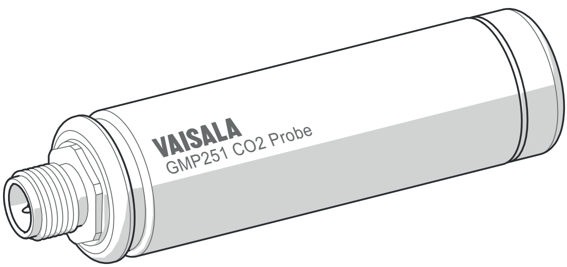
USER'S GUIDE

Vaisala CARBOCAP® Carbon Dioxide Probe GMP251



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1 GENERAL INFORMATION

Documentation Conventions

Warning alerts you to a serious hazard. If you do not read and follow instructions very 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.

About this Document

Table 1 Document Revision History

Document code	Published	Description
M211799EN-A	June 2015	This document. The first version.

Table 2 Related Documents

Document code	Description
M211798EN	Vaisala CARBOCAP® Carbon Dioxide Probe GMP251 Quick Guide

Safety

The GMP251 probe delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

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.

Do not modify the unit. Improper modification can damage the product or lead to malfunction.

Do not open the probe housing. There are no user serviceable parts inside.

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. It is possible to damage the product, however, by delivering an electrostatic discharge 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.

Recycling

Recycle all applicable material.

Dispose of the unit according to statutory regulations. Do not dispose of with regular household refuse.

Regulatory Compliances

GMP251 is in conformity with the provisions of the following EU directives:

- EMC Directive
- RoHS Directive

Conformity is shown by compliance with the following standards:

- EN 61326-1: Electrical equipment for measurement, control, and laboratory use – EMC requirements – Generic environment.
- EN 550022: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.

Patent Notice

GMP251 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
Japan Patent Office	4263285
Finnish Patent Office	112005
	105598

Trademarks

CARBOCAP® is a registered trademark of Vaisala Oyj.

All other trademarks are the property of their respective owners.

Software License

This product contains software developed by Vaisala. Use of the software is governed by license terms and conditions included in the applicable supply contract or, in the absence of separate license terms and conditions, by the General License Conditions of Vaisala Group.

Warranty

Visit our Internet pages for more information and our standard warranty terms and conditions: 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.

2 PRODUCT OVERVIEW

Introduction to GMP251

Vaisala CARBOCAP® Carbon Dioxide Probe 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 CARBOCAP® technology and Vaisala's 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. The probe also has an internal temperature sensor, which allows compensation of the measurement 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.

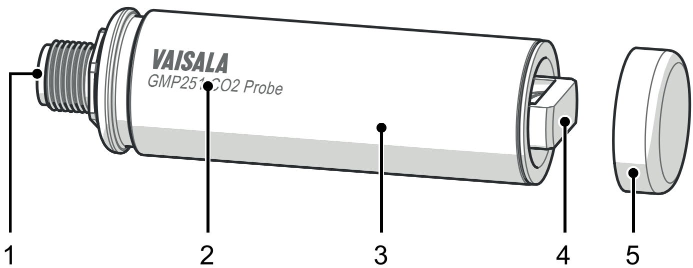


Figure 1 GMP251 Probe Parts

1 = 5-pin M12 connector. For pinout, see Wiring on page 15
2 = Laser-printed type label.
3 = Probe body. Contains the main component board.
4 = Measurement cuvette with optics and CARBOCAP® CO_2 sensor.
5 = Filter.

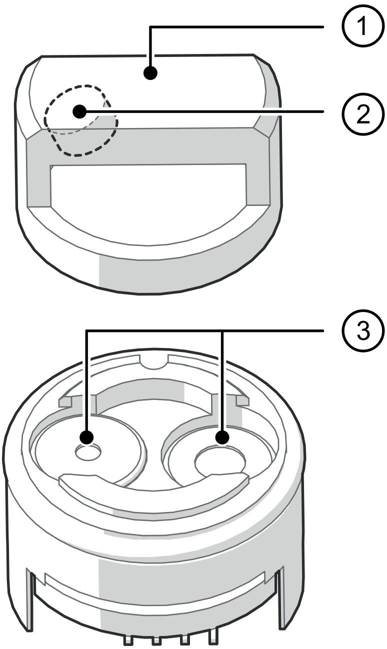
Do not attempt to open the probe body. There are no user-serviceable parts inside the probe body.

