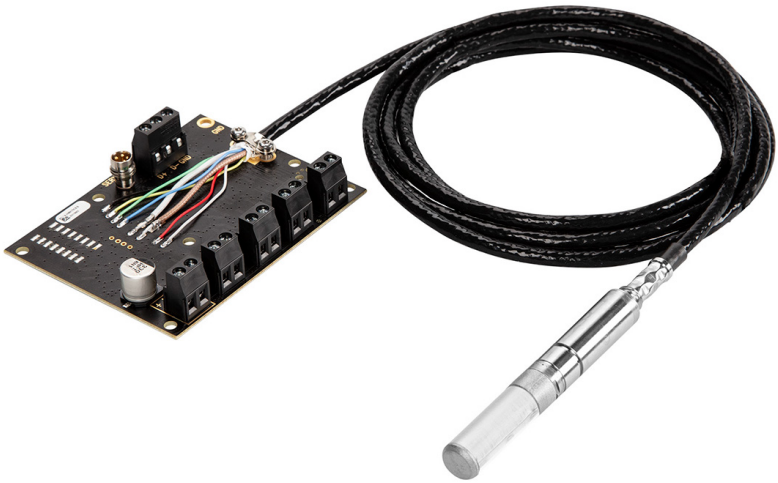
M212259EN-A

User Guide

Vaisala HUMICAP® Humidity and Temperature Module

HMM170



VAISALA

PUBLISHED BY

Vaisala Oyj
Vanha Nurmijärventie 21, FI-01670 Vantaa, Finland
P.O. Box 26, FI-00421 Helsinki, Finland
+358 9 8949 1

Visit our Internet pages at www.vaisala.com.

Table of Contents

List of Figures

List of Tables

1. About This Document

1.1 Version Information

This document provides instructions for installing, operating, and maintaining Vaisala HUMICAP® Humidity and Temperature Module HMM170.

Table 1 Document Versions (in English)

Document Code	Date	Description
M212259EN-A	June 2019	First version.

1.2 Related Manuals

Table 2 Related Manuals

Document Code	Name
M212260EN	*HMM170 Quick 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.

Note highlights important information on using the product.

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

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

2. Product Overview

2.1 Introduction to HMM170

Vaisala HUMICAP® Humidity and Temperature Module HMM170 is an open frame OEM module for integration into demanding environmental chambers and harsh conditions. The module provides a digital RS-485/Modbus RTU output and three freely configurable analog output channels. The module provides relative humidity, temperature, dew point, and other calculated parameters.

HMM170 probe covers the full temperature range -70 ... +180 °C (-94 ... +356 °F) used in climate chambers and the whole humidity range up to condensation. The small probe and compact component board offer easy and flexible installation. The probe cable options (2, 5, or 10 m (6.5, 16.4, or 32.8 ft)) offer excellent cost optimization and flexibility to any OEM application. By ordering HMM170 with the appropriate sensor, you can use the module in environments that are frequently sterilized with vaporized hydrogen peroxide (H_2O_2) or to measure humidity in oil medium, for example, for transformer and engine monitoring applications.

The latest general purpose HUMICAP® R2 sensor has an improved corrosion resistance. The sensor can tolerate typical chemicals, such as cleaning agents used in climate chambers. The automatic sensor chemical purge function keeps the sensor clean from typical chemical fumes and the additional probe warming function prevents condensation. In case HMM170 gets in contact with water, the automatic heating rapidly dries the sensor to enable fast and accurate humidity measurement.

HMM170 is easy to install and convenient to use. It provides both digital and analog outputs for multiple needs. An integrated service port enables a quick and simple way to configure, check, and calibrate the module with the help of a USB cable and Vaisala Insight software.

2.2 Basic Features and Options

- Three humidity sensor types:
  - Vaisala HUMICAP® R2C (general use)
  - Vaisala HUMICAP® 180VC (for H_2O_2 use)
  - Vaisala HUMICAP® 180L2 (for moisture in oil)
- Sensor purge provides superior chemical resistance
- Probe and sensor warming functions minimize condensation on probe
- Analog output options:
  - 0/4 ... 20 mA
  - 0/1 ... 5 V
  - 0 ... 5/10 V
- Probe cable lengths:
  - 2, 5, or 10 m (6.5, 16.4, or 32.8 ft)
- Various filter types

- Service port for maintenance
  - Supports Vaisala MI70 Handheld Measurement Indicator
  - Optional USB cable for easy connection to Vaisala Insight software for configuration, diagnostics, and temporary online monitoring

2.3 Sensor Types

HMM170 is available with three different sensor types.

Table 3 HMM170 Sensor Types

Sensor Type	Description
HUMICAP® R2C	A general purpose industrial humidity sensor with high humidity durability, good long term stability, and good tolerance against chemical exposure.
HUMICAP® 180L2	A sensor that is optimized for measurement of humidity in oil medium. It has good tolerance against chemicals and moderate humidity durability. The HUMICAP® 180L2 sensor measures moisture in oil in terms of the water activity (a_w) and temperature (T). Water activity indicates directly whether there is a risk of free water formation. The measurement is also independent of oil type and age. In addition to water activity, the HMM170 can output ppm, the average mass concentration of water in oil. The HUMICAP® 180L2 sensor does not support probe heating or chemical purge.
HUMICAP® 180VC	A composite humidity sensor with catalytic surface for use in applications where the sensor is exposed to H_2O_2 (hydrogen peroxide). Catalytic HUMICAP® 180VC sensor is a good choice when you want to measure RH between bio-decontamination cycles and you are not interested in saturation level of the air mixture during the bio-decontamination phase. Catalytic layer protects the sensor during the bio-decontamination phase. Catalytic layer catalyzes H_2O_2 into water vapor and oxygen. Therefore, the sensing polymer detects only water vapor and shows correct Relative Humidity value.

