M211799EN-G

User Guide

Vaisala CARBOCAP® Carbon Dioxide Probe

GMP251

VAISALA

PUBLISHED BY

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1. About This Document

1.1 Version Information

Table 1 Document versions

Document Code	Date	Description
M211799EN-G	March 2018	• Added information about using the probe with Vaisala Insight PC software. • PuTTy terminal settings instructions updated. • Calibration uncertainty specification updated. • Added recommendation to disable MI70 indicator's automatic power off feature when used with GMP251. • Updated instructions on using MI70 to configure environmental compensations. • Default device address in serial line communication corrected (240). • Corrected the unit information of **sdelay** command. • Added a note about maximum voltage output to analog error state output configuration. • Information on Modbus register numbers updated.
M211799EN-F	June 2017	• Added information about using the probe with Vaisala Indigo transmitters. • Modbus status register values updated. • Spray shield accessory ASM212017SP added. • Calibration uncertainty specification updated. • Calibration adapter order code corrected.
M211799EN-E	August 2016	Modbus status register values and descriptions updated.

1.2 Related Manuals

Table 2 Related Manuals

Document Code	Description
M211798EN	Vaisala CARBOCAP® Carbon Dioxide Probe GMP251 Quick Guide
M211897EN	Vaisala CARBOCAP® Carbon Dioxide Probe GMP252 User Guide
M211893EN	Vaisala CARBOCAP® Carbon Dioxide Probe GMP252 Quick Guide
M211877EN	Vaisala Indigo™ 201 Analog Output Transmitter User Guide
M211876EN	Vaisala Indigo™ 201 Analog Output Transmitter Quick Guide
M211966EN	Vaisala Indigo™ 202 Digital Transmitter User Guide
M211967EN	Vaisala Indigo™ 202 Digital Transmitter Quick Guide

1.3 Documentation Conventions

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! 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.

1.4 Trademarks

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

Windows® is either a registered trademark or trademark of Microsoft Corporation in the United States and other countries.

All other product or company names that may be mentioned in this publication are trade names, trademarks, or registered trademarks of their respective owners.

1.5 Patent Notice

This product is protected by the following patents and their corresponding national rights:

Table 3 Applicable Patents

Patent Issued By	Patent Number
United States Patent and Trademark Office	US 5,827,438
	US 6,177,673
European Patent Office	EP0776023
	EP0922972
German Patent and Trade Mark Office	69615635

Patent Issued By	Patent Number
Japan Patent Office	4263285
Finnish Patent Office	112005
	105598

2. Product Overview

2.1 Introduction to GMP251

GMP251 is designed for CO_2 measurement in demanding applications that require reliable and accurate performance. The measurement range is 0 ... 20 %CO_2.

The probe is based on Vaisala's patented 2nd generation CARBOCAP® technology and equipped with Vaisala Microglow infrared light source. The probe is easy to install with a plug-in/plug-out M12 connection.

Sensor performance is optimized at 5 %CO_2 measurement. For compensation purposes, the probe also includes an internal temperature sensor that allows measurement compensation according to ambient temperature. As dust and most chemicals do not affect the measurement, and the effect of temperature, pressure and background gas can be compensated for, the probe can provide accurate and stable measurements in a wide range of applications.

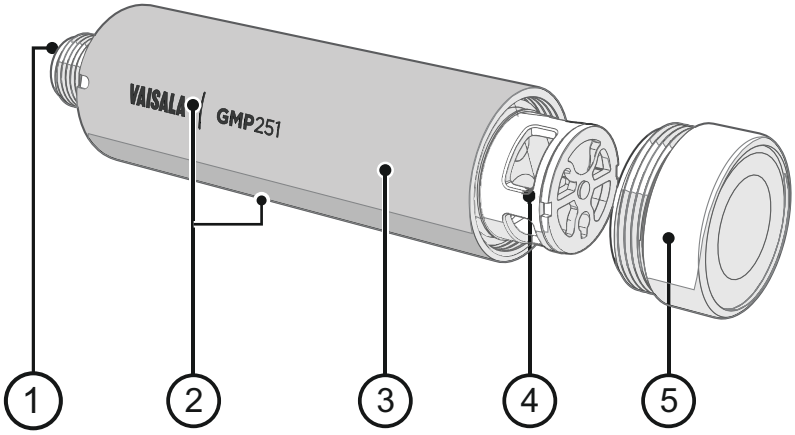


Figure 1 GMP251 Probe Parts

1 5-pin M12 connector. For pinout, see Wiring (page 24).
2 Probe name and orientation mark for Vaisala transmitter installations (front) and laser-printed type label (back).
3 Probe body. Contains the main component board.
4 Measurement cuvette with optics and CARBOCAP® CO_2 sensor.
5 Filter (see Filter Options (page 13).

CAUTION! Do not attempt to open the probe body. There are no user serviceable parts inside the probe body.

2.2 Basic Features and Options

- CO_2 measurement range 0 ... 20 %.
- Vaisala CARBOCAP® CO_2 sensor with excellent long-term stability.
- Measurement compensated for effects of temperature, pressure, and background gas. The temperature compensation can be based on an integrated temperature sensor or use a set temperature. Pressure and background gas parameters can be set to the probe.
- Heating to avoid condensation on optical elements.
- Digital output with RS-485:
  - Modbus RTU
  - Vaisala Industrial Protocol
- Analog output:
  - Current output (0 ... 20 mA or 4 ... 20 mA)
  - Voltage output (0 ... 5 V or 0 ... 10 V)
- Compatible with MI70 hand-held meter
- Can be used as a stand-alone probe or with Vaisala Indigo transmitters.
- Can be connected to Vaisala Insight software for configuration, diagnostics, and temporary online monitoring.
- Easy plug-in, plug-out.

More Information

- Operating Principle of CO2 Measurement (page 14)
- Environmental Compensation (page 15)
- GMP251 Specifications (page 101)
- Vaisala Industrial Protocol Overview (page 25)
- Modbus (page 57)
- Overview of MI70 Support (page 83)

2.2.1 Connectivity to Vaisala Insight Software

The probe can be connected to Vaisala Insight software using a Vaisala USB cable (no. 242659). With the Insight software, you can:

- Calibrate and adjust the measurement.
- See device information and status.
- See real-time measurement.
- Configure serial communication settings, purge settings, filtering factor, and analog output parameters and scaling.

More Information

- Connecting to Insight Software (page 59)

2.2.2 Additional Features with Indigo Transmitters

GMP251 probes manufactured from 2017 onwards are compatible with Vaisala Indigo transmitters. Connecting the probe to an Indigo transmitter provides a range of additional options for outputs, measurement viewing, status monitoring, and configuration interface access.

Examples of additional features available with Indigo transmitters include:

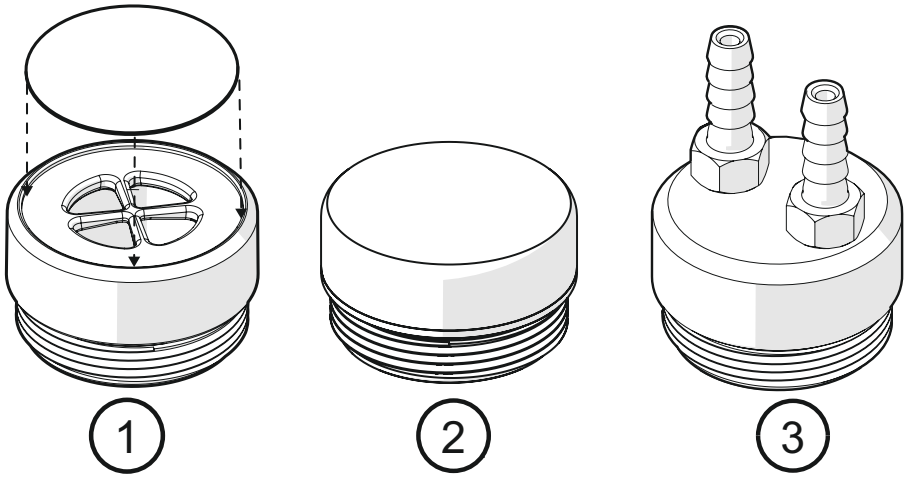
- 3.5" TFT LCD color display or non-display model with LED indicator
- Digital output or 3 analog outputs (depending on the transmitter model)
- 2 configurable relays
- Wireless browser-based configuration interface for mobile devices and computers (IEEE 802.11 b/g/n WLAN)

The selection of available additional features (for example, output and connectivity options) varies depending on the Indigo transmitter model. For more information on Indigo transmitters, see www.vaisala.com/indigo.

More Information

‣ Indigo Overview (page 61)

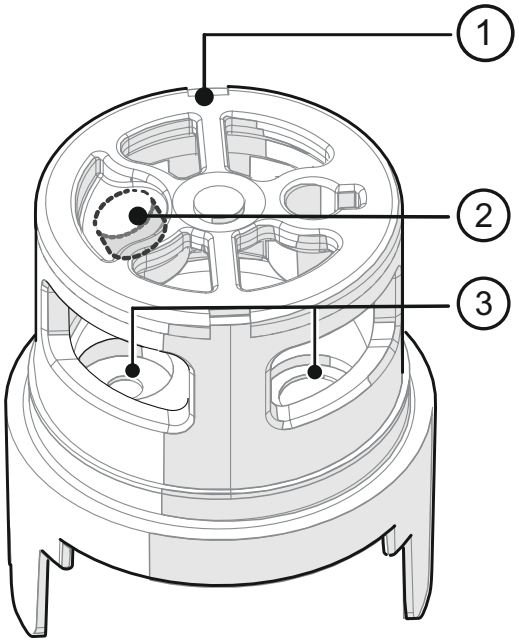
2.3 Filter Options



The following filter options are available for GMP251:

1. Standard membrane filter, order code ASM211650SP. Gas can enter only through the top of the filter (plastic grid covered with membrane), the sides of the filter are solid.
2. Porous sintered PTFE filter for extra protection, order code DRW243649SP. The porous material of the filter allows gas to enter from all sides of the filter.
3. Flow-through adapter, order code ASM211697SP. Two gas ports for controlled gas feed (port outer diameter 4.6 mm, port hole inner diameter 2 mm, suitable for tubing with 4 mm inner diameter).

2.4 Operating Principle of CO_2 Measurement



The Vaisala CARBOCAP® sensor used in the probe is a silicon-based, nondispersive infrared (NDIR) sensor for measurement of gaseous carbon dioxide in air-like gases.

Figure 2 Probe Cuvette with Mirror and Sensor Chips

1 Cuvette
2 Mirror
3 Sensor chips under TO5 package

The sensitivity to carbon dioxide 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 a thermopile detector that measures the light intensity at a wavelength determined by a Fabry–Pérot interferometer (FPI) and a band pass filter.

The carbon dioxide measurement consists of two steps: first, the FPI is electrically tuned so that its pass band coincides with the characteristic absorption wavelength of carbon dioxide 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 carbon dioxide 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. A heater chip is utilized to prevent condensation in normal operation.

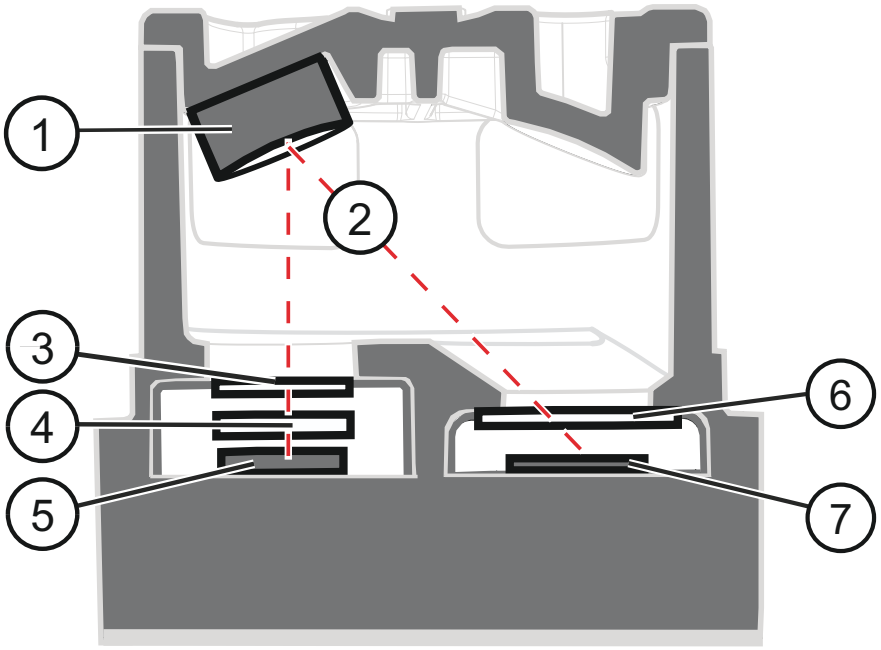


Figure 3 CO_2 Measurement in the Measurement Cuvette

1 Gold-plated mirror
2 Light absorbed by CO_2 in the measured gas
3 Hermetic window
4 Fabry-Pérot interferometer
5 Light source (Microglow)
6 Hermetic window
7 Thermopile detector

2.5 Environmental Compensation

When necessary, various environmental compensations can be applied to improve the CO_2 measurement accuracy of the probe.

The probe can compensate for the effects of the following parameters:

- Temperature
- Pressure
- Background gas oxygen (O_2) content
- Background gas relative humidity (%RH)

To apply an accurate relative humidity compensation, make sure that also the temperature compensation and pressure compensation configurations match the measurement environment.

The probe has an on-board temperature sensor that can be used to compensate for temperature. Additionally, if the probe is integrated in a system that measures one or more of the compensation parameters (T, P, RH, O_2), they can be updated to the probe continuously.

Compensation parameters are configured on the order form when ordering the probe, and can later be updated using Vaisala Industrial Protocol or Modbus protocol.

You can also turn off any of the compensations. In that case, the probe uses the default compensation value that is mathematically neutral for the probe's internal compensation model.

You can configure the environmental compensation settings with any of the following options:

- Vaisala Industrial Protocol serial commands
- Vaisala Insight software
- Indigo transmitter's wireless configuration interface
- Modbus configuration registers
- MI70 hand-held indicator

The environmental compensation configuration options available in the MI70 handheld indicator are not compatible with the probe. Using MI70 to configure the environmental compensation settings of the probe can decrease measurement accuracy.

More Information

- Effect of Environmental Compensations (page 93)
- Environmental Compensation Commands (page 49)
- Vaisala Insight Software (page 59)
- Changing Environmental Compensation Settings with Indigo (page 74)
- Configuration Registers (page 110)
- Changing Environmental Compensation Settings with MI70 Indicator (page 86)

2.5.1 Temperature Compensation

The probe can measure the approximate temperature of the CARBOCAP® sensor for compensation, or use a fixed setpoint. Unless a dedicated temperature measurement is available and can be regularly updated to the probe, it is strongly recommended to use the probe's internal temperature compensation to ensure real-time accurate measurements. If the measurement is made in a constant temperature, the constant temperature can be set as the compensation value (fixed setpoint option).

If temperature compensation is turned off, the probe uses the default value of +25 °C (+77 °F).

When the probe is installed through a flange and part of the probe and the cable is left outside the measuring environment, it is possible that temperature conduction from the probe body and cable outside the measurement environment affects the temperature compensation and decreases measurement accuracy.

2.5.2 Pressure Compensation

The probe does not have on-board pressure measurement. However, a pressure reading from an external source can be used as a setpoint value for compensation using Vaisala Industrial Protocol or Modbus.

If pressure compensation is turned off, the probe uses the default compensation value of 1013 hPa.

2.5.3 Background Gas Compensation

The probe does not have on-board oxygen or relative humidity measurement. However, oxygen and relative humidity readings from an external source can be used as setpoint values for compensation via Vaisala Industrial Protocol or Modbus. The default setpoint values are as follows:

- Oxygen concentration: 19.7 %O_2 or 21 %O_2
- Relative humidity: 50 %RH or 93 %RH

If background gas compensations are turned off, the probe uses the value 0 % for both.

More Information

- Environmental Compensation (page 15)
- Configuration Registers (page 110)

2.6 Probe Startup

When powered on, the probe starts up within 20 seconds. Measurements from the outputs (digital and analog) become available during this time but note that they will only reach specified accuracy after a 4-minute warm-up period. For this reason, you should design your system so that it does not rely on measurements from the probe during this time.

Specifically note that the CO_2 reading will rise to the correct reading as the sensor's infrared emitter achieves operation temperature.

2.7 Filtering Factor

You can set a filtering factor that affects the speed at which the latest CO_2 measurement is integrated into the output of the probe. This allows averaging the output if the measuring environment produces occasional exceptionally high or low readings.

The filtering factor can be set either with Modbus configuration registers or with an Indigo transmitter's wireless configuration interface.

More Information

- Configuration Registers (page 110)
- Configuring Filtering Factor with Indigo (page 75)

2.8 Analog Output Overrange Behavior

The analog output of the probe has a defined behavior when the values measured by the probe are outside the scaled analog output range. At first, the output is clipped when the measurement exceeds a set limit (the measurement continues, but the output does not change from the clipped value).

When the measurement exceeds the second limit (error limit), the analog output switches to the error state defined for the output.

The table below lists the clipping and error limits and default error state outputs for the analog voltage and current outputs.

Table 4 Analog Output Overrange Clipping and Error Limits

Output Voltage / Current	Clipping Limit	Error Limit	Default Error State Output
0 ... 5 V	>5 %	>10 %	0 V
0 ... 10 V	>1 %	>10 %	0 V
0 ... 20 mA	>5 %	>10 %	23 mA
4 ... 20 mA	>5 %	>10 %	2 mA

The same clipping and error limits are applied when the measured value drops back to the scaled range: at first the output returns to the clipped value from the error state, and then to normal output.

Clipping and error state limits differ for 0 ... 10 V and 0 ... 5 V outputs. For 0 ... 10 V output the limits are 1 % and 10 %, and for 0 ... 5 V output the limits are 5 % and 10 %.

When setting the error output voltage (**amode** command), note that the probe's maximum voltage output is 10.325 V.

More Information

- Analog Output (page 41)
- Configuring Analog Outputs with Indigo 201 (page 69)
- Analog Output (page 41)

2.8.1 Analog Output Overrange Example

Consider a probe with 0 ... 5 V output, scaled to 0 ... 200 000 ppm (= 0 ... 20 %) CO_2.

- When the measured CO_2 rises above 20 %, the output rises above 5 V.
- The output keeps rising until the measurement is 21 %CO_2, at which point the probe outputs 5.25 V.
- If the CO_2 level rises above 21 %CO_2, the output still remains at 5.25 V.
- If the CO_2 level rises above 22 %CO_2, the output enters the error state, which is 0 V for the 0 ... 5 V output.

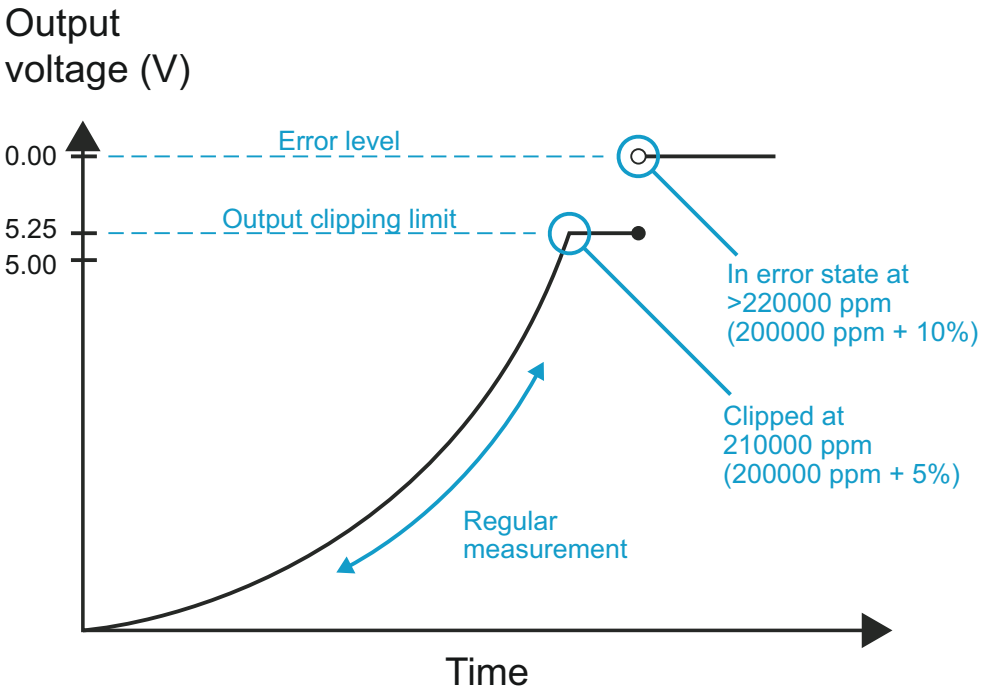


Figure 4 Example of Analog Output Overrange Behavior

This example uses output scaled to 0 ... 5 V and 0 ... 200000 ppm, error level set to 0 V, clipping set to 5 % overrange, and error limit set to 10 % overrange. CO_2 concentrations (ppm) are indicated for the clipping point and error limit point.

This overrange and error behavior is specific to the analog output, and does not affect the readings of the digital outputs.

