USER'S GUIDE

Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT130

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CHAPTER 1
GENERAL INFORMATION

This chapter provides general notes for the manual and HMT130.

About This Manual

This manual provides information for installing, operating, and maintaining the Humidity and Temperature Transmitter HMT130.

Contents of This Manual

This manual consists of the following chapters:

- Chapter 1, General Information, provides general notes for the manual and HMT130.
- Chapter 2, Product Overview, provides general information about the Vaisala Humidity and Temperature Transmitter HMT130
- Chapter 3, Installation, provides information on the installation of Vaisala Humidity and Temperature Transmitter HMT130
- Chapter 4, Operation, contains information that is needed to operate the HMT130.
- Chapter 5, Maintenance, provides information that is needed in basic maintenance of the product.
- Chapter 6, Troubleshooting, describes error messages and analog output error behavior, introduces some common problems, their probable causes and remedies and provides contact information for Technical Support
- Chapter 7, Technical Data, provides the technical data of the product.
- Appendix A, Calculation Formulas, contains the formulas used for the calculated output quantities.
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Version Information

Table 1   Manual Revisions

Manual Code	Description
M211280EN-A	November 2010. First version.

Related Manuals

Table 2   Related Manuals

Manual Code	Manual Name
M210185EN	Humidity Calibrator HMK15 User's Guide
M210297EN	Hand-held Humidity and Temperature Meter HM70 User's Guide
M210316EN	HMI41 Indicator and HMP41/45/46 Probes Operating Manual
M211060EN	HMP60/110 Probe User's Guide

Documentation Conventions

Throughout the manual, important safety considerations are highlighted as follows:

WARNING	Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death.

CAUTION	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	Note highlights important information on using the product.

Safety

The Humidity and Temperature Transmitter HMT130 delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

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

ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

-   Handle ESD sensitive components on a properly grounded and protected ESD workbench. When this is not possible, ground yourself to the equipment chassis before touching the boards. Ground yourself with a wrist strap and a resistive connection cord. When neither of the above is possible, touch a conductive part of the equipment chassis with your other hand before touching the boards.
-   Always hold the boards by the edges and avoid touching the component contacts.

Recycling

	Recycle all applicable material.

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

Regulatory Compliances

Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT130 is in conformity with the provisions of the following EU directives:

- EMC-Directive (2004/108/EC)

Conformity is shown by compliance with the following standards:

- EN 61326-1: Electrical equipment for measurement, control and laboratory use – EMC requirements – for use in industrial locations.
- EN 55022 + Am1: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.

$$C\,E \qquad \mathbf{C}_{N17728}$$

Patent Notice

The HMT130 is protected by the following patents and their corresponding national rights:

Finnish patent 98861, French patent 6650303, German patent 69418174, Japanese patent 3585973, UK patent 0665303, U.S. patent 5607564.

Trademarks

HUMICAP® is a registered trademark of Vaisala Oyj.

License Agreement

All rights to any software are held by Vaisala or third parties. The customer is allowed to use the software only to the extent that is provided by the applicable supply contract or Software License Agreement.

Warranty

For certain products Vaisala normally gives a limited one-year warranty. Visit our Internet pages for more information and our standard warranty terms and conditions: www.vaisala.com/services/warranty.html.

For certain products Vaisala normally gives a limited one-year 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.

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CHAPTER 2
PRODUCT OVERVIEW

Thank you for choosing the Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT130. This chapter introduces you to its features.

The Vaisala range of relative humidity measurement instruments covers all the applications from ventilation to process control in demanding conditions. For more information about other Vaisala relative humidity instruments, please contact your Vaisala representative or visit www.vaisala.com.

Introduction to the HMT130

The Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT130 measures relative humidity and temperature and outputs the measurements to voltage outputs and RS-485. Other quantities, such as dewpoint (Td) can be calculated from the basic RH and T values according to the device configuration. HMT130 is powered with a 10 ... 35 VDC or a 24 VAC supply (15 ... 35 VDC or 24 VAC required when using 0 ... 10 V output). It outputs two analog voltage signals with nominal 0 ... 10 V range. HMT130 has also an RS-485 digital interface and a relay.

HMT130 transmitter's output quantities are configurable. Available quantities for outputs are limited to two at the time. These two quantities can be used freely at any outputs (display, service port and voltage outputs).

Available quantities are RH, T, Td, Td/f, a, x, h, Tw, pws and pw.

The default output quantities are set at the factory during order time. These factory preset quantity selections can be changed afterwards via the service port if necessary.

The HMT130T and HMT130H models are single-parameter transmitters. The only output quantity of HMT130T is temperature. The output of the HMT130H can be configured to be any one of the humidity-related quantities (RH, Td, Td/f, a, x, h, Tw, pws and pw).

Accessories

The following accessories are optionally available:

- Duct installation kit
- Rain shield with installation kit
- Rain/solar radiation shield installation kit (for pole installation)
- Probe mounting flange
- Probe mounting clamp
- Constant output probe (HMP110REF, gives constant RH and T values)

Fixed and Remote Probe Models

The HMT130 is available either with a fixed probe directly attached to the transmitter housing or a remote probe with different (3/5/10m) cable lengths. All extension cables can be easily cascaded in order to obtain longer reach; see Options and Accessories on page 81.

Optional Display

The HMT130 is also available with an optional graphical 128*64 resolution LCD display. The display shows the measurement results of selected parameters in selected units (defined at the time of ordering). The parameters are displayed simultaeously at two separate rows on the display.

Interchangeable Probe

The HMP110 relative humidity probe used in the HMT130 transmitter is fully interchangeable. You can easily remove the probe and replace it with a new one without having to adjust the transmitter. You have the following options when purchasing a new probe from Vaisala:

- Order a new probe and keep your current one.
- Order a new probe and return the old one to Vaisala (replacement probe).

NOTE	Only probes that have a compatible digital output (VDIGI mode) can be used with HMT130 transmitter. Compatible probes have the letter "V" as the first letter in their order code. The order code is written on the probe.

Constant Output Probe

The constant output probe is a testing accessory that can be used to check transmitter's functions and measurement signal transfer chain all the way to the control system. The constant output probe does not measure humidity and temperature; instead, it outputs constant humidity and temperature readings.

The values output by the constant output probe are specified when ordering. These values are written on an additional label on the probe body.

The procedure for using the constant output probe is simply to replace the original probe for the duration of the testing:

1. Disconnect the normal probe from transmitter.
2. Connect the constant output probe to the transmitter.
3. Check that all used outputs (analog, display, serial line) show the correct measurement values.
4. After checking the outputs, disconnect the constant output probe and reconnect the original probe.

NOTE	The transmitter goes to the error state for a short time when the probe is changed. This is normal.

Transmitter Components

Figure 1 below illustrates the main features of HMT130. On the left is a remote probe model without display, and on the right is a fixed probe model with the optional display. The numbers and arrows indicate the main components of the transmitters.
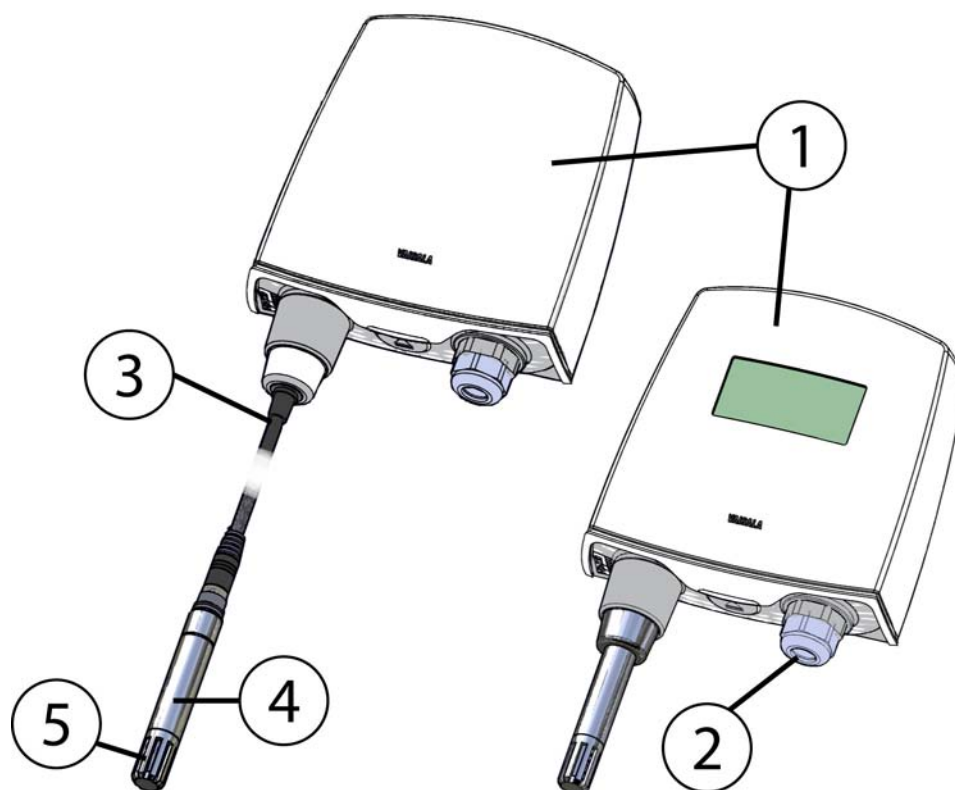
1007-001

Figure 1   HMT130 Components

The following numbers refer to Figure 1 above:

1   =   Transmitter enclosure
2   =   Cable bushing: cable gland, cable grommet, or conduit fitting.
3   =   Probe cable
4   =   HMP110 probe
5   =   Plastic grid filter

See section Options and Accessories on page 81 for accessory parts and their numbers.

CHAPTER 3
INSTALLATION

Mounting

Wall Mounting

1. Open the HMT130 cover by pushing the releasing button at the bottom of the transmitter housing and gently pulling the bottom part of the cover towards yourself.

2. Make sure that the HMT130 Humidity and Temperature Transmitter is correctly aligned and attach it directly to the wall with up to four screws (not included in the package).
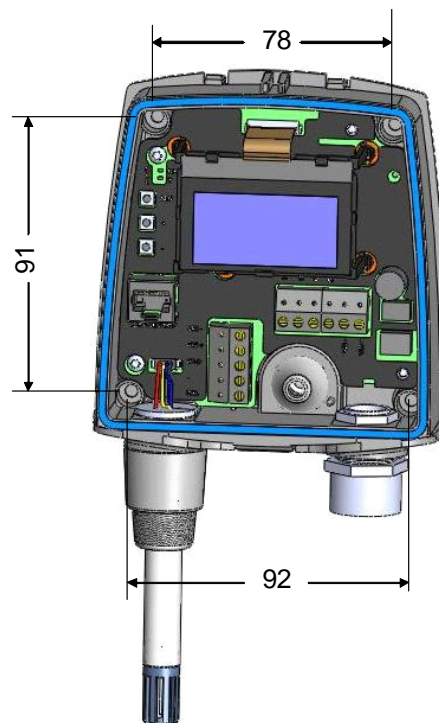
1011-160

Figure 2   HMT130 Wall Mounting

NOTE	Select the size and type of the fastening screws according to the wall material (wood, stone, etc.). Even though using all four screws is strongly recommended, the HMT130 enclosure fastening holes are initially covered with a thin plastic membrane, so less than four screws could be also be used without sacrificing the ingress protection (IP) class of the enclosure. The diameter of the fastening screws is typically between 3.5 and 4mm.

Installation with Rain Shield

The installation kit with rain shield includes a metal mounting plate and a rain shield for the transmitter. Vaisala order code: 215109.
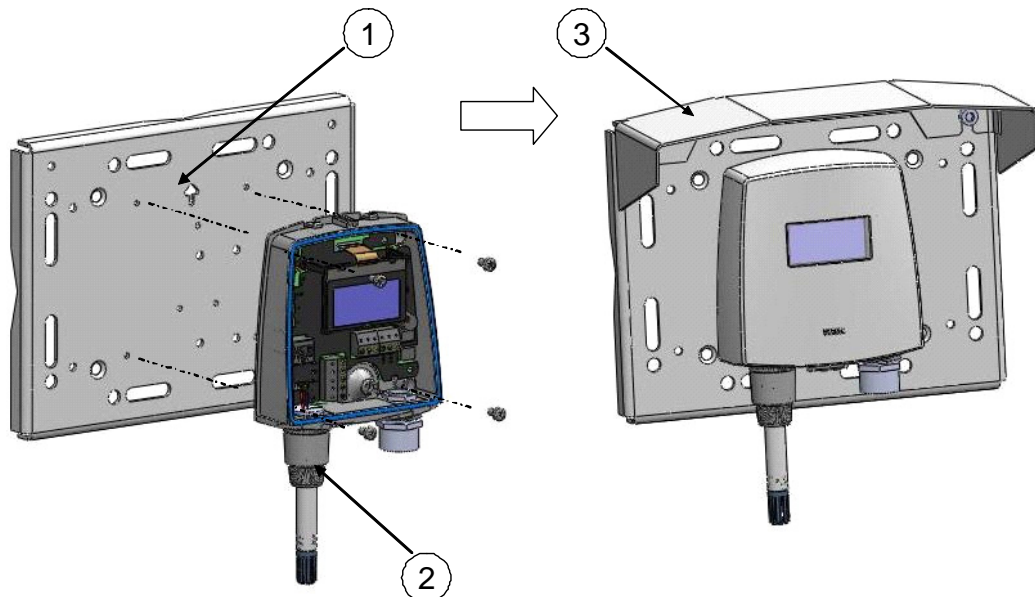
1011-161

Figure 3   HMT130 Installation with Rain Shield

1.   Fasten the metal mounting plate to the wall or pole with screws (see Figure 3 above). Note the arrow on the mounting plate. Attach the mounting plate with the arrow pointing upwards.

