M211060EN-N

User Guide

Vaisala Humidity and Temperature Probes

HMP60 and HMP110 Series

VAISALA

PUBLISHED BY

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1. About this document

1.1 Version information

This document provides information for installing, operating, and maintaining Vaisala Humidity and Temperature Probes HMP60 and HMP110 Series devices:

- Vaisala INTERCAP® Humidity and Temperature Probe HMP60
- Vaisala INTERCAP® Humidity and Temperature Probe HMP63
- Vaisala HUMICAP® Humidity and Temperature Probe HMP110
- Vaisala HUMICAP® Humidity and Temperature Probe HMP113
- Vaisala HUMICAP® Humidity and Temperature Probe HMP115
- Vaisala Wide-Range Temperature Probe TMP115

Table 1 Document versions (English)

Document code	Date	Description
M211060EN-N	February 2025	Added information on the compatibility of TMT120 and TMT130 transmitters with the TMP115 probe. Updated sections: • Probe models (page 16) • Installation accessories (optional) (page 19) • Spare parts and accessories (page 122)

Document code	Date	Description
M211060EN-M	October 2024	Added information on the HMP115, HMP115T and TMP115 probe models. Added information on using and calibrating the HMP60 and HMP110 series probes with the Indigo80 handheld indicator. Added a separate chapter for calibration and adjustment information, and updated calibration and adjustment procedures. Updated Modbus register number notation. Added sections: • Measured parameters (page 15) • Probe models (page 16) • Probe holder (page 19) • Thermal dampener block (page 25) • Probe mounting flange dimensions (page 122) Updated sections: • Basic features and options (page 17) • Output options (page 18) • Filter options (page 18) • Wiring multiple digital devices (page 35) • Communication settings (page 126) • Installation accessories (optional) (page 19) • Adjusting RH for new HUMICAP sensor in Insight PC software (page 80) • Changing the HUMICAP 180R/180V sensor (page 97) • Error messages in Insight PC software and Indigo80 handheld indicator (page 101) • Unknown serial settings (page 103) • HMP60 specifications (page 104) • HMP63 specifications (page 107) • HMP110 specifications (page 110) • HMP113 specifications (page 113)
M211060EN-L	January 2023	Updated sections: • HMP60 specifications (page 104) • HMP63 specifications (page 107) • HMP113 specifications (page 113)

1.2 Related manuals

Table 2 Related manuals

Document code	Name
M211059EN	Vaisala HMP60 and HMP110 Series Humidity and Temperature Probes Multilingual Quick Guide

Document code	Name
M212722EN	Vaisala Indigo80 Handheld Indicator User Guide
M210297EN	Vaisala HM70 Handheld Humidity and Temperature Meter User Guide
M211080EN	Vaisala Mounting Flange for Humidity Probes Quick Reference Guide
M211106EN	Vaisala Loop Power Converter Quick Reference Guide
M210185EN	Vaisala HMK15 Humidity Calibrator User Guide

1.3 Documentation conventions

WARNING! 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! 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.

Highlights important information on using the product.

Gives information for using the product more efficiently.

Lists tools needed to perform the task.

Indicates that you need to take some notes during the task.

1.4 Trademarks

Vaisala INTERCAP® and Vaisala HUMICAP® are registered trademarks of Vaisala Oyj.

Modbus® is a registered trademark of Schneider Automation Inc.

2. Product overview

2.1 Introduction to HMP60 and HMP110 series

Vaisala Humidity and Temperature Probes HMP60 and HMP110 Series are simple and cost-effective humidity and temperature probes suitable for various volume applications:

- Integration into other manufacturers' equipment
- Incubators
- Glove boxes
- Greenhouses
- Fermentation chambers
- Data loggers
- Handheld meters

HMP60 series probes use the interchangeable Vaisala INTERCAP® sensor for humidity measurement. No recalibration is required after sensor replacement.

HMP110 series probes use the Vaisala HUMICAP® 180R sensor for increased accuracy in humidity measurement. For applications where H_2O_2 (for example, vaporized hydrogen peroxide (VHP)) is present, the HMP110 probe models can also be ordered with the HUMICAP® 180V catalytic sensor. All HMP110 series probes require calibration after sensor replacement. This can be done, for example, with Vaisala Insight PC software or on the serial line using the optional Vaisala USB cable.

Wide-Range Temperature Probe TMP115 is ideal for use in temperature-controlled chambers, cryogenic applications, incubators, LN2 tanks, and blood/tissue banks. TMP115 uses a platinum RTD temperature sensor for superior measurement stability.

2.1.1 Measured parameters

HMP60 and HMP110 Series include probe models for measuring relative humidity and temperature. Several calculated parameters are optionally available. The T-only models measure only temperature.

Table 3 Parameters measured by HMP60, HMP63, HMP110, HMP113 and HMP115 probe models

Parameter	Abbreviation	Metric unit	Non-metric unit
Measured parameters			
Relative humidity	RH	%RH	%RH
Temperature	T	°C	°F
Calculated parameters			
Dew point/frost point temperature [1)]	$T_{d/f}$	°C	°F
Wet bulb temperature	T_w	°C	°F

Parameter	Abbreviation	Metric unit	Non-metric unit
Absolute humidity	a	g/m^3	gr/ft^3
Mixing ratio	x	g/kg	gr/lb
Enthalpy	h	kJ/kg	Btu/lb

1) When the dew point is below 0 °C, the probe outputs frost point for T_d.

Table 4 Parameters measured by HMP63T, HMP110T, HMP115T and TMP115 probe models

Parameter	Abbreviation	Metric unit	Non-metric unit
Temperature	T	°C	°F

2.1.2 Probe models

Table 5 Probe models

Probe model		Description
	HMP60	IP65 rated stainless steel probe with INTERCAP® sensor. Rugged probe for demanding applications.
	HMP110	IP65 rated stainless steel probe with HUMICAP® 180R sensor. Rugged probe with higher accuracy for demanding applications. Compatible with RFL100, CWL100, and VDL200 data loggers (digital output required).
	HMP110T	IP65 rated stainless steel probe with temperature sensor only. Has the same temperature measurement performance as HMP110. Compatible with RFL100 and VDL200 data loggers (digital output required), and TMT120 and TMT130 transmitters.
	HMP110REF	IP65 rated stainless steel probe. Does not measure; instead, outputs constant humidity and temperature readings on serial line. Useful for validating installations of HMT120 and HMT130 transmitters, for example.

Probe model		Description
	HMP63	IP54 rated probe with PC/ABS plastic housing and INTERCAP® sensor. Lightweight probe with faster thermal response time. Not for permanent outdoor use.
	HMP113	IP54 rated probe with PC/ABS plastic housing and HUMICAP® 180R sensor. Lightweight probe with higher accuracy and faster thermal response time. Not for permanent outdoor use. Used with the Vaisala HM40 handheld meter (digital output required).
	HMP115	IP54 rated probe with PC/ABS plastic housing and HUMICAP® 180R sensor. For general purpose measurement. Digital output only. Designed for use with RFL100, CWL100, and VDL200 data loggers.
	HMP115T	IP54 rated probe with PC/ABS plastic housing, with temperature sensor only. Digital output only. Designed for use with RFL100, CWL100, and VDL200 data loggers.
	TMP115	Temperature probe for measurement in a wide range of conditions. Digital output only. Compatible with RFL100, CWL100, and VDL200 data loggers, and TMT120 and TMT130 transmitters. Available as 50 cm (1 ft 7.7 in) and 3 m (9.8 ft) long versions. Length includes the probe body and sensor tip. Temperature measurement range −196 ... +150 °C (−320 ... +302 °F). Operating temperature range of the probe body is −40 ... +60 °C (−40 ... +140 °F).

2.2 Basic features and options

- Analog and digital output options
- Small size
- Low power consumption
- IP65 stainless steel body on HMP60 and HMP110 models
- IP54 lightweight plastic body on HMP63, HMP113 and HMP115 models
- IP67 stainless steel sensor tip and IP65 lightweight plastic body on the TMP115 model

- Several filter options
- Can be connected temporarily to the Vaisala Insight PC software for configuration, calibration and adjustment, and monitoring.
- Can also be used with several other Vaisala devices, such as the Indigo80 handheld indicator.

More information

- Output options (page 18)
- Filter options (page 18)

2.2.1 Output options

The available output options depend on the probe model and probe configuration selected when ordering the probe.

You can modify the output configuration by connecting the probe temporarily to the Insight PC software or the Indigo80 handheld indicator.

When you order a probe as a digital probe, analog output channels are not available.

More information

- HMP60 specifications (page 104)
- HMP63 specifications (page 107)
- HMP110 specifications (page 110)
- HMP113 specifications (page 113)
- HMP115 specifications (page 116)
- TMP115 specifications (page 118)

2.2.2 Filter options

Figure 1 Filters for HMP60, HMP110, and HMP110T

1 Plastic grid filter (fastest response time)
2 PTFE membrane filter, pore size 0.2 µm
3 Stainless steel sintered filter, pore size 38 µm
4 PTFE membrane filter with stainless steel grid, pore size 0.2 µm
5 PTFE sintered filter, pore size 20 µm

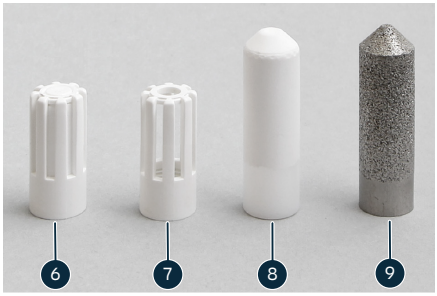


Figure 2 Filters for HMP63, HMP113, HMP115 and HMP115T

6 Plastic membrane filter, pore size 0.2 µm
7 Plastic grid filter for (portable use only, fastest response time)
8 Sintered PTFE filter, pore size 20 µm
9 Stainless steel sintered filter, pore size 38 µm (available for HMP63 and HMP113 only)

All filters are 12 mm in diameter.

2.3 Installation accessories (optional)

- Probe holder (page 19)
- Probe mounting clamp (page 20)
- Probe mounting flange (page 22)
- Duct installation kit (page 24) - for HMP60, HMP110, and HMP110T
- Plastic M12 installation nuts - for HMP60, HMP110, and HMP110T
- Plastic locking bushing (page 24) - for HMP63 and HMP113
- Thermal dampener block (page 25) - for TMP115
- Loop power converter (page 26) - 4–20 mA, separate module, compatible with humidity accuracy only
- Cables (page 27) - Shielded 0.3-m and 3.0-m (1-ft and 9.8-ft) connection cables with threaded connector for probe connection, open end wires on the other end

For item codes, see Spare parts and accessories (page 122).

2.3.1 Probe holder

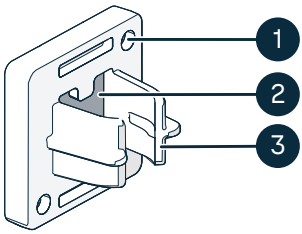


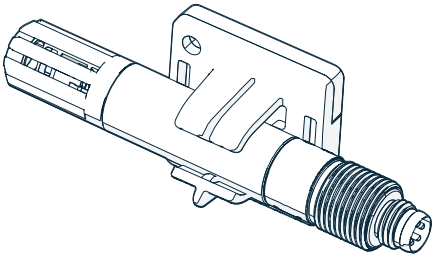
Figure 3 Probe holder ASM213382

1 Holes for attaching the holder with screws (screws not included)
2 Magnet
3 Probe attachment

The probe holder is a versatile mounting accessory for securing Ø 12 mm diameter cable mounted probes.

To attach the probe, simply press the body of the probe into the probe attachment. HMP115 and TMP115 probes have a groove that locks the probe in the holder when it is centered in the probe attachment.

Figure 4 HMP110 probe in the probe holder



2.3.2 Probe mounting clamp

The optional mounting clamp makes it easy to install the probe on the wall of the measurement environment. The probe can be detached for calibration simply by loosening the lower screw.

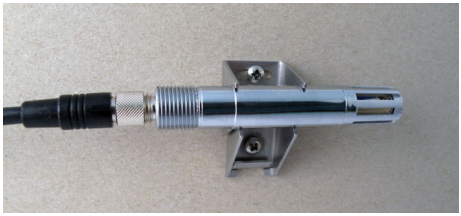
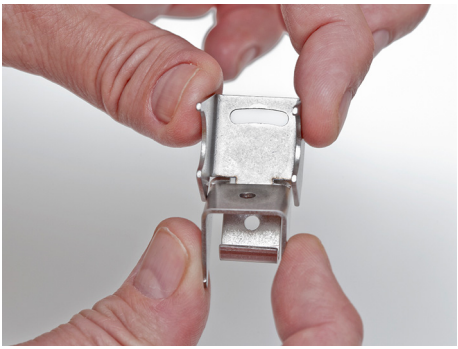


Figure 5 Probe mounting clamp in use

The probe mounting clamp is delivered in 2 parts that must be connected when it is used:

1. Align the slots on the clamp parts.



2. Slide the lower clamp part over to the bottom end of the upper part.

3. Place the clamp to the intended location and secure the upper clamp part with a screw.

4. Place the probe in the clamp.
5. Tighten the lower clamp part with a screw.

2.3.3 Probe mounting flange

The probe mounting flange is a silicone flange that you can use to hold the probe in a through-wall installation. The flange is a general purpose mounting accessory for Ø 12 mm probes, and comes with a sealing plug for coaxial cables that is not needed when you use the flange with HMP60 and HMP110 series probes. For more information, see Mounting Flange for Humidity Probes Quick Reference Guide (M211080EN).

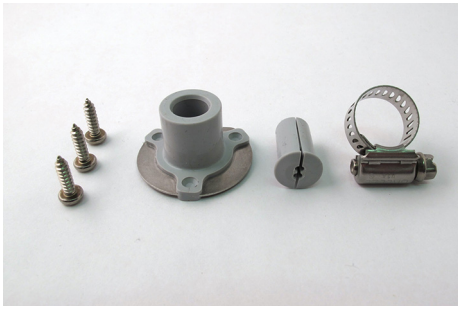


Figure 6 Probe mounting flange

More information

- Probe mounting flange dimensions (page 122)

2.3.4 Duct installation kit

The duct installation kit includes a plastic pipe with a flange (Vaisala item code 215619). To install the probe with the duct installation kit, drill a hole to the duct wall, assemble the probe to the duct installation kit, slide the probe head through the hole, and attach the flange to the duct wall with 4 screws.

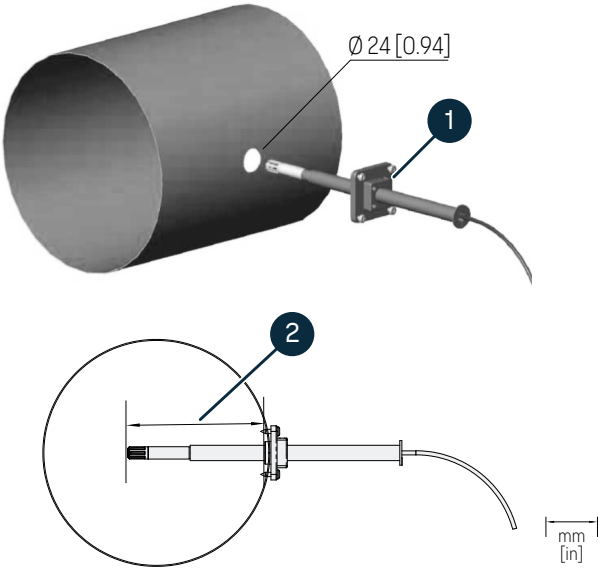


Figure 7 Probe installation with the duct installation kit

1 Tension screw
2 Installation depth. Adjust the depth and lock in place with the tension screw.

More information

- Mounting HMP60, HMP110, and HMP110T probes (page 29)

2.3.5 Plastic locking bushing

You can connect HMP63 and HMP113 probes to compatible Vaisala instruments using a plastic locking bushing that is placed over the probe. The bushing has a M15×1 thread. It is compatible with HMT120 and HMT130 transmitters, and the HM40 handheld meter.

Figure 8 HMP113 with plastic locking bushing

2.3.6 Thermal dampener block

The thermal dampener block accessory (Vaisala item code 236310SP) is designed for slowing down the naturally fast response time of temperature probes. They are typically used in cold storage applications to avoid triggering temperature alarms too rapidly by better matching the response time of the measurement to the product being stored. The thermal dampener block adds more thermal mass to the sensor tip, equivalent to that of 40 ml of glycol. 2 sensor tips can be attached simultaneously.

The thermal dampener block is compatible with the TMP115 probe, and also other temperature probes with sensor tips that are 4.8 mm (0.19 in) in diameter.

Sensor tips are secured to the block with thumb screw, no tools are required. Do not overtighten the screw to avoid damaging the sensor tip.

Figure 9 Thermal dampener block with TMP115 probe head inserted

2.3.7 Loop power converter

The loop power converter is an open frame module that converts one 0–2.5 V DC voltage output to a 4–20 mA current output. To use the loop power converter module, the probe must be in the analog output mode. The desired parameter is on channel 1, which must be scaled to 0–2.5 V.

The loop power converter is not intended to be operated without the probe connected. It does not implement logic to detect that the probe is missing, or to control the output in such a case.

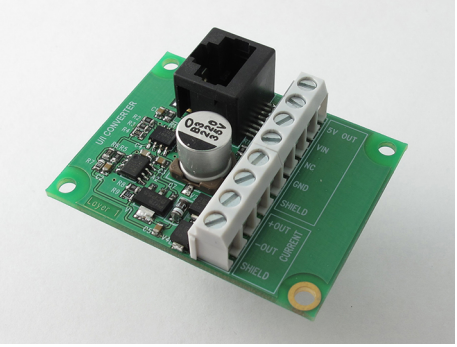


Figure 10 Loop power converter

More information

- Wiring with loop power converter (page 36)

2.3.8 Cables

Connection cables have a straight, threaded female M8 connector on one end and open wires on the other end. You can use other compatible M8 series cables.

Figure 11 Cable with threaded connector

The Vaisala USB cable (item code 219690) has a straight, threaded female M8 connector on one end, and a USB Type A male plug on the other. The USB cable is intended for maintenance purposes only, not for permanent installation.

Figure 12 USB cable for PC connection

More information

- Spare parts and accessories (page 122)

2.4 Safety

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

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.

Before you connect the probe to a device, it is recommended to power off the device.

2.4.1 ESD protection

Electrostatic discharge (ESD) can damage 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, removing, or inserting any objects in the equipment housing.

To avoid delivering high static voltages to the product:

- Handle ESD-sensitive components on a properly grounded and protected ESD workbench or by grounding yourself to the equipment chassis with a wrist strap and a resistive connection cord.
- If you are unable to take either precaution, touch a conductive part of the equipment chassis with your other hand before touching ESD-sensitive components.
- Hold component boards by the edges and avoid touching component contacts.

3. Installation

3.1 Installation overview

These instructions cover cable installation of the HMP60 and HMP110 series probes. For instructions on connecting probes to host devices, such as transmitters and data loggers, see the user documentation of the corresponding host device.

3.2 Mounting HMP60, HMP110, and HMP110T probes

HMP60, HMP110, and HMP110T are designed to be mounted from the M12 thread on the probe body or from the smooth part of the probe body. For a convenient installation, use the optional installation accessories:

- Use the plastic mounting nuts to hold the probe in a through-wall installation
- Use the probe mounting clamp or probe holder to hold the probe on a wall
- Use the probe mounting flange to hold the probe in a through-wall installation

Avoid placing the probe in a place where condensation can run onto the sensor.