You can change the analog output overrange behavior using the **aover** command.

2.9 Safety

The probe delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

WARNING! When returning a product for calibration or repair, make sure it has not been exposed to dangerous contamination, and is safe to handle without special precautions.

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

CAUTION! Do not attempt to open the probe body. There are no user serviceable parts inside the probe body.

2.9.1 ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching an exposed contact on the product.

To make sure you are not delivering high static voltages yourself, avoid touching the pins on the M12 connector.

2.10 Regulatory Compliances

The probe is in conformity with the provisions of the following EU directives:

- RoHS Directive
- EMC Directive

Conformity is shown by compliance with the following standards:

- EN 50581: Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.
- EN 61326-1: Electrical equipment for measurement, control, and laboratory use – EMC requirements – Generic environment.
- EN 55022: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.

3. Installation

3.1 GMP251 Probe Dimensions

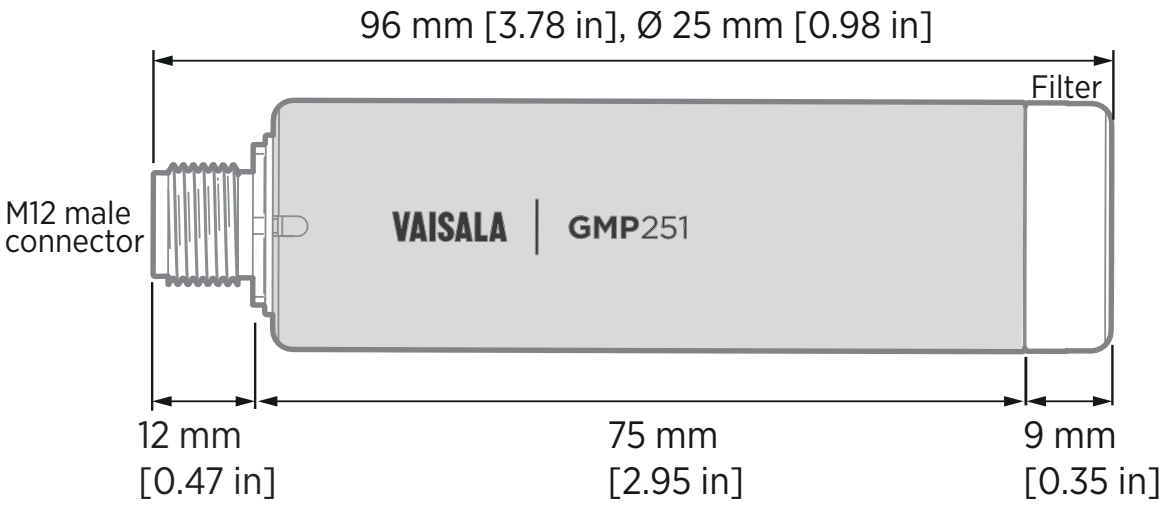


Figure 5 GMP251 Dimensions

3.2 Recommended Installation

The probe can be installed in an environment with an operating temperature range -40 ... +60 °C (-40 ... +140 °F). Make sure the probe is in a location that represents the measurement environment properly.

The 5-pin male M12 connector on the probe provides an easy plug-in/plug-out connection to a compatible cable.

3.3 Installation Accessories

The probe can be installed through a surface using the optional flange accessory (Vaisala product code 243261SP), or attached for example to a wall with the optional clip accessory (two-clip set, Vaisala product code 243257SP).

For installations where a pressure washer is used to clean the measurement area, a spray shield with an IP9X rating (Vaisala product code ASM212017SP) is available as an optional accessory.

3.3.1 243261SP Mounting Flange

The optional flange accessory is used to install the probe body through a wall or other surface.

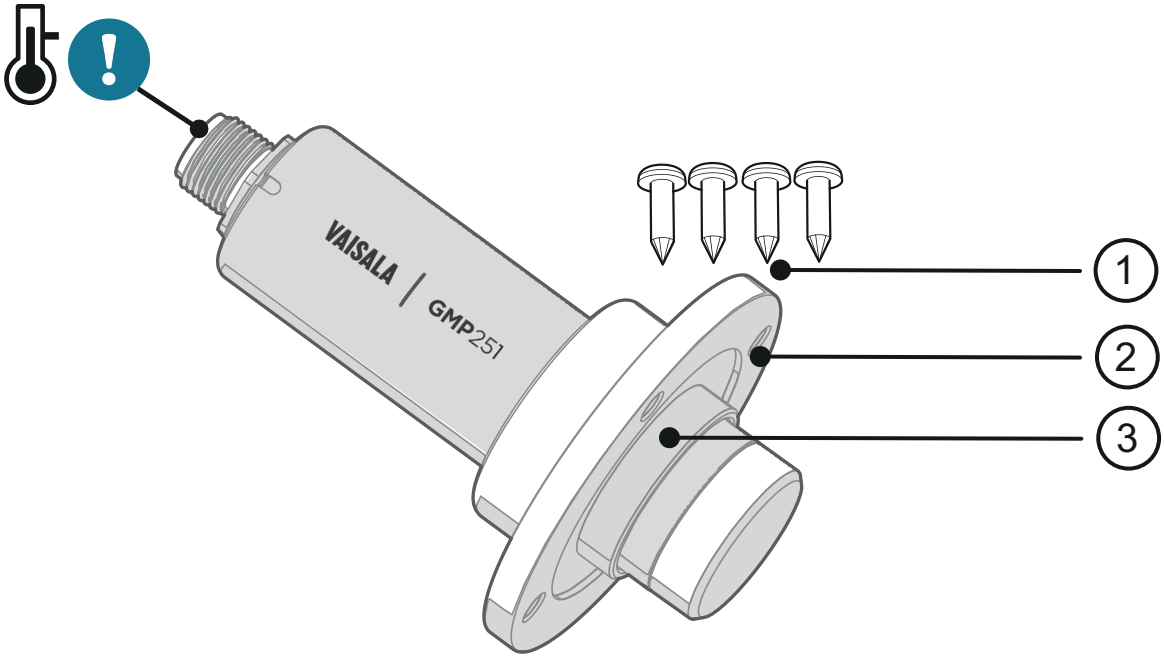


Figure 6 Probe with 243261SP Mounting Flange

1 4 Phillips head screws (included)
2 Mounting flange (diameter 60 mm) with four Ø 4.2 mm screw holes
3 Gasket ring

Leaving part of the probe body and the cable outside the measurement environment can cause heat conduction that affects the temperature compensation and measurement accuracy.

3.3.2 243257SP Mounting Clips

The optional mounting clips (set of two clips) are used to hold the probe in place for example on a wall or other surface. Each clip base attaches to the installation surface with one screw (screw hole Ø 4.2 mm).

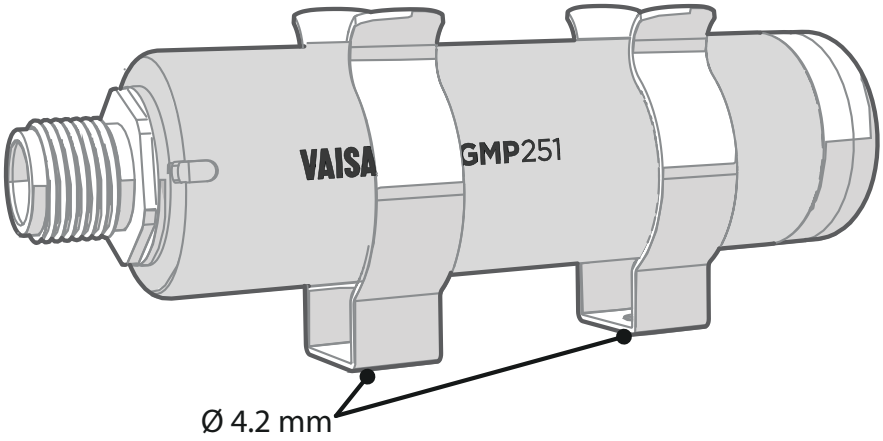


Figure 7 Probe in 243257SP Mounting Clips

3.3.3 ASM212017SP Spray Shield

The optional spray shield (Vaisala order code: ASM212017SP) allows washing the probe with a pressure washer without exposing the sensor to moisture (IP9X rating).

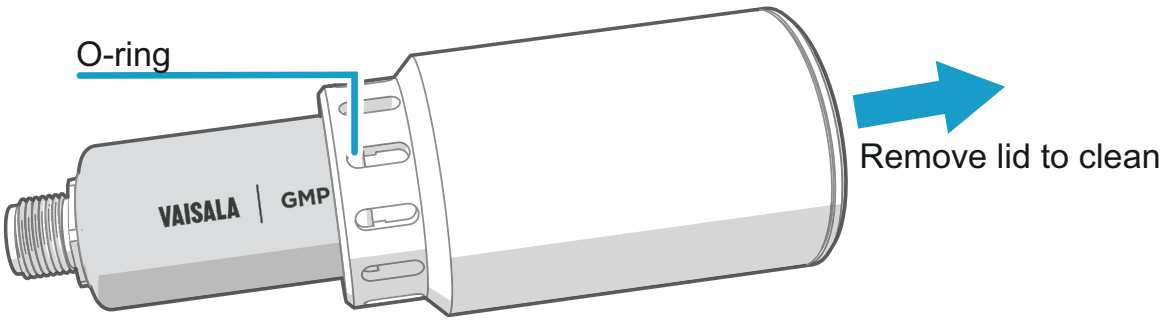


Figure 8 Probe with ASM212017SP Spray Shield

The spray shield can limit or prevent the use of the probe mounting clips (243257SP).

More Information

- ASM212017SP Spray Shield Dimensions (page 106)

3.4 Power Supply

The supply voltage range of the probe is 12 ... 30 VDC with the digital output option. If the analog output is used, the supply voltage range is 12 ... 30 VDC for voltage output and 20 ... 30 VDC for current output.

Typical power consumption is less than 0.4 W in continuous operation, and the maximum is 0.5 W.

More Information

- GMP251 Specifications (page 101)

3.5 Wiring

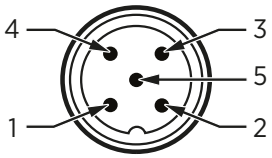


Table 5 M12 Male Connector

Pin#	Function	Note	Cable 223263SP Wire Colors
1	Power in	• With digital output: 12 ... 30 VDC • With voltage output: 12 ... 30 VDC • With current output: 20 ... 30 VDC Typical average power consumption <0.4 W, maximum 0.5 W.	Brown
2	RS-485- or voltage output	Voltage: 0 ... 5 VDC or 0 ... 10 VDC (default analog output scaling)	White
3	GND	–	Blue
4	RS-485 + or current output	Current: 0 ... 20 mA or 4 ... 20 mA (default analog output scaling)	Black
5	Output control	Connecting pin #5 to GND (pin #3) forces the probe to analog output mode. If an analog output configuration has not been selected, default 0 ... 10 VDC and 4 ... 20 mA scalings are used. If pin #5 is not connected, the analog or digital output selected when ordering or set later through configuration is used.	Gray

Note that the probe always remains in analog mode when pin #5 is connected to pin #3, and cannot be switched to digital output in this wiring option.

4. Vaisala Industrial Protocol

4.1 Vaisala Industrial Protocol Overview

The RS-485 line of the probe provides an implementation of the Vaisala Industrial Protocol that can be used for service and configuration use, or for interfacing with the system to which the probe is integrated. The protocol is a plaintext protocol suitable for use both by human operators and automated systems.

4.2 Serial Interface Settings

Table 6 Default Serial Interface Settings

Property	Description/Value
Bit rate	19200
Parity	None
Data bits	8
Stop bit	1
Flow control	None

4.3 Physical Interface

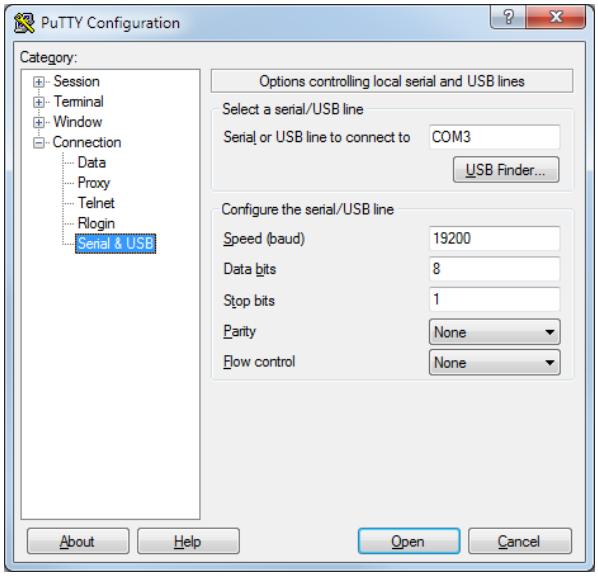
The physical interface is a non-isolated 2-wire interface. The data lines are RS-485 D- and RS-485 D+. Ground is shared with power supply. The connector is a 5-pin male M12.

4.4 Connecting with a Computer

- Vaisala USB service cable (order code 242659)
- Computer with:
  - Windows operating system
  - Terminal application (for example PuTTy, available from www.vaisala.com/software)
  - Free USB port
  - Driver for Vaisala USB service cable installed (available on the cable installation media and at www.vaisala.com/software)

The steps below describe how to connect to the probe using the PuTTY terminal application for Windows and a USB computer connection cable. Connecting with a computer allows you to configure and troubleshoot your probe using serial line commands.

1. If you have not used the Vaisala USB cable before, install the driver before attempting to use the cable.
2. Connect the USB serial interface cable between your computer and the M12 connector of the probe.
3. Start the PuTTY application.
4. Select **Connection > Serial & USB** and check that the correct COM port is selected in the **Serial or USB line to connect to** field. If you are using the PuTTY terminal application supplied by Vaisala, you can press the **USB Finder** button to open the Vaisala USB Instrument Finder program.
5. Check that the other serial settings are correct for your connection, and change if necessary. **Flow control** should be set to **None** unless you have a reason to change it.



6. Select **Terminal**. Use the following settings:
   Local Echo: Select **Force on**. This setting ensures that your typing is shown on the session window.

> **CAUTION!** Make sure that the **Send line ends with line feeds (CR+LF)** option is not selected. Enabling this option can cause issues with the terminal connection.

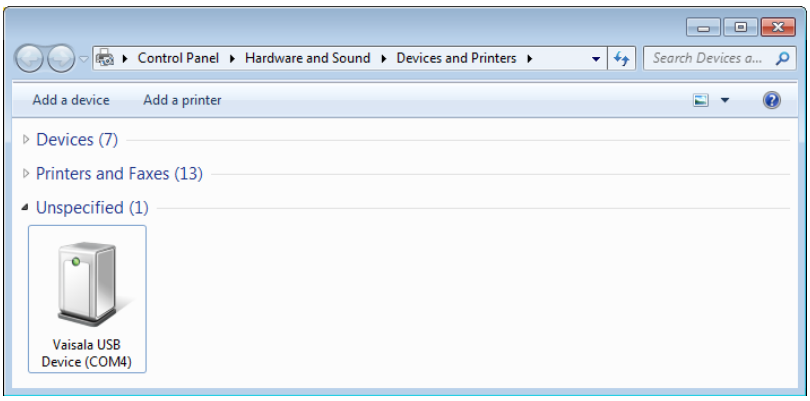
7. To open the connection window and start using the serial line, select **Open**.

> If PuTTY is unable to open the serial port you selected, it shows you an error message instead. If this happens, restart PuTTY and check the settings.

4.4.1 Installing the Driver for the USB Service Cable

Only Windows® operating systems are supported by the driver of the USB service cable.

1. Connect the USB service cable to a USB port on your computer. Windows® detects the new device and installs the appropriate driver.
2. Open **Devices and Printers** from the Windows® Start menu. Use search to find it if necessary (search for "devices").
3. Locate the cable in the list of devices:
   - If the device is listed as **Vaisala USB Device** with a COM port number in brackets, the cable is ready for use. **Note the COM port number, you will need it later.**
   - If the device is listed as **Vaisala USB Instrument Cable** without a COM port number listed, you must install the driver manually.



4. To install the driver manually:
   a. Disconnect the USB service cable from the computer.
   b. Download the Vaisala USB driver at http://www.vaisala.com/software (select the appropriate USB Instrument Driver Setup for your cable).
   c. Run the USB driver installation program *`Vaisala USB Device Driver Setup.exe`*. Accept the installation defaults.
   d. Go back to step 1 and verify that the driver installation works as expected.

4.5 Accessing Serial Commands from Modbus or Analog Mode

1. Connect the USB cable to your PC and start the terminal application as instructed in Connecting with a Computer (page 25).
2. Start a new terminal session using the default serial settings.

3. Keep the Enter key pressed down and connect the probe to the USB cable. When the probe is powered on (connected to your PC with the USB cable), you must send five carriage returns (Enter key presses) within 0.7 seconds to force the probe to serial command mode. The probe model information appears in the terminal application when the mode has been succesfully changed, and Vaisala Industrial Protocol commands are available for use.
4. To test the connection, enter for example the **?** command. If the mode change failed, close the terminal application, disconnect the probe from the USB cable, and repeat step 2 and step 3.
5. To keep the serial mode in use (forced serial mode access is temporary and switches off at reset), select a serial output option (stop/run/poll) with the **smode** command.

Note that the probe always remains in analog mode when pin #5 is connected to pin #3, and cannot be switched to digital output in this wiring option.

4.6 Enabling Modbus Mode from Vaisala Industrial Protocol

If you need to switch from Vaisala Industrial Protocol to Modbus mode, you must configure the following settings:

- Serial line operating mode
- Modbus address
- Serial line settings (bit rate, parity, stop and data bits)

1. Connect the USB cable to your PC and start the terminal application as instructed in Connecting with a Computer (page 25).
2. Set the serial mode to Modbus with the **smode** command:

```
smode modbus
```

3. Set the Modbus address to 240 with the **addr** command:

```
addr 240
```

4. Set the serial line settings to 19200/N/8/2 with the **seri** command:

```
seri 19200 N 8 2
```

5. Power off (disconnect) the probe or reset with the **reset**command. The new configuration is available at the next restart.

4.7 Changing From Digital Output to Analog Output

1. Set up a terminal connection as instructed in Connecting with a Computer (page 25).
2. Change the mode from digital to analog with the **smode** serial command: **smode analog**.
3. Reset the probe (disconnect and reconnect the cable or use the **reset** serial command) to power on in analog output mode.

4.8 Serial Commands

The notation **<cr>** refers to the carriage return control character, which you can send in a terminal application by pressing enter on your keyboard. Before entering commands, send a **<cr>** to clear the command buffer.

You can enter the commands in uppercase or lowercase. In the command examples, the keyboard input by the user is in bold type.

Table 7 (page 29) lists the basic serial commands that are available by default. To access advanced serial commands (listed in Table 8 (page 30)), enter the command **pass 1300**.

Table 7 Basic Serial Commands

Command	Description
Device information and status	
?	Show probe information.
??	Show probe information (will respond in **POLL** mode).
errs	Show currently active errors.
help	Show list of currently available serial commands.
snum	Show probe serial number.
system	Show probe firmware information.
time	Show probe operation hours and uptime.
vers	Show probe firmware version.
Serial line output and communication	
close	Close connection to probe (**POLL** mode)
form [modifier string]	Show or set output format.

Command	Description
intv [0 ... 255 s/min/h]	Set continuous output interval for **R** command.
open [address]	Open connection to probe in **POLL** mode.
r	Start the continuous outputting.
s	Stop the continuous outputting.
sdelay [1 ... 255]	Show or set serial line transmission delay (1 ... 255, 1 unit = 4 milliseconds)
send	Output a single measurement message.
seri [baud data stop parity]	Show or set the serial interface settings.
smode [mode]	Show or set startup serial mode: **RUN**, **STOP**, or **POLL**.
Environmental compensation	
env	Show or set environmental parameters.
Adjustment information	
adate	Show CO_2 factory adjustment date.
atext	Show CO_2 factory adjustment information.
Other commands	
reset	Reset the probe.
pass [1300]	Access advanced serial commands.

Table 8 Advanced Serial Commands

Command	Description
Serial line output and communication	
addr [0 ... 254]	Show or set probe address.
Analog output	
amode	Show or set analog output mode (analog output limits and error level).
aover	Show or set analog output overrange and clipping behavior.
asel	Show or set analog output parameter and scaling.
Calibration and adjustment	
cco2	Adjust CO_2 measurement gain and offset.
cdate	Show or set calibration date.
ct	Adjust temperature measurement offset.
ctext	Show or set calibration information.
Environmental compensation	
o2cmode	Show or set oxygen compensation mode.

Command	Description
pcmode	Show or set pressure compensation mode.
rhcmode	Show or set humidity compensation mode.
tcmode	Show or set temperature compensation mode.
Other commands	
frestore	Restore probe to factory settings.

4.9 Device Information and Status

Table 9 ? Command

Syntax	Description
?<cr>	Show listing of device information.
??<cr>	Show listing of device information even if device is in poll mode and connection has not been opened using the **open** command.