2.   Drill holes for the screws in the HMT130 frame, and fasten HMT130 Humidity and Temperature Transmitter to the metal mounting plate with four (M4) screws.

3.   Fasten the rain shield to the metal mounting plate with two (M6) mounting screws.

Installation with Radiation Shield

DTR502 with probe installation kit includes a rain/solar radiation shield DTR502 and a plastic installation support for the humidity probe. Vaisala order code: DTR502B. If you already have the DTR502 shield and need only the installation support for the probe, it is available with Vaisala order code 210623.

1.   Fasten the probe to the installation support with two cable ties (items 3 and 4 in Figure 4 below).

2.   Insert and attach the support to the radiation shield by tightening the plastic nut (2).

3.   Attach the entire radiation shield/probe assembly to a pole mast (pole mast diameter: 30 ... 60 mm/1.2 ... 2.3") with the U-bolt and support arm.

0505-248
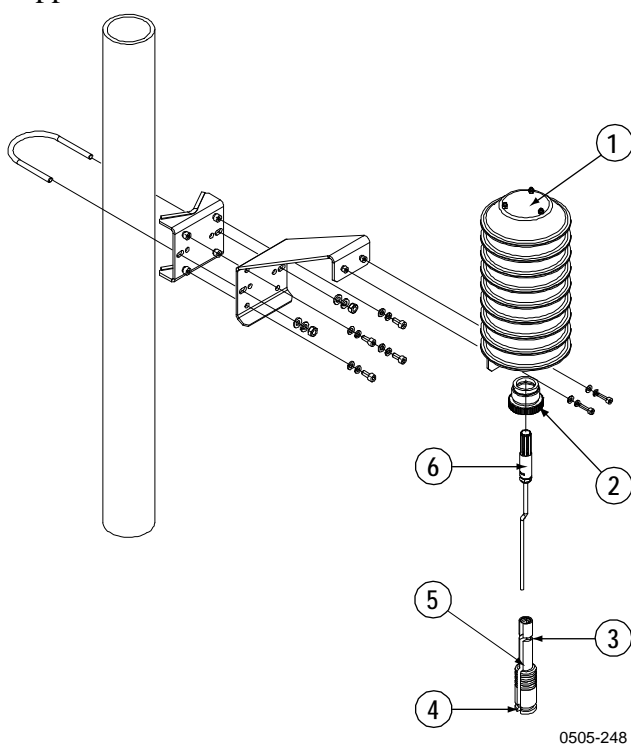
Figure 4   Installation of the Probe with Radiation Shield

The following numbers refer to Figure 4 above:

1   =   DTR502
2   =   Plastics nut
3, 4   =   Cable tie
5   =   Adapter DRW213054 (installation support)
6   =   Probe

Duct Installation Kit

The duct installation kit includes a plastic pipe with a flange (Vaisala order code: 215619). To install the HMP110 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 four screws. See section Probe Assembly with Duct Installation Kit on page 21 for details.
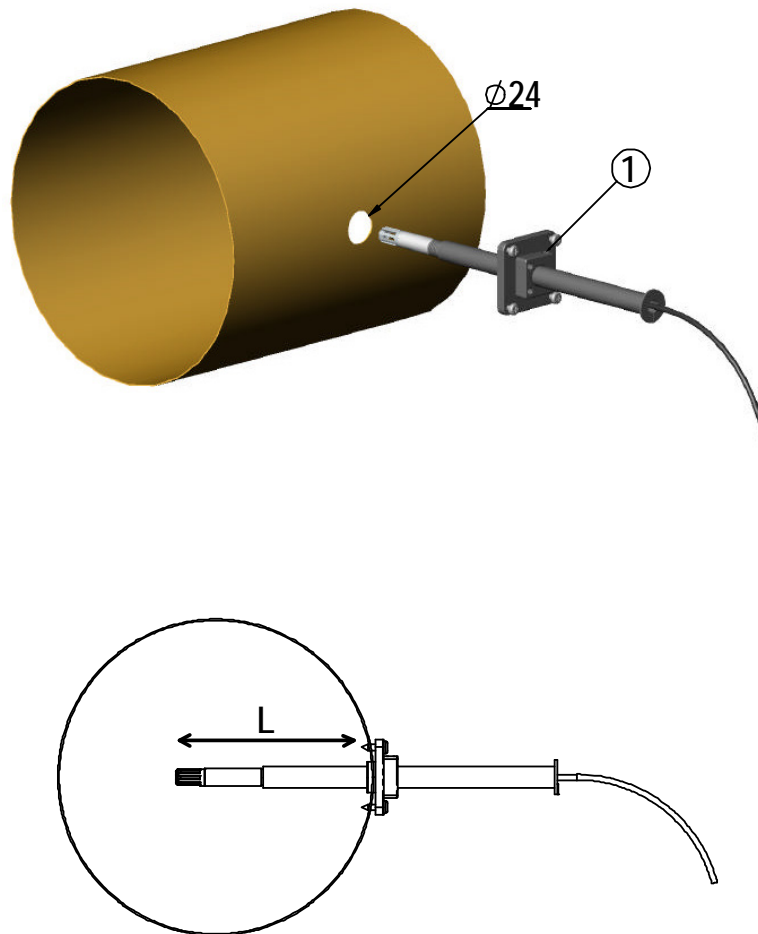
0505-176

Figure 5   Probe Installation with the Duct Installation Kit

The following explanations refer to Figure 5 above:

1   =   Tension screw

Distance L can be adjusted and locked in place with the tension screw.

Probe Assembly with Duct Installation Kit

0505-177
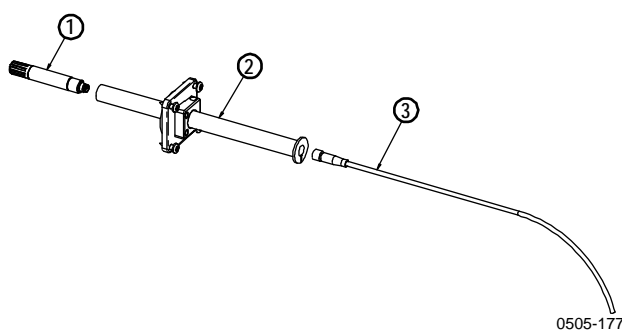
Figure 6   Assembly of the Probe with Duct Installation Kit

The following numbers refer to Figure 6 above:

1   =   HMP110
2   =   Duct installation kit
3   =   Probe cable

1.   Slide the probe cable through the duct installation kit plastic pipe.
2.   Attach the probe cable to the HMP110 Humidity Probe.
3.   Attach probe assembly to the duct.

Drilling Instructions for Duct Installation Kit

0505-178
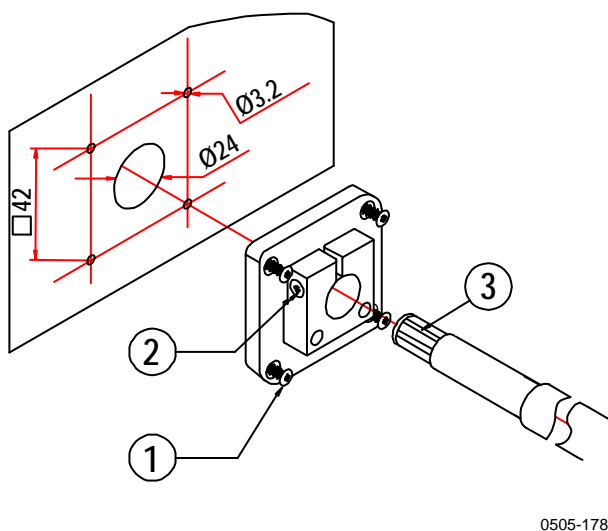
Figure 7   Drilling Instructions

The following numbers refer to Figure 7 above:

1   =   Mounting screw
2   =   Tension screw
3   =   HMP110 assembled in duct installation kit plastic pipe

Drill the holes for the duct installation kit as follows:

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).

Probe Mounting Flange

The probe mounting flange (Vaisala order code: 226061) is a general
purpose mounting flange for 12 mm diameter probes. It can be used to
hold the HMP110 probe in a through-wall installation.

NOTE	The coaxial silicone plug that is delivered with the flange is not suitable for use with the probe cable of the HMT130.

0911-109

Figure 8   Optional Probe Mounting Flange

Probe Mounting Clamp

The optional mounting clamp (Vaisala order code: 226067) 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.

Installing the entire probe in the measurement environment prevents heat conduction to the sensor, and is the recommended installation method.

1001-138

Figure 9   Optional Probe Mounting Clamp

CAUTION	Attaching the probe mounting clamp to a conductive wall material should be avoided, since the potential galvanic connection to the power supplies and uncontrolled earth current loops could cause measurement errors or even damage to the HMT130 transmitter

Connections
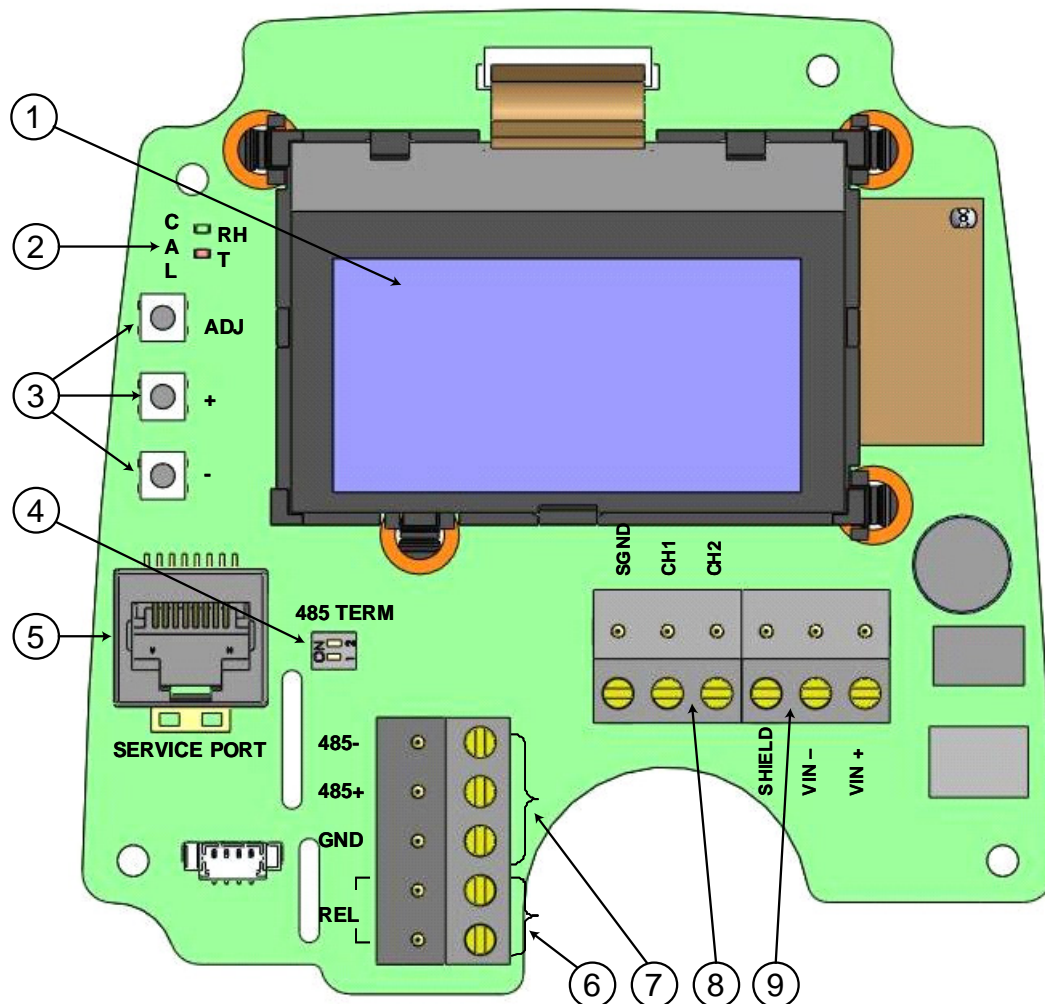
1011-162

Figure 10   HMT130 Component Board

The following numbers refer to Figure 10 above:

1	=	Optional LCD display
2	=	Indicator LEDs
3	=	Adjustment buttons
4	=	RS-485 bus termination switch
5	=	Service port
6	=	Relay terminals
7	=	RS-485 bus
8	=	Analog outputs
9	=	Power supply connectors

1.   Open the transmitter cover by pressing the releasing button at the bottom side of the transmitter.

2.   Insert the signal wires through the selected cable gland/conduit fitting in the bottom of the transmitter or alternatively through the rubber grommet at the back side of the transmitter.

3.   Connect the wires as indicated in Figure 11, Figure 12, and in Table 3 below. Suitable wire size is between $0.5mm^2$ and $1.5mm^2$.

