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User Manual TDS501

Dew Point Sensor down to -70 °C Td (-94 °F Td)

Modbus

www.epluse.com

Content

1 General Information

This user manual serves for ensuring 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. does not accept warranty and liability claims neither upon this publication nor in case of improper treatment of the described products.

All information, technical data and diagrams included in this document are based on the information available at the time of writing. It 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 described product(s) and the contents of this document may be changed or improved at any time without prior notice.

PLEASE NOTE

Find this document and further product information on our website at www.epluse.com/tds501.

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.

Informational notes

Informational notes provide important information which stands out due to its relevance.

INFO

The information symbol indicates tips on handling the device or provides additional information on it. The information is useful for reaching optimal performance of the device.

The title field can 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.

- Avoid any unnessessary mechanical stress and inproppriate use.
- Do not apply the supply voltage to the RS485 data lines.
- Installation, electrical connection, maintenance and commissioning may only be carried out by qualified personnel.
- Use the TDS501 only as intended and observe all technical specifications.
- The sensor elements must not be touched when replacing the filter cap.
- Never operate the device without filter cap.
- For sensor cleaning and filter cap replacement please refer to the “Cleaning Instructions” at www.epluse.com.

1.2.2. Intended Use

The TDS501 is intended to measure the dew point temperature Td of compressed air and other non-corrosive gases under pressure and non-explosive atmosphere. The sensor can be installed in a pressurized system up to 80 bar (1 160 psi). It has leak rate B according to EN 12266-1.

The device is constructed for operation with separated extra-low voltage (SELV).

⚠ WARNING

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

The manufacturer cannot be held responsible for damages as a result of incorrect handling, installation and maintenance of the device.

- Do not use the TDS501 in explosive atmosphere. The device is not certified for use in hazardous areas with potentially explosive atmosphere.
- Do not use the TDS501 for measurement in aggressive gases.
- If there are any questions or uncertainties about the chemicals in the measured gas, please contact the E+E customer service.
- This device is not appropriate for safety, emergency stop or other critical applications where device malfunction or failure could cause injury to human beings.
- To avoid damage, the appliance must 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 TDS501 may only be operated in accordance to the conditions described in this user manual and within the specification included in chapter 8 Technical Data.
- The installation, inspection and maintenance steps recommended by the manufacturer must be observed and carried out in the interests of the user’s safety and the functionality of the equipment.
- Unauthorized product modification leads to loss of all warranty claims. Modification may be accomplished only with an explicit permission of E+E Elektronik Ges.m.b.H.!

1.2.3. Mounting, Start-up and Operation

The TDS501 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. Set up and install the device in a way that does not impair its safe use. The user is responsible for observing all applicable local and international safety guidelines for safe installation and operation of the device. This user manual contains information and warnings that must be observed by the user 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 damages incurred due to failure to comply with the applicable regulations, operating instructions or the specified operating conditions. Consequential damages are excluded from the liability.

WARNING

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

- Mounting, installation, commissioning, start-up, operation and maintenance of the device may be performed by qualified staff only. Such staff must be authorized 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 shall be thoroughly checked by authorized staff before putting the device into operation.
- Do not put damaged products into operation and protect them from accidental commissioning. Label the damaged product as defective.
- A faulty device may only be investigated and possibly repaired by qualified, trained and authorized staff. If the fault cannot be fixed, the device must be removed from the process.
- Service operations other than described in this user manual may only be performed by the manufacturer.

1.3 Environmental Aspects

PLEASE NOTE

Products from E+E Elektronik Ges.m.b.H. are developed and manufactured in compliance with all 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.

2 Scope of Supply

- TDS501 Dew Point Sensor down to -70 °C Td (-94 °F), according to ordering guide
- Inspection certificate according to DIN EN 10204-3.1
- Quick Guide

3 Product Description

3.1 General

The compact TDS501 Dew Point Sensor with a measuring range down to -70 °C Td (-94 °F Td) and a robust stainless steel enclosure is ideal for industrial applications with very low moisture levels and with pressure up to 80 bar (1 160 psi). Application examples are industrial drying processes, clean rooms and compressed air systems.

