E+E

your partner
in sensor
technology.

User Manual HTS401

Modular Humidity and Temperature Sensor for Demanding Climate Control



Modbus

www.epluse.com

Content

1 General Information ... 3
1.1 Explanation of Warning Notices and Symbols ... 3
1.2 Safety Instructions ... 4
1.2.1. General Safety Instructions ... 4
1.2.2. Intended Use ... 4
1.2.3. Mounting, Start-up and Operation ... 4
1.3 ESD Protection ... 5
2 Scope of Supply ... 5
3 Product Description ... 6
3.1 General ... 6
3.2 Dimensions ... 8
3.3 Electrical Connection ... 9
3.4 Remote Probe HTS401P for Type T3 ... 11
3.5 Outputs ... 11
3.6 Configuration Interface ... 12
3.7 Heating Modes ... 13
3.7.1. Overview ... 13
3.7.2. Automatic ReCovery (ARC) against Chemical Pollution ... 13
3.7.3. Condensation Guard (CG) against Temporary Condensation ... 15
3.8 Optional Display ... 17
4 Mounting and Installation ... 18
4.1 General ... 18
4.2 Recommendations for Accurate Humidity and Temperature Measurement ... 18
4.3 Outdoor Installation with Radiation Shield ... 19
5 Setup and Configuration ... 20
5.1 Product Configuration ... 21
5.1.1. HTS401 Configuration using the USB-C configuration stick ... 21
5.2 PCS10 Product Configuration Software ... 21
5.3 RS485 Digital Interface ... 22
5.3.1. Hardware Bus Termination ... 22
5.3.2. Device Address ... 22
5.3.3. Modbus RTU Protocol Settings ... 22
5.3.4. Application Specific Parameters ... 23
5.4 Modbus Register Map ... 24
5.5 HTS401 Modbus Backwards Compatibility to EE210 and EE212 ... 26
5.6 Configurable Custom Modbus Map ... 27
5.7 Device Status Indication ... 28
5.8 Modbus RTU Example ... 29
6 Maintenance and Service ... 30
6.1 Sensing Module Replacement ... 30
6.2 Filter Cap Exchange ... 31
6.3 Display Change ... 31
6.4 Self Diagnosis and Error Messages ... 31
6.4.1. Error Messages in PCS10 ... 31
6.4.2. Error Messages on the Display ... 32
6.4.3. Error Indication on the Analogue Output (NAMUR) ... 32
6.5 Repairs ... 32
6.6 Spare Parts ... 33
7 Accessories ... 33
8 Technical Data ... 34
9 Conformity ... 37
9.1 Declarations of Conformity ... 37
9.2 Electromagnetic Compatibility ... 37
9.3 FCC Part 15 Compliance Statement ... 37
9.4 ICES-003 Compliance Statement ... 37
10 Recycling of the Device ... 37

1 General Information

This user manual is intended to ensure proper handling and optimal functioning of the device. The user manual shall be read before commissioning the equipment and it shall be provided to all staff involved in transport, installation, operation, maintenance and repair. E+E Elektronik Ges.m.b.H. accepts no liability for any warranty or liability claims arising from this publication or improper handling of the product(s) described.

All information, technical data and diagrams included in this document are based on the information available at the time of writing. The document may contain technical inaccuracies and typographical errors. The contents will be revised on a regular basis and changes will be implemented in subsequent versions. The product(s) described and the contents of this document may be changed or improved at any time without prior notice.

All rights are reserved by E+E Elektronik Ges.m.b.H. No part of this document may be reproduced, published or publicly displayed in any form or by any means, nor may its contents be modified, translated, adapted, sold or disclosed to a third party without prior written permission of E+E Elektronik Ges.m.b.H.

PLEASE NOTE

Find this document and further product information on our website at www.epluse.com/hts401.

1.1 Explanation of Warning Notices and Symbols

Safety precautions

Precautionary statements warn of hazards in handling the device and provide information on their prevention. The safety instruction labeling is classified by hazard severity and is divided into the following groups:

DANGER

Danger indicates hazards for persons. If the safety instruction marked in this way is not followed, the hazard will verly likely result in severe injury or death.

WARNING

Warning indicates hazards for persons. If the safety instruction marked in this way is not followed, there is a risk of injury or death.

CAUTION

Caution indicates hazards for persons. If the safety instruction marked in this way is not followed, minor or moderate injuries may occur.

NOTICE

Notice signals danger to objects or data. If the notice is not observed, damage to property or data may occur.

Informative notes

Informative notes provide important information that is characterised by its relevance.

INFO

The information symbol indicates tips on handling the device or provides additional information on it. This information is useful to achieve optimum performance of the device.

The title field may deviate from “INFO” depending on the context. For instance, it may also read “PLEASE NOTE”.

1.2 Safety Instructions

1.2.1. General Safety Instructions

NOTICE

Improper handling of the device may result in its damage.

- The HTS401 enclosure, the sensing probe and the sensing module shall not be exposed to unnecessary mechanical stress.
- Do not apply the supply voltage to the RS485 data lines.
- The HTS401 electronics is sensitive to electrostatic discharge (ESD), appropriate protective measures shall be taken when touching it.
- Use the HTS401 only as intended and observe all technical specifications.

1.2.2. Intended Use

The HTS401 is a relative humidity / temperature (RH / T) sensor for demanding HVAC applications and climate control. It can be mounted on walls, in ducts or fitted with a remote probe, both indoors and outdoors.

⚠ WARNING

Non-compliance with the product documentation may cause safety risks for people and the entire measurement installation.

The manufacturer is not liable for any damage caused by improper handling, installation and maintenance of the device.

- Do not use HTS401 in explosive atmosphere or for measurement of aggressive gases.
- This device is not appropriate for safety, emergency stop or other critical applications where device malfunction or failure could cause injury to human beings.
- The device may not be manipulated with tools other than specifically described in this manual.

NOTICE

Failure to follow the instructions in this user manual may lead to measurement inaccuracy and device failures.

- The HTS401 may only be operated under the conditions described in this user manual and within the specification included in chapter 8 Technical Data.
- Any unauthorised product modifications will invalidate all warranty claims. Modifications may only be carried out with express authorisation of E+E Elektronik Ges.m.b.H.!
- The sensor must be operated with the filter cap on at all times. Do not touch the sensing element inside the sensing head.
- While replacing the filter cap, take very good care not to touch or rub the sensing elements.

1.2.3. Mounting, Start-up and Operation

The HTS401 has been produced under state of the art manufacturing conditions, has been thoroughly tested and has left the factory after fulfilling all safety criteria. The manufacturer has taken all precautions to ensure safe operation of the device. The device shall be set up and installed in a way that does not impair its safe use. All applicable local and international safety guidelines for safe installation and operation of the device have to be observed. This user manual contains information and warnings that must be observed in order to ensure safe operation.

ⓘ PLEASE NOTE

The manufacturer or his authorised agent can only be held liable in case of willful or gross negligence. In any case, the scope of liability is limited to the corresponding amount of the order issued to the manufacturer. The manufacturer assumes no liability for damage caused by non-compliance with the applicable regulations, operating instructions or the specified operating conditions. Any consequential damage is excluded from liability.

⚠ WARNING

Non-compliance with the product documentation may result in accidents, personal injury or property damage.

- Mounting, installation, commissioning, start-up, operation and maintenance of the device may only be carried out by qualified staff. Such staff must be authorised by the operator of the facility to carry out the mentioned activities.
- The qualified staff must have read and understood this user manual and must follow the instructions contained within. The manufacturer accepts no responsibility for non-compliance with instructions, recommendations and warnings.
- All process and electrical connections must be thoroughly checked by authorised staff before commissioning the device.
- Do not install or start-up a device suspected to be faulty. Mark it clearly as faulty and remove it from the process.
- Service operations other than described in this user manual may only be performed by the manufacturer. A faulty device may only be investigated and possibly repaired by qualified, trained and authorised staff. If the fault cannot be fixed, the device shall be removed from the process.

1.3 ESD Protection



The sensing elements and the electronics board are ESD (electrostatic discharge) sensitive components of the device and must be handled as such. The failure to do so may damage the device by electrostatic discharges when touching exposed sensitive components.

2 Scope of Supply

HTS401 sensor

	Included in all versions	Option
HTS401 modular RH/T sensor	✓	
HTS401 mounting kit	✓	
Inspection certificate according to DIN EN 10204-3.1	✓	
Test report according to DIN EN 10204-2.2		Types T1 and T2 with RX1, Type T3
Mounting flange		Type T2 with polycarbonate enclosure
Additional cable gland		Output J3
Quick Guide HTS401 with RS485 interface		Output J3

HTS401P remote probe (order with Type T3)

	Included in all versions	Option
Inspection certificate according to DIN EN 10204-3.1	✓	
Plastic mounting flange	✓	

3 Product Description

3.1 General

The HTS401 is a RH / T sensor for demanding and challenging applications in climate control. It is available for wall or duct mounting as well as with a remote probe, for indoors or outdoors.

Product Variants

Three different HTS401 types provide a broad range of options for measurement tasks:

Probe Type	Description
T1	Wall mount - polycarbonate enclosure and probe tube, optionally available with exchangeable rapidX sensing module
T2	Duct mount - polycarbonate enclosure and probe tube, optionally available with exchangeable rapidX sensing module or die-cast aluminium enclosure and stainless steel probe tube
T3	Remote probe - polycarbonate enclosure and remote probe tube, connected via M12 cable

Tab. 1 HTS401 types overview

Available Quantities, Units and Measuring Ranges

Parameter		Measured	Calculated	Units	Range
Relative humidity	Uw	✓		%RH	0...100 %RH non-condensing
Temperature	T	✓		°C, °F, K	-40...+80 °C (-40...+176 °F)
Dew point temperature	Td		✓	°C, °F, K	-40...+80 °C (-40...+140 °F)
Frost point temperature	Tf		✓	°C, °F, K	-40...0 °C (-40...+32 °F)
Wet bulb temperature	Tw		✓	°C, °F, K	-10...+80 °C (14...140 °F)
Ice bulb temperature	Ti		✓	°C, °F, K	-40...0 °C (-40...+32 °F)
Water vapour partial pressure	e		✓	mbar, psi	0...475 mbar (0...6.9 psi)
Mixing ratio	r		✓	g/kg, gr/lb	0...550 g/kg (0...4125 gr/lb)
Absolute humidity	dv		✓	g/m^3, gr/ft^3	0...270 g/m^3 (0...108 gr/ft^3)
Specific enthalpy	h		✓	kJ/kg, BTU/lb	-40...1590 kJ/kg (-10...640 BTU/lb)

Tab. 2 HTS401 scope of measured and calculated quantities available as output

rapidX Pluggable Sensing Module

Sensor types are available that feature the pluggable RH / T sensing module with rapidX technology. The module can easily be exchanged on-site and even during operation without switching off the HTS401 sensor (hot-swap). Please refer to chapter 6.1 Sensing Module Replacement for more details.

Configuration and Adjustment

The optional USB-C configuration stick and the free PCS10 Product Configuration Software facilitate easy configuration and adjustment of the HTS401. Please refer to chapter 5.2 PCS10 Product Configuration Software.

Supply

The HTS401 power supply depends on the design and is provided via a cable gland directly to the screw terminals on the circuit board. For the details, please refer to chapter 3.3 Electrical Connection and to the “General” section of chapter 8 Technical Data.

Output

The measured / calculated data is available on two freely selectable and scalable analogue outputs or on the digital RS485 interface with Modbus RTU protocol.
For the details, please refer to chapter 3.5 Outputs.

Materials

The HTS401 enclosure is available in either polycarbonate or die-cast aluminium. For polycarbonate enclosure, the probe tube is also made of polycarbonate. A duct mount type enclosure from die-cast aluminium comes with a stainless steel probe tube. The filter options are fully available for all types and materials.

Display

An optional display for on-site monitoring of the measuring values allows for a quick overview of the prevailing conditions in the process. Please refer to chapter 3.8 Optional Display.

