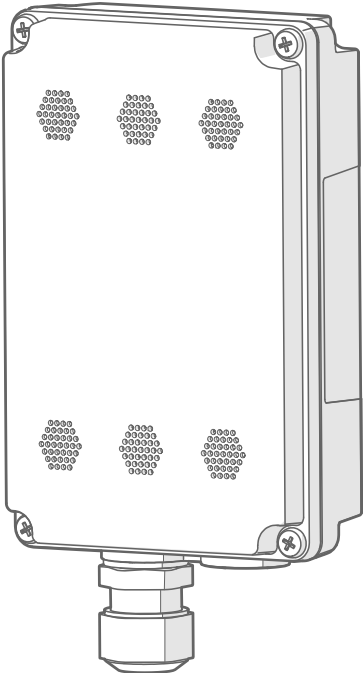


Quick Guide

Vaisala CARBOCAP[®] Carbon Dioxide
and Temperature Transmitter

GMW87M



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Product overview

Vaisala CARBOCAP® Carbon Dioxide and Temperature Transmitter GMW87M is a wall-mount transmitter designed to fulfill the needs for CO₂ measurements in demanding conditions (for example, dusty or humid installation locations).

GMW87M can be accessed with the Modbus RTU protocol over an RS-485 interface. The communication settings for the protocol are entered with DIP switches on the GMW87M component board.

For information on measurement performance and technical specifications of the transmitter, see [Technical data \(page 13\)](#).

Transmitter parts

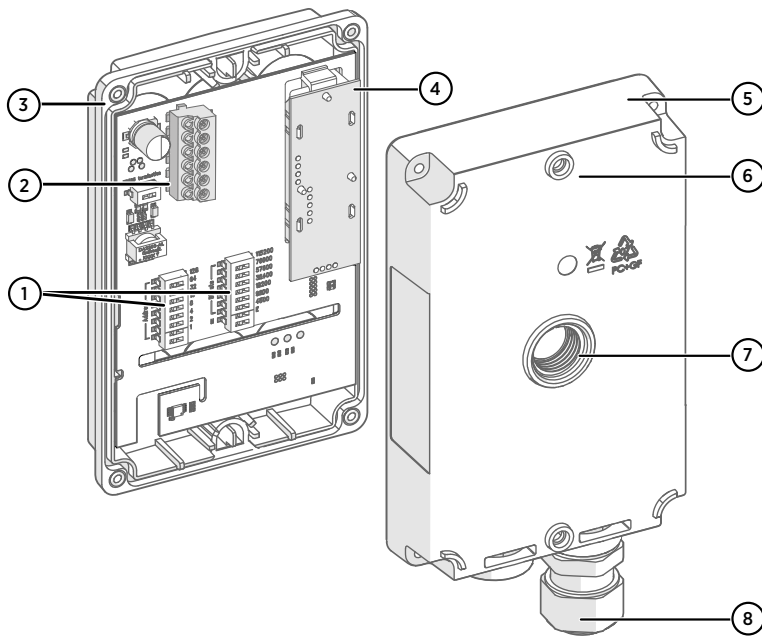


Figure 1 GMW87M transmitter parts

- 1 DIP switches for Modbus settings
- 2 Screw terminals. The screw terminal block is detachable for easy installation.
- 3 Transmitter cover with captive screws (4 pcs)
- 4 GM10 carbon dioxide measurement module
- 5 Mounting base
- 6 Screw holes for mounting on top and bottom of mounting base (2 screws, Ø 3.5 mm)
- 7 Alternative lead-through for wiring through the back
- 8 Cable gland for leading wires inside the enclosure

In GMW87M, the component board is located on the cover of the enclosure. Wires are led into the enclosure either through a cable gland on the bottom of the mounting base or a sealed lead-through at the back. The enclosure is opened and closed with 4 screws.

Safety

The GMW87M transmitter delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:



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



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



CAUTION! Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Avoid touching exposed component contacts during installation and maintenance.

Regulatory compliances

Vaisala GMW80 series transmitters are in conformity with the provisions of the following EU directives:

- RoHS Directive
- EMC Directive

The conformity is declared with using 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 – Immunity test requirements for equipment intended to be used in an industrial electromagnetic environment.
- EN 55032: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.