Example:

```
?
Device : GMP251
Copyright : Copyright (c) Vaisala Oyj 2015. All rights
reserved.
SW Name : GMP251
SW version : 1.0.0
SNUM : GMP233_5_18
SSNUM : S1234567
CBNUM : c1234567
Calibrated : 20150604 @ Vaisala/R&D
Address : 0
Smode : STOP
```

Table 10 Errs Command

Syntax	Description
errs<cr>	Show active error(s). For a list of possible errors and their remedies, see Error Messages (page 97).

Syntax	Description
Example (no active errors): **errs** NO CRITICAL ERRORS NO ERRORS NO WARNINGS STATUS NORMAL	

Table 11 Help Command

Syntax	Description
help<cr>	Show list of currently available serial commands.
Example (showing a list of the basic commands): **help** ADATE ADDR ATEXT CLOSE ENV ERRS FORM HELP INTV PASS RR ESET RX SDELAY SEND SENDX SERI SMODE SNUM SYSTEM UNIQID TIME VERS	

Table 12 Snum Command

Syntax	Description
snum<cr>	Show serial number of the probe.

Syntax	Description
Example: **snum** SNUM : M0220028	

Table 13 System Command

Syntax	Description
system<cr>	Show probe firmware information.
Example: **system** Device Name : GMP251 SW Name : GMP251 SW version : 1.0.0 Operating system : TSFOS1.0	

Table 14 Time Command

Syntax	Description
time<cr>	Show how long the probe has been in operation since the last startup or reset. The operation counter is in format hh:mm:ss.
Example: **time** Time : 01:41:24	

Table 15 Vers Command

Syntax	Description
vers<cr>	Show firmware version of the probe.
Example: **vers** SW version : 1.0.0	

4.10 Serial Line Output and Communication

Table 16 Addr Command

Syntax	Description
addr<cr>	Show current device address. Addresses are required for **POLL** mode.
addr [aaa]<cr>	Set new device address. **aaa** = address, 0 ... 254 (default = 240)
Example (shows 0 as current address, enter 5 as the new address): **addr** Address : 0 **addr 5** Address : 5	

Table 17 Close Command

Syntax	Description
close<cr>	Close the connection that was opened with the **open** command.
Example: **close** line closed	

Table 18 Form Command

Syntax	Description
form<cr>	Show the currently used measurement format.
form /<cr>	Reset measurement format to default.
form [sss]<cr>	Set a new measurement format. **sss** = String consisting of modifiers and abbreviations for measured parameters. See Table 19 (page 36) and Table 20 (page 36). Maximum length is 150 characters. Maximum length may be shorter when text strings are used.

Syntax	Description
Example (show currently used measurement format (default format shown here)): **form** 6.0 "CO2=" CO2 " " U3 #r #n Output example (continuous output from RUN mode): CO2= 452 ppm	
Example (set output format as %CO_2): **form 3.1 "CO2=" CO2% " " U4 #r #n** OK Output example (continuous output from RUN mode): CO2= 5.1 %CO2 CO2= 5.1 %CO2 CO2= 5.0 %CO2 ...	
Example (set output format as CO_2 ppm with Modulus-65536 checksum): **form 6.0 "CO2=" CO2 " " U3 " " CS4 #r #n** OK Output example (continuous output from RUN mode): CO2= 3563 ppm 9F CO2= 3562 ppm 9E CO2= 3559 ppm A4 ...	

Syntax	Description

Example (set output format as CO_2 ppm, with **start of text** (ASCII character 002) and **end of text** (003) ASCII codes, and without line feed and carriage return at the end):
`form #002 6.0 "CO2=" CO2 " " U3 #003`
`OK`
Output example (continuous output from RUN mode, ASCII codes not visible here):
`CO2= 866 ppm CO2= 866 ppm CO2= 867 ppm CO2= 867 ppm`
`CO2= 867 ppm CO2= 868 ppm CO2= 868 ppm CO2= 869 ppm`
`...`	

Table 19 Output Parameters for Form Command

Output Parameter	Abbreviation in Form Command
Carbon dioxide in ppm	**co2**
Carbon dioxide in percent	**co2%**
Currently used temperature compensation value	**tcomp**
Currently used pressure compensation value	**pcomp**
Currently used oxygen concentration compensation value	**o2comp**
Currently used relative humidity compensation value	**rhcomp**

Table 20 Modifiers for Form Command

Modifier	Description
x.y	Length modifier (number of digits and decimal places).
#t	Tabulator.
#r	Carriage return.
#n	Line feed.
""	String constant, length 1 ... 15 characters.
#xxx	ASCII code value (decimal) of a special character; for example, #027 for ESC.
addr	Probe address (0 ... 254).
sn	Probe serial number.
time	Cumulative operating hours of the probe.

Modifier	Description
ux	Name of the measurement unit using x number of characters. For example, **u3** shows the name of the measurement unit with three characters.
cs4	Modulus-65536 checksum of message sent so far, ASCII encoded hexadecimal notation.
csx	NMEA xor-checksum of message sent so far, ASCII encoded hexadecimal notation.

You can also use the backslash character \ instead of the hash character #.

Table 21 Intv Command

Syntax	Description
intv<cr>	Show the output interval of the automatically repeating measurement messages (**r** command and run mode).

intv [iii uuu]<cr>	Set the output interval.
	• iii = interval, range 0 ... 255
	• u = unit for interval setting:
	  • s = seconds
	  • min = minutes
	  • h = hours
	If you set the interval to 0, the output messages are output as quickly as they are generated, without additional delay.

Example: **intv 5 s** Output interval: 5 S	

Table 22 Open Command

Syntax	Description
open [aaa]<cr>	Open a connection to a device at the specified address. Required when device is in poll mode. **aaa** = address, range 0 ... 254.

Syntax	Description
Example (target probe in POLL mode, with address 52): **open 52** GMP251: 52 Opened for operator commands	

Table 23 R Command

Syntax	Description
r<cr>	Start the continuous outputting of measurement values as an ASCII text string to the serial line. The probe keeps outputting measurement messages at the interval that has been set with the **intv** command until stopped with the **s** command.
Example: **r** CO2= 5.1 %CO2 CO2= 5.1 %CO2 CO2= 5.1 %CO2 CO2= 5.0 %CO2 CO2= 5.0 %CO2 ...	

Table 24 S Command

Syntax	Description
s<cr>	Stop the continuous outputting that was started with the **r** command.
Example: ... CO2= 5.1 %CO2 CO2= 5.0 %CO2 CO2= 5.0 %CO2 **s**	

Table 25 Sdelay Command

Syntax	Description
sdelay<cr>	Show serial line transmission delay (1 ... 255, 1 unit = 4 milliseconds).

Syntax	Description
sdelay [delay]<cr>	Set a new serial line transmission delay. **delay** = Serial line delay, range 1 ... 255 (1 unit = 4 milliseconds).
Example (set delay to 0.1 seconds = 25 units): **sdelay 25** COM transmit delay : 25	

Table 26 Send Command

Syntax	Description
send<cr>	Output a single measurement message.
send [aaa]<cr>	Output a single measurement message from a device in poll mode. **aaa** = address of the probe, range 0 ... 254
Example: **send** CO2= 5.0 %CO2	
Example (target probe in **POLL** mode, with address 52): **send 52** CO2= 5.0 %CO2	

Table 27 Seri Command

Syntax	Description
seri<cr>	Show current serial line settings.

Syntax	Description
seri [b p d s]<cr>	Set new serial line settings. The new settings will be taken into use when the probe is reset or powered up. **b** = baud rate (9600, 19200, or 38400) **p** = parity • **n** = none • **e** = even • **o** = odd **d** = data bits (7 or 8) **s** = stop bits (1 or 2) For Modbus, baud rate must be 9600 ... 38400 and parity must be none.

Example (show current settings):

```
seri
Com1 Baud rate : 19200
Com1 Parity : N
Com1 Data bits : 8
Com1 Stop bits : 1
```

Example (set serial line to 9600 baud, even, 7 data bits, and 1 stop bit, and reset the probe to take the new settings in use):

```
seri 9600 e 7 1
OK
seri
Com1 Baud rate : 9600
Com1 Parity : E
Com1 Data bits : 7
Com1 Stop bits : 1
reset
GMP251 1.0.0
```

Table 28 Smode Command

Syntax	Description
smode<cr>	Show current start-up operating mode of the serial line, and prompt to enter new mode.

Syntax	Description
smode [mode]<cr>	Set serial line start-up operating mode. New mode is taken into use when the device is reset or powered up. Available modes: **stop** = No automatic output. All commands available. Default mode. **run** = Automatic output of measurement messages. You can stop the output with the **s** command, and recontinue with the **r** command. **poll** = No automatic output. Will respond to addressed **send** command and **??** command. You can use other commands after opening a connection using an addressed **open** command. Use with RS-485 buses where multiple probes can share the same line. **modbus** = Serial line communication uses the Modbus protocol (seeModbus (page 57)). Serial line commands (Vaisala Industrial Protocol) are not accessible in the Modbus mode. For instructions on returning to serial mode, see Accessing Serial Commands from Modbus or Analog Mode (page 27). **analog** = Switches the probe from digital output to analog output (active after probe reset). Serial line commands are not accessible in the analog mode: for instructions on returning to serial mode, see Accessing Serial Commands from Modbus or Analog Mode (page 27).
Example (set serial mode to "poll"): **smode poll** Serial mode : POLL	

4.11 Analog Output

Table 29 Amode Command

Syntax	Description
amode [channel]<cr>	Show currently set analog output limits and error level. **channel** = Analog output channel • 1 = voltage output (V) • 2 = current output (mA)

Syntax	Description
amode [channel lo_value hi_value error_value]<cr>	Set new analog output limits and error output value. **channel** = Analog output channel • 1 = voltage output (V) • 2 = current output (mA) **lo_value** = Low limit of the channel. **hi_value** = High limit of the channel. **error_value** = Error value of the channel. When setting the error output voltage, note that the probe's maximum voltage output is 10.325 V.
Example (show current configuration): **pass 1300** **amode 1** Aout 1 range (V) : 0.00 ... 10.00 (error : 0.00) **amode 2** Aout 2 range (mA) : 4.00 ... 20.00 (error : 2.00)	
Example (set channel 1 to 0 ... 5 V, and error output to 0.0 V; set channel 2 to 0 ... 20 mA, and error output to 23 mA): **amode 1 0 5 0.0** Aout 1 range (V) : 0.00 ... 5.00 (error : 0.00) **amode 2 0 20 23** Aout 2 range (mA) : 0.00 ... 20.00 (error : 23.00)	

Table 30 Aover Command

Syntax	Description
aover [channel<cr>	Show the behavior of the analog output when the measured value is outside the scaled output range. **channel** = Analog output channel • 1 = voltage output (V) • 2 = current output (mA)

Syntax	Description
aover [channel clipping error_ limit]<cr>	Set the behavior of the analog output when the measured value is outside the scaled output range. **channel** = Analog output channel • 1 = voltage output (V) • 2 = current output (mA) **clipping** = Output margin (%) at which the output is clipped. **error_limit** = Measurement value margin (%) at which the output of the channel goes into the error state. The current or voltage output of the error state is defined using the **amode** command, see Table 29 (page 41) on the previous page.
Example (view currently set analog output overrange behavior on channel 1): **pass 1300** **aover 1** Aout 1 clipping :5.00 % Aout 1 error limit :10.00 %	

Example (for channel 1):

1. View currently set analog output scaling (**asel** command), limits and error level (**amode** command), and overrange behavior (**aover** command):

```
pass 1300
asel 1
Aout 1 quantity : CO2(0 ... 200000)
amode 1
Aout 1 range (V) : 0.00 ... 5.00 (error : 0.00)
aover 1
Aout 1 clipping :1.00 %
Aout 1 error limit :5.00 %
```

2. Set analog output overrange clipping to 5 % and error limit to 10 %:

```
aover 1 5 10
Aout 1 clipping : 5.00 %
Aout 1 error limit : 10.00 %
```

The analog output now behaves like this:

- Clipping is now set to 5.00 %, meaning the voltage output is allowed to vary between 0 … 5.25 V. The analog channel will output the measurement for 0 … 210 000 ppm, but range 0 … 5 V remains scaled to 0 … 200 000 ppm.

- Error limit is 10 %, which means the output will show the error state (0 V) when the measured CO_2 concentration is 10 % outside the scaled output range. With the settings above, this will happen if the measured CO_2 concentration is outside range 0 ... 220 000 ppm.
- The voltage output will never be above 5.25 V because of clipping: the voltage output is clipped when the output reaches 5.25 V, and if the measured CO_2 concentration keeps rising above 220 000 ppm, the output jumps directly to the error state 0 V.

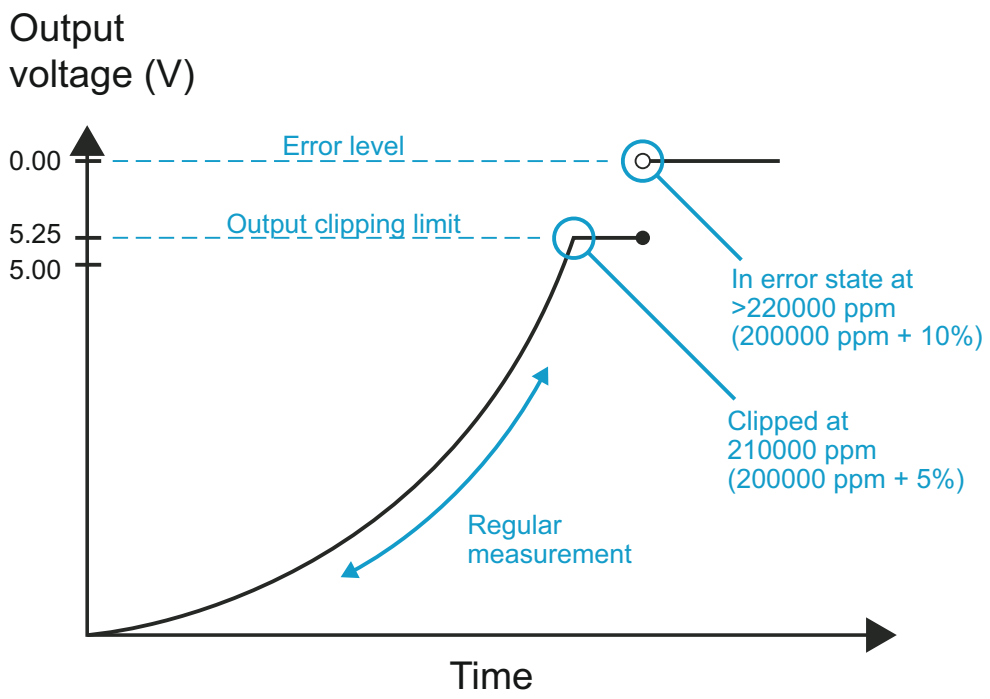


Figure 9 Example of Analog Output Overrange Behavior

The example shown above uses output scaled to 0 ... 5 V and 0 ... 200 000 ppm, has error level set to 0 V, clipping set to 5 % overrange, and error limit set to 10 % overrange. CO_2 concentrations (ppm) are indicated for the clipping point and error limit point.

Table 31 Asel Command

Syntax	Description
asel [channel]<cr>	Show the parameter and scaling of the analog output in ppm. **channel** = Analog output channel • 1 = voltage output (V) • 2 = current output (mA)

Syntax	Description
asel [channel] [parameter lowlimit highlimit]<cr>	Set the parameter and scaling of the analog output. **channel** = Analog output channel **parameter** = Parameter that is output on analog channel. The only parameter available is CO_2 (in ppm). **lowlimit** = Lower limit of channel scaling in ppm. Minimum value is -1000000 ppm (= - 100 %). **highlimit** = High limit of channel scaling in ppm. Maximum value is 1000000 ppm (= 100 %).
Example (for channel 1, show the currently set analog output parameter and scaling): **pass 1300** **asel 1** Aout 1 quantity : CO2(0 ... 200000 ppm)	
Example (for channel 1, set scaling to 0 ... 10 % (= 100 000 ppm)): **pass 1300** **asel 1 co2 0 100000** Aout 1 quantity : CO2(0 ... 100000 ppm)	

4.12 Calibration and Adjustment

CAUTION! Before using the calibration and adjustment commands, read through Calibration and Adjustment (page 92). Make sure that the environmental compensation settings of the probe are properly set for your calibration environment; see Environmental Compensation (page 15).

Table 32 Adate Command

Syntax	Description
adate<cr>	Show CO_2 factory adjustment date.
Example: **adate** Adjustment date : 20150420	

Table 33 Atext Command

Syntax	Description
atext<cr>	Show CO_2 factory adjustment information.
Example: **atext** Adjusted at Vaisala/Helsinki	

Table 34 Cdate Command

Syntax	Description
cdate<cr>	Show calibration date.
cdate [yyyymmdd]<cr>	Set a new calibration date. **yyyymmdd** = Year (yyyy), month (mm) and day (dd) of calibration
Example: **pass 1300** **cdate** Calibration date : 20150220	
Example (set a new calibration date to June 30, 2015): **cdate 20150630** Calibration date : 20150630	

Table 35 Ctext Command

Syntax	Description
ctext<cr>	Show calibration information text.
ctext [text]<cr>	Set a new calibration information text to be shown after the automatic text "Calibrated at".
Example: **pass 1300** **ctext** Calibrated at 5.0% in lab	

Syntax	Description
Example (set a new information text): **ctext 0% 5% by NN** Calibrated at 0% 5% by NN	

Table 36 CCO2 Command

Syntax	Description
cco2<cr>	Show current user adjustment status.
cco2 -lo [co2]<cr> **cco2 -hi [co2]<cr>**	Perform a 1-point (only either low or high concentration) or 2-point (both low and high concentrations) calibration and adjustment. **-lo** = Adjustment at low concentration (under 2 %CO2) **-hi** = Adjustment at high concentration (over 2 %CO2) **co2** = CO2 concentration reference in ppm
cco2 -save<cr>	Save the currently entered adjustments. Successfully saving the adjustment clears the calibration date (**cdate** command) and calibration text (**ctext** command) that have been stored in the probe. Use those commands to enter a new calibration date and text.
cco2 -cancel<cr>	Cancel currently entered adjustments.
cco2 -reset<cr>	Clear user adjustments.
Example (show current user adjustment status; no adjustment done): **pass 1300** **cco2** 1.Ref. point low 0 1.Meas. point low 0 2.Ref. point high 200000 2.Meas. point high 200000 Gain : 1.0000 Offset : 0.0000	

Syntax	Description

Example (perform a 1-point calibration):

1. Let the probe stabilize in the desired CO_2 concentration (here: 5 %CO_2 (=50000 ppm)).
2. Enter the calibration commands:

```
pass 1300
cco2 -hi 50000
OK
cco2 -save
OK
```

3. Enter a new calibration date and information text:

```
cdate 20150630
Calibration date : 20150630
ctext 5% in lab
Calibrated at 5% in lab
```

Syntax	Description

Example (perform 2-point calibration):

1. Let the probe stabilize in the desired low CO_2 concentration (here: 0 %CO_2).
2. Enter the calibration commands:

```
pass 1300
cco2 -lo 0
OK
cco2 -save
OK
```

3. Let the probe stabilize in the desired high CO_2 concentration (here: 5 %CO_2 (=50000 ppm)).
4. Enter the calibration commands:

```
pass 1300
cco2 -hi 50000
OK
cco2 -save
OK
```

5. Enter a new calibration date and information text:

```
pass 1300
cdate 20150430
Calibration date : 20150430
ctext 0% 5% by NN
Calibrated at 0% 5% by NN
```

4.13 Environmental Compensation Commands

To apply an accurate relative humidity compensation, the temperature and pressure compensation configurations must also match your measurement environment. See the **rhcmode**, **tcmode** and **pcmode** commands for instructions on enabling compensation configuration, and **env** command for instructions on setting a compensation value.

For more information on environmental compensation and the default (neutral) compensation values used for disabled compensations, see Environmental Compensation (page 15).

Table 37 Env Command

Syntax	Description
env<cr>	Show current compensation values. Before using this command, you must enable environmental compensation using the following commands: • **o2cmode [on]** • **pcmode [on]** • **rhcmode [on]** • **tcmode [on | measured]**
env [temp | pres | oxy | hum] [value]<cr>	Set new permanent compensation values and store them in **EEPROM**. EEPROM: • Non-volatile memory, values retained during power off. • Number of writes is limited to 30000 cycles by memory implementation. • Must only be used for writing permanent values, to avoid wearing out the EEPROM. **temp** = Compensation temperature. Range -40 ... +100 °C (-40 ... +212 °F). **pres** = Compensation pressure. Range 500 ... 1150 hPa. **oxy** = Oxygen content of background gas. Range 0 ... 100 %. **hum** = Relative humidity of background gas. Range 0 ... 100 %.

Syntax	Description
env [xtemp | xpres | xoxy | xhum] [value]<cr>	Set new compensation values and store them in **RAM**. RAM: • Volatile memory that loses the values when probe is reset, and where values are loaded from non-volatile (EEPROM) memory at power-on. • Must be used for continuously updated values. **xtemp** = Compensation temperature stored in RAM. Range -40 ... 100 °C (-40 ... +212 °F). **xpres** = Compensation pressure stored in RAM. Range 500 ... 1150 hPa. **xoxy** = Oxygen content of background gas stored in RAM. Range 0 ... 100 %. **xhum** = Relative humidity of background gas stored in RAM. Range 0 ... 100 %. Note: If temperature compensation is configured to use an internally measured value (**tcmode** is set to **measured**), it will continuously update the value in RAM, overriding any temperature value that is written to RAM with the ENV command.