Pressure Compensation

The HTS401 performs pressure compensation of all humidity-related quantities. A pressure value of 1013.25 mbar is set at the factory. If the actual pressure deviates from the factory setting, the desired working pressure value may be entered via PCS10 Product Configuration Software and via Modbus command for the version with RS485 digital interface.

Heating Modes against Chemical Contamination and High Humidity

Automatic ReCovery (ARC) is used to outgase chemical pollution and thus eliminate possible drift effects, especially outdoors. This is achieved with an intense heating of the RH / T sensing element. The function can be perfectly tailored to the application requirements being triggered:

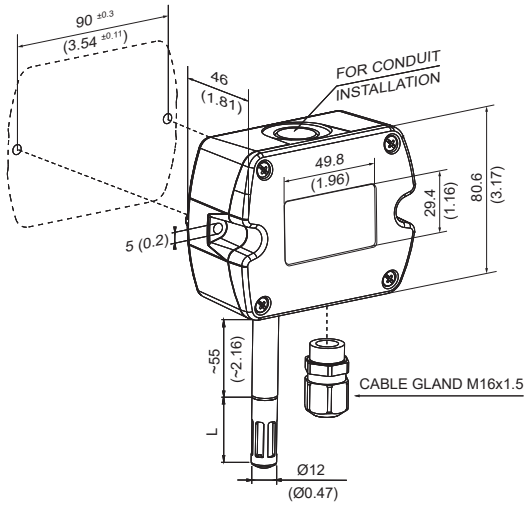
- Manually via PCS10
- By a certain cyclic time interval configurable via PCS10, or ex works
- Via RS485 digital interface

The **Condensation Guard (CG)** is designed for applications with variable humidity where condensation may occur for short periods of time. The CG protects the RH / T sensing element by targeted heating. This prevents temporary condensation and its negative effects on the measurement results. The CG heating is triggered by a predefined RH threshold, factory set via order code and configurable with PCS10.

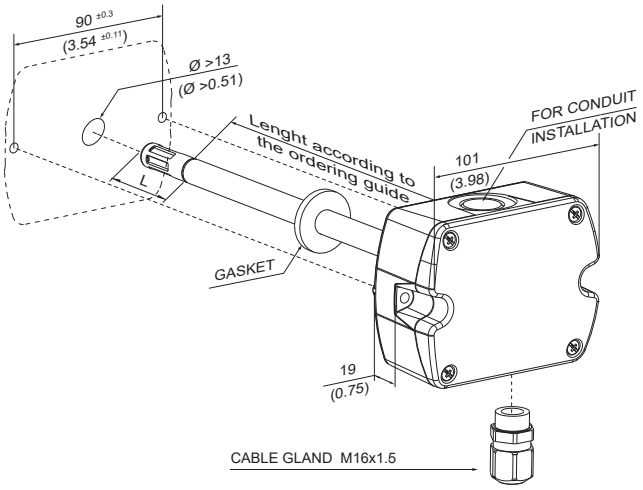
3.2 Dimensions

Values in mm/inch

Type T1



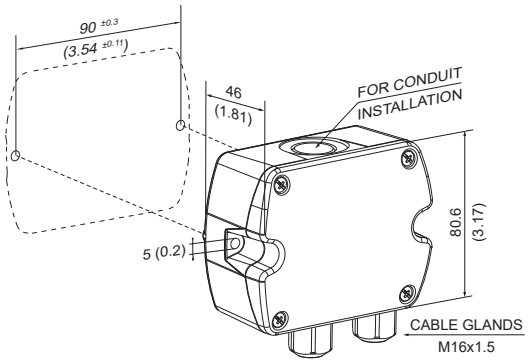
Type T2



L = filter cap length	mm (inch)
Membrane	34 (1.4)
Stainless steel	33 (1.3)
Stainless steel	34 (1.4)[1)]
Metal grid	33 (1.3)

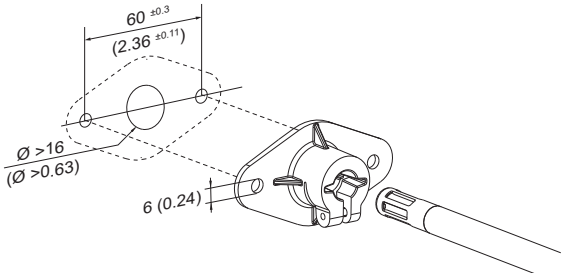
1) With rapidX sensing module

Type T3 (for remote probe)

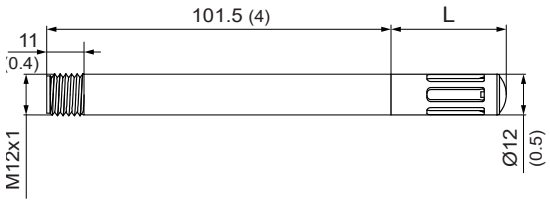


Plastic mounting flange

in the scope of supply for types T2 and T3 with polycarbonate enclosure

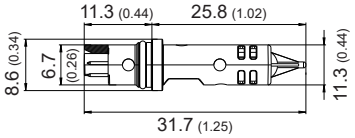


HTS401P remote probe

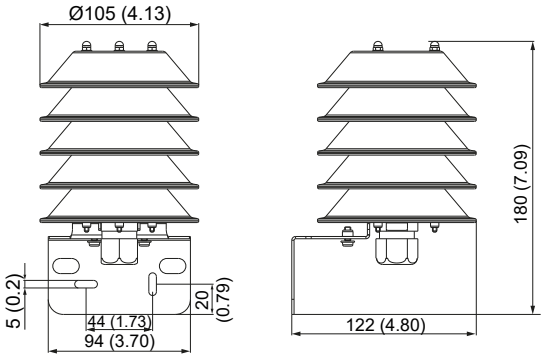


HTS401M Sensing Module

in the scope of supply for types with rapidX technology

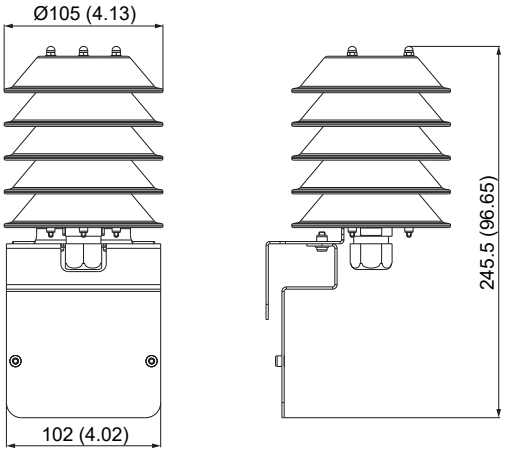


Radiation shield HA010514 for Type T3
needs to be ordered separately
basic plate [1] mount



1) Basic plate for wall mount or pole mount, mounting ring in the scope of supply of radation shield HA010514

with mounting plate[1] for sensor enclosure



1) In the scope of supply of radation shield HA010514

3.3 Electrical Connection

The HTS401 features screw terminals on the electronics board for connecting the power supply and the outputs. The cables are fed into the enclosure through the M16 cable gland.

	Power supply	Output	Probe
Type T1 - wall mount	Screw terminals, cables are fed into enclosure through M16 cable gland.		Hardwired
Type T2 - duct mount			Hardwired
Type T3 - remote probe			Via M12 probe connection cable, 4 poles

Tab. 3 HTS401 electrical connection

NOTICE

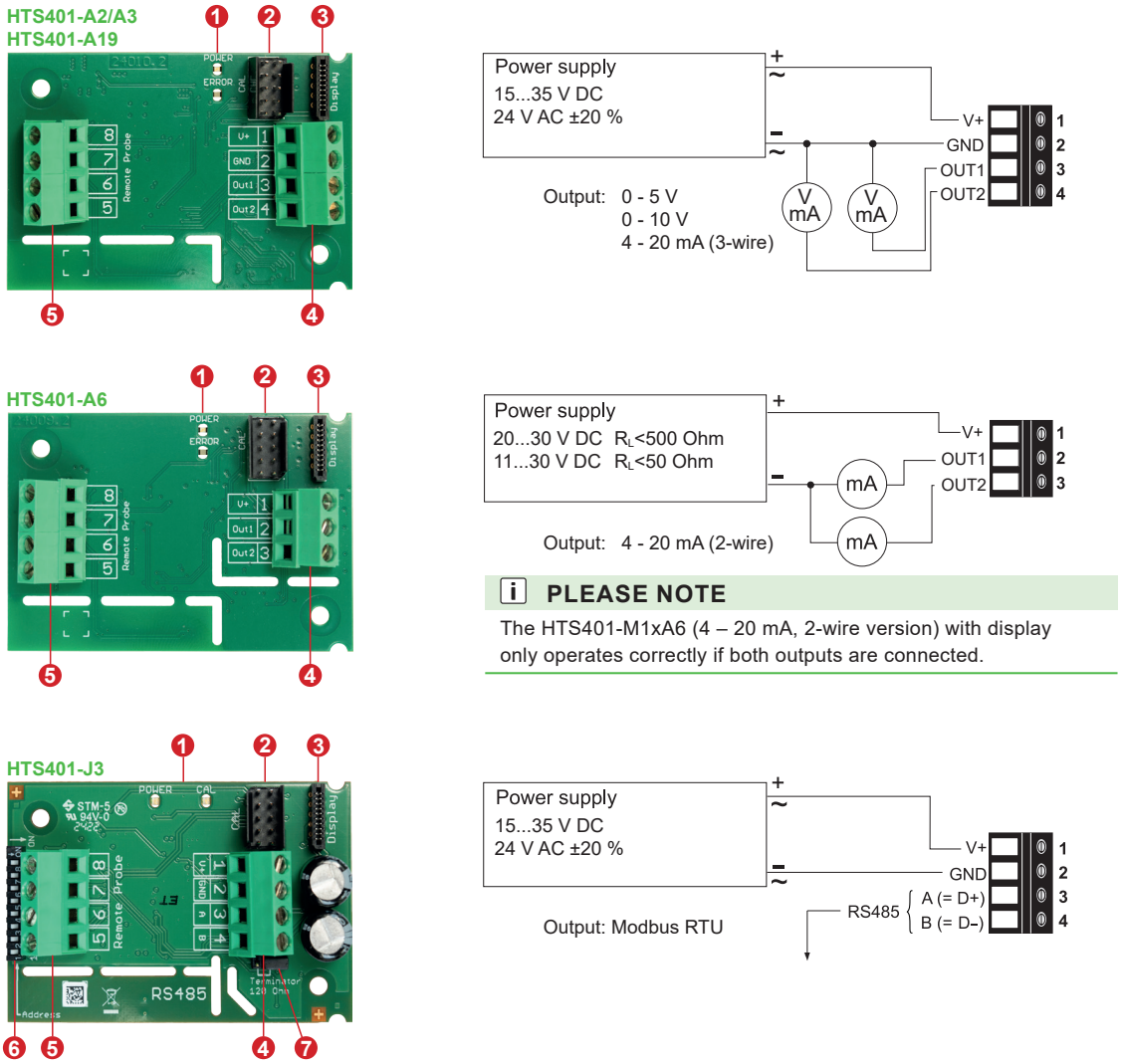
Make sure that the cable glands are closed tightly for the power supply and outputs cable. This is necessary for assuring the IP rating of the enclosure according to HTS401 specification, as well as for stress relief at the screw terminals on the HTS401 board.

⚠ WARNING

Incorrect installation, wiring or power supply may cause overheating and therefore personal injuries or damage to property.

It is essential that the cables are not under voltage during installation. No voltage must be applied when the product is connected or disconnected. For correct cabling of the device, always observe the presented wiring diagram for the product version used.

The manufacturer cannot be held responsible for personal injuries or damage to property as a result of incorrect handling, installation, wiring, power supply and maintenance of the device.



PLEASE NOTE

The HTS401-M1xA6 (4 – 20 mA, 2-wire version) with display only operates correctly if both outputs are connected.