Installation

The GMW87 transmitter is designed to be installed on a mounting box or directly to a wall surface. For transmitter dimensions, see [Figure 3 \(page 6\)](#).

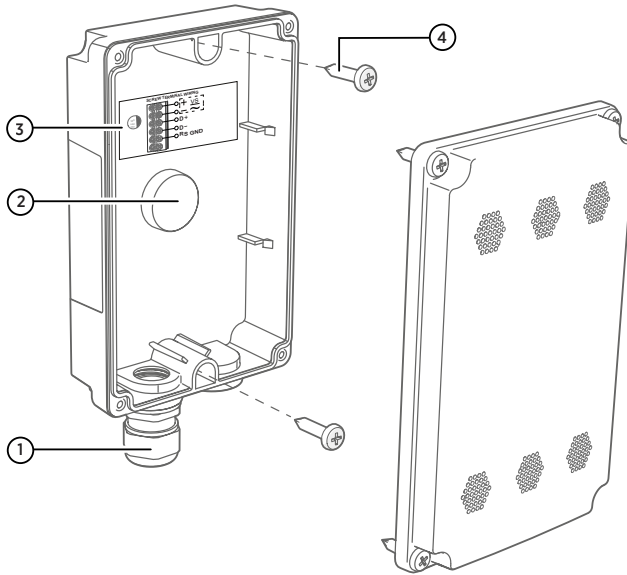


Figure 2 Mounting GMW87M

- 1 Cable gland for leading the input/output cable (\varnothing 4 ... 8 mm) inside the enclosure
- 2 Alternative lead-through for wiring through the back (break seal and transfer cable gland to the threads on this lead-through)
- 3 Wiring instructions label
- 4 Mounting screws (2 pcs, \varnothing 3.5 mm, head $\varnothing \leq 8$ mm)

- ▶ 1. Open the transmitter cover (4 screws) and use 2 mounting screws (\varnothing 3.5 mm) to attach the mounting base to the installation surface. Point the cable gland straight down.
- 2. Route the input/output cable through the cable gland.



If you use the alternative lead-through on the back of the transmitter, seal the hole on the bottom of the transmitter after removing the cable gland.

3. For ease of installation, you can disconnect the screw terminal block by pulling it out from the component board.
4. Attach wiring to the screw terminals as shown on the wiring instructions label. See also [Wiring \(page 6\)](#).
5. If you disconnected the screw terminal block, plug it back in. Make sure it is positioned correctly.

6. Push down gently on the GM10 module. The module should be straight and firmly connected.
7. Tighten the cable gland and close the transmitter cover (4 screws).



CAUTION! Mounting bases are tailored to the individual transmitter at the factory. If you attach several mounting bases before connecting the transmitters, store the transmitters in their original shipping boxes, so that you can match the serial number on the mounting base to the serial number on the shipping box.

