provided cable glands to maintain the ingress protection rating of the cabinet.

6. Turn power on from circuit breaker F3.
7. Check the correct operation of the system.
8. Tie the auxiliary device cables together with a cable tie.

4.11 Connecting mains power

- Mains power cable with 2.5-mm^2 (14 AWG) conductor and 9 ... 16-mm (0.35 ... 0.63 in) external diameter. Must be compliant with local regulations for mains power cables.
- Cable stripping tool
- Screwdriver with 3-mm-wide (0.12-in) slotted head
- Adjustable wrench

WARNING! Only licensed experts may install electrical components. They must adhere to local and state legislation and regulations.

WARNING! Make sure that you prepare and connect only de-energized wires.

WARNING! Keep away from live circuits. Operating personnel must observe safety regulations at all times.

WARNING! If the diameter of your mains power cable is not compatible with the cable gland marked **AC in** or **DC in**, you can use either of the two cable glands marked **Spare** (diameter 5 ... 10 mm (0.2 ... 0.39 in)). If you are not wiring any relay outputs, you can also use cable gland marked **Relay out** (diameter 7 ... 12 mm (0.28 ... 0.47 in)). If the **AC in** or **DC in** cable gland is left unused, remember to plug it so that the cabinet remains tight.
If the power supply unit has no suitable cable gland free, you can replace the cable gland marked **AC in** or **DC in** with a certified cable gland that is suitable for protecting the cable and providing strain relief.

1. Install needed external disconnection and overcurrent protection devices (for example, circuit breakers) for the mains power connection. Note the following:
   - The external disconnection and overcurrent protection device for AC mains power (OPTPSU1) must be rated 16 A or 20 A at 250 V AC, and must conform to any additional local regulations.
   - The external disconnection and overcurrent protection device for DC mains power (OPTPSU2) must be rated 16 A at 250 V DC and conform to any additional local regulations.

     CAUTION! External overcurrent protection device, such as a circuit breaker, must be installed to the supply side and it must be suitable for the applicable operating temperature range in order to comply with the EN 61010-1 electrical safety standard.

   - The disconnection device must be visible from the DGA monitor, or lockable with a key to prevent accidental switching on during installation and maintenance.
   - The DGA monitor should not block access to the disconnection device after it has been installed. The disconnection device should remain easy to operate.

2. Clearly mark the disconnection device as the disconnection device for the OPT100 Optimus DGA Monitor.
3. Make sure the external disconnection device is turned off. If possible, lock it in the off position.
4. Run the AC or DC cable between the external disconnection device and the power supply unit of the DGA monitor.
5. Connect the AC or DC cable to the external disconnection device.
6. Open the cable gland marked **AC in** or **DC in** on the power supply unit. Remove the plug and store it for later use.
7. Prepare the cable for connection to the power supply unit:
   a. Strip 14 cm (5.51 in) of the cable to expose the wires.
   b. Cut off 2 cm (0.79 in) of the line and neutral wires (brown and blue). Leave the green and yellow grounding wire 14 cm (5.51 in) long.

      CAUTION! Make sure that the grounding wire is longer than the line and neutral wires. Under mechanical stress, the grounding wire must be the last to disconnect from the protective ground terminal.

   c. Strip the ends of the individual wires to expose the conductors for 1 cm (0.4 in).
8. Insert the cable through the outer nut and the inner seal.
9. Start inserting the cable through the cable gland, and stop when the unstripped cable is visible through the gland.

10. Inside the power supply unit, connect the wires to terminal block **X1**:

    a. Connecting OPTPSU1 (AC):

> **CAUTION!** Line and neutral **must** be connected to the correct terminals or surge protection of the DGA monitor will not function appropriately. If you are uncertain which wire is line and which is neutral, make sure by measuring their potential with respect to ground.

Table 10 Terminal block X1 wiring

Signal	Wire color	Terminal
Line	Brown	L
Neutral	Blue	N
Ground	Green/yellow	⏚

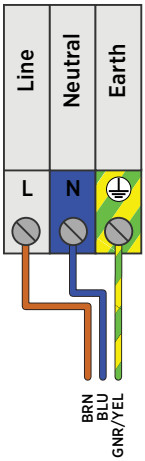


Figure 27 Terminal block X1 wiring for OPTPSU1 (AC)

    b. Connecting OPTPSU2 (DC):

> **CAUTION!** Positive and negative **must** be connected to the correct terminals or surge protection of the DGA monitor will not function appropriately. If you are uncertain which wire is positive and which is negative, make sure by measuring their potential with respect to ground.

Table 11 Terminal block X1 wiring

Signal	Wire color	Terminal
Positive	Brown	+
Negative	Blue	-
Ground	Green/yellow	⏚

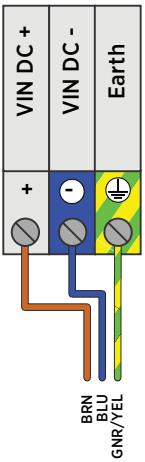


Figure 28 Terminal block X1 wiring for OPTPSU2 (DC)

11. Tighten the **AC in** or **DC in** cable gland. The cable gland is also the strain relief for the cable, so make sure the gland holds the cable tight.

4.12 Verifying tightness of cable glands

- Adjustable wrench

To maintain cabinet tightness and provide strain relief to the cables, all cable glands on the DGA monitor and the power supply unit must be tightened. Unused cable glands must remain plugged.

1. Check every cable gland that is in use:
   a. Pull on the cable slightly to verify that the cable is securely held by the cable gland.
   b. Tighten the cable gland if the cable moves easily.

2. Check that every unused cable gland is plugged and tightened.

5. Commissioning

5.1 Turning on DGA monitor

CAUTION! Verify that the DGA monitor is correctly wired and grounded before turning it on.

CAUTION! If the circuit breakers will not stay in the ON position, turn off Mains power to the DGA monitor immediately and inspect the Mains and OPTPSU power wiring. The circuit breakers may be tripping because of a loose wire or incorrect connection.