Fig. 1 HTS401 connection options

No.	Function	
❶	POWER LED Information during operation	
	Off	Main board failure or no power supply
	Flashing (1 Hz)	Normal operation
	Flashing (5 Hz)	10 s after power-on or reset, during ARC or CG element heating
	ERROR LED (analogue versions) Information during setup with the optional USB-C configuration stick HA011070 and the PCS10 Product Configuration Software	
	Off	Error-free operation
	Flashing (1 Hz)	Error has occurred
	Red and green flashing alternately	Start-up
	CAL LED (versions with digital interface) Indicates communication between sensor and PCS10	
❷	Configuration connector (USB-C configuration stick)	
❸	FFC cable socket for the display	
❹	Screw terminals for power supply and outputs	
❺	Screw terminals, remote probe connection	
❻	Address DIP switch for RS485 interface	
❼	Jumper for activation/deactivation of bus termination resistor 120 Ω	

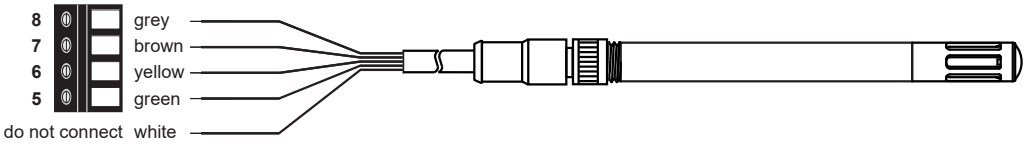
Tab. 4 Parts of the HTS401 electronics board types

3.4 Remote Probe HTS401P for Type T3

The HTS401P (remote probe for HTS401-M1T3x) shall be ordered and is supplied as separate item. HTS401P is to be connected to the HTS401 by the user.

Procedure:

1. First install the cable gland (included in the HTS401 scope of supply) on the HTS401 enclosure.
2. Before connecting the probe, disconnect the HTS401 power supply.
3. Feed the connection cable (HA010831/HA010832/HA010833/HA010834) through the cable gland and connect it to the screw terminals according to the connection diagram below.



When using other cables than (HA010831/HA010832/HA010833/HA010834), use the following pin connection of the HTS401P for connecting it on the main PCB.



M12 device plug
front view

Pin on probe's plug	Terminal Number on PCB
1	8
2	7
3	5
4	6

PLEASE NOTE

HTS401P is an intelligent probe with digital output which is interchangeable. If the sensor or its cable is damaged or a longer cable is needed, please order a replacement part according to the HTS401 datasheet. The replacement part shall be installed as described above.

3.5 Outputs

The measured data is available on two analogue outputs or via digital RS485 interface with Modbus RTU protocol. The freely scalable analogue outputs both are either current (4 - 20 mA, 2-wire or 3-wire) or voltage (0 - 10 V or 0 - 5 V). Configuration is selected at the time of order and can be changed in the field via PCS10 Product Configuration Software and USB-C configuration stick (HA011070).

Optionally, an LC display with up to three lines is available. For details, please refer to chapter 3.8 Optional Display.

Output	Please refer to chapter
Two freely selectable and scalable outputs for RH and T, both current or voltage	-
Digital interface RS485 with Modbus RTU protocol	5.3 RS485 Digital Interface
Optional: LC display with up to three lines	3.8 Optional Display

Tab. 5 Interface overview

Parameter		Measurement Units
Relative humidity	Uw	%RH
Temperature	T	°C, °F, K
Dew point temperature[1)]	Td	°C, °F, K
Frost point temperature[2)]	Tf	°C, °F, K
Wet bulb temperature	Tw	°C, °F, K
Ice bulb temperature[3)]	Ti	°C, °F, K
Water vapour partial pressure	e	mbar, psi
Mixing ratio	r	g/kg, gr/lb
Absolute humidity	dv	g/m^3, gr/ft^3
Specific enthalpy	h	kJ/kg, ft lbf/lb, BTU/lb

1) Td accuracy according to RH and T uncertainties, please use the E+E Humidity Caclulator for details.
2) Equals Td above 0 °C (32 °F).
3) Equals Tw above 0 °C (32 °F).

Tab. 6 HTS401 scope of quantities and units

3.6 Configuration Interface

The HTS401 is ready to use and does not require any further configuration. The factory setup of HTS401 corresponds to the specified order code. Please refer to the datasheet at www.epluse.com/hts401.

The HTS401 features a USB configuration interface for configuration, adjustment and firmware update via PCS10 (please refer to chapter 5 Setup and Configuration).

If needed, the factory setup can be changed via

- Free PCS10 Product Configuration Software.
  Please refer to chapter 5.2 PCS10 Product Configuration Software.
- Modbus RTU protocol (if the RS485 option is selected).
  Please refer to chapter 5.3 RS485 Digital Interface.

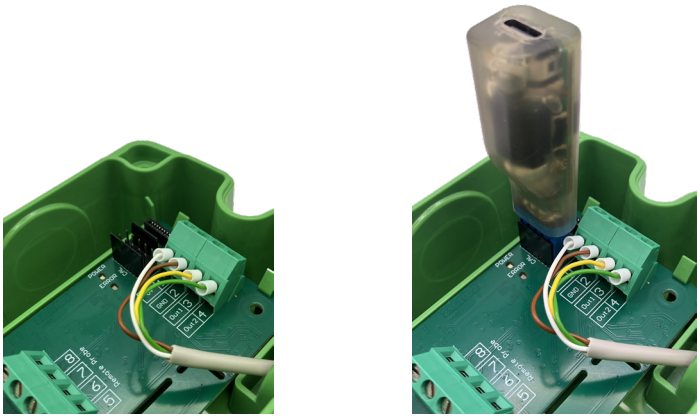


Fig. 2 HTS401 configuration interface with USB-C configuration stick unplugged / plugged

PLEASE NOTE

- The full scope of configuration is available with the PCS10.
- Configuration with the Modbus RTU protocol only refers to the Modbus communication settings.

3.7 Heating Modes

3.7.1. Overview

The intelligent heating modes on the HTS401 are available for all types with 3-wire output: A2/A3/A19/J3.

Operating Mode	Use in Environments with	Function Trigger
Automatic Recovery	Chemical pollution	Power-on, manual or cyclic[1)]
Condensation Guard (CG)	Temporary condensation	RH threshold[1)]

1) Factory setting: according to ordering guide

Tab. 7 HTS401 heating opteration modes

3.7.2. Automatic ReCovery (ARC) against Chemical Pollution

When capacitive humidity sensing elements are exposed to chemical pollution (e.g. detergent residues), foreign molecules can contaminate the sensing element and distort the measurement reading of the sensor. With the ARC function, these impurities can be evaporated from the sensing element by brief and intensive heating.

PLEASE NOTE

Before a recalibration is done after an ARC cycle, reconditioning of the sensing element is recommended. For best reconditioning, please allow 2 free calibration cycles between 15 %RH and 90 %RH in steps of ~20 %RH and 20 min stabilisation time.

The ARC function is characterised by its triggers and parameters which are described below. All the parameters have factory default settings according to the order code and can be modified via PCS10 Product Configuration Software.

Parameter	Setting option	Factory setting
Heating duration	60 s...3 600 s (60 s...1 h)	1 200 s
Recovery duration	0 s... 3 600 s (0 s...1 h)	360 s
ARC at power-on	Activated, deactivated	According to order code
Cyclic ARC	Activated with a cycle duration of 10...14400 min (10 min...10 days), deactivated	According to order code

Tab. 8 Overview of ARC Parameters

ARC Parameters

Heating duration: Defines the time in which the monolithic measurement cell is intensively heated. A heating time of at least 20 minutes (20 min = factory setting) is recommended when unknown chemical pollution has occurred.

Recovery duration: The cool-down time is necessary for the sensing element to get back to ambient temperature. The cool-down time depends significantly on the prevailing flow velocity at the measuring point and the resulting heat dissipation.

The factory setting for the recovery duration is 6 minutes, which is suitable for processes involving an air flow of around 3 m/s (590 ft/min) and a residual temperature difference of less than 0.5 °C. Please refer to Tab. 9 for the recommended cool-down time at different air velocities.

Air velocity at the measuring point	Recommended cool down time for $\Delta T<0.5$ °C
0.2 m/s (39 ft/min, room convection)	15 min
3 m/s (590 ft/min)	6 min (factory setting)
5 m/s (984 ft/min)	4 min
10 m/s (1 969 ft/min)	3 min

Tab. 9 Recommended cool-down time dependent on air velocity

During the ARC cycle (heating and cool-down time), the RH / T values at the outputs are frozen. The measuring values at all outputs are kept at the values that were valid at the time the process started. At the end of the cycle, the outputs (analogue and digital) and display return to normal operation.

For Modbus types, the remaining ARC process time in seconds is available in the register 0x1FD (510_{DEC}).

ARC Function Triggers

Manual: A manual start of the ARC function is recommended when
- chemical pollution on the sensing element is expected (cleaning/sterilization) or
- measurement readings deviate significantly from a calibration reference.

INFO

The manual ARC start can also be triggered via RS485 command.

At power on: The ARC cycle starts immediately at the device's power-on and is carried out once.

Cyclic: ARC can be configured to start periodically at a certain time interval. The feature properties are selected at the time of ordering and can be changed via PCS10.

PLEASE NOTE

The cyclic ARC start can be ordered with a cycle interval of 24 h and start at power-on.

To achieve this behaviour with the PCS10 Product Configuration Software, both, the "at power on" and the "cyclic" options have to be activated.

Periodic heating shall be used to minimize drift effects in applications with high chemical pollution and outdoor operation. The ideal cycle time depends on the type of pollution and its concentration and has to be determined empirically. For general use or as a starting point, an interval of 24 hours should be used.

Indications on the Optional Display

As soon as the ARC cycle starts, the optional display shows the following indications for the entire heating duration:
- "heating: 0" when ARC trigger "At power on" is enabled
- "heating: 1" when ARC trigger "Start ARC now" or "Cyclic" is enabled

During the subsequent recovery duration, the frozen measurement values are displayed.
After recovery, the display returns to normal operation.

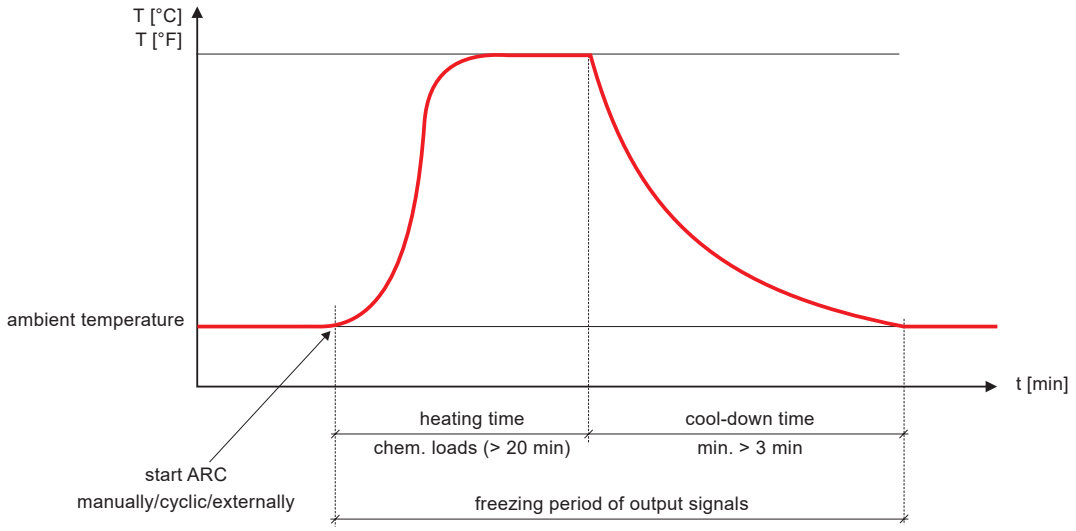


Fig. 3 ARC process in detail

PLEASE NOTE

If the defined cool-down time is too short, the measurements may be incorrect.