3.2.1 Probe assembly with duct installation kit

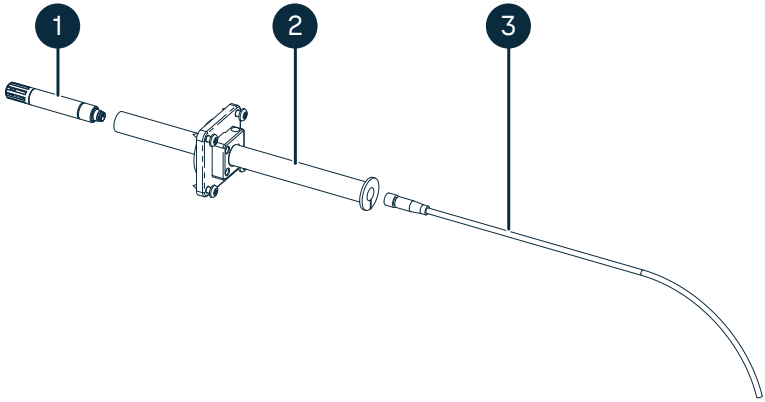


Figure 13 Assembly of the probe with duct installation kit

1 HMP60, HMP110, or HMP110T probe
2 Duct installation kit
3 Probe connection cable

1. Slide the probe connection cable through the duct installation kit plastic pipe.
2. Attach the cable to the probe.
3. Attach the probe assembly to the duct.

3.2.2 Drilling instructions for duct installation kit

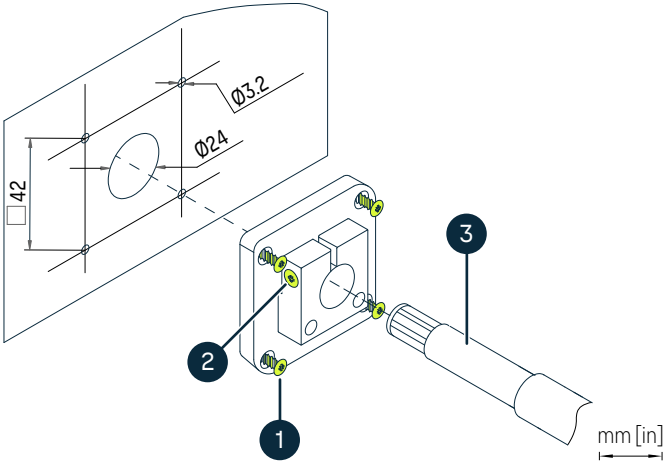


Figure 14 Drilling instructions

1 Mounting screw
2 Tension screw
3 Probe assembled in duct installation kit plastic pipe

1. Use a 24-mm drill bit to drill a hole to the duct wall for the humidity probe.
2. Drill holes for the duct installation kit mounting screws around the hole in a square arrangement, 42 mm apart from each other. Use a 3.2-mm drill bit to drill the holes for the mounting screws (four ST4.2×16-C-Z DIN 7981 screws).

3.3 Mounting HMP63 and HMP113 probes

HMP63 and HMP113 probes do not have a thread on the probe body. For a convenient installation, use the optional installation accessories:

- Use the probe mounting clamp or probe holder to hold the probe on a wall.
- Use the probe mounting flange to hold the probe in a through-wall installation.
- If you are using the probe with HMT120 or HMT130 transmitter, or HM40 handheld meter, use the plastic locking bushing.

Avoid placing the probe in a place where condensation can run onto the sensor.

More information

- Installation accessories (optional) (page 19)

3.4 Mounting HMP115 probes

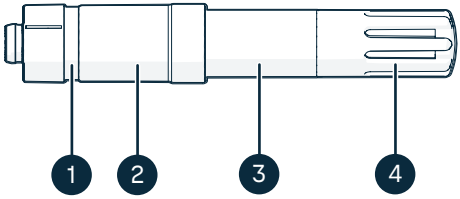


Figure 15 HMP115 probe

1 If using a probe holder, align it to this groove.
2 Plastic sleeve that locks the probe in place when connected to a mechanically compatible host device (for example, RFL100 data logger). Diameter 14 mm (0.55 in) at this point.
3 Attach from this area if using a cable tie. Diameter 12 mm (0.47 in) at this point.
4 Sensor protection filter. Do not attach from this area.

More information

- Installation accessories (optional) (page 19)

3.5 Mounting TMP115 probes

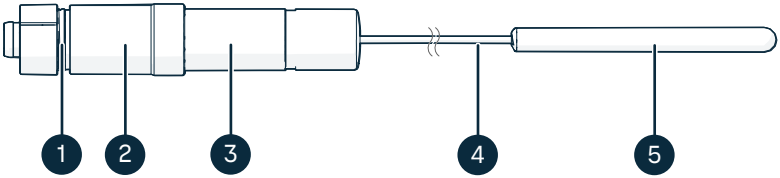


Figure 16 TMP115 probe

1 If using a probe holder, align it to this groove.
2 Plastic sleeve that locks the probe body in place when connected to a mechanically compatible host device (for example, RFL100 data logger). Diameter 14 mm (0.55 in) at this point.
3 Probe body with measurement electronics. Attach from this area if using a cable tie. Diameter 12 mm (0.47 in) at this point. Operating temperature range −40 … +60 °C (−40 … +140 °F).
4 Sensor cable. Do not cut or bend into a tight loop.
5 Sensor tip, diameter 4.8 mm (0.19 in). Secure using a cable tie or insert into thermal dampener block for added thermal mass. Insert into the probe support accessory when using together with a CO_2 probe. Operating temperature range −196 … +150 °C (−320.8 … +302 °F).

CAUTION! The operating temperature range of the sensor tip is much wider than that of the probe body. Leave the probe body outside the measured environment if possible, and avoid inserting it in environments that are outside its operating range.

When working with equipment in extremely cold temperatures, use appropriate personal protective equipment such as thermally insulated gloves and clothing. Wear protective eyewear if working with coolants such as liquid nitrogen, and observe safe handling and storage precautions.

More information

- Installation accessories (optional) (page 19)

3.6 Wiring

Before you connect the probe to a device, it is recommended to power off the device.

For a secure connection to the probe, connect to the 4-pin M8 connector using a threaded connector.

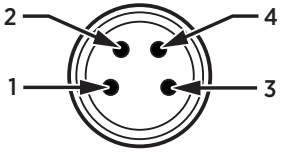


Figure 17 M8 4-pin male connector

Pin-out of HMP60 / HMP63 / HMP110 analog / HMP113 / HMP110T

1 5–28 V DC (V_{out} 0–1 / 0–2.5 V)
8–28 V DC (V_{out} 0–5 / 1–5 V)
Wire color: brown
2 Channel 1: RH / Td / T
0–1 / 2.5 / 5 V, 1–5 V
Wire color: white
3 GND / AGND
Wire color: blue
4 Channel 2: RH / Td / T
0–1 / 2.5 / 5 V, 1–5 V
(HMP110T has no output on channel 2)
Wire color: black

Pin-out of HMP110REF / HMP110 digital / HMP115 / HMP115T / TMP115

1 5–28 V DC
Wire color: brown
2 RS-485: -
Wire color: white
3 GND
Wire color: blue
4 RS-485: +
Wire color: black

The grounding method depends on the probe and the installation type.

Table 6 Grounding methods

Probe	Grounding method
HMP63 HMP113 HMP115 HMP115T	Vaisala recommends to use a shielded cable and connect the shield to ground. In the shielded cables supplied by Vaisala, the threaded connector connects the shield to the probe housing.
HMP60 HMP110 HMP110T HMP110REF TMP115	There are two ways to ground the probe depending on installation type. Choose only one of these methods: • Grounding is provided by the metal cover of the probe. If using shielded cables, shield is NOT connected to ground. • A shielded cable is used, and the shield is connected to ground. In the shielded cables supplied by Vaisala, the threaded connector connects the shield to the probe housing.

When the probe is connected to a power supply, there is a delay as the probe starts up and the analog output stabilizes. The delay depends on the output type, and on the operating voltage that is supplied to the probe:

- Probes with analog output:
  - 4 s at operating voltage 13.5–16.5 V DC
  - 2 s at other valid operating voltages
- Probes with digital output: 2 s

3.6.1 Wiring multiple digital devices

The maximum number of HMP60/HMP110 probes that you can connect to a system over the RS-485 interface is 32 when the communication speed is 19200 bps or lower.

Connecting other devices can decrease the maximum number of HMP60/HMP110 probes. If other devices require the use of termination, connect HMP60/HMP110 probes using an RS-485 repeater, or take into account the possible increase of current consumption.

The following figures show the recommended wiring when connecting multiple devices to the RS-485 interface using either a separate local power supply for each device or a common power supply.

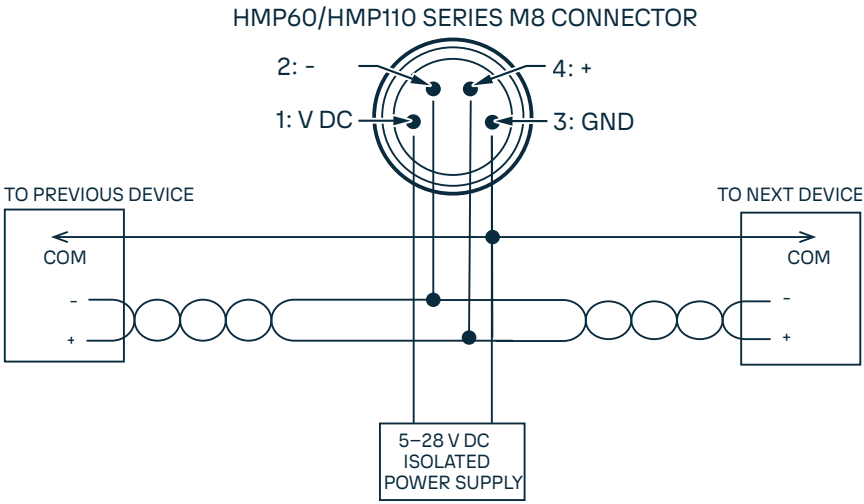


Figure 18 Wiring multiple devices using local power supply

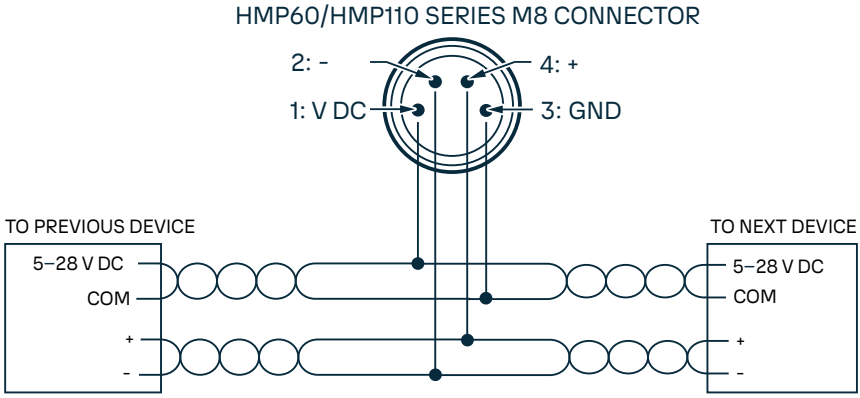


Figure 19 Wiring multiple devices using common power supply

3.6.2 Wiring with loop power converter

To use the loop power converter module with an HMP60 or HMP110 series probe, the probe must be in the analog output mode. The desired parameter is on channel 1, which must be scaled to 0–2.5 V.

You cannot use the loop power converter with the digital-only probes.

When using the loop power converter module, power the module with 8–28 VDC. The operating voltage for the probe (5 V DC) is delivered by the module.

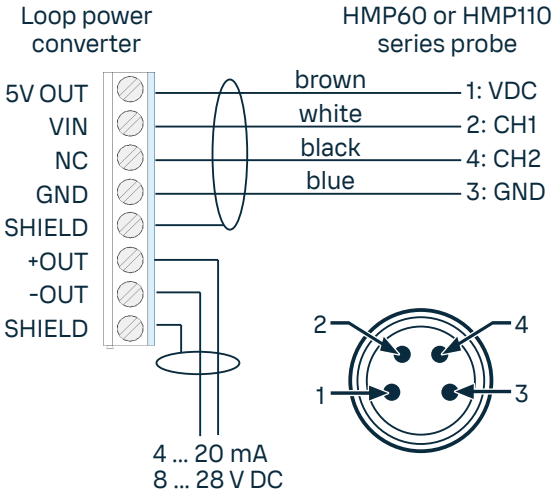


Figure 20 Wiring with loop power converter module

For more information, see Loop Power Converter Quick Reference Guide (M211106EN).

More information

- Output options (page 18)

3.6.3 Power supply requirements

The operating voltage for the HMP60 and HMP110 series probes must be in the following range:

Table 7 Operating voltage ranges

HMP60 / HMP63 / HMP110 analog / HMP113 / HMP110T	HMP110REF / HMP110 digital / HMP115 / HMP115T / TMP115
5–28 V DC (V_{out} 0–1 / 0–2.5 V)	5–28 V DC
8–28 V DC (V_{out} 0–5 / 1–5 V)	

Current consumption is 1 mA on average, which makes the probes well suited for running on battery power. The maximum peak consumption is 5 mA.

Recommendations

- Continuous use over high operating voltage may cause heating. To conserve power and minimize the warming of the probe, use the lowest operating voltage in the allowed range.
- Using low impedance loads on the signal outputs increase the current consumption by up to 0.5 mA. High impedance loads are recommended to minimize warming of the probe.
- Frequent interrogation of the probe using the RS-485 interface will also increase current consumption from the average value. More frequent interrogation than once per second is not recommended.

4. Modbus communication

The Modbus variant used in HMP60 and HMP110 series probes is Modbus RTU. Modbus support was added to HMP60 and HMP110 probes in 2016 for probe software version 2.1.4. The following table lists the default communication settings used when Modbus is enabled at the factory (chosen when ordering).

Table 8 Default Modbus communication settings

Description	Default value
Serial bit rate	19200
Parity	None
Number of data bits	8
Number of stop bits	2
Flow control	None
Modbus device address	240
Serial delay	0
Communication mode	Modbus RTU

Use Vaisala Insight software to change the Modbus serial communication settings if needed. Download Vaisala Insight software at www.vaisala.com/insight.

The instrument must be switched off and on before the communication setting changes take effect.

More information

- Accessing serial line command interface from analog or Modbus mode (page 51)
- Modbus reference (page 126)
- Wiring multiple digital devices (page 35)

5. Vaisala Insight PC software

Vaisala Insight PC software is a service and utility software for Indigo-compatible and other Vaisala devices. Insight is available for Microsoft Windows® operating systems (64-bit only).

With Insight, you can:

- See device information and status.
- See real-time measurement data.
- Configure serial communication settings, filtering factor, and analog output parameters and scaling.
- Calibrate and adjust the device.
- Perform short-term data logging for laboratory testing or evaluation purposes, for example.

Download Insight at vaisala.com/insight.

The probe can be connected to Insight using a Vaisala USB cable (item code 219690).

HMP60 and HMP110 probes support Insight from probe software version 2.1.4 onwards.

5.1 Insight PC software overview

Figure 21 Insight PC software main menu view with HMP110

1 Select ⚙ to access Insight main menu.
   - **Configure device**: probe options and general settings.
   - **Export settings**: creates a text file export of the device settings.
   - **Calibrate**: options for calibrating and adjusting the measurement of the probe, viewing adjustment data, and restoring factory adjustments.
   - Probe reset quick selection.
   - **About device**: general device information such as serial number and software version.
2 Select **Settings** to switch between the **Basic mode** and **Advanced mode** user modes, change the units of parameters (metric/non-metric), enter a factory code to access restricted functionalities, or view information about the Insight software.
3 **Monitoring** provides options for monitoring and recording selected parameters, and exporting the monitoring data as a CSV (comma-separated values) file.
4 Device information menu with the following tabs:
   - **Measurements**: measurement graph view with parameter drop-down selection.
   - **Calibration information**: read-only information about the latest stored calibration.
   - **Diagnostics**: troubleshooting and administrative information about the device status.

5.2 Connecting to Insight PC software

- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- M8-4F USB service cable (Vaisala item code 219690)

CAUTION! When connecting several devices at the same time, note that your computer may not be able to supply enough power through its USB ports. Use an externally powered USB hub that can supply >2 W for each port.

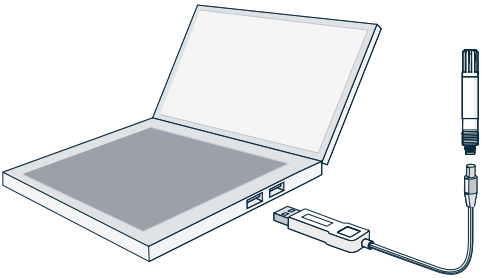


Figure 22 Connecting probe to Insight

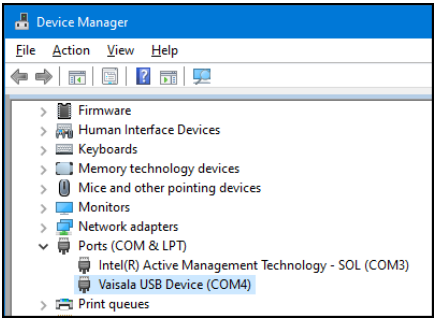
1. Open the Insight software on your computer.
2. Connect the USB cable to a free USB port on the computer.
3. Connect the probe to the USB cable.
4. Wait for the Insight software to detect the probe.

5.2.1 Installing 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 **Device Manager** from the Windows® Start menu. Use search to find it if necessary (search for "device").

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.
   - 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 vaisala.com/software (select the appropriate USB Instrument Driver Setup for your cable).
   c. Extract the driver zip file and 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.

6. Using probe with Indigo80 handheld indicator

6.1 Indigo80 handheld indicator

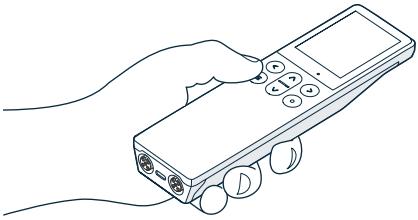


Figure 23 Indigo80 handheld indicator

Vaisala Indigo80 Handheld Indicator is a portable diagnostics tool that accommodates up to two compatible Vaisala devices for measuring a wide range of parameters.

With the indicator, you can:

- See real-time measurements and device and status information
- Log measurement data
- Calibrate and adjust the probe
- Configure probe features and settings such as filtering factor, analog output overrange behavior, serial communication, and analog output.
- Enable another connected probe to function as the reference instrument for relative humidity and/or temperature during calibration and adjustment.

Accessing certain configuration options for your probe is possible only using the free Insight PC software, downloadable at vaisala.com/insight.

The help tours in the indicator's user interface guide you through the key features of the indicator. You can access the tours in the **Help** menu by pressing the ☰ button.

For more information on using the indicator, for example, editing the measurement views and performing data logging, see Indigo80 User Guide (M212722EN).

More information

- Configuring probe features with Indigo80 handheld indicator (page 47)
- Calibration and adjustment with Indigo80 handheld indicator (page 81)

6.1.1 Probe compatibility

The Indigo80 handheld indicator is tested for compatibility with probes that have firmware version 2.6.3 or newer.

For the most up-to-date version compatibility information, see Indigo80-compatible Firmware Technical Note (M212901EN).

6.1.2 Indigo80 keypad

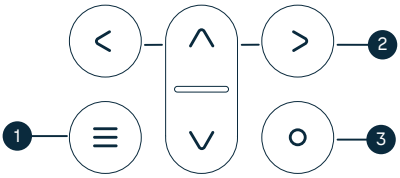


Figure 24 Indigo80 keypad

1 Power on/off and main menu button
2 Arrow buttons for navigating menus and scrolling views
3 Select button for selecting items in the user interface

6.1.3 Indigo80 main menu

Pressing the ☰ button while navigating the Indigo80 menus and views opens the main menu.

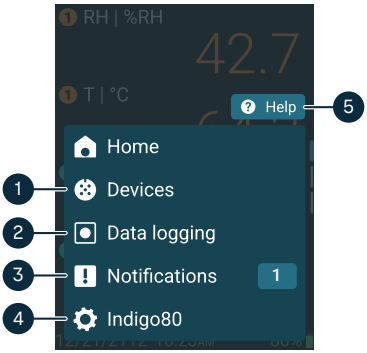


Figure 25 Indigo80 main menu

1 **Devices** menu contains, for example, options related to sensor purge, calibration, and environment settings (depending on the connected device).
2 **Data logging** menu for setting logging interval and duration, and browsing data files.
3 **Notifications** menu displays notifications related to Indigo80 and the connected devices.
4 **Indigo80** menu for changing the settings of Indigo80 (for example, date, time, and language) and viewing device information.
5 **Help** menu contains tours showing the key features of Indigo80, as well as instructions for sending devices to Vaisala for calibration and maintenance.