Example (Show current compensation values; all compensations are enabled. Note that temperature compensation is in "measured" mode, so the value in use is constantly changing):

```
env
In eeprom:
Temperature (C) : 25.00
Pressure (hPa) : 1013.00
Oxygen (%O2) : 21.00
Humidity (%RH) : 50.00

In use:
Temperature (C) : 36.40
Pressure (hPa) : 1013.00
Oxygen (%O2) : 19.70
Humidity (%RH) : 93.00
```

Syntax	Description
Example (set temperature compensation to setpoint mode, and change temperature setpoint value to 37.2 in RAM): **pass 1300** **tcmode on** T COMP MODE : ON **env xtemp 37.2** In eeprom: Temperature (C) : 25.00 Pressure (hPa) : 1013.00 Oxygen (%O2) : 21.00 Humidity (%RH) : 50.000 In use: Temperature (C) : 37.2 Pressure (hPa) : 1013.00 Oxygen (%O2) : 19.70 Humidity (%RH) : 93.00	

Table 38 O2cmode Command

Syntax	Description
o2cmode<cr>	Check current oxygen compensation mode. Possible modes: • **on** = Compensation enabled using setpoint value. • **off** = Compensation disabled, default (neutral) value used: see Environmental Compensation (page 15)
o2cmode [on | off]<cr>	Change oxygen compensation mode (**on** or **off**).
Example (check oxygen compensation mode; oxygen compensation is disabled, a neutral value is used): **pass 1300** **o2cmode** O2 COMP MODE : OFF	
Example (enable oxygen compensation): **pass 1300** **o2cmode on** O2 COMP MODE : ON	

Table 39 Pcmode Command

Syntax	Description
pcmode<cr>	Check current pressure compensation mode. Possible modes: • **on** = Compensation enabled using setpoint value. • **off** = Compensation disabled, default (neutral) value used: see Environmental Compensation (page 15).
pcmode [on | off]<cr>	Change pressure compensation mode (**on** or **off**).
Example (check pressure compensation mode; pressure compensation is enabled using a setpoint value): **pass 1300** **pcmode** P COMP MODE : ON	

Table 40 Rhcmode Command

Syntax	Description
rhcmode<cr>	Check current relative humidity compensation mode. Possible modes: • **on** = Compensation enabled using setpoint value. • **off** = Compensation disabled, default (neutral) value used: see Environmental Compensation (page 15). To apply an accurate relative humidity compensation, make sure that the temperature compensation and pressure compensation configurations also match the measurement environment.
rhcmode [on | off]<cr>	Change relative humidity compensation mode (**on** or **off**).
Example (check relative humidity compensation mode; relative humidity compensation is disabled, a neutral value is used): **pass 1300** **rhcmode** RH COMP MODE : OFF	

Syntax	Description
Example (enable temperature, pressure and relative humidity compensation using setpoint values): **pass 1300** **tcmode on** T COMP MODE : ON **pcmode on** P COMP MODE : ON **rhcmode on** RH COMP MODE : ON	

Table 41 Tcmode Command

Syntax	Description
tcmode<cr>	Check current temperature compensation mode. Possible modes: • **on** = Compensation enabled using setpoint value. • **off** = Compensation disabled, default (neutral) value used: see Environmental Compensation (page 15). • **measured** = Compensation enabled using internal measurement.
tcmode [on | off | measured]<cr>	Change temperature compensation mode (**on**, **off** or **measured**).
Example (check temperature compensation mode; temperature compensation is enabled using a setpoint value): **pass 1300** **tcmode** T COMP MODE : ON	
Example (change temperature compensation to use internal measurement): **pass 1300** **tcmode measured** T COMP MODE : MEASURED	

4.14 Other Commands

Table 42 Frestore Command

Syntax	Description
frestore<cr>	Restore the probe to its factory configuration. All user settings and user calibration parameters will be lost. After using the **frestore** command, reset the probe using the **reset** command.
Example (restore the factory settings and reset the probe): **pass 1300** **frestore** Parameters restored to factory defaults **reset** GMP251 1.0.0	

Table 43 Pass Command

Syntax	Description
pass [code]<cr>	Access advanced serial commands. Advanced commands can be used until the next reset. **code** = Code for enabling advanced commands (1300).
Example: **pass 1300**	

Table 44 Reset Command

Syntax	Description
reset<cr>	Reset the probe. The probe will restart as if it had just been powered on.
Example: **reset** GMP251 1.0.0	

5. Modbus

The probe can be accessed using the Modbus serial communication protocol. The supported Modbus variant is Modbus RTU (Serial Modbus) over RS-485 interface.

For instructions on enabling the Modbus mode when you are using the probe with Vaisala Industrial Protocol, see Enabling Modbus Mode from Vaisala Industrial Protocol (page 28).

For instructions on switching to Vaisala Industrial Protocol when the probe is in Modbus mode, see Accessing Serial Commands from Modbus or Analog Mode (page 27).

For information on using Modbus with the Indigo 202 digital transmitter, see Using Modbus with Indigo 202 (page 71).

The pre-configured default Modbus serial settings are presented in the following table.

Table 45 Default Modbus Serial Communication Settings

Description	Default Value
Serial bit rate	19200
Parity	N
Number of data bits	8
Number of stop bits	2
Modbus device address	240

More Information

- Modbus Registers (page 109)

6. Vaisala Insight Software

Vaisala Insight software is a configuration software for Indigo-compatible probes. The supported operating systems are Windows 7 (64-bit), Windows 8.1 (64-bit), and Windows 10 (64-bit).

With the Insight software, you can:

- See device information and status.
- See real-time measurement.
- Configure serial communication settings, purge settings, filtering factor, and analog output parameters and scaling.
- Calibrate and adjust the device.

Download Vaisala Insight software at www.vaisala.com/insight.

The probe can be connected to Vaisala Insight software using a Vaisala USB cable (no. 242659).

GMP251 probes support Insight from probe software version 1.3.0 onwards.

6.1 Connecting to Insight Software

- Computer with Vaisala Insight software installed
- USB connection cable (no. 242659)

Figure 10 Connecting Probe to Insight

Connect the probe to the Insight software in the exact order described in the following steps.

1. Open the Insight software.
2. Connect the USB cable to a free USB port on the PC.
3. Connect the probe to the USB cable.
4. Wait for Insight software to detect the probe.

7. Using GMP251 with Indigo Transmitters

7.1 Indigo Overview

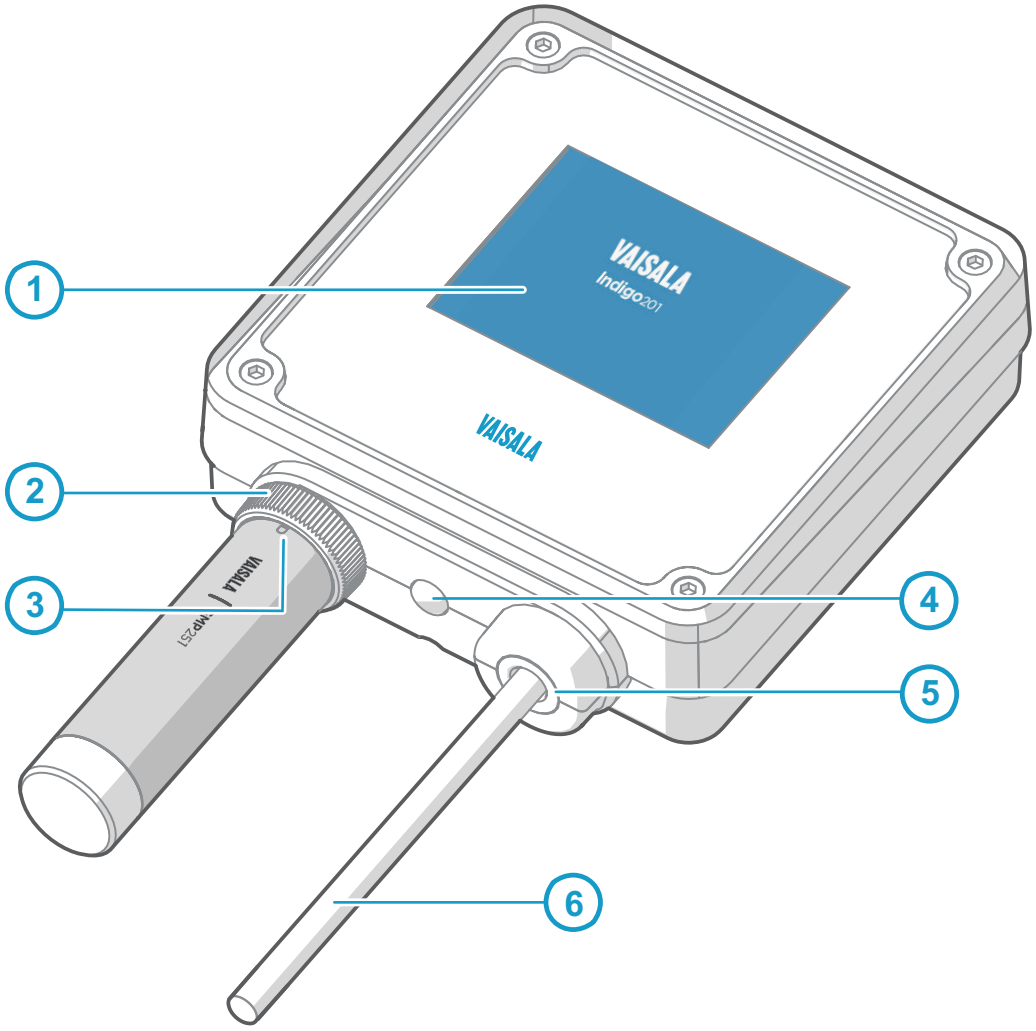


Figure 11 GMP251 Attached to Indigo Transmitter

1 3.5” TFT LCD color display: non-display option with LED available for certain models.
2 Probe locking wheel: insert probe, hold in place and turn the wheel counterclockwise.
3 Probe orientation mark: insert the probe with the orientation mark facing out.
4 Wireless configuration interface (WLAN) activation button.
5 Rubber lead-through with strain relief. Cable feedthrough option also at back of transmitter.
6 Input/output cable.

The probe can be connected to Vaisala Indigo transmitters, either directly on the transmitter from the probe's connector, or by using a cable between Indigo and the probe.

Indigo transmitters are host devices that extend the feature set of connected probes with a range of additional options for outputs, configuration access, measurement viewing, and status monitoring.

The selection of available additional features (for example, output and connectivity options) varies depending on the Indigo transmitter model. Depending on the model, a display is available as an optional selection or as a standard feature. In the non-display model, an LED indicator is used for notifications.

7.1.1 Wireless Configuration Interface Overview

Indigo transmitters are configured using a wireless browser-based configuration interface (requires a mobile device or computer with IEE 802.11 b/g/n WLAN wireless connectivity). In addition to probe and transmitter configuration and calibration, you can also use the wireless interface to view measurement data and status information.

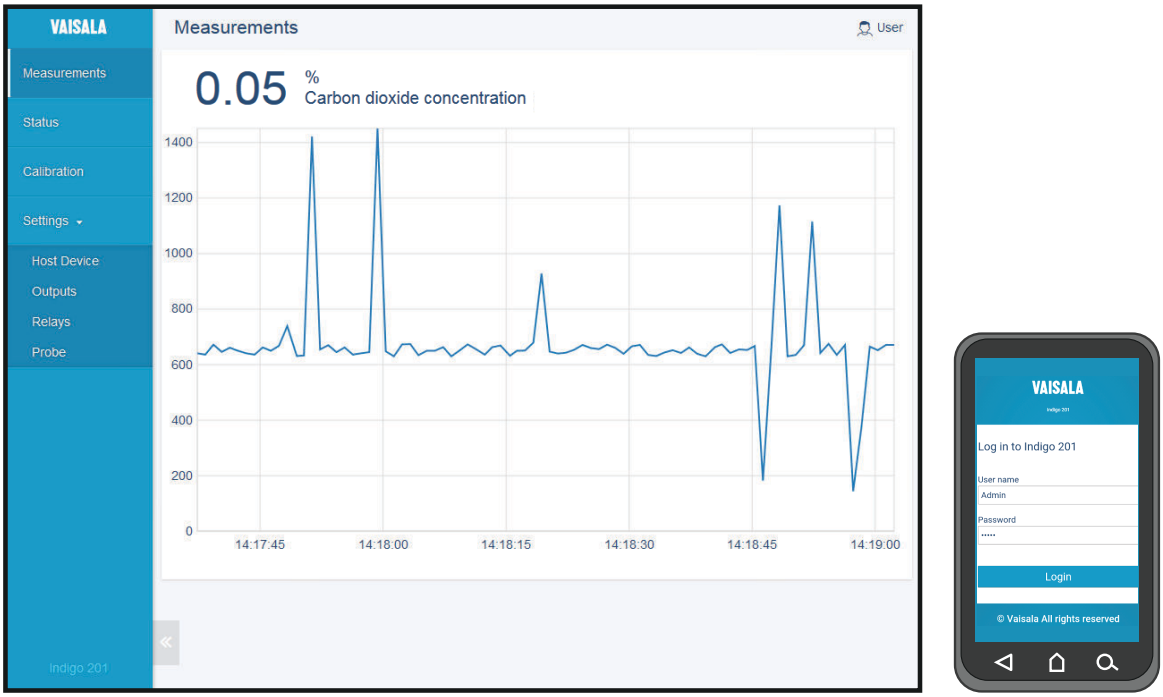


Figure 12 Desktop and Mobile Example Views

The wireless configuration interface has two user levels:

- All users have view-only access (no configuration rights, not password protected).
- Personnel that carry out configuration tasks can log in with an administrative password that allows changing the transmitter and probe settings.

To use the wireless configuration interface to modify the settings of your Indigo transmitter and the connected probe, you must first enable the transmitter's wireless connection and then connect to Indigo with your mobile device or computer. Most major browsers (for example, Firefox, Chrome, Safari, and Internet Explorer) are supported: using the most recent version is recommended.

7.2 Taking a Probe in Use with Indigo

In order to use the probe with an Indigo transmitter, you need to connect the probe to an Indigo transmitter and use a mobile device or computer to review the transmitter and probe configuration with Indigo's wireless configuration interface.

- Indigo-compatible probe and Indigo transmitter
- Mobile device or computer that supports wireless connectivity (IEEE 802.11 b/g/n WLAN)
- Web browser

To take the probe in use with Indigo:

1. Connect the probe to a wired and powered Indigo transmitter and check that the transmitter recognizes the probe (green LED/display notification).
2. Enable Indigo's wireless connection and open the Indigo wireless configuration interface in your mobile device or computer.
3. Use Indigo's wireless configuration interface to check that the probe and transmitter settings are correct for your system. For instructions on using the wireless configuration interface, see the *User Guide* of the Indigo transmitter.

More Information

- Attaching Probes and Cables (page 65)
- Connecting to Wireless Configuration Interface (page 66)
- Wireless Interface Menus (page 68)
- Logging in to Wireless Configuration Interface (page 67)

7.2.1 Checking Indigo Support in Probe

To verify that your probe supports Indigo, check the serial number on the probe body. All probes intended for use with Indigo manufactured from 2017 onwards (serial numbers starting with the letter **N** or latter in alphabetical order) are compatible with Indigo.

Figure 13 Serial Number on Probe Body (GMP251 Example)

1 Probes with a serial number starting with the letter **N** have been manufactured in 2017.

7.3 Attaching Probes and Cables

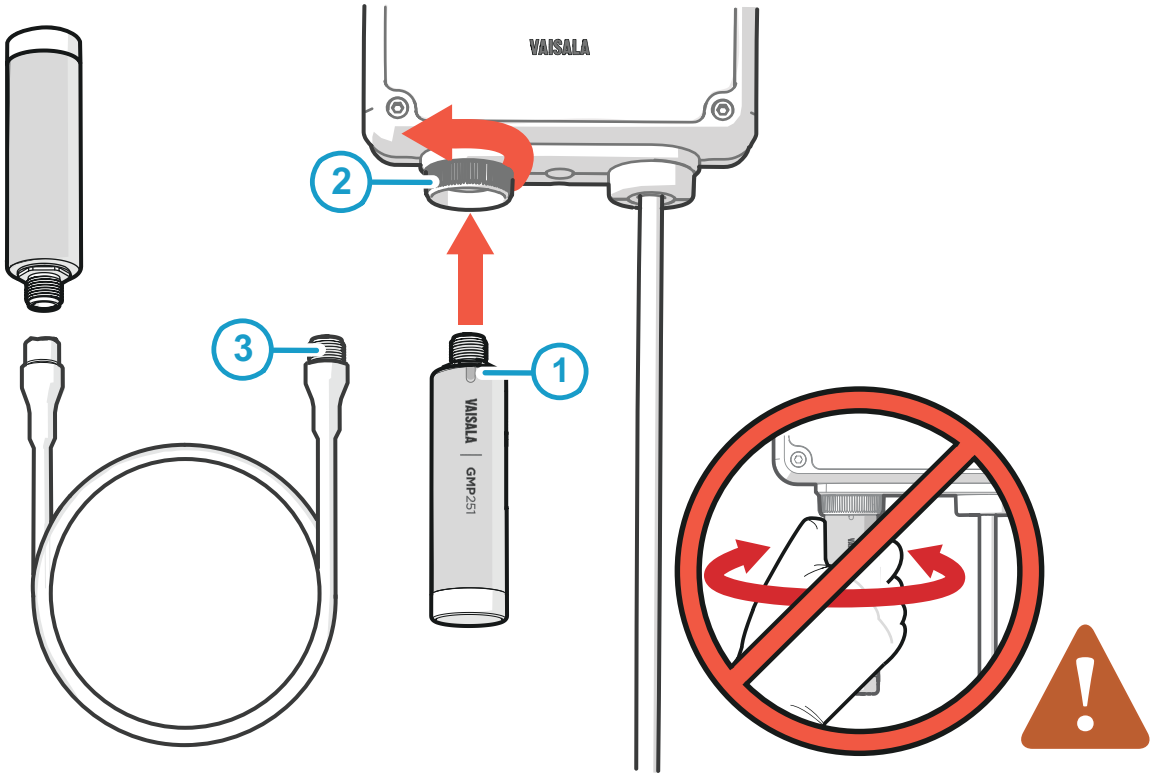


Figure 14 Attaching Probes and Cables to Indigo

1 Insert probes into the probe connector with the orientation mark facing out.
2 Probes are locked in place with the locking wheel. **Never turn from the probe body.**
3 Connect probe cables in the same way as probes: insert the cable in the connector and hold in place while turning the locking wheel.

1. Insert the probe into the probe connector with the orientation mark on the probe body facing out.
2. Hold the probe in the probe connector and lock it in place by turning the locking wheel counterclockwise. Never turn the probe body when attaching or removing probes, only the locking wheel of the Indigo transmitter.
3. When the transmitter recognizes the connected probe, it shows a notification message on the display (for example, **Probe Connected: GMP251**). In the non-display model, a green LED is lit when Indigo recognizes the probe.

7.4 Connecting to Wireless Configuration Interface

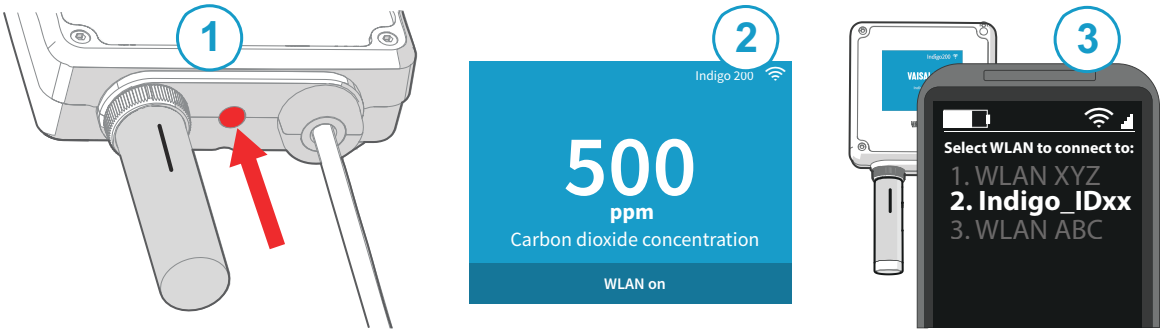


Figure 15 Enabling and Accessing Indigo's Wireless Configuration Interface

1 Wireless connection activation button
2 Wireless connection indicator (WLAN symbol) on the Indigo display
3 Choose Indigo (**Indigo_ID[xx]**) from your wireless device's list of available connections

To connect to the wireless configuration interface:

1. Press the wireless connection activation button on the bottom of the transmitter.
2. When the wireless configuration interface becomes available, the Indigo display shows a connection notification. In the Indigo models with an LED indicator, the LED blinks green when the connection is active.
3. Open the wireless connection menu in your mobile device or computer and select **Indigo_ID[xx]** (transmitter-specific SSID) from the list of available connections.
4. Depending on your device, the wireless configuration interface either launches automatically in your browser after you connect to Indigo, or you may need to start your browser application manually.
5. When you open the Indigo interface in your browser, you are prompted to log in.