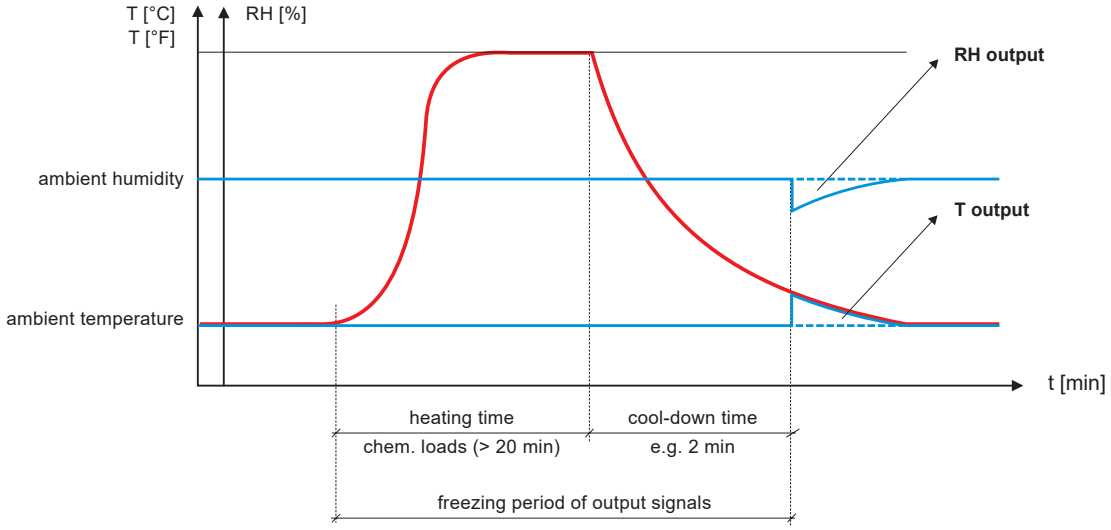


Fig. 4 ARC cycle with cool-down time too short

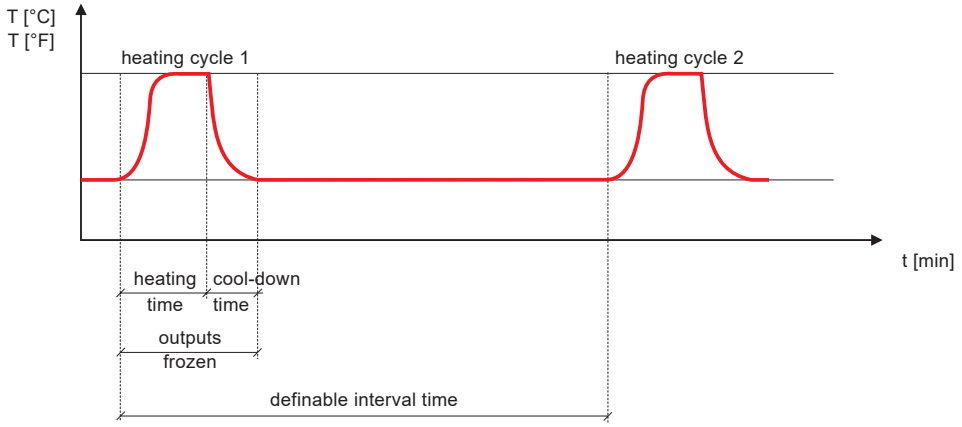


Fig. 5 ARC cycle and interval

3.7.3. Condensation Guard (CG) against Temporary Condensation

Temporary condensation on the sensing element in highly humid environments is eliminated when a specified RH trigger (factory setting: acc. to order code) is reached. By intensive heating of the sensing element for 10 seconds, occurring dew is evaporated. The sensing element cools off quickly within approximately 3 minutes and returns to its measurement function.

If condensation is still detected after the CG cycle, it restarts immediately or after the predefined lock time.

Parameter	Setting option	Factory setting
Cool-down duration	–	180 s
RH threshold	90...100 %RH	According to order code
Lock time	0...3 600 s (0...60 min)	According to order code

Tab. 10 Overview of CG Parameters

During the complete heating and cool-down process, the values all at the outputs are frozen. In other words, the measuring values at the outputs are kept constant during the CG cycle.

The CG function can be preconfigured using the order code options. The lock time is configurable.

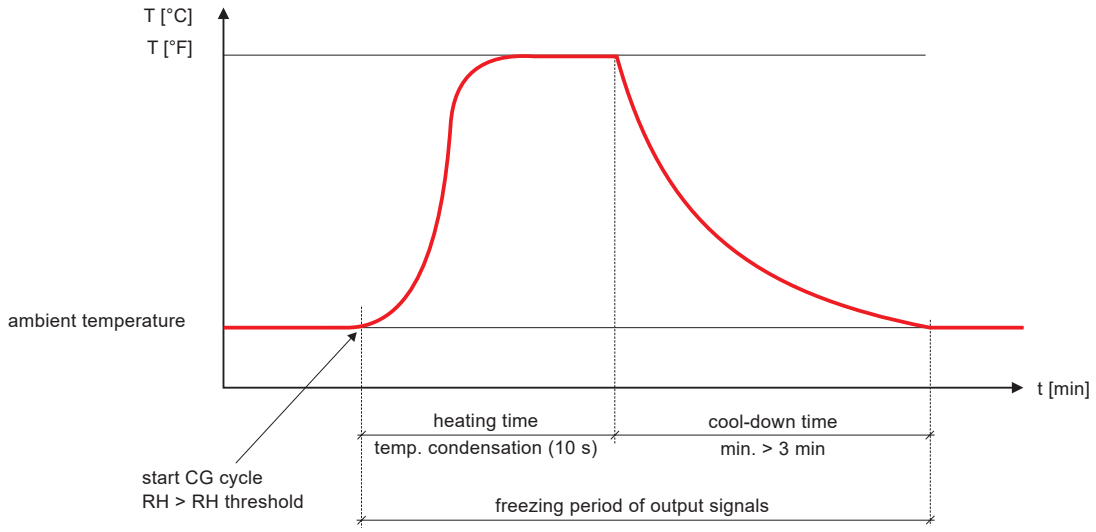


Fig. 6 CG cycle in detail

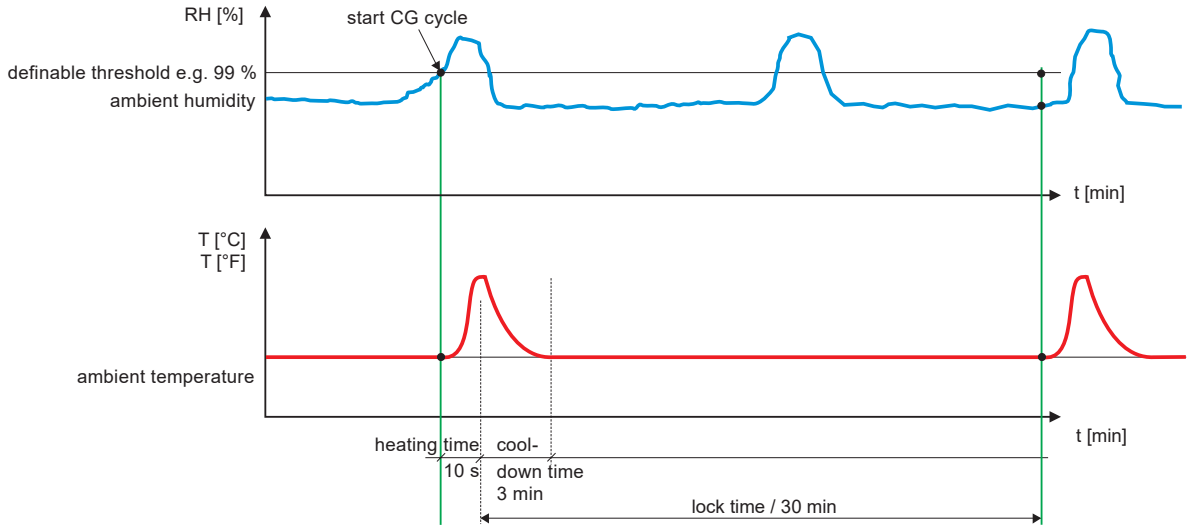


Fig. 7 CG cycles with a lock time of 30 min

PLEASE NOTE

The lock time has to be set according to the application needs. A lock time too short might result in permanent freezing of the outputs.

Via the PCS10, the following CG parameters can be configured:

- Humidity threshold
- Cool down time
- Lock time

PLEASE NOTE

When heating has ended, the system blocks any subsequent heating for 30 minutes. That means if the ambient humidity remains above the defined set point after the initial heating, the next CG cycle starts again after 30 minutes.

3.8 Optional Display

The optional display is available for all HTS401 types.

Per factory setup, the display shows the two measurands selected for output 1 and output 2 for analogue versions (according to the ordering code). Versions with digital interface indicate RH and T.



Fig. 8 HTS401 with display

The display layout can be modified via PCS10 Product Configuration Software. The configuration options include the display of 1, 2 or 3 lines, and the displayed quantities. Further, the contrast and the orientation of the display can be adapted.

The settings can be adjusted via PCS10 Product Configuration Software. Please refer to chapter 5 Setup and Configuration for details.

INFO

The display is available as a spare part, intended for both, replacement and retrofit. This means that also HTS401 sensors purchased as non-display variants can be equipped with a display. Simply replace the cover with one that has a display integrated. The display is connected to the circuit board via a FFC cable. There is no configuration necessary.

PLEASE NOTE

It is possible to convert a display variant to a non-display variant without any configuration.

PLEASE NOTE

The HTS401-M1xA6 (4 – 20 mA, 2-wire version) with display operates correctly only if both outputs are connected.

4 Mounting and Installation

4.1 General

For mounting the cable gland (in the scope of supply) onto the HTS401 enclosure, use a matching wrench.

When using HTS401 with a conduit connection for the North American market, carefully open the blind at the top of the enclosure using a flat screwdriver. Take good care to avoid damaging the electronics inside the enclosure. The conduit adapter is not included in the scope of supply. The M16x1.5 opening for the cable gland shall be tightly closed using the blind plug included in the scope of supply (please refer to also chapter 3.2 Dimensions).

4.2 Recommendations for Accurate Humidity and Temperature Measurement

The sensing elements and output electronics of an HTS401 are incorporated in a compact enclosure and are designed to be mounted in a specific direction.

Any heat generated by the electronics rises upwards, so the sensor tube must point downwards to prevent the heat from affecting the measurement.

Any residual self-heating effects are compensated in typical operating conditions (e.g. supply voltage: 24 V DC, load resistance for current types: 250 Ω, air velocity at measuring point: 0.2 m/s (39 ft/min)).

For best measurement results, the HTS401

- must be installed so that the RH sensor is pointing downwards whenever possible
- must be installed in an environment where the medium to be measured flows sufficiently around the RH/T sensing probe.
- shall not be placed in the proximity of heat sources such as heating radiators or fan heaters.

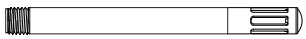
For HTS401 wall mount types please mind the following rules for sensor positioning. Mount the sensor:

- 2 m (6.6 ft) away from inlets and outlets
- In a place where the air can circulate freely. Best accuracy is achieved with a velocity of min. 0.2 m/s (39 ft/min) of the air surrounding the probe. Depending on the installation position, flow direction and flow velocity, the accuracy may decline.
- Not in places where heat accumulation may occur
- Not in places where draughts may occur

HTS401 duct mount types must be installed in a way that temperature gradients due to thermal coupling, which lead to incorrect measurements, are avoided along the sensor tube.