2.4 Output Parameters

- ● Output parameter is available
- ◐ Value of output parameter is locked unless temperature is written to register 0334_{hex} from an external source
- ○ Value of output parameter is locked
- – Output parameter is not valid for sensor type

Table 4 Availability of Output Parameters

Output Parameter	HUMICAP® R2C and 180VC Sensor			HUMICAP® 180L2 Sensor
	Normal Operation	**During Heating**	**During Purge**	
Relative humidity	●	◐	○	–
Temperature	●	◐	○	●
Dew point temperature	●	●	○	–
Dew/frost point temperature	●	●	○	–
Dew/frost point temperature at 1 atm	●	●	○	–
Dew point temperature at 1 atm	●	●	○	–
Absolute humidity	●	◐	○	–
Mixing ratio	●	◐	○	–
Wet-bulb temperature	●	◐	○	–
Water concentration	●	◐	○	–
Water vapor pressure	●	●	○	–
Water vapor saturation pressure	●	◐	○	–
Enthalpy	●	◐	○	–
Water activity	–	–	–	●
Dew point temperature difference	●	◐	○	–
Absolute humidity at NTP	●	◐	○	–
Water concentration in oil	–	–	–	●
Relative saturation	–	–	–	●
Water mass fraction	●	◐	○	–

2.5 Probe Head

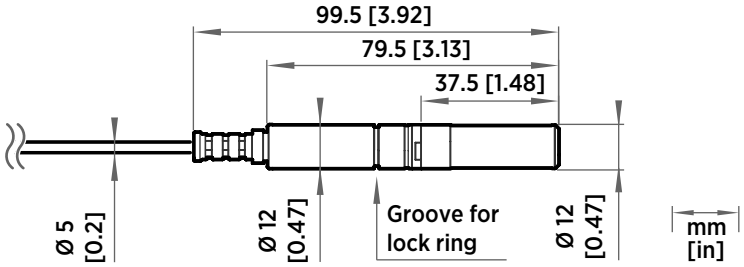


Figure 1 HMM170 Probe Head Dimensions

HMM170 is designed for applications that involve constant high humidity or rapid changes in humidity, such as drying and test chambers, combustion air, and other humidifiers and meteorological measurements, where measurement performance and chemical tolerance are essential.

- Temperature measurement range −70 ... +180 °C (−94 ... +356 °F)
- Operating temperature range for probe −70 ... +180 °C (−94 ... +356 °F)
- Probe and sensor warming functions minimize condensation on probe
- Vapor and pressure proof construction
- Stainless steel mesh filter standard in delivery

Probe Heating

HMM170 supports probe heating. Probe heating heats up not only the sensor, but the entire probe head. When probe temperature is heated above dew point temperature, condensation on the probe can be avoided while measuring the dew point temperature of the process.

Probe heating is normally disabled. If you select to enable probe heating, output parameters that are dependent on temperature measurement (such as relative humidity) are disabled, unless the true temperature of the measured environment is updated to the temperature compensation register of the probe from another measurement instrument. Output parameters that can be measured or calculated without this external temperature information (such as dew point temperature) are available even without the temperature input.

2.6 Chemical Purge

Chemical purge is a 4-minute process where the sensors are heated to remove possible contamination. The purge is essential for the long-term performance and accuracy of the probe. During the purge, measurements are not available.

Depending on the selected sensor, the purge is automatically performed:

- At probe start-up
- At probe start-up and after every 24 hours

The HUMICAP® 180L2 sensor does not support chemical purge.

You can trigger a purge manually at any time with Vaisala Insight software or Modbus, or by closing the external purge trigger on the component board.

2.7 Filter Types

All filters available for the HMM170 are 12 mm (0.47 in) in diameter. Note the operational temperature range of each filter.

Table 5 Filter Types and Properties

	Filter Type	Diameter	Pore Size	Temperature Range
	PPS plastic grid with stainless steel net	12 mm (0.47 in)	15 µm	−70 ... +180 °C (−94 ... +356 °F)
	Stainless steel sintered	12 mm (0.47 in)	38 µm	−70 ... +180 °C (−94 ... +356 °F)
	Stainless steel filter for moisture in oil	12 mm (0.47 in)	3.15 mm	−70 ... +180 °C (−94 ... +356 °F)
	Porous PTFE (general purpose)	12 mm (0.47 in)	8 µm	−70 ... +180 °C (−94 ... +356 °F)

More Information

- Spare Parts and Accessories (page 32)

2.8 LED Indicator

The LED indicator on the component board provides a visual indication of the status of the HMM170. The alarm LED functionality is preset at the factory according to order form.

Table 6 LED Indicator States

LED Color	Meaning
Not lit	Module is powered off or LED functionality is disabled.
Green	Module is powered on and ready for operation.
Green and blinking	Module is powering up or communicating with the probe.
Red	Module is in error state.

You can use Vaisala Insight software to disable the LED indicator.

2.9 Safety

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

WARNING! Ground the product and verify installation grounding periodically to minimize shock hazard.

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

2.9.1 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.

2.10 Regulatory Compliances

HMM170 is in conformity with the provisions of the following EU directive(s):

- RoHS Directive
- WEEE Directive

Electromagnetic compatibility of HMM170 has been tested according to the following product family standard:

EN61326-1 Electrical equipment for measurement, control and laboratory use - EMC requirements - for use in light industrial environments.

The Electrostatic Discharge test (EN 61000-4-2) was not applied to the open frame module. In the final product the module PC-board should be installed in a user restricted location / enclosure for continued ESD protection.

3. Installation

3.1 Installing Module

The measurement probe with cable is attached to the component board at Vaisala. Do not disconnect and reconnect the cable.

1. Attach the module securely using the mounting holes on the corners of the component board.

CAUTION! The module is delivered with a set of standoffs. Use these or other applicable standoffs to attach the module to the minimum height of 6 mm (0.24 in).

