# About this document

## Version information

This document provides instructions for installing, using, and maintaining Vaisala MGP241 Multigas Probe for carbon dioxide and humidity measurement.

**Document versions (English)**

| Document code | Date | Description |
|---|---|---|
| M213080EN-A | October 2024 | First version. |

## Documentation conventions

**WARNING! Warning** alerts you to a hazardous situation that, if not avoided, could result in death or serious injury.

**CAUTION! Caution** alerts you to a hazardous situation that, if not avoided, could result in minor or moderate injury.

**NOTICE! Notice** alerts you to a situation that, if not avoided, could result in the product to be damaged or important data to be lost.

Highlights important information on using the product.

## Trademarks

Vaisala® and CARBOCAP® are registered trademarks of Vaisala Oyj.

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# Product overview

# Introduction to MGP241 Multigas Probe

The MGP241 probe measures carbon dioxide ($CO_2$) and humidity ($H_2O$ vapor) in demanding conditions. MGP241 measures carbon dioxide and humidity in vol-% or ppm by volume units, or alternatively dew point temperature ($T_d$) and frost point temperature ($T_f$). The patented CARBOCAP infrared technology enables simultaneous detection of multiple gases unlike the traditional non-dispersive infrared (NDIR) measurement technique. This allows compensation for sensor drift, sensor aging, and for any cross-interference effects between measured gases. Calibration gases are not needed for routine operation; a functional check and drift check every 12 months is recommended.

MGP241 measures gases directly in the process without a need for drying or other sample treatment. This simplifies the installation and minimizes the footprint of the measurement solution compared to traditional gas analyzers. The rapid measurement cycle takes only seconds, providing direct real time measurements for process control and monitoring. The $CO_2$ measurement can be shown either as wet basis or dry basis values. Thanks to the built in temperature and pressure compensation algorithms, and the CARBOCAP infrared technology, the measurement is stable and reliable across a wide range of process and environmental conditions.

The MGP241 probe has 3 4–20 mA analog outputs for $CO_2$ and $H_2O$ vapor concentrations and for retransmission of analog input, as well as a 4–20 mA analog input for external pressure or temperature signal used for compensation. The probe also offers Modbus RTU protocol for digital connectivity. For easy-to-use access to configuration, diagnostics, and calibration and adjustment functionalities, the MGP241 probe can be connected to Vaisala Insight PC software with a USB cable accessory, and it can also be connected to Indigo host devices: Indigo80, Indigo300, and Indigo520.

# MGP241 basic features and options

- Available measurement parameters: carbon dioxide ($CO_2$) and humidity ($H_2O$ vapor)
- Standalone probe with digital Modbus® RTU over RS-485 and 3 analog outputs (4–20 mA)
- Analog input (4–20 mA) for external temperature or pressure compensation for more accurate measurement
- Compatible with Vaisala Insight PC software and Vaisala Indigo host devices

## Measurement parameters

**MGP241 measurement parameters**

| Parameter | Unit | Measurement range |
|---|---|---|
| Carbon dioxide ($CO_2$) | Volume-% | 0–100 vol-% |
| Water vapor ($H_2O$) | • Volume-%<br>• Dew point and frost point temperature | • 0–25 vol-%<br>• -10 … +60 °C (+14 … +140 °F) |

## Wet basis and dry basis measurement output

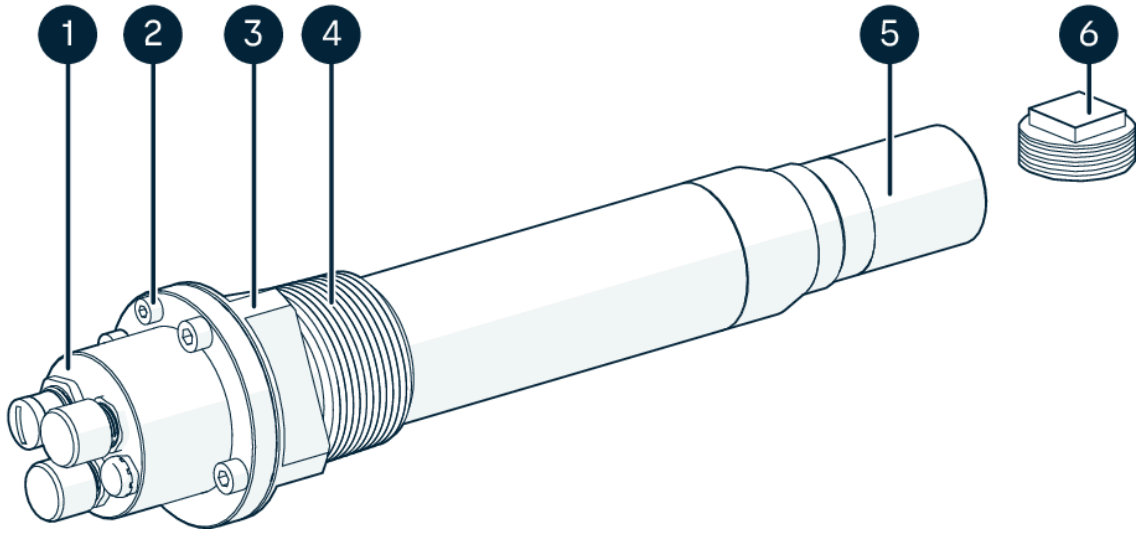
MGP241 carbon dioxide and water vapor measurements can be shown either as wet basis or dry basis values. The wet basis / dry basis measurement output selection is made when ordering the probe, and can be configured with Vaisala Insight PC software or Modbus.

## Connectivity to Vaisala Insight software

The probe can be connected to Vaisala Insight software using a Vaisala USB cable (item code 257295). With the Insight software, you can:

- Calibrate and adjust the measurement.
- See device information and status.
- See real-time measurement.
- Configure serial communication settings, analog input and output parameters and scaling, and environmental compensations.

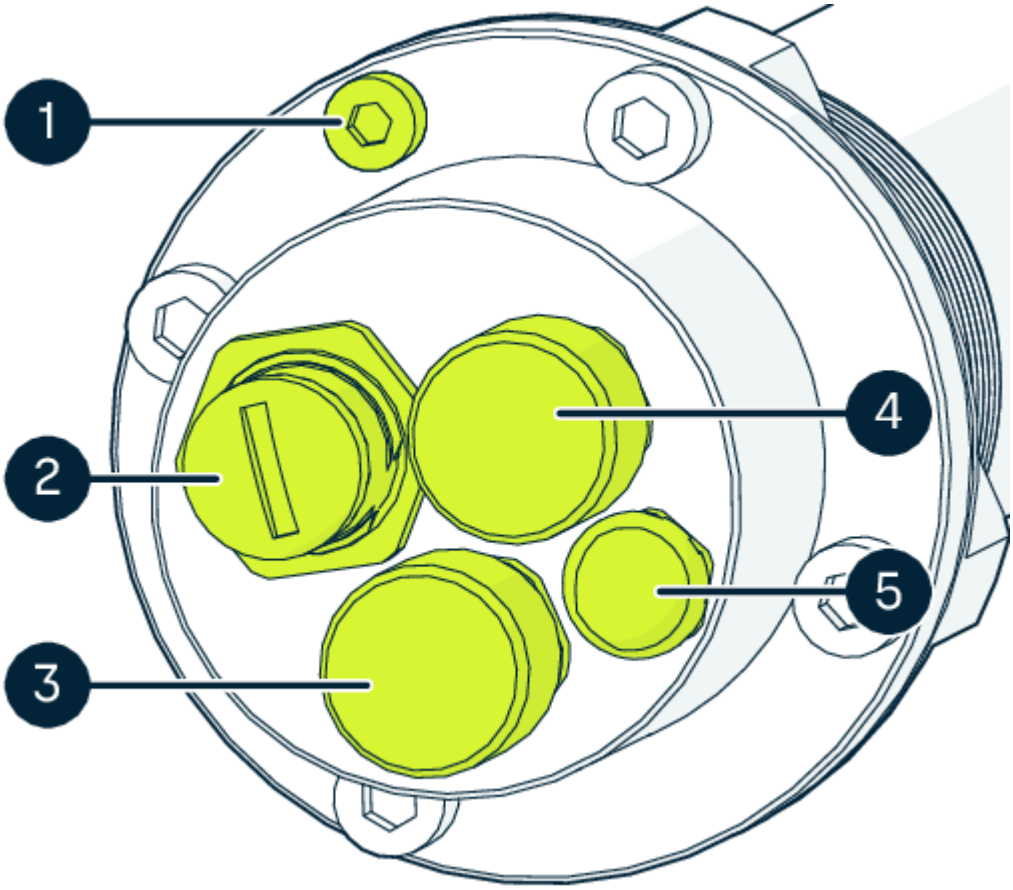
# MGP241 probe parts




**MGP241 probe parts**

1 Cable connection ports
2 Grounding point
3 Tightening nut: only tighten from the tightening nut when installing (wrench size: 50 mm (1.97 in))
4 1.5 in male NPT thread: **never install to any other thread type than 1.5 in female NPT thread**
5 Probe filter
6 1.5 in NPT thread test plug