6.2 Connecting probes to Indigo80

- Probe connection cable (M8-M12, Vaisala item code 262195SP)

Up to two Vaisala Indigo-compatible measurement devices can be connected to the ports located on the bottom of Indigo80. You can connect and disconnect devices both when the indicator is powered on and when it is off.

Vaisala recommends using cables provided by Vaisala when connecting devices to the indicator. Cables and other accessories are available to order at store.vaisala.com.

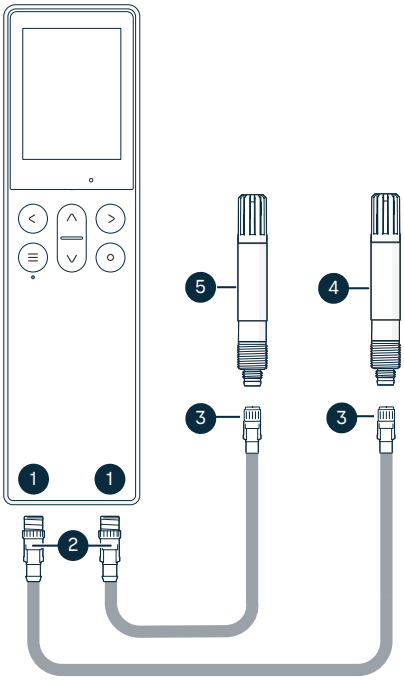


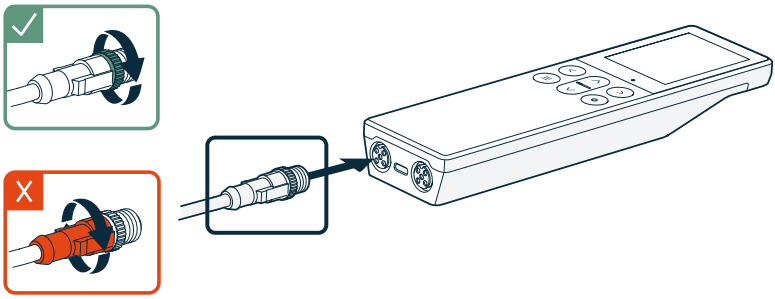
Figure 26 Example of connecting probes to Indigo80

1 M12-5F ports on the bottom of Indigo80 for connecting compatible Vaisala devices. Ports are labeled ❶ and ❷.
2 M12-5M cable connector
3 M8-4F cable connector
4 Probe displayed as ❶ by Indigo80
5 Probe displayed as ❷ by Indigo80

1. If the indicator is powered and no devices are connected to it, the text **Please connect a probe** will be shown on the display.

2. Insert the probe connection cable in one of the ports on the bottom of the indicator.

   - **Note the orientation of the cable connector when inserting it**
   - **Hold the connector in place while turning its locking ring clockwise – never twist the connector body!**



3. Connect the probe to the M8 end of the probe connection cable.

   When the indicator recognizes the connected probe, it shows a notification on the display. A probe connected to the leftmost port in the indicator is labeled ❶ on the indicator's display, while the probe in the rightmost port is labeled ❷.

4. To change probes, simply detach the cable from the probe and connect a new probe.

6.3 Configuring probe features with Indigo80 handheld indicator

- Probe connection cable (M8-M12, Vaisala item code 262195SP)

Accessing certain configuration options for your probe is possible only using the free Insight PC software, downloadable at vaisala.com/insight.

1. Connect the probe(s) to the indicator.
2. Open the indicator main menu by pressing ☰.
3. Select **Devices**. If you have more than one device connected to the indicator, make a further selection between the devices.
4. Select **Settings** to access and change the features available for your probe.
5. Exit the menu by pressing ‹ or return to the main menu by pressing ☰.

6.3.1 Example of configuring filtering factor with Indigo80 handheld indicator

- Probe connection cable (M8-M12, Vaisala item code 262195SP)

The filtering factor allows averaging the output if the measuring environment produces occasional exceptionally high or low readings.

This example shows how to configure the filtering factor as **0.9** using the Indigo80 handheld indicator.

This means that the new measurement output is a combination of the latest measurement (90 %) and the previous measurement (10 %).

1. Connect the probe(s) to the indicator.
2. Open the indicator main menu by pressing ☰.
3. Select **Devices**. If you have more than one device connected to the indicator, make a further selection between the devices.
4. Select **Settings**.
5. Select **Filtering factor**.
   a. Use the arrow buttons to set the value as **0.9**.
   b. Select **Set**.
6. Exit the menu by pressing ⟲ or return to the main menu by pressing ☰.

7. Serial line communication

In analog probes, serial line communication is intended for service use only.

HMP60 and HMP110 series probes support 2-wire RS-485 communication. The RS-485 interface is non-isolated and offers a maximum communications rate of 57600 bps.

There is no internal termination for the RS-485 on the probe. Use of termination resistors is not recommended. If the resistors are used, the possible increase in current consumption should be taken into account.

7.1 Connecting to serial interface

Connection to the serial interface is through the 4-pin connector on the probe.

For temporary use of the serial interface (for example, calibration), you can use the optional Vaisala USB cable (item code 219690). Before you can use the cable, you must install the provided USB driver on your PC.

The Vaisala USB cable is not designed for permanent installations. When using the USB cable, no separate power unit is needed. The probe is powered through the USB port.

For permanent interfacing to a host system, use a shielded cable with a threaded connector.

The probe does not echo typed characters back to the terminal screen. To see the commands you type, you need to enable the "local echo" setting in your terminal program.

A new command cannot be received while the probe is sending data out. Wait until the instrument has completed its response before entering the next command.

Table 9 Default serial communication settings

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

You can change the serial settings and operate in RUN, STOP, POLL, and MODBUS modes.

After power-up the probe (in STOP mode) outputs the software version and the command prompt.

- In RUN mode, a measurement output starts immediately after power-up.
- In POLL mode, the probe does not output anything after power-up. It must be accessed with an addressed command.
- In MODBUS mode, the probe does not output anything after power-up: serial line commands are not in use and the probe must be used with the Modbus protocol.

More information

- Wiring (page 34)
- Installing driver for the USB service cable (page 42)
- Accessing serial line command interface from analog or Modbus mode (page 51)
- Set serial interface mode (page 58)

7.2 Terminal application settings for digital probes

The following steps describe how to connect to digital probes using the PuTTY terminal application for Windows (available for download at www.vaisala.com/software) and the USB serial interface.

If you have an analog probe, you can still connect to the serial line by following the instructions in Accessing serial line command interface from analog or Modbus mode (page 51).

1. Connect Vaisala USB cable 219690 between your PC and the probe.
2. Start the PuTTY application.
3. Select the **Serial** settings category, and check that the correct COM port is selected in the **Serial line to connect to** field.

   To check which port the USB cable is using, open **Device Manager** from the Windows® Start menu and check under the **Ports** category.
4. Check that the other serial settings are correct for your connection, and change if necessary.
5. 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 an error message instead. If this happens, restart PuTTY and check the settings.
6. You may need to adjust the **Local echo** setting in the **Terminal** category to see what you are typing on the serial line. To access the configuration screen while a session is running, right-click over the session window, and select **Change Settings**.

If the probe is in Modbus mode, to access the serial port command interface, follow the instructions in Accessing serial line command interface from analog or Modbus mode (page 51).

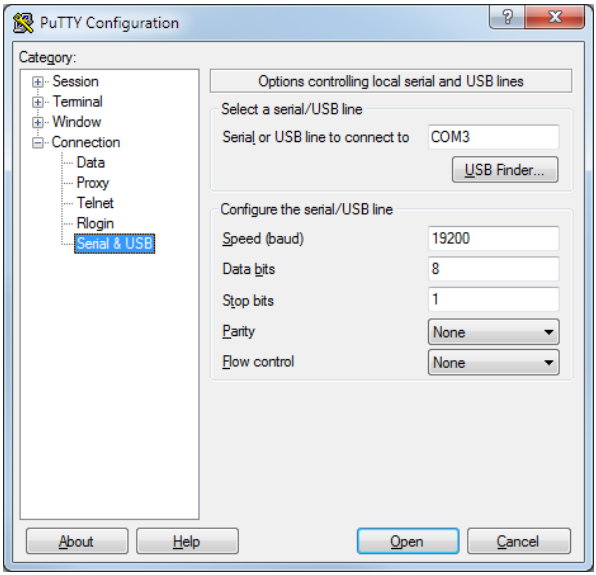


Figure 27 PuTTY terminal application

7.3 Accessing serial line command interface from analog or Modbus mode

Follow the steps below to connect to the serial line when the probe is in analog or Modbus mode. You can also use the procedure to retrieve the communication settings of your device, if you do not know them. You must use the Vaisala USB cable (Vaisala item code 219690) in this case.

1. Connect the USB cable to the PC and install the driver, if necessary. Do not connect the cable to the probe yet.
2. Open the terminal program and open a connection to the corresponding COM port using the default settings 19200, 8, N, 1, no flow control.
3. Select the **Serial** settings category, and check that the **Serial line to connect to** field contains the correct COM port.

   To check which port the USB cable is using, open **Device Manager** from the Windows® Start menu and check under the **Ports** category.
4. To open the connection window and start using the serial line, select **Open**.
5. Keep the **ENTER** key pressed down and connect the other end of the USB cable to the probe. This causes the probe to start in RS-485 mode, using the default serial settings. You can now use the probe with the terminal program.

6. To prevent the analog or Modbus mode from being restored on the next power-up, select a different serial mode with the **smode** command.
7. To switch back to analog mode or Modbus mode from a serial mode, use the **smode analog** or **smode modbus** command to select analog or Modbus mode. Reset or power cycle the probe to restart in the selected mode.

The probe cannot be used with the MI70 handheld indicator or the HM40 meter when the probe is in analog mode. To use the probe with MI70 or HM40, enable a serial mode (for example, STOP) as instructed above.

More information

- List of serial commands (page 52)
- Set serial interface mode (page 58)

7.4 List of serial commands

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

The notation <cr> refers to pressing the carriage return (**Enter** key on your computer keyboard). Press **Esc** to clear the command buffer before starting to enter commands.

Available commands depend on the probe model and its order configuration. For example, commands for configuring analog output are not available if the probe only has digital output. Issue the **HELP** command to display the currently available commands.

Table 10 List of serial commands (software version 2.4.0)

Command	Description
?	Output information about the device
AERR	Set analog output error level
AMODE	View or set the analog output mode
AOVER [ON/OFF]	Allow analog outputs to exceed their range 10 %
ASEL	Set analog output parameters and scaling
CDATE	View or set the calibration date
CODE	View the order code of the probe
CRH	Calibrate and adjust RH measurement
CRHCLR	Clear adjustment of RH measurement

Command	Description
CT	Calibrate and adjust T measurement
CTCLR	Clear adjustment of T measurement
CTEXT	View or set the calibration information field
ERRS	List present probe errors
FILT [0.001 ... 1]	Set the result filtering
FRESTORE	Restore factory settings
HELP	List available commands
INTV [0 ... 255 S/MIN/H]	Set the continuous output interval (for RUN mode)
L	Displays user adjustment parameters
R	Start the continuous outputting
RESET	Reset the probe
RHLIMIT	Extend maximum RH reading
S	Stop the continuous outputting
SDELAY [0 ... 255]	View or set serial line answer minimum delay
SEND [0 ... 255]	Output the reading once
SNUM	View the serial number of the probe
UNIT	Select metric or non-metric output units
VERS	View software version of the probe

Table 11 Additional commands for probes with RS-485 output

Command	Description
??	Output information about the device in POLL mode
ADDR [0 ... 255]	Set the probe address (for POLL mode)
CLOSE	Close the temporary connection (Back to POLL mode)
OPEN [0 ... 255]	Open a temporary connection to a POLL mode device
SERI [baud p d s]	User Port settings (Default: 19200 N 8 1) baud: 300 ... 57600
SMODE [STOP/RUN/POLL/MODBUS/VDIGI/ANALOG]	Set the serial interface mode

7.5 Device information and status

7.5.1 View device information

The **?** command outputs a listing of device information.

?<cr>

Example (output from HMP63):

```
?
HMP63 / 1.0.4
Serial number  : H3640004
Batch number   : T0001109
Sensor number  : H0000322
Sensor model   : Intercap
Order code     : A12A0A2B0
Cal. date      : 20120907
Cal. info      : VAISALA/HEL
Time           : 00:21:05
Serial mode    :   ANALOG
Baud P D S     :    19200 N 8 1
Output interval:        1 S
Serial delay   :       30
Analog delay   :       10 S
Address        :        0
Filter         :    1.000
Ch1 output     :  0 ... 1 V
Ch2 output     :  0 ... 1 V
Ch1 RH   lo    :     0.00 %RH
Ch1 RH   hi    :   100.00 %RH
Ch2 T    lo    :   -40.00 'C
Ch2 T    hi    :    60.00 'C
```

If the probe is in POLL mode, but a connection has not been opened using the **OPEN** command, issue the **??** command.

??<cr>

More information

- Set serial line settings (page 57)

7.5.2 View calibration information

Use the **CDATE** command to view the calibration date and **CTEXT** to view the calibration info text. Date format for **CDATE** is YYYYMMDD.

CDATE<cr>

CTEXT<cr>

Examples:

```
cdate
Cal. date      : 20150109
```

```
ctext
Cal. info      : VAISALA/HEL
```

7.5.3 Enter calibration information

To enter the calibration date, use the **CDATE** command (**cdate** [YYYYMMDD]). To enter a text string with information about the calibration, use the **CTEXT** command (**ctext** [string]).

CDATE [yyyymmdd] <cr>

CTEXT [text string] <cr>

Example:

```
cdate 20151125

Cal. date      : 20151125
ctext Calibrated in Room 1
Cal. info      : Calibrated in Room 1
```

7.5.4 View order code

Use the **CODE** command to view the order code that has been stored in the probe. This command is useful if you need to order a new probe with the same options.

CODE<cr>

Example:

```
code
Order code     : A12A0A2B0
```

7.5.5 View serial number

Use the **SNUM** command to view the serial number of the probe.

SNUM<cr>

Example:

```
snum
Serial number  : H3640004
```

7.5.6 View software version

Use the **VERS** command to display the software version of the probe.

VERS<cr>

Example:

```
vers
HMP63 / 1.0.4
```

7.6 Serial line output commands

7.6.1 Start measurement output

Use the **R** command to start the continuous outputting of measurement values as an ASCII text string to the serial line.

For HMP60 and HMP110, the output always includes readings for temperature, RH and Td. For temperature-only probes, such as HMP110T, the output includes only temperature.

R<cr>

Example (HMP60 and HMP110):

```
r
T= 22.6 'C RH= 22.8 %RH Td=  0.3 'C
T= 22.6 'C RH= 22.5 %RH Td=  0.2 'C
T= 22.6 'C RH= 22.5 %RH Td=  0.2 'C
…
```

Example (HMP110T):

```
r
T= 22.6 'C
T= 22.6 'C
T= 22.6 'C
…
```

Outputting the results continues in intervals issued with the command **INTV**. You can stop the output by entering the **S** command.

7.6.2 Stop measurement output

Use the **S** command or press the **ESC** key to stop the continuous measurement output.

S<cr>

7.6.3 Output the measurement message once

Use the **SEND** command to output the measurement values once. If the probe is in POLL mode and the line is not open for commands, specify the address of the probe to receive the measurement message.

SEND [aaa]<cr>

Syntax	Description
aaa	Address of the probe, range 0 ... 255. Set with the **ADDR** command.

Example (probe in STOP mode, no address needed):

```
send
T= 22.7 'C RH= 20.0 %RH Td= -1.5 'C
```

Example (probe in POLL mode, with address 10):

```
send 10
T= 22.8 'C RH= 20.1 %RH Td= -1.3 'C
```

7.7 Configuring serial line operation

7.7.1 Set serial line settings

Use the **SERI** command to show or set the serial line settings. The new settings will be taken into use when the probe is reset or powered up.

SERI [b p d s]

Syntax	Description
b	baud rate (300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600)
p	parity (n = none, e = even, o = odd)
d	data bits (7 or 8)
s	stop bits (1 or 2)

Example (shows default settings):

```
seri
Baud P D S     :    19200 N 8 1
```

7.7.2 Set serial interface mode

Use the **SMODE** command to set the operation mode of the serial interface. The new mode is applied when probe is reset.

SMODE [xxx]<cr>

Syntax	Description
xxx	Operation mode of the serial interface.

Table 12 Serial interface modes

Mode	Description
STOP	Probe outputs only when a command is issued. Any command can be used.
RUN	Probe automatically outputs measurement messages on the serial line. Only command **S** or the **ESC** key can be used to stop the output.
POLL	Probe outputs only when a command is issued. Probes communicate one at a time when the specific address is called on the serial line, which is useful when more than one probe is connected to one serial bus. Any command can be used after the line has been opened using the **OPEN** command. See descriptions of the commands **ADDR** and **OPEN**.
MODBUS	Measurement outputs must be read from the transmitter using the Modbus protocol. For more information, see Modbus communication (page 39) and Modbus reference (page 126).
VDIGI	Special serial interface mode that is only used for interoperability with Vaisala devices such as HMT120, HMT130, and HM40. This mode is set at Vaisala for probes that are ordered for such use.
ANALOG	No serial line, analog outputs active. For instructions on how to enter the serial line when in analog mode, see Accessing serial line command interface from analog or Modbus mode (page 51). Note that analog output channels are not available in the digital-only HMP110. See Output options (page 18).

Example (check current mode):

```
smode
Serial mode    :     STOP     ?
```

Example (change mode to POLL mode):

```
smode poll
Serial mode    :     POLL
```

In the RUN mode, the probe may send the measurement data message right as you are typing the **S** command to stop the sending. Therefore, you may need to repeat the **S** command. This must be noted especially when designing computer programs to access the probe.

The digital-only HMP110 probe option cannot be set to analog mode.

7.7.3 Set output interval

Use the **INTV** command to show or set the output interval of the serial line measurement messages (applies when **R** command or RUN mode is used). The shortest output interval is 1 second. This command has no effect on the operation of the analog output.

INTV [n xxx]<cr>

Syntax	Description
n	Time interval in range 1 ... 255
xxx	Time unit = "S", "MIN", or "H"

Example:

```
intv 1 s
Value               : 1
Unit                : S
```

7.7.4 Set measurement filtering

Use the **FILT** command to view or set the speed at which the latest measurement result is integrated into the humidity and temperature readings. The command affects both analog output and serial line output.

FILT [a.aaa]<cr>

Syntax	Description
a.aaa	Range 0.001 ... 1.0. 1.0 = No filtering, the latest measurement is output without averaging 0.5 = Average of the last 2 measurements 0.1 = Average of approximately 16 measurements

Example (default setting, no filtering):

```
filt
Filter          :    1.000     ?
```

Example (set filtering to 0.5):

```
filt 0.5
Filter          :    0.500
```

7.7.5 Set probe address

Use the **ADDR** command to view or set the probe address. To operate in the POLL mode, the probe must have an address. If multiple probes share the same serial line, each probe must have a different address.

ADDR [nn]<cr>

Syntax	Description
nn	Address (0 ... 255)

Example:

```
addr
Address         :        0
```

More information

- Set serial line settings (page 57)

7.7.6 Set serial interface delay

Use the **SDELAY** command to view or set the serial interface answer minimum delay.

SDELAY [delay]<cr>

Syntax	Description
delay	Range 0 ... 255. Value corresponds to 4 milliseconds (for example, 5 = 0.020 second minimum answer delay)

Example:

```
sdelay
Serial delay    :       30
```

```
sdelay 50
Serial delay   :       50
```

7.7.7 Set measurement units

Use the **UNIT** command to view or set the measurement units that are used in the serial line measurement messages.

UNIT [M/N]<cr>

M is for metric units, N is for non-metric units.