HTS401P remote probe types

- In case the HTS401P remote probe is not entirely located in the environment to be monitored, large temperature differences along the probe will lead to temperature gradients. These will have an influence on the accuracy. Therefore, it is of paramount importance to minimize the temperature gradients. The biggest part of the probe shall be located in the target environment and the rest shall be thermally well insulated.
- For outdoor applications, the HTS401P shall be equipped with a radiation shield (HA010502 without enclosure mounting plate) which provides protection from rain, snow and ice. This also causes a natural ventilation which largely prevents overheating of the probe in the sun and thus a distortion of the measured values.
- Best accuracy is achieved with a velocity of min. 0.2 m/s (39 ft/min) of the air surrounding the probe. Depending on the installation position, flow direction and flow velocity, the accuracy may decline. The following table gives a concise overview. Please note that the vertical positioning with the sensing element upside is the most sensitive one concerning accuracy. Because of possible self heating due to the sensor electronics, it is crucial to have the indicated air flow velocity.

Flow direction of the medium	Probe direction		
			
←	> 0.2 m/s (39 ft/min)	> 0.2 m/s (39 ft/min)	> 0.2 m/s (39 ft/min)
→	> 0.2 m/s (39 ft/min)	> 0.2 m/s (39 ft/min)	This type of mounting is not recommended
↑	> 0.2 m/s (39 ft/min)	This type of mounting is not recommended	> 0.2 m/s (39 ft/min)
↓	This type of mounting is not recommended	> 0.2 m/s (39 ft/min)	> 0.2 m/s (39 ft/min)

Tab. 11 Mounting position, air velocity and accuracy

4.3 Outdoor Installation with Radiation Shield

HTS401-T3xxx can be installed with a radiation shield (order code HA010514). Choose an appropriate place to mount the sensor observing the general mounting instructions and recommended mounting positions of the radiation shield.

PLEASE NOTE

The radiation shield HA010514 holds both, the HTS401P remote probe as well as the HTS401 enclosure.

The radiation shield HA010502 accommodates the HTS401P remote probe only.

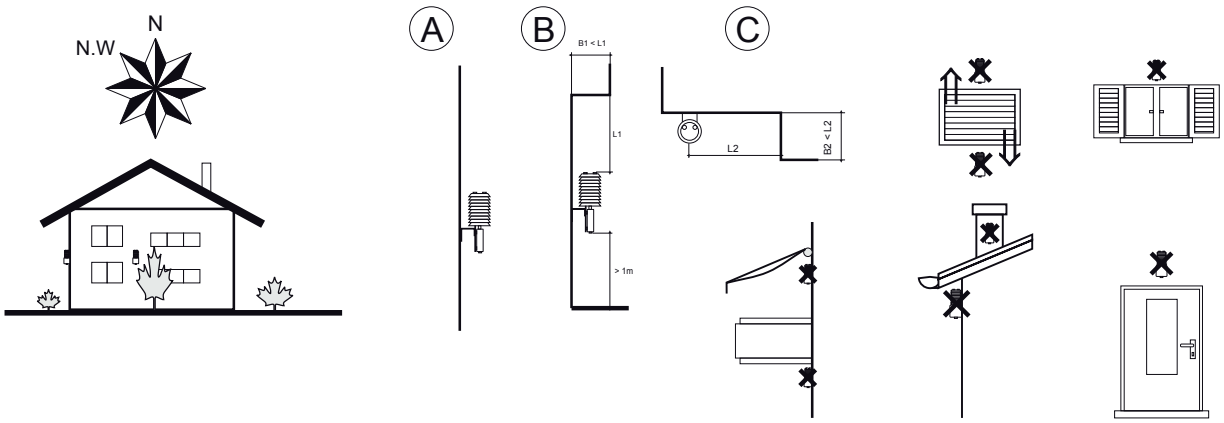


Fig. 9 Mounting position

Follow these steps to mount the HTS401 in the radiation shield (see Fig. 10 below):

1. Install the mounting plate with the radiation shield onto either a wall or a pole.
2. Attach the support plate by driving the screws from the underside of the plate.
3. Place the HTS401 enclosure onto the support plate and tighten the screws.
4. Insert the HTS401P probe into the radiation shield until it is fully seated, and secure it using the integrated cable gland.

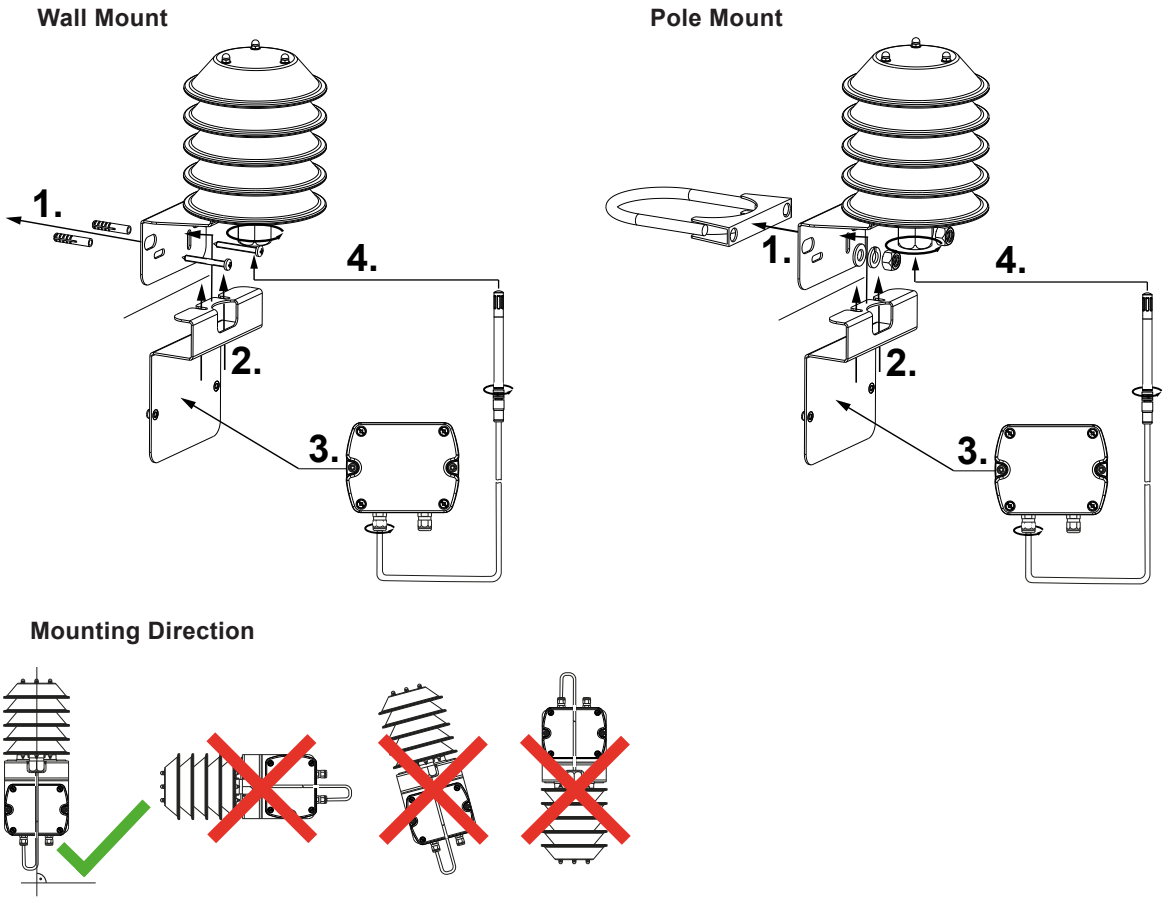


Fig. 10 Mounting instruction

5 Setup and Configuration

The HTS401 is ready to use and does not require any configuration by the user. The factory setup of HTS401 corresponds to the type number ordered. Please refer to the datasheet at www.epluse.com/hts401. If needed, the factory setup can be changed. This chapter describes the configuration possibilites with the PCS10 Product Configuration Software and via the digital RS485 interface with Modbus RTU.

5.1 Product Configuration

5.1.1. HTS401 Configuration using the USB-C configuration stick

All HTS401 types, analogue and digital, can be configured via their configuration interface. For this purpose, the USB-C configuration stick HA011070 is plugged into the socket on the HTS401 electronics board.

NOTICE

The USB-C configuration stick HA011070 galvanically isolates the USB interface of the PC from the HTS401 configuration interface. When using the USB-C configuration stick, the HTS401 needs external supply.

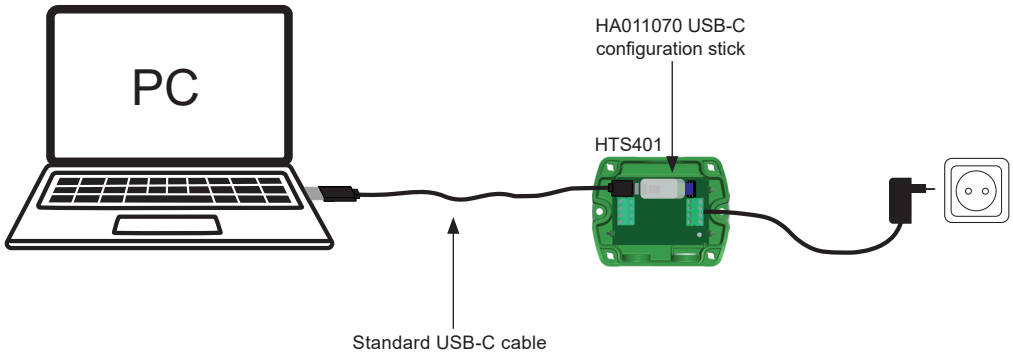


Fig. 11 HTS401 configuration using the HA011070 USB-C configuration stick

5.2 PCS10 Product Configuration Software

The PCS10 provides a convenient graphical user interface to the HTS401 for changing the factory setup. For this purpose, the PC is connected to the board via the USB-C configuration stick and a USB cable. The HTS401 has to powered separately, no power supply is provided via USB.

With the PCS10, it is possible to change the digital communication settings, the analogue settings and to perform a RH and T adjustment in the form of an offset or as a 2-point adjustment. For the purpose of pressure compensation, the barometric air pressure at the operating site may be set. The ARC and/or CG parameters may be set and changed.

To use the software to change the settings, please proceed as follows:

1. Download the PCS10 Product Configuration Software from www.epluse.com/pcs10 and install it on the PC.
2. Connect the HTS401 to the PC using the configuration adapter.
3. Start the PCS10 software.
4. Follow the instructions on the PCS10 opening page for scanning the ports and identifying the connected device
5. Click on the desired setup mode from the main PCS10 menu on the left. Follow the online instructions of the PCS10 which are displayed when clicking the “Tutorial” button.
6. Changes are uploaded to the sensor by pressing the “Sync” button.

5.3 RS485 Digital Interface

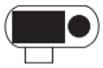
5.3.1. Hardware Bus Termination

For bus termination, the HTS401 with digital interface features an internal 120 Ω resistor which can be activated using the jumper on the electronics board (refer to also chapter 3.3 Electrical Connection and Fig. 1 HTS401 connection options for details).

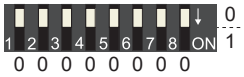
- Jumper not mounted (right position = factory setup): bus is not terminated



- Jumper mounted (left position): bus is terminated



5.3.2. Device Address

Address Switch	Option
	**Address setting via PCS10 Product Configuration Software (= factory setting)** All DIP switches at position 0 → factory-set default address (49_{DEC}, 0x31) applicable, can be changed via software (PCS10 or Modbus protocol, permitted values: 1…247). Example: Address is set via configuration software.
	**Address setting via DIP switches** DIP switches in any other position than 0 indicate the effective Modbus address which overrules the factory setting and any Modbus address set via PCS10 or Modbus command (permitted values: 1…247). Example: Address set to 11_{DEC} ($0000\ 1011_{BIN}$).

5.3.3. Modbus RTU Protocol Settings

	Factory settings	User selectable values (via PCS10)
Baud rate	9 600	9 600, 19 200, 38 400, 57 600, 76 800, 115 200
Data bits	8	8
Parity	Even	None, odd, even
Stop bits	1	1, 2
Modbus address	49 (0x31)	1...247

Tab. 12 Modbus RTU protocol settings

PLEASE NOTE

- The recommended settings for multiple devices in a Modbus RTU network are 9600, 8, even, 1.
- The HTS401 represents 1 unit load on an RS485 network.