Basic Features and Options

- CO_2 measurement range 0 ... 20 %
- Vaisala CARBOCAP® CO_2 sensor with excellent long-term stability. See Operating Principle of CO2 Measurement on the next page and Specifications on page 49.
- Measurement compensated for effects of temperature, pressure, and background gas. Temperature compensation can be based on an integrated temperature sensor. See Environmental Compensation on page 10.
- Heating to avoid condensation on optical elements.
- Digital output with RS-485 (Vaisala Industrial Protocol)
- Analog output:
  - Current output (0 ... 20 mA or 4 ... 20 mA)
  - Voltage output (0 ... 5 V or 0...10 V)
- Easy plug-in, plug-out

Operating Principle of CO_2 Measurement

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



1 = Cuvette

2 = Mirror

3 = Sensor chips under TO5 package

Figure 2 CARBOCAP® Sensor of the Probe

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. 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.

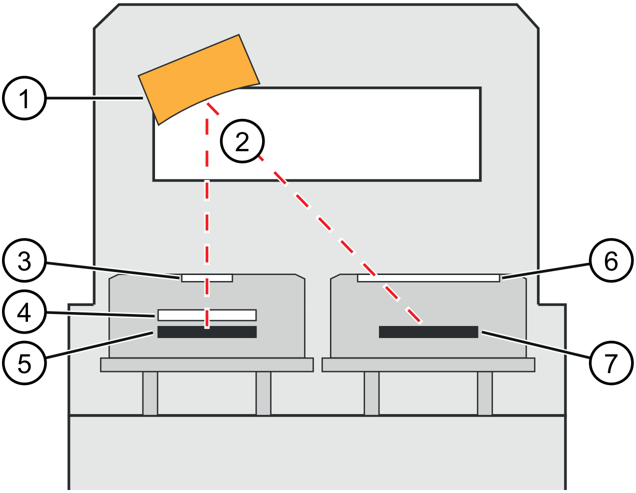


Figure 3 CO_2 Measurement in the Measurement Cuvette

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

Environmental Compensation

When necessary, various environmental compensations can be applied to improve the 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)

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.

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.

Temperature Compensation

The probe can measure the approximate temperature of the CARBOCAP® sensor for compensation, or use a fixed setpoint. The temperature measurement is accurate enough to be useful for compensation, and is recommended for use unless a dedicated temperature measurement is available and can be regularly updated to the probe.

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

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 via Vaisala Industrial Protocol (see Environmental Compensation on page 39).

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

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 (see Environmental Compensation on page 39). 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.

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 15-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.

Analog Output Overrange Behavior

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 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%	>2%	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.

Note that the 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 2%, and for 0 ... 5 V output the limits are 5% and 10%.

For 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.

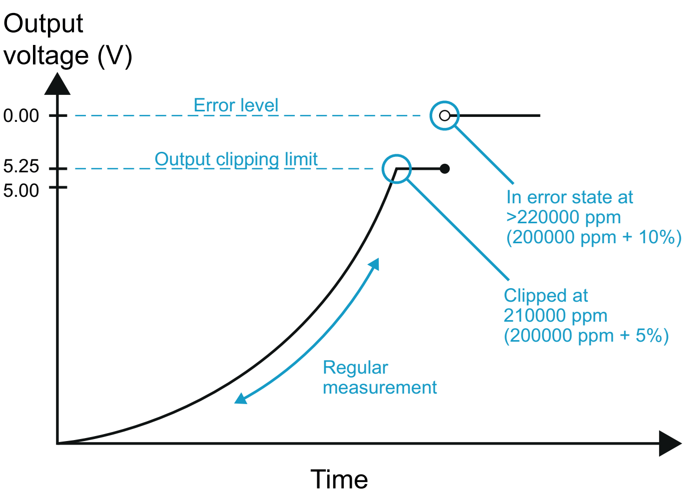


Figure 4 Example of analog output overrange behavior with output scaled to 0 … 5 V and 0 … 200000 ppm, error level set to 0 V, clipping set to 5 % overrange, and error limit set to 10 % overrange. CO_2 concentrations (ppm) are indicated clipping point and error limit point.