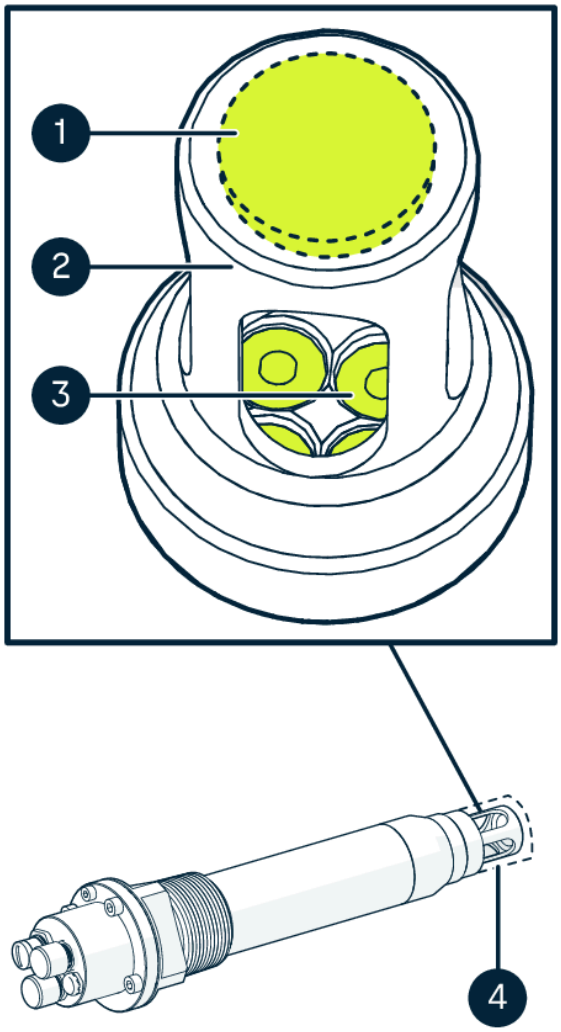
Cable connection ports




**MGP241 cable connectors**

1 M4 ring terminal: grounding point
2 M12-4F port: analog input
3 M12-5M port: used for powering and digital output
4 M12-8M port: used for powering and analog outputs
5 Breather plug: do not adjust

# Measurement principle




**The Vaisala CARBOCAP® sensor used in the probe is a silicon-based, non-dispersive infrared (NDIR) sensor for the measurement of carbon dioxide ($CO_2$), and humidity ($H_2O$).**

**Probe cuvette with mirror and sensor chips**

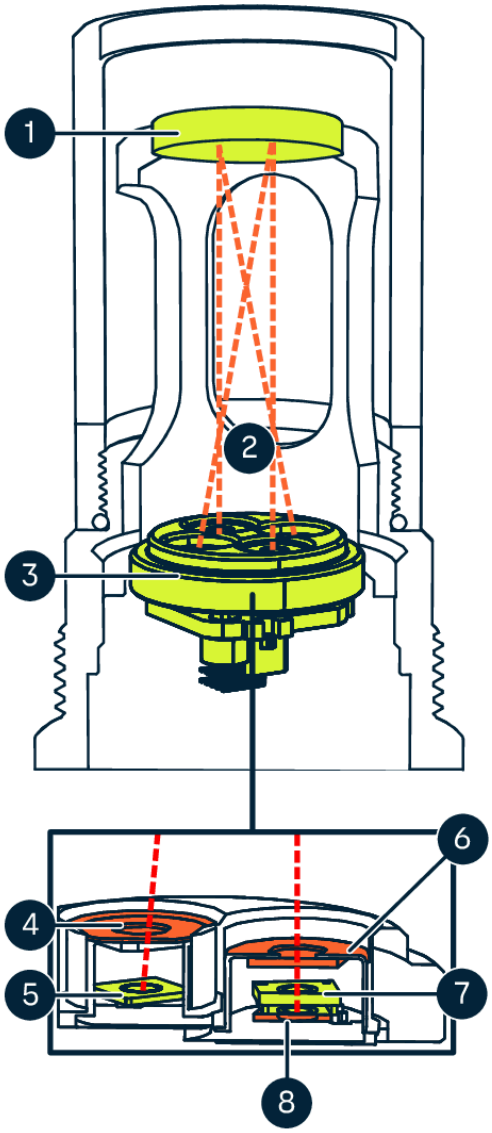
1 Mirror
2 Cuvette
3 Sensor chips under TO5 packages
4 Probe filter covering the cuvette

> **NOTICE!** The probe filter must be in place when the probe is inserted into the process for the instrument to function as intended.

The sensitivity to gases is based on absorption of infrared light at a characteristic wavelength. During measurement, infrared light is routed through the cuvette that contains the gas to be measured. A mirror reflects the light from the cuvette to thermopile detectors that measure the light intensity at a wavelength determined by Fabry–Pérot interferometer (FPI) and a band pass filter.

The measurement consists of two steps: first, the FPI is electrically tuned so that its pass band coincides with the characteristic absorption wavelength of the measured gas and the signal is recorded. Second, the pass band is shifted to a wavelength where no absorption occurs in order to get a reference signal. The ratio of these two signals, one at the absorption wavelength and the other at the reference wavelength, gives the fraction of light absorption from which the gas concentration is calculated. Measuring the reference signal compensates the possible effects of sensor aging and signal attenuation due to dirt on optical surfaces, making the sensor very stable over time.

TO5 packages with hermetic windows are used to protect the sensor chips from moisture and contamination.




**Measurement in the measurement cuvette**

1 Mirror
2 Light absorbed by the measured gases
3 Sensor chips under TO5 packages (see items 4–8)
4 Hermetic window
5 Thermopile detector
6 Hermetic window
7 Fabry–Pérot interferometer
8 Light source (microglow)

## Safety

This product has been type-tested for safety. Note the following precautions:

**CAUTION!** To avoid compromising the leak tightness of the installation:

- Ensure that the thread type of the installation port is 1.5 in female NPT. If unsure, verify the thread type with the 1.5 in NPT thread test plug.
- Apply PTFE tape to the 1.5 in male NPT thread of the probe as instructed in Installing the probe, and make sure that the PTFE tape seal has not been damaged by rotating the probe open (counter-clockwise) in the installation port.

# Regulatory statements

## FCC Part 15 compliance statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that the interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

> **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.

## Canada ICES-3 / NMB-3 compliance statement

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

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

# Installation

## Installation overview

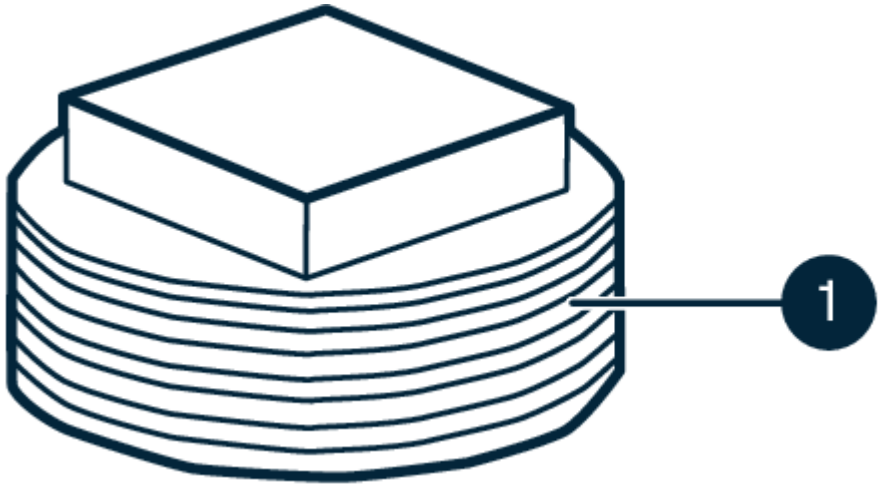
MGP241 can be installed either directly into the process (for example, through a flange or ball valve in the actual process pipeline), or using a flow-through adapter (for example, in a sampling line installation or when performing a field calibration).

> When installing MGP241 series probes into pipes with condensing gas, it is typical for the probe to require some time to heat up and recover from condensation. Installing the MGP241 probe into pipes with condensing gas and intermittent flow is not recommended.

### NPT 1.5 in thread test plug 257525SP

> **NOTICE!** The correct thread type in which to install MGP241 is **1.5 in female NPT**. Installing into any other thread type can damage the equipment and compromise the leak tightness of the connection. If unsure, verify the thread type with the NPT 1.5 in thread test plug.

1. NPT 1.5 in male thread (same as on MGP241 connector)




**NPT 1.5 in thread test plug**

MGP241 comes shipped with an NPT 1.5 in male thread test plug (Vaisala order code: 257525SP). If you are uncertain about the thread type of the process connector you want to install MGP241 into, use the thread test plug to check that it fits into the process connector threads (that is, that the process connector thread type is **NPT 1.5 in female**).