2. Make sure that the module has a good earth connection from the plated mounting hole.

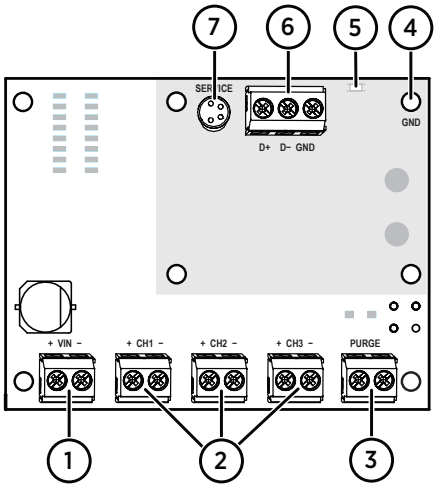


Figure 2 HMM170 Component Board

1 Power input (12 ... 35 VDC)
2 Active analog outputs (0/4 ... 20 mA, 1 ... 5 V, 0 ... 5/10 V)
3 External purge trigger (closing activates purge)
4 Grounding point
5 LED Indicator
6 Digital RS-485 (Modbus) port
7 Service port (temporary connection, MI70, USB cable with Vaisala Insight Software)

If you are replacing HMM100, the mounting holes in the grey area are compatible with HMM100.

3.2 Installing Probe

In humidity measurement and especially in calibration it is essential that temperature of the probe and measuring environment is the same. Even a small difference in temperature between the environment and the probe causes an error. For example, if the temperature is +20 °C (68 °F) and the relative humidity 100 %RH, a difference of ±1 °C (±1.8 °F) between the environment and the probe causes an error of ±6 %RH.

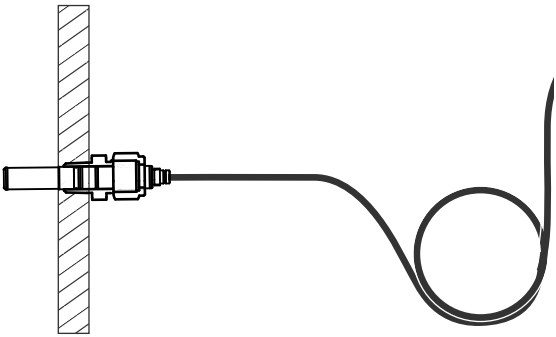


Figure 3 HMM170 Probe Installation

1. Select the mounting location for the probe.
   - The probe should be entirely in the measurement environment, with sufficient distance to the outer walls of the chamber or duct. Air should flow freely around the probe.
   - The probe location should represent well the environmental or process conditions, and it should be as clean as possible.
2. Mount the probe head horizontally to prevent any water condensing on the probe head from running to the sensors.
3. Let the cable hang loosely to prevent condensed water from running along the cable to the probe head.
4. Seal the cable pass-through using the Vaisala installation accessories.

If the temperature of the measured environment differs greatly from ambient temperature, the whole probe and preferably plenty of cable must be inside the process. This prevents measurement inaccuracy caused by heat conduction along the cable.

More Information

- Spare Parts and Accessories (page 32)

3.3 Vaisala Insight Software

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

With the Insight software, you can:

- See device information and status
- See real-time measurement
- Calibrate and adjust the device
- Configure device features such as measurement filtering, chemical purge, heating, and serial communication

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

HMM170 can be connected to Vaisala Insight software using a Vaisala USB cable (no. 219690).

3.3.1 Connecting to Insight Software

- Computer with Vaisala Insight software installed
- USB connection cable (order code 219690)

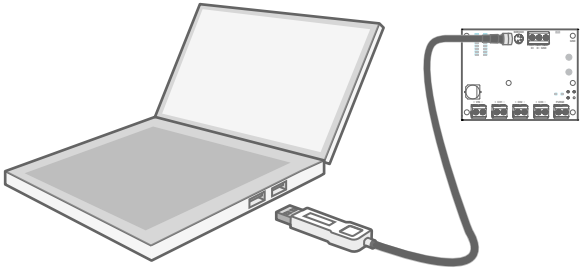


Figure 4 Connecting Module to Insight

1. Open the Insight software.
2. Connect the USB cable to a free USB port on the PC.
3. Connect the USB cable to the service port of the module. The USB cable powers up the module.

3.3.2 Configuration Options

Select **> Configure Device** to access configuration options in Insight software.

The available configuration options correspond to the Modbus configuration registers. Insight software is the recommended way to change the device configuration.

You can restore the device back to its default settings using the **Factory Default Settings > Restore Settings** function. Doing this will also clear any user adjustment and restore the latest factory calibration.

More Information

- Modbus Reference (page 33)

4. Operation

4.1 Using Service Port

The HMM170 has a 4-pin M8 service port connector on the component board. Vaisala offers an optional USB cable (Vaisala order code 219690) for connecting the module to your PC.

The service port is intended for short-term use such as calibration. For permanent installation, use the permanent digital Modbus and/or analog terminals.

If you have not used the HMM170 USB cable before, first install the driver.

More Information

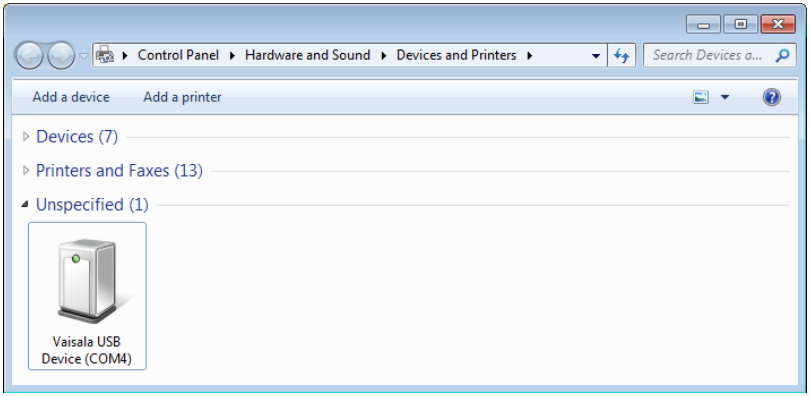
- Installing the Driver for the USB Service Cable (page 18)

4.1.1 Installing the Driver for the USB Service Cable

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

1. Connect the USB service cable to a USB port on your computer. Windows® detects the new device and installs the appropriate driver.
2. Open **Devices and Printers** from the Windows® Start menu. Use search to find it if necessary (search for "devices").