Only one device can be connected to the wireless configuration interface at a time.

More Information

- Logging in to Wireless Configuration Interface (page 67)
- Wireless Interface Menus (page 68)

7.5 Logging in to Wireless Configuration Interface

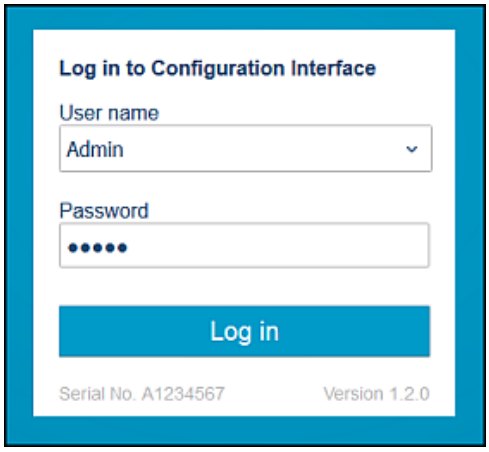


Figure 16 Indigo Login View

When you open Indigo's wireless configuration interface in your browser, you are prompted to log in. There are 2 available user levels:

- **User**: view-only access available for all users. Does not require a password.
- **Admin**: password-protected access. To change settings, you must log in as admin.

To log in:

1. Enter the user name and password:
   a. To log in as user (view-only access, no configuration rights), select **User** from the **User name** dropdown. Leave the **Password** field empty.
   b. To log in as admin (required for configuration), select **Admin** in the **User name** dropdown and type the admin password (default: **12345**) in the **Password** field.
2. Select **Log in** after entering the login credentials. The wireless configuration interface opens in the **Measurements** view.

The user level (**User** or **Admin**) is shown in the upper right corner of all menu views. Select the user/admin icon in the upper right corner to change the user level.

7.6 Wireless Interface Menus

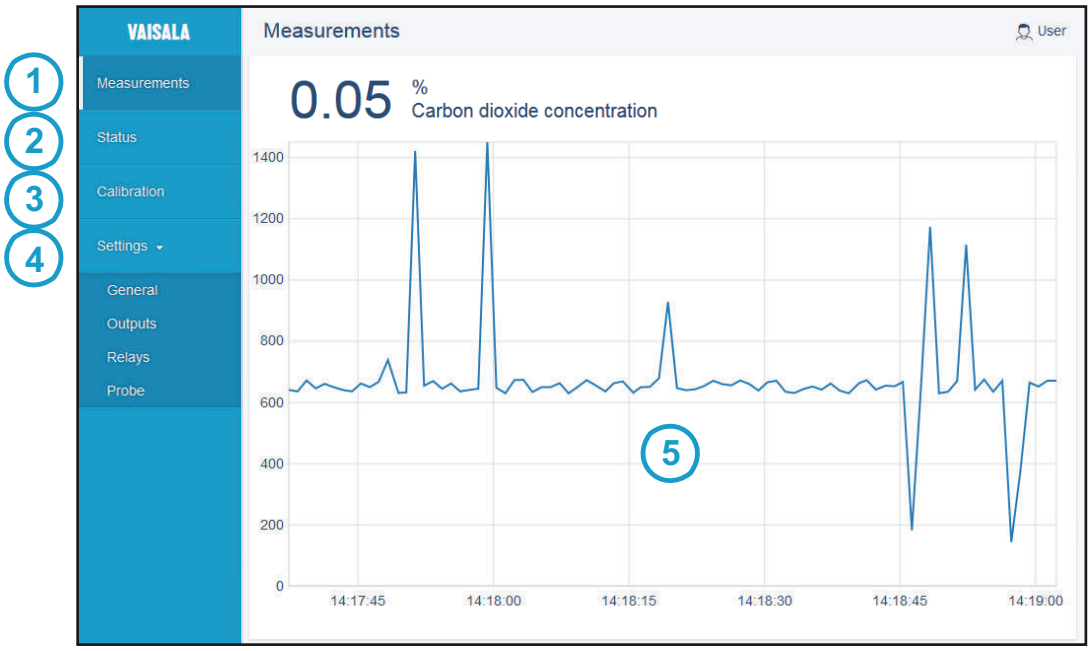


Figure 17 Wireless Configuration Interface, Desktop Browser View

1 **Measurements**: displays the measurement data of the connected probe
2 **Status**: contains information about the status of Indigo and the connected probe (for example, notifications and alarms)
3 **Calibration**: calibrate and adjust probes using references. Available options (for example, adjustment points) vary depending on the probe model.
4 **Settings**: contains options for configuring the connection and display settings, outputs, relays, probe-specific settings, and general device preferences

- **General** submenu: device information and general settings, wireless connection and display settings
- **Outputs** submenu: options for configuring analog or digital outputs (depending on transmitter model).
- **Relays** submenu: settings for controlling relays A and B
- **Probe** submenu: probe-specific settings such as environmental compensations and filtering factor

5 Main display area for menus and measurement information (desktop browser example)

For more information on the configuration options available in Indigo transmitters, see the *User Guide* of your transmitter.

7.7 Configuring Analog Outputs with Indigo 201

Indigo 201 analog output transmitters have 3 analog current (mA) or voltage (V) outputs. Each analog output has the same set of configuration options (analog output 1 shown in example).

Note that you must select either the current or voltage output mode: using both current and voltage outputs is not possible.

When you enter a value into a field, the value is saved automatically when you exit the input field (for example, tap on an area outside of the field).

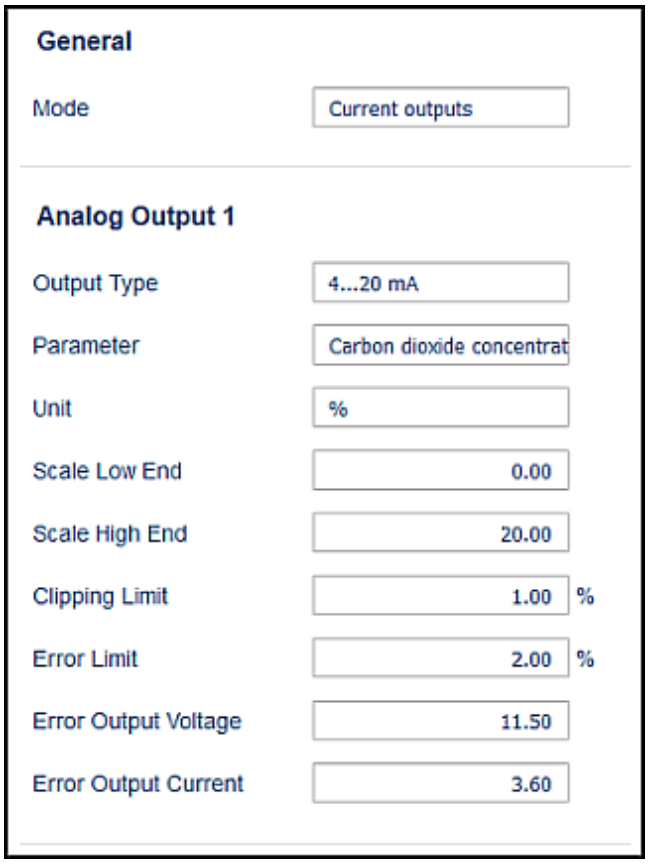


Figure 18 Indigo 201 Analog Output Configuration Options

For detailed instructions on configuring analog outputs in the Indigo 201 wireless configuration interface, see *Indigo 201 Analog Output Transmitter User Guide*.

More Information

- Indigo 201 Analog Output Mode Selection (page 70)

7.7.1 Receiving Analog Output Settings from Probe

When you take Indigo 201 in use for the first time and have not entered an analog output configuration, the transmitter automatically adapts the analog output configuration of the first Vaisala Indigo-compatible probe you connect.

If an analog output configuration already exists in Indigo 201 (that is, you have previously connected a probe or configured the settings), you need to set the analog output configuration of the new probe manually. Analog output from the transmitter is halted and does not resume until you have set the new probe's configuration.

Alternatively, you can clear the analog output settings in Indigo 201 configuration. This returns the transmitter to a state where it automatically starts using the analog output configuration of the next connected probe. The analog output settings can be cleared from the **Settings > General** menu.

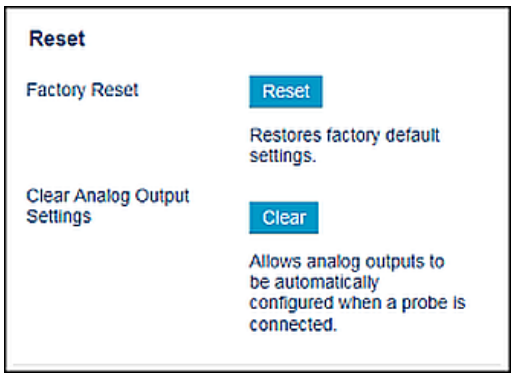


Figure 19 Clearing Analog Output Settings

7.7.2 Indigo 201 Analog Output Mode Selection

Indigo 201 has 3 analog output channels for either current (mA) or voltage (V) output. All 3 channels must use the same output mode (mA or V): it is not possible to use both voltage and current outputs simultaneously.

The output mode selection is made in the **Settings > Outputs** menu of the wireless configuration interface.

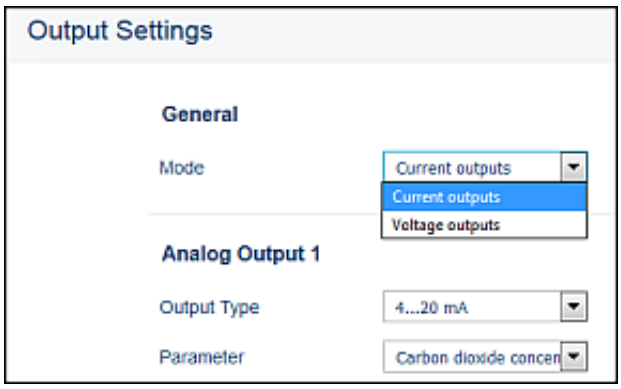


Figure 20 Selecting Indigo 201 Analog Output Mode

7.8 Using Modbus with Indigo 202

Indigo 202 digital transmitters are designed for Modbus RTU (RS-485) communication. There are 2 groups of Modbus register addresses in use in Indigo 202: probe registers and Indigo registers. The probe registers are received from the connected probe, and are organized according to the probe's register map. Indigo registers include transmitter-specific information.

Received Modbus requests for register operations are treated in two different ways depending on the register address. Addresses above $DFFF_{hex}$ (that is, Indigo registers) are handled as normal requests. Lower addresses (that is, probe registers 0000_{hex} ... $DFFF_{hex}$) are passed to the measurement probe, and the response from the probe is again passed to original Modbus client. Indigo can also have a cache for commonly requested registers (Measurement registers).

The maximum response delay is 2 seconds (when data content needs to be fetched from the probe). The minimum delay between requests is 10 ms.

For more details on the information relayed within Indigo 202 (transmitter-specific) Modbus registers, see *Indigo 202 Digital Transmitter User Guide*.

Table 46 Indigo 202 Modbus Registers

Address	Name	Data Type
Probe registers (according to the connected probe's register map) [1)]		
0000_{hex}	First measurement probe address	
$DFFF_{hex}$	Last measurement probe address	
Indigo registers		
$E000_{hex}$	Status	16-bit
$E001_{hex}$	Notification and error bits	16-bit

Address	Name	Data Type
$E002_{hex}$	Connected probe	text [30]
$E011_{hex}$	Relay A status	enum
$E012_{hex}$	Relay B status	enum

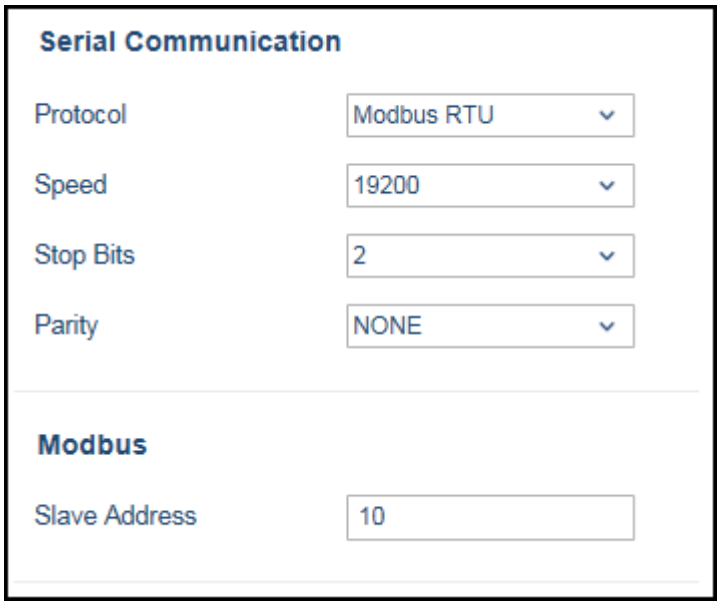
1) *See the connected probe's Modbus documentation for probe-specific register information*

More Information

- Modbus Registers (page 109)
- Modbus (page 57)

7.8.1 Modbus Serial Communication Settings

The **Settings > Outputs** menu of the wireless configuration interface contains the configuration options for Modbus serial communication.



Protocol — Modbus protocol options. The **Modbus RTU** protocol is in use by default.

Speed — Select the baud rate used in Modbus communication: **4800**, **9600**, **19200**, **38400**, **57600**, or **115200**. Default: **19200**.

Stop Bits — Stop bits used in Modbus communication: **1** or **2**. Default: **2**.

Parity — Select **EVEN**, **ODD** or **NONE**. Default: **NONE**.

Slave Address — Address used when Indigo functions as a Modbus slave (range: **1** ... **247**). Default: **10**.

7.9 Configuring Relays with Indigo

Indigo transmitters have 2 configurable relays (relay A and relay B). Both relays have configuration options for selecting the parameter that is used to control the relay, activation triggers, hysteresis, and error state behavior.

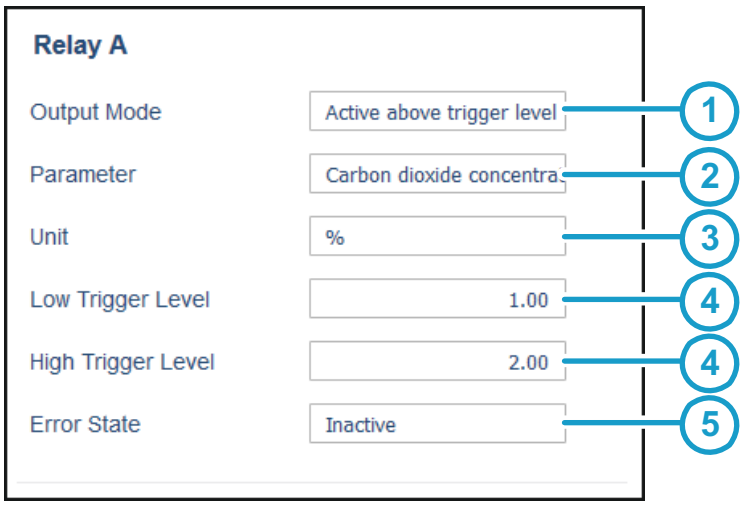


Figure 21 Relay Configuration Options

1 **Output Mode:** Select whether the relay activates above or below a set trigger value (or set the relay **Off**).
2 **Parameter:** The measurement that is used to control the relay.
3 **Unit:** Select the unit of the measurement parameter that controls the relay (for example, % if the measurement is in $\%CO_2$).
4 **Low Trigger Level** and **High Trigger Level:** If you want to activate the relay above or below a single setpoint without using hysteresis, enter the same value for the low trigger and the high trigger. The **Output Mode** selection defines whether the relay activates above or below this value.
If you want to set a hysteresis, define the limits of the hysteresis with the low and high triggers. See the Indigo documentation for instructions on setting a hysteresis.
5 **Error State:** Select which state the relay is set to when an error occurs (on, off, or remains in its current state)

For detailed instructions on configuring relays with Indigo, see the Indigo transmitter's *User Guide*.

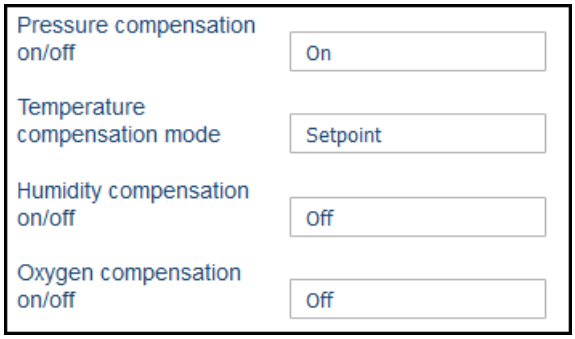
7.10 Changing Environmental Compensation Settings with Indigo

The configuration options in Indigo transmitters include probe-specific settings that vary depending on the features of the connected probe.

In the case of Vaisala CARBOCAP® Carbon Dioxide Probes GMP251 and GMP252, the probe-specific settings allow configuring the filtering factor and environmental compensations.

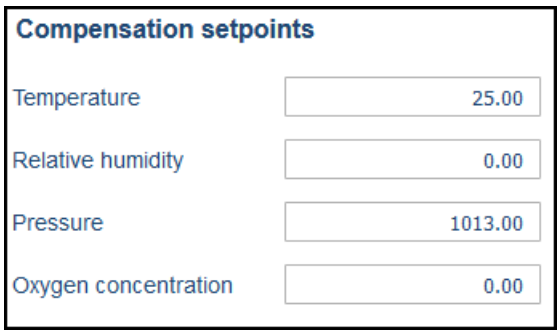
To change the environmental compensation settings:

1. Launch the Indigo wireless configuration interface and open the **Settings > Probe** menu.
2. Enable the required environmental compensations (set the compensation **On** or **Off**) you need to use in the **Measurement** selections. For temperature compensation, select either the measurement from the probe sensor (**Measured**), or manual **Setpoint** entry.

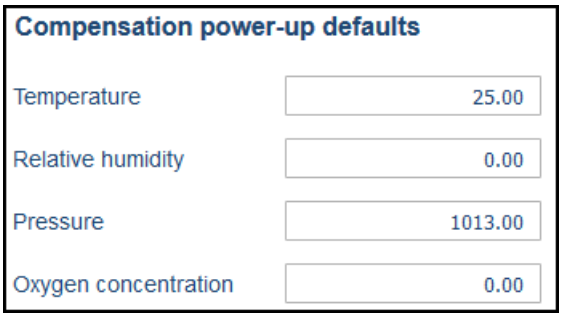


3. Enter the setpoint values for the compensations you have enabled into the **Compensation setpoints** text fields.

The values entered into the **Compensation setpoints** fields are only for temporary use: when you reset the probe, the default values (see **Compensation power-up defaults**) are restored.



4. Enter the power-up default compensation values that are stored into the probe's permanent memory.



The values entered into the **Compensation power-up defaults** fields remain in use also after probe reset.

5. The values you enter are saved automatically when you exit the input field (for example, tap on an area outside of the field).

Note that the environmental compensations you set in the **Settings > Probe** and the compensations set on the **Configuration** tab of the **Calibration** menu are interconnected: the configuration set in either menu is applied to both.

7.11 Configuring Filtering Factor with Indigo

The filtering factor affects the speed at which the latest measurement is integrated into the output of the probe: a new measurement is produced approximately every two seconds. You can configure the filtering factor in the **Settings > Probe** menu of Indigo's wireless configuration interface.

By default, the filtering factor is set to 1.0 (1.0 = 100 in the configuration range), which means the latest measurement is shown directly in the output, without any filtering. To apply filtering, enter a lower filtering factor to include previous measurements in the calculation of measurement output. For example, changing the filtering factor to 0.1 results in an output that is a combination of previous measurements (90%) and the latest measurement (10%).

The configuration range of the filtering factor is 0 ... 100: for example, to set the factor to 0.5, set the value to 50.

More Information

- Filtering Factor (page 116)

7.12 Calibrating GMP251 with Indigo

7.12.1 Indigo Calibration Overview

You can carry out 1-point and 2-point adjustments with the Indigo transmitter's wireless configuration interface. In addition to calibrating and adjusting probes, you can view the current adjustments and restore the probe's factory adjustment.