### Installation preparations

Before starting the installation, check the following:

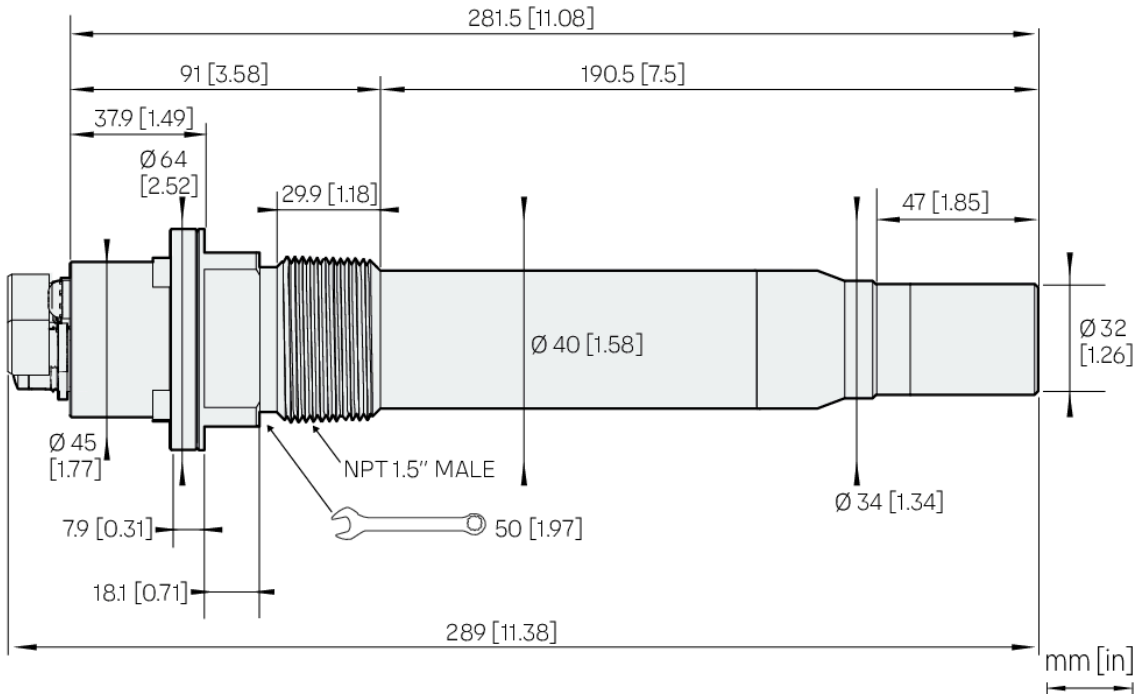
> Installing the MGP241 probe into pipes with condensing gas and intermittent flow is not recommended. When the probe is installed into a pipe with condensing gas, it is typical for the probe to require some time to heat up and recover from condensation.

- The MGP241 probe requires a dedicated 19–30 V DC power supply. In addition to the power supply input for the probe, each analog output must be externally powered.
- Review the information in Pressure compensation input options and make sure that you are using a pressure compensation input source that matches the settings of your MGP241 probe.
- Inspect the probe for any possible damage or dirt that could compromise the leak tightness of the device.
- If you install MGP241 to the process using a ball valve, note that it is necessary to use a 2 in ball valve and a reducer in order to accommodate the probe head (diameter 1.58 in).

> The NPT threads of the probe can have sharp edges. To avoid injury when touching the threads, wear protective gloves.

The probe can cause a foot injury if dropped. To avoid foot injuries, wear protective shoes.

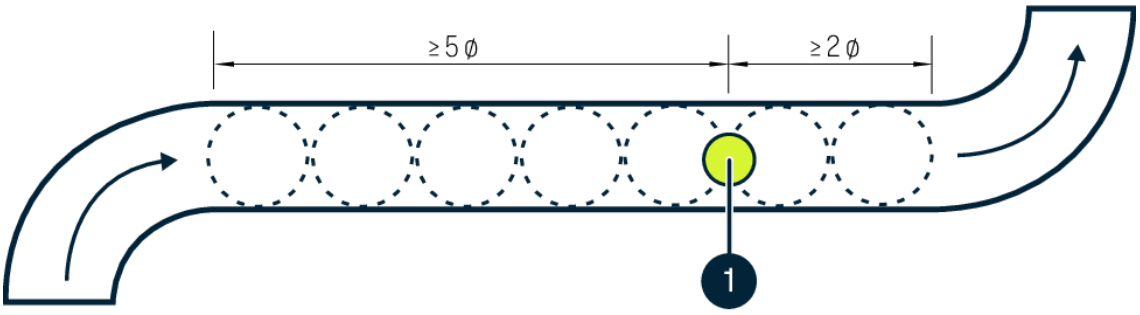
## MGP241 dimensions




**MGP241 dimensions**

## Recommended installation position on pipeline

Install the probe in a straight run of pipeline, ≥ 5 pipe diameters downstream of the closest bend or other feature affecting gas flow, and ≥ 2 pipe diameters upstream to the next bend or similar feature. For best results, use the orientation and installation depth of MGP241 threaded port installation example with recommended orientation and depth.




**recommended MGP241 installation position on pipeline**

1 Recommended MGP241 installation position on pipeline.

### Gas safety during installation

**CAUTION!** To avoid compromising the leak tightness of the installation:

- Ensure that the thread type of the installation port is 1.5 in female NPT. If unsure, verify the thread type with the 1.5 in NPT thread test plug.
- Apply PTFE tape to the 1.5 in male NPT thread of the probe as instructed in Installing the probe, and make sure that the PTFE tape seal has not been damaged by rotating the probe open (counter-clockwise) in the installation port.

### Pressure compensation input options

Accurate measurement readings require compensating for the pressure of the measured process. MGP241 does not measure pressure, meaning that it is mandatory to set up a pressure compensation input source. The following pressure input options are available:

- Pressure measurement received from a Modbus client through a serial line connection.
- Pressure measurement received from an external pressure measurement instrument through the M12-4F connector.
  - The external pressure instrument connected to MGP241 must output 4–20 mA and use absolute pressure units. The default range for the input is 1–1.6 bar(a).
- If the process pressure is constant, a fixed pressure compensation value can be configured into use.

The pressure compensation input settings (for example, input type selection and input scaling) of MGP241 must match the pressure input source used in your application.

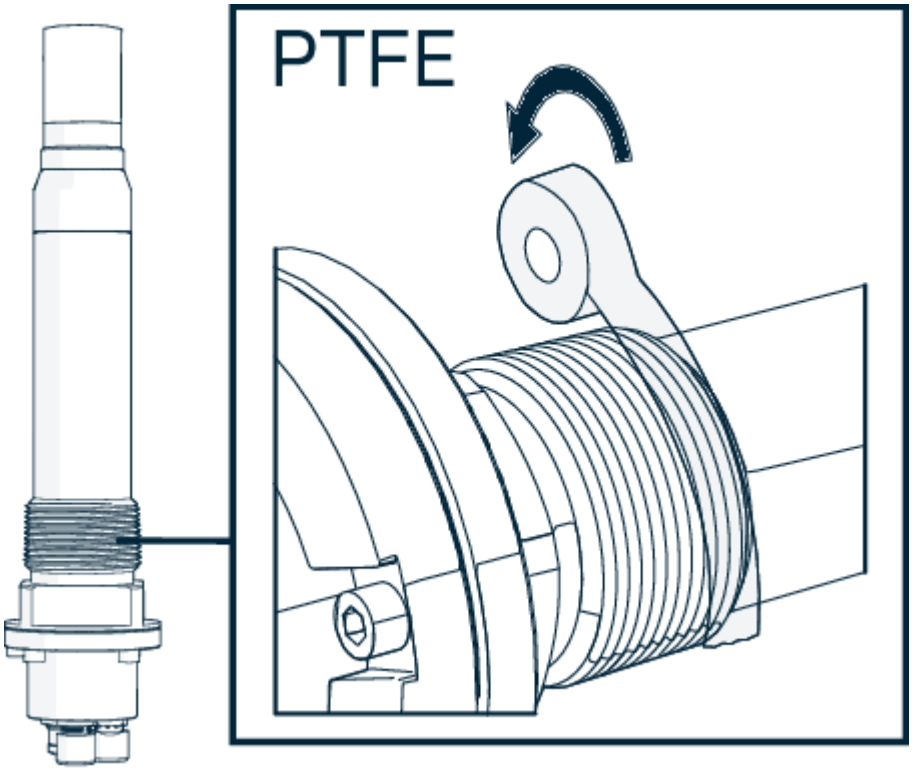
## Installing the probe

- Adjustable wrench (or a similar suitable tool) for turning the tightening nut
- PTFE tape (wide) for the probe threads

**NOTICE!** The correct thread type in which to install MGP241 is **1.5 in female NPT**. Installing into any other thread type can damage the equipment and compromise the leak tightness of the connection. If unsure, verify the thread type with the NPT 1.5 in thread test plug.

When you use a ball valve to install MGP241, it is necessary to use a 2 in ball valve and a reducer in order to accommodate the probe head (diameter 40 mm (1.58 in)).

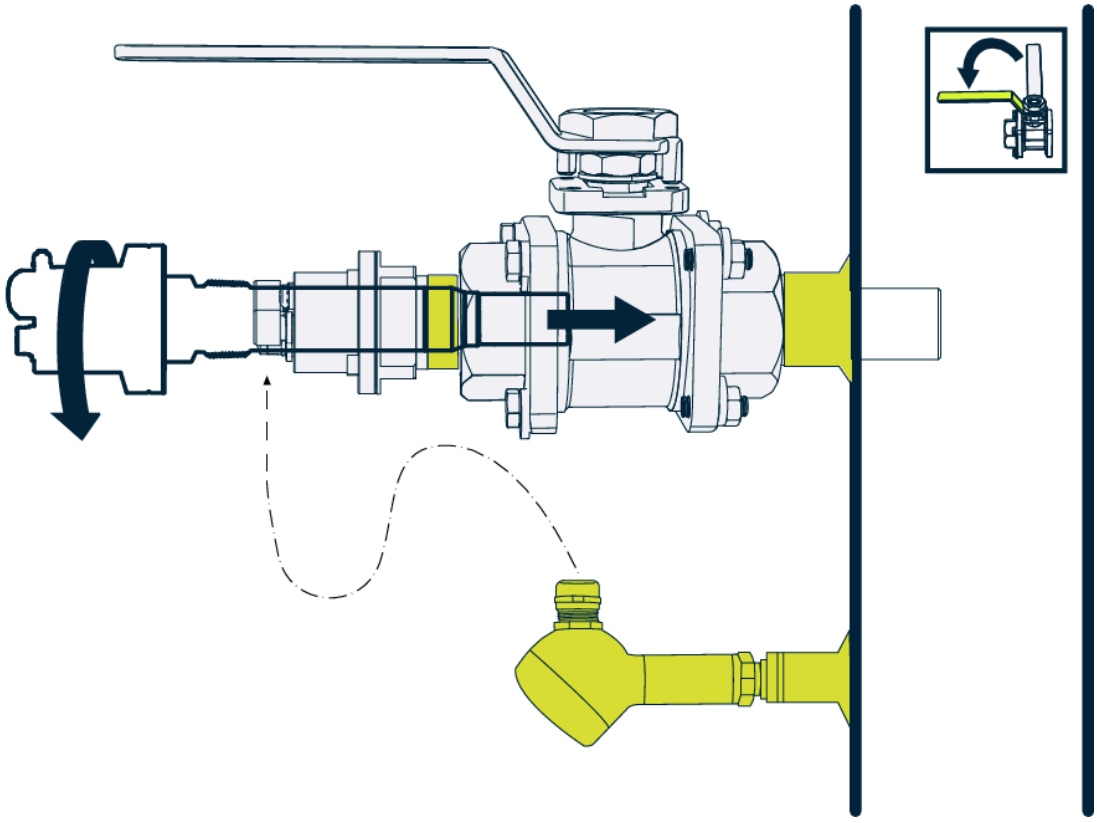
1. Inspect the probe threads and remove any possible dirt.
2. Wrap PTFE tape in the direction of the thread spiral, starting from the first thread. Keep the edge of the tape parallel to the face of the thread while wrapping.