Parameter	Metric unit	Non-metric unit
RH	%RH	%RH
T_d	°C	°F
T	°C	°F

Examples:

```
unit
Units          : Metric
```

```
unit n
Units          : Non metric
```

7.8 Calibration commands

7.8.1 Calibrate humidity measurement

Use the **CRH** command to perform a 1-point or 2-point correction to the capacitance measurement of the probe. This command changes the offset and/or gain of the humidity measurement, depending on the calibration and reference:

- 1-point calibration with a single < 50 %RH reference will adjust the offset of the capacitance measurement
- 1-point calibration with a single > 50 %RH reference will adjust the gain of the capacitance measurement
- 2-point calibration will adjust both offset and gain. The first point requires a < 50 %RH humidity reference, the second point must be > 50 %RH. There must also be at least 30 percentage point difference between the references.

CRH [reference]<cr>

This command is not available on the HMP110T.

When performing a 1-point calibration, you need to place the probe in the reference humidity and wait for 20–40 minutes for the humidity to stabilize. To apply the adjustment, enter the **CRH** command with the reference %RH as a parameter.

Example: 1-point calibration (LiCl reference, 11 %RH):

```
crh 11
OK
```

Example: 1-point calibration with NaCl reference (75 %RH):

```
crh 75
OK
```

Giving the command without parameters starts the 2-point calibration. Remember to allow the humidity to stabilize for 20–40 minutes after changing the reference.

Example: 2-point calibration with LiCl (11 %RH) and NaCL (75 %RH) references:

```
crh
RH  :  11.2684 1. ref ? 11
 Press any key when ready ...
RH  :  75.0612 2. ref ? 75
OK
```

7.8.2 Clear adjustment of RH measurement

Use the **CRHCLR** command to clear the adjustment of RH measurement that has been done using the **CRH** command. This command is not available on the HMP110T.

CRHCLR<cr>

Example:

```
crhclr
OK
```

7.8.3 Calibrate temperature measurement

Use the **CT** command to perform a 1-point or 2-point temperature (T) calibration. 1-point calibration adjusts the offset for the measurement, 2-point calibration adjusts offset and gain.

CT [reference]<cr>

When performing a 1-point calibration, you need to place the probe in a single temperature reference and wait for 20–40 minutes for the temperature to stabilize. To apply the adjustment, enter the **CT** command with the reference temperature as a parameter.

Example: 1-point calibration

```
ct 23.5
OK
```

Giving the command without parameters starts the 2-point calibration. Remember to allow the temperature to stabilize for 20–40 minutes after changing the reference. The first reference point must be smaller than the second point, and the difference between the reference points must be more than 30 °C. To update the measured value while the command is running, press enter without inputting a value.

Example: 2-point calibration

```
ct
T : 22.03 Ref1 ? 22
Press any key when ready ...
T : 55.12 Ref2 ? 55
OK
```

7.8.4 Clear adjustment of T measurement

Use the **CTCLR** command to clear the adjustment of temperature measurement that has been done using the **CT** command.

CTCLR<cr>

Example:

```
ctclr
OK
```

7.9 Other commands

7.9.1 Set analog output mode

Use the **AMODE** command to show or set the operation mode of the analog output. This command is not in use in the digital-only HMP110 probe option.

AMODE `[ch1] [ch2]`<cr>

Syntax	Description
`ch1`	Analog output mode for channel 1, range 0 ... 3. The options are: `0` (0 ... 1 V) `1` (0 ... 2.5 V) `2` (0 ... 5 V) `3` (1 ... 5 V)

Syntax	Description
ch2	Analog output mode for channel 2, range 0 ... 3. The options are the same as for channel 1.

Example (show current output modes):

```
amode
Ch1 output     :  0 ... 1 V
Ch2 output     :  0 ... 1 V
```

Example (set channel 1 to 0 ... 1 V and channel 2 to 0 ... 5 V):

```
amode 0 2
Ch1 output     :  0 ... 1 V
Ch2 output     :  0 ... 5 V
```

7.9.2 Set analog output parameters and scaling

Use the **ASEL** command to show or set the output parameters and scaling of the analog outputs. This command is not in use in the digital-only HMP110 probe option.

ASEL [ch1 ch2] [ch1low ch1high ch2low ch2high]<cr>

Syntax	Description
ch1	Output parameter for channel 1. The options are: • RH = Relative humidity • T = Temperature • Td = Dew point temperature • Tw = Wet bulb temperature • a = Absolute humidity • x = Mixing ratio • h = Enthalpy
ch2	Output parameters for channel 2. The options are same as for channel 1.
ch1low	Low limit for channel 1 output scaling.
ch1high	High limit for channel 1 output scaling.
ch2low	Low limit for channel 2 output scaling.
ch2high	High limit for channel 2 output scaling.

Example (show current output parameters and scaling):

```
asel ?
Ch1 RH lo : 0.00 %RH ?
Ch1 RH hi : 100.00 %RH ?
Ch2 T lo : -20.00 'C ?
Ch2 T hi : 80.00 'C ?
```

Example (change channel 1 to output dew point temperature, adjust scaling to -40 ... 60 °C for channel 1 and to -20 ... 80 °C for channel 2):

```
asel td t -40 60 -20 80
Ch1 Td   lo    :   -40.00 'C
Ch1 Td   hi    :    60.00 'C
Ch2 T    lo    :   -20.00 'C
Ch2 T    hi    :    80.00 'C
```

Example (change channel 1 to output temperature and channel 2 to output relative humidity, adjust scaling for channel 1 to -40 ... 60 °C when prompted):

```
asel t rh
Ch1 T    lo    :   -20.00 'C ? -40
Ch1 T    hi    :    80.00 'C ? 60
Ch2 RH   lo    :     0.00 %RH ?
Ch2 RH   hi    :   100.00 %RH ?
```

7.9.3 Set analog output error indication level

If the device is malfunctioning, the analog output is set to a specified level. This overrides the normal measurement output of the channel. The default error level is 0 V, or another value predefined by the customer when ordering the device. You can set the level using the **AERR** command. This command is not in use in the digital-only HMP110 probe option.

AERR [ch1 ch2] <cr>

Syntax	Description
ch1	Error level of the analog output for channel 1. The available range depends on the output mode (check with **AMODE** command).
ch2	Error level of the analog output for channel 2. The available range depends on the output mode (check with **AMODE** command).

Example (show present output modes):

```
amode
Ch1 output     :  0 ... 1 V
Ch2 output     :  0 ... 1 V
```

Example (check present analog output error level):

```
aerr
Ch1 error out: 0.000V ?
Ch2 error out: 0.000V ?
```

Example (set analog output error level to 1 V on both channels):

```
aerr 1 1
Ch1 error out: 1.000V ?
Ch2 error out: 1.000V ?
```

The error output value is displayed only when there are minor electrical faults such as humidity sensor damage. When there is a severe device malfunction, the error output value is not necessarily shown.

7.9.4 Extend analog output range

Use the **AOVER** command to allow the analog output channels to exceed their specified range by 10 %. The scaling of the parameter remains as before; the extra range is used for additional measurement range in the wet end. This command is not in use in the digital-only HMP110 probe option.

AOVER [ON/OFF]<cr>

The following example illustrates how the analog output is affected. Channel 1 outputs T_d with voltage output 0 ... 5 V (−40 °C ... +60 °C). After giving the **AOVER** ON command, the range is 0 ... 5.5 V (−40 °C ... +70 °C). Note that the +60 °C T_d point is still at 5 V.

Example:

```
aover on
AOVER               :       ON
```

7.9.5 Extend maximum RH reading

With digital output, use the **RHLIMIT** command to set the maximum RH reading from 100 % (default) up to 120 %.

With analog output, the **RHLIMIT** command allows you to extend the high limit of the analog output scaling up to 120 %. This command does not change the scaling automatically. To change the scaling, use the **ASEL** command.

RHLIMIT [max_rh]<cr>

Syntax	Description
max_rh	Maximum reading of the RH parameter. Possible values are 100.0 ... 120.0. The default value is 100.0.

Example (extend the maximum RH reading to 120 %):

```
rhlimit 120
Max. RH %      :    120.0 %RH
```

Example (on analog output, extend the maximum RH reading to 120 % and scale the RH output on channel 2 from (0 ... 1 V) 0 ... 100 % to (0 ... 1 V) 0 ... 120 %):

```
rhlimit 120
Max. RH %      :    120.0 %RH
asel ?
Ch1 T    lo    :   -20.00 'C ?
Ch1 T    hi    :    80.00 'C ?
Ch2 RH   lo    :     0.00 %RH ?
Ch2 RH   hi    :   100.00 %RH ? 120
```

More information

- Set analog output parameters and scaling (page 64)

7.9.6 Display command list

Use the **HELP** command to display a list of the currently available commands.

HELP<cr>

7.9.7 Display the currently active errors

Use the **ERRS** command to display the currently active error codes.

ERRS<cr>

Example (no active errors):

```
errs
0000h
No errors
```

Table 13 Error messages on ERRS command

ERRS command response	Corresponding error
T MEAS error	Temperature measurement error. [44]
F meas error	Humidity measurement error. [45]
RH sensor failure	Humidity sensor failure. [46]
Frequency measurement outside the permissible value range	Capacitance reference error. [47]
Ambient temperature error	Ambient temperature out of range. [48]

ERRS command response	Corresponding error
Program flash check sum error	Firmware checksum mismatch. [49]
Parameter flash check sum error	Device settings corrupted. [50]
INFOA check sum error	Additional configuration settings corrupted. [51]
SCOEFS check sum error	Sensor coefficients corrupted. [52]
CURRENT check sum error	Main configuration settings corrupted. [53]
Voltage error	Supply voltage out of range. [55]
General flash failure w/r	Non-volatile memory read/write failure. [57]
Calibration certificate check sum failure	Calibration certificate checksum mismatch. [58]

Refer to Error messages in Insight PC software and Indigo80 handheld indicator (page 101) for more information about the error states.

More information

- Solving typical problems (page 100)

7.9.8 Connect to the probe in POLL mode

Use the **OPEN** command to connect to a probe that is in POLL mode.

OPEN [aa]<cr>

Syntax	Description
aa	address (0 ... 255)

Example:

```
open 1
HMP110   1 line opened for operator commands
```

7.9.9 Close the connection in POLL mode

The **CLOSE** command closes the connection to the probe.

CLOSE<cr>

Example:

```
close
line closed
```

7.9.10 Reset the probe

Use the **RESET** command to reset the probe. Upon reset or power-up, the probe enters the serial mode that has been set with the **SMODE** command.

RESET<cr>

Example (probe set to serial mode STOP, will output probe model and software version at reset):

```
reset
HMP60 / 1.00.0
```

Example (probe set to serial mode RUN, will start to output measurement messages at reset):

```
reset
T= 23.6 'C RH= 20.2 %RH Td= -0.5 'C
T= 23.6 'C RH= 20.2 %RH Td= -0.5 'C
T= 23.3 'C RH= 20.2 %RH Td= -0.8 'C
...
```

7.9.11 Restore factory settings

Use the **FRESTORE** command to restore the factory settings to the probe. All user settings, including the user-performed calibration corrections, will be lost. The probe will revert back to the factory calibrated settings.

FRESTORE<cr>

Example:

```
frestore
Factory settings restored
```

8. Calibration and adjustment

8.1 Overview of calibration and adjustment

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**.

If you think the device is not measuring correctly, calibration and adjustment is not the first thing to do. Check the following first:

- Make sure nothing is interfering with the measurement: heat sources, temperature differences, or condensation.
- Check that there is no moisture on the probe. If the sensor has become wet, wait for it to dry.
- Always wait for the measurement to stabilize.

Vaisala recommends calibrating the accuracy of the probes yearly. The probe is fully calibrated and adjusted as shipped from the factory, and a calibration reminder with a 12-month interval is activated in the probe. To maintain the accuracy of the measurement, calibrate and adjust the probe as indicated by the calibration reminder, or as needed. Typical calibration interval is one year, but depending on the application it may be necessary to check the accuracy more frequently.

Vaisala offers comprehensive customer care throughout the life cycle of our measurement instruments and systems, including calibration and adjustment. Our factory services are provided worldwide with fast deliveries. See vaisala.com/calibration.

To perform calibration and adjustment procedures yourself, follow the applicable procedure(s) as listed in Calibration and adjustment procedures (page 72). Note that there are some requirements to the conditions needed for calibration and adjustment; see Adjustment points and environments (page 71).

If calibration indicates that **humidity measurement accuracy** is not within specification:

- Probes with INTERCAP® humidity sensor (HMP60 and HMP63): replace the humidity measurement sensor. While it is possible to adjust the humidity measurement of these probes, they are really designed to be maintained by INTERCAP® sensor replacement as this is fast and requires no special equipment or environments.
- Probes with HUMICAP® humidity sensor (HMP110, HMP113, HMP115): perform the applicable adjustment procedure. If adjustment is not enough to restore the humidity measurement accuracy, continue to humidity sensor replacement. Note that adjustment after sensor replacement is also necessary.

If calibration indicates that **temperature measurement accuracy** is not within specification, they should be adjusted using the applicable procedure. The temperature measurement is very stable so adjustment is rarely needed. HMP60 and HMP110 series probes do not support temperature sensor replacement by users.

8.2 Adjustment points and environments

Measurement probes can be **calibrated** in any environment that is within their operating range. For example, output from the TMP115 probe can be checked and compared at any temperature in range -196 ... +150 °C (-320.8 ... +302 °F). However, probes should only be **adjusted** in conditions where they have good accuracy. Refer to the accuracy specification of the probe you intend to adjust. Probes will not accept the adjustment if the adjustment points are unsuitable.

Adjustment can be done in 1–5 points depending on the parameter, adjustment method, and accuracy requirements. Because stabilization of temperature and humidity takes time, you should expect the adjustment procedure to take at least 30 minutes for each adjustment point.

Adjustment of temperature measurement is typically not necessary.

1-point adjustment adjusts the measurement in a single measurement point only. Output from the entire measurement range is offset by the correction amount. 1-point adjustment is appropriate when accurate measurement is needed in a specific measurement point.

2-point adjustment adjust the measurement in 2 points. Vaisala humidity sensors are so linear that 2 points are enough to reach the specified accuracy over the entire humidity measurement range. 2-point RH and T adjustments have the following requirements:

- When adjusting RH, the first point requires a < 50 %RH humidity reference, and the second point must be > 50 %RH. The difference between the references must be at least 30 %RH.
- When adjusting T, the difference between the 2 references must be at least 30 °C (54 °F).

Multipoint adjustment adjusts the measurement in 3–5 points. This adjustment is available for RH measurement using the Insight software in Advanced mode. The difference between the references must be at least 2 %RH. Multipoint adjustment is only needed if standards or operating procedures explicitly require more than 2 adjustment points.

Vaisala recommends adjusting humidity in 2 points, 11 %RH and 75 %RH. These humidities can be produced using LiCl and NaCl salt chambers of the Vaisala HMK15 Humidity Calibrator. For more information, see HMK15 User Guide (M210185EN).

When working with equipment in extremely hot or cold temperatures, use appropriate personal protective equipment such as thermally insulated gloves and clothing. Wear protective eyewear if working with coolants such as liquid nitrogen, and observe safe handling and storage precautions.

8.3 Calibration and adjustment procedures

HMP60 and HMP110 series probes are used with many transmitters and data loggers. A simple way to check the measurement accuracy of the probes is to perform a field calibration using a reference instrument. This method does not require the probe to be disconnected, and a separate reference environment is not needed either. See Field calibration using a reference instrument (page 72).

Disconnected probes can be connected to a computer or a handheld device for calibration and adjustment. See the following sections for calibration and adjustment procedures:

- Adjustment using Insight PC software (page 73)
- Calibration and adjustment with Indigo80 handheld indicator (page 81)
- Calibration and adjustment using HM40 handheld meter (page 85)
- Adjustment using MI70 indicator (page 89)
- Adjustment using serial line (page 91)

For connection cable options, see Cables (page 27) and Spare parts and accessories (page 122).

8.3.1 Field calibration using a reference instrument

- Calibrated reference instrument that measures the parameter(s) being calibrated

When the probe is connected to a transmitter or a data logger that has a display, you can easily perform a field calibration of the probe using a second humidity and temperature measurement instrument that has a display.

1. Place the probe of the reference instrument (or the entire instrument) in the same environment as the probe that you are checking. The environment should be as stable as possible.
2. Wait for 30 minutes for humidity and temperature to stabilize. Verify that measurements are no longer changing at the end of the stabilization period.
3. Record the readings from both instruments.

8.3.2 Adjustment using Insight PC software

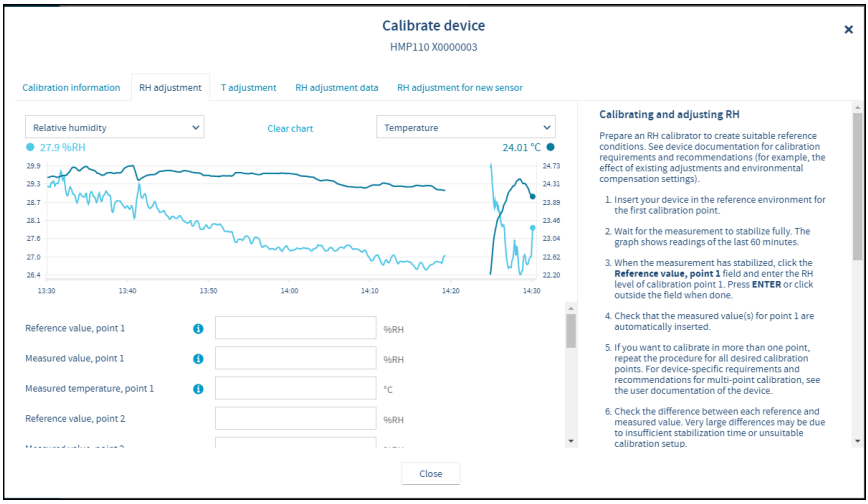


Figure 28 HMP110 RH calibration view example in Insight

You can adjust humidity and temperature measurement parameters by connecting the probe to the Vaisala Insight PC software. Relative humidity can be adjusted in 1–5 points, and temperature with a 1-point or 2-point adjustment.

Calibrating and adjusting measurements with the Insight PC software requires the following:

- M8-4F USB service cable (Vaisala item code 219690)
- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- Humidity or temperature references for the adjustment points (1–5 for RH, 1 or 2 for temperature). For an example of RH references for a 5-point adjustment using Vaisala Humidity Calibrator HMK15, see Table 14 (page 76).

2 adjustment points (close to the low and high ends of the used RH range) is enough to reach the specified accuracy over the whole range. However, if your standards or operating procedures explicitly require 3–5 adjustment points, you can perform a multipoint adjustment (3–5 points) with the Insight PC software. Note that RH adjustment in more than 2 points (3–5 points) requires using the Insight PC software in the **Advanced mode** user mode. The user mode selection is done in the Insight **Settings** menu.

If you have a list of previously collected calibration readings (for example, from a 3rd party laboratory calibration), you can adjust the device with the Insight PC software without having to generate the calibration conditions and wait for stabilization. For instructions, see Adjustment in Insight using previously measured values (page 78).

More information

- Connecting to Insight PC software (page 42)
- Adjustment points and environments (page 71)

8.3.2.1 1-point and 2-point T adjustment with Insight PC software

To adjust the temperature measurement with the Insight PC software you need:

- M8-4F USB service cable (Vaisala item code 219690)
- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- 1–2 temperature references.

1. Open the Insight software on your computer.
2. Connect the probe to the PC with USB cable 219690 and wait for Insight to detect the probe.
3. Select **> Calibrate > Yes** to open the calibration menu and switch the probe to calibration mode.

   In calibration mode, the probe will not use functions that may interfere with calibration and adjustment.
4. Open the **T adjustment** tab.
5. Remove the filter from the probe and insert the probe in the first reference environment.
6. Wait for the measurement to stabilize fully. The graph shows readings of the last 60 minutes.
7. When the measurement has stabilized, click the **Reference value, point 1** field and enter the temperature of the first adjustment reference. Press **Enter** or click outside the field when done.
8. Check that the measured value(s) for point 1 are automatically inserted.
9. If you want to make a 2-point adjustment, repeat steps step 5... step 8 for the second adjustment point.
10. Check the difference between each reference and measured value. Very large differences may be due to insufficient stabilization time or unsuitable calibration setup.

