M211857EN-A

# Installation Guide

Vaisala Optimus<sup>™</sup> DGA Monitor for Transformers OPT100





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# **1. About This Document**

# 1.1 Version Information

## Table 1 Document Versions

Document Code	Date	Description
M211857EN-A	-	First version.

OPT100 Installation Guide

# 2. Planning The Installation

# 2.1 Installation Safety



**WARNING!** Read the installation instructions carefully before installing the product. If you encounter the following marking during installation, 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 only de-energized wires.



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



**WARNING!** Ground the DGA monitor chassis 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 the DGA monitor that are marked with the symbol below heat up during normal operation. Avoid touching the hot surfaces and wear protective gloves when working inside the enclosure. Whenever possible, allow the device 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
- Commisioning
- Installation verification

These phases correspond to chapters of the Installation Guide. As part of the final installation verification phase, use the provided installation checklists to make sure you have done all of the required installation steps.

# 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 enclosure
  - Swagelok<sup>®</sup> fitting SS-10M0-61-6M (2 pcs)
  - Protection shell for Ethernet connector
  - Relay control cable (marked **RELAY**, Vaisala cable CBL210539)
  - Enclosure key
- Power Supply Unit (Vaisala item OPT100PSU)
  - Power Supply Unit enclosure
  - DC power cable (Vaisala cable CBL210544)
  - Enclosure 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
- Radiation Shield (Vaisala item OPTSHLD1)
  - Radiation shield (delivered in three parts)
  - Screws and washers

## DGA Monitor Installation and Commissioning

- Grounding cable with max 16 mm<sup>2</sup> conductor. Enough to reach from the DGA monitor and the power supply unit to the grounding point(s).
- AC power cable with 2.5 mm<sup>2</sup> (AWG10) wires and 9 ... 16 mm external diameter. Must be compliant with local regulations for mains power cables.
- Relay cable
- RS-485 cable

- Shielded outdoor Ethernet cable with a RJ-45 connector for the permanent Ethernet connection
- Laptop computer with:
  - RJ-45 Ethernet connector
- Web browser (Google Chrome, Microsoft Internet Explorer, or Mozilla Firefox)
- Ethernet cable with RJ-45 connectors for temporary use

#### **Oil Pipe Construction**

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 pipe with 10 mm (0.393 in) outer diameter, at least 6 mm (0.24 in) inner diameter. Enough to connect the inlet and outlet 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 recommended oil pipe size). For 3/8 inch pipe, use Swagelok<sup>®</sup> adapter SS-600-R-10M.
- Pipe fittings for joining pipe sections
- Pipe supports
- Oil pipe insulation (if necessary)
- · Oil absorption material for controlling possible leaks
- Rags for wiping off oil

#### Other

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

# 2.5 Recommended Tools

#### Hand Tools

- Screwdrivers with slotted and Phillips heads
- Wrenches of various sizes
- Socket wrench and socket set
- Hex keys
- Cutting tools
- Cable stripping tool
- Metal file
- Measuring tape
- Impact drill and bits
- Bubble level
- Multimeter

## **Tools for Oil Pipe Construction**

• Pipe bending tool

- Pipe cutting tool
- Pipe deburring tool
- Pressurized air, either a bottle or a compressor
- Degreasing cleaning spray
- Container for waste oil (at least 5 liter capacity)

# 2.6 Storing and Transporting the 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. Honor any handling instructions marked on the outside of the packaging.

After installation, store the packaging in a dry place. You can reuse it if the DGA monitor is stored and/or transported again.

## 2.7 Preparations for Reinstalling a 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* for details.

# 2.8 Installation Site Requirements

DGA monitor can be installed and successfully operated in a wide variety of environments. Operation in cold environments may require trace heating elements and thermal insulation to be placed over the exposed sections of the oil pipes. 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

The 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 will be used to install the DGA monitor, 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 Recommended Locations of Oil Connections

You must build two oil lines between the DGA monitor and the transformer: one for intake of fresh oil, and an outlet line for returning the measured oil. 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). The location of oil connections on the transformer impacts the performance of the DGA monitor.