Do not tape beyond the edge of the threads or leave loose tape hanging.

3. Insert the probe into the **1.5 in female NPT** installation port and rotate it clockwise until it sits firmly in the port. Do not tighten the probe to full tightness, only enough to keep it securely in place when wiring.

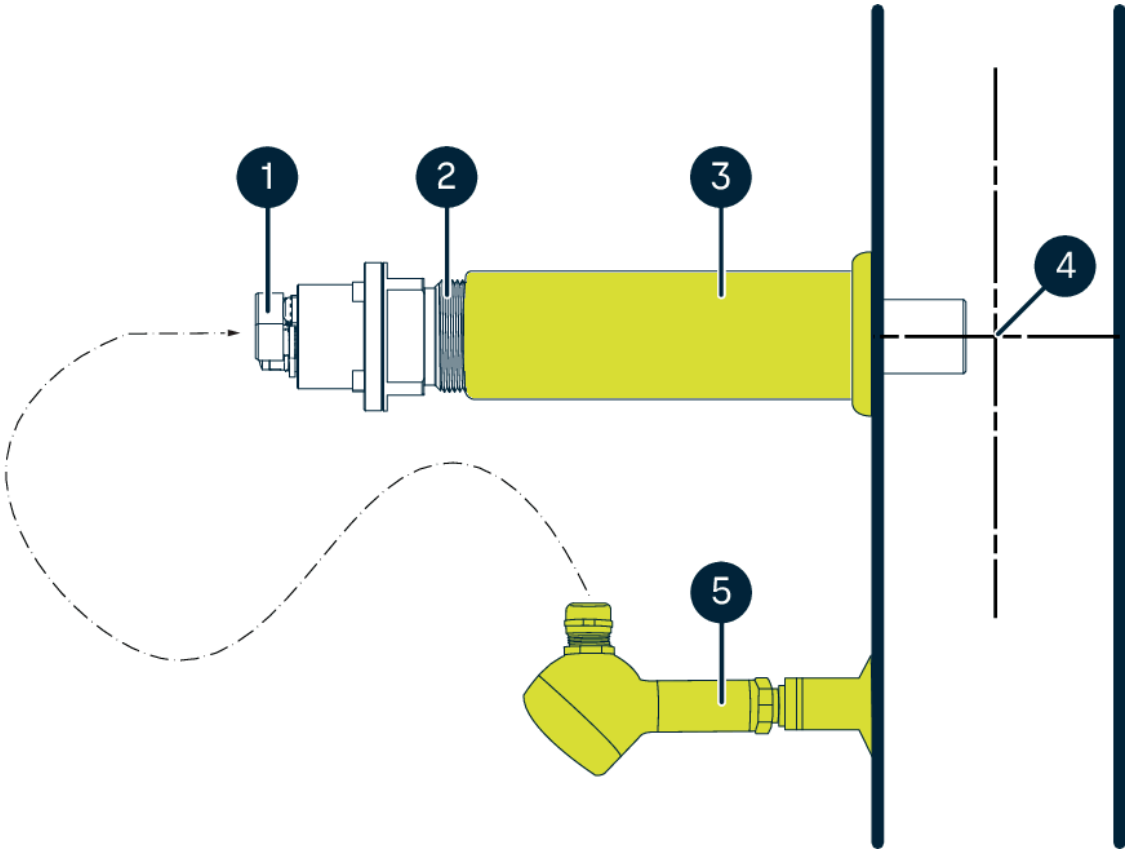
An external pressure measurement instrument is shown here as an example of pressure compensation input options: for a description of alternative options, see Pressure compensation input options.



**NOTICE!** Rotating the probe open (counter-clockwise) after it has been installed into the port can tear the PTFE tape. Only adjust the position of the probe in the installation port by tightening (rotating clockwise).

4. Connect input, output, and power supply cables to the cable connectors as required in your application.
5. See Finalizing installation for instructions on attaching grounding to the probe grounding point.

## Installation into threaded port




**You can install the MGP241 probe in a threaded port on the process pipeline.**

**An external pressure measurement instrument (item 5) is shown as an example of pressure compensation input options. For a description of alternative pressure compensation options, see Pressure compensation input options.**

**MGP241 threaded port installation example with recommended orientation and depth**

1 External pressure or temperature sensor input wiring: use the M12-4F connector.

Power supply input, and RS-485 communication wiring: use the M12-5M connector.

Standard analog output, and power supply input: use the M12-8M connector.

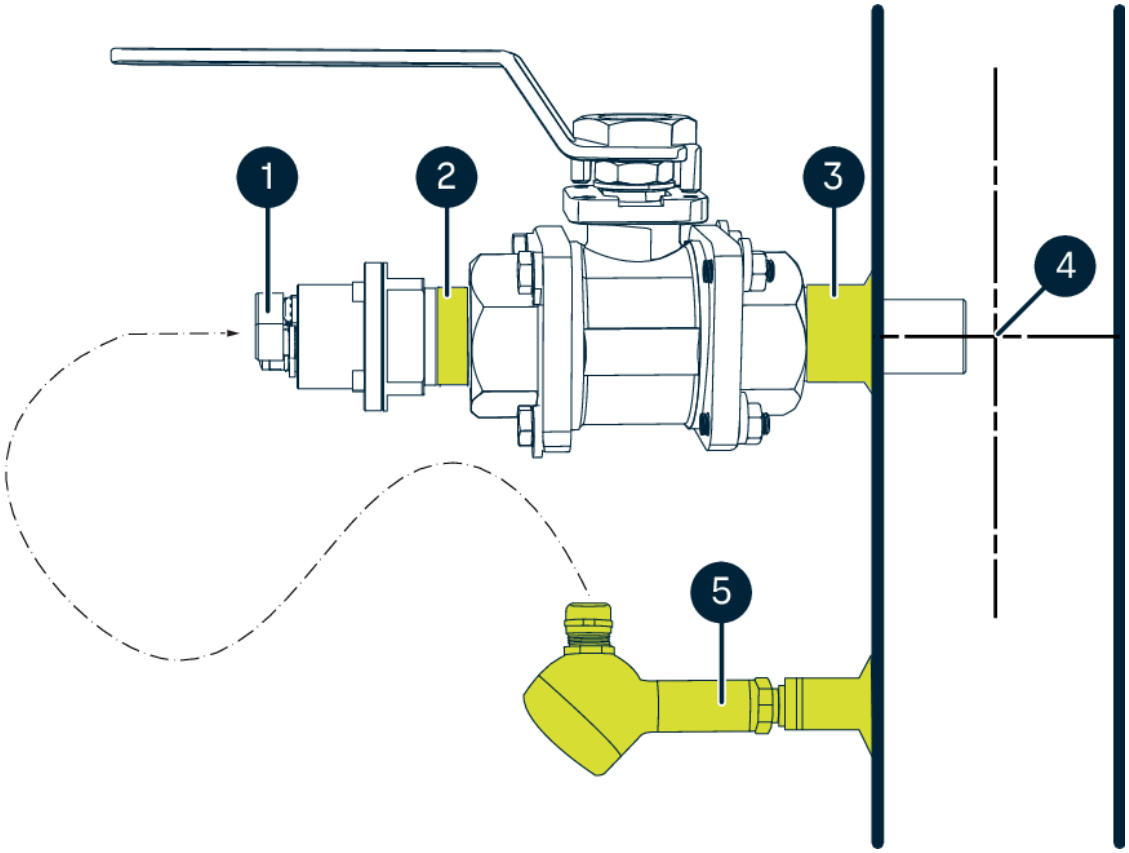
2 1.5 in male NPT thread on MGP241: **never install to any other thread type than 1.5 in female NPT**.

3 Threaded installation port with 1.5 in female NPT thread on the process pipe.

4 For best results, install MGP241 horizontally. The recommended position for the tip of the filter is within 1/3 of the pipe's diameter from the pipe centerline. If this is not achievable, other positions inside the pipe can be used as well. In smaller pipes, the installation depth can be adjusted by using an adapter such as a ball valve.

5 Example pressure compensation input option: an external measurement instrument connected to the MGP241 input terminals.