4.   Switch on the RS-485 bus termination switch if necessary. For more information on the RS-485 bus termination switch see section

5.   Close the cover by keeping it slightly tilted and first attaching it to the fixing snaps at the top of the enclosure base and then pushing the lower part of the cover firmly forward until it locks. The transmitter is ready for use.
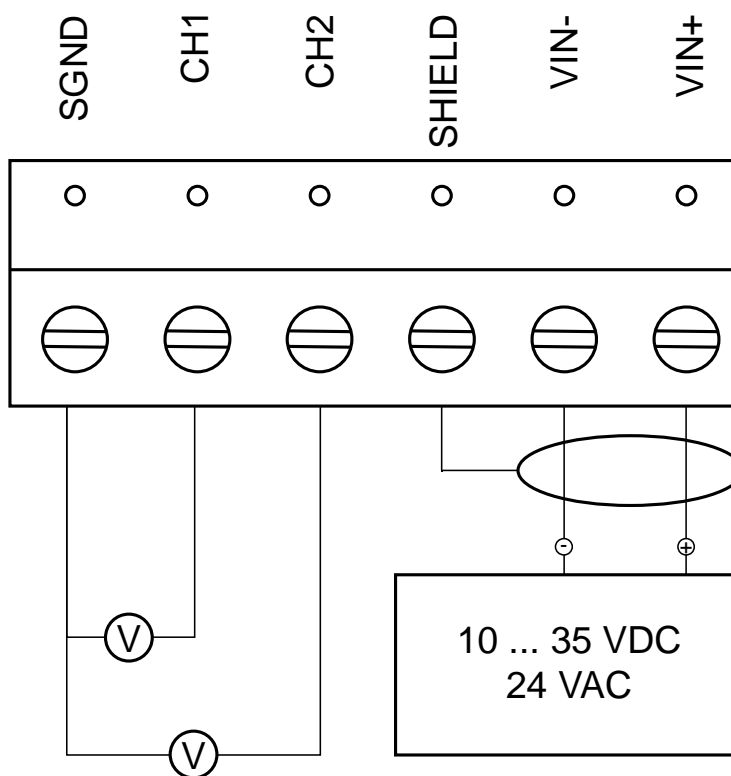
1011-163

Figure 11   Power Supply And Voltage Outputs

NOTE	15 ... 35 VDC or 24 VAC is needed when using the 0 ... 10 V output.
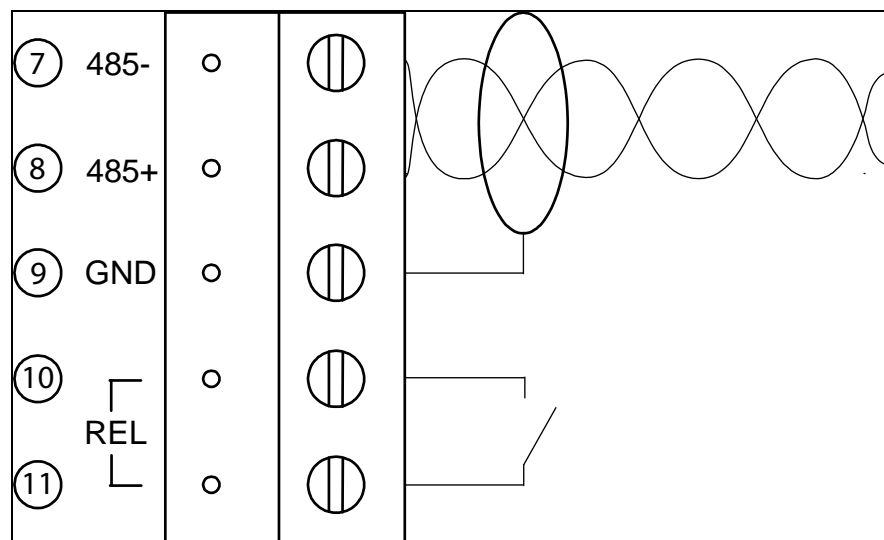
1011-164

Figure 12   Serial Communication and Relay

Table 3   Wiring Table

Terminal	Description
1	SGND (signal ground)
2	CH1+ (signal +)
3	CH2+ (signal +)
4	Cable shield (optional)
5	Vin- (power supply - or VAC)
6	Vin+ (power supply + or VAC)
7	485-
8	485+
9	GND (ground)
10	Relay
11	Relay

Numbers 1 ... 6 in the first column of the wiring table refer to Figure 11 on page 25 and numbers 7 ... 11 to Figure 12 above.

RS-485 Bus Termination

If you use RS-485 to connect just one HMT130 to a master computer, enable the internal termination of HMT130 by switching switches 1 and 2 ON. Make sure that the master's end of the line is also terminated (by using master's internal termination or with a separate terminator).

If you are connecting many transmitters to the same RS-485 bus, make sure that switches 1 and 2 are OFF and terminate the bus with separate terminators at both ends. This allows removing any transmitter without blocking the bus operation.

CHAPTER 4
OPERATION

This chapter contains information that is needed to operate the HMT130.

Using the Service Port

HMT130 motherboard has an 8-pin RJ-45 connector for service use. Service port uses RS-232 signaling levels. Vaisala offers an optional USB cable (Vaisala order code 219685) for connecting the transmitter to your PC.

NOTE	The service port is intended for short-term use such as calibration. For permanent installation, use the analog output or the RS-485 serial line.
	Connecting a PC to the service port may cause erroneous analog output because of a possible ground loop. Use the service port for service only, and disconnect the PC after the service operation.

The cable can also provide operation power to the transmitter, so the wires at the screw terminals need not to be connected in order to operate the transmitter.

If you have not used the HMT130 USB cable before, install the driver that came with the cable. Refer to section Installing the Driver for the USB Cable below for detailed instructions.

Installing the Driver for the USB Cable

Before taking the USB cable into use, you must install the provided USB driver on your PC. When installing the driver, you must acknowledge any security prompts that may appear. The driver is compatible with Windows 2000, Windows XP, Windows Server 2003, and Windows Vista.

1.	Check that the USB cable is not connected. Disconnect the cable if you have already connected it.

2. Insert the media that came with the cable, or download the driver from www.vaisala.com.

3. Execute the USB driver installation program (setup.exe), and accept the installation defaults. The installation of the driver may take several minutes.

4. After the driver has been installed, connect the USB cable to a USB port on your PC. Windows will detect the new device, and use the driver automatically.

5. The installation has reserved a COM port for the cable. Verify the port number, and the status of the cable, using the **Vaisala USB Instrument Finder** program that has been installed in the Windows Start menu.

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

There is no reason to uninstall the driver for normal use. However, if you wish to remove the driver files and all Vaisala USB cable devices, you can do so by uninstalling the entry for **Vaisala USB Instrument Driver** from the **Add or Remove Programs** (**Programs and Features** in Windows Vista) in the Windows Control Panel.

Terminal Application Settings

The default settings of the HMT130 serial interface are presented in Table 4.

Table 4   Default Serial Interface Setting

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

The steps below describe how to connect to the HMT130 using the PuTTY terminal application for Windows (available for download at www.vaisala.com) and the USB serial interface cable:

1. Connect the USB cable between your PC and the service port of the HMT130.

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.

    Note: You can check which port the USB cable is using with the **Vaisala USB Instrument Finder program** that has been installed in the Windows Start menu.

4. Check that the other serial settings are correct for your connection, and change if necessary. **Flow control** should be set to **None** unless you have a reason to change it.

5. Click the **Open** button to open the connection window and start using the serial line.

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

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, click the right mouse button over the session window, and select **Change Settings...** from the pop-up menu.
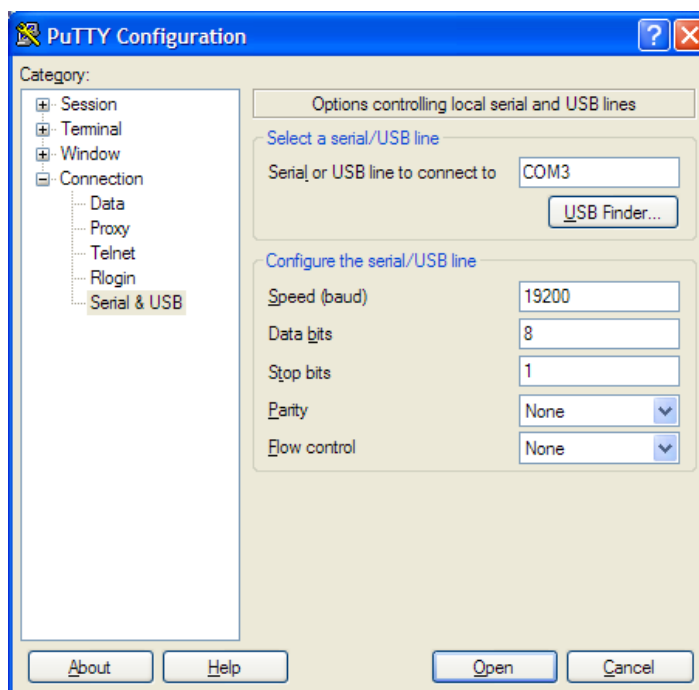
0807-004

Figure 13   PuTTY Terminal Application

List of Serial Commands

All commands can be issued either in uppercase or lowercase. The notation <cr> refers to pressing the carriage return (ENTER) key on your computer keyboard. Enter a <cr> to clear the command buffer before starting to enter commands.

Whenever you change any of the parameters and want to store the changes permanently, use the **SAVE** command.

Table 5   **Serial Port Commands**

Command	Description
?	Show transmitter information
??	Show transmitter information (POLL mode)
ACAL	Calibrate analog outputs
ADDR	Set/show device address
AERR	Set/show analog output error levels
AMODE	Set/show analog output mode
AOUT	Show analog output status
ASEL	Set/show analog output quantities and scaling
ATEST	Test analog outputs
CALCS	Set/show measured quantities
CDATE	Set/show calibration date
CLOSE	Start POLL mode
CRH	Calibrate probe RH
CRHCLR	Restore probe RH factory calibration
CT	Calibrate probe T
CTCLR	Restore probe T factory calibration
CTEXT	Set/show calibration info
DSEL	Set/show displayed quantities
ECHO	Set/show terminal echo mode
ENV	Set/show environmental parameters
ERRS	Display active errors
FORM	Set/show output formatting
FRESTORE	Restore all transmitter settings to factory defaults
HELP	List available commands
INTV	Set/show the continuous output interval
OPEN	Stop POLL mode
R	Start continuous outputting
RESET	Reset transmitter
RESTORE	Restores the latest saved settings
RMODE	Set/show relay operating mode
ROUT	Show all relay-related parameters
RSEL	Set/show relay quantity
S	Stop continuous outputting
SAVE	Save changed settings to FLASH memory
SDELAY	Set/show RS-485 turnaround time for User Port
SEND	Output the reading once
SERI	Set/show Port settings (Default: 19200 N 8 1)
SERI2	Set/show User Port settings (Default: 19200 N 8 1)
SMODE	Set the serial interface mode
SYSTEM	Show transmitter information and build date
UNIT	Set/show output unit
VERS	Show firmware version of the transmitter

Device Information and Status

Show Device Information

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

?<cr>

Example:

```
>?
Device Name         : HMT130
SW Name             : HMT120/130
SW model            : HMT130
SW version          : 0.9.3.389
Serial number       : "F2220101"
Address             : 0
Unit                : METRIC
Ch1 Status          : ON
Ch2 Status          : ON
Probe name          : "HMP110"
Probe SW            : "1.01.1"
Probe SW date       : ""
Probe SN            : "F0740011"
>
```

Set/Show Available Quantities

The **CALCS** command shows the abbreviations of the quantities measured by HMT130. The command can also be used to select the desired quantities for measurement. Only after the quantities have been set with the **CALCS** command, can these quantities be selected for different outputs (see commands **DSEL**, **ASEL**, and **FORM**). The quantities in **DSEL**, **ASEL**, **RSEL,** and **FORM** must match with **CALCS**.

CALCS [*q1 q2*]<cr>

Where

q1, q2   =   Any two of the allowed quantity parameters, i.e. RH, T, TD, TDF, A, X, H, TW, PWS, PW

Examples:

```
>calcs
RH Td
>

calcs td t
>
```

NOTE	Single-parameter transmitters HMT130H and HMT130T have only one quantity (T for HMT130T, and RH, TD, TDF, A, X, H, TW, PWS, PW for HMT130H.)

Set/Show Calibration Date

Use the **CDATE** command to show or set the calibration date field. (Calibration refers to the calibration of the HMT130's analog outputs.)

CDATE [*date*]<cr>

where

date   =   Calibration date in format yyyy-mm-dd

Examples:

```
>cdate
Calibrated          : "NOT SET"
>

>cdate 2009-06-22
Calibrated          : "2009-06-22"
>
```

Set/Show Calibration Information

Use the **CTEXT** command to show or set the calibration info field. (Calibration refers to the calibration of the HMT130's analog outputs.)

CTEXT [*location*]<cr>

where

location   =   Freely defined text string typically indicating the calibration location

Examples:

```
>ctext
Calib. info: "VAISALA HELSINKI"
>

>ctext "Calibration lab 2"
Calib. info: "Calibration lab 2"
>
```

Show Analog Output Status

The **AOUT** command shows the following information:

- **Analog out mode** is the output mode for the channel, for example 0 ... 10 V.
- **Error level** is the level that the analog output is set to in case of transmitter error.
- **Status** indicates the current status of the channel. The statuses are
  - **ON**: Normal measurement operation.
  - **OFF**: No quantity selected for the channel using the **ASEL** command. See section Set/Show Analog Output Quantity and Scaling on page 42.
  - **ERROR**: Transmitter error, channel set to error level.
  - **TEST**: Analog channel being tested using the **ATEST** command. See section Test Analog Outputs on page 44.