The core of the TDS501 is the E+E Quattro Sensor Technology, based on a four-element measurement with robust capacitive sensing elements. These are used for a continuous measurement scheme with excellent long-term stability and durability against condensation. The integrated auto-calibration procedure enables a measurement accuracy of <2 °C Td (<3.6 °F Td). The TDS501 performs auto-calibration every 30 minutes. The output signal is not frozen during the auto-calibration procedure, except during initialisation. Please refer to chapter 3.3 TDS501 Initialisation.

The measured values for dew point, frost point or volume concentration are available on an analogue 4 - 20 mA or a digital Modbus RTU output.

Available Quantities, Units and Measuring Ranges

Parameter		Unit	Range	
Dew point temperature	Td	°C (°F)	-70 (-94)	30 (86)
Frost point temperature[1)]	Tf	°C (°F)	-65 (-85)	0 (32)
Volume concentration	Wv	ppm	0.1	42 000
Water vapor partial pressure	e	mbar (psi)	0.001 ($1.45 \cdot 10^{-5}$)	50 (0.73)[2)]

1) Equals Td above 0 °C (32 °F).
2) Ambient pressure / customer setting.

Configuration and Adjustment

The free PCS10 Product Configuration Software and the optional Modbus configuration adapter facilitate easy configuration and adjustment of the TDS501. Please refer to chapter 5.1 PCS10 Product Configuration Software and chapter 7 Accessories.

Supply

The TDS501 with analogue output shall be supplied with 13 - 30 V DC, while the variant with digital interface shall be supplied with 10 - 30 V DC, both via M12 connector. Please refer to chapter 8 Technical Data.

Output

The measured / calculated data is available at the freely selectable and scalable analogue outputs or the digital RS485 interface with Modbus RTU protocol. The analogue output provides valid measuring values throughout operation, also during auto-calibration. If needed for any process or signalling integrity, there is the option to indicate the auto-calibration activity by “freezing” at a value of 2 mA. The digital version provides a Modbus register which indicates the state of auto-calibration.
For more details, please refer to chapter 5 Setup and Configuration.

The TDS501 features an error indication on its analogue outputs according to the NAMUR NE 043. Please refer to chapter 6.5.

Materials

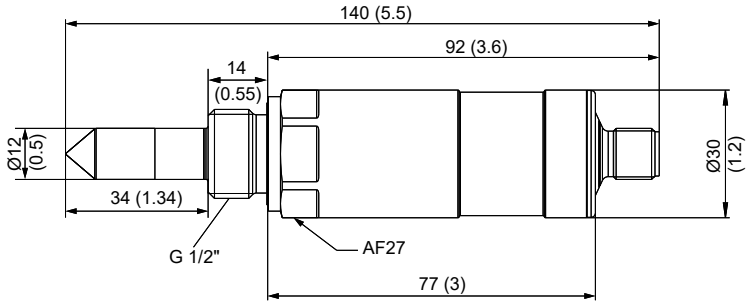
All TDS501 probe types and filter caps are made of stainless steel for protection against possible damage in rough industrial environments.

3.2 Dimensions

Values in mm (inch)

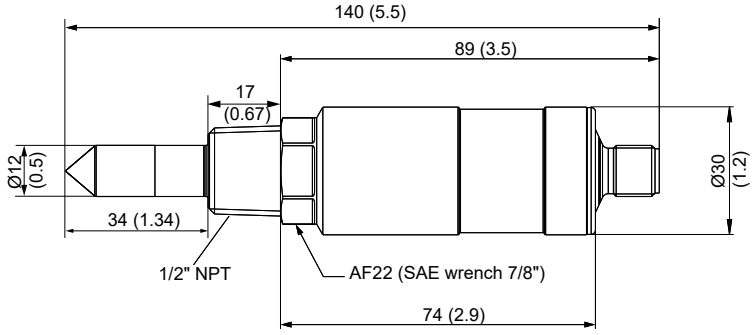
ISO Thread

G 1/2"