Figure 1 Possible Locations of Oil Connections

- 1 Oil reservoir. Not recommended.
- 2 Side of the oil tank, top level. Good for returning the measured oil.
- 3 Side of the oil tank, high enough from the bottom to enable proper oil movement. Good for oil intake. Moisture response time is moderate depending on the oil volume.
- 4 Straight section in the radiator's outlet pipe. Good location if the pipe has guaranteed oil flow.

Oil flow guarantees that the sampled oil is representative, and the cooling flow carries the outlet oil from the monitor away from the inlet. Compared to the radiator inlet pipe, oil in the outlet pipe is cooler, preventing unnecessary heating of the DGA monitor.

5 Drain valve of the oil tank. Not recommended. Measurement response time is poor due to static oil flow. There is also risk of separated water (leading to wrong results) and oil sludge (risk of sensor contamination and clogged filter).



DGA monitor needs to pump oil in both directions during initialization and maintenance. To make sure this is possible, check that:

- Intake and outlet valves are both **below oil level** in the transformer. There should be no risk of drawing gas into the pipes even when the flow is reversed.
- There are no flow direction control valves on the oil lines.

# **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 place it on a stable surface with the door pointing up.

**CAUTION!** The cable glands and oil connections of the DGA monitor are located on the bottom of the enclosure. 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.

# 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 hex 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.
- 3. Drill holes for the anchors using an impact drill and an 8 mm drill bit. The holes must be 60 mm deep.
- 4. Install the anchors in the holes.
- 5. Verify that the mounting stand is securely anchored.
- 6. Attach the mounting stand to the anchors.

- 7. Attach the DGA monitor to the top of the mounting stand.
- 8. Tighten the screws to 20 Nm tightness.



## 3.2.1 OPT100 Parts with Ground Mounting Set

Mounting stand

Status LEDs

Door lock

**OPT100 DGA Monitor** 

Door lock (3 pcs)

Power Supply Unit



# Figure 4 OPT100 Rear Parts with Ground Mounting Set

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

## 3.2.2 OPT100 Dimensions with Ground Mounting Set

Dimensions are in millimeters and inches (in brackets).



Figure 5 OPT100 Dimensions with Ground Mounting Set

# 3.3 Mounting with Wall Mounting Set

- X
- Wall Mounting Set (Vaisala item OPTMSET1)
  - Installation beam (2 pcs)
  - Cradle for Power Supply Unit
  - Screws and washers
- 6 mm hex key
- 1. Attach one of the installation beams to the mounting location, at a height where you want the top of the OPT100 enclosure 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 enclosure (four screws in total). Tighten them enough to safely bear the weight of the enclosure 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 enclosure up and hang it from installation beams by the screws. If the lower installation beam is not at the correct height, reattach it at the correct height before attempting this step again.
  - 5. Tighten the four screws to secure the enclosure in place.

6. Add a second screw (with washer) below each of the installed screws, and tighten them.

The enclosure is now secured to the installation beams by a total of eight screws. The second set of mounting holes at the ends of the installation beam is used to secure the radiation shield. They should remain free at this point.



## 3.3.1 OPT100 Parts with Wall Mounting Set



## Figure 6 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 7 OPT100 Rear Parts with Wall Mounting Set

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

# 3.4 Installing the 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 recommended oil pipe size). For 3/8 inch pipe, use Swagelok<sup>®</sup> adapter SS-600-R-10M.
  - Recommended oil pipe material: stainless steel pipe with 10 mm (0.393 in) outer diameter, at least 6 mm (0.24 in) inner diameter. Enough to connect the inlet and outlet 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
  - Degreasing cleaning spray
  - Wrenches of various sizes
  - Container for waste oil (at least 5 liter capacity)



**CAUTION!** When working with oil pipes and connectors, keep everything clean and off the ground. Dirty parts may contaminate the transformer oil or cause connections to leak.



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. See 3.5 Attaching the Power Supply Unit (page 24).



Wear protective eyewear and gloves.

If you are unsure which valves on the transformer to use for oil intake and return, see 2.8.2 Recommended Locations of Oil Connections (page 13).