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. For instructions, see Aover Command on page 32.

3 INSTALLATION

Dimensions

The dimensions are given in millimeters (mm).

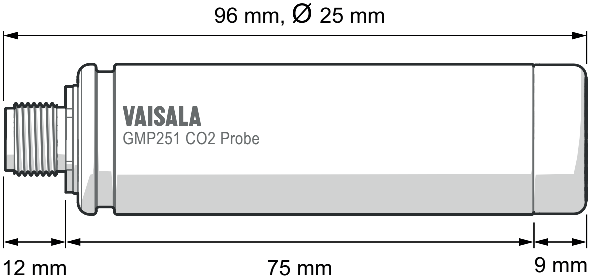


Figure 5 GMP251 Dimensions

Recommended Installation

The probe can be installed in an environment with an operating temperature range -40 ... +60 °C. 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.

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 13 ... 20 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.

Wiring

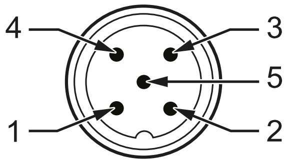


Figure 6 GMP251 M12 Male Connector Pins

Pin #	Function	Note	Wire colors, cable with open wires (item no. 223263)	Wire colors, high temperature durable cable (item no. CBL210347)
1	Power in	With digital output: 12 ... 30 VDC With voltage output: 13 ... 20 VDC With current output: 20 ... 30 VDC Typical average power consumption <0.4 W, maximum 0.5 W	Brown	Gray
2	RS-485- or voltage output	Voltage: 0 ... 5 VDC, or 0 ... 10 VDC	White	Black
3	GND		Blue	Blue
4	RS-485 + or current output	Current: 0 … 20 mA, or 4 ... 20 mA	Black	Brown
5	Output control	If not connected, provides digital output. If connected to pin 3, provides analog output.	Gray	Green-yellow

4 VAISALA INDUSTRIAL PROTOCOL

Overview

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.

Table 5 Default Serial Interface Settings

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

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. For connector pinout and wiring information, see Wiring on page 15.

Connecting with a Computer

- Vaisala USB service cable (order code 242659)
- Computer with:
  - Windows operating system
  - Terminal application (e.g. 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)

Connecting with a computer allows you to configure and troubleshoot your probe using serial line commands. For a list of commands, see Serial Commands on page 19.

When connecting using a computer, use the Vaisala USB cable (Vaisala order code 242659) and a suitable terminal application:

- If you have not used the Vaisala USB cable before, install the driver before attempting to use the cable. For detailed instructions, see Installing the Driver for the USB Service Cable below.
- For more information on using a terminal application, see Terminal Application Settings on the facing page.

Installing the Driver for the USB Service Cable

Before taking the USB service cable into use for the first time, you must install the provided USB driver on your computer (requires Windows). When installing the driver, you must accept any security prompts that may appear.

1. Check that the USB service cable is not connected. Disconnect the cable if you have already connected it.
2. Insert the media that came with the cable, or download the latest driver from www.vaisala.com/software.
3. Run the USB driver installation program (setup.exe), and accept the installation defaults. The installation of the driver may take several minutes.
4. After the driver has been installed, connect the USB service cable to a USB port on your computer. Windows will detect the new device, and use the driver automatically.
5. The installation has reserved a COM port for the cable. Verify the port number, and the status of the cable, using the Vaisala USB Instrument Finder program that has been installed in the Windows Start menu.