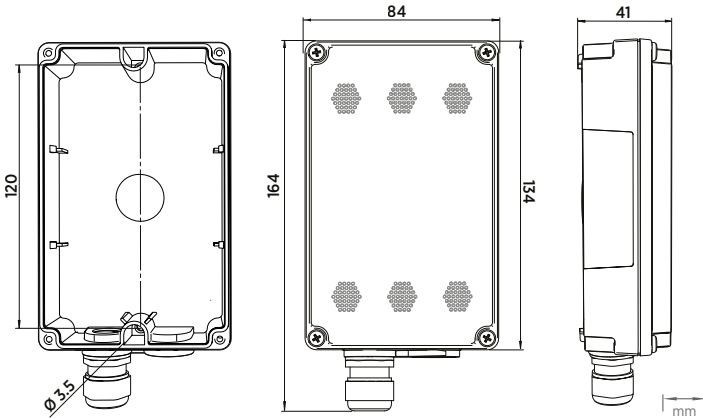


Figure 3 GMW87M dimensions

Wiring

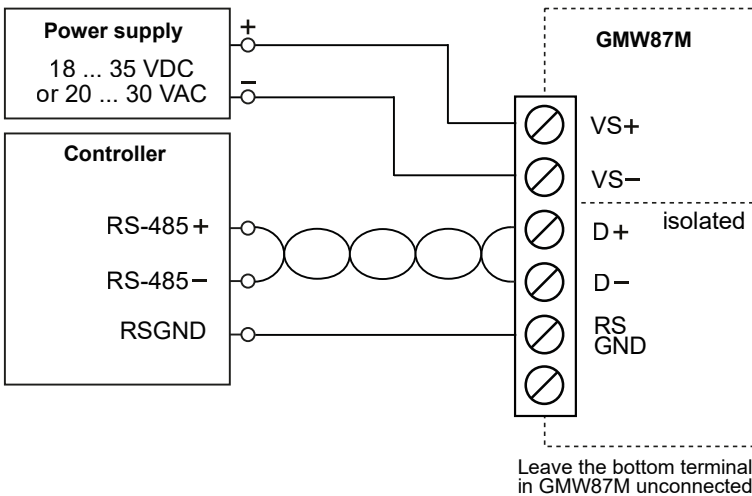


Figure 4 GMW87M wiring diagram

Modbus communication

The Modbus variant used in GMW87M is Modbus RTU. For a list of the Modbus registers available in GMW87M, see [Modbus registers \(page 10\)](#).

You can use up to 8 transmitters on the same RS-485 line. You must configure each transmitter on the line to have a different Modbus address.



Before taking the transmitter into use, check that the Modbus device address, bit rate setting, and parity setting match the settings in your system. The number of stop bits is not significant. The device supports automatically both 1 and 2 stop bits.

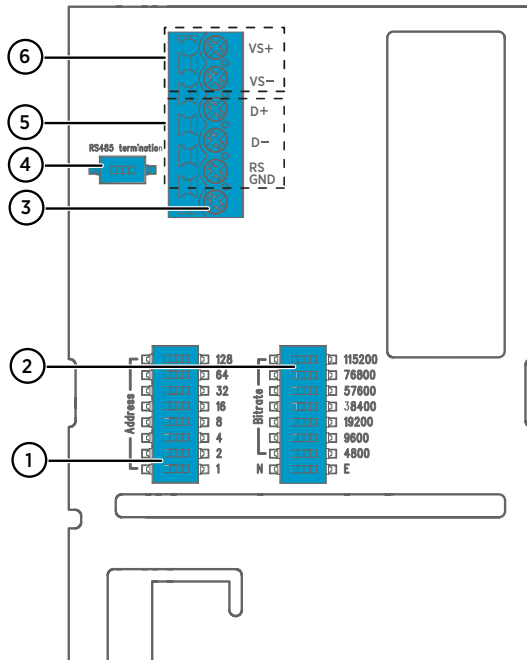


Figure 5 GMW87M component board with DIP switches and screw terminals

- 1 DIP switches for setting the GMW87M Modbus device address
- 2 DIP switches for selecting Modbus communication bit rate and parity (N/E)
- 3 Screw terminal not used in GMW87M
- 4 Switch for 120 Ω RS-485 bus termination. Switch RS-485 bus termination **ON** only on the last device of the wiring if there is no separate terminator on the bus.
- 5 RS-485 (Modbus) screw terminals
- 6 Power supply input (18 ... 35 VDC or 20 ... 30 VAC) screw terminals

Make selections with the DIP switches by sliding the DIP switch to the right (**ON**). Keep the other DIP switches on the left position (**OFF**).

Setting Modbus device address with DIP switches

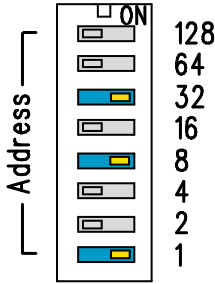


Figure 6 Modbus device address DIP switch example

DIP switches 32, 8, and 1 set to ON

The Modbus device address is encoded in eight bit binary form, with each numbered switch representing a single bit. This example shows address 41 selected: DIP switches 32, 8, and 1 (decimal: 41, binary: 00101001) are set to ON.

Modbus device address ranges

The Modbus device address range for the transmitter is 1 ... 247. Up to 255 is possible, but non-standard.

If no address is selected (0), the device is off-line and will not respond to any Modbus requests.