AOUT<cr>

Example:

```
>aout
*** ANALOG OUTPUT 1 ***
Ch1 Analog out mode : 0_10V
Ch1 Error level     : 10.8
Ch1 Quantity        : RH
Ch1 Status          : ON
RH lo               : 0
RH hi               : 100
RH                  : 36.64 %
Ch1 Voltage         : 3.66 V

*** ANALOG OUTPUT 2 ***
Ch2 Analog out mode : 0_10V
Ch2 Error level     : 10.8
Ch2 Quantity        : T
Ch2 Status          : ON
T lo                : -60
T hi                : 100
T                   : 23.85 'C
Ch2 Voltage         : 5.24 V
>
```

Show System Information

SYSTEM<cr>

Example:

```
>system
Device Name          : HMT130
SW Name              : HMT120/130
SW model             : HMT130
SW version           : 1.0.0.500
Serial number        : A1234567
>
```

Show Firmware Version

VERS<cr>

Example:

```
>vers
HMT130 / 0.1.0.103
>
```

Serial Line Output Commands

Start Continuous Outputting

Use the **R** command to start the continuous outputting of measurement values as an ASCII text string to the serial line. The output always includes the readings of the currently selected analog output quantities.

R [X]<cr>

Example:

```
>r
RH= 25.10% T= 24.77'C
RH= 25.12% T= 24.96'C
…
```

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

Output data formatting can be defined with **FORM** command. With X parameter the transmitter will output RH + T value in predefined format regardless of what quantities are selected.

Stop Continuous Outputting

Use the **S** command to stop the continuous measurement output:

S<cr>

Set/Show 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 one second. This command has no effect on the operation of the analog outputs.

INTV [*n xxx*]<cr>

where

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

Examples:

```
>intv
Value             : 1
Unit              : S
>

>intv 3 min
Value             : 3
Unit              : MIN
>
```

Output a Reading Once

Use the **SEND** command to output a single measurement reading from the transmitter.

SEND [X]<cr>

Example:

```
>send
RH= 25.12 % T= 24.91 'C
>
```

With X parameter the transmitter will output RH + T value in predefined format regardless of what quantities are selected.

Calibration Commands

Serial commands that are related to calibration are described below. For the actual calibration procedures, see section **Calibration and Adjustment** on page 58.

Calibrate Humidity Measurement

Use the **CRH** command to perform a one-point or two-point humidity (RH) calibration.

CRH<cr>

When performing a one-point calibration, you need to place the probe in a single humidity reference with RH < 50%. Run the command and enter the exact RH of the reference after the measurement has stabilized. Exit the command by pressing the ESC key before proceeding to the second point (see example below). To update the value, press ENTER without inputting a value.

For two-point calibration, the first point requires a RH < 35% humidity reference, the second point must be RH > 50%.

Example 1: One-point calibration

```
>crh
RH:      11.29915720 Ref1 ? 11.3
Press ENTER to continue or ESC to exit
OK
>
```

Example 2: Two-point calibration

```
>crh
RH:      11.29915720 Ref1 ? 11.3
Press ENTER to continue or ESC to exit
RH:      75.04306440 Ref2 ? 75
OK
>
```

Example 3: No calibration, only updating the value

```
>crh
RH:      20.28000200 Ref1 ?
RH:      20.14000000 Ref1 ?
Calibration terminated with ESC
>
```

Restore Probe RH Factory Calibration

Use the **CRHCLR** to restore the probe RH factory calibration.

CRHCLR<cr>

Example:

```
>crhclr
OK
>
```

Calibrate Temperature Measurement

Use the **CT** command to perform a one-point or two-point temperature (T) calibration.

CT<cr>

When performing a one-point calibration, you need to place the probe in a single temperature reference. Run the command and enter the exact temperature of the reference after the measurement has stabilized. Exit the command by pressing the ESC key before proceeding to the second point. To update the value, press ENTER without inputting a value.

For two-point calibration, the second reference point must be at least 20 ⁰C warmer than the first. The measurement reading for the second point will appear when this requirement is met.

Example 1: One-point calibration

```
>ct
T  21.9827 Ref1 ? 22
Press ENTER to continue or ESC to exit
OK
>
```

Example 2: Two-point calibration

```
>ct
T  22.0007 Ref1 ? 22
Press ENTER to continue or ESC to exit
T  44.9847 Ref2 ? 45
OK
>
```

Example 3: No calibration, only updating the value

```
>ct
T  22.0007 Ref1 ?
T  22.0145 Ref1 ?
Calibration terminated with ESC
>
```

Restore Probe T Factory Calibration

Use the **CTCLR** to restore the probe T factory calibration.

CTCLR<cr>

Example:

```
>ctclr
OK
>
```

Calibrate Analog Output

Use the **ACAL** command to calibrate the analog voltage outputs.

ACAL<cr>

After you give this command, the CH1 analog output of the transmitter is set to the low limit (0V). Measure the output and enter the measured value. After entering the low limit, you must measure and enter the high limit also (for example 10V, depends on the output mode of the channel). The same procedure is then repeated with CH2.

Calculated coefficients are printed after the measured values are given.

Example:

```
>acal
Ch1  V1 (V)  ? 0.11
Ch1  V2 (V)  ? 10.21
  1.92308600E+02 a0
  2.58811860E+03 a1
OK
Ch2  V1 (V)  ? 0.11
Ch2  V2 (V)  ? 10.20
  1.92024420E+02 a0
  2.59068400E+03 a1
OK
```

NOTE	Question mark is displayed after certain stabilization time has expired. Values should be entered only after question mark is displayed. Values entered before question mark will be discarded.

Configuring Serial Line Operation

Set/Show Serial Line Settings

Use the **SERI** command to show or set the serial line settings for the serial port that you are currently using (service port or user port).

Use the **SAVE** command after changing the settings to store them. The new settings will be taken into use when the transmitter is reset or powered up.

SERI [*b p d s*]<cr>

where

b = baud rate (9600, 19200, 38400, 76800, 115200)
p = parity (n = none, e = even, o = odd)
d = data bits (7 or 8)
s = stop bits (1 or 2)

Examples:

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

>seri 9600 e 7 1
Baud rate          : 9600
Parity             : E
Data bits          : 7
Stop bits          : 1
>save
Saving settings...done
>
```

Set/Show Terminal Echo

To show or set the terminal echo status, use the **ECHO** command.

ECHO [ON/OFF]<cr>

Examples:

```
>echo
COM1 Echo               : OFF
>

>echo on
COM1 Echo               : ON
```

Set/Show Serial Interface Mode

Use the **SMODE** command to show or set the serial interface mode. Note that a separate **SAVE** command is not needed to store the new serial interface mode setting.

SMODE [STOP/RUN]<cr>

In STOP mode: outputting only when command is issued, any command can be used.

In RUN mode: outputting automatically, only command **S** can be used.

Example:

```
>smode stop
Output mode    : STOP
>
```

Configuring Measurement Parameters

Set/Show Environmental Parameters

Use the **ENV** command to show or set the environmental compensation values. In HMT130, the humidity measurement can be compensated for ambient pressure. The value set using **ENV** command is a permanent value which will survive a restart.

ENV [*x.xxxx*]<cr>

where

x.xxxx   =   Absolute pressure in the measuring environment. The default is **1.013**. The pressure unit is bar.

Example:

```
>env
Pressure (bar)     : 1.013
>

>env 0.980
Pressure (bar)     : 0.98
>save
Saving settings...done
>
```

NOTE	You can use the Vaisala Humidity Calculator to simulate the effect of pressure change to dewpoint. The Humidity Calculator can be found at: www.vaisala.com/humiditycalculator

Configuring Analog Output

Set/Show Analog Output Mode

Use the **AMODE** command to show or set the analog output mode.

AMODE [CH1mode CH2mode] [CH1lowlimit CH1highlimit]
[CH2lowlimit CH2highlimit]<cr>

Where

CH1mode   =   0_5V (Output scale 0 … 5V)
CH2mode   0_10V (Output scale 0 … 10V)
                  X_YV (Output scale lowlimit … highlimit)

CH1lowlimit =   Low limit for output voltage
CH2lowlimit
CH1highlimit =   High limit for output voltage
CH2highlimit

Example (Channel 1 limits configured as 1 ... 6 volts and Channel 2 as
0 ... 5 volts):

```
>amode x_yv 0_5V 1 6
Ch1 Analog out mode : X_YV
Ch2 Analog out mode : 0_5V
Ch1 low limit       : 1
Ch1 high limit      : 6
>
```

Example (User prompted to accept currently used channel limits or enter
new limits):

```
>amode x_yv
Ch1 Analog out mode : X_YV
Ch2 Analog out mode : 0_10V ?
Ch1 low limit       : 0 ?
Ch1 high limit      : 10 ? 1
>
```

Set/Show Analog Output Error Levels

Use the **AERR** command to show or set the analog output error levels.

AERR [*level1 level2*]<cr>

where

level1 level2 = Error levels for analog output channel

Examples:

```
>aerr
Ch1 Error level     : 0.0
Ch2 Error level     : 0.0
>

>aerr 10.8 10.8
Ch1 Error level     : 10.8
Ch2 Error level     : 10.8
>
```

Set/Show Analog Output Quantity and Scaling

After you have defined the quantities with the **CALCS** command, use the **ASEL** command to show or set the quantity output by the analog channels, and the scaling that is used. If you do not enter scaling limits, default values are used. Valid quantities are: RH, T, TD, TDF, A, X, H, TW, PWS, PW and NONE. NONE parameter disables analog output and output is forced to error level.

ASEL [*q1 q2*] [*lo1 hi1 lo2 hi2*]<cr>

where

q1 q2   = Analog output channel quantities
lo1 lo2 = Low limits of scaling
hi1 hi2 = High limits of scaling

Syntax for single-parameter transmitters:

ASEL [*q*] [*lo hi*]<cr>

Where

q   = Analog output channel quantity
lo = Low limit of scaling
hi = High limit of scaling

Examples:

```
>asel
Ch1 Quantity        : RH
RH lo               : 0
RH hi               : 100
Ch2 Quantity        : T
T lo                : -60
T hi                : 100
>

>asel rh td
Ch1 Quantity        : RH
RH lo               : 0
RH hi               : 100
Ch2 Quantity        : TD
Td lo               : -40
Td hi               : 60
>

>asel t td 0 60 -20 60
Ch1 Quantity        : T
T lo                : 0
T hi                : 60
Ch2 Quantity        : TD
Td lo               : -20
Td hi               : 60
>

>asel rh none
Ch1 Quantity        : RH
RH lo               : 0
RH hi               : 100
Ch2 Quantity        : NONE
>

>asel none none
Ch1 Quantity        : NONE
Ch2 Quantity        : NONE
>
```

Test Analog Outputs

Use the **ATEST** command to test the analog outputs. The **ATEST** command will force the output to the given value, which can then be measured with a calibrated multimeter.

ATEST command affects only the analog outputs and hence it does not disable measurement functions. **ATEST** without parameters will exit the test mode and let the measurement continue. It will also indicate the the current analog output levels in normal measurement state.

ATEST [*val1 val2*]<cr>

where

val1 val2   =   Analog channel output value (V)

Examples:

```
>atest
CH1: 2.360000
CH2: 3.765010
>

>atest 5.0 5.0
CH1: 5.000000
CH2: 5.000000
>
```

Configuring Relay Output

Set/Show Relay Quantity

After you have defined the quantities with the **CALCS** command, use the **RSEL** command to show or set the relay quantity. Valid quantity parameters are RH, T, TD, TDF, A, X, H, TW, PWS and PW.

RSEL [*q*]<cr>

where

q   =   Quantity to define relay state.

Example:

```
>RSEL T
Relay quantity      : T
```

Set/Show Relay Operating Mode

Use the **RMODE** command to set/show relay mode, low and high limits. Relay modes are OFF, LO_OPEN and HI_OPEN. Low and high values specify relay operation limits for the selected quantity.

RMODE [*xxxx*] [lo] [hi]<cr>

where

xxxx = OFF, LO_OPEN or HI_OPEN
lo = Low limit
hi = High limit

In OFF mode:	relay contacts are always open
In LO_OPEN mode:	relay contacts are opened when the value is below the set low limit and closed when value is above the high limit.
In HI_OPEN mode:	relay contacts are opened when the value is above the set high limit and closed when value is below the low limit.

Example:

```
>RMODE LO_OPEN 10 20
Relay mode          : LO_OPEN
Relay low           : 10
Relay high          : 20
```

Show Relay Settings

Use the **ROUT** command to show the current relay settings.

ROUT<cr>

Example:

```
>ROUT

*** RELAY OUTPUT ***
Relay quantity      : RH
RH                  : 22.35 %
Relay mode          : LO_OPEN
Relay low           : 10
Relay high          : 20
Relay status        : CLOSED
```

Other Commands

Set/Show Displayed Quantities

After you have defined the quantities with the **CALCS** command, use the **DSEL** command to show or set the displayed quantities. Number of parameters determine the display mode (ie. one or two rows). If one quantity is given, display will switch to one row mode. If two quantities are given, two row mode is used. Valid quantities are: RH, T, TD, TDF, A, X, H, TW, PWS and PW.

DSEL [*q1 q2*]<cr>

where

q1 q2   =   Quantities to be shown on transmitter display

Syntax for single-parameter transmitters:

DSEL [*q*]<cr>

where

q   =   Quantity to be shown on transmitter display

Examples:

```
>dsel
1. quantity         : RH
2. quantity         : T
>

>dsel rh t
1. quantity         : RH
2. quantity         : T
>

>dsel t
1. quantity         : T
>
```

Set/Show Output Formatting

After you have defined the quantities with the **CALCS** command, use the **FORM** command to set the output format for **SEND** and **R** commands.

FORM [*format*]<cr>

where

format = A formatting string, which can consist of following fields:

""	String constant
x.y	Value length modifier. x is numbers before dot and y is numbers after dot.
Ux	Unit field length. U…U format is also supported.
Q	Quantity name (e.g. rh, t, td etc.)
#t or \t	Tabulator
#r or \r	Carriage return
#n or \n	Line feed (new line)

Note 1. Quantity must be after x.y and Ux modifiers.
Note 2. There must be a space between parameters, #r#n or \r\n is not supported.
Note 3. Max. string length is 80 characters.
Note 4. If Ux parameter is not used, unit is not displayed.

Examples:

```
>form "RH= " 3.2 U2 rh #r #n
>send
RH= 32.16 %
>


>form "t=" 4.1 U3 t \t "rh=" 3.2 U2 rh \r \n
>send
t=  22.5 'C    rh= 29.12 %
>


>form "t=" 4.1 U3 t \t "rh=" rh \r \n
>send
t=  22.3 'C    rh=  29.5  %
>


>form 3.2 UUU "RH=" rh \t "T=" t \r \n
>send
RH= 27.99  %    T= 23.34 'C
>


>form 3.3 rh " " t \r \n
>send
 26.740  23.660
>


>form "->" "RH=" 3.2 U2 rh " " "T=" 3.1 U3 t #r #n
>send
->RH= 27.79 % T= 23.4 'C
>
```

Display Command List

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

HELP<cr>

Display Active Errors

Use the **ERRS** command to display the currently active error codes. For troubleshooting active errors, see **Table 7** on page 75.

ERRS<cr>

Example (no active errors):

```
>errs
No errors.
>
```

Save Changed Settings

Use the **SAVE** command to save changed settings to the transmitter FLASH memory. Most settings have to be saved or the changes are lost at the next reset or power down.

NOTE	The **SMODE** command saves the new serial mode immediately; a separate **SAVE** command is not needed.
	The probe calibration commands (CRH, CT, CRHCLR, CTCLR) store the parameters into the probe's memory automatically without a separate **SAVE** command.

SAVE<cr>

Example:

```
>save
Saving settings...done
>
```

Restore Saved Settings

Use the **RESTORE** command to restore saved settings from transmitter
FLASH memory to RAM. All unsaved changes will be lost.

RESTORE<cr>

Example:

```
>restore
Restoring default settings...done
>
```

Reset Transmitter

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

After reset the configuration is loaded from FLASH memory. That
configuration can be altered with SAVE-command.

RESET<cr>

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

```
>reset
HMT130 / 0.1.0.001
Type "help" for command list
>
```

Restore Factory Settings

Use the **FRESTORE** command to restore the factory settings to the
transmitter. All user settings, including the user-performed calibration
corrections, will be lost. The transmitter will revert back to the factory
calibrated settings. Note that this only returns the factory settings of the
transmitter and not of the interchangeable probe (see section Restore
Probe RH Factory Calibration on page 37 and section Restore Probe T
Factory Calibration on page 38).

FRESTORE<cr>

Example:

```
>frestore
Restoring factory defaults...done
>
```

Set/Show Output Unit

Use the **UNIT** command for output unit selection (metric or non-metric).

UNIT [METRIC/NON_METRIC]<cr>

Example:

```
>unit
Unit                 : METRIC
>

>unit non_metric
Unit                 : NON_METRIC
>
```

Operating the User Port (RS-485)

The RS-485 interface enables communication between RS-485 network and HMT130 transmitter. The RS-485 interface is not isolated.

Networking Commands

Set the RS-485 interface by using the following commands. The other serial line commands are presented in section List of Serial Commands on page 30.

SERI
Use the **SERI** command to input RS-485 bus settings. This command affects the serial port where the settings are given (service port or user port).

SERI [b p d s]<cr>

where

b = bit rate (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200)
p = parity (n = none, e = even, o = odd)
d = data bits (7 or 8)
s = stop bits (1 or 2)

SERI2
The **SERI2** command is equivalent to the **SERI** command, but it affects only the user port settings. The main purpose of the command is to change the user port settings via the service port.

SERI2 [b p d s]<cr>

ECHO

Use the **ECHO** command to enable/disable echo of characters received over the serial line.

ECHO [*x*]<cr>

where

x   =   ON/OFF (default = OFF)

When using 2-wire connection, echo must be always disabled.

SMODE

Use the **SMODE** command to set the default serial interface mode.

SMODE [*xxxx*]<cr>

where

xxxx   = STOP, RUN or POLL
In STOP mode: measurements output only by command SEND, all
                 commands can be used
In RUN mode: outputting automatically, only command S can be
                 used to stop.
In POLL mode: measurements output only with command SEND
                 [*addr*].

When several transmitters are connected to the same line, each transmitter must be entered an own address in the initial configuration, and POLL mode must be used.

SDELAY

Use the **SDELAY** command to set the answer delay (RS-485 turnaround time) for the User Port.

SDELAY [*delay*]<cr>

where

delay = RS-485 turnaround time in milliseconds, range 0 ... 1000 ms.

 Example:

```
>sdelay 100
Turnaround time    : 100
>
```

INTV

Use the **INTV** command to set the RUN mode output interval.

INTV [*n xxx*]<cr>

where

n   =   1 - 255
xxx =   S, MIN or H

This command sets the RUN mode output interval. The time interval is used only when the RUN mode is active. For example, the output interval is set to 10 minutes.

```
>INTV 10 min
Output intrv.  :    10 min
>
```

Setting RUN output interval to zero enables the fastest possible output rate.

ADDR

Addresses are required only for POLL mode (see serial line command SMODE on page 51). Use the **ADDR** command to input the RS-485 transmitter address.

OPEN [*aa*]<cr>

where

aa   =   address (0 ... 99) (default = 0)

Example: the transmitter is configured to address 99.

```
>ADDR
Address : 2 ?  99
>
```


SEND

Use the SEND command to output the reading once in POLL mode:

SEND [*aa*]<cr>

where

aa   =   address of the transmitter

OPEN

When all transmitters on the RS-485 bus are in POLL mode the **OPEN** command sets one transmitter temporarily to STOP mode so that other commands can be entered.

OPEN [*aa***]<cr>**

where

aa = address of the transmitter (0 ... 99)

CLOSE

The **CLOSE** command switches the transmitter back to the POLL mode.

CLOSE<cr>

Example:

```
>OPEN 2     (opens the line to transmitter 2, other
transmitters stay in POLL mode)