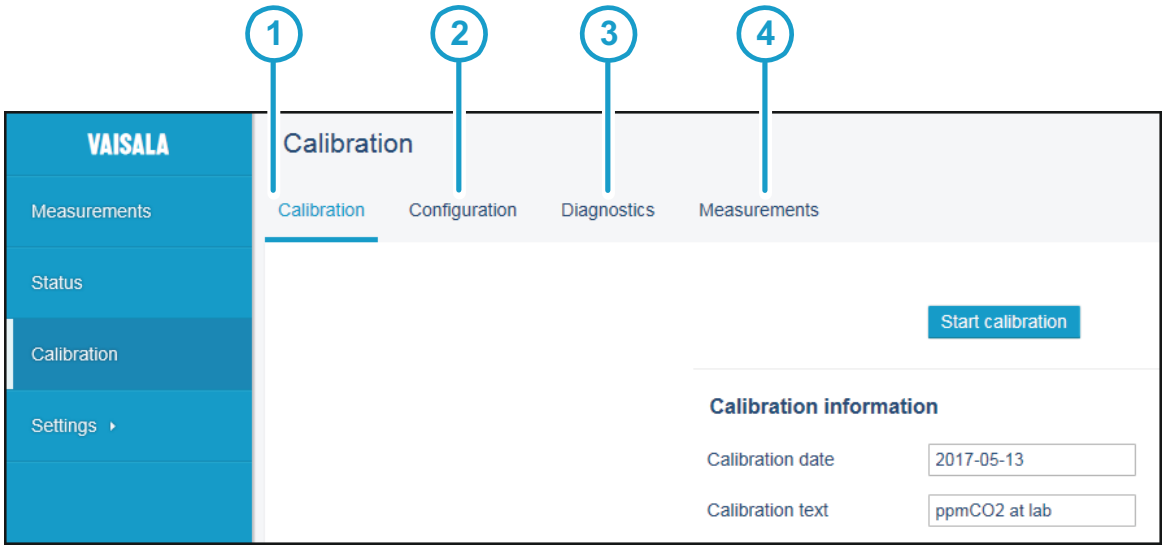


Figure 22 Calibration Menu Main View

1 Calibration tab
2 Configuration tab
3 Diagnostics tab
4 Measurements tab

There are 4 tabs in the **Calibration** menu:

- **Calibration**: the main adjustment view with options for making adjustments, viewing adjustments, and restoring factory adjustments.
- **Configuration**: options for using environmental compensations (probe-specific range of options) that allow compensating for the conditions present in the calibration environment, for example, pressure, temperature, and background gases. Also includes probe-specific configuration options that are not mandatory for use with Indigo.

- **Diagnostics**: this tab contains information about the status of the measurement and the probe, and shows the current environmental compensation configuration.
- **Measurements**: this tab shows the current probe measurement in numeric format (use this view, for example, when you need to follow measurement stablization in a reference environment without leaving the **Calibration** menu).

Before adjusting the probe's measurement, make sure you have gone through the information in Calibration and Adjustment (page 92).

Starting and Closing Calibration Mode in Indigo

In order to be able to use the calibration options, you must switch the operation of the probe and Indigo to calibration mode with the **Start calibration** button.

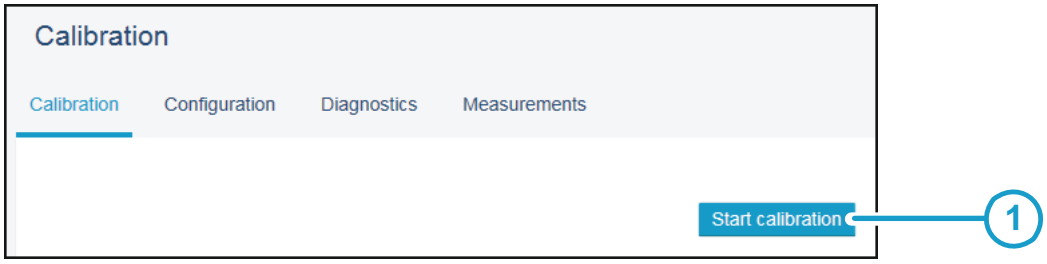


Figure 23 Start Calibration Button

1 **Start calibration** button on the **Calibration** tab

When you start the calibration mode, the **Start calibration** button is replaced with the **Stop calibration** button. The calibration mode remains active until you close it by selecting **Stop calibration**.

You can use other menus while the calibration mode is active, and return to the **Calibration** menu later to complete your adjustments.

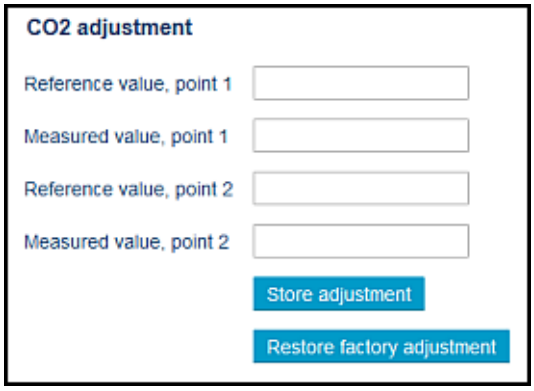
Always close the calibration mode to return the probe and Indigo to normal operating mode. The measurement performance of the probe can be affected when used in calibration mode. You must close the calibration mode with the **Stop calibration** button also when no changes are made.

7.12.2 Restoring Factory Adjustment

Always restore factory adjustment before entering a new adjustment. This prevents any possible earlier adjustments having an effect on the new adjustment you make.

To restore factory adjustment:

1. Connect to the wireless configuration interface and open the **Calibration** menu.
2. Start the calibration mode with the **Start calibration** button.
3. On the **Calibration** tab, scroll down to the parameter you want to adjust (for example, **CO2 adjustment**) and select **Restore factory adjustment**.



4. Restore the factory adjustment with the **Restore factory adjustment** button for each parameter separately as needed.
5. To verify that the factory adjustment was restored, check the adjustment data information at the bottom of the **Calibration** tab view.
6. Close the calibration mode with the **Stop calibration** button.

7.12.3 Calibration PIN Code

Probe calibration can be locked and unlocked with a calibration PIN code in the Indigo transmitter's **Settings > Probe** menu. By default, the calibration PIN code is in place and calibration is enabled. Do not remove the PIN code from the probe settings unless you need to block access to calibration settings.

For GMP251, the calibration PIN code is **1300**.

7.12.4 1-point Adjustment with Indigo

Prepare the calibration reference (for example, a reference gas with a known concentration) before starting the adjustment.

When you enter a value into a field, the value is saved automatically when you exit the input field (for example, tap on an area outside of the field).

To make a 1-point adjustment with Indigo wireless configuration interface:

1. Connect to the wireless configuration interface and open the **Calibration** menu.
2. Start the calibration mode with the **Start calibration** button.

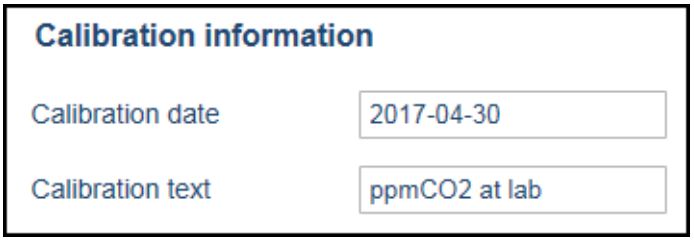
   If you cannot enter configurations after selecting **Start calibration**, check that the calibration PIN code is in place in the **Settings > Probe** menu.

3. If you need to set environmental compensations, enable and set the required compensations on the **Configuration** tab.

   Note that the environmental compensations you set on the **Configuration** tab and the compensations you set in the **Settings > Probe** menu are interconnected: the configuration set in either menu is applied to both.

4. Remove any possible previous adjustments by restoring the factory adjustment: select **Restore factory adjustment** for each parameter you are adjusting.

5. Enter the calibration date and calibration information into the corresponding text fields.



6. Place the probe in the reference environment (adjustment point 1) and wait until the measurement has stabilized. You can follow the stabilization from the **Measurements** tab.
7. Enter the value of the reference (for example, **500** if calibrating with a 500 ppmCO_2 reference gas) into the **Reference value, point 1** field.

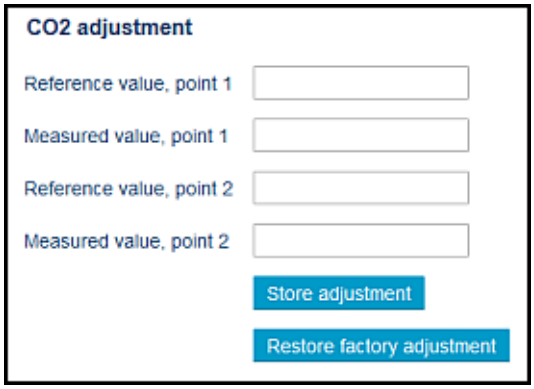
8. After you enter the reference value, the value of the **Measured value, point 1** field updates automatically.
9. After you have entered the reference point, select **Store adjustment** to save the adjustment.
10. Close the calibration mode with the **Stop calibration** button.
11. To check that the adjustment was carried out correctly, review the information in the **Adjustment data** fields at the bottom of the view.

7.12.5 2-point Adjustment with Indigo

To make a 2-point adjustment, you need a low reference and a high reference (select references that are near the low and high ends of your measurement range). Prepare the calibration references (for example, reference gases with known concentrations) before starting the adjustment.

To make a 2-point adjustment with Indigo wireless configuration interface:

1. Open the wireless configuration interface in the browser of your wireless device and open the **Calibration** menu.
2. Start the calibration mode with the **Start calibration** button.
3. If you need to set environmental compensations, enable and set the required compensations on the **Configuration** tab.
4. Remove any possible previous adjustments by restoring the factory adjustment: select **Restore factory adjustment** for each parameter you are adjusting.



5. Enter the calibration date and calibration information into the corresponding text fields.
6. Place the probe in the first reference environment (adjustment point 1) and wait until the measurement has stabilized.
7. Enter the value of the first reference (for example, **0** if calibrating with a 0 ppmCO_2 reference gas) into the **Reference value, point 1** field.
8. After you enter the reference value, the value of the **Measured value, point 1** field updates automatically.

9. Place the probe in the second reference environment (adjustment point 2) and wait until the measurement has stabilized.
10. Enter the value of the second reference (for example, **2000** if calibrating with a 2000 ppmCO_2 reference gas) into the **Reference value, point 2** field.
11. When both reference points have been entered, select **Store adjustment** to save the adjustment.
12. Close the calibration mode with the **Stop calibration** button.
13. To check that the adjustment was carried out correctly, review the information in the **Adjustment data** fields at the bottom of the view.

8. Operating with MI70 Indicator

8.1 Overview of MI70 Support

The probe is compatible with instruments that utilize the MI70 indicator, for example the GM70 Hand-Held Carbon Dioxide Meter. The MI70 indicator is a convenient service tool for viewing the measurement readings and performing calibration and one-point adjustment.

8.1.1 Probe Warm-Up and MI70 Automatic Power Off

Note that the probe's warm-up time to full accuracy specification when starting up the probe can be several minutes. When you power the probe with the MI70 indicator, disable the automatic power off feature of MI70 to keep the probe powered on continuously in order to avoid probe restart. To ensure powering during measurements, it is recommended to use the MI70 charging adapter when possible.

8.2 Basic Display

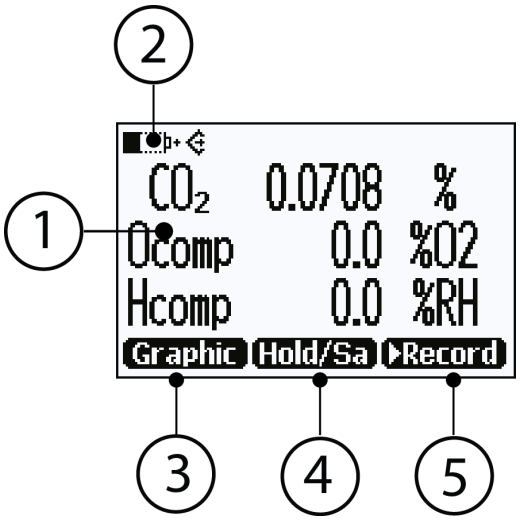


Figure 24 MI70 Basic Display

1 Measured parameter and compensations (up to three items on display simultaneously). You can change the shown items in **Main menu > Display > Quantities and units**.
2 Battery indicator. Shows current status (charge) of the battery.
3 Function key **Graphic** shows the readings as a curve.
4 Function key **Hold/Save** freezes the display and you can save the reading in the MI70 memory.
5 Function key **Record** is a quick access to the **Recording/Viewing** menu.

You can change the default function key shortcuts (**Graphic**, **Hold/Save**, **Record**) to other menus or functions in **Main menu > Settings > User interface > Program shortcut keys**.

8.3 Graphical Display

The graphical display shows you the measurements as a curve (the curve of the uppermost quantity shown in the basic display). From the curve you can examine the data trend and history of the last minutes.

To open the graphical display, select **Graphic** in the basic display or select **Main menu > Display > Graphic history > Show**.

To get the statistical info on the graph area (minimum, maximum, and average values), press **Info**.

To get the curve of the other selected quantities, press **Next**. To get the curves of all the quantities, press **Next** until the text **All** appears, and then select **All**.

To zoom in and out, press the up/down arrow keys.

To move back and forward in the timeline, use the left/right arrow keys.

8.4 Main Menu

In the main menu, you can configure the MI70 settings and basic display options, view information about the probe, access recordings and clear the memory, set alarms, start adjustments, and use the analog output option of the MI70 indicator.

To open the main menu and navigate in the menus:

1. Go to the basic display.
2. Press any arrow key, then select **Open** (must be pressed within 5 seconds or the indicator returns to the basic display).
3. Move in the menus using the buttons.
4. Select an item with the button.
5. To return to the previous level, press .
6. To return to normal operation, press **Exit**.

8.5 Connecting Probe to MI70 Indicator

1. If the probe is installed permanently into a device (for example, an incubator or a chamber), disconnect the probe from the connector.
2. If the MI70 indicator is on, turn it off.
3. Connect the probe to the MI70 indicator using the MI70 connection cable (Vaisala order code: CBL210472).
4. Turn on the MI70 indicator (time and date are requested at first startup). MI70 detects the probe and proceeds to show the measurement screen. The parameters measured by probe will start to show valid measurement results after a few seconds.

8.6 MI70 Indicator Parts

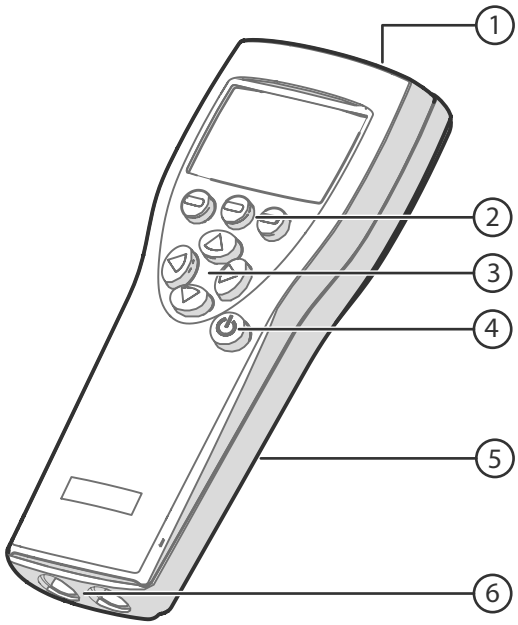


Figure 25 MI70 Indicator Parts

1 Charger socket
2 Function buttons. The functions change according to what you are doing with the indicator.
3 Arrow buttons:
- Move up in a menu
- Move down in a menu
- Enter a sub-menu
- Return to previous menu level

4 Power On/Off button
5 Battery compartment at the back of the indicator
6 Two ports (labeled I and II) for connecting probes and instruments.

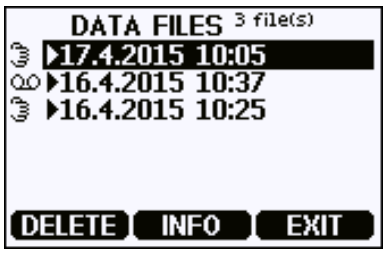
To open menus, press an arrow button and then press the shortcut buttons. To activate a function shown above the shortcut button, press the shortcut button. To navigate in the menus, press arrow buttons.

8.7 Holding and Saving the Display

With the **Hold/Save** function, you can freeze a certain display reading. This reading can be saved in the MI70 memory and it will be available even after MI70 is disconnected from the transmitter.

1. In the basic display, select **Hold/Save**. Alternatively, select **Main menu > Display > Hold/Save display > Hold**.
2. Press **Save**.
3. To view the saved display, go to basic display and select **Record > View recorded data**. Alternatively, select **Main menu > Recording/Viewing > View recorded data**.
   A list of saved displays and data recordings appears. The icons on the left of the date and time indicate whether the file is a saved display or a longer recording of data:
   Saved display
   Data recording

4. Select the saved display based on date and time by pressing the right arrow key.



8.8 Recording Data

With MI70, you can record transmitter measurement data over a certain period at chosen intervals. These recordings are saved in MI70 memory and are available even after MI70 is disconnected from the transmitter.

8.9 Changing Environmental Compensation Settings with MI70 Indicator

You can see the compensation values that are currently used by the probe by selecting them as display quantities from **Main menu > Display > Quantities and Units**. The quantities are as follows:

- **Tcomp**: currently active temperature compensation value.
- **Pcomp**: currently active pressure compensation value.
- **Ocomp**: currently active oxygen concentration compensation value.
- **Hcomp**: currently active relative humidity compensation value.

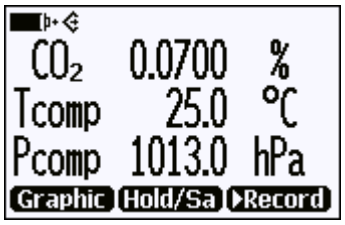


Figure 26 CO_2 Reading with Tcomp and Pcomp on MI70 Screen

You can change the compensation settings from **Main menu > Settings > Measurement settings**.

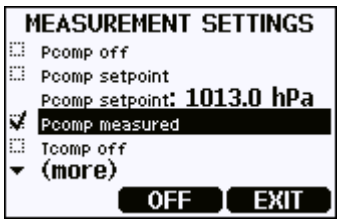


Figure 27 Probe Compensation Settings on MI70 Screen

When you turn a compensation off, the probe still shows a value for the corresponding display quantity (for example, Pcomp shows 1013.2 hPa). This is the default compensation value that is mathematically neutral for the probe's internal compensation model.

GMP251 cannot receive the compensation values from a second probe connected to MI70. Only direct configuration is supported.

8.10 Calibration and Adjustment with MI70 Indicator

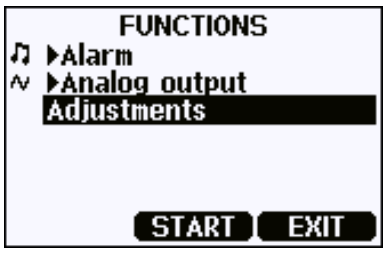
Before using the MI70 indicator for calibration and adjustment, read the instructions in Calibration and Adjustment (page 92). Make sure that the environmental compensation settings of the probe are properly set for your calibration environment; see Changing Environmental Compensation Settings with MI70 Indicator (page 86).

When two probes are connected to the MI70 indicator, MI70 uses Roman numerals "I" and "II" to indicate which port the parameter or function in question is connected to.

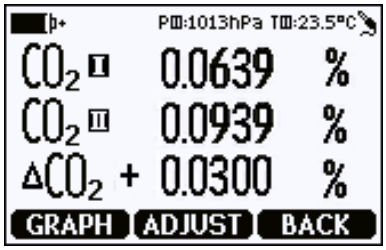
8.10.1 1-Point Adjustment with an MI70-Compatible Reference Probe

1. Connect the GMP251 probe to Port I of the MI70 indicator.
2. Connect the calibrated reference probe to Port II. Make sure the reference probe is in the same environment as the GMP251's sensor.
3. If you are using the calibration adapter to feed a calibration gas to the GMP251, you must feed the same gas to the reference probe also. Refer to the documentation of your reference probe on how to do this, and what accessories you need.
4. Turn on the MI70 indicator.

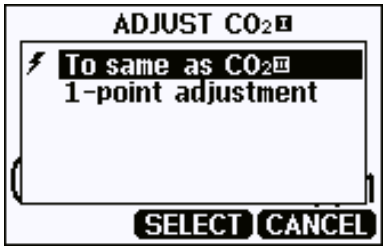
5. Start the adjustment sequence from **Main menu > Functions > Adjustments**.



6. MI70 notifies you that automatic power off is disabled during adjustment mode, press **OK** to acknowledge.
7. To proceed with the adjustment, select the **CO2(I)** parameter in the **Select Quantity** screen. In the **Select Quantity** screen you can also view the currently used compensation values, and the **Last adjustment date** information. You can update the date and text using the **CDATE** and **CTEXT** commands on the serial line.
8. You may be prompted to check the environmental settings of the reference probe before proceeding. Press **Yes** to check the settings and **Exit** when you have checked and corrected the settings.
9. The adjustment mode is now active, and you can see the measured CO_2 readings and their difference on the screen. Allow the measurement to stabilize. To proceed with the adjustment, press **Adjust**.



10. Select **To same as CO2(II)**.

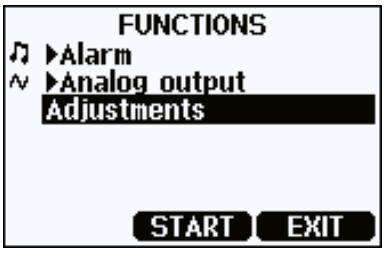


11. You will be prompted to confirm you want to adjust: select **Yes**.

12. If the adjustment is successful, MI70 will show the text **Adjustment Done**, after which you will return to the adjustment mode. At this point you can press **Back** and **Exit** to leave the adjustment mode. The adjustment is now completed. If the adjustment cannot be applied, MI70 will show the text **Cannot adjust**, possibly followed by a text stating the reason. A possible reason for an adjustment failure is attempting to apply a very large correction to the reading.