Windows will recognize each individual service cable as a different device, and reserve a new COM port. Remember to use the correct port in the settings of your terminal program.

Terminal Application Settings

The steps below describe how to connect to the probe using the PuTTY terminal application for Windows (available for download at www.vaisala.com/software) and a USB computer connection cable:

1. Connect the USB serial interface cable between your PC and the M12 connector of the probe.
2. Start the PuTTY application.
3. 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.

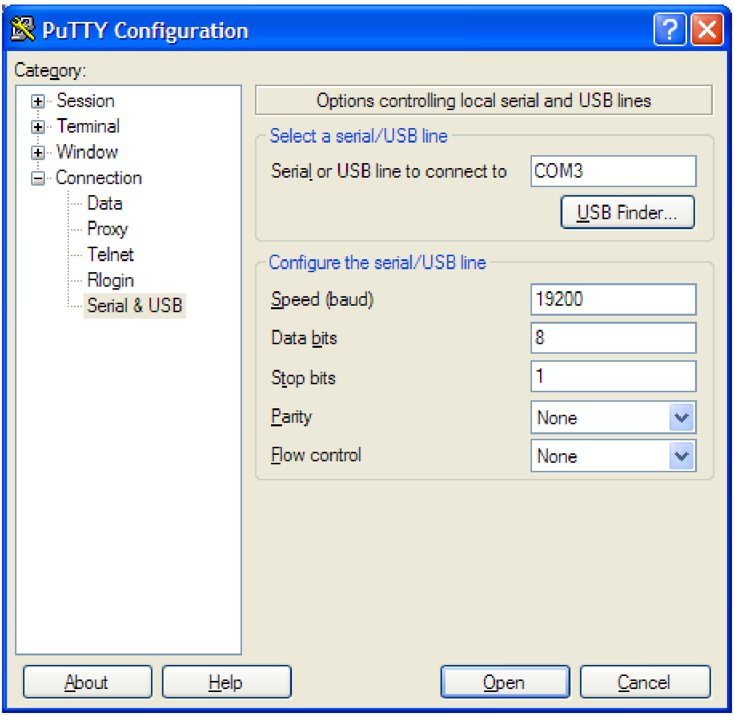


Figure 7 PuTTY Terminal Application

4. 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.

   The default serial settings are listed in Table 5 on page 16
5. Select **Terminal**. Use the following settings:
   - **Local Echo**: "Force on". This setting ensures that your typing is shown on the session window.
   - **Send line ends with line feeds (CR+LF)**: Selected. This setting ensures that all text lines remain visible on the session window.
6. Click the **Open** button to open the connection window and start using the serial line.

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

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 6 below lists the basic serial commands that are available by default. To access advanced serial commands (listed in Table 7 on page 21), enter the command `pass 1300`.

Table 6 Basic Serial Commands

Command	Description	Page
Device information and status		
`?`	Show probe information.	22
`??`	Show probe information (will respond in POLL mode).	22
`errs`	Show currently active errors.	22
`help`	Show list of currently available serial commands.	23
`snum`	Show probe serial number.	23
`system`	Show probe firmware information.	23

Command	Description	Page
`time`	Show probe operation hours and uptime.	24
`vers`	Show probe firmware version.	24
Serial line output and communication		
`close`	Close connection to probe (POLL mode)	24
`form [modifier string]`	Show or set output format.	25
`intv [0 ... 255 s/min/h]`	Set continuous output interval for R command.	27
`open [address]`	Open connection to probe in POLL mode.	27
`r`	Start the continuous outputting.	28
`s`	Stop the continuous outputting.	28
`sdelay [0 ... 255]`	Show or set serial line transmission delay in milliseconds.	28
`send`	Output a single measurement message.	29
`seri [baud data stop parity]`	Show or set the serial interface settings.	29
`smode [mode]`	Show or set startup serial mode: RUN, STOP, or POLL.	30
Environmental compensation		
`env`	Show or set environmental parameters.	39
Adjustment information		
`adate`	Show CO_2 factory adjustment date.	36
`atext`	Show CO_2 factory adjustment information.	36
Other commands		
`reset`	Reset the probe.	44
`pass [1300]`	Access advanced serial commands.	44