Ball valve installation




**You can use a ball valve to install MGP241.**

**An external pressure measurement instrument (item 5) is shown as an example of pressure compensation input options. For a description of alternative pressure compensation options, see Pressure compensation input options.**

**MGP241 ball valve installation example with recommended orientation and depth**

1 External pressure or temperature sensor input wiring: use the M12-4F port.

Power supply input, and RS-485 communication wiring: use the M12-5M port.

Standard analog output, and power supply input: use the M12-8M port.

2 1.5 in male NPT thread on MGP241: **never install to any other thread type than 1.5 in female NPT**. When you use a ball valve to install MGP241, it is necessary to use a 2 in ball valve with a 1.5 in thread reducer in order to accommodate the probe head (diameter 1.57 in).

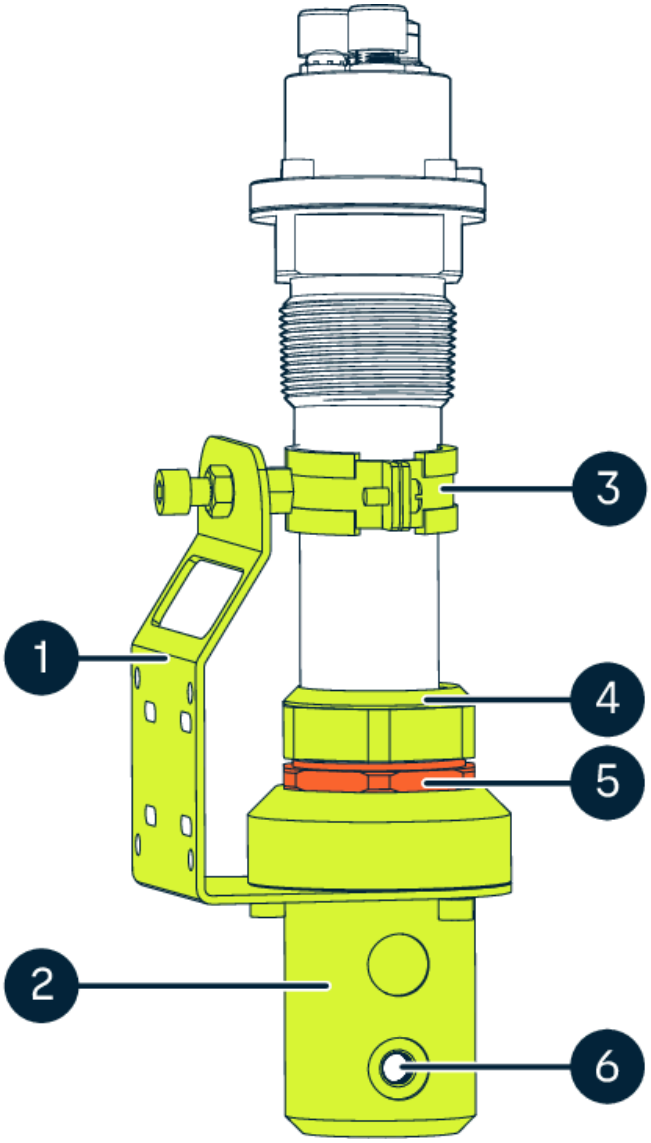
3 Threaded stub welded to the pipe wall for ball valve process connection.

4 For best results, install MGP241 horizontally. The recommended position for the tip of the filter is within 1/3 of the pipe's diameter from the pipe centerline. If this is not achievable, other positions inside the pipe can be used as well. In smaller pipes, the installation depth can be adjusted by using an adapter such as the ball valve in this example.

5 Example pressure compensation input option: an external measurement instrument connected to the MGP241 input terminals.

When you use a ball valve to install MGP241, it is necessary to use a 2 in ball valve and a reducer in order to accommodate the probe head (diameter 40 mm (1.58 in)).

Flow-through adapter installation




**You can install MGP241 with an flow-though adapter accessory (Vaisala order code: 258877).**

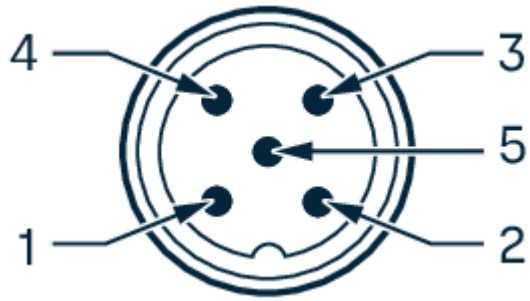
**MGP241 in flow-through adapter 258877**

1 Mounting plate (attach to mounting surface with screws or ties)
2 Gas tube inlet port, G 1/8 (on the other side of the adapter)
3 Clamp with 2 screws
4 Probe gland tightening nut
5 Probe gland locknut: **do not turn**
6 Gas tube outlet port, G 1/8

# Wiring

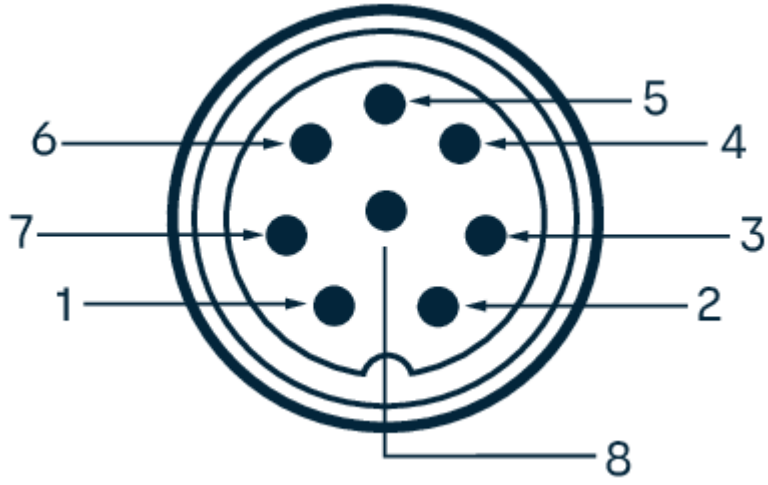

**M12 4-pin A-coded female connector pinout**

| Pin # | Function | Notes | Wire colors in Vaisala cables |
|---|---|---|---|
| 1 | Analog input + | 4–20 mA, isolated, for external pressure or temperature sensor | Brown |
| 2 | Not connected | | White |
| 3 | Analog input - | 4–20 mA, isolated, for external pressure or temperature sensor | Blue |
| 4 | Not connected | | Black |




**M12 5-pin A-coded male connector pinout**

| Pin # | Function | Notes | Wire colors in Vaisala cables |
|---|---|---|---|
| 1 | Voltage supply + | Operating voltage: 19–30 V<br>Current consumption: 80 mA typical, 500 mA max. | Brown |
| 2 | RS-485 - | | White |
| 3 | Voltage supply - | | Blue |
| 4 | RS-485 + | | Black |
| 5 | RS GND | | Gray |

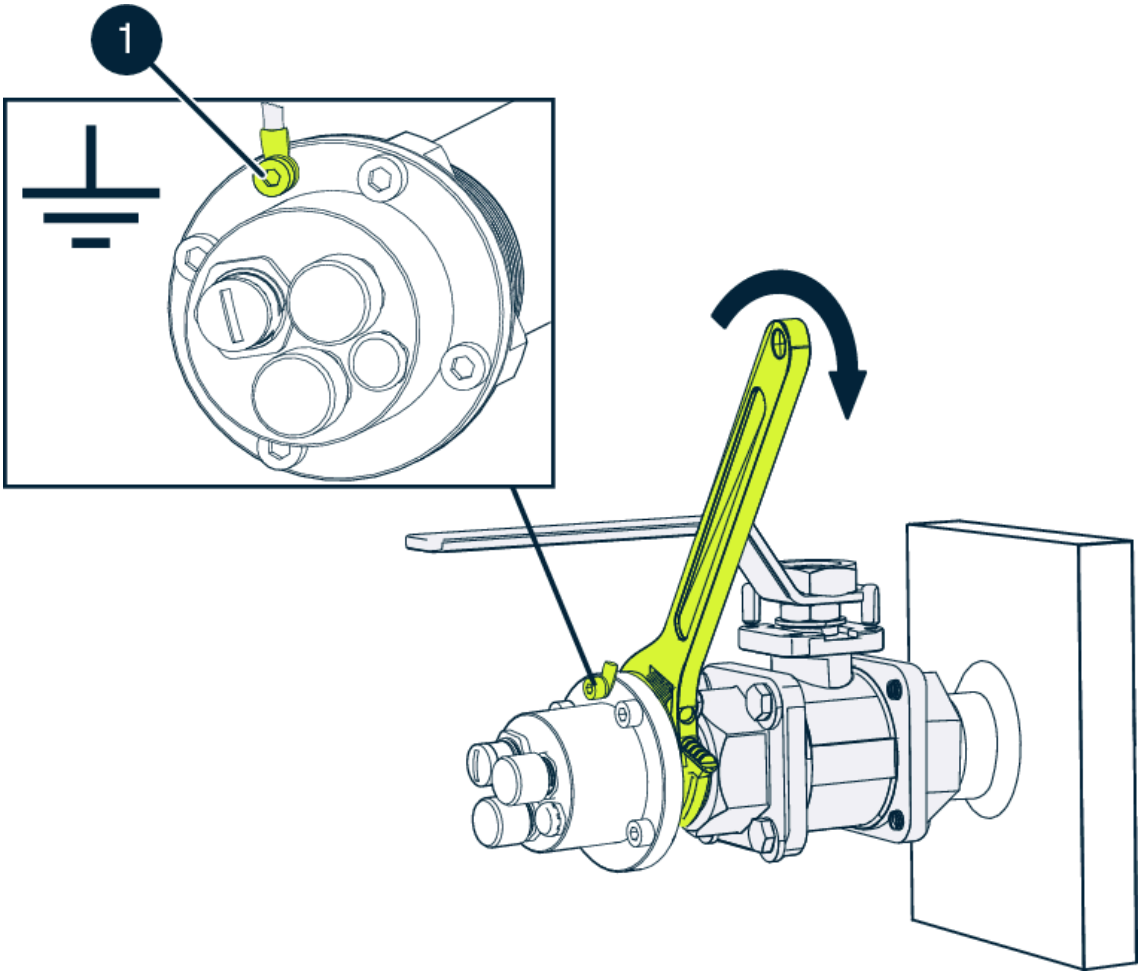



**M12 8-pin A-coded male connector pinout**

| Pin # | Function | Notes | Wire colors in Vaisala cables |
|---|---|---|---|
| 1 | Analog output 1 + | | White |
| 2 | Analog output 3 - | | Brown |
| 3 | Analog output 1 - | | Green |
| 4 | Analog output 2 + | | Yellow |
| 5 | Analog output 2 - | | Gray |
| 6 | Analog output 3 + | | Pink |
| 7 | Voltage supply + | Operating voltage: 19–30 V | Blue |
| 8 | Voltage supply - | Operating voltage: 19–30 V | Red |