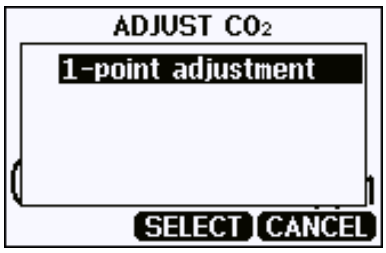
8.10.2 1-Point Adjustment with a Reference Gas

1. Connect the GMP251 to Port I of the MI70 indicator.
2. Feed a calibration gas to the GMP251 using the calibration adapter accessory (Vaisala order code: DRW244827SP). If you are using ambient air as the calibration gas, you must have a reference meter in the same environment to verify the CO_2 concentration.
3. Turn on the MI70 indicator.
4. Start the adjustment sequence from **Main menu > Functions > Adjustments**.

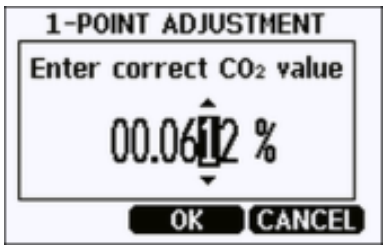


5. MI70 notifies you that automatic power off is disabled during adjustment mode, press **OK** to acknowledge.
6. Select the CO_2 parameter when prompted.
7. You may be prompted to check the environmental settings of the reference probe before proceeding. Press **Yes** to check the settings and **Exit** when you have checked and corrected the settings.
8. The adjustment mode is now active, and you can see the measured CO_2 reading on the screen. To proceed with the adjustment, press **Adjust**.

9. Select **1-point adjustment**.



10. You will be prompted if you really want to adjust. Select **Yes**.
11. You are now in the 1-point adjustment screen. Allow the measurement to stabilize and press **Ready**.
12. Enter the CO_2 concentration of the reference gas and press **OK**.



13. You will be prompted if you really want to adjust. Select **Yes**.
14. If the adjustment is successful, MI70 will show the text **Adjustment Done**, after which you will return to the adjustment mode. At this point you can press **Back** and **Exit** to leave the adjustment mode. The adjustment is now completed. If the adjustment cannot be applied, MI70 will show the text **Cannot adjust**, possibly followed by a text stating the reason. A possible reason for an adjustment failure is attempting to apply a very large correction to the reading.

9. Maintenance

9.1 Cleaning

You can clean the probe body by wiping it with a moist cloth. Standard cleaning agents can be used.

When cleaning, follow these precautions:

- Do not immerse the probe in liquid to clean it.
- Be careful not to block the filter when cleaning the probe. The optional sintered PTFE filter is especially sensitive to blockage.
- When changing the filter, you can use clean instrument air to gently blow any loose dirt and filter material from the sensor. Do not attempt to clean the optical surfaces in any other manner.

9.1.1 Chemical Tolerance

The following chemicals can be used to clean the probe:

- H_2O_2 (2000 ppm), non-condensing
- Alcohol-based cleaning agents such as ethanol and IPA (70 % Isopropyl Alcohol, 30 % water)
- Acetone
- Acetic acid

Avoid exposing the probe to chemicals for unnecessarily long periods of time. Do not immerse the probe in a chemical, and wipe chemicals off the probe after cleaning.

9.2 Changing the Filter

Change the filter to a new one if it shows visible signs of contamination or dirt. When changing the filter, use clean gloves to avoid blocking the pores of the new filter.

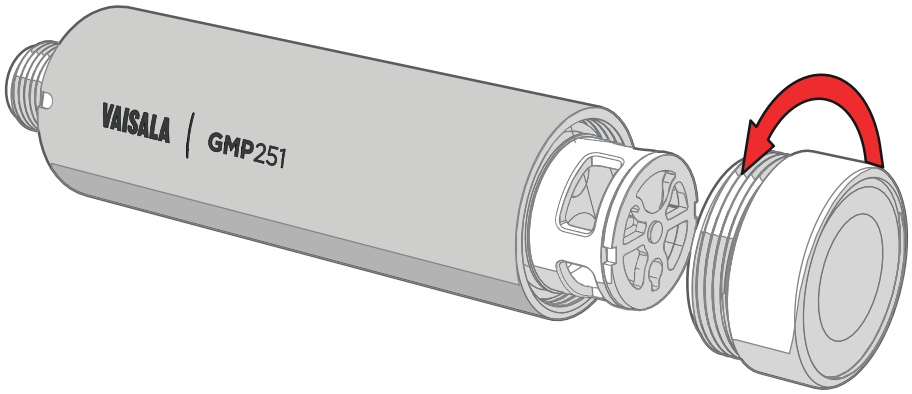


Figure 28 Opening the Filter

CAUTION! When changing the filter, you can use clean instrument air to gently blow any loose dirt and filter material from the sensor. Do not attempt to clean the optical surfaces in any other manner.

9.3 Calibration and Adjustment

Calibrate and adjust the CO_2 measurement of the probe as needed. Before starting, read through this section completely so that you are aware of your options, and the main factors that affect the result.

Performing an accurate calibration and adjustment takes some time and preparation. Instead of doing it yourself, you can also have a Vaisala Service Center calibrate and adjust your probe.

Calibration means comparing the measurement output of the device to a known reference, such as a known environment in a calibration chamber or the output of a reference instrument. Correcting the reading of the device so that it measures accurately is referred to as **adjustment**.

9.3.1 Calibration Setup

Using Hand-Held Meter as Reference

You can perform a 1-point calibration using a hand-held meter as a reference. You will need a calibrated reference instrument to compare against, for example a GM70 hand-held meter with a calibrated GMP221 probe.

With the probe and the reference instrument in the same space, allow the measurement to stabilize before comparing the readings. Try to provide as stable an environment as you can during this time. Avoid working around the probe and reference instrument during this time.

Using Calibration Gas as Reference

There are two easy ways to use a calibration gas as a reference:

- You can supply the gas to the probe using the calibration adapter accessory (Vaisala order code DRW244827SP). Gas flow should be in the range 0.5 ... 1.1 l/min, recommendation is 1 l/min. Allow the measurement to stabilize for three minutes before starting the calibration.
- You can fill the entire incubator with the calibration gas. You can use calibration gas a reference by putting the probe in a suitable chamber (for example, an incubator) and filling that chamber with the calibration gas.

To perform a two-point adjustment, you need two calibration gases: one gas that is below 2 %CO2 (low-end reference) and one that is above 2 %CO_2 (high-end reference).

When supplying the gas from a gas bottle, make sure the gas bottle has stabilized to room temperature before starting.

9.3.2 Effect of Environmental Compensations

The probe has various environmental compensations that improve its CO_2 measurement accuracy (see Environmental Compensation (page 15)). As the calibration and adjustment environment may differ from the actual measurement environment, you must make sure that the compensation settings are properly set. Here are some key points to remember:

- Pressure and temperature compensations have a significant effect on accuracy. If you are using setpoint values instead of the values from the built-in temperature sensor or an integrated system, make sure to correct the setpoints so that they correspond to your calibration situation. Consider switching temperature compensation to use the internal sensor and/or integrated system when calibrating, and then switching back when calibration and adjustment is done.
- The effect of background gas compensations for humidity and oxygen may be significant when using calibration gases, since these gases are often dry and oxygen-free. For example, pure nitrogen gas is typically used as a convenient 0 ppm CO_2 reference. As it does not contain any oxygen or humidity, the compensations for them must be set to zero.
- Remember to restore the normal compensation settings after completing calibration and adjustment. If you are integrating the calibration functionality of the probe as part of a control software, also implement proper handling of the environmental compensations.

More Information

- Environmental Compensation (page 15)

9.3.3 Limits of Adjustment

The probe limits the amount of adjustment that is allowed to the CO_2 measurement. The maximum correction that you can apply is 1000 ppm + 25 % of the probe's uncorrected reading. Previous user adjustments do not affect this limit (the correction is not cumulative). This feature limits the possible error introduced by incorrect adjustment.

For example, if you are adjusting using a 5 %CO_2 calibration gas (50000 ppm), the maximum correction you can apply is approximately 13500 ppm. Attempting to apply a greater adjustment will fail. Notification of failure from the probe depends on the interface you are using for adjustment.

9.3.4 Adjustment Types

You can adjust the CO_2 measurement of the probe in one or two points.

- One-point adjustment is recommended if you are interested in maintaining a fixed CO_2 level. For best result, use a calibration gas with a CO_2 concentration that is close to the intended level.
- Two-point adjustment is recommended if you typically measure a variable CO_2 level.

Available adjustment functions depend on the interface you use to operate the probe. If you want to integrate the functionality into a control system, the Modbus interface and the Vaisala industrial protocol are recommended. If you want to compare the reading of the probe to a reference instrument and adjust it accordingly, use an MI70 hand-held indicator and a reference probe.

Vaisala Industrial Protocol

Vaisala industrial protocol supports 1-point and 2-point adjustment with the **`cco2`** command. Configuration of the environmental compensation settings can be done using serial line commands.

Modbus

The environmental compensation settings can be configured using Modbus registers.

MI70 Hand-Held Indicator

The MI70 hand-held indicator supports 1-point adjustment, either using a calibration gas or using a reference instrument that is connected to the MI70.

Vaisala Insight PC software

You can carry out 1-point and 2-point adjustments and change the environmental compensation settings with the Insight software (requires USB cable 242659).

Vaisala Indigo transmitters

You can use the Indigo transmitter's wireless configuration interface to carry out 1-point and 2-point adjustments and change the environmental compensation settings.

More Information

- Calibration and Adjustment (page 45)
- Configuration Registers (page 110)
- Calibration and Adjustment with MI70 Indicator (page 87)
- Calibrating GMP251 with Indigo (page 76)

9.3.5 DRW244827SP Calibration Adapter

The optional calibration adapter accessory can be used to feed a reference gas to the probe through a gas port when calibrating. Gas flow should be in the range 0.5 ... 1.1 l/min, recommendation is 1 l/min. Allow the measurement to stabilize for three minutes before starting the calibration.

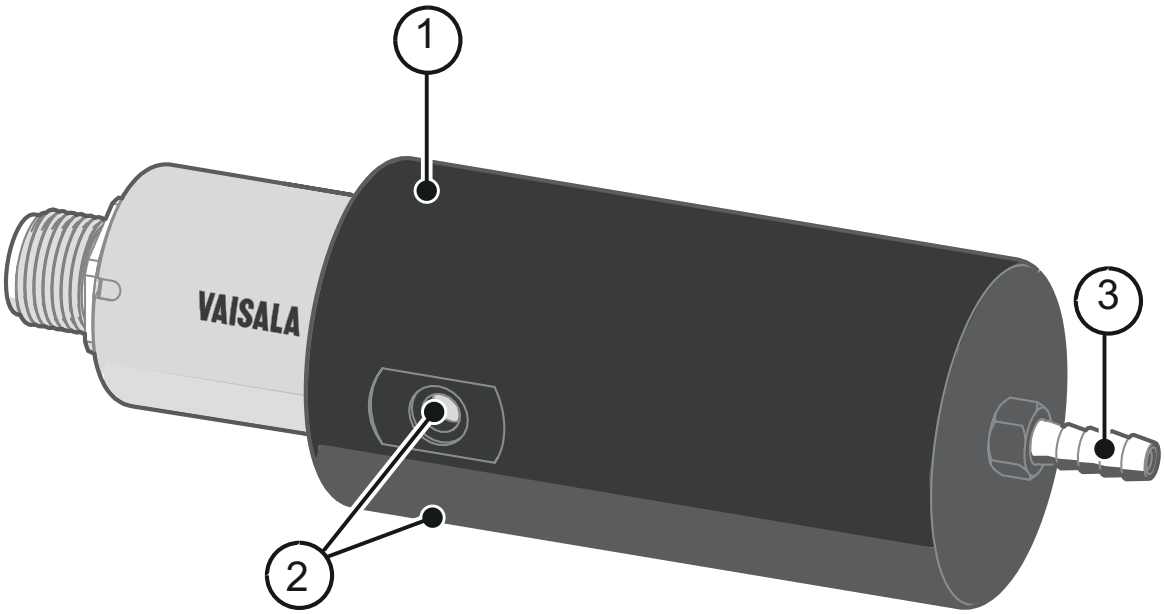


Figure 29 DRW244827SP Calibration Adapter with Probe Inserted

1 O-ring inside the adapter
2 Gas outlet on each side of the adapter
3 Gas port (port outer diameter 4.6 mm, port hole inner diameter 2 mm, suitable for tubing with 4 mm inner diameter)

10. Troubleshooting

10.1 Problem Situations

Problem	Possible Cause	Remedy
Analog output reading is unchanging and appears incorrect.	Analog output is in error state.	Remove the cause of the error state and the analog output will recover its normal function.
Probe outputs stars "****" on serial line instead of measurement data.	Incorrect supply voltage.	Check the power supply. Check the active errors using the ERRS command on the serial line.
	Unsuitable operating environment.	Verify that the operating environment is within specified operating limits.
Unable to access probe on the RS-485 line.	Incorrect wiring.	Check that the RS-485 connection is wired correctly.
	Probe in POLL mode with unknown address.	Power cycle or reset the probe and try again.
CO_2 measurement not working.	Condensation on the sensor.	Remove the filter and check if condensation has formed on the sensor. If yes, dry out the condensation with instrument air and insert a new dry filter. Keep the probe powered and operating to prevent re-occurrence.

10.2 Error Messages

The error messages are categorized according to the severity of the status:

- **Critical errors** are fatal to the operation of the unit. It may not be able to respond to communication at all, and will not measure correctly.
- **Errors** prevent CO_2 measurement and cause the analog outputs to be set to the error state. Depending on the problem, errors may resolve themselves. For example, sensor heating will eventually dry out condensation on the optical surfaces.
- **Warnings** do not prevent normal operation but may indicate possible problems.
- **Status** indicates a known state of the unit.

Error Message	Description	Recommended Action
Critical errors		
Program memory crc critical error	Program memory is corrupted.	Fatal error, contact Vaisala.

Error Message	Description	Recommended Action
Parameter memory crc critical error	Parameter memory is corrupted.	Fatal error, contact Vaisala.
Errors		
Low supply voltage error		Check supply voltage.
Internal 30 V error	Low internal 30 V voltage.	
Low RX signal error	Low input signal. Can be caused by dirt or condensation on the optical surfaces.	Wait to see if condensation is removed by heat.
Internal 8 V error	Low internal 8 V voltage.	
RX signal cut error	Signal distortion (EMC interference)	
Out of measurement range error	CO_2 concentration is too high to measure.	Wait for CO_2 concentration to fall into the measurable range.
Sensor heater error	Sensor heater resistance is out of range.	
IR temperature error	IR source temperature error.	
FPI slope error	Signal receiver error.	Contact Vaisala.
Internal 2.5 V error	Internal 2.5 V voltage out of range.	
Internal 1.7 V error	Internal 1.7 V voltage out of range.	
Low IR current error	IR source failure.	Contact Vaisala.
Warnings		
Signal too low warning	Low input signal. Can be caused by dirt or condensation on the optical surfaces.	Continue normally.
Cut warning	EMC interference error limit approaching.	Check for EMC interference sources.
Unexpected restart detected	Transmitter is reset by watchdog process.	Continue normally.
Status messages		
CO_2 adjustment mode active		Complete the CO_2 adjustment.

10.3 Analog Output Error State

The probe sets the analog output channel into a defined error level instead of the measured result in two situations:

- Probe detects a measurement malfunction. This means an actual measurement problem, such as sensor damage or unsuitable environmental conditions.
- Measured value(s) are significantly outside the scaled output range.

The default error level depends on the output type:

Output	Default Error Level
0 ... 20 mA	23 mA
4 ... 20 mA	2 mA
0 ... 5 V	0 V
0 ... 10 V	0 V

The probe resumes normal operation of the analog output when the cause of the error state is removed.

10.4 Indigo Wireless Connection Troubleshooting

The following table contains troubleshooting information related to accessing the wireless (WLAN) configuration interface of Vaisala Indigo transmitters.

Problem	Possible Cause	Remedy
The wireless device has connected to the Indigo access point, but the configuration interface does not launch.	The device you are using to connect to Indigo does not launch the browser automatically after connecting to the access point.	After connecting to Indigo, open your browser application.
	The wireless connection requires an authentication or acknowledgement before the Indigo interface opens in your browser.	Check your device's notifications to see if an authentication or login prompt is present for the Indigo connection. Acknowledge the connection and open your browser application if the interface does not launch automatically.
The Indigo access point does not show up in your device's list of available WLAN connections.	Indigo access point is not enabled or an error has occurred.	Switch off the Indigo WLAN connection, enable the connection again and retry.
	Your device is too far from the transmitter or obstacles are blocking the signal.	Move closer to the transmitter and refresh your device's access point list.
Indigo shows up in the list of available wireless connections, but connecting to it does not work.	A device is already connected to the Indigo access point.	Ensure that your device is the only one that is connecting to the wireless configuration interface.
The interface does not open in the browser.	The browser has issues with loading the landing page.	Enter the default Indigo IP address **http://192.168.1.1** in the browser's address bar.
Cannot connect to the Indigo access point with iPhone.	The iPhone WLAN settings prevent establishing a connection.	See the iPhone connection instructions in the Indigo transmitter's *User Guide*.

Problem	Possible Cause	Remedy
Indigo does not respond when pressing the wireless connection activation button.	WLAN functionality has been disabled with the WLAN ON/OFF DIP switch on Indigo's circuit board.	Enable WLAN functionality with the WLAN ON/OFF DIP switch. See the instructions in the Indigo transmitter's *User Guide*.

11. Technical Data

11.1 GMP251 Specifications

Table 47 Measurement Performance

Property	Description/Value
Measurement range	0 ... 20 %CO_2
Accuracy at 25 °C (77 °F) and 1013 hPa (incl. Repeatability and Non-linearity)	
At 5 %CO_2	±0.1 %CO_2
0 ... 8 %CO_2	±0.2 %CO_2
8 ... 20 %CO_2	±0.4 %CO_2
Calibration Uncertainty	
At 5 %CO_2	±0.12 %CO_2
At 20 %CO_2	±0.32 %CO_2
Long-Term Stability	
0 ... 8 %CO_2	±0.3 %CO_2/year
8 ... 12 %CO_2	±0.5 %CO_2/year
12 ... 20 %CO_2	±1.0 %CO_2/year
Temperature Dependence	
With compensation at 5 %CO_2, 0 ... +50 °C (+32 ... +122 °F)	< ±0.05 %CO_2
With compensation, 0 ... 20 %CO_2,-40 ... +60 °C (-40 ... +140 °F)	±0.045 % of reading/°C
Without temperature compensation at 5 %CO_2 (typical)	-0.25 % of reading/°C
Pressure Dependence	
With compensation at 5 %CO_2 700 ... 1100 hPa	±0.05 %CO_2
With compensation, 0 ... 20 %CO_2 500 ... 1200 hPa	±0.015 % of reading/hPa
Without compensation (typical)	+0.15 % of reading/hPa
Humidity Dependence	
With compensation, 0 ... 20 %CO_2, 0 ... 100 %RH	±0.7 % of reading (at +25 °C (+77 °F))
Without compensation (typical)	+0.05 % of reading / %RH
O_2 Dependence	

Property	Description/Value
With compensation, 0 ... 20 %CO_2, 0 ... 90 %O_2	±0.6 % of reading (at +25 °C (+77 °F))
Without compensation (typical)	-0.08 % of reading / %O_2
Flow Rate Dependence (for Flow-Through Model Option)	
< 1 l/min flow	No effect
1 ... 10 l/min flow	< 0.6 % of reading/ l/min
Start-up time at +25 °C (+77 °F)	< 10 s
Warm-up time for full spec.	< 4 min
Response Time (T90)	
With standard filter	< 1 min
Flow-through model with > 0.1 l/min	< 1 min
With spray shield	< 2 min

Table 48 Operating Environment

Property	Description/Value
Operating temperature of CO_2 measurement	-40 ... +60 °C (-40 ... +140 °F)
Storage temperature	-40 ... +70 °C (-40 ... +158 °F)
Pressure	
Compensated	500 ... 1100 hPa
Operating	< 1.5 bar
Humidity	0 ... 100 %RH, non-condensing
Gas Flow (for Flow-Through Option)	
Operating range	< 10 l/min
Recommended range	0.1 ... 0.8 l/min
Condensation prevention	Sensor head heating, when power on
EMC compliance	EN61326-1, Generic Environment
Chemical tolerance (temporary exposure during cleaning)	• H_2O_2 (2000 ppm, non-condensing) • Alcohol-based cleaning agents (for example ethanol and IPA) • Acetone • Acetic acid

Table 49 Inputs and Outputs

Property	Description/Value
Analog outputs	• 0 ... 5/10 V (scalable), min load 10 kΩ • 0/4 ... 20 mA (scalable), max load 500 Ω

Property	Description/Value
Digital output	Over RS-485: • Modbus • Vaisala Industrial Protocol
Operating Voltage	
With digital output in use	12 ... 30 VDC
With voltage output in use	12 ... 30 VDC
With current output in use	20 ... 30 VDC
Power Consumption	
Typical (continuous operation)	0.4 W
Maximum	0.5 W

Table 50 Mechanical Specifications

Property	Description/Value
Weight, probe	45 g (1.59 oz)
Materials	
Probe housing	PET plastic
Filter	PTFE membrane, PET plastic grid
Connector	Nickel plated brass, M12 / 5 pin
IP rating, probe body	IP65
Connector	M12 5-pin male
Dimensions	
Probe diameter	25 mm (0.98 in)
Probe length	96 mm (3.78 in)

11.2 Spare Parts and Accessories

Information on spare parts, accessories, and calibration products is available online at www.vaisala.com and store.vaisala.com.