1. Verify that the circuit breakers **Main** and **Heat** inside the DGA monitor are turned on.
2. Turn on Mains power from the external disconnection device.
3. Turn on the circuit breaker **F1 Main** and switch **S1** inside the power supply unit.
4. Check the **DC OK** LED on the power supply:
   - If the LED is lit solid green, OPTPSU power to the DGA monitor is successfully turned on.
   - If the LED keeps blinking, it is likely that the 24 V DC connection to DGA monitor is wired incorrectly. Turn off switch **S1** and Mains power, and correct the problem before attempting to power on the DGA monitor again.

5.2 Connecting to user interface

- Laptop computer with:
  - RJ45 Ethernet connector
  - Web browser (Google Chrome, Microsoft Edge, or Mozilla Firefox)
- Ethernet cable with RJ45 connectors for temporary use
- Administration password for this DGA Monitor

1. Connect your computer to the same network as the DGA monitor. If you are connecting locally, connect the network cable between your computer and the port marked **ETH1** on the processing unit inside the DGA monitor.

2. Open a web browser, and enter the IP address of the DGA monitor in the address bar:
   - If you connect locally through the ETH1 port, use the following IP address: **192.168.28.2**
   - If you connect through the network meant for SCADA integration, use the IP address that has been assigned to the DGA monitor.
3. You will get a warning that your connection is not secure. This is expected and happens when connecting with a new device. The user interface of the DGA monitor is secured with a self-signed certificate by default. Continue despite the warning. HTTPS traffic is always encrypted even if the certificate is not trusted.
4. Select **Admin** as the user name.
5. Enter the unique administration password for this DGA monitor. The password is included in the delivery documentation.
6. Select **Log in**.

5.3 Changing administrator password

CAUTION! If you forget your administrator password, contact Vaisala Support to reset it for you.

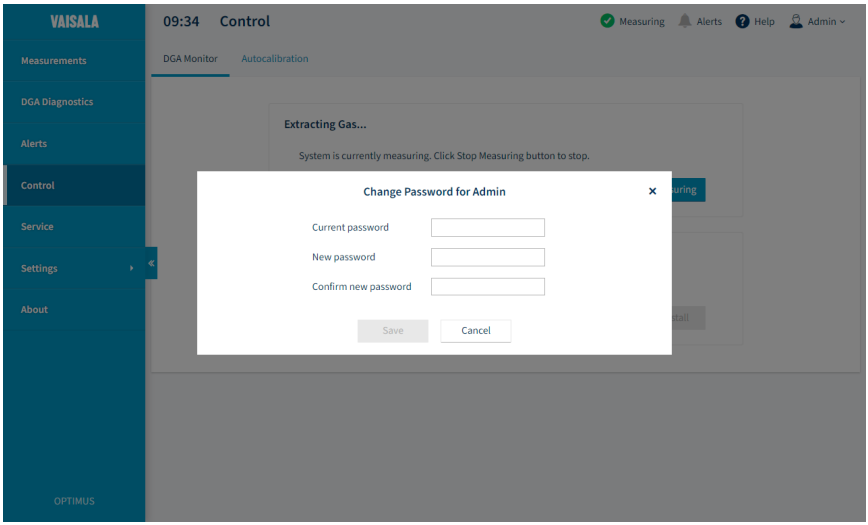
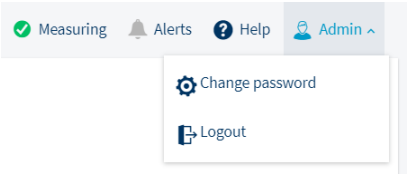


Figure 29 Changing administrator password

1. In the top right corner, select **Admin > Change password**.



2. Enter the current password in **Current password**.
3. Enter the new password in **New password** and **Confirm new password**.

   The new password must be at least 8 characters long.
4. Select **Save**.

5.4 Configuring network connection

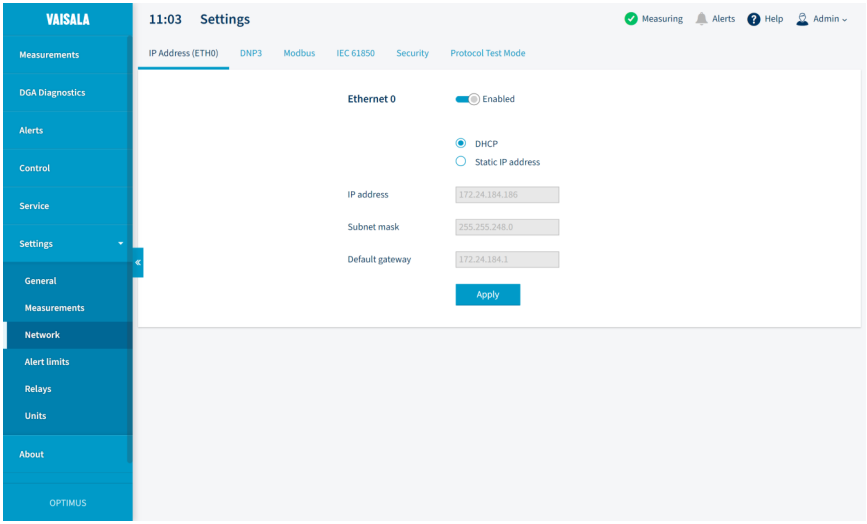


Figure 30 IP address settings page

Configure the network settings of the external Ethernet connection (ETH0).

1. In the user interface, select **Settings > Network > IP address**.
2. Select if the external Ethernet connection should be **Enabled** or **Disabled**.

3. If you enabled the external Ethernet connection, select how its IP address is assigned: **DHCP** for automatic assignment, or **Static IP address** to enter the values manually.
4. If you selected **Static IP address**, enter the following values:
   - **IP address**
   - **Subnet mask**
   - **Default gateway**

> IP addresses in 192.168.28.0/24 cannot be used for the external network connection (ETH0) since they are reserved for the service port (ETH1).