Device address, baud rate, parity and stop bits can be set via:

- PCS10 Product Configuration Software and the USB-C configuration stick HA011070.
  The PCS10 can be downloaded free of charge from www.epluse.com/pcs10.
- Modbus protocol in the register 1 (0x00) and 2 (0x01).
  Refer to Application Note Modbus AN0103 (available at www.epluse.com/hts401).

The serial number as ASCII-code is located in read-only registers 1 – 8 (0x00 – 0x07, 16 bits per address).
The firmware version is located in register 9 (0x08) (bit 15...8 = major release; bit 7...0 = minor release).
The sensor name is located in register address 10 (0x09).

NOTICE

When reading information that spans multiple registers, it is always necessary to read all registers, even if the desired information requires less.

NOTICE

To obtain the correct floating point values, both registers have to be read within the same reading cycle. The measured value may change between two Modbus requests. This can cause inconsistencies in the exponent and mantissa.

INFO

The Modbus function codes mentioned throughout this document shall be used as described in chapter 6 of of MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, available at https://www.modbus.org/.

Communication settings (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Write register: function code 0x06			
Modbus address[4]	1	00	1
Modbus protocol settings[4]	2	01	1

Device information (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Read register: function code 0x03 / 0x04			
Serial number (as ASCII)	1	00	8
Firmware version	9	08	1
Sensor name (as ASCII)	10	09	8

1) Register number (decimal) starts from 1.
2) Register address (hexadecimal) starts from 0.
3) Number of registers
4) For Modbus address and protocol settings refer to Application Note Modbus AN0103 (available at www.epluse.com/hts401).

Tab. 13 HTS401 registers for device setup

5.3.4. Application Specific Parameters

Application settings (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Write register: function code 0x06			
ARC start	509	1FC	1

Device information (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Read register: function code 0x03			
ARC remaining seconds	510	1FD	1
Device status (bit decoded)[4]	602	259	1

Application parameters

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Write registers: function code 0x10 / Read registers: function code 0x03 / 0x04			
Air pressure[5]	5001	1388	2

1) Register number (decimal) starts from 1.
2) Register address (hexadecimal) starts from 0.
3) Number of registers
4) Refer to chapter 5.7 Device Status Indication.
5) Ambient pressure in mbar, with 2 decimal digits, default value 1013.25 mbar.

Tab. 14 HTS401 application specific registers for device setup

5.4 Modbus Register Map

The measurement data is stored as 32 bit floating point values (data type FLOAT32) and as 16 bit signed integer values (data type INT16).

FLOAT32

Parameter	Unit	Register number[1)] [DEC]	Register address[2)] [HEX]
Read register: function code 0x03 / 0x04			
Temperature T	°C	1003	3EA
	°F	1005	3EC
	K	1009	3F0
Relative humidity RH, Uw	%RH	1021	3FC
Water vapour partial pressure e	mbar	1101	44C
	psi	1103	44E
Dew point temperature Td	°C	1105	450
	°F	1107	452
	°K	1147	47A
Wet bulb temperature Tw	°C	1109	454
	°F	1111	456
	K	1145	478
Absolute humidity dv	g/m^3	1113	458
	gr/ft^3	1115	45A
Mixing ratio r	g/kg	1121	460
	gr/lb	1123	462
Specific enthalpy h	kJ/kg	1125	464
	ft lbf/lb	1127	466
	BTU/lb	1129	468
Frost point temperature Tf	°C	1131	46A
	°F	1133	46C
	K	1149	47C
Ice bulb temperature Ti	°C	1237	4D4
	°F	1239	4D6
	K	1241	4D8

INT16

Parameter	Unit	Scale[3)]	Register number[1)] [DEC]	Register address[2)] [HEX]
Read register: function code 0x03 / 0x04				
Temperature T	°C	100	4002	FA1
	°F	50	4003	FA2
	K	50	4005	FA4
Relative humidity RH, Uw	%RH	100	4011	FAA
Water vapour partial pressure e	mbar	10	4051	FD2
	psi	1000	4052	FD3
Dew point temperature Td	°C	100	4053	FD4
	°F	100	4054	FD5
	K	100	4074	FE9
Wet bulb temperature Tw	°C	100	4055	FD6
	°F	100	4056	FD7
	K	100	4073	FE8
Absolute humidity dv	g/m^3	10	4057	FD8
	gr/ft^3	10	4058	FD9
Mixing ratio r	g/kg	10	4061	FDC
	gr/lb	10	4062	FDD
Specific enthalpy h	kJ/kg	1	4063	FDE
	ft lbf/lb	1	4064	FDF
	BTU/lb	1	4065	FE0
Frost point temperature Tf	°C	100	4066	FE1
	°F	100	4067	FE2
	K	100	4075	FEA
Ice bulb temperature Ti	°C	100	4119	1016
	°F	100	4120	1017
	K	50	4121	1018

1) Register number (decimal) starts from 1
2) Register address (hexadecimal) starts from 0
3) Examples: For scale 100, the reading of 2550 means a value of 25.5. For scale 50, the reading of 2550 means a value of 51.

Tab. 15 HTS401 FLOAT32 and INT16 measured data registers

5.5 HTS401 Modbus Backwards Compatibility to EE210 and EE212

The HTS401 can directly replace an EE210 / EE212 sensor. This is valid for Modbus types as well as for all types with analogue output.

The measurement data is stored as 32 bit floating point values (data type FLOAT32) and as 16 bit signed integer values (data type INT16).

PLEASE NOTE

For full backwards compatibility, it is necessary to chose the correct unit via ordering code.

FLOAT32

Parameter	Unit[1)]	Register number[2)] [DEC]	Register address[3)] [HEX]
Read register: function code 0x03 / 0x04			
Temperature	°C, °F	26	19
Relative humidity	%	28	1B
Water vapour partial pressure	mbar, psi	30	1D
Dew point temperature	°C, °F	32	1F
Wet bulb temperature	°C, °F	34	21
Absolute humidity	g/m^3, gr/ft^3	36	23
Mixing ratio	g/kg, gr/lb	38	25
Specific enthalpy	kJ/kg,BTU/lb	40	27
Frost point temperature	°C, °F	42	29

INT16

Parameter	Unit[1)]	Scale[4)]	Register number[2)] [DEC]	Register address[3)] [HEX]
Read register: function code 0x03 / 0x04				
Temperature	°C, °F	100	301	12C
Relative humidity	%	100	302	12D
Water vapour partial pressure	mbar, psi	100	303	12E
Dew point temperature	°C, °F	100	304	12F
Wet bulb temperature	°C, °F	100	305	130
Absolute humidity	g/m^3, gr/ft^3	100	306	131
Mixing ratio	g/kg, gr/lb	100	307	132
Specific enthalpy	kJ/kg,BTU/lb	100	308	133
Frost point temperature	°C, °F	100	309	134

1) The choice of measurement units (metric or non-metric) must be done according to the ordering guide.
Switching from metric to non-metric or vice versa by using the PCS10 is not possible.
2) Register number (decimal) starts from 1
3) Register address (hexadecimal) starts from 0
4) Examples: For scale 100, the reading of 2550 means a value of 25.5. For scale 50, the reading of 2550 means a value of 51.

Tab. 16 EE210 / EE212 FLOAT32 and INT16 measured data registers available in HTS401

5.6 Configurable Custom Modbus Map

It is possible to map measured value / status registers arbitrarily to a block of up to 20 registers provided for this purpose. This means that registers of interest can be mapped to a range of consecutive registers, so that important values can be queried with a single command in one block.

The custom map can be configured via:

- PCS10 Product Configuration Software and USB-C configuration stick.
  The PCS10 can be downloaded free of charge from www.epluse.com/pcs10.
- Modbus protocol commands, refer to the example in chapter 5.8 Modbus RTU Example.

The register block for the configuration of the customisable Modbus map consists of the registers 6001 (0x1770) to 6010 (0x1779). For the block-wise query of the measured values behind Modbus registers 3001 (0xBB8) to 3020 (0xBCB), the firmware accesses this configuration area and thus gets the information which measured value/status registers are to be output. A maximum of 10 user-defined registers can be mapped. The table below shows an example:

Registers ...		**... with these assigned measurands ...**			**... map to registers ...**		**... mirrored from source registers**	
Dec	**Hex**	**Meas.**	**Unit**	**Type**	**Dec**	**Hex**	**Dec**	**Hex**
Function code 0x10					*Function code 0x03/0x04*			
6001	1770	RH	%	FLOAT32	3001	BB8	1021	3FC
				FLOAT32	3002	BB9	1022	3FD
6002	1771	T	°C	FLOAT32	3003	BBA	1003	3EA
				FLOAT32	3004	BBB	1004	3EB
6003	1772	Td	°C	FLOAT32	3005	BBC	1105	450
				FLOAT32	3006	BBD	1106	451
6004	1773	Tw	°C	FLOAT32	3007	BBE	1109	454
				FLOAT32	3008	BBF	1110	455
6005	1774	T	°F	FLOAT32	3009	BC0	1005	3EC
				FLOAT32	3010	BC1	1006	3ED
6006	1775	Td	°F	FLOAT32	3011	BC2	1107	452
				FLOAT32	3012	BC3	1108	453
6007	1776	RH	%	INT16	3013	BC4	4011	FAA
6008	1777	T	°C	INT16	3014	BC5	4002	FA1
6009	1778	T	°F	INT16	3015	BC6	4003	FA2
6010	1779	-	-	-	3016	BC7	65536	FFFF
					3017	BC8	65536	FFFF
					3018	BC9	65536	FFFF
					3019	BCA	65536	FFFF
					3020	BCB	65536	FFFF

Tab. 17 Custom Modbus map example

5.7 Device Status Indication

The HTS401 features a status register that contains all status and error information. The status information can be read from Modbus register 602 (0x259). Errors are displayed in bit-coded form. If an event is present, the corresponding bit is set to 1.

If a critical error occurs, all Modbus values are set to NaN (according to IEEE754 for data type FLOAT32) or to 0x8000 (INT16).

Measured values out of range are limited by the corresponding limit value.

Error Bits	Description	Recommended action
Bit 0	Sensor communication failure	Return the unit to the E+E Customer Service
Bit 1	Temperature below minimum limit	Observe the lower working range limit
Bit 2	Temperature above maximum limit	Observe the upper working range limit
Bit 3	T sensor broken	Return the unit to the E+E Customer Service
Bit 4	Humidity below minimum limit	Observe the lower working range limit
Bit 5	Humidity above maximum limit	Observe the upper working range limit
Bit 6	RH sensor broken	Return the unit to the E+E Customer Service
Bit 7	Heating active	-
Bit 8	-	-
Bit 9	-	-
Bit 10	-	-
Bit 11	-	-
Bit 12	-	-
Bit 13	-	-
Bit 14	-	-
Bit 15	-	-

Tab. 18 Device status indication

5.8 Modbus RTU Example

The HTS401's Modbus address is 49 [0x31].