Name	Order Code
Standard membrane filter	ASM211650SP
Porous sintered PTFE filter (extra protection)	DRW243649SP
Probe cable with open wires (1.5 m (4.9 ft))	223263SP

Name	Order Code
Probe cable with open wires and 90° plug (0.6 m (1.97 ft)	244669SP
Probe cable with open wires (10 m (32.8 ft))	216546SP
Flow-through adapter with gas ports	ASM211697SP
USB cable for PC connection[1)]	242659
MI70 connection cable for probe	CBL210472
Flat cable for GMP250 probes, M12 5-pin	CBL210493SP
Probe mounting clips (2 pcs)	243257SP
Probe mounting flange	243261SP
Calibration adapter	DRW244827SP
Spray shield	ASM212017SP

1) Vaisala Insight software for Windows® available at www.vaisala.com/insight.

11.3 GMP251 Probe Dimensions

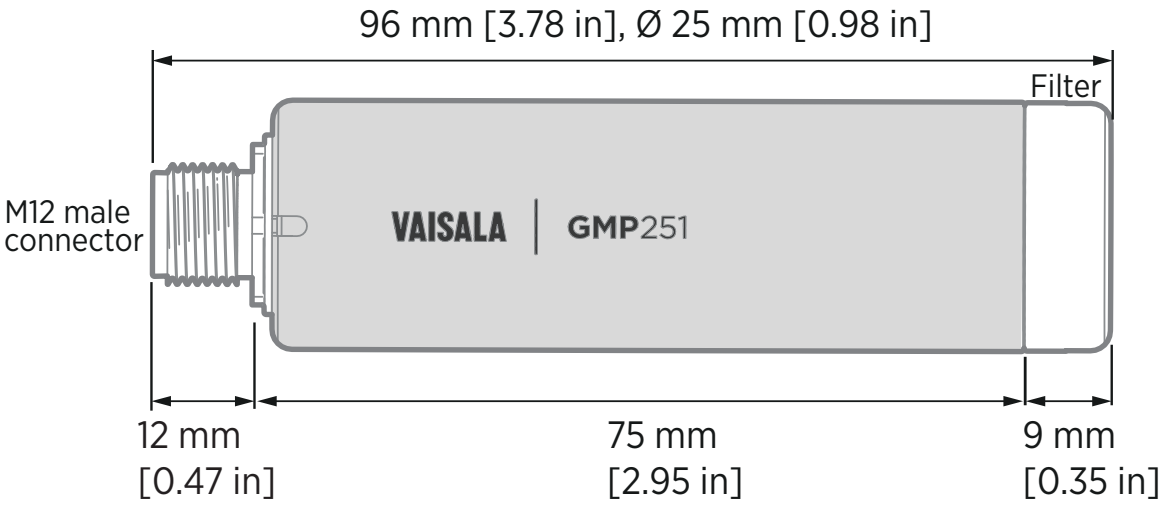


Figure 30 GMP251 Dimensions

11.4 243261SP Mounting Flange Dimensions

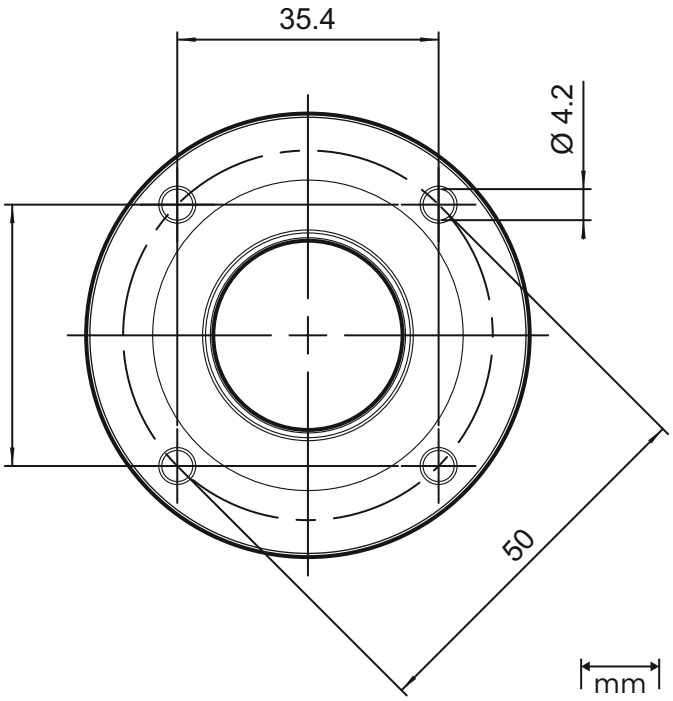


Figure 31 243261SP Mounting Flange Dimensions

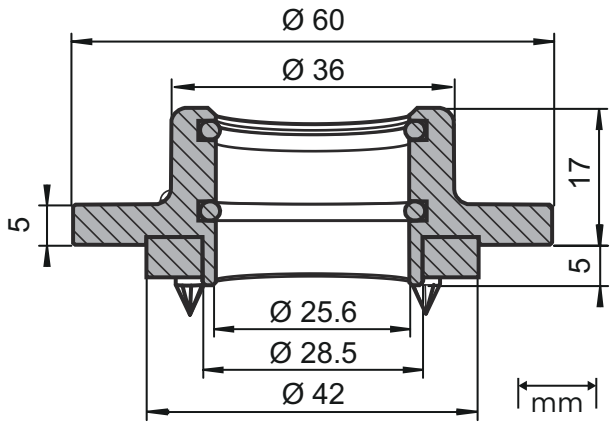


Figure 32 243261SP Mounting Flange Dimensions, Cross Section

11.5 DRW244827SP Calibration Adapter Dimensions

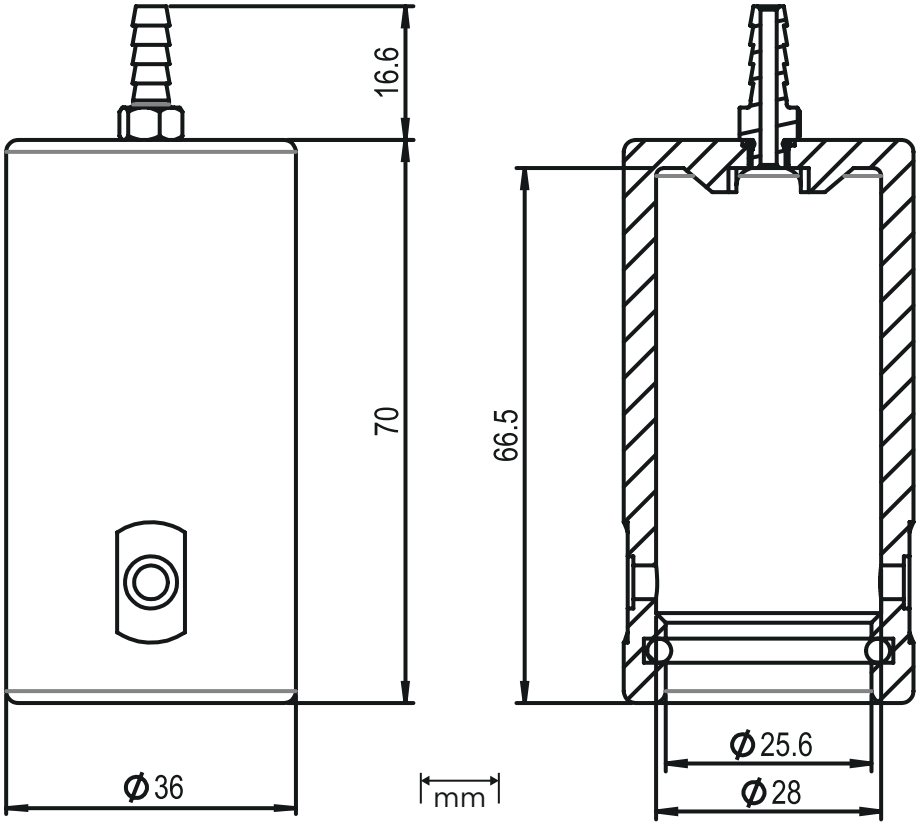


Figure 33 DRW244827SP Calibration Adapter Dimensions

11.6 ASM212017SP Spray Shield Dimensions

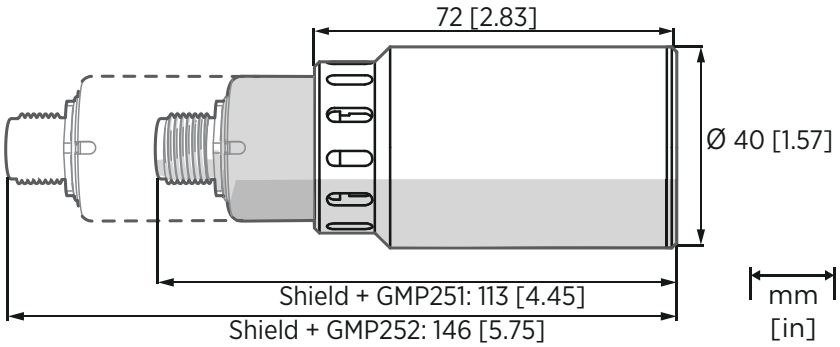


Figure 34 ASM212017SP Spray Shield Dimensions

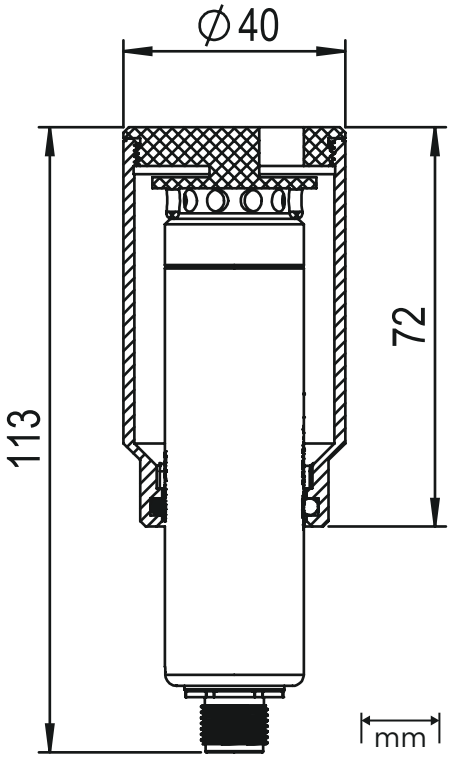


Figure 35 GMP251 Spray Shield Cross Section

Appendix A. Modbus Reference

A.1 Function Codes

Table 51 Supported Function Codes

Function Code (Decimal)	Function Code (Hexadecimal)	Name
03	03_{hex}	Read Holding Registers
16	10_{hex}	Write Multiple Registers
43/14	$2B_{hex}$ / $0E_{hex}$	Read Device Identification

A.2 Modbus Registers

CAUTION! Registers are numbered in decimal, starting from one. Register addresses in actual Modbus messages (Modbus Protocol Data Unit (PDU) are in hexadecimal and start from zero. Subtract 1 from the register number presented in this manual to get the address used in the Modbus message. For example, the register number 769 (Modbus address) corresponds to address 0300_{hex} in the Modbus message.

Accessing unavailable (temporarily missing) measurement data does not generate an exception. “Unavailable” value (a quiet NaN for floating point data or 0000_{hex} for integer data) is returned instead. An exception is generated only for any access outside the applicable register ranges.

A.2.1 Measurement Data

Table 52 Modbus Measurement Data Registers (Read-Only)

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Unit
1	0000_{hex}	Measured CO_2 value	32-bit float	ppm
3	0002_{hex}	Compensation T	32-bit float	°C
5	0004_{hex}	Measured T	32-bit float	°C
257	0100_{hex}	Measured CO_2 value	16-bit signed integer	ppm (up to 32 000 ppm)

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Unit
258	0101_{hex}	Measured CO_2 value	16-bit signed integer	ppm[1)] (scaled, up to approx. 320 000 ppm)

1) The ppm output of the second Measured CO_2 value register (number 258) is scaled and must be multiplied by 10.

A.2.2 Configuration Registers

CAUTION! Default power-up values (registers 513-519) are written into non-volatile EEPROM memory. The EEPROM memory implementation has a limit of 30000 writes, and is intended to be used only when saving long-term or permanent configurations. Use the volatile memory (registers 521 ... 527, values cleared on power-up) for non-permanent configurations (for example, if the probe is used in a system that regularly updates the compensation values).

Table 53 Modbus Configuration Data Registers (Writable)

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Unit / Valid Range
513	0200_{hex}	Power-up value for pressure compensation	32-bit float	hPa 700 ... 1500 hPa Operating <1.5 bar (Init/default: 1013.25)
515	0202_{hex}	Power-up value for temperature compensation	32-bit float	°C -40 ... +80 (Init/default: 25)
517	0204_{hex}	Power-up value for humidity compensation	32-bit float	%RH 0 ... 100 % (Init/default: 0)
519	0206_{hex}	Power-up value for oxygen compensation	32-bit float	$\%O_2$ 0 ... 100 % (Init/default: 0)
521	0208_{hex}	Volatile (value cleared at probe reset) pressure compensation	32-bit float	Range 700 ... 1500 hPa (Init copied from power-up value)
523	$020A_{hex}$	Volatile (value cleared at probe reset) temperature compensation	32-bit float	Range -40 ... +80 °C (Init copied from power-up value)

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Unit / Valid Range
525	$020C_{hex}$	Volatile (value cleared at probe reset) humidity compensation	32-bit float	Range 0 ... 100 %RH (Init copied from power-up value)
527	$020E_{hex}$	Volatile (value cleared at probe reset) oxygen compensation	32-bit float	Range 0 ... 100 $\%O_2$ (Init copied from power-up value)
769	0300_{hex}	Modbus address	16-bit integer	Valid range 1 ... 247 (default: 240)
770	0301_{hex}	Serial speed	enum	Valid range 4800 ... 115200 0 = 4800 1 = 9600 2 = 19200 3 = 38400 4 = 57600 5 = 115200 (default: 2 (19200))
771	0302_{hex}	Serial parity	enum	0 = None 1 = Even 2 = Odd (default: 0 (None))
772	0303_{hex}	Serial stop bits	16-bit integer	Valid range 1...2 (default: 2)
773	0304_{hex}	Pressure compensation mode	enum	0 = Off 1 = On (default: 1 (On))
774	0305_{hex}	Temperature compensation mode	enum	0 = Off 1 = Given 2 = Measured (default: 2 (Measured))
775	0306_{hex}	Humidity compensation mode	enum	0 = Off 1 = On (default: 0 (Off))
776	0307_{hex}	Oxygen compensation mode	enum	0 = Off 1 = On (default: 0 (Off))

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Unit / Valid Range
777	0308_{hex}	CO_2 filtering factor	16-bit integer	Valid range 0 ... 100 (default: 100 (no filtering)). For information on setting the filtering factor, see Filtering Factor (page 116).

To apply an accurate relative humidity compensation (775), you must also enable temperature compensation (774) and pressure compensation (773).

A.2.3 Status Registers

Table 54 Modbus Status Registers (Read-Only)

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Notes
2049	0800_{hex}	Device status	16-bit	0 = Status OK. 1 = Critical error. 2 = Error. 4 = Warning.
2050	0801_{hex}	CO_2 status	16-bit	0 = Status OK. 2 = CO_2 reading not reliable. Appears during transmitter start-up. 256 = Measurement not ready. Appears during transmitter start-up.

Multiple statuses can be present simultaneously. In those cases, the value of the status register is the sum of the status values. For example, the value of the device status register is **6** if a warning (**4**) and an error (**2**) are present simultaneously.

More Information

- Error Messages (page 97)

A.2.4 Device Identification Objects

Table 55 Device Identification Objects

Object ID (Decimal)	Object ID (Hexadecimal)	Object Name	Example Contents
0	00_{hex}	VendorName	"Vaisala"
1	01_{hex}	ProductCode	"GMP25x Carbon Dioxide Probe "
2	02_{hex}	MajorMinorVersion	Software version (for example "1.2.3")
3	03_{hex}	VendorUrl	"http://www.vaisala.com/"
4	04_{hex}	ProductName	"GMP25X "
128	80_{hex}	SerialNumber[1)]	Transmitter serial number (for example, "K0710040")
129	81_{hex}	Calibration date[1)]	Date of the factory calibration
130	82_{hex}	Calibration text[1)]	Information text of the factory calibration

1) Vaisala-specific device information object

A.3 Modbus Communication Examples

Reading CO_2 Value

Device address used in the following examples is 240 ($F0_{hex}$).
The values returned by the device differ depending on the ambient conditions and/or device settings. Your device might not return exactly same values.

Request		Response	
Bytes on the Line (Hexadecimal)	**Description**	**Bytes on the Line (Hexadecimal)**	**Description**
(silence for 3.5 bytes)	Start of Modbus RTU frame	(silence for 3.5 bytes)	Start of Modbus RTU frame
$F0_{hex}$	GMP25x address	$F0_{hex}$	GMP25x address
03_{hex}	Function (Read Holding Registers)	03_{hex}	Function (Read Holding Registers)
00_{hex}	Register address	04_{hex}	Number of data bytes
00_{hex}		$D4_{hex}$	Value of first register (least significant word)
00_{hex}	Number of 16-bit registers to read (2)	$7A_{hex}$	
02_{hex}		43_{hex}	Value of second register (most significant word)
$D1_{hex}$	Modbus RTU checksum	$E8_{hex}$	
$2A_{hex}$		33_{hex}	Modbus RTU checksum
(silence for 3.5 bytes)	End of Modbus RTU frame	AB_{hex}	
		(silence for 3.5 bytes)	End of Modbus RTU frame

Communication Description	
Register address	1 (1-based Modbus documentation format) = 0000_{hex} (0-based format used in actual communication).
Data format	Two 16-bit Modbus registers interpreted as IEEE 754 binary32 floating point value, least significant word first.
Returned value	43E8D47Ah, which is binary32 representation of 465.65997 (ppm).

Writing Volatile Compensation Pressure Value

Request		Response	
Bytes on the Line (Hexadecimal)	**Description**	**Bytes on the Line (Hexadecimal)**	**Description**
(silence for 3.5 bytes)	Start of Modbus RTU frame	(silence for 3.5 bytes)	Start of Modbus RTU frame
$F0_{hex}$	GMP25x address	$F0_{hex}$	GMP25x address
10_{hex}	Function (Write Multiple Registers)	10_{hex}	Function (Write Multiple Registers)
02_{hex}	Register address	02_{hex}	Register address
08_{hex}		08_{hex}	
00_{hex}	Number of registers to write (2)	00_{hex}	Number of 16-bit registers written (2)
02_{hex}		02_{hex}	
04_{hex}	Number of data bytes	$D4_{hex}$	Modbus RTU checksum
50_{hex}	Value for the first register (least significant word)	93_{hex}	
00_{hex}		(silence for 3.5 bytes)	End of Modbus RTU frame
44_{hex}	Value for the second register (most significant word)		
$7D_{hex}$			
$0E_{hex}$	Modbus RTU checksum		
$B7_{hex}$			
(silence for 3.5 bytes)	End of Modbus RTU frame		

The response to a write function informs that the function was correctly received by the device. It does not guarantee that the written value was accepted by the device (for example, in case of out-of-range values).

To verify that the value was really accepted by the device, read the register value after writing.

Communication Description	
Register address	521 (1-based Modbus documentation format) = 0208_{hex} (0-based format used in actual communication).
Data format	Two 16-bit Modbus registers interpreted as IEEE 754 binary32 floating point value, least significant word first.
Value to write	1013.25 (hPa), in binary32 format $447D5000_{hex}$.

A.4 Filtering Factor

Modbus register 777 sets the CO_2 filtering factor.

The filtering factor affects the speed at which the latest CO_2 measurement is integrated into the output of the probe. A new measurement is produced approximately every two seconds.

By default, the filtering factor is set to 1.0, which means the latest measurement is shown directly in the output, without any filtering. If the measuring environment produces occasional exceptionally high or low readings that need to be averaged out in the output, filtering can be applied.

To apply filtering, you need to set a filtering factor that determines how much the previous measurements affect the calculation of measurement output. For example, when using filtering factor of 0.1, the new output is a combination of previous measurements (90 %) and the latest measurement (10 %).

Examples of the effect of filtering on output:

- Filtering factor 1.0 = No filtering, the latest measurement is output directly without integrating previous measurements.
- Filtering factor 0.5 = The reading output shows ~75 % of the measurement change after two two-second measurement cycles and ~93 % after four cycles.
- Filtering factor 0.1 = The reading output shows ~90 % of the measurement change after 22 measurement cycles.

The configuration range of the filtering factor is 0 ... 100 in the 16-bit register: for example, to set the factor to 0.5, set the value of the register to 50.

The following formula is used when calculating the output:

$$o_{\text{new}} = o_{\text{old}} + (m_{\text{new}} - o_{\text{old}}) \times f$$

o_{new}	New output
o_{old}	Previous output
m_{new}	New measurement
f	Filtering factor

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.

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.

Recycling

Recycle all applicable material.

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

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