3. Locate the cable in the list of devices:
   - If the device is listed as **Vaisala USB Device** with a COM port number in brackets, the cable is ready for use. **Note the COM port number, you will need it later.**
   - If the device is listed as **Vaisala USB Instrument Cable** without a COM port number listed, you must install the driver manually.



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

4.2 Modbus

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

More Information

- Modbus Reference (page 33)

4.3 Operating with MI70 Indicator

HMM170 is compatible with the MI70 handheld indicator. The MI70 indicator is a convenient service tool for viewing the measurement readings, adjusting the environmental compensation settings, and performing calibration and 1- or 2-point adjustment. MI70 is compatible with various Vaisala probes, transmitters, and modules.

You can use the MI70 indicator for the following tasks with HMM170:

- Measurement viewing and logging
- Calibration and 1- or 2-point adjustment
- Viewing information about the module

To connect HMM170 to an MI70 indicator, you need the optional MI70 connection cable (Vaisala order code 219980SP).

4.3.1 MI70 Indicator Parts

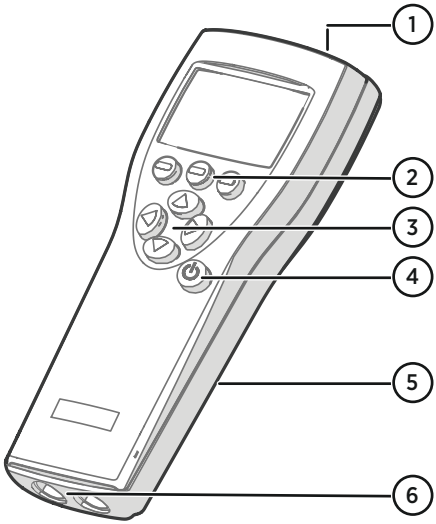


Figure 5 MI70 Indicator Parts

1 Charger socket
2 Function key shortcut buttons ⊖. The functions change according to what you are doing with the indicator.
3 Arrow buttons:
   - ▲ Move up in a menu
   - ▼ Move down in a menu
   - ▶ Enter a sub-menu
   - ◀ Return to previous menu level
4 Power On/Off button
5 Battery compartment at the back of the indicator
6 Two ports (labeled I and II) for connecting probes and instruments.

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

4.3.2 Connecting HMM170 to MI70 Indicator

- MI70 connection cable (Vaisala order code 219980SP)

1. If the MI70 indicator is on, turn it off.
2. Connect HMM170 to port I of the MI70 indicator using the MI70 connection cable.

3. Turn on the MI70 indicator. MI70 detects the HMM170 and proceeds to show the measurement screen. After a few seconds, MI70 will start to show valid measurement results from the module.

4.3.3 Basic Display

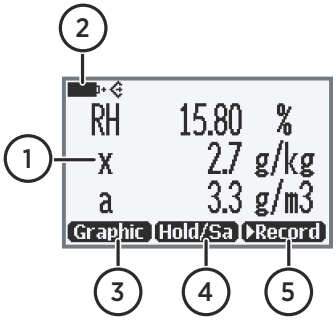


Figure 6 MI70 Basic Display

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

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

4.3.4 Graphical Display

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

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

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

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

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

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

4.3.5 Main Menu

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

To open the main menu and navigate in the menus:

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

4.3.6 Holding and Saving the Display

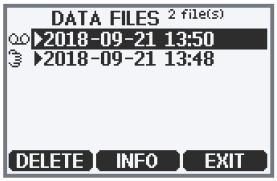
With the **Hold/Save** function, you can freeze a certain display reading. This reading can be saved in the MI70 memory and it will be available even after MI70 is disconnected from the transmitter.

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

   Saved display

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



4.3.7 Recording Data

With MI70, you can record measurement data over a certain period at chosen intervals. These recordings are saved in MI70 memory and are available even after MI70 is disconnected from the module. To start recording, select the **Record** function key in the basic display, or navigate to the recording menu: **Main menu > Recording/Viewing > Record data**.

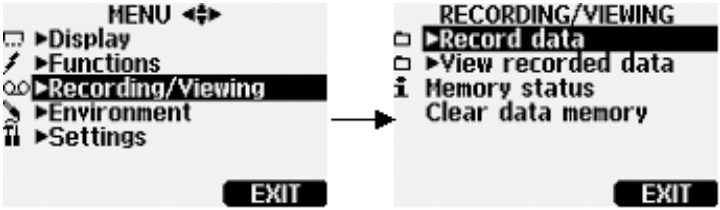


Figure 7 Recording/Viewing Menu

5. Maintenance

5.1 Cleaning Probe

- Lint-free cloth
- Isopropyl alcohol (70 %)

CAUTION! Do not attempt to clean the sensors under the filter in any way.

1. Moisten a lint-free cloth with isopropyl alcohol (70%).
2. Wipe the probe head and cable with the lint-free cloth.

   Do not spray anything directly on the probe head or immerse the probe head in liquid, since that may deposit impurities on the sensors.

   Do not wipe the filter: wiping the filter may block its pores and/or deposit residue on the filter. If the filter is heavily contaminated, replace it.

3. After cleaning the probe, it is recommended to perform a chemical purge.

More Information

- Chemical Purge (page 10)
- Replacing Filter (page 24)

5.2 Replacing Filter

- New compatible filter
- Clean lint-free gloves

CAUTION! Without the filter in place, the sensor is easily damaged – handle the probe head carefully.

1. Put on clean gloves before touching the filter.
2. Turn the filter counter-clockwise to loosen it.
3. Remove the filter from the probe head. Be careful not to touch the sensor with the filter.
4. Install a new filter on the probe head. Tighten the filter properly (recommended force 5 Nm).

More Information

- Filter Types (page 11)
- Spare Parts and Accessories (page 32)

5.3 Calibration and Adjustment

The module is fully calibrated and adjusted as shipped from the factory. To maintain the accuracy of the measurement, calibrate and adjust the module as needed. Typical calibration interval is one year, but depending on the application it may be necessary to check the accuracy more frequently.