Table 7 Advanced Serial Commands

Command	Description	Page
Serial line output and communication		
`addr [0 … 254]`	Show or set probe address.	24
Analog output		
`amode`	Show or set analog output mode (analog output limits and error level).	31
`aover`	Show or set analog output overrange and clipping behavior.	32
`asel`	Show or set analog output parameter and scaling.	35
Calibration and adjustment		
`cco2`	Adjust CO_2 measurement gain and offset.	37
`cdate`	Show or set calibration date.	36
`ctext`	Show or set calibration information.	36
Environmental compensation		
`o2cmode`	Show or set oxygen compensation mode.	41
`pcmode`	Show or set pressure compensation mode.	42
`rhcmode`	Show or set humidity compensation mode.	42
`tcmode`	Show or set temperature compensation mode.	43
Other commands		
`frestore`	Restore probe to factory settings.	43

Device Information and Status

Table 8 ? Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td><code>?<cr></code></td><td>Show listing of device information.</td></tr>
<tr><td><code>??<cr></code></td><td>Show listing of device information even if device is in poll mode and connection has not been opened using the <code>open</code> command.</td></tr>
<tr><td colspan="2">Example:<pre>
?
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
</pre></td></tr>
</table>

Table 9 Errs Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td><code>errs<cr></code></td><td>Show active error(s). For a list of possible errors and their remedies, see Error Messages on page 53.</td></tr>
<tr><td colspan="2">Example (no active errors):<pre>
errs
NO CRITICAL ERRORS
NO ERRORS
NO WARNINGS
STATUS NORMAL
</pre></td></tr>
</table>

Table 10 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 R RESET RX SDELAY SEND SENDX SERI SMODE SNUM SYSTEM UNIQID TIME VERS	

Table 11 Snum Command

Syntax	Description
snum<cr>	Show serial number of the probe.
Example: **snum** SNMUM : GMP233_5_18	

Table 12 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 13 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 14 Vers Command

Syntax	Description
`vers<cr>`	Show firmware version of the probe.

Example:

```
vers
SW version       : 1.0.0
```

Serial Line Output and Communication

Table 15 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 = 0)

Example (shows 0 as current address, enter 5 as the new address):

```
addr
Address              : 0
addr 5
Address              : 5
```

Table 16 Close Command

Syntax	Description
`close<cr>`	Close the connection that was opened with the `open` command.

Example:

```
close

line closed
```

Table 17 Form Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td>form<cr></td><td>Show the currently used measurement format.</td></tr>
<tr><td>form /<cr></td><td>Reset measurement format to default.</td></tr>
<tr><td>form [sss]<cr></td><td>Set a new measurement format.

sss = String consisting of modifiers and abbreviations for measured parameters.

See Table 18 on the facing page and Table 19 on the facing page.

Maximum length is 150 characters. Maximum length may be shorter when text strings are used.</td></tr>
<tr><td colspan="2">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</td></tr>
<tr><td colspan="2">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
...</td></tr>
<tr><td colspan="2">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
...</td></tr>
<tr><td colspan="2">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
...</td></tr>
</table>

Table 18 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 19 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.
`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 20 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 21 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.
Example (target probe in POLL mode, with address 52): **`open 52`** `GMP251: 52 Opened for operator commands`	

Table 22 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 23 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 24 Sdelay Command

Syntax	Description
`sdelay<cr>`	Show serial line transmission delay in milliseconds.
`sdelay [delay]<cr>`	Set a new serial line transmission delay. `delay` = Serial line delay, range 0 … 255 (milliseconds).
Example (set delay to 50 milliseconds): **sdelay 50** `COM transmit delay : 50`	

Table 25 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 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 26 Seri Command

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

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 27 Smode Command

Syntax	Description
smode<cr>	Show current start-up operating mode of the serial line, and prompt to enter new mode.
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.
Example (set serial mode to "poll"): **smode poll** Serial mode : POLL	

Analog Output

Table 28 Amode Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td>amode [channel<cr></td><td>Show currently set analog output limits and error level.
channel = Analog output channel
■ 1 = voltage output (V)
■ 2 = current output (mA)</td></tr>
<tr><td>amode [channel lo_value hi_value error_value]<cr></td><td>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.</td></tr>
<tr><td colspan="2">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)</td></tr>
<tr><td colspan="2">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):

pass 1300
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)</td></tr>
</table>

Table 29 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)
`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 28 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 %`	

Syntax	Description

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.