- Inspect the selected oil valves on the transformer. If there are any flow direction control
  valves previously installed, remove them. The DGA monitor needs to pump oil in both
  directions during initialization, and this will not work if there are flow direction
  controllers in the oil lines.
- 2. Clean the oil valves on the transformer from the outside and the inside. Use the degreasing cleaning spray.
- 3. Install the adapters to the inlet and outlet valves on the transformer to match them to the size of the oil pipe material.

- 4. 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.
- 5. Cut and bend the oil pipe to appropriate sections for building the oil lines.
- 6. Remove any sharp edges from the cut surfaces.
- 7. Clean any metal shavings from inside the pipes using pressurised air.
- 8. Build the oil lines between the valves and the oil connections on the DGA monitor marked **Oil In** and **Oil Out**.
- 9. Remove the plugs from the oil connections on the DGA monitor and store them for possible later use. Check that the oil connections are clean.
- 10. Connect both oil lines to the oil connections. Use the supplied adapters (delivered in a separate bag) and read their instructions for use before making the connections.
  - a. Insert nut of the connector over the oil pipe.
  - b. Insert the two ferrules over the pipe.
  - c. Fully insert the pipe into the fitting and against the shoulder; rotate the nut fingertight.
  - d. Hold the base of the connector with a second wrench to keep it from turning when tightening.
  - e. Mark the nut position.
  - f. Tighten the nut one and one quarter 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.

11. Install pipe supports where necessary to support the pipe mechanically. The pipe should be supported at least every two meters (six feet).



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).

# 3.5 Attaching the Power Supply Unit



• 6 mm hex 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 enclosure.

## 3.6 Attaching the Radiation Shield



- Radiation shield (delivered in three parts)
- Screws and washers
- 1. Attach the radiation shield to the OPT100 enclosure:



- 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 radiation shield are tight.
- d. Attach the top panel.

OPT100 Installation Guide

# 4. Electrical Installation

# 4.1 Cable Glands and Connectors



## Figure 8 OPT100 DGA Monitor Cable Glands and Connectors

- 1 **Oil Out**: connection for oil return line
- 2 **Oil In**: connection for oil intake
- <sup>3</sup>  $\perp$  Ground terminal
- 4 **RS-485**: cable gland for RS-485 connection
- 5 **Relay control out**: cable gland for relay control to power supply unit
- 6 **DC in**: 24 VDC connection from power supply unit
- 7 Ethernet: external RJ-45 connector for permanent Ethernet connection



#### Figure 9 OPTPSU1 Power Supply Unit Cable Glands and Connectors

- <sup>1</sup>  $\downarrow$  Ground terminal
- 2 AC in: Mains power input. 100 ... 240 VAC, 50 ... 60 Hz, 10 A
- 3 Spare
- 4 Spare
- 5 **Relay out**: Relay output. Max 250 VAC, 10 A
- 6 Relay control in: Relay control from DGA monitor
- 7 DC out: DC out to DGA monitor. 24 VDC, 20 A

## 4.2 Grounding the DGA Monitor



- Grounding cable with max 16 mm<sup>2</sup> conductor. Enough to reach from the DGA monitor and the power supply unit to the grounding point(s).
- Cable stripping tool
- Metal file
- Multimeter
- 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 a grounding 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.
    - c. Connect the other end of the cable to the grounding point.
    - d. Measuring 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.

## 4.3 Connecting DC Power to DGA Monitor

- X
- DC power cable (Vaisala cable CBL210544)
- 3 mm slotted screwdriver
- Adjustable wrench
- 1. Open the cable gland marked **DC in** on the DGA monitor. Remove the plug and store it for later use.
- 2. Insert the DC 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:

Signal	Wire Color Vaisala Cable CBL210544	Terminal
24 VDC +	Black with red marking	+
24 VDC -	Black	-
Ground	Green/yellow	Ŧ

## Table 2Terminal Block Y3 Wiring



Figure 10 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 DC 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 **X5**:

Signal	Wire Color Vaisala Cable CBL210544	Terminal
24 VDC +	Black with red marking	+
24 VDC -	Black	-
Ground	Green/yellow	<u>+</u>