Troubleshooting

If you experience problems with GMW87M, first see the following table concerning the behavior and error indications of the transmitter.

Table 1 Troubleshooting table

Problem	Solution
The device is not responding	<ul style="list-style-type: none"> Power-cycle the transmitter by disconnecting the screw terminal block Check power supply voltage Check wiring, including RS-485 bus polarity Check that RS GND is connected between the transmitter and the receiver Compare the DIP switch settings to your Modbus host settings Check that RS-485 termination is enabled only on the last device of the wiring Alternatively, try operation without RS-485 termination at all
Unexpected value in Modbus response	<ul style="list-style-type: none"> Change register number and/or data encoding settings in your Modbus host system
No measurement result and/or non-zero status code returned	<ul style="list-style-type: none"> Device is warming up, try again after 20 seconds Power-cycle the transmitter by disconnecting the screw terminal block Check that the GM10 module is properly attached Contact Vaisala for a replacement GM10 module

If you cannot locate the source of the error and return the transmitter to operational state, contact Vaisala technical support. See [Technical support \(page 15\)](#).

Modbus reference

Function codes

Table 2 Modbus function codes

Function code (decimal)	Function code (hexadecimal)	Name
03	03 _{hex}	Read Holding Registers
43/14	2B _{hex} / 0E _{hex}	Read Device Identification

Data encoding

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

32-bit floating point format

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

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

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



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



Reading the measurement data registers with incorrect floating point format setting may occasionally result in correct-looking values. It is highly recommended to verify that you have configured the floating point format correctly on your Modbus host system by reading a floating point value from a test value register.

16-bit integer format

Table 3 Interpretation of 16-bit signed integer values

Value	Description
0000 _{hex} ... 7FFE _{hex}	Value in range 0 ... 32766

Value	Description
8002 _{hex} ... FFFF _{hex}	Value in range -32766 ... -1 (2's complement)
8000 _{hex}	Value is not available

The 16-bit integer value for measured temperature in [Table 4 \(page 10\)](#) is scaled to include the necessary decimals.

Modbus registers



CAUTION! Registers are numbered in decimal, starting from 1. Register addresses in actual Modbus messages (Modbus Protocol Data Unit (PDU)) are in hexadecimal and start from zero. Subtract 1 from the register number presented in this manual to get the address used in the Modbus message (for example, register number 1 corresponds to address 0_{hex} in the actual Modbus message).

Accessing unavailable (temporarily missing) measurement data does not generate a Modbus exception. “Unavailable” value (a quiet NaN for floating point data or 8000_{hex} for integer data) is returned instead. An exception is generated only for any access outside the applicable register ranges.

Measurement data registers

Table 4 Modbus measurement data registers (read-only)

Register number	Address	Register description	Data format	Unit
1	0000 _{hex}	Measured CO ₂ value	32-bit float	ppm
5	0004 _{hex}	Measured temperature	32-bit float	°C
257	0100 _{hex}	Measured CO ₂ value	16-bit integer	ppm
259	0102 _{hex}	Measured temperature (T * 10)	16-bit integer	°C

Status registers

Table 5 Modbus status registers (read-only)

Register number	Address	Register description	Data format	Notes
513	0200 _{hex}	Device status	16-bit integer	0000_{hex} : Status OK; if other values are returned, see Troubleshooting (page 8) .
514	0201 _{hex}	Error code	32-bit integer	Used by Vaisala Technical Support when solving device problems

Register number	Address	Register description	Data format	Notes
519	0206 _{hex}	Temperature measurement status	16-bit integer	0000 _{hex} : Status OK 0004 _{hex} : Under range 0008 _{hex} : Over range 0080 _{hex} : Sensor failure 0100 _{hex} : Measurement not ready ¹⁾
520	0207 _{hex}	CO ₂ measurement status		

1) Applicable to CO₂ measurement only.

Test value registers

Read the known test values from the test registers to verify the functionality of your Modbus implementation.