5. Select **Apply** to save your changes.

5.5 Configuring user interface security

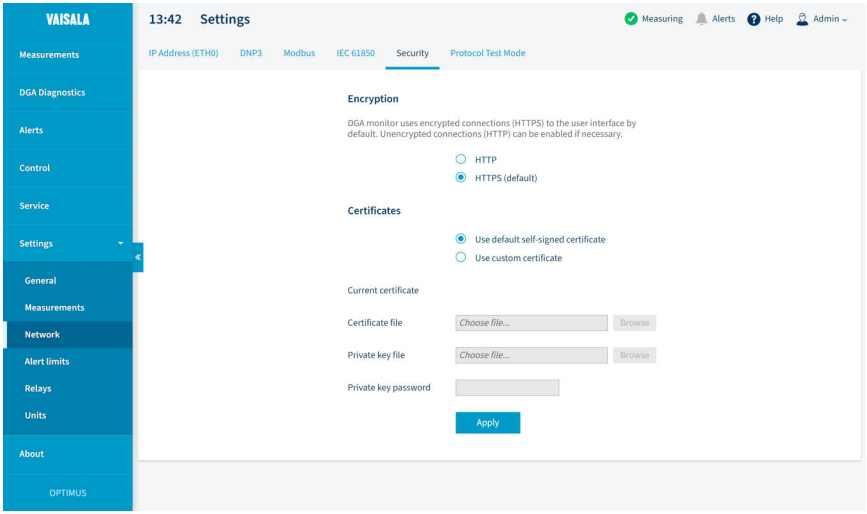


Figure 31 Network security settings page

Configure HTTPS encryption for the user interface connection. By default, DGA monitor only allows encrypted connections to the user interface (HTTPS) using a self-signed certificate. Any connections that request unencrypted communication (HTTP) are redirected to the encrypted interface (HTTPS).

The default self-signed certificate is not trusted by connecting web browsers and will give a warning that the connection is not secure. To remove the notification, install a trusted TLS certificate (TLS 1.1 or 1.2) on the DGA monitor. However, note that HTTPS traffic is always encrypted even if the certificate is not trusted. Vaisala recommends using encrypted connections (HTTPS).

1. In the user interface, select **Settings > Network > Security**.
2. Select **HTTP** to use unencrypted user interface connections, or **HTTPS (default)** to secure the interface using encryption.
3. To use your own certificate with HTTPS connections:
   a. Select **Upload certificate**.
   b. Select **Certificate file > Browse** and locate the certificate file.
   c. Select **Private key file > Browse** and locate the private key file.
   d. Enter the **Private key password** if your private key requires it.
4. Select **Apply** to save your changes.

If you change the security settings, the user interface will restart and you have to log in again.

5.6 Setting device name

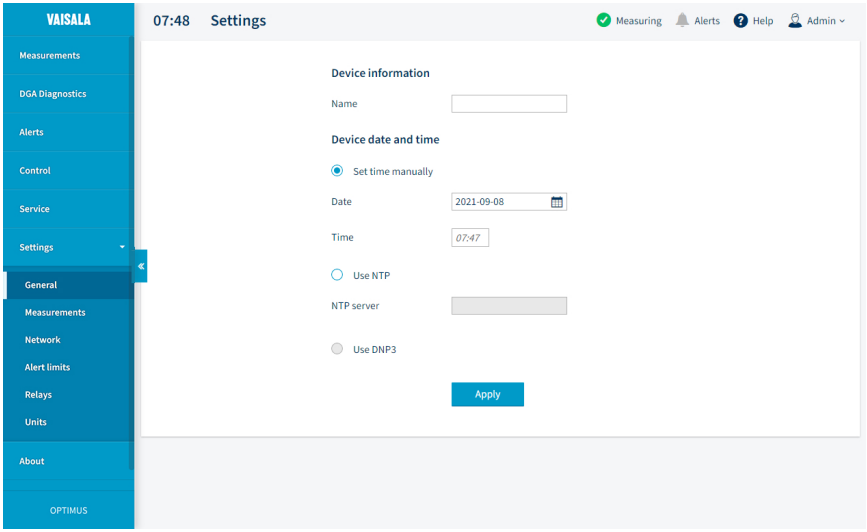


Figure 32 General settings page

You can give a name to the DGA monitor to help identify it. If the name is set, it is shown in:

- Login page
- Above the Optimus text in the navigation menu
- Names of files downloaded from the user interface

1. In the user interface, select **Settings > General**.
2. Enter a name for the device into **Name**. Maximum length is 64 characters. You can use alphanumerical characters, space, hyphen "-", and underscore "_".
3. Select **Apply** to save the name.

5.7 Setting date and time

CAUTION! When the DGA monitor is shipped from the Vaisala factory, its real-time clock (RTC) is stopped to allow for storage without draining the RTC back-up battery. Set date and time when starting the commissioning.

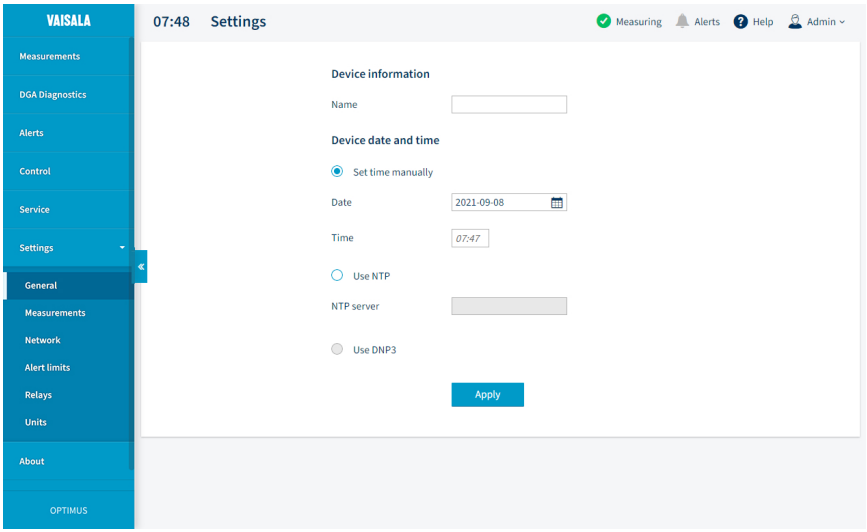


Figure 33 Date and time settings page

DGA monitor uses UTC (Coordinated Universal Time) internally. Time and time stamps in the user interface are shown according to the time zone of the connecting web browser.