Syntax	Description

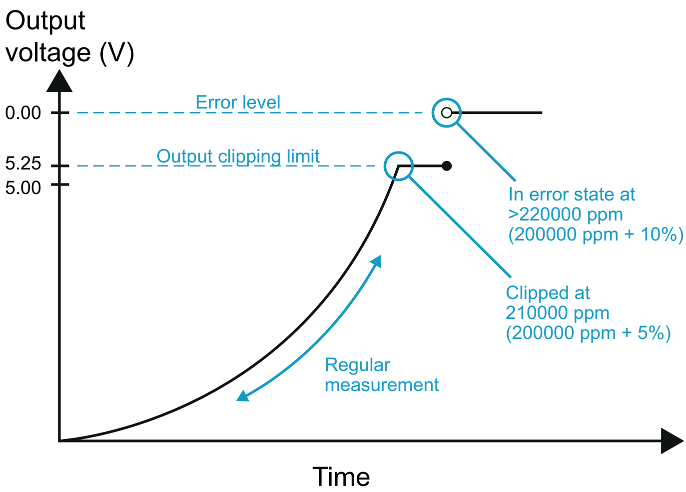


Figure 8 Example of analog output overrange behavior

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. CO2 concentrations (ppm) are indicated clipping point and error limit point.

Table 30 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)
`asel [channel] [parameter lowlimit highlimit]<cr>`	Set the parameter and scaling of the analog output. `channel` = Analog output channel ■ 1 = voltage output (V) ■ 2 = current output (mA) `parameter` = Parameter that is output on analog channel. The only parameter available is CO2 (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)`	

Calibration and Adjustment

Before using the calibration and adjustment commands, read through Calibration and Adjustment on page 46.

Make sure that the environmental compensation settings of the probe are properly set for your calibration environment; see section Environmental Compensation on page 39.

Table 31 Adate Command

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

Table 32 Atext Command

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

Table 33 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 34 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	
Example (set a new information text): **ctext 0% 5% by NN** Calibrated at 0% 5% by NN	

Table 35 CCO2 Command

Syntax	Description
`cco2<cr>`	Show current user adjustment status.
`cco2 -one [co2]<cr>`	Perform a 1-point calibration and adjustment. `-one` = Adjustment at one concentration only `co2` = CO_2 concentration reference in ppm

`cco2 -lo [co2]<cr>`
 	
`cco2 -hi [co2]<cr>`
	Perform a 2-point calibration and adjustment.
	
	`-lo` = Adjustment at low concentration (under 2 %CO_2)
	
	`-hi` = Adjustment at high concentration (over 2 %CO_2)
	
	`co2` = CO_2 concentration reference in ppm.

`cco2 -save<cr>`	Save the currently entered adjustments. Successfully saving the adjustment clears the calibration date (`cdate`) and calibration text (`ctext`) 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 low   200000
2.Meas. point low  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 -one 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`	

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`	

Environmental Compensation

Table 36 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. `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 memory at startup. ■ Must be used for continuously updated values. `xtemp` = Compensation temperature stored in RAM. Range -40 ... 100 °C. `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 37 O2cmode Command

Syntax	Description
o2cmode<cr>	Check current oxygen compensation mode. Possible modes: ■ on = Compensation enabled using setpoint value. ■ off = Compensation disabled, neutral value used.
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 38 Pcmode Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td><code>pcmode<cr></code></td><td>Check current pressure compensation mode.