When adjustment is necessary, you can have Vaisala calibrate and adjust the module. To order calibration services from Vaisala, visit store.vaisala.com. You can also do the adjustment yourself using the Insight software.

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

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.

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**.

5.3.1 Adjustment Points and Requirements

You can adjust the humidity measurement in 1 ... 5 points, and temperature measurement in 1 ... 2 points. Note the following:

- Humidity adjustment in more than two points is available when using Insight software in **Advanced Mode**.
- If you are adjusting in more than one humidity point, make sure the first two points are at least 10 %RH apart.
- The module will reject adjustments that are too large, that is, greater than 10 %RH for humidity and 0.5 °C (0.9 °F) for temperature. If the module appears to need such a large correction, perform a sensor purge and repeat the adjustment procedure. Make sure the measurement has stabilized and the reference environment is reliable. If the required adjustment is still too large, the module needs to be serviced by Vaisala.

When adjustment of humidity measurement is necessary, Vaisala recommends adjusting in two points, 11 %RH and 75 %RH. These humidities can be produced using the Vaisala HMK15 Humidity Calibrator.
Adjustment of temperature measurement is typically not necessary.

5.3.2 Adjusting Measurement with Insight Software

- Computer with Windows operating system and Vaisala Insight software installed
- Vaisala USB cable 219690 for connecting the module
- Reference environment(s) for producing the desired humidity and/or temperature

This procedure can be used to adjust the module's humidity or temperature measurement. If you want to adjust both, repeat the procedure.

Because stabilization of temperature and humidity takes time, you should expect the adjustment procedure to take at least 30 minutes for each adjustment point.

1. Connect the module to Insight. See Connecting to Insight Software (page 16).
2. If you intend to adjust humidity measurement, first select **> Purge** to perform a chemical purge to condition the sensor. Wait a few minutes for purge to complete.
3. Select **> Calibrate > Yes** to switch the module to calibration mode.
   In calibration mode, the device will not use functions that may interfere with calibration and adjustment.
4. Select the type of adjustment to perform: **RH adjustment** or **T adjustment**.

5. Define the needed adjustment for the first measurement point:
   a. Insert the probe head in the reference environment for the first calibration point.
   b. Wait for the measurement to stabilize fully.
   c. Click the **Reference value, point 1** text box and enter the reference value of the calibration point. Press **ENTER** or click outside the text box when done.
   d. The module automatically enters the measured values for the calibration point.
6. If you want to adjust in more than one point, repeat step 5 for all desired calibration points.

   You can adjust humidity measurement in up to five points when Insight is set to **Advanced mode**.

7. Select **Activate adjustment > Yes** to store the adjustment in the module.
8. Check the message that appears at the top of the screen. If the message indicates that the adjustment is activated successfully, your adjustment is stored in the module.
9. Select the **Calibration information** tab and update the **Calibration date** and **Calibration text**.
10. Select **Close > Yes** to exit the calibration mode.

5.3.3 Calibration and Adjustment Using MI70

- Vaisala MI70 Measurement Indicator
- Connection cable for MI70 Measurement Indicator (Vaisala item 219980SP)
- Reference environments for the desired calibration points

You can calibrate and adjust the HMM170 module in 1 or 2 points using the MI70 indicator. For a 2-point calibration, you need two reference environments. Note that when performing a 2-point RH calibration, the first point requires a < 50% RH humidity reference, and the second point must be > 50% RH. The difference between the two humidity references must be at least 30% RH.

Using the MI70 indicator, you can also do the 1-point calibration so that you compare the reading of the module to any MI70-compatible Vaisala device that provides the same measurement parameter.

1. Connect the HMM170 to port I of the MI70 indicator using the handheld connection cable.
2. If you want to calibrate by comparing to the reading of a reference probe, connect it to port II of the MI70 indicator.
3. Turn on the MI70 indicator.
4. Start the adjustment sequence from **Main menu > Functions > Adjustments**. If you have another device connected, make sure to start the adjustment sequence for device **I**.

5. MI70 notifies you that automatic power off is disabled during adjustment mode. Select **OK** to acknowledge.
6. Select **RH** or **T** parameter for adjustment and select **OK**. This procedure assumes you are adjusting relative humidity, but the same principles apply for temperature adjustment.
7. Insert the probe to be calibrated in the reference environment. If you are calibrating relative humidity using two reference environments, use the dry reference first. If you have a reference probe, insert that in the same environment. If you are comparing against the reading of a reference probe, you can also use the ambient condition as the reference environment, as long as its conditions are stable.
8. Wait for the measurement to stabilize. You can follow the stabilization from the **GRAPH** display. Select **ADJUST** when the reading is stabilized in the reference.
9. To perform the adjustment using one reference environment (1-point adjustment), perform these steps:
    a. Select **1-point adjustment > SELECT > OK**.
    b. When the measurement is stable, select **READY**.
    c. Give the reference RH value by using the arrow buttons and select **OK**.
    d. To confirm the adjustment, select **YES**. If you select **NO**, you return to the adjustment mode display and no changes are made.
    e. Continue from step 12.
10. To perform the adjustment using two reference environments (two-point adjustment), perform these steps:
    a. Select **2-point adjustment > SELECT > OK**.
    b. When the measurement is stable, select **READY**.
    c. Give the reference RH value by using the arrow buttons and select **OK**.
    d. Insert the probe to be calibrated in the second reference environment.
    e. When the measurement is stable, select **READY**.
    f. Give the reference RH value by using the arrow buttons and select **OK**.
    g. To confirm the adjustment, select **YES**. If you select **NO**, you return to the adjustment mode display and no changes are made.
    h. Continue from step 12.
11. To perform the adjustment using a reference probe, perform these steps:
    a. Select **To same as RH[II]**.
    b. To confirm the adjustment, select **YES**. If you select **NO**, you return to the adjustment mode display and no changes are made.
12. Calibration and adjustment is now completed. Select **BACK** to exit the adjustment mode and **EXIT** to return to the basic display.
13. Disconnect the module from the MI70 indicator.