1. In the user interface, select **Settings > General**.
2. To set date and time manually:
   a. Select **Set time manually**.
   b. Select or enter the current date into **Date**. The format is yyyy-mm-dd.
   c. Enter the current time into **Time**. The field is in 24-hour clock notation in format hh:mm.
   d. Select **Apply** to save the set time.

3. To set up time synchronization with a Network Time Protocol (NTP) server:

   NTP synchronization requires that the network connection is configured and the IP address of the NTP server is reachable.

   a. Select **Use NTP**.
   b. Enter the IP address of the NTP server into **NTP server**.
   c. Select **Apply** to start time synchronization.

      Status of time synchronization is shown below the **NTP server** field. If the status shows **Connecting...** and does not progress to **Synchronizing time...** even after waiting for a minute, verify that the network connection is working and configured, and the IP address of the NTP server is correctly entered.

   d. Wait for the message **Time successfully synchronized** to appear.
4. To set up time synchronization using DNP3 protocol:
   a. Enable and configure the DN3 protocol.
   b. Select **Use DNP3**.
   c. Select **Apply** to start time synchronization.

More information

- Configuring DNP3 protocol (page 77)

5.8 Initializing DGA monitor

- 5-mm Allen key

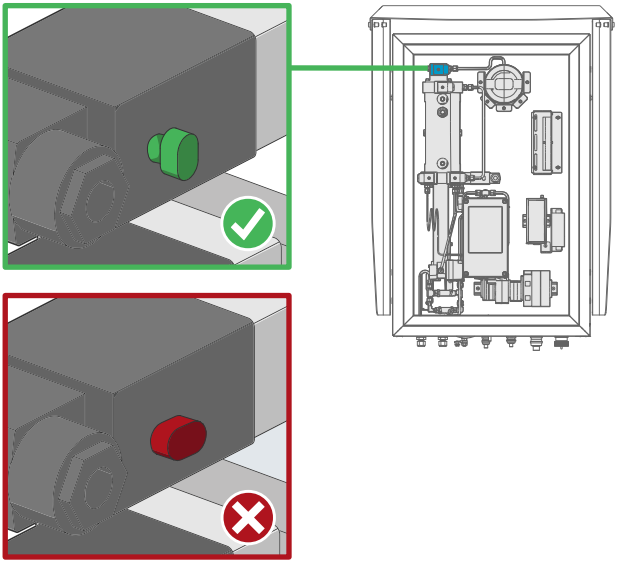
Before starting the initialization, make sure that:

- DGA monitor is fully installed and wired.
- All oil connections are completed.
- DGA monitor is turned on.
- You are connected to the user interface with a web browser.

You must have physical access to the DGA monitor cabinet and the oil valves on the transformer. Do not try to perform the initialization remotely.
You can stop the initialization sequence at most phases by selecting **Control > Cancel**.

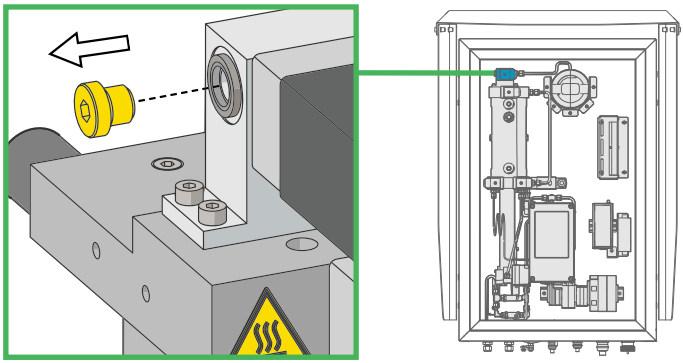
While waiting between the initialization steps, you can navigate away from the **Control** page and access the other pages (for example, to perform system configuration tasks). Remember to come back to the **Control** page to complete the initialization.

1. In the user interface, select **Control**.
2. Read the instructions on screen and verify that DGA monitor is waiting to be initialized.
3. Select **Start** to start the initialization sequence.
4. Turn the gray knob on the side of the bleed valve 90° counterclockwise to open the manual override lock. The knob pops outward when the lock is open. Select **OK** when done.

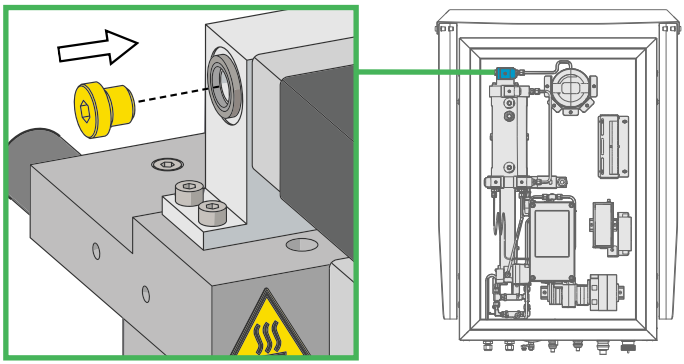


The initialization sequence performs a test to verify that the manual lock on the bleed valve is now open. In rare cases, it is possible for the test to fail even if the lock has been opened. If the test fails, you can choose to skip the test and proceed with the initialization. Skip the test only if you are certain the lock is open.

5. Remove the bleed plug from the bleed valve using the 5-mm Allen key. It does not take many rotations to remove so be careful not to drop it. Select **OK** when done.