    If you want to save the adjustment into the device, select **Activate adjustment**.
    To exit without taking the adjustment in use, select **Close**.

11. After adjusting your device, update the information in the **Calibration information** tab.

8.3.2.2 1-point and 2-point RH adjustment with Insight PC software

To adjust the RH measurement of your probe with the Insight PC software you need:

- M8-4F USB service cable (Vaisala item code 219690)
- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- 1–2 humidity references.

1-point and 2-point RH adjustments are available in both the **Basic mode** and **Advanced mode** Insight user modes. Multipoint RH adjustments (3–5 adjustment points) are only available in **Advanced mode**. The user mode selection is done in the Insight **Settings** menu.

1. Open the Insight software on your computer.
2. Connect the probe to the PC with USB cable 219690 and wait for Insight to detect the probe.
3. Select **> Calibrate > Yes** to open the calibration menu and switch the probe to calibration mode.

   In calibration mode, the probe will not use functions that may interfere with calibration and adjustment.
4. Open the **RH adjustment** tab.
5. Remove the filter from the probe and insert the probe in the first reference environment.
6. Wait for the measurement to stabilize fully. The graph shows readings of the last 60 minutes.
7. When the measurement has stabilized, click the **Reference value, point 1** field and enter the RH level of the first adjustment reference. Press **Enter** or click outside the field when done.
8. Check that the measured value(s) for point 1 are automatically inserted.
9. If you want to make a 2-point adjustment, repeat steps step 5... step 8 for the second adjustment point.
10. Check the difference between each reference and measured value. Very large differences may be due to insufficient stabilization time or unsuitable calibration setup.

    If you want to save the adjustment into the device, select **Activate adjustment**.
    To exit without taking the adjustment in use, select **Close**.
11. After adjusting your device, update the information in the **Calibration information** tab.

8.3.2.3 Multipoint RH adjustment with Insight PC software

To perform a multipoint adjustment (3–5 adjustment points) to the RH measurement of your probe with the Insight PC software you need:

- M8-4F USB service cable (Vaisala item code 219690)
- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- 3–5 humidity references. For reference examples for a 5-point adjustment, see Table 14 (page 76).

For more information on using a humidity calibrator and salt chamber references, see HMK15 User Guide (M210185EN).

A 2-point adjustment (close to the low and high ends of the used RH range) is enough to reach the specified accuracy over the entire range. However, if your standards or operating procedures explicitly require 3–5 adjustment points, perform a multipoint adjustment (3–5 points) with the Insight PC software.

Table 14 Adjustment reference examples for 5-point adjustment

Salt chamber solution	RH at 25 °C
LiCl	11.3 %RH [1)]
MgCl	32.8 %RH [1)]
NaCl	75.3 %RH [1)]
KCl	84.3 %RH [1)]
K_2SO_4	97.3 %RH [1)]

1) *See Greenspan's calibration table in HMK15 User Guide (M210185EN) for salt reference humidity uncertainties in different temperatures.*

The following 5-point adjustment example procedure uses the Vaisala HMK15 Humidity Calibrator. LiCl salt (11.3 %RH) is used as the first reference point, and following 4 references are as shown in Table 14 (page 76).

1. Open the Insight software on your computer.

   Note that you must use Insight in the **Advanced mode** user mode to carry out a multipoint adjustment (3–5 adjustment points). The user mode selection is done in the Insight **Settings** menu.
2. Connect the probe to the PC with USB cable 219690 and wait for Insight to detect the probe.

3. Select ⚙ **> Calibrate > Yes** to open the calibration menu and switch the probe to calibration mode.

   In calibration mode, the probe will not use functions that may interfere with calibration and adjustment.
4. Open the **RH adjustment** tab.
5. Remove the filter from the probe and insert the probe in the LiCl salt chamber of the humidity calibrator (11.3 %RH).
6. Wait for the measurement to stabilize fully. The graph shows the readings of the last 60 minutes.
7. When the measurement has stabilized, click the **Reference value, point 1** field and enter the RH level of calibration point 1 (11.3 %RH). Press **Enter** or click outside the field when done.
8. Check that the measured value(s) for point 1 are automatically inserted.
9. Repeat steps step 5... step 8 for the remaining 2–4 reference humidities (see Table 14 (page 76)).
10. Check the difference between each reference and measured value. Very large differences may be due to insufficient stabilization time or unsuitable calibration setup.

    If you want to adjust the device, select **Activate adjustment**.
    To exit without taking the adjustment in use, select **Close**.
11. After adjusting your device, update the information in the **Calibration information** tab.

8.3.2.4 Adjustment in Insight using previously measured values

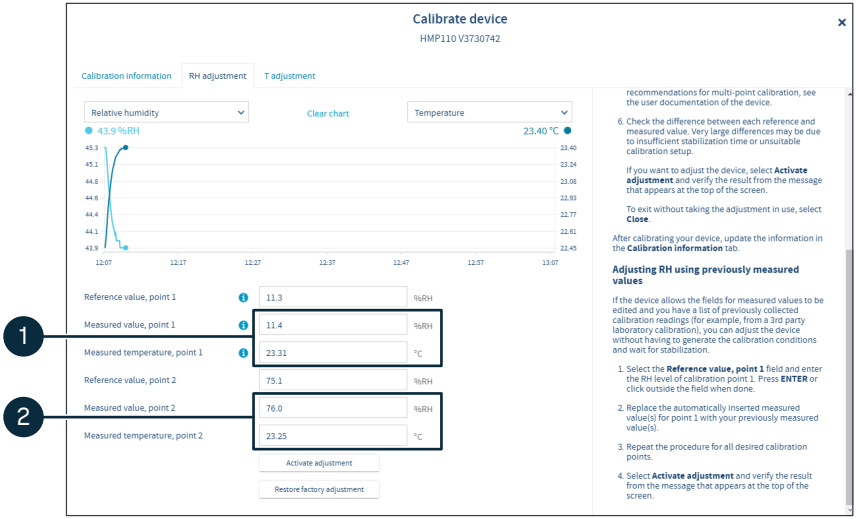


Figure 29 Example RH adjustment view when entering previously measured values

1 Measured RH and T values for point 1
2 Measured RH and T values for point 2

If you have a list of previously collected calibration readings (for example, from a 3rd party laboratory calibration), you can adjust the probe without having to generate the calibration conditions and wait for stabilization. Both RH and T can be adjusted using previously measured values.

If you adjust the probe using previously measured values, the device readings will be corrected and **your previous calibration certificate will not be valid anymore**. If an up-to-date calibration certificate is still needed, you must perform the calibration again to detect any remaining measurement error after the adjustment.

To adjust the measurement of the probe with the Insight PC software using previously measured values, you need:

- M8-4F USB service cable (Vaisala item code 219690)
- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- Previously collected measurement values that are entered in the adjustment.

The following example describes a 2-point RH adjustment in Insight using previously measured values:

1. Open the Insight software on your computer.
2. Connect the probe to the PC with USB cable 219690 and wait for Insight to detect the probe.
3. Select **> Calibrate > Yes** to open the calibration menu and switch the probe to calibration mode.

   In calibration mode, the probe will not use functions that may interfere with calibration and adjustment.
4. Open the **RH adjustment** tab.
5. When entering previously measured values, there is no need to insert the probe in a reference environment or wait for stabilization. Enter the RH level of your first reference in the **Reference value, point 1** field.
6. Replace the automatically inserted value in the **Measured value, point 1** field with the value that you have measured previously.

   In case of RH adjustment, also replace the automatically inserted temperature value in the **Measured temperature, point 1** field.
7. Repeat steps step 5 and step 6 for all desired calibration points.

   If you want to save the adjustment into the device, select **Activate adjustment**.
   To exit without taking the adjustment in use, select **Close**.
8. After adjusting your device, update the information in the **Calibration information** tab.

8.3.2.5 Adjusting RH for new HUMICAP sensor in Insight PC software

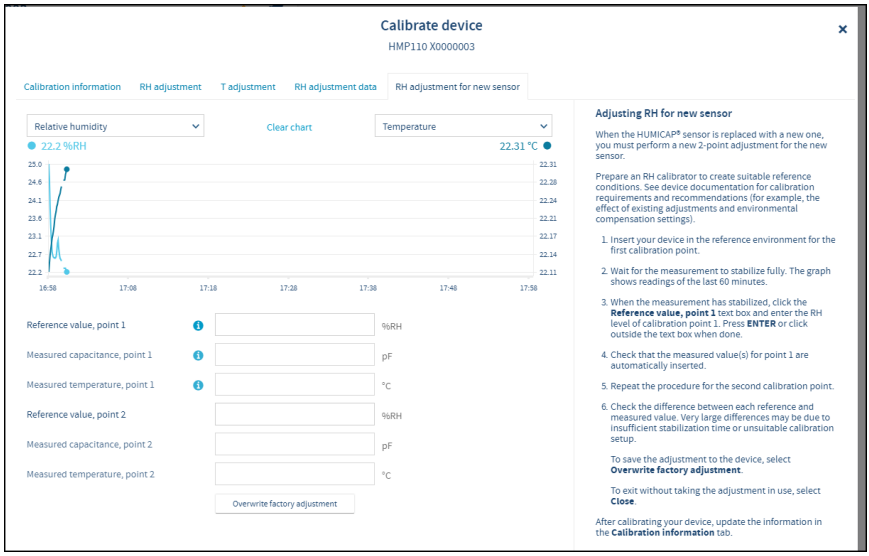


Figure 30 New sensor RH adjustment menu in Insight PC software

When the HUMICAP® sensor is replaced with a new one, you must perform a new 2-point adjustment for the new sensor. For the adjustment, you need:

- M8-4F USB service cable (Vaisala item code 219690)
- Computer with a Microsoft Windows® operating system (64-bit version) and Vaisala Insight PC software installed
- 2 humidity references.

1. Prepare an RH calibrator to create suitable reference conditions.
2. Open the Insight software on your computer.

   Note that you must use Insight in the **Advanced mode** user mode to perform an RH adjustment for a new HUMICAP sensor. The user mode selection is done in the **Settings** menu.
3. Connect the probe to the PC with USB cable 219690 and wait for Insight to detect the probe.
4. Remove the filter from the probe and insert the probe in the first humidity reference environment.

5. Select ⚙ **> Calibrate > Yes** to open the calibration menu and switch the probe to calibration mode.

   In calibration mode, the probe will not use functions that may interfere with calibration and adjustment.
6. Open the **RH adjustment for new sensor** tab.
7. Wait for the measurement to stabilize fully. The graph shows readings of the last 60 minutes.
8. When the measurement has stabilized, click the **Reference value, point 1** field and enter the RH level of the first reference point. Press **Enter** or click outside the field when done.
9. Check that the measured value(s) for point 1 are automatically inserted.
10. Place the probe in the second reference environment and repeat steps step 7 ... step 9 for the second reference.
11. To save the adjustment into the device, select **Overwrite factory adjustment**.
12. After adjusting your device, update the information in the **Calibration information** tab.

8.3.3 Calibration and adjustment with Indigo80 handheld indicator

The Indigo80 handheld indicator provides two ways to calibrate and adjust measurements for probes: **Guided calibration** and **Manual adjustment**.

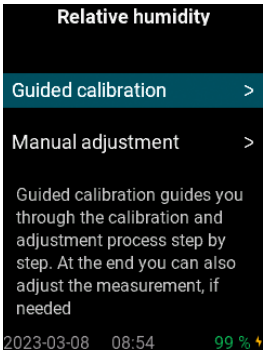


Figure 31 Indigo80 calibration methods for probes

- Choose **Guided calibration** when you have a reference environment or a calibrated reference instrument and want the indicator to guide you through the calibration process step by step. At the end you can also adjust the measurement, if needed.
- Choose **Manual adjustment** if you already have previously collected calibration readings (for example, from a calibration certificate) for 1 or 2 calibration points and want to adjust the probe to correct the observed errors. No separate reference instrument or reference environment is needed during the manual adjustment procedure. For all other use cases, **Guided calibration** is recommended.

8.3.3.1 Performing guided calibration with Indigo80 handheld indicator

- Probe connection cable (M8-M12, Vaisala item code 262195SP)
- Reference environment(s) or reference instruments for producing the desired reference values

In guided calibration, the indicator guides you through the calibration process step by step. At the end, you can also adjust the measurement, if needed.

You can choose to do either 1-point or 2-point calibration, and choose to use the reference environment or instrument of your choice, for example, another probe connected to your indicator.

For relative humidity, you can choose to use Vaisala HMK15 Humidity Calibrator. For more information on HMK15, see HMK15 User Guide (M210185EN).

Guided calibration using a reference environment, including stabilization time, typically takes 1 to 2 hours depending on the number of calibration points.

Before you start, familiarize yourself with information on adjustment points and requirements for your probe.

1. Connect the probe(s) to the indicator.
2. Open the indicator main menu by pressing ☰.
3. Select **Devices**. If you have more than one device connected to the indicator, make a further selection between the devices.
4. Select **Calibrate / Adjust**.
5. Acknowledge the notification by pressing **OK**.
6. Select the type of calibration or adjustment to perform, for example, **RH adjustment**.
7. Select **Guided calibration**.
8. In **Calibration points**, select the number of calibration points: **1 point** or **2 points**.
9. In **Reference**, select the desired reference environment(s) or reference instrument(s).

   Selection **Other reference** allows you to use any reference environment(s) of your choice. For 2-point calibration of relative humidity, you can select two salts from the list, one for each calibration point.
   When you have selected the reference environments for 2-point calibration, press ⟨ to get back to the previous view.
10. Select **Start calibration**.

    The indicator guides you through the calibration process from this point onwards. Press ⟩ to proceed from one view to another.

More information

- Connecting probes to Indigo80 (page 46)
- Adjustment points and environments (page 71)

8.3.3.2 Performing manual adjustment with Indigo80 handheld indicator using previously measured values

- Probe connection cable (M8-M12, Vaisala item code 262195SP)
- Previously collected calibration readings, for example, a calibration certificate

This procedure tells you how to use the Indigo80 handheld indicator to adjust the probe's measurement in 1–2 points when you have a list of previously collected calibration readings available (for example, in a calibration certificate from a 3rd party laboratory calibration). You can adjust the probe without having to generate the calibration conditions and wait for stabilization.

Both RH and T can be adjusted using previously measured values.

Before you start, familiarize yourself with information on adjustment points and requirements for your probe.

If you adjust the probe using previously measured values, the device readings will be corrected and **your previous calibration certificate will not be valid anymore**. If an up-to-date calibration certificate is still needed, you must perform the calibration again to detect any remaining measurement error after the adjustment.

1. Connect the probe(s) to the indicator.
2. Open the indicator main menu by pressing ☰.
3. Select **Devices**. If you have more than one device connected to the indicator, make a further selection between the devices.
4. Select **Calibrate / Adjust**.
5. Acknowledge the notification by pressing **OK**.
6. Select the type of calibration or adjustment to perform, for example, **RH adjustment**.
7. If you have **two probes** connected to the indicator:
   a. Select **Manual adjustment**.
   b. Scroll down and acknowledge the notification by pressing **OK**.
   c. The options **Read from device** and **Enter manually** will be visible at this point. Select **Enter manually**.

      Should you need to read the reference value from another device connected to Indigo80, Vaisala recommends accessing this functionality from the **Guided calibration** menu of Indigo80.
8. If you have **one probe** connected to the indicator:
   a. Select **Manual adjustment**.
   b. Scroll down and acknowledge the notification by pressing **OK**.

9. Select **Reference value, point 1**.
10. Use the arrow buttons to set the reference value (for example, the reference humidity from your calibration certificate), and then select **OK** or **Set**.
11. Scroll down and select the **Measured value, point 1** field. Replace the automatically inserted value with your previously measured calibration reading (for example, the observed humidity value from your calibration certificate).
12. Scroll down and select the **Measured temperature, point 1** field. Select the correct unit, then replace the automatically inserted temperature value with your previously measured value (for example, the observed temperature value from your calibration certificate).

    Scroll down and repeat for **Reference value, point 2**, **Measured value, point 2**, and **Measured temperature, point 2** (if performing a 2-point adjustment).
13. To store the adjustments to the probe, scroll down and select **Activate adjustment > OK**. Confirm by selecting **OK**.

    To exit without taking the adjustment in use, press ☰ to end calibration.
14. Update the calibration information in **Calibrate / Adjust > Calibration information**. Navigate to the **Calibration information** menu by pressing ←.
15. Press ☰ to end calibration.

More information

- Connecting probes to Indigo80 (page 46)
- Adjustment points and environments (page 71)
- Performing guided calibration with Indigo80 handheld indicator (page 82)

8.3.3.3 Restoring factory adjustment with Indigo80 handheld indicator

- Probe connection cable (M8-M12, Vaisala item code 262195SP)

If needed, you can restore the factory adjustment for your probe's output parameters using the Indigo80 handheld indicator.

1. Connect the probe(s) to the indicator.
2. Open the indicator main menu by pressing ☰.
3. Select **Devices**. If you have more than one device connected to the indicator, make a further selection between the devices.
4. Select **Calibrate / Adjust**.
5. Acknowledge the notification by pressing **OK**.
6. Select the type of adjustment to restore.

   For example, select **RH adjustment**.

7. If you have **two probes** connected to the indicator:
   a. Select **Manual adjustment**.
   b. Scroll down and acknowledge the notification by pressing **OK**.
   c. The options **Read from device** and **Enter manually** will be visible at this point. Select **Enter manually**.
8. If you have **one probe** connected to the indicator:
   a. Select **Manual adjustment**.
   b. Scroll down and acknowledge the notification by pressing **OK**.
9. Scroll down and select **Restore factory adjustment > OK**.
10. Confirm by selecting **OK**.
11. Press ☰ to end calibration.

More information

- Connecting probes to Indigo80 (page 46)

8.3.4 Calibration and adjustment using HM40 handheld meter

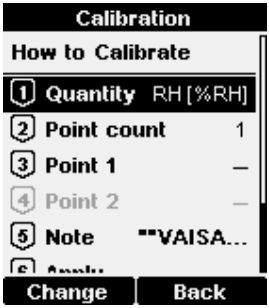
If the probe is in analog mode, it cannot be used with the HM40 handheld meter or MI70 indicator. Instead, use the Insight PC software to adjust the probe.

- Connection cable for HM40 Handheld Meter, for example, Vaisala item HMT120Z300
- Reference environments for the desired calibration and adjustment points

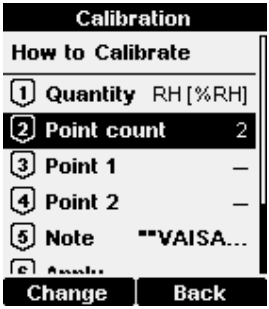
You can calibrate and adjust RH and T measurement probes in 1 or 2 points using the HM40 handheld meter.

1. Connect the probe to HM40 using the connection cable.
2. Turn on HM40 and check that measurements from the probe are displayed on the screen.
3. Select **Menu > Settings > Time & Date** and verify that the current time and date are set correctly on the HM40. Correct them if needed. The current date will be automatically set as the calibration date of the probe when adjustment is applied in step 12.
4. Select **Menu > Calibration**.

5. Select the parameter to be calibrated at menu item **[1] Quantity**.

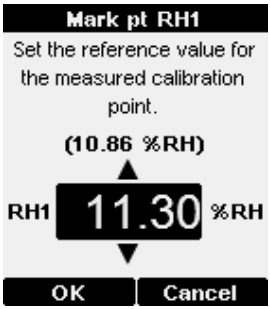


6. Select number of calibration points at menu item **[2] Point count**.

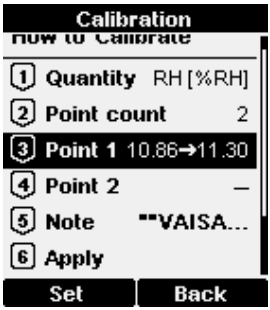


7. Place the probe in the first reference environment (first calibration point). Wait 20 – 40 minutes for the reading to stabilize.

8. Select **[3] Point 1 > Set**. The meter now shows the currently measured value of the selected parameter. Set the reference value using the arrow buttons and select **OK**.