## Table 3Terminal Block X5 Wiring



Figure 11 Terminal Block X5 Wiring

## 4.4 Connecting Relay Control to Power Supply Unit

- Relay control cable (marked **RELAY**, Vaisala cable CBL210539)
- 3 mm slotted screwdriver
- 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 4Terminal 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 12 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 5Terminal 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 13 Terminal Block X4 Wiring

# 4.5 Connecting RS-485



- RS-485 cable
- 3 mm slotted screwdriver
- Cable stripping tool

6

The default settings of the RS-485 line are:

- Serial settings 19200, 8, E, 1
- Modbus RTU slave
- MAC address 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 6 Terminal Block Y1 Wiring

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



Figure 14 Terminal Block Y1 Wiring Example

## 4.6 Connecting Ethernet



- Shielded outdoor Ethernet cable with a RJ-45 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.

 Assemble the protection shell over the RJ-45 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 enclosure.

- 2. Open the plug marked **Ethernet** under the DGA monitor.
- 3. Plug in the Ethernet cable.
- 4. Tighten the connector by hand.

## 4.7 Connecting Relays



- Relay cable
- 3 mm slotted screwdriver
- Adjustable wrench



- Maximum switching current of the relays:
- 6A (at 250VAC)
- 2 A (at 24 VDC)
- 0.2 A (at 250 VDC)
- 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 7Terminal 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 15 Terminal Block X3 Wiring for Normally Open (NO) Relay Connection

# 4.8 Connecting AC (Mains) Power

- AC power cable with 2.5 mm<sup>2</sup> (AWG10) wires and 9 ... 16 mm external diameter. Must be compliant with local regulations for mains power cables.
- Cable stripping tool
- 3 mm slotted screwdriver
- 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 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**, you can use either of the two cable glands marked **Spare** (diameter 5 ... 10 mm). If you are not wiring any relay outputs, you can also use cable gland marked **Relay out** (diameter 7 ... 12 mm). If the **AC in** cable gland is left unused, remember to plug it so that the enclosure remains tight. If the power supply unit has no suitable cable gland free, you can replace the cable gland marked **AC in** with a certified cable gland that is suitable for protecting the cable

gland marked **AC in** with a certified cable gland that is suitable for protecting the cable and providing strain relief.

- 1. Install an external disconnection device for the AC power connection (for example, a circuit breaker). Note the following:
  - The disconnection device must be rated 16 A or 20 A at 250 VAC, and must conform to any additional local regulations.
  - 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 DGA Monitor.

- 3. Make sure the external disconnection device is turned off. If possible, lock it in the off position.
- 4. Run the AC cable between the external disconnection device and the power supply unit of the DGA monitor.
- 5. Connect the AC cable to the external disconnection device.
- 6. Open the cable gland marked **AC 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 AC 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:



Wiring colors may be different depending on your cable.

## Table 8 Terminal Block X1 Wiring

Signal	Wire Color	Terminal
Line	Brown	L
Neutral	Blue	Ν
Ground	Green/yellow	Ð

## Figure 16 Terminal Block X1 Wiring



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

# 4.9 Verifying Tightness of Cable Glands



Adjustable wrench

To maintain enclosure 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.

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# 5. Commissioning

# 5.1 Turning On the DGA Monitor



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

# 5.2 Connecting to the User Interface



- Laptop computer with:
  - RJ-45 Ethernet connector
  - Web browser (Google Chrome, Microsoft Internet Explorer, or Mozilla Firefox)
- Ethernet cable with RJ-45 connectors for temporary use
- Administration password for your OPT100 DGA Monitor
- 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 on the computer, and enter the IP address of the DGA monitor in the address bar:
    - If you are connecting locally through the ETH1 port, the IP address is always **192.168.28.2**.
    - If you are connecting through the network meant for SCADA integration, use the IP address that has been assigned to the DGA monitor.
  - 3. Enter **Admin** as the user name.

- 4. Enter the unique administration password for this OPT100 DGA Monitor. The password is included in the OPT100 delivery documentation.
- 5. Select Log in. The user interface opens in your browser.