6. Open the oil intake and return valves on the transformer and select **OK** .
7. Wait for the DGA monitor to fill with oil. Oil pressure from the transformer is used in the beginning of the filling, and assisted using the oil pump of the DGA monitor in the later stage. Typical duration of this step is 30 ... 60 minutes, depending on oil pressure, viscosity, temperature, and length of the oil lines.
8. When instructed to do so, reattach the bleed plug to the bleed valve. Select **Continue** when done.



9. When the user interface informs that the initialization is complete, select **OK**. DGA monitor is now in standby, waiting for you to start the measurement.

5.9 Configuring autocalibration

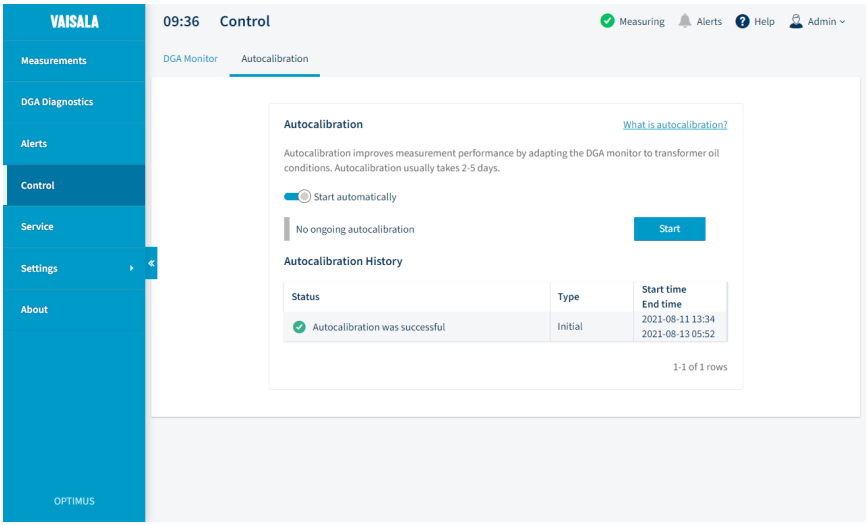


Figure 34 Autocalibration page

Starting with software version 1.11.0, the DGA monitor performs autocalibration when needed and when environmental conditions are suitable. Vaisala recommends leaving this feature enabled, but **Admin** user can disable it from the **Autocalibration** page.

Even if the automatically started autocalibration is disabled, the initial autocalibration will still run after the DGA monitor has been initialized. Autocalibration can also be manually started.

1. In the user interface, select **Control > Autocalibration**.
2. Configure the setting with the switch:
   - Disable automatically started autocalibration by moving the switch to the left.
   - Enable automatically started autocalibration by setting the switch to position **Start automatically**.

5.10 Configuring Modbus protocol

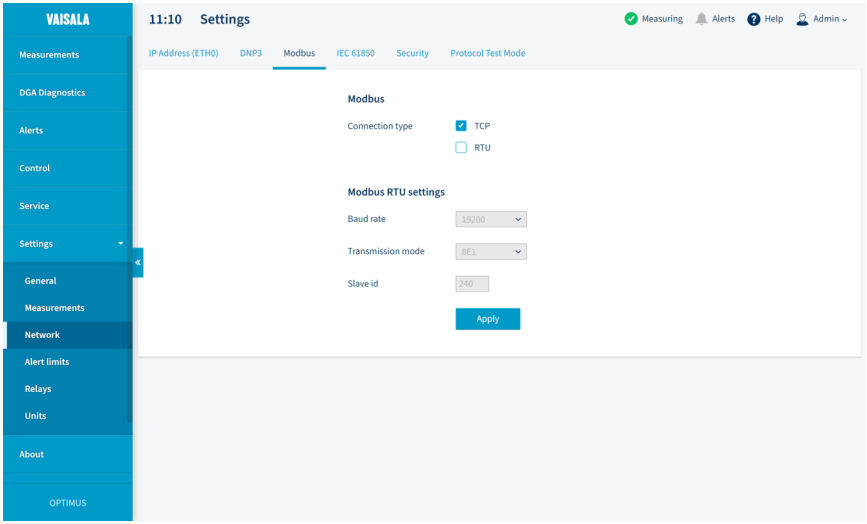


Figure 35 Modbus settings page

1. In the user interface, select **Settings > Network > Modbus**.
2. Select the connection type(s) for which Modbus protocol should be enabled. Select **TCP** (Ethernet), **RTU** (serial line), or both.
3. If you enabled Modbus RTU, configure the serial connection:
   a. Select **Baud rate** for the connection. Available options are:
      - 4800
      - 9600
      - 19200
      - 38400
      - 57600
      - 115200
   b. Select **Transmission mode**, 8E1 or 8N2.
   c. Enter the Modbus **Slave ID** for the DGA monitor. Range 1 ... 247.
4. Click **Apply** to save your changes.

5.11 Configuring DNP3 protocol

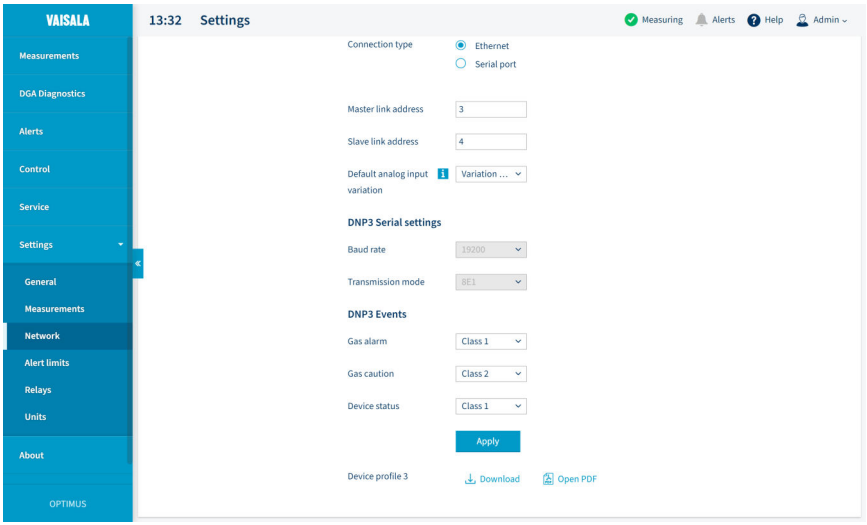


Figure 36 DNP3 settings page

DNP3 protocol is an optional feature and requires a license. If a license is not installed on the DGA monitor, you cannot enable the protocol. Contact Vaisala for acquiring the license.