6. Technical Data

6.1 HMM170 Specifications

Table 7 Measurement Performance

Property	Description/Value
Relative Humidity	
Measurement range	0 ... 100 %RH
Accuracy [1]	
at +15 ... +25 °C (59 ... +77 °F)	±1 %RH (0 ... 90 %RH) ±1.7 %RH (90 ... 100 %RH)
at -20 ... +40 °C (-4 ... +104 °F)	± (1.0 + 0.008 × reading) %RH
at -40 ... +180 °C (-40 ... +356 °F)	± (1.5 + 0.015 × reading) %RH
Factory calibration uncertainty at +20 °C (+68 °F) [2]	±0.6 %RH (0 ... 40 %RH) ±1.0 %RH (40 ... 90 %RH) ±1.1 %RH (90 ... 95 %RH)
Humidity sensor types	Vaisala HUMICAP® R2C Vaisala HUMICAP® 180L2 Vaisala HUMICAP® 180VC
Response time (90 %) at +20 °C (+68 °F) in 0.1 m/s air flow with Vaisala HUMICAP® R2C sensor:	
with steel netting filter with sintered filter	50 s 60 s
Temperature	
Measurement range	-70 ... +180 °C (-94 ... +356 °F)
Temperature sensor	Pt100 RTD Class F0.1 IEC 60751
Typical accuracy at +20 °C (+68 °F)	±0.2 °C (± 0.36 °F)

1) *Including non-linearity, hysteresis and repeatability.*
2) *Defined as ±2 standard deviation limits. Small variations possible; see also calibration certificate.*

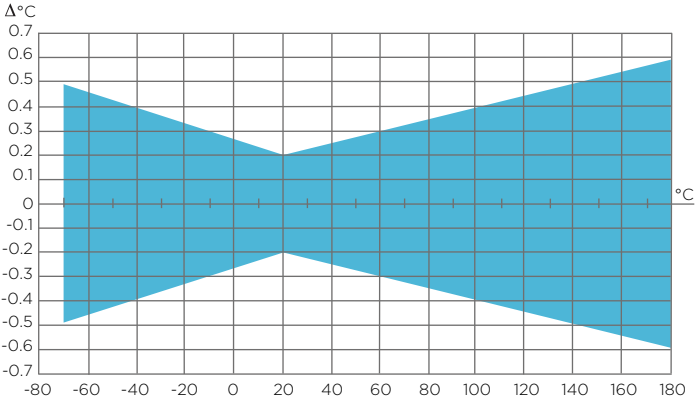


Figure 8 Accuracy over Temperature Range in Temperature Measurement

Table 8 Operating Environment

Property	Description/Value
Operating temperature for component board	-40 ... +60 °C (-40 ... +140 °F)
Operating humidity range for component board	0 ... 100 %RH, non-condensing
Storage temperature	-55 ... +80 °C (-67 ... +176 °F)
Operating pressure	0 ... 10 bar

Table 9 Inputs and Outputs

Property	Description/Value
Three analog outputs (selectable and scalable)	0 ... 20 mA, 4 ... 20 mA 0 ... 1 V, 0 ... 5 V, 1 ... 5 V, or 0 ... 10 V
Typical accuracy of analog output at +20 °C (+68 °F)	±0.05 % full scale
Typical temperature dependence of analog output	0.005 %/°C (0.003 %/°F) full scale
Digital output	RS-485 serial, Modbus
Service port	M8 connector for USB cable
Operating voltage	15 ... 35 VDC
Power Consumption	
Analog outputs	12 mA (voltage) 50 mA (current)

Property	Description/Value
Chemical purge at 24 VDC	+220 mA
Warmed probe at 24 VDC	+240 mA
External load	R_L < 500 Ω
Start-up time	3 s at power-up
Maximum wire size	0.5 ... 1.5 mm^2 (AWG)

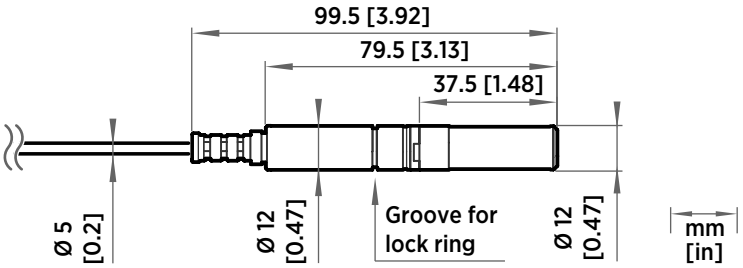


Figure 9 Probe Head Dimensions

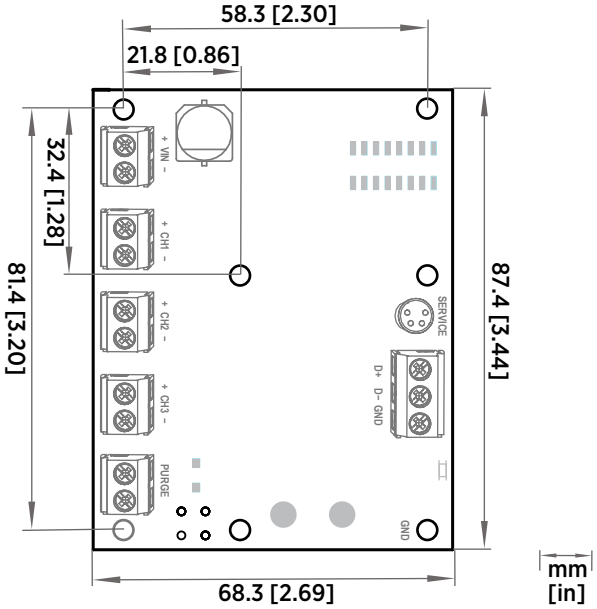


Figure 10 Component Board Dimensions

6.2 Spare Parts and Accessories

Table 10 Spare Parts and Accessories

Item	Order Code
USB cable for PC connection	219690
MI70 connection cable	219980SP
Feedthrough	HMP247CG
Swagelok NPT 1/2″ adapter	SWG12NPT12
Swagelok ISO 1/2″ adapter	SWG12ISO12
Duct installation kit for probe	210697
PPS Plastic grid and stainless steel netting	DRW010281SP
Stainless steel sintered filter	HM47280SP
Sintered PTFE filter with 20 µm pore size	219452SP
Stainless steel filter	HM47453SP

Appendix A. Modbus Reference

A.1 Default Communication Settings

Table 11 Default Modbus Serial 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

You can use up to ten probes on the same RS-485 line. You must configure each probe on the line to have a different Modbus address.