Please refer to

- Chapter 6 of MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, available at https://www.modbus.org/.
- E+E Application Note Modbus AN0103 (available at www.epluse.com/hts401)

Read the temperature (FLOAT32) T = 25.087642669677734375 °C from register address 0x3EA:

Master (e.g. PLC) **HTS401**

Request [Hex]:

Modbus address	Function code	Starting address Hi	Starting address Lo	Qty. of registers Hi	Qty. of registers Lo	CRC	
31	03	03	EA	00	02	E0	4B

Response [Hex]:

Modbus address	Function code	Byte count	Register 1 value Hi	Register 1 value Lo	Register 2 value Hi	Register 2 value Lo	CRC	
31	03	04	B3	7E	41	C8	53	AB

Tab. 19 Example temperature query

Decoding of floating point values:

Floating point values are stored according to IEEE754. The byte pairs [1], [2] and [3], [4] are transformed as follows (register contents taken from T reading Modbus request/response example above):

Modbus response [Hex]

Register 1 Hi [3]	Register 1 Lo [4]	Register 2 Hi [1]	Register 2 Lo [2]
B3	7E	41	C8
MMMM MMMM	MMMM MMMM	SEEE EEEE	EMMM MMMM

Tab. 20 Modbus response

IEEE754

Register 2 Hi [1]	Register 2 Lo [2]	Register 1 Hi [3]	Register 1 Lo [4]
41	C8	B3	7E
0100 0001	1100 1000	1011 0011	0111 1110
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
Decimal value: 25.087642669677734375			

Tab. 21 Data representation according to IEEE754

6 Maintenance and Service

6.1 Sensing Module Replacement

If needed, the HTS401M sensing module can be replaced by a new one. Please refer to chapter 6.6 Spare Parts for the order code.

The sensing module with rapidX technology allows a fast and tool-free exchange even during operation. There is no need to switch off the HTS401 for this purpose (hot-swap).

PLEASE NOTE

Extreme working conditions such as highly polluted, aggressive and chemically contaminated environment might require periodical maintenance of the device. The modular design facilitates maintenance. Replacing the sensing module under the above conditions is a standard maintenance operation, with the sensing module being a wear component. Any warranty claims relating to measurement drift or sensing module failure caused by the harsh working environment are excluded.

PLEASE NOTE

For a newly ordered HTS401M sensing module, the inspection certificate according to DIN EN 10204-3.1 is available online only from https://certificates.epluse.com. The serial number is lasered onto the module as a 2D bar code. Please refer to Fig. 12.



Fig. 12 HTS401M with serial number 2D bar code



Fig. 13 HTS401 modular construction

Procedure:

1. Remove the filter cap by turning it counter-clockwise.
2. Remove the sensing module by pulling it straight out from the probe.
3. Plug the new HTS401M sensing module into the output unit.
4. Screw the filter cap fingertight onto the probe.

6.2 Filter Cap Exchange

In a dusty, polluted environment it might be necessary to replace the filter cap once in a while. In most of the cases, a clogged filter shows visible contamination or dirt. Longer response time of the measurement also indicates a clogged filter cap. In such cases, replace the filter by a new, original one, refer to the Accessories datasheet.

Procedure:

1. Turn the filter cap counter-clockwise for removing it.
2. Install the new filter cap fingertight by turning it clockwise.

6.3 Display Change

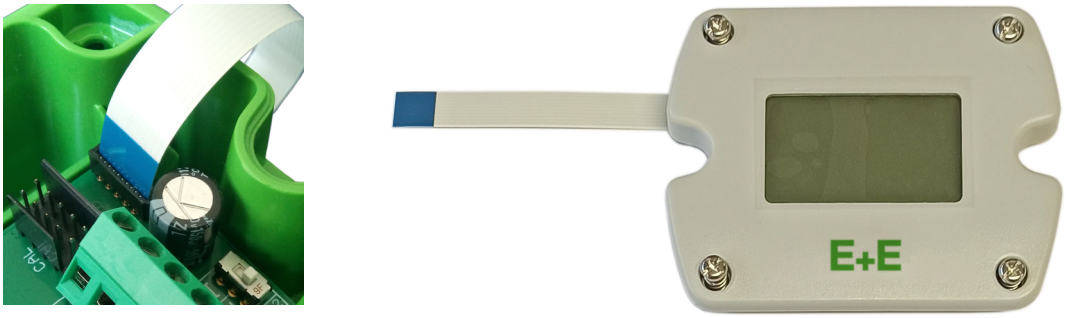


Fig. 14 Display and FFC cable connection on the HTS401 electronics board

When connecting the display's FFC cable to the HTS401 electronics board, please observe the correct orientation. The blue cable stiffener needs to be positioned on the left side as shown in Fig. 14.

NOTICE

Disconnecting or connecting the display while the HTS401 is powered may cause damages to HTS401 and to the display.

Always switch off the HTS401 before exchanging the display.

6.4 Self Diagnosis and Error Messages

The PCS10 information section contains error messages from HTS401, if errors occur. The following table shows the error codes and their meaning. Please note that this table directly corresponds to Tab. 18 Device status indication in chapter 5.7

6.4.1. Error Messages in PCS10

Error code	Description	Recommended action
7.x	Temperature measurement incorrect	1. Check the actual temperature with the temperature output scaling of the ordered sensor, check the wiring 2. Service recommended, check the repair possibilities with the E+E service
9.x	Humidity measurement incorrect	1. Check the actual temperature with the temperature output scaling of the ordered sensor, check the wiring 2. Service recommended, check the repair possibilities with the E+E service
19.x	Sensing element not accessible	Service recommended, check the repair possibilities with the E+E service Please note: The error message also occurs when exchanging the rapidX pluggable sensing module. As soon as the module is plugged, the error message will disappear.

Tab. 22 Possible error messages for HTS401

6.4.2. Error Messages on the Display

Error Description	Error Code (Display)	Error Category	Recommended Action
Voltage out short circuit - output 1 only*	1.x	1	Check the wiring of the outputs
Current loop open - output 1 only	2.x		Check the wiring of the outputs
RH sensor polluted	3.x		Clean the sensor
Hardware error	5.x	2	Return the faulty unit to E+E for service
	6.x		
	8.x		
Temperature measurement failure	7.x		
Humidity measurement failure	9.x		
	10.x		
For all other error codes accurring on the display, please contact the E+E service team.			

* not available with 0 – 1 V output

Tab. 23 Overview of error codes

Error Category	Description
1	**Non-critical error**, can be solved by the user. ▪ The display blinks. ▪ The red status LED lights continuously.
2	**Critical error**, return the device to E+E for service. ▪ The display blinks. ▪ The red status LED flashes.

Tab. 24 Explanation of the error category

6.4.3. Error Indication on the Analogue Output (NAMUR)

The HTS401 features an error indication on its analogue outputs according to the NAMUR NE 043 recommendations (Standardization of the Signal Level for the Failure Information of Digital Transmitters, Edition 2003-02-03, see www.namur.net/en/recommendations-and-worksheets/current-nena.html).

Output signal	NAMUR signal level
0 – 10 V	11 V
4 – 20 mA	21 mA

Tab. 25 NAMUR error indication

NAMUR error indication is disabled by factory default. With the PCS10 Product Configuration Software, the feature can be enabled and the threshold levels can be customised.

PLEASE NOTE

During a rapidX module exchange, communication between the HTS401 and the RH/T sensing module is lost. This is interpreted as an internal failure, resulting in NAMUR signal levels being applied to the outputs. Once the module exchange is complete, the outputs will return to their normal state.

6.5 Repairs

PLEASE NOTE

Repairs may only be carried out by the manufacturer. Any attempt of unauthorised repair excludes any warranty claims.

6.6 Spare Parts

Description	Code
Display for HTS401	**D09P**
Sensing Module for HTS401	
Single packed	**HTS401M-PK4**
Multipackage / Tray[1)]	**HTS401M-PK6**

1) Minimum order quantity: 10 pcs

For accessories please refer to the HTS401 datasheet at www.epluse.com/hts401 and to the Accessories datasheet.

7 Accessories

For further information please refer to the Accessories datasheet.

Description	Code
PCS10 Product Configuration Software (free download: www.epluse.com/pcs10)	**PCS10**
USB-C configuration stick	**HA011070**
Stainless steel mounting flange Ø12 mm (0.47")	**HA010201**
Sensor connection cable PVC, 5 poles, M12x1 socket ←→ wire ferrules	
0.5 m (1.6 ft)	**HA010831**
2 m (6.6 ft)	**HA010832**
5 m (16.4 ft)	**HA010833**
10 m (32.8 ft)	**HA010834**
Protection cap for Ø12 mm probe	**HA010783**
Radiation shield for HTS401P	**HA010514**
Power supply adapter 24 V DC	**V03**

8 Technical Data

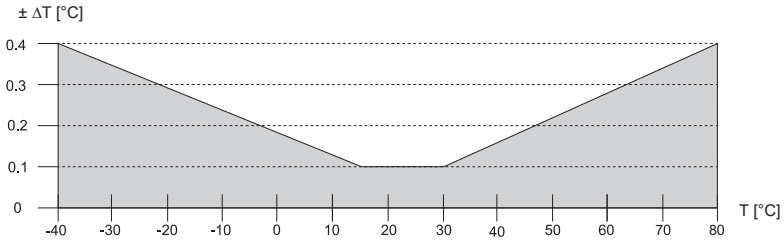
Measurands

Relative humidity (RH)

Measuring range	0...100 %RH	
Accuracy[1] incl. hysteresis, non-linearity and repeatability		
@ -15…40 °C (-5...+104 °F), ≤90 %RH	±(0.95 + 0.0013 • mv) %RH	
>90 %RH	±1.8 %RH	
@ -40…60 °C (-40...+140 °F), 0…100 %RH	±(1.15 + 0.013 • mv) %RH	mv = measured value
@ >60...80 °C (>140...176 °F), 0…100 %RH	±1.9 %RH	
Factory calibration uncertainty[2]		
0...90 %RH	±(0.7 + 0.003 • mv) %RH	
90...100 %RH	±1 %RH	mv = measured value

1) Defined against E+E calibration reference.
2) Defined at 23 °C (73 °F) with a coverage factor k=2, corresponding to a confidence level of 95 %.

Temperature (T)

Measuring range	
Wall mount (T1)	-40...+60 °C (-40...+140 °F)
Duct mount (T2)	-40...+80 °C (-40...+176 °F)
With remote probe (T3)	-40...+80 °C (-40...+176 °F)
Accuracy[1]	
Factory calibration uncertainty[2]	±0.1 °C

1) Defined against E+E calibration reference.
2) Defined at 23 °C (73 °F) with a coverage factor k=2, corresponding to a confidence level of 95 %

Calculated quantities

		from		up to		unit	
Dew point temperature	Td[1]	-40	(-40)	80	(176)	°C	(°F)
Frost point temperature	Tf[2]	-40	(-40)	0	(32)	°C	(°F)
Wet bulb temperature	Tw	-10	(14)	80	(176)	°C	(°F)
Ice bulb temperature	Ti[3]	-40	(-40)	0	(32)	°C	(°F)
Water vapour partial pressure	e	0	(0)	475	(6.9)	mbar	(psi)
Mixing ratio	r	0	(0)	550	(4125)	g/kg	(gr/lb)
Absolute humidity	dv	0	(0)	270	(108)	g/m^3	(gr/ft^3)
Specific enthalpy	h	-40	(-10)	1590	(640)	kJ/kg	(BTU/lb)

1) Td accuracy according to RH and T uncertainties, please use the E+E Humidity Caclulator for details.
2) Equals Td above 0 °C (32 °F).
3) Equals Tw above 0 °C (32 °F).