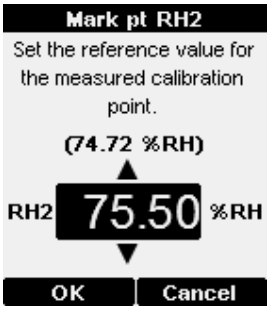


Correction to measurement at point 1 is now shown in the text for menu item **[3] Point 1**. If you are only doing a 1-point calibration, skip to step 11.

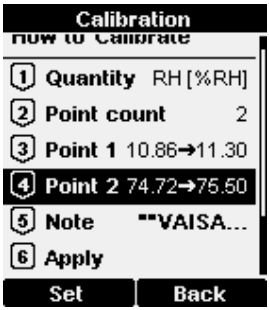


9. Place the probe in the second reference environment (second calibration point). Wait 20 – 40 minutes for the reading to stabilize.

10. Select **[4] Point 2 > Set** The meter now shows the currently measured value of the selected parameter. Set the reference value using the arrow buttons and select **OK**.

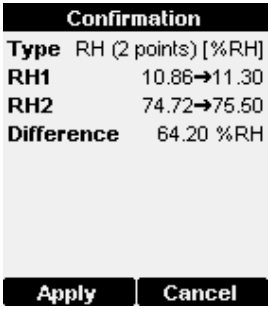


Correction to measurement at point 2 is now shown in the text for the menu item **[4] Point 2**.



11. Select **[5] Note** to edit the calibration info text that will be stored in the probe when the adjustment is applied in step 12. Edit the text using the select button and arrow keys. When done, select the **OK** character in the bottom right corner. To exit without changing the text, select **Cancel**.

12. Select **[6] Apply** to view the calibration result. Verify the corrections in the confirmation screen and select **Apply** to apply the adjustment to the probe, or **Cancel** to exit without applying the adjustment.



13. Disconnect the probe from the HM40.

8.3.5 Adjustment using MI70 indicator

If the probe is in analog mode, it cannot be used with the HM40 handheld meter or MI70 indicator. Instead, use the Insight PC software to adjust the probe.

For more information on the MI70 indicator and the HM70 meter, see HM70 User Guide (M211060EN).

8.3.5.1 1-point adjustment of RH measurement using MI70 indicator

To perform a 1-point adjustment to the RH measurement of the probe using the MI70 indicator, you need:

- Connection cable for MI70 indicator (Vaisala item code 219980)
- One humidity reference

The following procedure uses the HMK15 Humidity Calibrator. LiCl salt (11.3 %RH at 25 °C) is used as the reference point. The reference point should be chosen to match the measurement needs.

For more information on using a humidity calibrator and salt chamber references, see HMK15 User Guide (M210185EN).

If you want to perform a 2-point adjustment instead of a 1-point adjustment, use the Vaisala Insight PC software or the serial line.

1. Connect the probe to Port I of the MI70 indicator.
2. Turn on the MI70 indicator.
3. Start the adjustment sequence from **Main menu > Functions > Adjustments**.
4. MI70 notifies you that automatic power off is disabled during adjustment mode, press **OK** to acknowledge.
5. Select the **RH** parameter when prompted.
6. Now the adjustment mode is on, press **ADJUST** to select the adjustment method.
7. Select **1-point adjustment**, press **SELECT**. Press **OK** to continue.
8. Insert the probe in the LiCl salt chamber of the humidity calibrator (11 %RH).

   You can follow the stabilization from the **GRAPH** display. Press **READY** when the reading is stabilized.
9. Give the reference humidity value by using the arrow buttons. Press **OK**.
10. Confirm the adjustment, press **YES** (by pressing **NO** you return to adjustment mode display and no changes are made).
11. Adjustment has been carried out. Press **BACK** to exit the adjustment mode, and press **EXIT** to return to the basic display.

More information

- 2-point adjustment of RH measurement (page 92)

8.3.5.2 1-point adjustment of temperature measurement using MI70 indicator

To perform a 1-point adjustment to the temperature measurement of the probe using the MI70 indicator, you need:

- Connection cable for MI70 indicator (Vaisala item code 219980)
- One known and stable temperature reference

1. Connect the probe to Port I of the MI70 indicator.
2. Turn on the MI70 indicator.
3. Start the adjustment sequence from **Main menu > Functions > Adjustments**.
4. MI70 notifies you that automatic power off is disabled during adjustment mode, press **OK** to acknowledge.
5. Select the **T** parameter when prompted.
6. Now the adjustment mode is on, press **ADJUST** to select the adjustment method.
7. Select **1-point adjustment**, press **SELECT**.
8. Set the probe to a reference temperature. You can follow the stabilization from the **GRAPH** display. Press **READY** when the reading is stabilized in the reference.
9. Give the reference temperature value by using the arrow buttons. Press **OK**.
10. Confirm the adjustment, press **YES** (by pressing **NO** you return to adjustment mode display and no changes are made).
11. Calibration is carried out. Press **BACK** to exit the adjustment mode and **EXIT** to return to the basic display.

8.3.6 Adjustment using serial line

If you are adjusting a probe that is in the analog output mode, start the probe in RS-485 mode. For instructions, see Accessing serial line command interface from analog or Modbus mode (page 51).

8.3.6.1 1-point adjustment of RH measurement

To perform a 1-point adjustment to the RH measurement of the probe using serial line, you need:

- M8-4F USB service cable (Vaisala item code 219690)
- PC with a terminal application
- One humidity reference

The following example procedure uses the HMK15 Humidity Calibrator. LiCl salt (11.3 %RH at 25 °C) is used as the reference point. The reference point should be chosen to match the measurement needs.

For more information on using a humidity calibrator and salt chamber references, see HMK15 User Guide (M210185EN).

1. Connect the USB cable to the PC, but do not connect it to the probe yet.
2. Remove the filter from the probe and insert the probe in the LiCl salt chamber of the humidity calibrator (11.3 %RH).
3. Start a terminal application and set the correct connection settings. The default serial settings are **19200 8 N 1**. Remember to check which COM port the USB cable is using.
4. Wait for 20–40 minutes for the humidity to stabilize.
5. Start the terminal session and connect the USB cable to the probe. If your probe is in the analog output mode, press **Enter** a few times to start it in RS-485 mode.
6. Verify that the connection works by giving the **?** command.

   ```
   ?
   ```

   If the probe does not respond with device information:
   - Disconnect the USB cable from the probe and retry. If your probe is in the analog output mode, press **Enter** a few times immediately after connecting the USB cable.
   - Try the **??** command in case the probe is in POLL mode, open the line using **OPEN** command if necessary.
   - Check your serial line settings and cable connections.
7. Use the **ERRS** command to see that no errors are active.

   ```
   errs
   ```

8. Give the **CRH** command, with the **%RH** value of the reference as a parameter (in this case **11.3** for LiCl).

   ```
   crh 11.3
   OK
   ```

More information

- Clear adjustment of RH measurement (page 62)

8.3.6.2 2-point adjustment of RH measurement

To perform a 2-point adjustment to the RH measurement of the HMP110 or HMP113 using serial line you need:

- M8-4F USB service cable (Vaisala item code 219690)
- PC with a terminal application
- Two humidity references. The first point requires a < 50 %RH humidity reference, the second point must be > 50 %RH. There must also be at least 30 %RH difference between the references.

The following example procedure uses the HMK15 Humidity Calibrator. LiCl salt (11.3 %RH) at 25 °C is used as the first reference point, NaCl (75.3 %RH at 25 °C) as the second.

For more information on using a humidity calibrator and salt chamber references, see HMK15 User Guide (M210185EN).

1. Connect the USB cable to the PC, but do not connect it to the probe yet.
2. Remove the filter from the probe and insert the probe in the LiCl salt chamber of the humidity calibrator (11.3 %RH).
3. Start a terminal application and set the correct connection settings. The default serial settings are **19200 8 N 1**. Remember to check which COM port the USB cable is using.
4. Wait for 20–40 minutes for the humidity to stabilize.
5. Start the terminal session and connect the USB cable to the probe. If your probe is in the analog output mode, you need to press **Enter** a few times to start it in RS-485 mode.
6. Verify that the connection works by giving the **?** command.

   ```
   ?
   ```

   If the probe does not respond with device information:
   - Disconnect the USB cable from the probe and retry. If your probe is in the analog output mode, press **Enter** a few times immediately after connecting the USB cable.
   - Try the **??** command in case the probe is in POLL mode, open the line using the **OPEN** command if necessary.
   - Check your serial line settings and cable connections.
7. When your serial connection is working, use **ERRS** command to see that no errors are active.

   ```
   errs
   ```

8. Use the **SEND** command to verify the currently measured RH value.

   ```
   send
   T= 22.9 'C RH= 11.1 %RH Td= -8.0 'C
   ```

9. Give the **CRH** command to display the current RH measurement. Press **Enter** to refresh the RH measurement to check that the measurement has stabilized.

```
crh
RH: 11.39800112 Ref1 ?
RH: 11.38377201 Ref1 ?
RH: 11.37988329 Ref1 ?
```

10. When the shown RH measurement shown is stable, enter the value of the first measurement humidity reference (11.3 %RH) and press **Enter**.

```
RH: 11.37989400 Ref1 11.3
Press any key when ready
```

11. After entering the first reference point correction, press **Enter** to continue to the second reference point correction.
12. Insert the probe in the NaCl salt chamber (75.3 %RH) and wait for 20 ... 40 minutes for humidity and temperature to stabilize.
13. Press **Enter** to refresh the RH measurement to check that the measurement has stabilized.

```
RH: 74.87782214 Ref2 ?
RH: 74.89157890 Ref2 ?
RH: 74.91556023 Ref2 ?
```

14. When the shown RH measurement shown is stable, enter the value of the second humidity measurement reference (75.3 %RH) and press **Enter**.

```
RH: 75.12007531 Ref2 75.3
OK
>
```

15. Use the **SEND** command to verify that the measurement is OK.

If the entered adjustment is incorrect, you can remove the effects of RH calibration (returning the RH measurement of the probe to the factory calibrated state) with the **CRHCLR** command. For instructions, see Clear adjustment of RH measurement (page 62).

More information

- Clear adjustment of RH measurement (page 62)

8.3.6.3 1-point adjustment of T measurement

To perform a 1-point adjustment to the temperature measurement of the probe using serial line, you need:

- M8-4F USB service cable (Vaisala item code 219690)
- PC with a terminal application
- One known and stable temperature reference

1. Connect the USB cable to the PC, but do not connect it to the probe yet.
2. Remove the filter from the probe and insert the probe in the temperature reference.
3. Start a terminal application and set the correct connection settings. The default serial settings are **19200 8 N 1**. Remember to check which COM port the USB cable is using.
4. Wait for 20–40 minutes for the temperature to stabilize.
5. Start the terminal session and connect the USB cable to the probe. If your probe is in the analog output mode, you need to press **Enter** a few times to start it in RS-485 mode.
6. Verify that the connection works by giving the **?** command.

   ```
   ?
   ```

   If the probe does not respond with device information:
   - Disconnect the USB cable from the probe and retry. If your probe is in the analog output mode, press **Enter** a few times immediately after connecting the USB cable.
   - Try the **??** command in case the probe is in POLL mode, open the line using **OPEN** command if necessary.
   - Check your serial line settings and cable connections.
7. When your serial connection is working, use the **ERRS** command to see that no errors are active.

   ```
   errs
   ```

8. Give the **CT** command, with the temperature value of the reference as a parameter.

   ```
   ct 23.5
   OK
   ```

9. Use the **SEND** command to verify that the measurement is OK.

If the entered adjustment is incorrect, you can remove the effects of T calibration (returning the T measurement of the probe to the factory calibrated state) with the **CTCLR** command. For instructions, see Clear adjustment of T measurement (page 63).

More information

- Clear adjustment of T measurement (page 63)

9. Maintenance

9.1 Cleaning

The probes can be lightly cleaned when necessary.

Wipe the probe body clean with a soft, lint-free cloth moistened with mild detergent. For TMP115 probes, wipe the probe cable and sensor tip as well.

Note that wiping the membrane filter or stainless steel sintered filter may block its pores and/or deposit residue on the filter. If the filter is heavily contaminated, replace it.

Do not use solvents or compressed air. Do not spray anything directly on the probe.

9.2 Replacing filter

The filter on the probe should be replaced when it is damaged or dirty.

1. Turn the filter counter-clockwise to loosen it.
2. Remove the filter from the probe. Be careful not to touch the sensors with the filter. Without the filter in place, the sensors are easily damaged – handle the probe carefully.
3. Install a new filter on the probe, and tighten it so it is finger-tight. Make sure the filter sits straight and meets the threads properly.

Order new filters from Vaisala.

More information

- Filter options (page 18)
- Spare parts and accessories (page 122)
- Maintenance and calibration services (page 135)

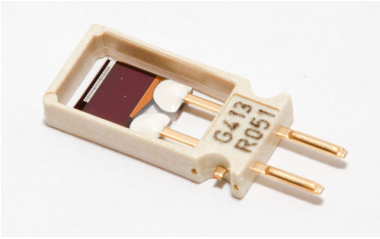
9.3 Changing the HUMICAP 180R/180V sensor

This procedure applies to HMP110, HMP113, and HMP115 probes only. Replacing the humidity sensor of these probes is necessary in normal operation. If the accuracy of the probe does not seem to be within specification, it is likely that the accuracy can be restored by performing the adjustment procedure.

Follow this procedure to replace the humidity sensor in case it has been damaged, or normal adjustment is not sufficient to restore the measurement accuracy. Calibration and adjustment of the humidity measurement is required after the sensor change.

To perform this procedure, you need a new HUMICAP® 180R/180V sensor. It is also recommended that you replace the filter with a new one.

1. Remove the filter from the probe by turning it counter-clockwise.
2. There are 2 sensors under the filter, the HUMICAP® sensor and a temperature sensor. Identify the HUMICAP® sensor. Do not touch the temperature sensor.



3. Pull out the old HUMICAP® sensor and insert a new one. Handle the new sensor by the plastic frame.

CAUTION! Do not touch the sensor plate.

4. Perform a 2-point adjustment of the RH measurement using the Insight PC software, the **RH adjustment for new sensor** function. This **RH adjustment for new sensor** must be done every time after the sensor has been replaced.
5. Attach a new filter on the probe.

More information

- Adjusting RH for new HUMICAP sensor in Insight PC software (page 80)

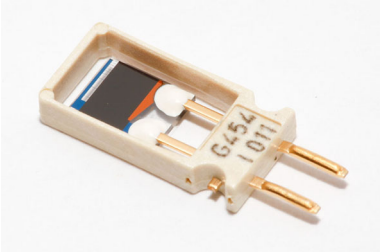
9.4 Changing the INTERCAP sensor

This procedure applies to HMP60 and HMP63 probes only. Follow this procedure to replace the INTERCAP® humidity sensor of the HMP60 and HMP63 probe when calibration indicates the humidity measurement is not in specification. No adjustment after the sensor change is needed.

To perform this procedure, you need a new INTERCAP® sensor. It is also recommended that you replace the filter with a new one.

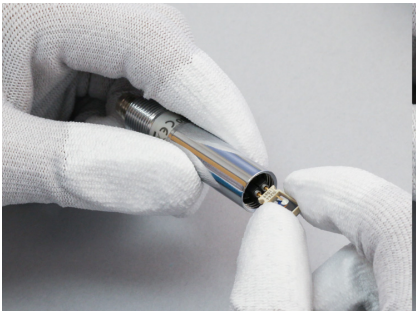
1. Remove the filter from the probe by turning it counter-clockwise.

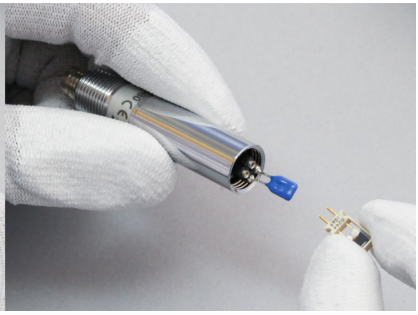
2. There are 2 sensors under the filter, the INTERCAP® sensor and a temperature sensor. Identify the INTERCAP® sensor. Do not touch the temperature sensor.



3. Pull out the old INTERCAP® sensor and insert a new one. Handle the new sensor by the plastic frame.

> **CAUTION!** Do not touch the sensor plate.





4. Attach a new filter on the probe.

10. Troubleshooting

10.1 Analog output error notification

If the device is unable to measure due to an error, the analog output is set to an error level. The default error level is 0 V, or another value predefined by the customer when ordering the device.

You can change the analog output error level using the **AERR** command.

More information

- Set analog output error indication level (page 65)

10.2 Solving typical problems

You can check the error message via the serial interface by using the **ERRS** command. If you are unable to remove the errors, contact Vaisala. For contact information, see Technical support (page 135).

Table 15 Troubleshooting table

Problem or message	Likely causes and solutions
Measurement not working. There is an active error that indicates a problem with measurement.	Sensor(s) damaged or missing. Open the filter and check.
	Check the supply voltage of the probe.
	Check the output mode of the probe using serial line.
Humidity measurement appears to be wrong.	Check for condensation on the probe and sensor.
	Calibrate and adjust the probe (probes with HUMICAP® humidity sensor).
	Calibrate the probe and change the sensor if necessary (probes with INTERCAP® humidity sensor).

Problem or message	Likely causes and solutions
The probe is not responding to any serial commands.	Disconnect the USB cable from the probe and retry. If your probe is in the analog output mode, press **Enter** a few times immediately after connecting the USB cable.
	Try the **??** command in case the probe is in POLL mode, open the line using **OPEN** command if necessary.
	Check your serial line settings and cable connections.
One or more errors are active.	See Error messages in Insight PC software and Indigo80 handheld indicator (page 101).

More information

- Technical support (page 135)

10.3 Error messages in Insight PC software and Indigo80 handheld indicator

Table 16 Error messages in Insight PC software and Indigo80 handheld indicator

Error	Likely cause	Suggested solution
Temperature measurement error. [44]	Temperature sensor is short circuited, damaged, or missing.	Check that the legs of the temperature sensor are not short circuited. Contact Vaisala if the temperature sensor is damaged.
Humidity measurement error. [45]	Humidity sensor is wet.	Wait for the humidity sensor to dry, or remove the filter and gently dry the sensors and the filter with clean instrument air.
Humidity sensor failure. [46]	Humidity sensor is damaged or missing.	Replace the humidity sensor or contact Vaisala.
Ambient temperature out of range. [48]	Ambient temperature is too high.	Lower the temperature at the installation site.
Supply voltage out of range. [55]	Supply voltage is too low.	Check and correct the power supply and wiring.

Error	Likely cause	Suggested solution
Capacitance reference error. [47]	Internal device failure.	Power-cycle the device, and if necessary, restore the factory settings. If the error remains, contact Vaisala.
Firmware checksum mismatch. [49]		
Device settings corrupted. [50]		
Additional configuration settings corrupted. [51]		
Sensor coefficients corrupted. [52]		
Main configuration settings corrupted. [53]		
Non-volatile memory read/write failure. [57]		
Calibration certificate checksum mismatch. [58]		
Calibration is about to expire. [352]	This message is displayed by the calibration reminder functionality.	Calibrate the probe and update the calibration date information.
Calibration has expired. [353]	This warning is displayed by the calibration reminder functionality if the calibration interval has been exceeded.	Calibrate the probe and update the calibration date information.

In case of constant error, contact Vaisala.

More information

- Technical support (page 135)

10.4 Error codes in MI70 handheld indicator

If several errors are active at the same time, the MI70 shows the sum of currently active error codes. The hexadecimal prefix "0x" might not be displayed in MI70.

Refer to Error messages in Insight PC software and Indigo80 handheld indicator (page 101) for more information about the error states.