1. In the user interface, select **Settings > Network > DNP3**.
2. Select if the DNP3 protocol should be **Enabled** or **Disabled**.
3. If you enabled the DNP3 protocol, configure the following settings:

   Connection type
   Interface where DNP3 protocol will be available.

   Slave link address
   Address of this DGA monitor.

   Master link address
   Address of the DNP3 master.

   Default analog input variation
   Data format variation for analog input values. Variations 1 ... 6 are available.

4. If you selected **Serial port** as the connection type, configure the following settings:

   Baud rate
   Baud rate of the serial connection. Available options are 4800, 9600, 19200, 38400, 57600, and 115200.

   Transmission mode
   Number of data bits, parity, and number of stop bits used in serial communication. Available options are 8E1 and 8N2.

5. Set the classes used for the **Gas alarm**, **Gas caution**, and **Device status** events.
6. Select **Apply** to save your changes.

Select **Download** to download the DGA monitor device profile in XML format. It is needed to configure your DNP3 master system.

5.12 Configuring IEC 61850 protocol

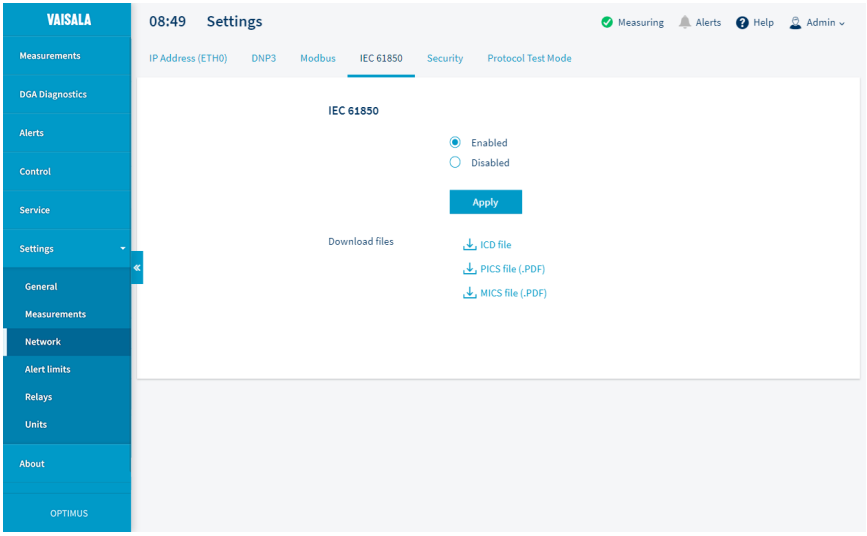


Figure 37 IEC 61850 settings page

IEC 61850 protocol is an optional feature and requires a license. If a license is not installed on the DGA monitor, you cannot enable the protocol. Contact Vaisala for acquiring the license.

1. In the user interface, select **Settings > Network > IEC 61850**.
2. Select if the IEC 61850 protocol should be **Enabled** or **Disabled**.
3. Select **Apply** to save your changes.

Download the following supporting documents from this page:
- IED Capability Description (ICD) file
- Protocol Implementation Conformance Statement (PICS)
- Model Implementation Conformance Statement (MICS)

5.13 Using protocol test mode

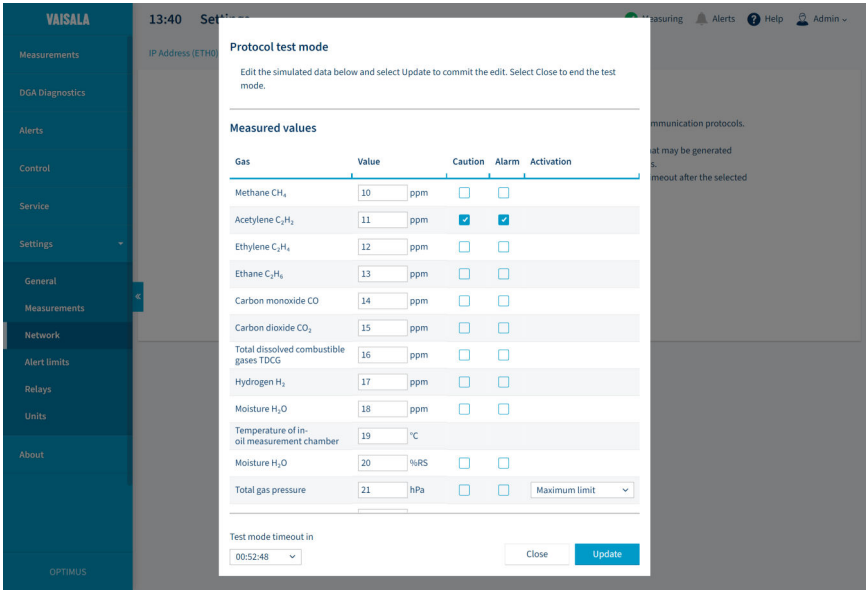


Figure 38 Protocol test mode enabled

1. In the user interface, select **Settings > Network > Protocol Test Mode**.
2. Check the status of the protocols listed under **Protocols**. Make sure the protocols you want are enabled. If they are not, you must enable and configure them first before continuing this procedure.

3. Select **Start** to enable the protocol test mode and open the protocol test mode page.

> The page is preconfigured with arbitrary default values for measurement parameters. The values are all different to make it easy to verify on the SCADA side that the correct parameter is being read and displayed. Scroll the page to reveal all of the fields.