## Finalizing installation

- Allen key (3 mm)
- Grounding screw set (screw, washer, ring terminal), provided
- ≥ 4 $mm^2$ wire




1 Probe grounding point

1. Attach the mounting screw set to the probe grounding point. The correct order for the mounting screw set installation is ring terminal, washer, and screw. Tightening torque for the screw is 3 Nm.
2. Connect the MGP241 grounding point to the grounding rail of the installation site with a ≥ 4 $mm^2$ wire. Attach the wire to the ring terminal and press the terminal shut tightly.
3. Switch on the power supply input.

# Technical data

## MGP241 specifications

### Measurement performance

| Property | Carbon dioxide $CO_2$ | Water vapor $H_2O$ |
|---|---|---|
| Sensor | CARBOCAP® | CARBOCAP® |
| Measurement unit | Volume-%, $ppm_v$ | Volume-%, $ppm_v$, dew point °C, dew point °F |
| Measurement range | 0–100 vol-% | 0–25 vol-%, –10 … +60 °C (+14 … +140 °F) |
| Accuracy at +25 °C (+77 °F) and 1013 mbar [1] [2] | 0–90 vol-%: **±2 vol-%**<br>90–100 vol-%: **±1 vol-%** | 0–25 vol-%: **±0.5 vol-%** |
| Repeatability [2] | ±0.4 vol-% at 95 vol-% | ±0.1 vol-% at 2.5 vol-% |
| Temperature dependence (typical) | Compensated,<br>0–100 vol-%:<br>**±0.1 % of reading / °C** | Compensated,<br>0–25 vol-%:<br>**±0.1 % of reading / °C** |
| | Uncompensated,<br>0–100 vol-%:<br>**±0.6 % of reading / °C** | Uncompensated,<br>0–25 vol-%:<br>**±0.4 % of reading / °C** |
| Pressure dependence (typical) | Compensated,<br>0–100 vol-%:<br>**±0.015 % of reading / mbar** | Compensated,<br>0–25 vol-%:<br>**±0.01 % of reading / mbar** |
| | Uncompensated,<br>0–100 vol-%:<br>**±0.25 % of reading / mbar** | Uncompensated,<br>0–25 vol-%:<br>**±0.20 % of reading / mbar** |
| Long-term stability | ±2 vol-% / year | ±2 vol-% / year |
| Startup time [3] | 3 min | |
| Warm-up time [4] | 30 s [5] | |
| Response time ($T_{90}$) | 90 s [6] | |
| Response time with flow-through adapter | 90 s at ≥ 0.5 l/min [6]<br>(recommended: 0.5–1 l/min) | |

### Powering

| Property | Description/Value |
|---|---|
| Operating voltage | 19–30 V DC |
| Power consumption | Typical: 3 W<br>Maximum: 6 W |
| Current consumption | 100–300 mA |

### Inputs and outputs

| Property | Description/Value |
|---|---|
| **Analog inputs** | |
| Number of analog inputs | 1 |
| Input type | 4–20 mA, isolated, for external pressure or temperature sensor [7] |
| **Analog outputs** | |
| Number of analog outputs | 3 |
| Output type | 4–20 mA, scalable, isolated |
| Accuracy | ±0.2 % F.S. at 25 °C |
| Temperature dependence | ±0.005% / °C full scale |
| External loads | $R_L$: 0 Ω<br>$R_L$: 500 Ω |

| Property | Description/Value |
|---|---|
| **Digital communication** | |
| Serial communication | RS-485 (Modbus RTU) |

### Mechanical specification

| Property | Description/Value |
|---|---|
| Weight | 1.4 kg (3.09 lb) |
| Connectors | M12 5-pin male for digital output<br>M12 8-pin male for analog output<br>M12 4-pin female for analog input |
| **Materials** | |
| Probe body | AISI316L stainless steel, PPS |
| Filter cap | Sintered PTFE |

### Operating environment

| Property | Description/Value |
|---|---|
| Operating environment | Outdoor use |
| IP rating | IP65: Dust-tight. Protected from water jets from any direction. |
| Operating temperature | −40 … +60 °C (−40 … +140 °F) |
| Operating humidity | 0–100 %RH |
| Operating pressure | −500 … +500 mbar |
| Storage temperature | −40 … +60 °C (−40 … +140 °F) |
| Storage humidity | 0–90 %RH |
| Process pressure | −500 … +500 mbar |
| Process temperature | +0 … +60 °C (+32 … +140 °F) |
| Process flow | 0–20 m/s |

### Compliance

| Property | Description/Value |
|---|---|
| EU directives and regulations | EMC Directive (2014/30/EU)<br>REACH Regulation (EC 1907/2006)<br>RoHS Directive (2011/65/EU) as amended by 2015/863 |
| Electromagnetic compatibility (EMC) | EN 61326-1, industrial environment |
| Compliance marks | CE, China RoHS, FCC, ICES, RCM |

### Compatible devices

| Device or series | Models |
|---|---|
| Indigo80 Handheld Indicator | Indigo80 |
| Indigo300 Transmitter | Indigo300 |
| Indigo500 Series Transmitters | Indigo520 |

### Accessories and spare parts

| Item | Order code |
|---|---|
| Sintered PTFE filter (includes O-ring) | DRW249919SP |
| Flow-through adapter | 258877 |
| NPT 1.5 in thread test plug | 257525SP |
| USB Service Cable M12-5F, RS-485 | 242659 |
| Probe connection cable, 1 m (3 ft 3 in) | CBL210896-1MSP |
| Probe connection cable, 3 m (9 ft 11 in) | CBL210896-3MSP |
| Probe connection cable, 5 m (16 ft 5 in) | CBL210896-5MSP |
| Probe connection cable, 10 m (32 ft 10 in) | CBL210896-10MSP |
| Probe connection cable, 1 m (3 ft 3 in) | INDIGOCABLE1M |
| Probe connection cable, 3 m (9 ft 11 in) | INDIGOCABLE3M |
| Probe connection cable, 5 m (16 ft 5 in) | INDIGOCABLE5M |
| Probe connection cable, 10 m (32 ft 10 in) | INDIGOCABLE10M |

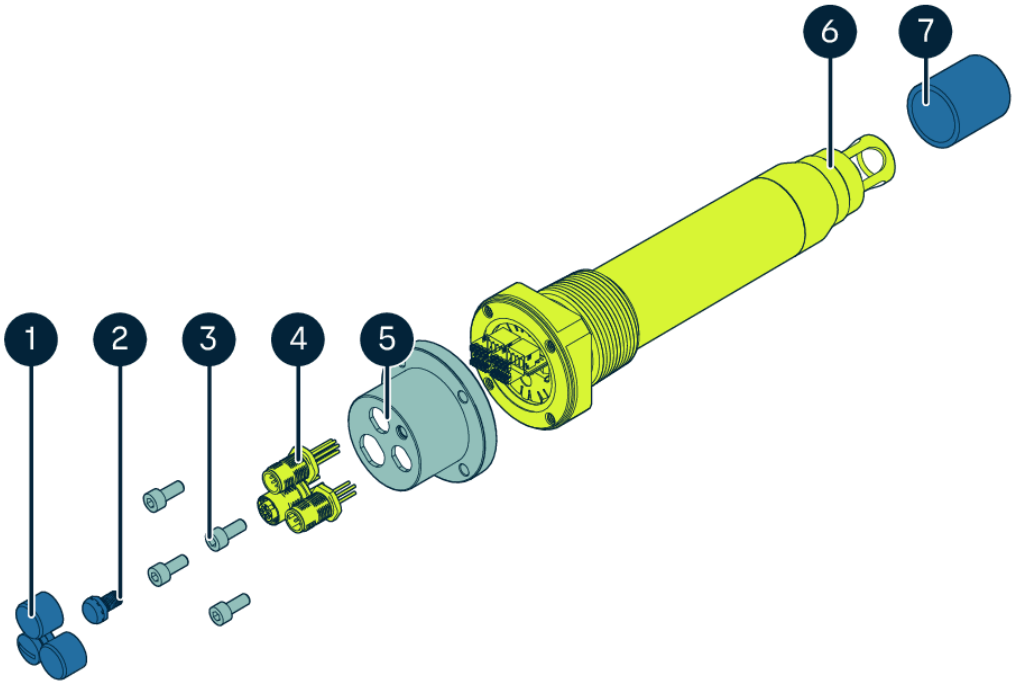
[1] Excluding cross-interferences to other gases.