A.2 Function Codes

Table 12 Modbus Function Codes

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

A.3.1 32-Bit Floating Point or Integer Format

Least significant 16 bits of floating point or integer numbers are placed at the smaller Modbus address as specified in Open Modbus TCP Specification, Release 1.0. This is also known as "little-endian" or "Modicon" word order. Floating point values are represented in standard IEEE 32-bit floating point format.

Despite the specification, some Modbus masters may expect "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 "quiet NaN" value is returned for unavailable values. A quiet NaN is, for example, $7FC00000_{hex}$; however, the master should understand any NaN value.

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

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 13 16-bit Signed Integer Format Details

Value	Description
0000_{hex} ... $7FFE_{hex}$	Value in range 0 ... 32766
8002_{hex} ... $FFFF_{hex}$	Value in range -32766 ... -1 (2's complement)
8000_{hex}	Value is not available (quiet NaN)

Some values may exceed the signed 16-bit range even in normal operation. To access such values, use the floating point registers instead.

A.4 Modbus Registers

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

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

A.4.1 Measurement Data Registers

Table 14 Modbus Measurement Data Registers (Read-Only)

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Metric Unit
Floating Point Values				
1	0000_{hex}	Relative humidity	32-bit float	%RH
3	0002_{hex}	Temperature	32-bit float	°C
7	0006_{hex}	Dew point temperature	32-bit float	°C
9	0008_{hex}	Dew/frost point temperature	32-bit float	°C
11	$000A_{hex}$	Dew/frost point temperature at 1 atm	32-bit float	°C
13	$000C_{hex}$	Dew point temperature at 1 atm	32-bit float	°C
15	$000E_{hex}$	Absolute humidity	32-bit float	g/m^3
17	0010_{hex}	Mixing ratio	32-bit float	g/kg
19	0012_{hex}	Wet-bulb temperature	32-bit float	°C
21	0014_{hex}	Water concentration	32-bit float	ppm_v
23	0016_{hex}	Water vapor pressure	32-bit float	hPa
25	0018_{hex}	Water vapor saturation pressure	32-bit float	hPa
27	$001A_{hex}$	Enthalpy	32-bit float	kJ/kg
29	$001C_{hex}$	Water activity	32-bit float	a_w
31	$001E_{hex}$	Dew point temperature difference	32-bit float	°C
33	0020_{hex}	Absolute humidity at NTP	32-bit float	g/m^3
35	0022_{hex}	Water concentration in oil	32-bit float	ppm_w

Register Number (Decimal)	Address (Hexadecimal)	Register Description	Data Format	Metric Unit
Floating Point Values				
41	0028_{hex}	Relative saturation	32-bit float	%
65	0040_{hex}	Water mass fraction	32-bit float	ppm_w
Integer Values				
257	0100_{hex}	Relative humidity	16-bit signed integer	%RH * 100
258	0101_{hex}	Temperature	16-bit signed integer	°C * 100
260	0103_{hex}	Dew point temperature	16-bit signed integer	°C * 100
261	0104_{hex}	Dew/frost point temperature	16-bit signed integer	°C * 100
262	0105_{hex}	Dew/frost point temperature at 1 atm	16-bit signed integer	°C * 100
263	0106_{hex}	Dew point temperature at 1 atm	16-bit signed integer	°C * 100
264	0107_{hex}	Absolute humidity	16-bit signed integer	g/m^3 * 100
265	0108_{hex}	Mixing ratio	16-bit signed integer	g/kg * 100
266	0109_{hex}	Wet-bulb temperature	16-bit signed integer	°C * 100
267	$010A_{hex}$	Water vapor concentration	16-bit signed integer	ppm_v
268	$010B_{hex}$	Water vapor pressure	16-bit signed integer	hPa * 10
269	$010C_{hex}$	Water vapor saturation pressure	16-bit signed integer	hPa * 10
270	$010D_{hex}$	Enthalpy	16-bit signed integer	kJ/kg * 100
271	$010E_{hex}$	Water activity	16-bit signed integer	a_w
272	$010F_{hex}$	Dew point temperature difference	16-bit signed integer	°C * 10

Integer Values				
273	0110_{hex}	Absolute humidity at NTP	16-bit signed integer	$g/m^3 * 100$
274	0111_{hex}	Parts per million in oil	16-bit signed integer	ppm_w
277	0114_{hex}	Relative saturation	16-bit signed integer	% * 100
289	0120_{hex}	Water mass fraction	16-bit signed integer	ppm_w

A.4.2 Configuration Registers

Table 15 Modbus Configuration Data Registers (Writable)

Register Number (Decimal)	Register Address (Hexadecimal)	Register Description	Data Format	Unit / Valid Range
General				
1287	0506_{hex}	Extra heat on/off. Enables heating of humidity sensor when close to saturation. Measurement is disabled for the duration of heating and cooling.	16-bit boolean	0 = Off (default) 1 = On
1289	0508_{hex}	Probe heating on/off. When on, output parameters that depend on temperature measurement (for example, relative humidity) are disabled unless temperature is written to register 0334_{hex} from an external source.	16-bit boolean	0 = Off (default) 1 = On
2561	$0A00_{hex}$	User information	Text	Text string of 24 bytes in UTF-8 encoding