Table 17 Error codes in MI70

Transmitter error code in MI70	Corresponding error
0x1	Temperature measurement error. [44]
0x2	Humidity measurement error. [45]
0x4	Humidity sensor failure. [46]
0x8	Capacitance reference error. [47]
0x10	Ambient temperature out of range. [48]
0x20	Firmware checksum mismatch. [49]
0x40	Device settings corrupted. [50]
0x80	Additional configuration settings corrupted. [51]
0x100	Sensor coefficients corrupted. [52]
0x200	Main configuration settings corrupted. [53]
0x800	Supply voltage out of range. [55]
0x2000	Non-volatile memory read/write failure. [57]
0x4000	Calibration certificate checksum mismatch. [58]

10.5 Unknown serial settings

If you do not know the current serial settings of your probe, follow this procedure to access the serial line: Accessing serial line command interface from analog or Modbus mode (page 51).

Alternatively, you can connect the probe to the Insight PC software to verify the current settings.

More information

- Vaisala Insight PC software (page 40)

11. Technical data

11.1 HMP60 specifications

Table 18 HMP60 measurement performance

Property	Description/Value
Relative humidity	
Measurement range	0–100 %RH
Typical accuracy:	
at 0 ... +40 °C (+32 ... +140 °F)	±3 %RH (0–90 %RH) ±5 %RH (90–100 %RH)
at −40 ... 0 °C and +40 ... +60 °C (−40 ... +32 °F and +104 ... +140 °F)	±5 %RH (0–90 %RH) ±7 %RH (90–100 %RH)
Humidity sensor	Vaisala INTERCAP®
Temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Accuracy:	
at +10 ... +30 °C (+50 ... +86 °F) at −40 ... +10 and +30 ... +60 °C (−40 ... +50 and +86 ... +140 °F)	±0.5 °C (±0.9 °F) ±0.6 °C (±1.08 °F)
Dew/frost point temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Typical accuracy:	
at +32 ... +40 °C (0 ... +140 °F) when dew point depression [1] < +15 °C (< +59 °F)	±2 °C (±3.6 °F)
at −40 ... 0 °C and +40 ... +60 °C (−40 ... +32 °F and +104 ... +140 °F) when dew point depression < +10 °C (< +50 °F)	±3 °C (±5.4 °F)
Analog outputs	
Accuracy at +20 °C (+68 °F)	±0.2 % of FS
Temperature dependence	±0.01 % of FS/°C (±0.006 % of FS/°F)

1) Dew point depression = ambient temperature − dew point.

Table 19 HMP60 calculated parameters

Property	Description/Value
Measurement ranges	
Dew/frost point temperature	−40 ... +60 °C (−40 ... +140 °F)
Wet bulb temperature	−40 ... +60 °C (−40 ... +140 °F)
Absolute humidity	0–130 g/m^3 (0–57 gr/ft^3)
Mixing ratio	0–153 g/kg (0–1069 gr/lb)
Enthalpy	−40 ... 459 kJ/kg (−9.6 ... 207 BTU/lb)

Table 20 HMP60 operating environment

Property	Description/Value
Operating temperature	−40 ... +60 °C (−40 ... +140 °F)
IP rating [1)]	IP65: Dust-tight. Protected from water jets from any direction.

1) Not applicable with the plastic grid filter.

Table 21 HMP60 compliance

Property	Description/Value
EU directives and regulations	EMC Directive (2014/30/EU) RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, industrial environment
EMC emissions	CISPR 32 / EN 55032, Class B
Compliance marks	CE, RCM, UKCA

Table 22 HMP60 inputs and outputs

Property	Description/Value
Power consumption	1 mA average, max. peak 5 mA
Operating voltage [1)]	
With 1 V / 2.5 V output	5–28 V DC
With 5 V output	8–28 V DC
With loop power converter	8–28 V DC
With digital output	5–28 V DC

Property	Description/Value
Start-up time	
Probes with analog output	4 s at operating voltage 13.5–16.5 V DC 2 s at other valid operating voltages
Probes with digital output	1 s
Outputs	
2 channels	0–1 V DC / 0–2.5 V DC / 0–5 V DC / 1–5 V DC
1-channel loop-power converter (separate module, compatible with humidity accuracy only)	4–20 mA
Digital output (optional)	RS-485 2-wire half duplex, supports Modbus RTU
External loads	
0–1 V	R_L min. 10 kΩ
Other voltage outputs	R_L min. 50 kΩ
Output parameters	
Relative humidity, temperature, dew/frost point temperature, wet bulb temperature, absolute humidity, mixing ratio, enthalpy	

1) Use lowest available operating voltage to minimize heating.

Table 23 HMP60 mechanical specifications

Property	Description/Value
Body thread	MI2×1 / 10 mm (0.4 in)
Cable connector	4-pin M8 (IEC 60947-5-2)
Materials	
Body	Stainless steel (AISI 316)
Grid filter	Chrome coated ABS plastic
Cable	Polyurethane or FEP
Weight	
Probe	17 g (0.6 oz)
Probe with 0.3 m (1 ft) cable	28 g (1 oz)

11.2 HMP63 specifications

Table 24 HMP63 measurement performance

Property	Description/Value
Relative humidity	
Measurement range	0–100 %RH
Typical accuracy:	
at 0 ... +40 °C (+32 ... +140 °F)	±3 %RH (0–90 %RH) ±5 %RH (90–100 %RH)
at −40 ... 0 °C and +40 ... +60 °C (−40 ... +32 °F and +104 ... +140 °F)	±5 %RH (0–90 %RH) ±7 %RH (90–100 %RH)
Humidity sensor	Vaisala INTERCAP®
Temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Accuracy:	
at +10 ... +30 °C (+50 ... +86 °F) at −40 ... +10 and +30 ... +60 °C (−40 ... +50 and +86 ... +140 °F)	±0.5 °C (±0.9 °F) ±0.6 °C (±1.08 °F)
Dew/frost point temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Typical accuracy:	
at 0 ... +40 °C (+32 ... +140 °F) when dew point depression[1] < 15 °C	±2 °C (±3.6 °F)
at −40 ... 0 °C and +40 ... +60 °C (−40 ... +32 °F and +104 ... +140 °F) when dew point depression < 10 °C [1)]	±3 °C (±5.4 °F)
Analog outputs	
Accuracy at 20 °C (+68 °F)	±0.2 % of FS
Temperature dependence	±0.01 % of FS/°C (±0.006 % of FS/°F)

1) *Dew point depression = ambient temperature − dew point*

Table 25 HMP63 calculated output parameters

Measurement ranges	

Dew/frost point temperature	–40 ... +60 °C (–40 ... +140 °F)
Wet bulb temperature	–40 ... +60°C (–40 ... +140°F)
Absolute humidity	0–130 g/m^3 (0–57 gr/ft^3)
Mixing ratio	0–153 g/kg (0–1069 gr/lb)
Enthalpy	–40 ... 459 kJ/kg (–9.6 ... 207 BTU/lb)

Table 26 HMP63 operating environment

Property	Description/Value
Operating temperature	–40 ... +60 °C (–40 ... +140 °F)
IP rating [1)]	IP54: Limited protection against dust. Protected from water splashes from any direction.

1) Not applicable with the plastic grid filter.

Table 27 HMP63 compliance

Property	Value/Description
EU directives and regulations	EMC Directive (2014/30/EU) RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, basic electromagnetic environment
EMC emissions	CISPR 32 / EN 55032, Class B
Compliance marks	CE, RCM, UKCA

Table 28 HMP63 inputs and outputs

Property	Description/Value
Power consumption	1 mA average, max. peak 5 mA
Operating voltage[1)]	
With 1 V / 2.5 V output	5–28 V DC
With 5 V output	8–28 V DC
With loop-power converter	8–28 V DC
With digital output	5–28 V DC
Start-up time	

Property	Description/Value
Probes with analog output	4 s at operating voltage 13.5–16.5 V DC 2 s at other valid operating voltages
Probes with digital output	1 s
Outputs	
2 channels	0–1 V DC / 0–2.5 V DC / 0–5 V DC / 1–5 V DC
1-channel loop-power converter (separate module, compatible with humidity accuracy only)	4–20 mA
Digital output (optional)	RS-485 2-wire half duplex, supports Modbus RTU
External loads	
0–1 V	R_L min. 10 kΩ
Other voltage outputs	R_L min. 50 kΩ
Output parameters	
Relative humidity, temperature, dew/frost point temperature, wet bulb temperature, absolute humidity, mixing ratio, enthalpy	

1) Use lowest available operating voltage to minimize heating.

Table 29 HMP63 mechanical specifications

Property	Description/Value
Cable connector	4-pin M8 (IEC 60947-5-2)
Materials	
Body	PC/ABS blend
Grid filter	PC (glass reinforced)
Cable	Polyurethane or FEP
Weight	
Probe	9 g (0.3 oz)
Probe with 0.3 m (1 ft) cable	20 g (0.7 oz)

11.3 HMP110 specifications

Table 30 HMP110 measurement performance

Property	Description/Value
Relative humidity	
Measurement range	0–100 %RH
Accuracy: [1) 2)]	
at 0 ... +40 °C (+32 ... +104 °F)	±1.5 %RH (0–90 %RH) ±2.5 %RH (90–100 %RH)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +80 °C (+104 ... +176 °F)	±3.0 %RH (0–90 %RH) ±4.0 %RH (90–100 %RH)
Factory calibration uncertainty at +20 °C (+68 °F)	±1.1 %RH (0–90 %RH) ±1.8 %RH (90–100 %RH)
Humidity sensor types	HUMICAP® 180R HUMICAP® 180V
Stability	±2 %RH over 2 years
T_{90} response time	With plastic grid filter: approx. 17 s With membrane filter: approx. 20s With stainless steel sintered filter: approx. 60 s
Temperature	
Measurement range	−40 ... +80 °C (−40 ... +176 °F)
Accuracy (probes with analog output):	
at 0 ... +40 °C (+32 ... +104 °F)	±0.2 °C (±0.36 °F)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +80 °C (+104 ... +176 °F)	±0.4 °C (±0.72 °F)
Accuracy (probes with digital output):	
at +15 ... +25 °C (+59 ... +77 °F)	±0.1 °C (±0.18 °F)
at 0 ... +15 °C (+ 32 ... +59 °F) and +25 ... +40 °C (+77 ... +104 °F)	±0.15 °C (±0.27 °F)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +80 °C (+104 ... +176 °F)	±0.4 °C (±0.72 °F)
Temperature sensor	Pt1000 RTD Class F0.1 IEC 60751
Dew/frost point temperature	
Measurement range	−40 ... +80 °C (−40 ... +176 °F)

Property	Description/Value
Accuracy (at 20 °C (68 °F) and 80 %RH [1]):	
at 0 ... +40 °C (+32 ... +104 °F) when dew point depression < +15 °C (+59 °F) [3] when dew point depression +15 ... +25 °C (+59 ... +77 °F)	 ±1 °C (±1.8 °F) ±2 °C (±3.6 °F)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +80 °C (+104 ... +176 °F), when dew point depression < +15 °C (+59 °F)	±2 °C (±3.6 °F)
Analog outputs	
Accuracy at +20 °C (+68 °F)	±0.2 % of FS
Temperature dependence	±0.01 % of FS/°C (±0.006 % of FS/°F)

1) *Including non-linearity, hysteresis, and repeatability.*
2) *With HUMICAP® 180V sensor, accuracy is not specified below −20 °C (−4 °F) operating temperature.*
3) *Dew point depression = ambient temperature − dew point.*

Table 31 HMP110 calculated parameters

Property	Description/Value
Measurement ranges	
Dew/frost point temperature	−40 ... +80 °C (−40 ... +176 °F)
Wet bulb temperature	−40 ... +80°C (−40 ... +176 °F)
Absolute humidity	0–291 g/m^3 (0–127 gr/ft^3)
Mixing ratio	0–548 g/kg (0–3836 gr/lb)
Enthalpy	−40 ... 1530 kJ/kg (−9.6 ... 674 BTU/lb)

Table 32 HMP110 operating environment

Property	Description/Value
Operating temperature	−40 ... +80 °C (−40 ... +176 °F)
IP rating [1]	IP65: Dust-tight. Protected from water jets from any direction.

1) *Not applicable with the plastic grid filter.*

Table 33 HMP110 compliance

Property	Description/Value
EU directives and regulations	EMC Directive (2014/30/EU) RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, industrial environment
EMC emissions	CISPR 32 / EN 55032, Class B
Compliance marks	CE, RCM, UKCA

Table 34 HMP110 inputs and outputs

Property	Description/Value
Power consumption	1 mA average, max. peak 5 mA
Operating voltage [1)]	
With 1 V / 2.5 V output	5–28 V DC
With 5 V output	8–28 V DC
With loop power converter	8–28 V DC
With digital output	5–28 V DC
Start-up time	
HMP110 probes with analog output	4 s at operating voltage 13.5–16.5 V DC 2 s at other valid operating voltages
HMP110 probes with digital output	1 s
Outputs	
2 channels	0–1 V DC / 0–2.5 V DC / 0–5 V DC / 1–5 V DC
1-channel loop-power converter (separate module, compatible with humidity accuracy only)	4–20 mA
Digital output (HMP110 probes with digital output)	RS-485 2-wire half duplex, supports Modbus RTU
External loads	
0–1 V	R_L min. 10 kΩ
Other voltage outputs	R_L min. 50 kΩ
Output parameters	

Property	Description/Value
Relative humidity, temperature, dew/frost point temperature, wet bulb temperature, absolute humidity, mixing ratio, enthalpy	

1) Use lowest available operating voltage to minimize heating.

Table 35 HMP110 mechanical specifications

Property	Description/Value
Body thread	MI2×1 / 10 mm (0.4 in)
Cable connector	M8 4-pin female (IEC 60947-5-2)
Materials	
Body	Stainless steel (AISI 316)
Grid filter	Chrome coated ABS plastic
Cable	Polyurethane or FEP
Weight	
Probe	17 g (0.6 oz)
Probe with 0.3 m (1 ft) cable	28 g (1 oz)

11.4 HMP113 specifications

Table 36 HMP113 measurement performance

Property	Description/Value
Relative humidity	
Measurement range	0–100 %RH
Accuracy (incl. non-linearity, hysteresis, and repeatability):	
at 0 ... +40 °C (+32 ... +104 °F)	±1.5 %RH (0–90 %RH) ±2.5 %RH (90–100 %RH)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +60 °C (+104 ... +140 °F)	±3.0 %RH (0–90 %RH) ±4.0 %RH (90–100 %RH)
Factory calibration uncertainty at +20 °C (+68 °F):	±1.1 %RH (0–90 %RH) ±1.8 %RH (90–100 %RH)
Humidity sensor	HUMICAP® 180R
Stability	±2 %RH over 2 years

Property	Description/Value
Temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Accuracy (probes with analog output):	
at 0 ... +40 °C (+32 ... +104 °F)	±0.2 °C (±0.36 °F)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +60 °C (+104 ... +140 °F)	±0.4 °C (±0.72 °F)
Accuracy (probes with digital output):	
at +15 ... +25 °C (+59 ... +77 °F)	±0.1 °C (±0.18 °F)
at 0 ... +15 °C (+ 32 ... +59 °F) and +25 ... +40 °C (+77 ... +104 °F)	±0.15 °C (±0.27 °F)
Temperature sensor	Pt1000 RTD Class F0.1 IEC 60751
Dew/frost point temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Accuracy (incl. non-linearity, hysteresis, and repeatability):	
at 0 ... +40 °C (+32 ... +104 °F) when dew point depression < +15 °C (+59 °F) [1)] when dew point depression +15 ... +25 °C (+59 ... +77 °F)	 ±1 °C (±1.8 °F) ±2 °C (±3.6 °F)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +60 °C (+104 ... +140 °F), when dew point depression < +15 °C (+59 °F)	±2 °C (±3.6 °F)
Analog outputs	
Accuracy at +20 °C (+68 °F)	±0.2 % of FS
Temperature dependence	±0.01 % of FS/°C (±0.006 % of FS/°F)

1) Dew point depression = ambient temperature − dew point

Table 37 HMP113 calculated parameters

Property	Description/Value
Measurement ranges	
Dew/frost point temperature	−40 ... +60 °C (−40 ... +140 °F)
Wet bulb temperature	−40 ... +60 °C (−40 ... +140 °F)
Absolute humidity	0–130 g/m^3 (0–57 gr/ft^3)
Mixing ratio	0–153 g/kg (0–1069 gr/lb)

Property	Description/Value
Enthalpy	–40 … 459 kJ/kg (–9.6 … 207 BTU/lb)

Table 38 HMP113 operating environment

Property	Description/Value
Operating temperature	–40 … +60 °C (–40 … +140 °F)
IP rating [1)]	IP54: Limited protection against dust. Protected from water splashes from any direction.

Table 39 HMP113 compliance

Property	Description/Value
EU directives and regulations	EMC Directive (2014/30/EU) RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, basic electromagnetic environment
EMC emissions	CISPR 32 / EN 55032, Class B
Compliance marks	CE, RCM, UKCA

Table 40 HMP113 inputs and outputs

Property	Description/Value
Power consumption	1 mA average, max. peak 5 mA
Operating voltage [1)]	
With 1 V / 2.5 V output	5–28 V DC
With 5 V output	8–28 V DC
With loop power converter	8–28 V DC
With digital output	5–28 V DC
Start-up time	
Probes with analog output	4 s at operating voltage 13.5–16.5 V DC 2 s at other valid operating voltages
Probes with digital output	1 s
Outputs	
2 channels	0–1 V DC / 0–2.5 V DC / 0–5 V DC / 1–5 V DC

Property	Description/Value
1-channel loop-power converter (separate module, compatible with humidity accuracy only)	4–20 mA
Digital output (optional)	RS-485 2-wire half duplex, supports Modbus RTU
External loads	
0–1 V	R_L min 10 kΩ
Other voltage outputs	R_L min 50 kΩ
Output parameters	
Relative humidity, temperature, dew/frost point temperature, wet bulb temperature, absolute humidity, mixing ratio, enthalpy	

1) Use lowest available operating voltage to minimize heating.

Table 41 HMP113 mechanical specifications

Property	Description/Value
Cable connector	4-pin M8 (IEC 60947-5-2)
Materials	
Body	PC/ABS blend
Grid filter	PC (glass reinforced)
Cable	Polyurethane or FEP
Weight	
Probe	9 g (0.3 oz)
Probe with 0.3 m (1 ft) cable	20 (0.7 oz)

11.5 HMP115 specifications

Table 42 HMP115 measurement performance

Property	Description/Value
Relative humidity	
Measurement range	0–100 %RH
Accuracy [1)]	

Property	Description/Value
at 0 ... +40 °C (+32 ... +104 °F)	±1.5 %RH (0–90 %RH) ±2.5 %RH (90–100 %RH)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +60 °C (+104 ... +140 °F)	±3.0 %RH (0–90 %RH) ±4.0 %RH (90–100 %RH)
Typical factory calibration uncertainty	±0.8 %RH
Humidity sensor	HUMICAP® 180R
Stability	±2 %RH over 2 years
Temperature	
Measurement range	−40 ... +60 °C (−40 ... +140 °F)
Accuracy	
at +15 ... +25 °C (+59 ... +77 °F)	±0.1 °C (±0.18 °F)
at 0 ... +40 °C (+32 ... +104 °F)	±0.2 °C (±0.36 °F)
at −40 ... 0 °C (−40 ... +32 °F) and +40 ... +60 °C (+104 ... +140 °F)	±0.4 °C (±0.72 °F)
Typical factory calibration uncertainty	±0.12 °C (±0.22 °F)
Temperature sensor	Pt1000 RTD Class F0.1 IEC 60751

1) *Including non-linearity, hysteresis, and repeatability.*

Table 43 HMP115 operating environment

Property	Description/Value
Operating temperature	−40 ... +60 °C (−40 ... +140 °F)
Operating humidity	0–100 %RH, non-condensing
IP rating [1)]	IP54: Limited protection against dust. Protected from water splashes from any direction.