4. To set your own test data:
   a. Edit the values as required.
   b. Check the checkboxes to enable the desired caution and warning level alerts.
   c. Select **Update** at the bottom of the page to take the new test data into use.
5. The test mode will end automatically after one hour. You can select a longer timeout from the drop-down menu marked **Test mode timeout in**. Select **Update** to take the new timeout into use.
6. Start testing by reading information from the DGA monitor from the SCADA system side.
7. When you are done testing, select **Close** to end the test mode immediately or wait until the end of the timeout.

5.14 Configuring gas level alerts

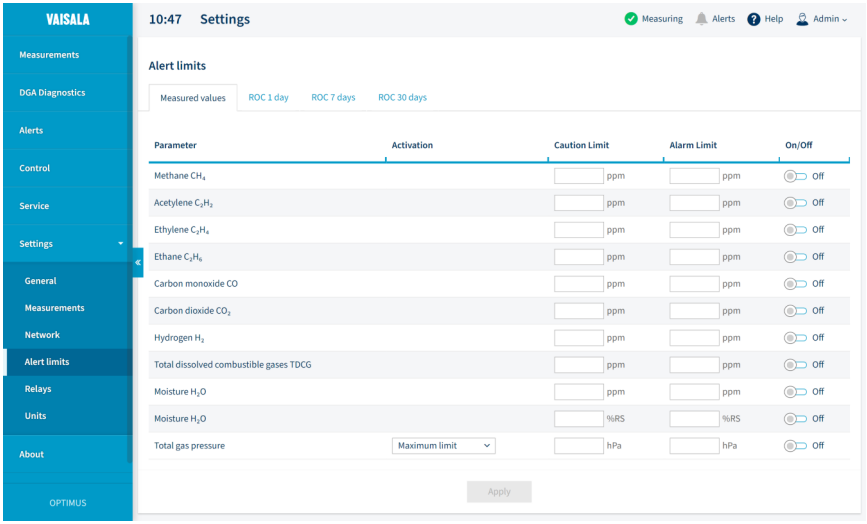


Figure 39 Alert limits settings page

Configure gas level alerts on the **Alert limits** settings page. There are separate rows for each individual gas level alert. Alerts for rate of change (ROC) values are on their own tabs. By default, all gas level alerts are off.

See OPT100 User Guide (M211858EN) for details.

1. In the user interface, select **Settings > Alert limits**.
2. For each alert you want to configure:
   a. Change to the tab that shows the alert you want to configure.
   b. Enter the **Caution Limit** in ppm. This is the limit that triggers a gas alert with caution severity.
   c. Enter the **Alarm Limit**. Alarm limit should be higher than the caution limit, except when configuring a minimum limit alert for total gas pressure (TGP).
   d. If the alert is for the total gas pressure (TGP) value, select if you want the limit value to be a **maximum limit** (alert active when value is above the limit) or a **minimum limit** (alert active when value is below the limit).
   e. Set the alert to **On** to enable it.

   It is possible to have only caution or alarm severity active. If you leave a limit value empty or enter a zero, the corresponding severity will not be active for that gas level alert.
3. Select **Apply** to take the new alert limit settings into use.

Changing gas alert settings will not immediately activate any new alerts. Gas alert status is updated only when the next measurement cycle results set is ready.

5.15 Configuring unit settings

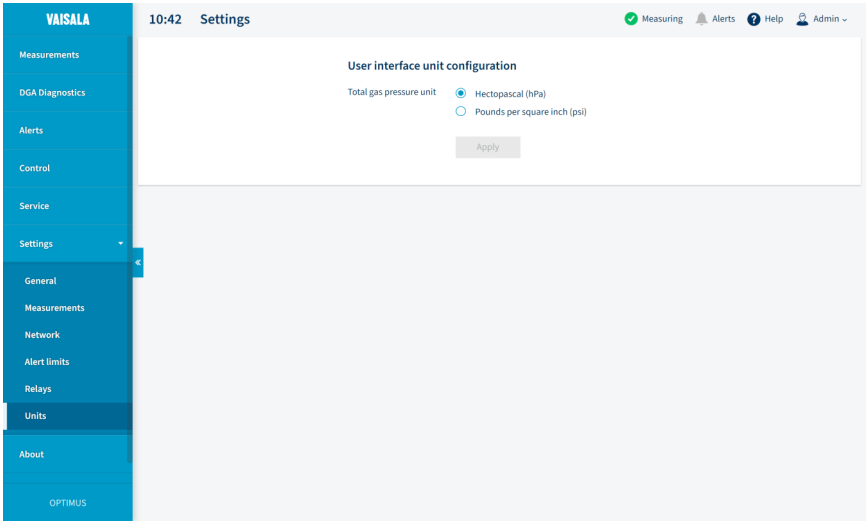


Figure 40 Unit settings page

1. In the user interface, select **Settings > Units**.
2. Select the preferred unit to use for total gas pressure (hPa or psi). This selection only affects the viewing of the user interface and the downloading of data from the **Latest values** page.
3. Select **Apply** to save the selection.