Compensation Setpoints				
769	0300_{hex}	Pressure compensation setpoint	32-bit float	Unit: hPA Default: 1013.25 hPa
821	0334_{hex}	Temperature compensation setpoint. If a value is written to this register, the device uses it instead of its own temperature measurement. When probe heating is in use, temperature must be written to this register to enable output parameters that depend on temperature measurement (for example, relative humidity).	32-bit float	Unit: °C
Purge				
773	0304_{hex}	Purge interval	32-bit float	Unit: min 10 ... 14400
1283	0502_{hex}	Interval purge on/off	16-bit boolean	0 = Off 1 = On
1284	0503_{hex}	Startup purge on/off	16-bit boolean	0 = Off 1 = On

Filtering				
795	$031A_{hex}$	Measurement filtering factor	32-bit float	Range: 0.000 ... 1.000 1.000 = Reading shows 100 % of the most recent measured value (no filtering, default). 0.01 ... 0.99 = Reading shows 1 ... 99 % of the most recent measured value and part of the previous reading (filtering is applied). For example, "0.9" means that the filtered measurement reading = 90 % of the most recent measured value + 10 % of the previous reading.
1281	0500_{hex}	Filtering on/off	16-bit boolean	0 = Off 1 = On
1282	0501_{hex}	Enable or disable measurement filtering using the user-defined filtering factor (register $031A_{hex}$)	16-bit boolean	0 = Off 1 = On
Communication				
1537	0600_{hex}	Modbus address	16-bit integer	1 ... 247 Default: 240

Communication				
1538	0601_{hex}	Bit rate	enum	0 = 300 1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600 6 = 19200 7 = 38400 8 = 57600 9 = 115200
1539	0602_{hex}	Parity, data, stop bits	enum	0 = None, 8, 1 1 = None, 8, 2 2 = Even, 8, 1 3 = Even, 8, 2 4 = Odd, 8, 1 5 = Odd, 8, 2 (default: 1 = None, 8, 2)
1540	0603_{hex}	Response delay	16-bit integer	Unit: ms Range: 0 ... 1000
Functions				
1285	0504_{hex}	Purge	16-bit function status	When writing to register: 1 = Activate purge
1542	0605_{hex}	Restart device	16-bit function status	When writing to register: 1 = Restart the device

A.4.3 Device Identification Objects

Table 16 Device Identification Objects

Object Id (Decimal)	Object Id (Hexadecimal)	Object Name	Example Contents
0	00_{hex}	VendorName	“Vaisala”
1	01_{hex}	ProductCode	"HMM170"
3	03_{hex}	VendorUrl	“http://www.vaisala.com/”
4	04_{hex}	ProductName	"Vaisala HUMICAP(R) Humidity and Temperature Module HMM170"
128	80_{hex}	SerialNumber	"NOT SET"
129	81_{hex}	CalibrationDate	
130	82_{hex}	CalibrationText	

A.4.4 Test Value Registers

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

Table 17 Modbus Test Registers (Read-Only)

Register Number (Decimal)	Register Address (Hexadecimal)	Register Description	Data Format	Test Value
7937	$1F00_{hex}$	Signed integer test	16-bit integer	-12345
7938	$1F01_{hex}$	Floating point test	32-bit float	-123.45
7940	$1F03_{hex}$	Text string test	text	Text string "-123.45"

A.4.5 Modbus Communication Examples

Reading Relative Humidity Value

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

Request		Response	
Bytes on the Line (Hexadecimal)	**Description**	**Bytes on the Line (Hexadecimal)**	**Description**
(silence for 3.5 bytes)	Start of Modbus RTU frame	(silence for 3.5 bytes)	Start of Modbus RTU frame
$F0_{hex}$	Device address	$F0_{hex}$	Device address
03_{hex}	Function (Read Holding Registers)	03_{hex}	Function (Read Holding Registers)
00_{hex}	Register address	04_{hex}	Number of data bytes
00_{hex}		$7A_{hex}$	Value of first register (least significant word)
00_{hex}	Number of 16-bit registers to read (2)	$E1_{hex}$	
02_{hex}		41_{hex}	Value of second register (most significant word)
$D1_{hex}$	Modbus RTU checksum	$F4_{hex}$	
$2A_{hex}$		05_{hex}	Modbus RTU checksum
(silence for 3.5 bytes)	End of Modbus RTU frame	06_{hex}	
		(silence for 3.5 bytes)	End of Modbus RTU frame

Communication Description	
Register address	1 (1-based Modbus documentation format) = 0000_{hex} (0-based format used in actual communication).
Data format	Two 16-bit Modbus registers interpreted as IEEE 754 binary32 floating point value, least significant word first.
Returned value	$41F47AE1_{hex}$, which is binary32 representation of 30.56 (%RH).

Writing Pressure Compensation Value

Request		Response	
Bytes on the Line (Hexadecimal)	**Description**	**Bytes on the Line (Hexadecimal)**	**Description**
(silence for 3.5 bytes)	Start of Modbus RTU frame	(silence for 3.5 bytes)	Start of Modbus RTU frame
$F0_{hex}$	Device address	$F0_{hex}$	Device address
10_{hex}	Function (Write Multiple Registers)	10_{hex}	Function (Write Multiple Registers)
03_{hex}	Register address	03_{hex}	Register address
00_{hex}		00_{hex}	
00_{hex}	Number of registers to write (2)	00_{hex}	Number of 16-bit registers written (2)
02_{hex}		02_{hex}	
04_{hex}	Number of data bytes	AD_{hex}	Modbus RTU checksum
$6E_{hex}$	Value for first register (least significant word)	54_{hex}	
14_{hex}			
44_{hex}	Value for second register (least significant word)	(silence for 3.5 bytes)	End of Modbus RTU frame
75_{hex}			
AB_{hex}	Modbus RTU checksum		
$4E_{hex}$			
(silence for 3.5 bytes)	End of Modbus RTU frame		

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

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

Communication Description	
Register address	769 (1-based Modbus documentation format) = 0300_{hex} (0-based format used in actual communication).

Communication Description	
Data format	Two 16-bit Modbus registers interpreted as IEEE 754 binary32 floating point value, least significant word first.
Value to write	$44756E14_{hex}$ = 981.72 (hPa)

Warranty

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

Technical Support

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

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

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

Recycling

Recycle all applicable material.

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

VAISALA

www.vaisala.com