>CRH        (for example, calibration performed)
...
>CLOSE                 (line closed)
```

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CHAPTER 5
MAINTENANCE

This chapter provides information that is needed in basic maintenance of the product.

Replacing the HUMICAP® Sensor

Fixed and Remote Probe Models

1. Remove the filter (plastic grid or sintered stainless steel).
2. Remove the damaged sensor and insert a new one.
3. Recalibrate the probe.
4. Replace a dirty filter to ensure a maximum lifetime and a fast response for the sensor. Do not attempt to clean the filter.

Removing and Fastening the Probe

Fixed Probe Model

Remove and replace the probe as follows:

1. Loosen the metal locking bushing by carefully turning it counter clockwise.
2. Remove the probe from the transmitter by pulling it gently downwards.
3. Attach the new probe to the four pin M8 panel connector at the transmitter (only one position possible).
4. Tighten the locking bushing to the M8 panel connector by turning it clockwise
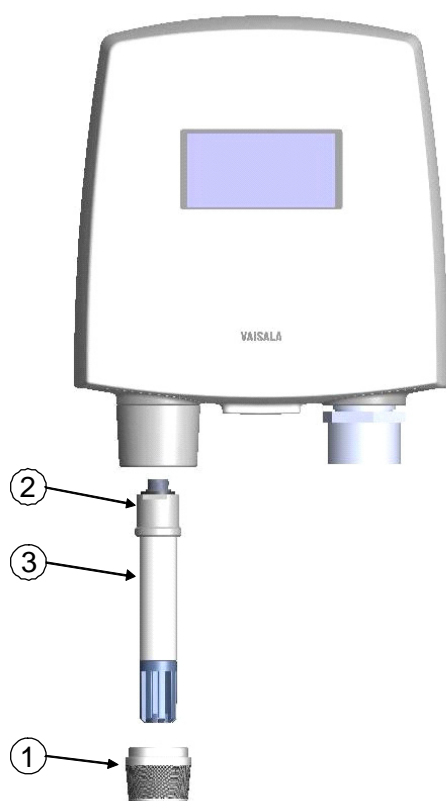
1011-153

Figure 14   Removing the Humidity Probe (Fixed Probe Model)

The following numbers refer to Figure 14 above:

1   =   Locking bushing
2   =   Holder bushing (attached permanently to the probe)
3   =   HMP110 probe

Remote Probe Model

1. Unscrew the small sleeve that secures the probe in place at the end of the probe cable and pull out the probe.

2. Replace the probe and screw the small sleeve back on, securing the probe tightly in place.
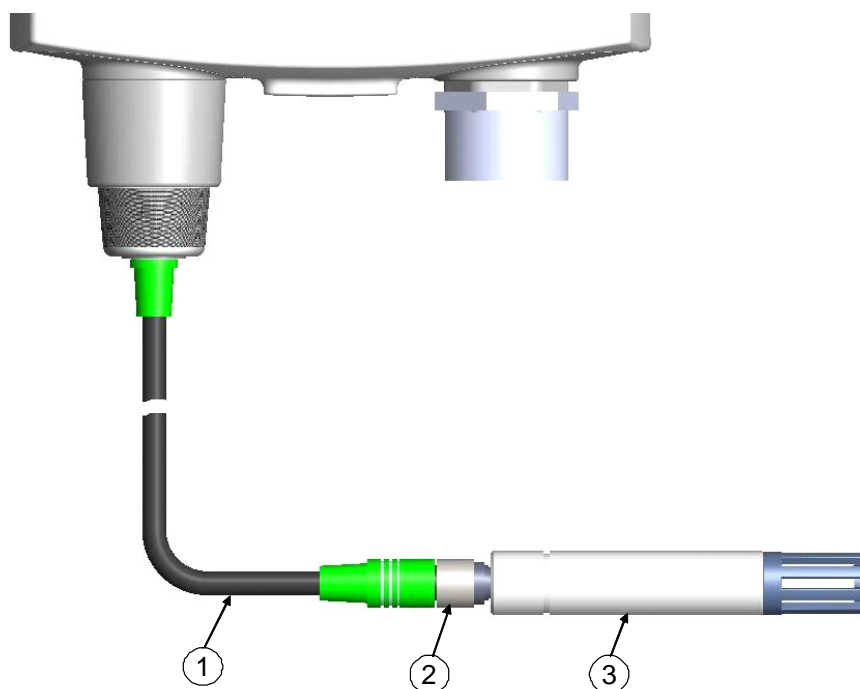
1011-154

Figure 15   Removing the Humidity Probe (Remote Probe Model)

The following numbers refer to Figure 15 above:

1   =   Probe cable
2   =   Sleeve securing the probe to the cable
3   =   HMP110 probe

Calibration and Adjustment

Calibrate and adjust the HMT130 using the push-buttons on the motherboard, serial line commands, or with portable humidity meters HM70 or HMI41.

A calibrator kit is needed for calibration against saturated salt solutions. The HMK15 Humidity Calibrator and pre-measured certified salts are available from Vaisala. For further information, please contact your Vaisala representative.

Vaisala Service Centers also offer accredited calibrations for humidity and temperature. See contact information on page 77.

It is also possible to remove the HMP110 probe and replace it with a new one. The old probe can be adjusted using another HMT130 transmitter body, if you have one available.

NOTE	RH Field Calibration and Adjustment, as instructed in the following pages, is restricted to a certain adjustment range to minimize the effects of special circumstances, such as chemical contamination. In case the probe is outside its adjustment/trim range due to, for example, chemical exposure, the calibration cannot be completed. In this case, it is recommended that you change the probe or contact Vaisala Services.

HMT130 Push-Button Calibration
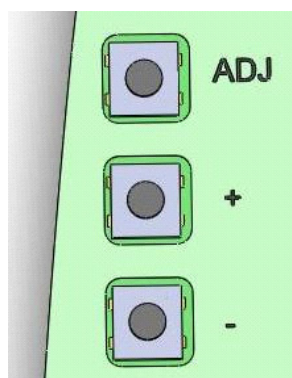
1011-155

Figure 16   Adjustment Buttons

Calibration and adjustment of the HMT130 can be done by using the adjustment buttons found at the transmitter. The two-point humidity adjustment is carried out by using two relative humidity references: for example saturated salt points 11 % RH (LiCl) and 75 % RH (NaCl). The

difference between the two humidity reference points must be at least 30 %RH. The difference between the two temperature reference points must be at least 30 °C.

NOTE	In push-button calibration, the transmitter outputs are by default relative humidity in the range 0…100% RH in CH1 and temperature in the range -40…+60°C in CH2 regardless what the actual transmitter settings are. Outputs mean in this case both the display and analog current outputs.

Humidity and Temperature Adjustment

To make a humidity or temperature adjustment (the same instructions apply to both one-point and two-point calibration):

1.   Open the transmitter cover and you can see three buttons marked **ADJ,** + and **-**. There are also two indicator LEDs, one green and one red on the HMT130 motherboard.
2.   Press the **ADJ** button and hold it down until the green indicator LED begins to blink slowly (800ms cycle time).
3.   HMT130 transmitter is now in RH calibration state. Analog output and optional display will still follow the actual measured RH value.

NOTE	If you do not wish to perform the RH adjustment at this time, press **ADJ** button one more time. The green indicator LED turns off and the red indicator LED begins to blink slowly (800ms cycle time) to indicate T calibration state. Now you can continue following the instructions from step 7 onwards.

4.   Remove the filter and insert the probe into a measurement hole of the dry end reference chamber (for example, LiCl: 11 % RH) to do the low humidity offset adjustment.

NOTE	Do not touch the adjustment buttons before the conditions have stabilized. This takes approximately 30 minutes.

5.   Press either the **-** or + button at least once, make sure that the U_{out} voltage is correct, adjust using the **-** and + buttons if needed, and press the **ADJ** button again. The green indicator LED begins to blink faster (400ms cycle time).

NOTE	If you do not wish to perform the two-point RH adjustment at this time, press the **ADJ** button one more time. The green indicator LED turns off and the red indicator LED begins to blink slowly (800ms cycle time) to indicate T calibration state. Now you can continue following the instructions from step 7 onwards.
	If one-point calibration is done at more than 50% RH, a gain adjustment is done instead of an offset adjustment.

6.   Insert the probe into the high end reference chamber (for example, NaCl: 75 % RH chamber in the humidity calibrator HMK15) and do the high humidity gain adjustment by using the **-** and + buttons to make sure the U_{out} voltage is correct (you have to press either **-** or + at least once even if the value is correct). To finish the RH calibration, press the **ADJ** button. The green LED is now turned off and the red indicator LED begins to blink slowly (800ms cycle time).

7.   HMT130 transmitter is now in T calibration state. Analog output and optional display will still follow the actual measured T value.

NOTE	If you do not wish to perform the T adjustment at this time, press **ADJ** button one more time. The red indicator LED is turned off and the transmitter returns to normal mode. The calibration procedure is now finished.

8.   Insert the probe into a known reference temperature (if Vaisala Humidity Calibrator HMK15 is not used) and let the temperature reading stabilize.

NOTE	Do not touch the adjustment buttons before the conditions have stabilized.

9.   Using the **-** and + buttons, make the temperature offset adjustment by making sure the U_{out} voltage is correct (you have to press either **-** or + at least once even if the value is correct) and press the **ADJ** button. The red indicator LED begins to blink faster (400ms cycle time).

NOTE	If you do not wish to perform the two-point T adjustment at this time, press the **ADJ** button one more time. The red indicator LED is turned off and the transmitter returns to normal mode. The calibration procedure is now finished.

10.   Insert the probe into another reference temperature.

NOTE	Do not touch the adjustment buttons before the conditions have stabilized.

11. Using the **-** and **+** buttons, make the temperature gain adjustment by making sure the U_{out} voltage is correct (you have to press either **-** or **+** at least once even if the value is correct).

12. Press the **ADJ** button one more time. The red indicator LED turns off and the transmitter returns to normal mode. The calibration procedure is now finished.

NOTE	In case of calibration error, both LEDs blink alternately at a very fast rate (cycle time 200ms) for a period of 2s after which the transmitter returns to normal mode.

NOTE	In case of using a HMT130 transmitter with display option, the following texts are shown at the display during calibration: "**Probe cal: RH 1**" corresponding the green LED blinking slowly "**Probe cal: RH 2**" corresponding the green LED blinking fast "**Probe cal: T 1**" corresponding the red LED blinking slowly "**Probe cal: T 2**" corresponding the red LED blinking fast "**Probe cal: Error**" corresponding both LEDs blinking alternately at very fast rate

Adjustment with HM70

You can check and adjust the HMT130 relative humidity measurement with the HM70 Hand-Held Humidity and Temperature meter. A HM70-connection cable is needed. Vaisala order code: 211339.

There are four types of adjustments available: field checking and adjustment using a calibrated reference probe, one-point adjustment using a calibrator, two-point adjustment using a calibrator, and LiCl-NaCl adjustment.

Follow the first seven steps and continue according to the chosen adjustment method.

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Figure 17   Location of the MI70 Probe and Cable Connector Ports

1.   Connect the 211339 HM70-connection cable to the SERVICE PORT connector on the HMT130 motherboard (see Figure 10 on page 24).

2.   Connect the other end of the connection cable to either of the HM70's connector ports located on the bottom of the indicator (see Figure 17 above).

3.   Turn on both devices (or just HM70, in case that HMT130 is on continuously).

4.   The reading of the transmitter is shown on the top or middle row of the indicator display, depending on which connector port the connection cable is connected to.

5.   Press the ADJ button on the HMT130 motherboard to open the adjustment mode. Both LEDs on HMT130 motherboard remain in OFF state and text "**Starting adjustment mode for HMP110**" is shown at the MI70 display.

NOTE	In case of using a HMT130 transmitter with display option the text "**MI70 adjustment mode**" is shown at the upper row of HMT130 display.

NOTE	From this point onward, the local adjustment buttons at HMT130 are disabled and adjustment is carried out using the MI70 indicator. HMT130 display and analog outputs will always follow the actual measured RH/T value when in MI70 adjustment mode. When operating the MI70, do not press the buttons too quickly or the calibration may fail. Wait for one second between each press.

6. Press OK to start adjustment.

7. Check the environment settings if needed. Otherwise, press NO. Select RH or T adjustment. Continue according to the directions of the desired adjustment method.

Field Checking and Adjustment Using a Calibrated Reference Probe

Follow steps 1 to 7 on page 62 and continue as follows:

8. Check that the probes are located in equal conditions and wait until the readings have stabilized (may take 30 minutes or more). If you are close to the probes, do not breath in their direction.

9. Press ADJUST to continue adjusting.

10. Choose To same as RH$_{I/II}$ from the MI70 adjustment menu, press SELECT (MI70 automatically recognizes which port the HMP70 series probe is connected to).

11. Confirm the adjustment by pressing YES.

12. The adjustment is done. Press BACK and EXIT to return to the basic display.

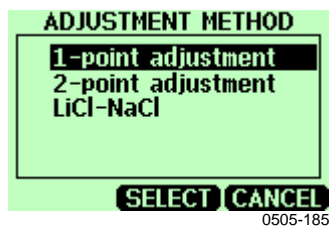13. Turn off the MI70 and detach the connection cable.

One-Point Adjustment Using a Calibrator