Outputs

Analogue

Two freely selectable and scalable outputs	0 – 5 V / 0 – 10 V 4 – 20 mA (2-wire) 4 – 20 mA (3-wire)	-1 mA < I_L < 1 mA R_L ≤ 500 Ω R_L ≤ 500 Ω	I_L = load current R_L = load resistance

Digital

Digital interface	RS485 (HTS401 = 1 unit load)
Supported measurands	RH, T, Td, Tw, Tf, Ti, e, dv, r, h
Protocol **Factory settings** **Supported Baud rates** **Data types for measured values**	Modbus RTU Baud rate according to ordering guide, parity even, 1 stop bit, Modbus address 49 (0x31) 9 600, 19 200, 38 400, 57 600, 76 800 and 115 200 FLOAT32 and INT16

General

Power supply class III USA & Canada: Class 2 supply necessary, max. voltage 30 V DC	**4 – 20 mA (2-wire)**	(10 V + R_L • 20 mA) < V+ < 35 V DC	
	4 – 20 mA (3-wire) **0 – 5 V / 0 – 10 V** **RS485**	15 – 35 V DC or 24 V AC ±20%	
Current consumption at 24 V	**Current output 2-wire**	DC supply max. 40 mA	with display max. 40 mA
	Current output 3-wire	DC supply typ. 5 mA AC supply typ. 8 mA_{rms}	with display typ. 47 mA with display typ. 75 mA_{rms}
	Voltage output	DC supply typ. 2 mA AC supply typ. 4 mA_{rms}	with display typ. 27 mA with display typ. 43 mA_{rms}
	Digital interface	DC supply typ. 5 mA AC supply typ. 15 mA_{rms}	with display typ. 25 mA with display typ. 41 mA_{rms}
	With ARC / CG active	DC supply max. 110 mA AC supply max. 110 mA_{rms}	
Electrical connection	Screw terminals max. 1.5 mm^2		
Cable gland	M16x1.5		
Cable length for Type T3 with remote Probe, max.	10 m (32.8 ft)		
Display[1)]	1, 2 or 3 lines, user configurable Active area 48 x 28 mm (1.9 x 1.1") Optional backlight		
Temperature ranges		**Without display**	**With display**
	Operation **Type T1** **Types T2/T3**	 -40...+60 °C (-40...+140 °F) -40...+80 °C (-40...+176 °F)	 -20...+50 °C (-4...+122 °F) -20...+50 °C (-4...+122 °F)
	Storage	-40...+60 °C (-40...+140 °F)	-20...+60 °C (-4...+140 °F)
Enclosure **Material** **Protection rating**	 PC (Polycarbonate), UL94 V-0 (with Display UL94 HB) approved, or die-cast aluminium IP66 / NEMA 4X (PC) / NEMA 4 (die-cast aluminium)		
Electromagnetic compatibility	EN 61326-1:2013 FCC Part15 Class A	EN 61326-2-3:2013 ICES-003 Class A	Industrial environment
Conformity	CE UKCA		

1) For display operation with HTS401-xA6 (4 – 20 mA, 2-wire) both outputs must be connected.

Accuracy of E+E Humidity and Temperature Sensors

The measurement accuracy depends both on the performance of the measuring instrument and on the correct installation in the application.

For best accuracy, every E+E RH and T sensor is multi-point factory adjusted and calibrated in a highly stable RH / T reactor. Using a high-precision dew point mirror as reference, the overall uncertainty of the factory calibration U_{cal} is minimal.

The total measurement uncertainty U_{total} for E+E sensors is calculated in accordance with EA-4/02 (European Accreditation, Evaluation of the Measurement Uncertainty in Calibration) and with GUM (Guide to the Expression of Uncertainty in Measurement) as follows:

$$U_{total} = k \bullet \sqrt{\left(\frac{U_{cal}}{2}\right)^2 + \left(\frac{u_{accuracy}}{\sqrt{3}}\right)^2}$$

U_{total} .....total accuracy incl. factory calibration
U_{cal}.....uncertainty of the factory calibration
$u_{accuracy}$...accuracy of the measurement device
k.....coverage factor k=2, corresponding to a confidence level of 95 %.

For external calibrations, U_{total} is to be used as the evaluation criterion. The calculation does not include effects due to long-term drift or chemical exposure.

As designated laboratory (NMI) responsible for maintaining the National Standard for humidity and temperature in Austria, E+E Elektronik represents the highest instance in humidity and temperature calibration.

9 Conformity

9.1 Declarations of Conformity

E+E Elektronik Ges.m.b.H. hereby declares that the product complies with the respective regulations listed below:

CE European directives and standards.

and

UKCA UK statutory instruments and designated standards.

Please refer to the product page at www.epluse.com/hts401 for the Declarations of Conformity.

9.2 Electromagnetic Compatibility

EMC for industrial environment.
The sensor is a group 1 device and corresponds to Class A.

⚠ WARNING

This device is not intended for use in residential areas and cannot ensure adequate protection of radio reception in such environments.

9.3 FCC Part 15 Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

9.4 ICES-003 Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

10 Recycling of the Device

PLEASE NOTE

Products from E+E Elektronik Ges.m.b.H. are developed and manufactured in compliance with relevant environmental protection requirements. Please observe local regulations for the disposal of the device.

For disposal, the individual components of the device must be separated according to local recycling regulations. The electronics shall be disposed of correctly as electronics waste.

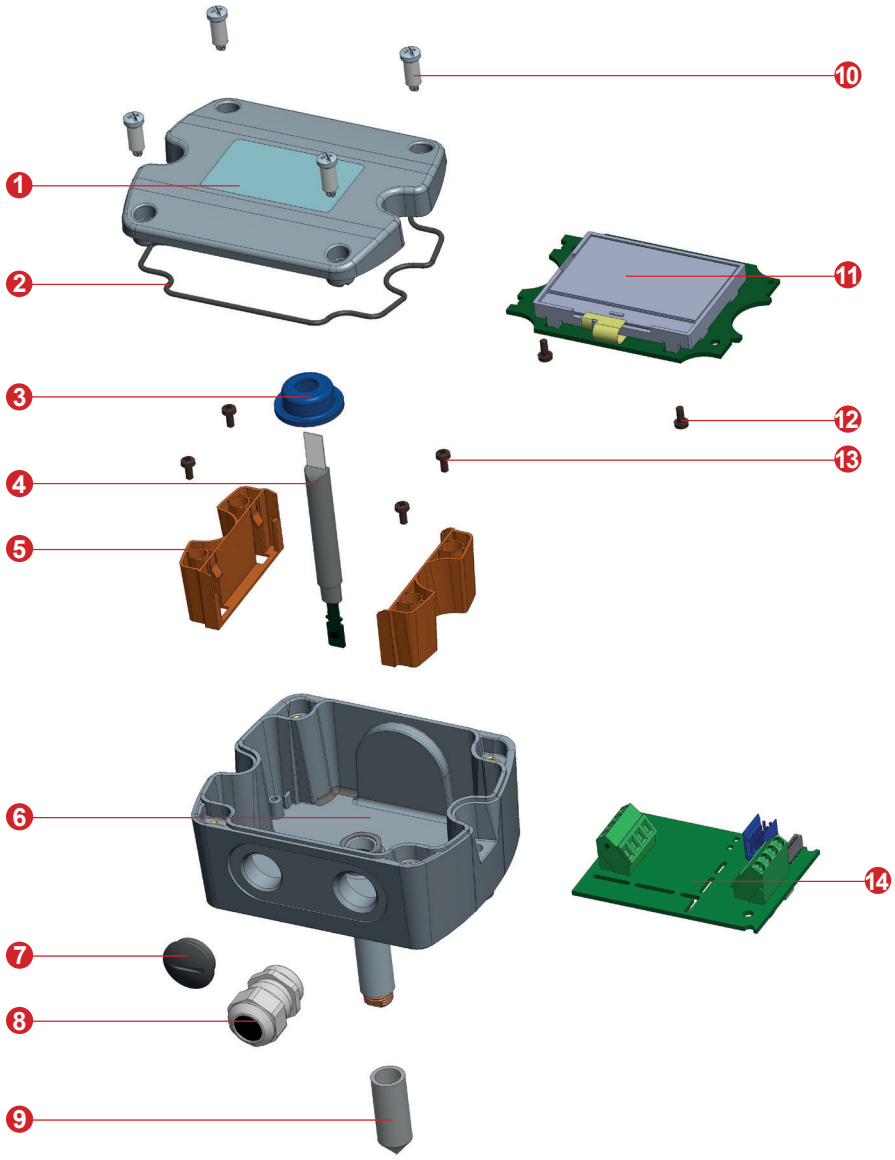


Fig. 15 Evaluation unit (duct mount version)

No.	Part	Material	Recycling Type
1	Cover	Polycarbonate	Plastics waste
2	Rubber seal	Neoprene	Plastics waste
3	Dummy plug	Plastic	Plastics waste
4	Probe electronics with moulding	Various materials	Electrical and Electronics waste
5	PCB fixation (for metal version)	Plastic	Plastics waste
6	Enclosure base with probe tube	Plastic	Plastics waste
	Enclosure base	Metal	Metal waste
7	Dummy plug	Plastic	Plastics waste
8	Cable gland	Polyamide	Plastics
9	Filter cap	Stainless steel	Metal waste
10	Bayonet screws	Steel	Metal waste
11	Display with electronics board	Various materials	Electrical and Electronics waste
12	Screws	Steel	Metal waste
13	Screws	Steel	Metal waste
14	Electronics board	Various materials	Electrical and Electronics waste

Tab. 26 Recycling of the parts of the HTS401 evaluation unit (duct mount version)

Probe



Fig. 16 Probe (wall mount version and remote version)

No.	Part	Material	Recycling Type
1	Probe, plastic tube	Various materials	Electrical and Electronics waste
	Probe, stainless steel tube		

Tab. 27 Recycling of the parts of the AVS701 evaluation unit (duct mount version)

HTS401M Sensing Module

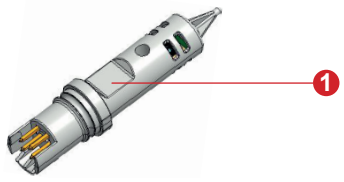


Fig. 17 HTS401M Sensing Module

No.	Part	Material	Recycling Type
1	Sensing Module	Various materials	Electrical and Electronics waste

Tab. 28 Recycling of the parts of the AVS701 evaluation unit (duct mount version)

Mounting Flange

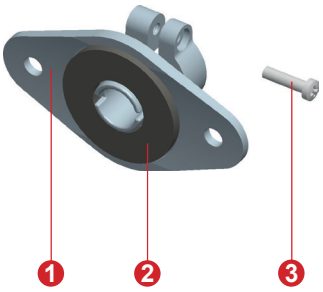


Fig. 18 HTS401 mounting set

No.	Part	Material	Recycling Type
1	Gland	Stainless steel	Electrical and Electronics waste
2	Floor	Various materials	Electrical and Electronics waste
3	Gasket	Foam rubber	Plastics waste

Tab. 29 Recycling of the stainless steel mounting flange (HTS401 types T2 and T3)

Mounting Set

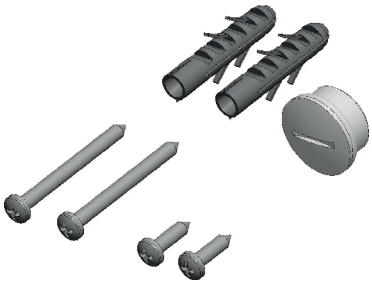


Fig. 19 HTS401 mounting set

No.	Part	Material	Recycling Type
1	Dowels	Plastic	Plastics waste
2	Phillips screws long	Steel	Metal waste
3	Dummy plug	Plastic	Plastics waste
4	Phillips screws short	Steel	Metal waste

Tab. 30 HTS401 mounting set

Company Headquarters &
Production Site

E+E Elektronik Ges.m.b.H.
Langwiesen 7
4209 Engerwitzdorf | Austria
T +43 7235 605-0
F +43 7235 605-8
info@epluse.com
www.epluse.com

Subsidiaries

E+E Sensor Technology (Shanghai) Co., Ltd.
T +86 21 6117 6129
info@epluse.cn

E+E Elektronik France SARL
T +33 4 74 72 35 82
info.fr@epluse.com

E+E Elektronik Deutschland GmbH
T +49 6171 69411-0
info.de@epluse.com

E+E Elektronik India Private Limited
T +91 990 440 5400
info.in@epluse.com

E+E Elektronik Italia S.r.l.
T +39 02 2707 86 36
info.it@epluse.com

E+E Elektronik Korea Ltd.
T +82 31 732 6050
info.kr@epluse.com

E+E Elektronik Corporation
T +1 847 490 0520
info.us@epluse.com

your partner
in sensor
technology.

BA_HTS401 | Version v1.1 | 04-2026
© Copyright E+E Elektronik Ges.m.b.H. | All rights reserved.

www.epluse.com