[2] Accuracy and repeatability specification at +25 °C (+77 °F) and 1013 mbar including non-linearity, calibration uncertainty, and repeatability; temperature and pressure compensated.
[3] Time to first reading.
[4] Time to specified accuracy.
[5] At +20 °C (+68 °F) ambient temperature.
[6] With standard PTFE filter.
[7] The optional analog input is galvanically isolated and provides power for the connected external pressure sensor.

## Recycling instructions

These recycling instructions guide you on the end-of-life treatment of this Vaisala product. As waste regulations and infrastructure vary in each country, these instructions only indicate the different components to be separated and common ways to handle them. Always follow local requirements when disposing of the product. Vaisala encourages to use the best available recycling practices to minimize related environmental impacts.

> Vaisala is committed to meeting the requirements of the EU Waste Electrical and Electronic Equipment (WEEE) Directive. This directive aims to minimize the impact of electrical and electronic goods on the environment, by increasing reuse and recycling, and reducing the amount of WEEE going to landfill. This symbol indicates that the product should be collected separately from other waste streams and treated appropriately.




| Recycling | Part | Material |
|---|---|---|
| Electrical and electronic waste | 4, 6 | Various |
| Metal waste | 3, 5 | Stainless steel |
| Plastic waste | 1, 2 | Polyamide 6 |
| | 7 | Polytetrafluoroethylene (PTFE) |

# Modbus reference

## Data encoding

In the data registers, the numeric values are available in one or two formats with separate register addresses: 32-bit IEEE floating point format and/or 16-bit signed integer format.

## 32-bit floating point or 32-bit integer format

Registers using **32-bit float** data format are encoded using the **binary32** encoding defined in IEEE 754. The format is also known as "single-precision floating point format".

The least significant 16 bits of a floating point number are placed at the Modbus register listed in the table, while the most significant 16 bits are placed in the register with number/address + 1, as specified in Open Modbus TCP Specification, Release 1.0. This is also known as "little-endian" or "Modicon" word order.

Despite the specification, some Modbus masters may expect a "big-endian" word order (most significant word first). In such case, you must select "word-swapped" floating point format in your Modbus master for the Modbus registers of the device.

A complete 32-bit floating point or 32-bit integer value should be read and written in a single Modbus transaction.

> **CAUTION!** Reading the measurement data registers with incorrect floating point format setting may occasionally result in correct-looking, but nevertheless incorrect values.

It is highly recommended to verify that you have configured the floating point format correctly on your Modbus host system by reading a floating point value from a test value register.

## 16-bit integer format

Some 16-bit integer values in the data registers are scaled to include the necessary decimals. The scaling factors for those values are shown in the register tables.

#### Interpretation of 16-bit signed integer values

| Value (decimal) | Value (hexadecimal) | Description |
|---|---|---|
| 0–32766 | 0x0000–0x7FFE | Value in range 0–32766 |
| 32767 | 0x7FFF | Value is 32767 or larger |
| 32768 | 0x8000 | Value is not available |
| 32769 | 0x8001 | Value is −32767 or smaller |
| 32770–65535 | 0x8002–0xFFFF | Value in range −32766 … −1 (2's complement) |

## Modbus registers

Registers are numbered in decimal, starting from 1. Register addresses in actual Modbus messages (Modbus Protocol Data Unit (PDU)) are in hexadecimal and start from zero. Register number 1 corresponds to address 0x0 in the actual Modbus message.

> **CAUTION!** Reading the wrong register(s) may result in correct-looking values. Check the reference documentation of your Modbus host (PLC) to verify which notation it uses for Modbus register addresses.

## Measurement data registers

### Modbus measurement data registers (read-only)

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Unit |
|---|---|---|---|---|
| **Floating point values** | | | | |
| 5 | 0x0004 | Carbon dioxide ($CO_2$) concentration | 32-bit float | $ppm_v$ |
| 7 | 0x0006 | Carbon dioxide ($CO_2$) concentration, dry basis | 32-bit float | $ppm_v$ |
| 9 | 0x0008 | Water ($H_2O$) concentration | 32-bit float | $ppm_v$ |
| 11 | 0x000A | Water ($H_2O$) concentration, dry basis | 32-bit float | $ppm_v$ |
| 13 | 0x000C | Dew point temperature | 32-bit float | $T_d$ °C |
| 15 | 0x000E | Dew / frost point temperature | 32-bit float | $T_{df}$ °C |
| 17 | 0x0010 | Sensor temperature | 32-bit float | Ts °C |
| **Integer values** | | | | |
| 259 | 0x0102 | Carbon dioxide ($CO_2$) concentration | 16-bit integer | $ppm_v$ / 100 (parts per ten thousand) |
| 260 | 0x0103 | Carbon dioxide ($CO_2$) concentration, dry basis | 16-bit integer | $ppm_v$ / 100 (parts per ten thousand) |
| 261 | 0x0104 | Water ($H_2O$) concentration | 16-bit integer | $ppm_v$ / 100 (parts per ten thousand) |
| 262 | 0x0105 | Water ($H_2O$) concentration, dry basis | 16-bit integer | $ppm_v$ / 100 (parts per ten thousand) |
| 263 | 0x0106 | Dew point temperature | 16-bit integer (× 10) | $T_{df}$ °C |
| 264 | 0x0107 | Dew / frost point temperature | 16-bit integer (× 10) | $T_{df}$ °C |

## Configuration registers

### Modbus configuration data registers (writable)

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Valid range |
|---|---|---|---|---|
| **Environmental compensation** | | | | |
| 769 | 0x0300 | Power-up value for pressure compensation | 32-bit float | Range: 450–1550 hPa<br>Init/default: 1013.25 |
| 771 | 0x0302 | Power-up value for temperature compensation | 32-bit float | Range: -10 ... +70 °C<br>Init/default: 25 |
| 773 | 0x0304 | Volatile pressure compensation (value cleared at probe reset) | 32-bit float | Range 450–1550 hPa<br>Init/default: 1013.25 |
| 775 | 0x0306 | Volatile temperature compensation (value cleared at probe reset) | 32-bit float | Range: -10 ... +70 °C<br>Init/default: 25 |
| **Function control** | | | | |
| 1281 | 0x0500 | Pressure compensation mode selection | Enum | **0** = Off<br>**1** = Setpoint<br>**2** = External |
| 1282 | 0x0501 | Temperature compensation mode selection | Enum | **0** = Off<br>**1** = Setpoint<br>**2** = Measured<br>**3** = External |
| **Communication** | | | | |
| 1537 | 0x0600 | Serial address | 16-bit integer | Valid range 1–255<br>Default: 240 |

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Valid range |
|---|---|---|---|---|
| **Environmental compensation** | | | | |
| 1538 | 0x0601 | Bit rate | Enum | Valid range 4800–115200<br>**4** = 4800<br>**5** = 9600<br>**6** = 19200<br>**7** = 38400<br>**8** = 57600<br>**9** = 115200<br>(default: **6** (19200)) |
| 1539 | 0x0602 | Parity, data, stop bits | Enum | **0** = N,8,1<br>**1** = N,8,2<br>**2** = E,8,1<br>**3** = E,8,2<br>**4** = O,8,1<br>**5** = O,8,2 |
| 1540 | 0x0603 | Response delay | 16-bit integer | Valid range 0–1000 |
| 1541 | 0x0604 | Restart device | Function | |
| **Analog output 1** | | | | |
| 1793 | 0x0700 | Analog output 1 mode selection | Enum | **0** = Disabled<br>**1** = 4–20 mA |
| 1794 | 0x0701 | Analog output 1 measurement parameter selection. When written, scalings are reset. | Reg | 0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis)<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis)<br>0x000C ($T_d$)<br>0x000E ($T_{df}$) |
| 1795 | 0x0702 | Scale low end for analog output 1 measurement parameter.<br>Minimum and maximum values vary for different parameters. | Float | Output parameters<br>0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis):<br>Minimum: 0<br>Maximum: 1000000<br>Output parameters<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis):<br>Minimum: 0<br>Maximum: 250000<br>Output parameters<br>0x000C ($T_d$)<br>0x000E ($T_{df}$):<br>Minimum: -10<br>Maximum: 60 |
| 1797 | 0x0704 | Scale high end for analog output 1 measurement parameter. | Float | Output parameters |

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Valid range |
|---|---|---|---|---|
| **Environmental compensation** | | | | |
| | | Minimum and maximum values vary for different parameters. | | 0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis):<br>Minimum: 0<br>Maximum: 1000000 |
| | | | | Output parameters<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis)<br>Minimum: 0<br>Maximum: 250000 |
| | | | | Output parameters<br>0x000C ($T_d$)<br>0x000E ($T_{df}$):<br>Minimum: -10<br>Maximum: +60 |
| 1799 | 0x0706 | Error output level (mA) | Float | Min. 0.5 mA<br>Max. 24 mA |
| 1801 | 0x0708 | Low clipping limit | Float | 0–2.5 % |
| 1803 | 0x070A | Low error limit | Float | 0–1025 % |
| 1805 | 0x070C | High clipping limit | Float | 0–12.5 % |
| 1807 | 0x070E | High error limit | Float | 0–1025 % |
| **Analog output 2** | | | | |
| 2049 | 0x0800 | Analog output 2 mode selection | Enum | **0** = Disabled<br>**1** = 4–20 mA |
| 2050 | 0x0801 | Analog output 2 measurement parameter selection. When written, scalings are reset. | Reg | 0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis)<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis)<br>0x000C ($T_d$)<br>0x000E ($T_{df}$) |
| 2051 | 0x0802 | Scale low end for analog output 2 measurement parameter.<br>Minimum and maximum values vary for different parameters. | Float | Output parameters<br>0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis):<br>Minimum: 0<br>Maximum: 1000000 |
| | | | | Output parameters<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis):<br>Minimum: 0<br>Maximum: 250000 |