When adjusting the transmitter in only one reference condition, please take care that the reference condition represents the measuring environment. MI70 indicator is used now only as a terminal for visualizing and setting the transmitter's RH reading.

Follow steps 1 to 7 on page 62 and continue as follows:
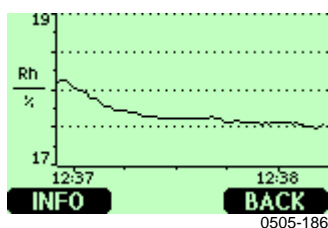
8. Remove the filter from the transmitter's probe and insert the probe head into the reference condition.

9. Press ADJUST to continue adjusting.

10. Choose 1-point adjustment from the MI70 adjustment menu and press SELECT.

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Figure 18   Example of the MI70 Adjustment Menu

11. Press READY when the reading has stabilized in the reference condition (may take 30 minutes or more). You can follow the stabilization from the GRAPH display.

0505-186

Figure 19   Example of the MI70 Adjustment Mode Graph Display

12. Enter the correct reference value with the arrow buttons. Press OK.

13. Confirm the adjustment by pressing YES.

14. The adjustment is done. Press BACK and EXIT to return to the basic display.

15. Turn off the MI70 and detach the connection cable.

Two-Point Adjustment Using a Calibrator

Note that the difference between the two reference humidities must be at least 50 %. MI70 indicator is used now only as a terminal for visualizing and setting the transmitter's RH reading.

Follow steps 1 to 7 on page 62 and continue as follows:

8. Remove the filter from the transmitter's probe and insert the probe head into the lower humidity reference condition.

9. Press ADJUST to continue adjusting.

10. Choose 2-point adjustment from the MI70 adjustment menu and press SELECT.

11. Press READY when the reading has stabilized in the first reference condition (may take 30 minutes or more). You can follow the stabilization from the GRAPH display.

12. Enter the correct reference value in the first condition with the arrow buttons. Press OK.

13. Remove the probe from the first reference condition and insert the probe head into the higher humidity reference condition.

14. Press READY when the reading has stabilized in the second reference condition (may take 30 minutes or more). You can follow the stabilization from the GRAPH display.

15. Enter the correct reference value in the second condition with the arrow buttons. Press OK.

16. Confirm the adjustment by pressing YES (by pressing NO you return to adjustment mode display and no changes are made). If the difference between the two reference conditions is less than 50 %RH, adjustment cannot be done.

17. The adjustment is done. Press BACK and EXIT to return to the basic display.

18. Turn off the MI70 and detach the connection cable.

LiCl-NaCl Adjustment

This adjustment is done using relative humidity references 11.3 % RH (LiCl) and 75.5 % RH (NaCl).

Follow steps 1 to 7 on page 62 and continue as follows:

8. Remove the filter from the transmitter's probe and insert the probe head into the LiCl salt chamber.

9. Press ADJUST to continue adjusting.

10. Choose LiCl-NaCl autom. from the MI70 adjustment menu and press SELECT. Press OK to accept the note telling about references.

11. Press READY when the reading has stabilized in the LiCl salt chamber (may take 30 minutes or more). You can follow the stabilization from the GRAPH display.

12. Remove the probe from the LiCl salt chamber and insert the probe head into the NaCl salt chamber.

13. Press READY when the reading has stabilized in the NaCl salt chamber (may take 30 minutes or more). You can follow the stabilization from the GRAPH display.

14. Confirm the adjustment by pressing YES (by pressing NO you return to adjustment mode display and no changes are made).

15. The adjustment is done. Press BACK and EXIT to return to the basic display.

16. Turn off the MI70 and detach the connection cable.

Temperature Field Check and Adjustment by Using a Calibrated Reference Probe

Follow steps 1 to 7 on page 62 and continue as follows:

8. Check that the probes are located in equal conditions and wait until the readings are stabilized (can take 30 minutes or more). If you are close to the probes, do not breathe in their direction.

9. Press ADJUST to continue adjusting.

10. Press To same as $T_{II/I}$, press SELECT. (MI70 always recognizes the port to which the HMP70 series probe is connected).

11. Confirm by pressing YES.

NOTE	If the temperature difference between the reference probe and HMT130 is too large, the adjustment cannot be done (HM70 will notify you of this). The available reserve for T adjustment of HMT130 depends on the initial temperature calibration of the unit.

12. Adjustment is done. Press BACK and EXIT to return to the basic display.

13. Switch off the MI70 and detach the calibration cable from MI70 and from the transmitter.

Adjustment with HMI41

You can check and adjust the HMT130 relative humidity measurement with the HMI41 indicator and HMP41/45/46 probes. A HMI41-connection cable is needed. Vaisala order code: 25917ZZ.

There are three adjustment modes available: offset (dry point), gain (wet point), and two-point adjustment. All of these can be performed using the HMI41 either as a reference meter (for example when the transmitter is mounted in an air-conditioning channel) or only as a terminal for visualizing and setting the transmitter's RH reading.

Offset and gain adjustments are performed the same way and differ only in internal calculations. Select offset adjustment when the reference humidity is < 65 %RH and gain adjustment when the reference humidity is ≥ 65 %RH. Two-point adjustment is more accurate, and includes both offset and gain corrections. For performing two-point adjustment, you need two separate measurement points with a difference of at least 50 %RH between them.

Follow the general directions of connecting the HMI41 to the HMT130 and selecting the HMI41 calibrator function and then continue according to the chosen adjustment method.

0505-187
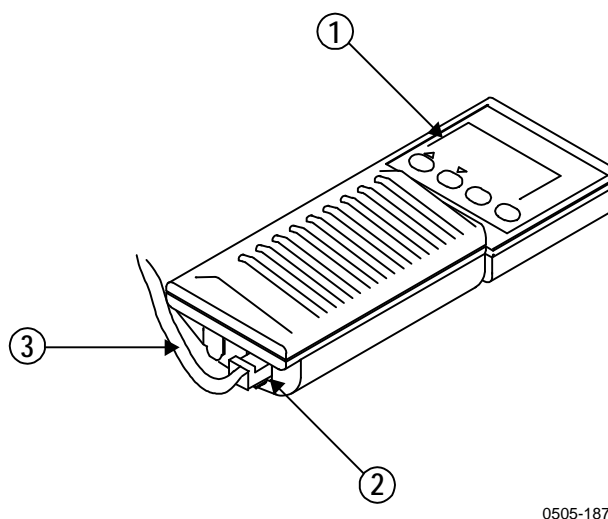
Figure 20   Location of the HMI41 Calibration Connector

The following numbers refer to Figure 20 above:

1   =   HMI41 indicator
2   =   EXT connector
3   =   25917ZZ connection cable

## Connections and Selecting the Calibrator Function

1. To select the calibrator function from the HMI41, press the ON/OFF
    button until you can see some text on the display. Then release the
    ON/OFF button and within 1 ... 2 seconds, press both ENTER and MODE
    buttons until the following display appears:

    ```
     SEtUP
    ```

2. After a few seconds, the display changes to show the following:

    ```
          0 °C
    set  Un it
    ```
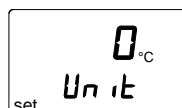
    If the basic settings (display units, automatic power off function,
    display quantities, and pressure) have to be changed, please refer to
    the HMI41 Operating Manual. Otherwise, press ENTER repeatedly
    until the following display appears:

    ```
           1
    set  StArt
    ```
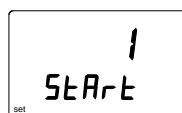
    To calibrate the HMT130, select number 3 with buttons ▲ (number
    up) and ▼ (number down) and then press ENTER.

3. Next the baud rate appears on the display. Use the baud rate 19200
    (= 19.2 on the HMI41 display) with the HMT130 series. If the
    baud rate on the HMI41 display is not correct, change it with
    buttons ▲ and ▼. When the baud rate is correct, press ENTER, and
    the serial communications settings display appears. The correct
    settings for HMT130 series are: N, 8, 1. If needed, change the
    settings with buttons ▲ and ▼ until they are correct, press ENTER,
    and then ON/OFF.

These setting are stored in the HMI41 memory; when the HMI41 is
turned on again, it will automatically wake up as a calibrator for digital
transmitters with these serial line settings. After making these settings,
continue with the adjustment and follow the directions of the chosen
adjustment method.

Offset and Gain Adjustments

Offset and gain adjustments are performed in the same way (they differ only in internal calculations), so this section is valid for both methods.

4. Connect the 25917ZZ HMI41-connection cable to the SERVICE PORT connector on the HMT130 motherboard (see Figure 10 on page 24).

5. Connect the other end of the connection cable to the EXT connector located on the bottom of the HMI41 indicator (see Figure 20 on page 67).

6. Turn on both devices. Wait until the following display appears:

    ```
    RH  CAL
        OFFSt
    ```
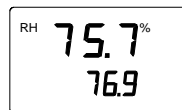
7. Select the appropriate adjustment mode with the ▲ and ▼ buttons. Select offset adjustment if the humidity is < 65 %RH and gain adjustment if the humidity is ≥ 65 %RH:

    ```
    RH  CAL          RH  CAL
        OFFSt    or      GA IN
    ```

    Press ENTER to confirm the selection. A display similar to the following appears:

    ```
    RH  75.7 %
        76.9
    ```

NOTE	In case of using a HMT130 transmitter with display option the text "**HMI41 adjustment mode**" is shown at the upper row of HMT130 display.

The next sections describe how to perform offset and gain adjustments in two different ways.

HMI41 as a Reference Meter

The HMI41 humidity probe is used to show the correct humidity value
(be sure that the reference probe has previously been adjusted). Connect
the cable and select the appropriate adjustment method as previously
explained, and continue according to the following instructions.

8. A display similar to the one below should be visible:
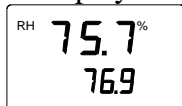
    RH **75.7**%
    76.9

    Numbers on the first line indicate the transmitter reading, and the
    numbers on the second line indicate the reference probe reading.

9. Let the readings stabilize (may take 30 minutes or more). If you
    prefer, you can change the display to show the difference in the
    readings. Press HOLD and a display similar to the following appears:

    ΔRH **– 1.2**%
    76.9
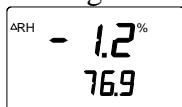
    The numbers on the first line indicate how much the transmitter
    reading differs from that of the HMI41 reference probe. The
    numbers on the second line indicate the reference probe reading.
    You can return to the previous display by pressing HOLD again.

10. When the readings have stabilized, press ENTER to conclude the
    adjustment. When ENTER is pressed, the transmitter reading is
    corrected to the reference probe reading. If the adjustment has been
    succesful, the following display appears:

    RH **CAL**
    PASS

11. The data is now stored in the transmitter memory. If the adjustment
    has not been succesful, the following display appears:

    RH **CAL**
    Error

    In this case, perform the adjustment again. Whether the adjustment
    was succesful or not, the HMI41 always returns to display the
    selected adjustment mode.

12. After succesfully completing the adjustment, turn off the HMI41
    and disconnect the cable.
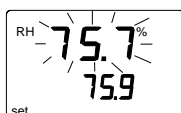
HMI41 as a Terminal

The HMI41 can also be used for visualizing and setting the transmitter's RH reading manually.

8.   A display similar to the one below should be visible:
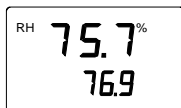
```
RH  75.7 %
        76.9
```

The numbers on the first line indicate the transmitter reading, and the numbers on the second line indicate the HMI41 probe reading.

9.   Let the readings stabilize and press MODE. The following display appears:

```
RH  75.7 %
        75.9
set
```

The HMI41 now works only as a terminal for setting the humidity reading. The numbers on the first line are blinking, and the numbers on the second line indicate the transmitter reading.

10.   You can now set the blinking reading to the correct value (for example, the equilibrium RH of a salt solution) with the buttons ▲ and ▼. Press ENTER to conclude the adjustment. If the adjustment has been succesful, the following display appears:

```
RH  CAL
        PASS
```

11.   The data is now stored in the transmitter memory. If the adjustment has not been succesful, the following display appears:

```
RH  CAL
        Error
```

In this case, perform the adjustment again. Whether the adjustment was succesful or not, the HMI41 always returns to display the selected adjustment mode.

12.   After succesfully completing the adjustment, turn off the HMI41 and disconnect the cable.

Troubleshooting

Table 6 presents a summary of the error messages that may appear during adjustment with the HMI41.

Table 6   Common Problems During Adjustment and Their Remedies

Error Message	Probable Cause	Remedy
^{RH}**CAL** Error	This message may appear, for example, if the difference between the reference humidities is too small (< 50 %RH).	Perform the adjustment again.
CON NECt	This message may appear during adjustment when the HMI41 is trying to contact the transmitter.	Wait.
con Error	The connection cable is not properly connected or the serial line settings of the HMI41 and the transmitter do not correspond.	Check the connection of the calibration cable. Check that the serial line settings in the HMI41 memory correspond to those of the transmitter.

Analog Output Tests

HMT130 has a built-in software function for testing the analog outputs. To test the outputs, do the following:

1. Make sure the transmitter is not in adjustment mode.

2. Press the + adjustment button (see Figure 16 on page 58).

   This sets the output voltage level to the high point of the analog output range (for example 10 V). The output stays at this level for about 30 seconds after the + adjustment button has been pressed.

3. Press the - adjustment button (see Figure 16 on page 58).

   This sets the output voltage level to the low point of the analog output range (for example 0 V). The output stays at this level for about 30 seconds after the - adjustment button has been pressed.
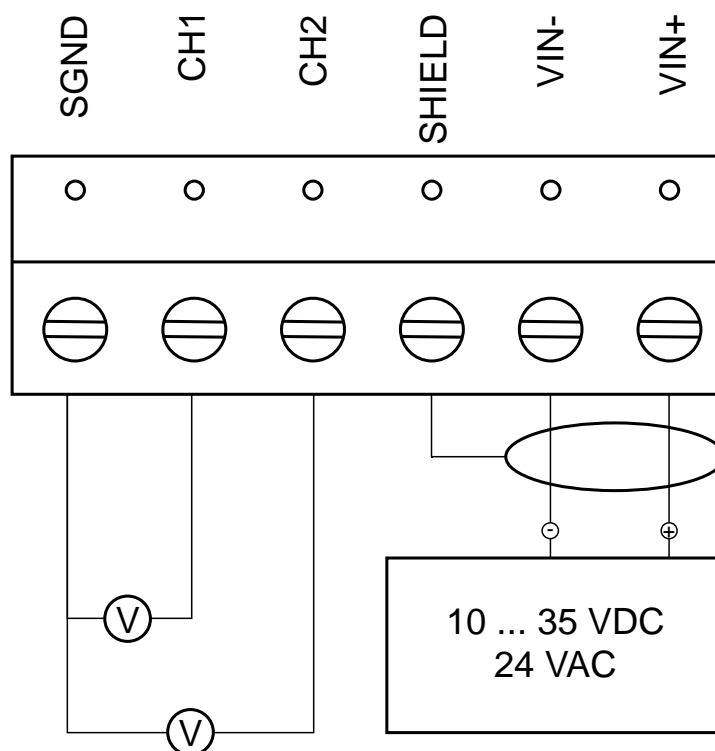
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Figure 21   HMT130 Output Voltage Measurement

NOTE	If you are using the HMT130 transmitter with the display option, the following texts are shown at the display during analog output test: "**Analog output test high**": analog output set to upper limit "**Analog output test low**": analog output set set to low limit

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CHAPTER 6
TROUBLESHOOTING

This chapter describes error messages and analog output error behavior, introduces some common problems, their probable causes and remedies and provides contact information for Technical Support.

Error Codes

HMT130 software includes number of different self diagnostics, such as flash and program memory checksum, probe communication status, probe checksum, operation voltage check, oscillator fault check etc.

At startup software checks factory/user settings checksum, program memory checksum and oscillator fault status. Other checks are made during runtime. Available error codes are shown in the table below.

Table 7   Error Codes and Texts

Code	Description	Error Text
1	Probe T measurement error	Probe T meas
2	Probe RH measurement error	Probe RA meas
3	Probe communication error	Probe communication
4	Probe checksum error	Probe checksum
5	Probe message form error	Probe message form
6	Program's flash checksum error	Program code checksum
7	Current settings checksum error (RAM)	Settings checksum
8	Factory flash not initialised	Factory defaults empty
9	User flash not initialised	User defaults empty
10	Voltage is too low to operate correctly	Voltage too low
11	Measurements not available	Measurements not available
12	Oscillator fault bit active	HW fault 1
13	Analog output quantity invalid	Analog output quantity invalid
14	Display quantity invalid	Display quantity invalid

Error text is shown by using the **ERRS** command via the serial interface. In case of using a HMT130 transmitter with display option the error code is shown at the display in format "**ERR:Code-1[.Code-2][.Code-n]**". Multiple errors are separated with a dot between the error codes.

Solving Typical Problems

You can check the error message via the serial interface by using the
ERRS command; see section **Error Codes** on page 75. In case of
constant error, please contact Vaisala technical support.

Table 8   Troubleshooting Table

Problem or Message	Likely Causes and Solutions
Measurement not working, any of the following errors is active: - Probe RH measurement error - Probe T measurement error	- Sensor(s) damaged or missing. Open the probe filter and check. - Calibration is not done. Calibrate the probe. - Check the supply voltage of the transmitter.
Transmitter cannot communicate with the probe, any of the following errors is active: - Probe communication error - Probe checksum error - Probe message form error - Measurements not available	- Check the attachment of the probe to the transmitter. - In case of remote probe, check also the interconnection cables. - Replace the probe if necessary.
Serial line command not working, outputs "Unknown command."	- Mistyped or unknown command, check the command syntax and parameters.
Cannot connect to serial line, current serial settings of the module are unknown.	Perform the following steps to connect: 1. Set your terminal settings to 19200 8 N 1 (the default settings of the transmitter). 2. Connect to the service port of the transmitter. 2. Power up the transmitter, and type "Z" on the serial line at least five times. 4. The transmitter will come online with the default settings. 5. Use the **SERI** command to set the desired serial settings, and use the **SAVE** command to save them.
Any of the following errors is active: - Current settings checksum error - Default settings checksum error	Internal error. Perform the following steps: 1. Reset or power cycle the module. Check if the error disappears. 2. Return the module to factory settings using the **FRESTORE** command. Check again. 3. If the error is still active, contact a Vaisala service center.
Any of the following errors is active: - Program checksum error - Factory flash defaults checksum error - Factory flash not initialized - Oscillator fault bit active	Faulty transmitter, contact a Vaisala service center.
Any of the following errors is active: - Analog output quantity invalid - Display quantity invalid	In case of "Analog output quantity invalid" error select the correct output quantities (set with the **CALCS** command) with **ASEL** command and in case of "Display quantity invalid" error select the correct display quantities with **DSEL** command.

Analog Output Error Notification

If the transmitter is unable to operate due to an error, the analog outputs will be set to an error level.

Default output voltage in error state is 0 V. Error voltage value can be changed via the serial interface by using the **AERR** command; see section Set/Show Analog Output Error Levels on page 42.

Technical Support

For technical questions, contact the Vaisala technical support via e-mail at helpdesk@vaisala.com.

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

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CHAPTER 7
TECHNICAL DATA

This chapter provides the technical data of the product.

Specifications

Table 9   Relative Humidity Measurement Specifications

Property	Description/Value
Measurement range	0 ... 100 % RH
Accuracy (including non-linearity, hysteresis, and repeatability): at 0 ... +40 °C (+32 ... +104 °F) at -40 ... 0 °C and +40 ... +80 °C (-40 ... +32 °F and +104...+176 °F)	 ±1.7 %RH (0 ... 90 % RH) ±2.5 %RH (90 ... 100 % RH) ±3.0 %RH (0 ... 90 % RH) ±4.0 %RH (90 ... 100 % RH)
Factory calibration uncertainty at +20 °C (+68 °F)	±1.5 %RH
Humidity sensor	HUMICAP® 180R

Table 10   Temperature Measurement Specifications

Property	Description/Value
Measurement range	-40 ... +80 °C (-40 ... +176 °F)
Accuracy over temperature range: at +15 ... +25 °C (+59 ... +77 °F) at 0 …+15 °C and +25 …+40 °C (+32 ... +59 °F and +77 ...+104 °F) at -40 ... 0 °C and +40 ... +80 °C (-40 ... +32 °F and +104...+176 °F)	 ±0.2 °C (±0.36 °F) ±0.25 °C (±0.45 °F) ±0.4 °C (±0.72 °F)
Temperature sensor	Pt1000 RTD 1/3 Class B IEC 751

Table 11   Operating Environment Specifications

Property	Description/Value

Operating temperature range
    Transmitter body, no display
    Transmitter body, with display
    HMP110 probe
	
	-40 ... +60 °C (-40 ... +140 °F)
	-20 ... +60 °C (-4 ... +140 °F)
	-40 ... +80 °C (-40 ... +176 °F)

Storage temperature range	-50 ... +70 °C (-58 ... +158 °F)
Electromagnetic compatibility	EN 61326-1:2006 Electrical equipment for measurement, control and laboratory use - EMC requirements - Basic immunity test requirements. EN 55022:2006 + Am 1:2007 Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement. Class B.

Table 12   Inputs and Outputs

Property	Description/Value
Output signal	0 … 1 V 0 … 5 V 0 ... 10 V User-defined between 0 ... 10 V
Min. output resistance	1 kohm
Supply voltage	10 ... 35 VDC 15 ... 35 VDC (when output 0 ... 10 V) 24 VAC (±20 %)
Current consumption at 24 VDC	8 mA, if relay closed 15 mA
Serial output	RS-485 (non-isolated)
Relay output	1 relay (max. 50 VDC, 200 mA)
Max. additional error caused by the analog outputs after calibration at +20 °C ambient temperature	±0.1% of full scale output signal
Temperature dependence of the analog outputs	±0.005% of full scale output signal

Table 13   **Mechanical Specifications**

Property	Description / Value

Material
    Transmitter housing
    Display window
    Probe body
    Probe grid filter
	
	PBT plastic
	PC plastic
	Chrome coated aluminum
	Chrome coated ABS plastic

Housing classification	IP65 (NEMA 4)

Connections
    Voltage outputs and RS-485
    Probe interface
	
	Screw terminals 0.5 ... 1.5 mm²
	4-pin M8 female panel connector

Probe cable lengths	3 m, 5 m, 10 m, cables can be cascaded up to 50 m
Display (optional)	128x64 resolution full graphics B&W display without backlight
Weight (Wall model, including probe)	270 g
Weight (10m cable model)	540 g

Options and Accessories

Table 14   **Options and Accessories**

Description	Order Code
HMP110 probe for HMT130	HMP110 – separate order form
HMP110R replacement probe for HMT130	HMP110R – separate order form
HMP110T temperature only probe for HMT130	HMP110T – separate order form
Constant output probe	HMP110REF – separate order form
Humidity sensor	Humicap180R
Probe mounting flange	226061
Probe mounting clamps, 10 pcs	226067

Sensor protection
    Plastic grid filter
    Membrane filter
    Stainless steel sintered filter
	
	DRW010522SP
	DRW010525
	HM46670SP

Probe cable 3 m	HMT120Z300
Probe cable 5 m	HMT120Z500
Probe cable 10 m	HMT120Z1000
Radiation shield	DTR502B
Rain shield with installation kit	215109
Duct installation kit	215619
HMI41 connection cable	25917ZZ
HM70 connection cable	211339
Service cable for PC, USB	219685

Transmitter Dimensions
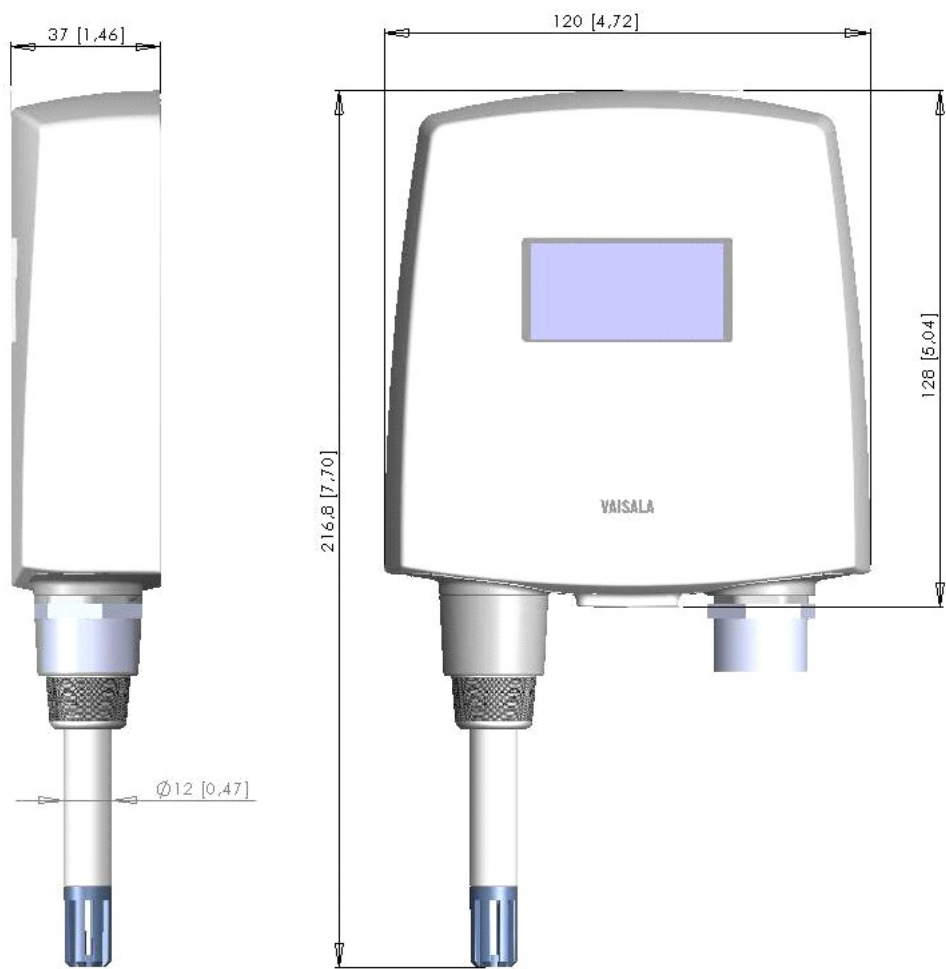
1011-158

Figure 22   Dimensions of the Fixed Probe Model in mm (inches)

37 [1,46]

120 [4,72]

157,95 [5,39]

128 [5,04]

VAISALA

71 [2,8]

Ø12 [0,47]
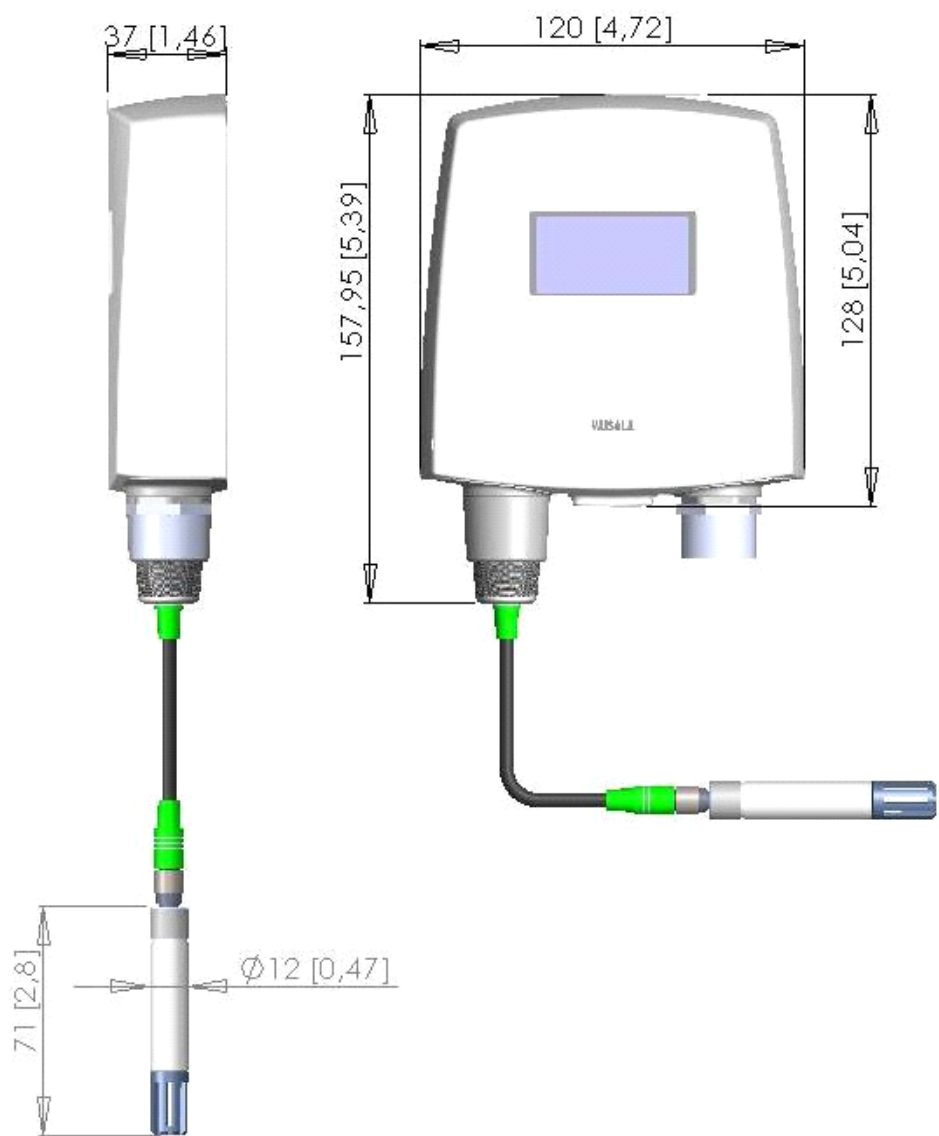
1011-159

Figure 23   Dimensions of the Remote Probe Model in mm (inches)

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APPENDIX A
CALCULATION FORMULAS

This appendix contains the formulas used for the calculated output quantities.

HMT130 transmitter receives relative humidity and temperature from the HMP110 probe. From these values dewpoint, frostpoint, absolute humidity, mixing ratio, enthalpy, wet bulb temperature, saturation vapor pressure and vapor pressure in normal pressure are calculated using the following equations.

Symbols:

T_d = Dewpoint temperature (°C)
P_w = Water vapor pressure (hPa)
P_{ws} = Saturation vapor pressure (hPa)
RH = Relative humidity (%)
x = Mixing ratio (g/kg)
p = Atmospheric pressure (hPa)
a = Absolute humidity (g/m3)
T = Temperature (°C)
h = Enthalpy (kJ/kg)
Tw = Wet bulb temperature (°C)
Tdf = Dew/frostpoint temperature (°C)

Dewpoint Temperature

The Dewpoint temperature (Td) of a moist air sample is the temperature to which the sample must be cooled to reach saturation with respect to liquid water.

Dewpoint temperature is calculated using:

$$T_d = \frac{T_n}{\dfrac{m}{\log\left(\dfrac{P_w}{A}\right)} - 1} \qquad \left[^\circ C\right] \qquad (1)$$

P_w is the water vapor pressure (see the equation below). The parameters A, m, and T_n depend on temperature according to the following table:

T	A	m	Tn
... 0 °C	6.119866	7.926104	250.4138
0 ... 50 °C	6.1078	7.5000	237.30
50 ... 100 °C	5.9987	7.3313	229.10
100 ... 150 °C	5.8493	7.2756	225.00
150 ... °C	6.2301	7.3033	230.00

Dew/frostpoint Temperature

Dew/frostpoint temperature is calculated using:

$$T_d \geq 0 \rightarrow T_{df} = T_d$$

$$T_d < 0 \rightarrow T_{df} = \frac{T_n}{\dfrac{m}{\log\left(\dfrac{P_w}{A}\right)} - 1} \qquad \left[^\circ C\right] \qquad (2)$$

P_w is the water vapor pressure (see the equation below). The parameters A, m, and T_n depend on temperature according to the following table:

Td	A	m	Tn
... 0 °C	6.1134	9.7911	273.47

Mixing Ratio

The mixing ratio (mass of water vapour/mass of dry gas) is calculated using:

$$x = B \times \frac{P_w}{p\text{-}P_w} \qquad\qquad [g/kg] \qquad\qquad (3)$$

where

B = 621.9907 g/kg

The value of B depends on the gas. 621.9907 g/kg is valid for air.

Absolute Humidity

Absoute humidity is defined as the mass of water vapour in a certain volume. If ideal gas behaviour is assumed the absolute humidity can be calculated using:

$$a = C \cdot \frac{P_w}{\left(T + 273.15\right)} \qquad\qquad [g/m^3] \qquad\qquad (4)$$

where

C = 216.679 gK/J

Enthalpy

Entalpy can be calculated from mixing ratio using:

$$h = T \cdot (1.01 + 0.00189 \cdot x) + 2.5 \cdot x \qquad [kJ/kg] \qquad\qquad (5)$$

Saturation Vapor Pressure

The saturation vapor pressure (P_{ws}) is the equilibrium water vapor pressure in a closed chamber containing liquid water. It is a function only of temperature, and it indicates the maximum amount of water that can exist in the vapor state.

The water vapor saturation pressure P_{ws} is calculated by using two equations (6 and 7):

$$\Theta = T - \sum_{i=o}^{3} C_i T^i \qquad [hPa] \qquad (6)$$

where

T = Temperature in K
C_i = Coefficients
C_0 = 0.49313580
C_1 = -0.46094296 * 10^{-2}
C_2 = 0.13746454 * 10^{-4}
C_3 = -0.12743214 * 10^{-7}

$$\ln P_{ws} = \sum_{i=-1}^{3} b_i \Theta^i + b_4 \ln \Theta \qquad (7)$$

where

b_i = Coefficients
b_{-1} = -0.58002206 * 10^4
b_0 = 0.13914993 * 10^1
b_1 = -0.48640239 * 10^{-1}
b_2 = 0.41764768 * 10^{-4}
b_3 = -0.14452093 * 10^{-7}
b_4 = 6.5459673

Water Vapor Pressure

Vapor pressure refers to the vapor pressure of water in air or other gas. Water vapor has a partial pressure Pw which is part of the total pressure of the gas.

The water vapor pressure is calculated using:

$$P_w = RH \cdot \frac{P_{ws}}{100} \qquad\qquad [hPa] \qquad\qquad (8)$$

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