# 5.3 Initializing the DGA Monitor



• 5 mm hex 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 enclosure 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**.

- 1. In the user interface, select **Control**.
  - 2. Read the instructions on screen and verify that the DGA monitor is waiting to be initialized.
  - 3. Select **Start** to start the initialization sequence.
- 4. Turn the manual override switch 90° counterclockwise on the side of the bleed valve to unlock it. Select **OK** when done.
- 5. Remove the pipe plug from the bleed valve using the 5 mm hex key. Select **OK** when done.
- 6. Open the oil intake and outlet 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. The duration of this step depends on the oil pressure, viscosity, temperature, and length of the oil lines.
- 8. When instructed to do so, replace the pipe plug on the bleed valve. Select **Continue** when done.
- 9. The user interface informs you when the initialization is complete. The DGA monitor is now in standby mode.

# 5.4 Starting Measurement Mode

In the measurement mode the DGA monitor repeats the measurement cycle continuously. Before starting the measurement mode, make sure that:

- DGA monitor has been successfully initialized and is currently in standby mode.
- 1. Start the measurement mode from **Control > Start Measuring**.
- 2. Wait for the first measurement cycle to complete. Depending on the starting conditions, it may take up to 90 minutes.
- 3. After the first cycle has been completed, verify that there are no oil leaks in the oil pipes or inside the DGA monitor.



The DGA monitor will warm up furing the first three measurement cycles. Measurements made during the warm-up cycles are not guaranteed to be within the accuracy specification.

# 5.5 Finalizing the Installation

- 1. If you have connected the DGA monitor to a host system using the Ethernet or RS-485 connections, verify the availability of the measurement data from the host system.
- 2. Verify that you have performed all installation steps according to the 6.1 Installation Checklist (page 47).
- 3. Before leaving the installation site, perform a safety check and lock up accoding to the 6.2 Safety Checklist (page 48).

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# 6. Installation Verification

# 6.1 Installation Checklist



Fill in the checklist and save it to record the tasks you have carried out. Make copies of the list when needed.

# Installation Preparations Recommended tools available Required materials and installation accessories available Installation site safety requirements met DGA monitor installation location selected Oil intake and outlet connection valves available Data connection to host system available at the installation site

Mechanical Installation		
	DGA monitor installed to selected location	
	Installation is vertical and not tilted more than 5 degrees	
	Oil intake and outlet pipes built between connection valves and DGA monitor installation location	
	Oil pipes connected to DGA monitor and transformer's oil valves	
	Insulation installed over oil pipes (if needed)	

Electrical Installation		
	Grounding cable installed between DGA monitor enclosure and grounding point	
	Grounding cable installed between power supply unit and grounding point	
	Mains power connected to power supply unit	
	DC power cable installed between DGA monitor and power supply unit	
	Data connection cable installed (RS-485 or Ethernet)	

Electrical Installation			
	Relay control cable installed between DGA monitor and power supply unit		
	Relay connections made to power supply unit (if needed)		
	All unused cable glands blocked		
	Cable glands tightened		

#### Commissioning DGA monitor turned on Oil intake and outlet connection valves open Connection to service interface OK Pipe plug removed from bleed valve Manual bleed valve override open П DGA monitor initialization cycle completed Pipe plug installed to bleed valve Completed first measurement cycle Π DGA monitor in measurement mode Data connection to host system verified

# 6.2 Safety Checklist

Verify all items in this safety checklist after you have completed all installation steps.

Safety		
	Mechanical installation stable and secure	
	Oil pipe connections checked for leaks	
	No active alarms in user interface	
	Status LED on DGA monitor door is green	
	Mains power connection and protective grounding verified	
	Pipe plug in place over the bleed valve	
	DGA monitor housing closed and locked with all three locks	

Safety	
	Power supply unit housing closed and locked

DGA monitor installation location	
Transformer	
Inspection date	
Inspected by	
Comments	

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# Technical Support



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

- Product name, model, and serial number
- 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.



Follow the statutory regulations for disposing of the product and packaging.

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www.vaisala.com