5.16 Configuring relays

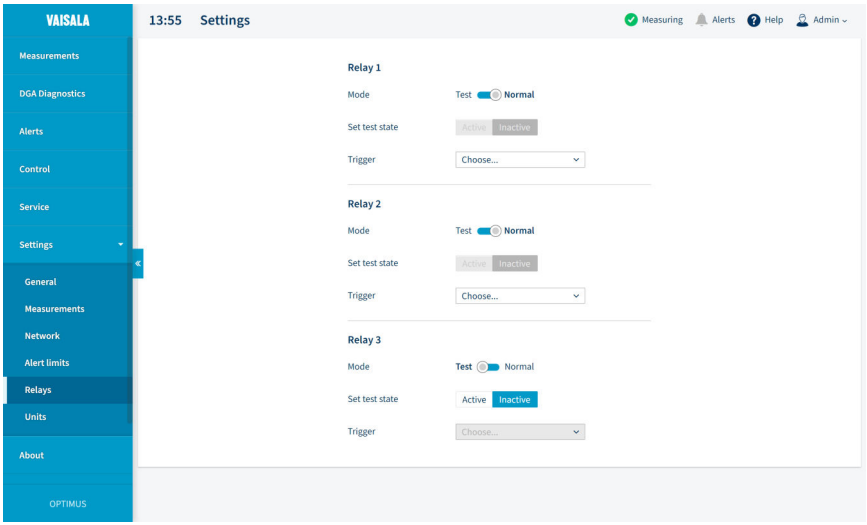


Figure 41 Relay settings page

1. In the user interface, select **Settings > Relays**.
2. Each of the three relays is configured individually. For each relay:
   a. Select relay **Mode**:
      - In **Normal** mode, the relay is activated by the selected **Trigger**.
      - In **Test** mode, the relay activation is controlled manually from the **Set test state** buttons.

      If the relay is not used, select the **Test** mode. You can also use it to test that wiring has been connected correctly.
   b. Select relay **Trigger**:
      - **Gas Caution** activates the relay if any gas level alert of **caution** severity is active.
      - **Gas Alarm** activates the relay if any gas level alert of **alarm** severity is active.
      - **Device Error** activates the relay if a device error is active.

   Settings are applied immediately.

5.17 Starting measurement

In normal operation DGA monitor repeats the measurement cycle continuously. You can only start the measurement if DGA monitor is currently in standby.

1. Start measurement from **Control > Start Measuring**.

> Since this is the first time measurement is started after initialization, the DGA monitor will perform autocalibration. Autocalibration improves measurement performance by adapting the DGA monitor to transformer oil conditions. After autocalibration, DGA monitor continues to measure normally. Autocalibration takes from 2 to 5 days depending on conditions. Measurements performed during autocalibration do not meet the accuracy and repeatability specifications and they should not be used for transformer diagnostics.

2. Wait for the first measurement cycle to complete. Depending on the starting conditions, it may take up to 90 minutes. Verify that there are no oil leaks in the oil pipes or inside DGA monitor.

5.18 Finalizing installation

1. If you have connected DGA monitor to a host system using Ethernet or RS-485 connections, verify the availability of measurement data from the host system.
2. Verify that you have performed all installation steps according to the configuration report.
3. Before leaving the installation site, perform a safety check and lock up according to the post-installation checklist.

> Keep the doors closed and locked when not actively working inside the enclosures or accessing the service port locally. Keeping the DGA monitor door closed when performing measurement is important for temperature management of measurement components.

More information

- DGA monitor configuration report (page 87)
- Post-installation checklist (page 89)

6. Installation report

6.1 Site and device information

Site information	
Company	
Contact information	
Substation name and address	
Date(s) of visit	
Transformer ID	

Site information	
Scope of work	

Device information	
DGA monitor model	
DGA monitor serial number	
Mounting type	
Oil line type and size	

Device information	
Oil inlet valve location	
Oil return valve location	
Other information	

6.2 DGA monitor configuration report

Table 12 Wiring

Item	Yes	No	Comment
Instrument power cable installed between DGA monitor and power supply unit	☐	☐	
Relay control cable installed between DGA monitor and power supply unit	☐	☐	
Devices connected to relays in power supply unit	☐	☐	

Item	Yes	No	Comment
RS-485 cable connected	☐	☐	
Ethernet cable connected	☐	☐	

Table 13 Configuration

Item	Yes	No	Comment
Date and time set	☐	☐	
Admin password changed	☐	☐	
Device name configured	☐	☐	
Ethernet connection configured	☐	☐	
User interface security configured	☐	☐	
Autocalibration configured	☐	☐	
IEC 61850 protocol configured and enabled	☐	☐	
DNP3 protocol configured and enabled	☐	☐	
Modbus protocol configured and enabled	☐	☐	

Item	Yes	No	Comment
Unit settings configured	☐	☐	
Relays configured and enabled	☐	☐	
Gas level alerts configured and enabled	☐	☐	

6.3 Post-installation checklist

Verify items in this checklist after you have completed all installation steps.
Table 14 Post-installation checklist

Item	Yes	No	Comment
Mechanical installation stable and secure	☐	☐	
DGA monitor is installed vertically and not tilted more than 5 degrees	☐	☐	
Mains power connection and protective grounding verified	☐	☐	
All unused cable glands blocked and cable glands tightened	☐	☐	
Operation of relays tested	☐	☐	
Oil pipe connections checked for leaks	☐	☐	

Item	Yes	No	Comment
Initialization completed successfully	☐	☐	
DGA monitor powered on and in measurement mode (not standby)	☐	☐	
No errors active in user interface	☐	☐	
Status LED on DGA monitor door is green	☐	☐	
Bleed plug in place on the bleed valve	☐	☐	
Connection to DGA monitor verified from SCADA system	☐	☐	
DGA monitor cabinet closed and locked with all three locks	☐	☐	
Power supply unit cabinet closed and locked	☐	☐	

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Maintenance and calibration services

Vaisala offers comprehensive customer care throughout the life cycle of our measurement instruments and systems. Our factory services are provided worldwide with fast deliveries. For more information, see www.vaisala.com/calibration.

- Vaisala Online Store at store.vaisala.com is available for most countries. You can browse the offering by product model and order the right accessories, spare parts, or maintenance and calibration services.
- To contact your local maintenance and calibration expert, see www.vaisala.com/contactus.

Technical support

Contact Vaisala technical support at helpdesk@vaisala.com. Provide at least the following supporting information as applicable:

- Product name, model, and serial number
- Software/Firmware version
- Name and location of the installation site
- Name and contact information of a technical person who can provide further information on the problem

For more information, see www.vaisala.com/support.

Warranty

For standard warranty terms and conditions, see www.vaisala.com/warranty.
Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

Recycling

Recycle all applicable material according to local regulations.

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