Possible modes:
■ <code>on</code> = Compensation enabled using setpoint value.
■ <code>off</code> = Compensation disabled, neutral value used.</td></tr>
<tr><td><code>pcmode [on | off]<cr></code></td><td>Change pressure compensation mode (<code>on</code> or <code>off</code>).</td></tr>
<tr><td colspan="2">Example (check pressure compensation mode; pressure compensation is enabled using a setpoint value):

<code>pass 1300</code>
<code>pcmode</code>
<code>P COMP MODE   : ON</code></td></tr>
</table>

Table 39 Rhcmode Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td><code>rhcmode<cr></code></td><td>Check current relative humidity compensation mode.

Possible modes:
■ <code>on</code> = Compensation enabled using setpoint value.
■ <code>off</code> = Compensation disabled, neutral value used.</td></tr>
<tr><td><code>rhcmode [on | off]<cr></code></td><td>Change relative humidity compensation mode (<code>on</code> or <code>off</code>).</td></tr>
<tr><td colspan="2">Example (check relative humidity compensation mode; relative humidity compensation is disabled, a neutral value is used):

<code>pass 1300</code>
<code>rhcmode</code>
<code>RH COMP MODE   : OFF</code></td></tr>
<tr><td colspan="2">Example (enable relative humidity compensation):

<code>pass 1300</code>
<code>rhcmode on</code>
<code>RH COMP MODE   : ON</code></td></tr>
</table>

Table 40 Tcmode Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td><code>tcmode<cr></code></td><td>Check current temperature compensation mode.
Possible modes:
■ <code>on</code> = Compensation enabled using setpoint value.
■ <code>off</code> = Compensation disabled, neutral value used.
■ <code>measured</code> = Compensation enabled using internal measurement.</td></tr>
<tr><td><code>tcmode [on | off | measured]<cr></code></td><td>Change temperature compensation mode (<code>on</code>, <code>off</code> or <code>measured</code>).</td></tr>
<tr><td colspan="2">Example (check temperature compensation mode; temperature compensation is enabled using a setpoint value):

<code>pass 1300</code>
<code>tcmode</code>
<code>T COMP MODE   : ON</code></td></tr>
<tr><td colspan="2">Example (change temperature compensation to use internal measurement):

<code>pass 1300</code>
<code>tcmode measured</code>
<code>T COMP MODE   : MEASURED</code></td></tr>
</table>

Other Commands

Table 41 Frestore Command

<table>
<tr><th>Syntax</th><th>Description</th></tr>
<tr><td><code>frestore<cr></code></td><td>Restore the probe to its factory configuration. All user settings and user calibration parameters will be lost.

Note: After using the <code>frestore</code> command, reset the probe using the <code>reset</code> command.</td></tr>
<tr><td colspan="2">Example (restore the factory settings and reset the probe):

<code>pass 1300</code>
<code>frestore</code>
<code>Parameters restored to factory defaults</code>
<code>reset</code>
<code>GMP251 1.0.0</code></td></tr>
</table>

Table 42 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 43 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 MAINTENANCE

Cleaning

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

Note the following precautions when cleaning:

- Do not immerse the probe in liquid to clean it.
- Be careful not to block the filter when cleaning the probe.
- 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.

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)
- DMSO
- 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.

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.

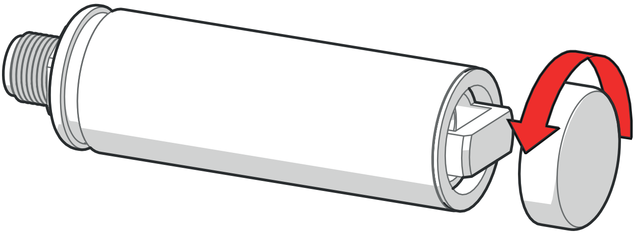


Figure 9 Removing the Filter

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.

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. For contact information, see Technical Support on page 55

Calibration means comparing the probe's reading to a known reference, such as calibration gas or a reference instrument. Correcting the reading of the probe so that is measures accurately is referred to as **adjustment**.