1) *Not applicable with the plastic grid filter.*

Table 44 HMP115 compliance

Property	Description/Value
EU directives and regulations	RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, industrial environment
Compliance marks	CE, RCM

Table 45 HMP115 inputs and outputs

Property	Description/Value
Power consumption	1 mA average, max. peak 5 mA
Operating voltage	5–28 V DC
Start-up time	1 s
Digital output	RS-485 2-wire half duplex, supports Modbus RTU

Table 46 HMP115 mechanical specifications

Property	Description/Value
Cable connector	4-pin M8 (IEC 60947-5-2)
Weight	9 g (0.3 oz)
Materials	
Body	PC/ABS blend
Grid filter	PC (glass reinforced)

11.6 TMP115 specifications

Table 47 TMP115 measurement performance

Property	Description/Value
Temperature	
Measurement range	–196 … +150 °C (–320 … +302 °F) [1)]
Accuracy over temperature range [2)]	
at –196 … –90 °C (–320 … –130 °F)	±2.5 °C (±4.5 °F)
at –90 … –30 °C (–130 … –22 °F)	±0.75 °C (±1.35 °F)
at –30 … 0 °C (–22 … +32 °F)	±0.5 °C (±0.9 °F)
at 0 … +50 °C (+32 … +122 °F)	±0.25 °C (±0.45 °F)
at +50 … +90 °C (+122 … +194 °F)	±0.75 °C (±1.35 °F)
at +90 … +150 °C (+194 … +302 °F)	±2.5 °C (±4.5 °F)
Temperature sensor	Pt100 RTD Class A IEC 751
Typical factory calibration uncertainty	
at –90 °C (–130 °F)	±0.13 °C (±0.234 °F)

Property	Description/Value
at −45 °C (−49 °F)	±0.07 °C (±0.149 °F)
at 0 °C (32 °F) and warmer	±0.06 °C (±0.128 °F)

1) *The measurement range of TMP115 probes manufactured with firmware version older than 2.6.3 is −196 … +90 °C (−320 … +194 °F).*
2) *Includes non-linearity, hysteresis, and repeatability.*

Table 48 TMP115 operating environment

Property	Description/Value
Operating temperature of sensor tip	−196 … +150 °C (−320 … +302 °F)
Operating temperature of probe body [1)]	−40 … +60 °C (−40 … +140 °F)
IP rating of sensor tip	IP67: Dust-tight. Protected from the effects of temporary immersion in water under standardized conditions of pressure and time.
IP rating of probe body	IP65: Dust-tight. Protected from water jets from any direction.

1) *Heat conduction along the probe cable may affect the temperature of the probe body. Model with 3 m (9.8 ft) probe cable is recommended for continuous measurement of very hot and cold temperatures.*

Table 49 TMP115 compliance

Property	Description/Value
EU directives and regulations	RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, industrial environment
Compliance marks	CE, RCM

Table 50 TMP115 inputs and outputs

Property	Description/Value
Operating voltage	5–28 V DC
Start-up time	1 s
Digital output	RS-485 2-wire half duplex, supports Modbus RTU
Output parameters	Temperature (°C)

Table 51 TMP115 mechanical specifications

Property	Specification
Cable connector	4-pin male M8 (IEC 60947-5-2)
Materials	
Probe body	PC/ABS blend
Cable	FEP
Sensor tip	Stainless steel (AISI 316)
Dimensions	
Probe length including cable and sensor tip	0.5 m (1 ft 7.7 in) or 3 m (9.8 ft)
Probe body diameter	14 mm (0.55 in)
Sensor tip length	70 mm (2.76 in)
Sensor tip diameter	4.76 mm (0.19 in)

11.7 Dimensions

11.7.1 HMP60, HMP110, and HMP110T dimensions

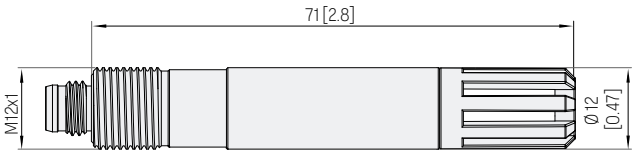


Figure 32 HMP60, HMP110, and HMP110T dimensions in mm [in]

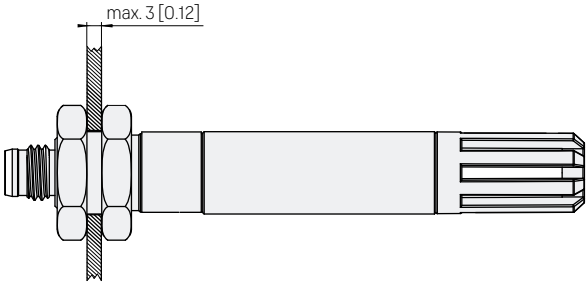


Figure 33 Installation with plastic M12 nuts

11.7.2 HMP63 and HMP113 dimensions

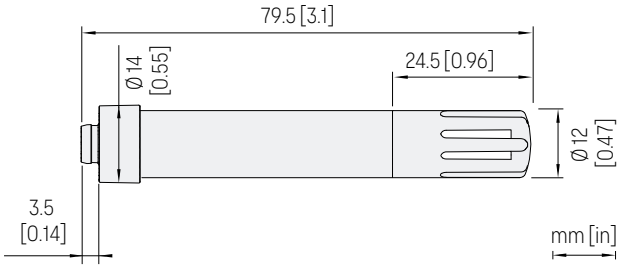


Figure 34 HMP63 and HMP113 dimensions in mm [in]

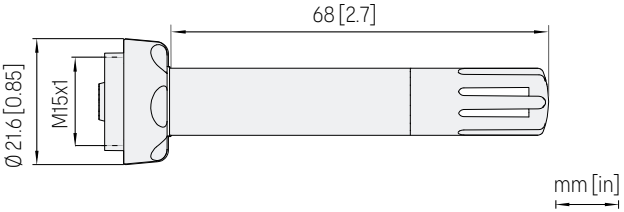


Figure 35 HMP63 and HMP113 with plastic locking bushing

11.7.3 HMP115 and HMP115T dimensions

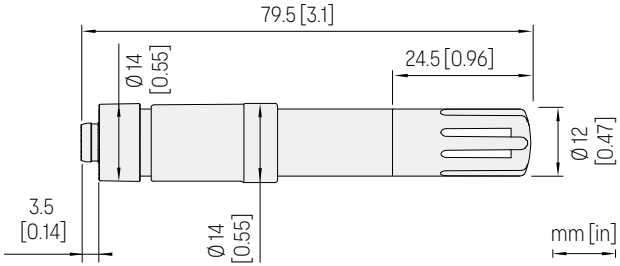


Figure 36 HMP115 and HMP115T dimensions

11.7.4 TMP115 dimensions

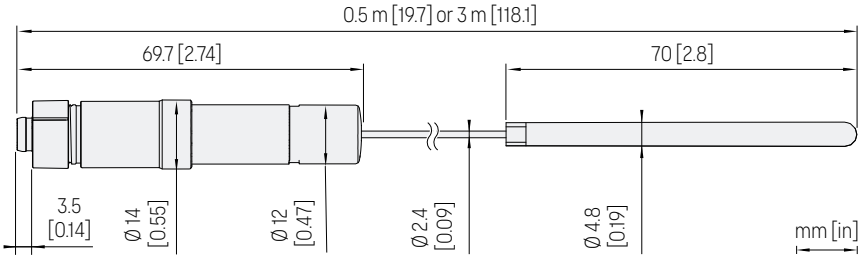


Figure 37 TMP115 dimensions

11.7.5 Probe mounting flange dimensions

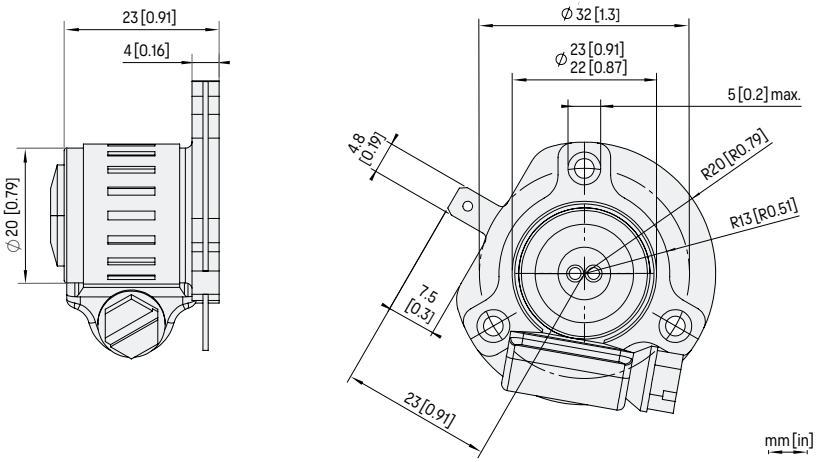


Figure 38 Probe mounting flange dimensions

11.8 Spare parts and accessories

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

For information on spare parts to use when the probe is connected to host devices, such as data loggers and transmitters, see the user documentation of the corresponding host device.

Table 52 HMP60, HMP63, HMP110, and HMP113 spare parts and accessories

Item	Item code
Sensors	
For HMP60 and HMP63:	
Vaisala INTERCAP® sensor, 1 pc	15778HM
Vaisala INTERCAP® sensor, 10 pcs	INTERCAPSET-10PCS
For HMP110 and HMP113:	
Vaisala HUMICAP® 180R	HUMICAP180R
Vaisala HUMICAP® 180V	HUMICAP180V
For HMP115:	
Vaisala HUMICAP® 180R	HUMICAP180R
Sensor protection	
For HMP60 and HMP110:	
Plastic grid filter	DRW010522SP
Membrane filter	DRW010525SP
Stainless steel sintered filter	HM46670SP
PTFE membrane filter with stainless steel grid	ASM212652SP
PTFE sintered filter	DRW244938SP
For HMP63, HMP113 and HMP115:	
Plastic grid filter	DRW240185SP
Plastic grid with membrane filter	ASM210856SP
Stainless steel sintered filter (For HMP63 and HMP113 only)	HM47280SP
Sintered PTFE filter	219452SP
Probe installation	
For HMP60, HMP110, and HMP110T:	
Duct installation kit	215619
For HMP60 and HMP110:	
Probe mounting clamp set, 10 pcs	226067

Item	Item code
Probe mounting flange	226061
Probe holder, 5 pcs	ASM213382SP
Plastic M12 installation nuts, 1 pair	18350SP
Flat extension cable 1 m (3 ft) [1)]	CBL210649SP
For HMP63 and HMP113:	
Probe mounting clamp set, 10 pcs	226067
Probe mounting flange	226061
Probe holder, 5 pcs	ASM213382SP
Plastic locking bushing (3 pcs) for attaching the probe to HM40 indicator	DRW238590SP
For HMP115, HMP115T and TMP115:	
Probe holder, 5 pcs	ASM213382SP
For TMP115:	
Probe nut (5 pcs) for connection to VDL200 data logger, TMT120/130 transmitter, and HM40 handheld meter	DRW257207SP
Thermal dampener block	236310SP
Connection adapters	
4 ... 20 mA loop power converter	UI-CONVERTER-1CB
Mounting bracket for converter	225979
USB cable for PC connection	219690
Connection cable for Indigo80 handheld indicator	262195SP
Connection cable for MI70 indicator	219980SP
Connection cable for HM40 handheld meter	HMT120Z300
Connection cables with open wires	
+60 °C 0.3 m (+140 °F 1 ft)	HMP50Z032SP
+60 °C 1.2 m (+140 °F 4 ft)	HMP50Z120
+60 °C 3 m (+140 °F 9.8 ft)	HMP50Z300SP
+80 °C 1.5 m (+176 °F 5 ft)	225777SP
+80 °C 3 m (+176 °F 10 ft)	225229SP
+180 °C 1.5 m (+356 °F 5 ft) FEP	238025

Item	Item code
+180 °C 3 m (+356 °F 10 ft) FEP	226902SP

1) Connection cable 219980SP is also needed if this cable is used with MI70 indicator.

Appendix A. Modbus reference

A.1 Communication settings

The following table lists the default Modbus serial settings of devices ordered with the Modbus configuration option.

Table 53 Modbus communication settings

Property	Description/Value
Serial bit rate	19200
Parity	None
Number of data bits	8
Number of stop bits	2
Flow control	None
Modbus device address	240
Serial delay	0
Communication mode	Modbus RTU

You can use up to 32 probes on the same RS-485 line when the communication speed is 19200 bps or lower. You must configure each probe on the line to have a different Modbus address.

After power-up, it may take up to 2 seconds before the probe responds to any Modbus request.

A.2 Function codes

Table 54 Supported Modbus function codes

Function code	Function code (hexadecimal)	Name
03	0x03	Read Holding Registers
16	0x10	Write Multiple Registers
43 / 14	0x2B / 0x0E	Read Device Identification

A.3 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.

For values that have both 32-bit and 16-bit register available, use of the 32-bit register is recommended.

A.3.1 32-bit floating point or 32-bit integer format

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

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

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

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

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

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

More information

- Test value registers (page 131)

A.3.2 16-bit integer format

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

Table 55 Interpretation of 16-bit signed integer values

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

A.4 Modbus registers

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

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

A.4.1 Measurement data registers

Table 56 Modbus measurement data registers (read-only)

Register number	Address	Register description	Data format	Unit
Floating point values				
1	0x0000	Relative humidity	32-bit float	%RH
	0x0001			
3	0x0002	Temperature [1)]	32-bit float	°C
	0x0003			
9	0x0008	Dew/frost point temperature	32-bit float	°C
	0x0009			
15	0x000E	Absolute humidity	32-bit float	g/m^3
	0x000F			
17	0x0010	Mixing ratio	32-bit float	g/kg
	0x0011			

Register number	Address	Register description	Data format	Unit
19	0x0012	Wet-bulb temperature	32-bit float	°C
	0x0013			
27	0x001A	Enthalpy	32-bit float	kJ/kg
	0x001B			
Integer values				
257	0x0100	Relative humidity	16-bit integer	%RH * 10
258	0x0101	Temperature [1)]	16-bit integer	°C * 10
261	0x0104	Dew/frost point temperature	16-bit integer	°C * 10
264	0x0107	Absolute humidity	16-bit integer	g/m^3 * 10
265	0x0108	Mixing ratio	16-bit integer	g/kg * 10
266	0x0109	Wet-bulb temperature	16-bit integer	°C * 10
270	0x010D	Enthalpy	16-bit integer	kJ/kg * 10

1) Only temperature output is available in probe model HMP110T.

A.4.2 Configuration registers

Table 57 Modbus configuration data registers (writable)

Register number	Register address	Register description	Data format	Unit / Valid range
Filtering				
785	0x0310	Measurement filtering factor	32-bit float	0.001 (maximum filtering) ... 1.000 (no filtering)
	0x0311			
Communication				
1537	0x0600	Modbus address	16-bit integer	1 ... 247
1538	0x0601	Bit rate [1)]	16-bit integer	5 = 9600 6 = 19200 7 = 38400 8 = 57600

Register number	Register address	Register description	Data format	Unit / Valid range
1539	0x0602	Parity, data, stop bits [1)]	16-bit integer	0 = None, 8, 1 1 = None, 8, 2 2 = Even, 8, 1 3 = Even, 8, 2 4 = Odd, 8, 1 5 = Odd, 8, 2
1540	0x0603	Response delay	16-bit integer	0 ... 1020 ms
1541	0x0604	Protocol	16-bit integer	6 = Modbus RTU
1542	0x0605	Restart device	16-bit integer	When writing to register: 1 = Restart the device

1) Changed setting will be activated on device restart.

If incompatible settings/protocol are selected and the probe is then restarted, it might no longer be possible to communicate with the probe using Modbus. You can override invalid communication settings in the Vaisala Insight PC software, **Settings** menu.

A.4.3 Status registers

Table 58 Modbus status data registers (read-only)

Register number	Address	Register description	Data format	Note
513	0x0200	Error status	16-bit integer	0x0000: One or more errors active 0x0001: No errors
516	0x0203 0x0204	Error code	32-bit integer	
518	0x0205 0x0206	Security hash	32-bit integer	Security hash changes when any change is made to device settings or adjustments, but also returns back to the previous value if such changes are reverted completely.

Table 59 Error codes on Modbus interface

Error code register value	Corresponding error
1	Temperature measurement error. [44]
2	Humidity measurement error. [45]
4	Humidity sensor failure. [46]
8	Capacitance reference error. [47]
16	Ambient temperature out of range. [48]
32	Firmware checksum mismatch. [49]
64	Device settings corrupted. [50]
128	Additional configuration settings corrupted. [51]
256	Sensor coefficients corrupted. [52]
512	Main configuration settings corrupted. [53]
2048	Supply voltage out of range. [55]
8192	Non-volatile memory read/write failure. [57]
16384	Calibration certificate checksum mismatch. [58]

If several errors are active at the same time, the Modbus error code register contains the sum of currently active error codes.

More information

- Error messages in Insight PC software and Indigo80 handheld indicator (page 101)

A.4.4 Test value registers

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

Table 60 Modbus test registers (read-only)

Register number	Register address	Register description	Data format	Test value
7937	0x1F00	Signed integer test	16-bit integer	-12345
7938	0x1F01	Floating point test	32-bit float	-123.45
	0x1F02			

Register number	Register address	Register description	Data format	Test value
7940	0x1F03	Text string test	text	Text string "-123.45"
	0x1F04			
	0x1F05			
	0x1F06			

A.5 Device identification objects

Table 61 Device identification objects

Object ID	Object ID (hexadecimal)	Object name	Example contents
0	0x00	VendorName	"Vaisala"
1	0x01	ProductCode	"HMP113"
2	0x02	MajorMinorVersion	"2.4.0" Software version of the device.
3	0x03	VendorUrl	"http://www.vaisala.com"
4	0x04	ProductName	"Vaisala HUMICAP(R) Humidity and Temperature Probe HMP113"
5	0x05	ModelName	"R00A0C1A0" Configuration code of the device. Length and content of the code are model-specific.
128	0x80	SerialNumber [1)]	"J1140501"
129	0x81	CalibrationDate [1)]	"2020-06-01" Calibration date in YYYY-MM-DD format. Empty string if not set/valid.
130	0x82	CalibrationText [1)]	"Vaisala/HEL" Calibration information text. Empty string if not set/valid.

1) Vaisala-specific device information object

A.6 Modbus communication examples

Reading relative humidity value

The device address used in the following examples is 240 (0xF0).
The values returned by the device change depending on ambient conditions and/or device settings.

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
0xF0	Probe address	0xF0	Probe address
0x03	Function (Read Holding Registers)	0x03	Function (Read Holding Registers)
0x00	Register address	0x04	Number of data bytes
0x00		0x7A	Value of first register (least significant word)
0x00	Number of 16-bit registers to read (2)	0xE1	
0x02		0x41	Value of second register (most significant word)
0xD1	Modbus RTU checksum	0xF4	
0x2A		0x62	Modbus RTU checksum
(silence for 3.5 bytes)	End of Modbus RTU frame	0x05	
		(silence for 3.5 bytes)	End of Modbus RTU frame

Communication description	
Register number	1 (1-based Modbus register number) = address 0x0000 (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	0x41F47AE1, which is binary32 representation of 30.56 (%RH).

Writing filtering factor 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
0xF0	Transmitter address	0xF0	Transmitter address
0x10	Function (Write Multiple Registers)	0x10	Function (Write Multiple Registers)
0x03	Register address	0x03	Register address
0x10		0x10	
0x00	Number of registers to write (2)	0x00	Number of 16-bit registers written (2)
0x02		0x02	
0x04	Number of data bytes	0x55	Modbus RTU checksum
0xCC	Value for the first register (least significant word)	0x68	
0xCD		(silence for 3.5 bytes)	End of Modbus RTU frame
0x3E	Value for the second register (most significant word)		
0x4C			
0x5E	Modbus RTU checksum		
0x96			
(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 number	785 (1-based Modbus register number) = address 0x0310 (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.
Value to write	0.2, in binary32 format 0x3E4CCCCD.

Maintenance and calibration services

Vaisala offers comprehensive customer care throughout the life cycle of our measurement instruments and systems. Our factory services are provided worldwide with fast deliveries. For more information, see vaisala.com/calibration.

- Vaisala Online Store at store.vaisala.com is available for most countries. You can browse the offering by product model and order the right accessories, spare parts, or maintenance and calibration services.
- To contact your local maintenance and calibration expert, see vaisala.com/contactus.

Warranty

For standard warranty terms and conditions, see vaisala.com/warranty.
Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

Technical support

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

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

For more information, see vaisala.com/support.

Recycling

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