Table 6 Modbus test registers (read-only)

Register number	Register address	Register description	Data format	Test value
7937	1F00 _{hex}	Signed integer test	16-bit integer	-12345
7938	1F01 _{hex}	Floating point test	32-bit float	-123.45
7940	1F03 _{hex}	Text string test	text	Text string: "-123.45"

Device identification objects

Table 7 Device identification objects

Object ID	Object ID (hexadecimal)	Object name	Example contents
0	00 _{hex}	VendorName	"Vaisala"
1	01 _{hex}	ProductCode	"GMW80"
2	02 _{hex}	MajorMinorVersion	Software version (for example, "1.4.0")
3	03 _{hex}	VendorUrl	"https://www.vaisala.com/"
4	04 _{hex}	ProductName	"Vaisala CARBOCAP(R) Carbon Dioxide Transmitter GMW80"
128	80 _{hex}	SerialNumber ¹⁾	Transmitter serial number, e.g. "J1140501"

1) Vaisala-specific device information object.

Modbus communication example

Reading CO₂ concentration value



The device address used in the following example is 240 (F0_{hex}). The values returned by the device differ depending on the ambient conditions. Your device might not return exactly the same values.

Request		Response	
Bytes on the line	Description	Bytes on the line	Description
(silence for 3.5 bytes)	Start of Modbus RTU frame	(silence for 3.5 bytes)	Start of Modbus RTU frame
F0 _{hex}	Transmitter address	F0 _{hex}	Transmitter 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}		E6 _{hex}	Value of first register (least significant word)
00 _{hex}	Number of 16-bit registers to read (2)	3A _{hex}	
02 _{hex}		44 _{hex}	Value of second register (most significant word)
D1 _{hex}	Modbus RTU checksum	17 _{hex}	
2A _{hex}		7E _{hex}	Modbus RTU checksum
(silence for 3.5 bytes)	End of Modbus RTU frame	B7 _{hex}	
		(silence for 3.5 bytes)	End of Modbus RTU frame

Communication description	
Register number	1 (1-based Modbus register number) = address 0000 _{hex} (0-based address 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	4417E63A _{hex} , which is binary32 representation of 607.6 (ppm CO ₂).

Technical data

Table 8 Measurement performance

Property	Specification
Carbon dioxide	
Measurement range	0 ... 5000 ppm
Accuracy across temperature range	
+20 ... +30 °C (+68 ... +86 °F)	±(30 ppm +3 % of reading)
+10 ... +20 °C (+50 ... +68 °F), +30 ... +40 °C (+86 ... +104 °F)	±(35 ppm +3.7 % of reading)
+0 ... +10 °C (+32 ... +50 °F), +40 ... +50 °C (+104 ... +122 °F)	±(40 ppm +4.8 % of reading)
Stability in typical HVAC applications	±(15 ppm + 2 % of reading) over five years
Warm-up time	10 min for full specification
Response time (63 %)	7 min
Carbon dioxide sensor	Vaisala CARBOCAP® GM10
Product lifetime	> 15 years

Table 9 Operating environment

Property	Specification
Operating temperature	0 ... +50 °C (+32 ... +122 °F)
Operating humidity	0 ... 95 %RH Dew point < 30 °C (+86 °F)
Storage temperature	-40 ... +70 °C (-40 ... +158 °F)
EMC compliance	EN61326-1, Industrial environment

Table 10 Inputs and outputs

Property	Specification
Supply voltage	18 ... 35 VDC 24 VAC ±20 % 50/60 Hz
Max. current consumption at 18 VDC	45 mA
Max. power consumption at 30 VAC	1 W

Property	Specification
Digital output (RS-485)	Isolated, supports Modbus RTU protocol <ul style="list-style-type: none"> • Modbus RTU address range: <ul style="list-style-type: none"> • 1 ... 247 (up to 255 possible, non-standard) • Bit rates: <ul style="list-style-type: none"> • 4800, 9600, 19200, 38400, 57600, 76800, 115200 • Parity: <ul style="list-style-type: none"> • None or Even • Supports automatically both 1 and 2 stop bits

Table 11 Mechanical specifications

Property	Specification
IP rating	IP64
Housing material	PC
Housing color	White (RAL9003)
Output connector	Screw terminal
Max. wire size	2.5 mm ² (AWG 12)
Weight	160 g (5.64 oz)

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 as applicable:

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

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

Recycling



Recycle all applicable material.



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

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