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 GMP222 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

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 %CO_2 (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.

Effect of Environmental Compensations

The probe has various environmental compensations that improve its CO_2 measurement accuracy (see Environmental Compensation on page 10). 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.

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.

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.

Vaisala Industrial Protocol

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

See Calibration and Adjustment on page 35 and Environmental Compensation on page 39.

6 TECHNICAL DATA

Specifications

Table 44 GMP251 Performance

Property	Specification
Measurement range	0...20 %CO_2
Accuracy at 25 °C and 1013 hPa (incl. repeatability and nonlinearity) 0...8 %CO_2 8...20 %CO_2	 ±0.3 %CO_2 ±0.5 %CO_2
Calibration uncertainty at 5 %CO_2 at 20 %CO_2	 ±0.1 %CO_2 ±0.2 %CO_2
Long-term stability 0...8 %CO_2 8...12 %CO_2 8...12 %CO_2	 ±0.4 %CO_2/year ±0.8 %CO_2/year ±1.5 %CO_2/year
Start-up time	< 20 s
Warm-up time for full spec.	< 15 min
Response time (T90)	< 1min

Table 45 Operating Environment

Property	Specification
Operating temperature of CO_2 measurement	-40 ... +60 °C
Storage temperature	-40 ... +70 °C
Pressure Compensated Operating	 500 ... 1100 hPa < 1.5 bar
Humidity	0...100 %RH, non-condensing
Condensation prevention	Sensor head heating, when power on

Property	Specification
Electromagnetic compatibility	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) ■ DMSO ■ Acetone ■ Acetic acid

Table 46 Inputs and Outputs

Property	Specification
Operating voltage	
With digital output in use	12...30 VDC
With voltage output in use	13...30 VDC
With current output in use	20...30 VDC
Digital output	Over RS-485: ■ Vaisala Industrial Protocol
Analog outputs	0 ... 5/10 V (scalable), min load 10kΩ 0/4 ... 20 mA (scalable), max load 500Ω
Power consumption	
Typical (continuous operation)	0.4 W
Maximum	0.5 W

Table 47 Mechanics

Property	Specification
Materials	
Probe housing material	PET plastic
Filter	Porous PTFE
Connector	Stainless steel
Housing classifications	
Probe body	IP65
Connector	M12 5-pin male

Property	Specification
Weight	
Probe	60 g
Dimensions	
Diameter	25 mm
Length	96 mm

Spare Parts and Accessories

Name	Order code
Cable with open wires (1.5 m)	223263SP
High temperature durable cable (1.1 m, special plug)	CBL210347SP
Porous PTFE filter	DRW243649SP
USB cable for PC connection	242659

7 TROUBLESHOOTING

Problem Situations

Problem	Possible Cause	Remedy
Analog output reading is unchanging and appears incorrect.	Analog output is in error state. See Analog Output Error State on page 54.	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 according to Wiring on page 15.
		Power cycle or reset the probe and try again.
	Probe in POLL mode with unknown address.	Issue the ?? command to make the probe output its information. The use the OPEN command to open a line to the probe's address.
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.

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.

Table 48 Error Messages in Vaisala Industrial Protocol

Error Message	Description	Recommended Action
Critical errors		
Program memory crc critical error	Program memory is corrupted.	Fatal error, contact Vaisala.
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. For cleaning instructions, see Cleaning on page 45.
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.

Error Message	Description	Recommended Action
Internal 2.5 V error	Internal 2.5 V voltage is out of range.	
Internal 1.7 V error	Internal 1.7 V voltage is 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.

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. For a more detailed explanation, see section Analog Output Overrange Behavior on page 12.

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.

Technical Support

For technical questions, contact the Vaisala technical support by e-mail at helpdesk@vaisala.com. Provide at least the following supporting information:

- Name and model of the product in question
- Serial number of the product
- Name and location of the installation site
- Name and contact information of a technically competent person who can provide further information on the problem.

For contact information of Vaisala Service Centers, see www.vaisala.com/servicecenters.

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