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Valid range |
|---|---|---|---|---|
| **Environmental compensation** | | | | |
| | | | | Output parameters<br>0x000C ($T_d$)<br>0x000E ($T_{df}$):<br>Minimum: -10<br>Maximum: +60 |
| 2053 | 0x0804 | Scale high end for analog output 2 measurement parameter.<br>Minimum and maximum values vary for different parameters. | Float | Output parameters<br>0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis):<br>Minimum: 0<br>Maximum: 1000000 |
| | | | | Output parameters<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis):<br>Minimum: 0<br>Maximum: 250000 |
| | | | | Output parameters<br>0x000C ($T_d$)<br>0x000E ($T_{df}$):<br>Minimum: -10<br>Maximum: +60 |
| 2055 | 0x0806 | Error output level (mA) | Float | Min. 0.5 mA<br>Max. 24 mA |
| 2057 | 0x0808 | Low clipping limit | Float | 0–2.5 % |
| 2059 | 0x080A | Low error limit | Float | 0–1025 % |
| 2061 | 0x080C | High clipping limit | Float | 0–12.5 % |
| 2063 | 0x080E | High error limit | Float | 0–1025 % |
| **Analog output 3** | | | | |
| 2305 | 0x0900 | Analog output 3 mode selection | Enum | **0** = Disabled<br>**1** = 4–20 mA |
| 2306 | 0x0901 | Analog output 3 measurement parameter selection. When written, scalings are reset. | Reg | 0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis)<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis)<br>0x000C ($T_d$)<br>0x000E ($T_{df}$) |
| 2307 | 0x0902 | Scale low end for analog output 3 measurement parameter.<br>Minimum and maximum values vary for different parameters. | Float | Output parameters<br>0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis):<br>Minimum: 0<br>Maximum: 1000000 |
| | | | | Output parameters |

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Valid range |
|---|---|---|---|---|
| **Environmental compensation** | | | | |
| | | | | 0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis):<br>Minimum: 0<br>Maximum: 250000 |
| | | | | Output parameters<br>0x000C ($T_d$)<br>0x000E ($T_{df}$):<br>Minimum: -10<br>Maximum: +60 |
| 2309 | 0x0904 | Scale high end for analog output 3 measurement parameter.<br>Minimum and maximum values vary for different parameters. | Float | Output parameters<br>0x0004 ($CO_2$ wet basis)<br>0x0006 ($CO_2$ dry basis):<br>Minimum: 0<br>Maximum: 1000000 |
| | | | | Output parameters<br>0x0008 ($H_2O$ wet basis)<br>0x000A ($H_2O$ dry basis):<br>Minimum: 0<br>Maximum: 250000 |
| | | | | Output parameters<br>0x000C ($T_d$)<br>0x000E ($T_{df}$):<br>Minimum: -10<br>Maximum: +60 |
| 2311 | 0x0906 | Error output level (mA) | Float | Min. 0.5 mA<br>Max. 24 mA |
| 2313 | 0x0908 | Low clipping limit | Float | 0–2.5 % |
| 2315 | 0x090A | Low error limit | Float | 0–1025 % |
| 2317 | 0x090C | High clipping limit | Float | 0–12.5 % |
| 2319 | 0x090E | High error limit | Float | 0–1025 % |
| **Analog input 1** | | | | |
| 2562 | 0x0A01 | Analog input 1 compensation parameter.<br>Read-only: controlled by the pressure and temperature compensation mode registers. | Reg | 0x0204 (pressure)<br>0x0206 (temperature) |
| 2563 | 0x0A02 | Scale low end for analog input 1 compensation parameter.<br>Minimum and maximum values vary for different parameters. | Float | 0x0204 (pressure)<br>Minimum: 0<br>Maximum: 20 000 |
| | | | | 0x0206 (temperature)<br>Minimum: -200<br>Maximum: +400 |
| 2565 | 0x0A04 | Scale high end for analog input 1 compensation parameter.<br>Minimum and maximum values vary for different parameters. | Float | 0x0204 (pressure)<br>Minimum: 0<br>Maximum: 20 000 |
| | | | | 0x0206 (temperature) |

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Valid range |
|---|---|---|---|---|
| **Environmental compensation** | | | | |
| | | | | Minimum: -200<br>Maximum: +400 |
| 2567 | 0x0A06 | Input value (read-only) | Float | |

## Status registers

### Modbus status data registers (read-only)

| Register number (decimal) | Address (hexadecimal) | Register description | Data format | Bitmask |
|---|---|---|---|---|
| 513 | 0x0200 | Device status code low | 32-bit signed integer | See Error codes in register 0x0200 (status code low). |
| 515 | 0x0202 | Device status code high | 32-bit signed integer | See Error codes in register 0x0202 (status code high). |
| 517 | 0x0204 | Pressure compensation values in use | Float | |
| 519 | 0x0206 | Temperature compensation values in use | Float | |
| 523 | 0x020A | $CO_2$ measurement status | 16-bit signed integer | **0x0000**: Unsupported<br>**0x0001**: Reading is not reliable<br>**0x0002**: Under range<br>**0x0003**: Over range<br>**0x0004**: Noisy<br>**0x0005**: Value locked<br>**0x0006**: Calibration expired<br>**0x0007**: Sensor failure<br>**0x0008**: Measurement not ready |
| 524 | 0x020B | $CO_2$ measurement status (dry basis) | 16-bit signed integer | |
| 525 | 0x020C | $H_2O$ measurement status | 16-bit signed integer | |
| 526 | 0x020D | $T_{df}$ measurement status | 16-bit signed integer | |
| 527 | 0x020E | $T_s$ measurement status | 16-bit signed integer | |
| 528 | 0x020F | Device status | 16-bit signed integer | **0x0000**: Critical failure<br>**0x0001**: Error<br>**0x0002**: Warning<br>**0x0003**: Notification |
| 529 | 0x0210 | Clear error log: the error log is cleared if 1 is written, other values are ignored. Register always reads as 0. | Function | |
| 530 | 0x0211 | Analog input level | Float | |
| 532 | 0x0213 | Analog input value | Float | |

### Error codes in register 0x0200 (status code low)

| Bitmask | Error message | Severity |
|---|---|---|
| 0x0000 | Firmware checksum mismatch. | Critical |
| 0x0001 | Device settings corrupted. | Critical |
| 0x0009 | Infrared source temperature too high. | Error |
| 0x0010 | Infrared source failure. | Error |
| 0x0011 | Infrared source failure. | Error |
| 0x0012 | Supply voltage out of range. | Error |
| 0x0013 | Internal voltage out of range. | Error |
| 0x0014 | Sensor signal low. | Error |
| 0x0015 | Sensor signal low. | Error |
| 0x0016 | Internal voltage out of range. | Error |
| 0x0017 | Sensor signal distorted. | Error |
| 0x0018 | Sensor signal distorted. | Error |

| Bitmask | Error message | Severity |
|---|---|---|
| 0x0020 | $CO_2$ measurement out of range. | Error |
| 0x0021 | $H_2O$ measurement out of range. | Error |
| 0x0022 | $T_d$ measurement out of range. | Error |
| 0x0023 | Sensor heater failure. | Error |
| 0x0024 | Infrared source temperature too high. | Error |
| 0x0025 | Internal temperature too high. | Error |
| 0x0026 | Temperature measurement error. | Error |
| 0x0027 | Supply power insufficient for analog input. | Error |
| 0x0028 | Analog input 1 out of range. | Error |
| 0x0030 | Internal temperature error. | Error |
| 0x0031 | Supply power insufficient for operation. | Error |

**Error codes in register 0x0202 (status code high)**

| Bitmask | Error message | Severity |
|---|---|---|
| 0x0032 | Sensor signal low. | Warning |
| 0x0033 | Sensor signal low. | Warning |
| 0x0034 | Internal temperature high. | Warning |
| 0x0035 | Sensor signal distorted. | Warning |
| 0x0036 | Sensor signal distorted. | Warning |
| 0x0037 | Sensor signal distorted. | Warning |
| 0x0038 | Unexpected device restart. | Warning |
| 0x0039 | Calibration has expired. | Warning |
| 0x0042 | Infrared source temperature out of range. | Warning |
| 0x0043 | Supply power insufficient for analog input. | Warning |
| 0x0044 | Infrared source temperature out of range. | Warning |
| 0x0048 | Heater off. | Info |
| 0x0049 | Calibration is about to expire. | Info |

## Device identification objects

**Device identification objects**

| Object ID (decimal) | Object ID (hexadecimal) | Object name | Example contents |
|---|---|---|---|
| 0 | 0x00 | VendorName | "Vaisala" |
| 1 | 0x01 | ProductCode | "MGP241 " |
| 2 | 0x02 | MajorMinorVersion | Software version (for example "1.2.3") |
| 3 | 0x03 | VendorUrl | "http://www.vaisala.com/" |
| 4 | 0x04 | ProductName | "Vaisala Multigas Probe MGP241" |
| 128 | 0x80 | SerialNumber [1] | Probe serial number (for example, "R0710040") |
| 129 | 0x81 | Calibration date [1] | Date of the factory calibration |
| 130 | 0x82 | Calibration text [1] | Information text of the factory calibration |

[1] Vaisala-specific device information object.

# Warranty

For standard warranty terms and conditions, see 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.

# 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 vaisala.com/support.