NPT Thread

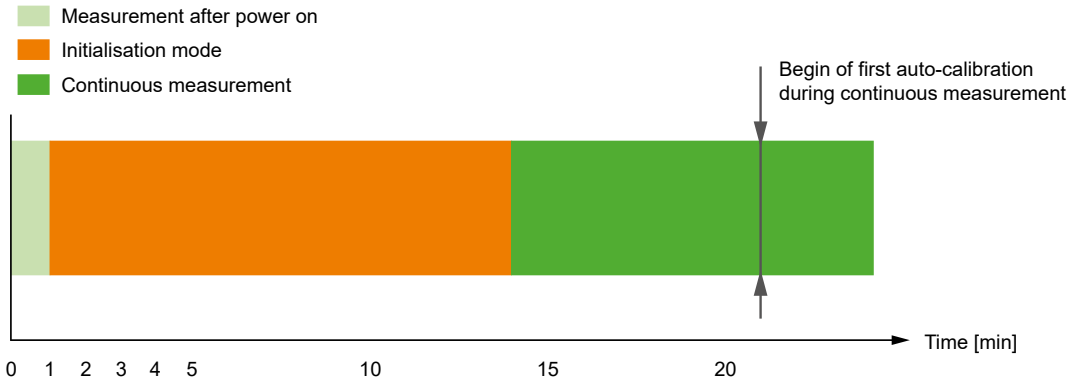
1/2"



3.3 TDS501 Initialisation

Each time the TDS501 is switched on, it performs an initialisation sequence.

During the first minute after power-up, the sensor delivers a regular measurement signal and then enters initialisation mode for a maximum of 13 minutes. The initialisation mode is the only time the measurement signal is frozen at the last measured value. After this start-up routine, the TDS501 is in normal operation and performs further auto-calibrations without any interruption of the measurement signal. The first auto-calibration starts 7 minutes after the initialisation sequence and is repeated every 30 minutes. The TDS501 can skip an auto-calibration cycle, if the sensor's environment does not allow calibration.



Tab. 1 TDS501 initialisation sequence

PLEASE NOTE

The sensor performs the described initialisation procedure each time it is powered up. To ensure consistent high-quality measurement, continuously supply the TDS501. Please refer to chapter 8 Technical Data.

Dependable values are available approximately 25 minutes after power-up.

3.4 Auto-Calibration

The TDS501's auto-calibration feature is based on the E+E Quattro Sensor platform that periodically corrects and optimises performance at the dry end of the dew point measurement range. Additionally, a sensor evaluation algorithm calculates an environment temperature compensation of the measured dew point temperature value. This ensures accurate measurements over the entire working range and extends re-calibration intervals. Previous generation sensors freeze the Td output signal during auto-calibrating for several minutes to the measured value prior to the procedure. The new generation provides a continuous output signal using the innovative E+E Quattro Sensor technology. Simple and efficient, one sensing element performs the measurement, while the second part periodically determines the required auto-calibration correction.

3.5 Electrical Connection

WARNING

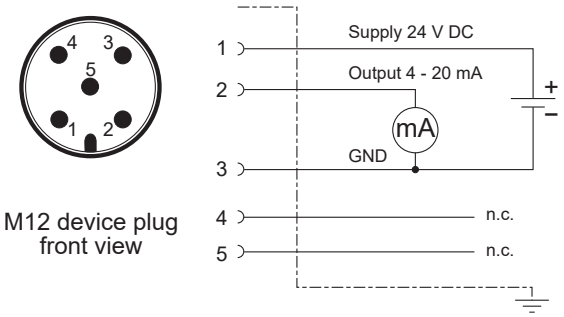
Incorrect installation, wiring or power supply may cause overheating and therefore personal injuries or damage to property.

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.

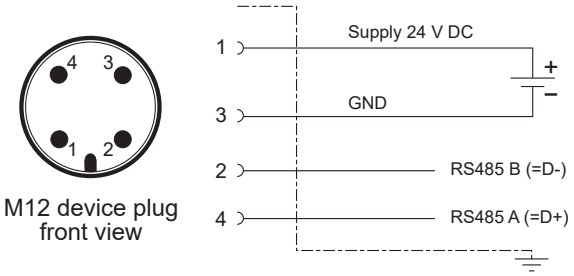
The TDS501 is electrically connected via the M12x1 plug. An attachable connector with a 5-pole socket is included.

Analogue Output 4 - 20 mA



Pin	Function
1	Supply voltage 24 V DC class III (Europe) / class 2 (North America)
2	Output 4 - 20 mA
3	GND
4	Do not connect
5	Do not connect

Digital Interface RS485 with Modbus RTU Protocol



Pin	Function
1	Supply voltage 24 V DC class III (Europe) / class 2 (North America)
2	RS485 B (D-)
3	GND
4	RS485 A (D+)

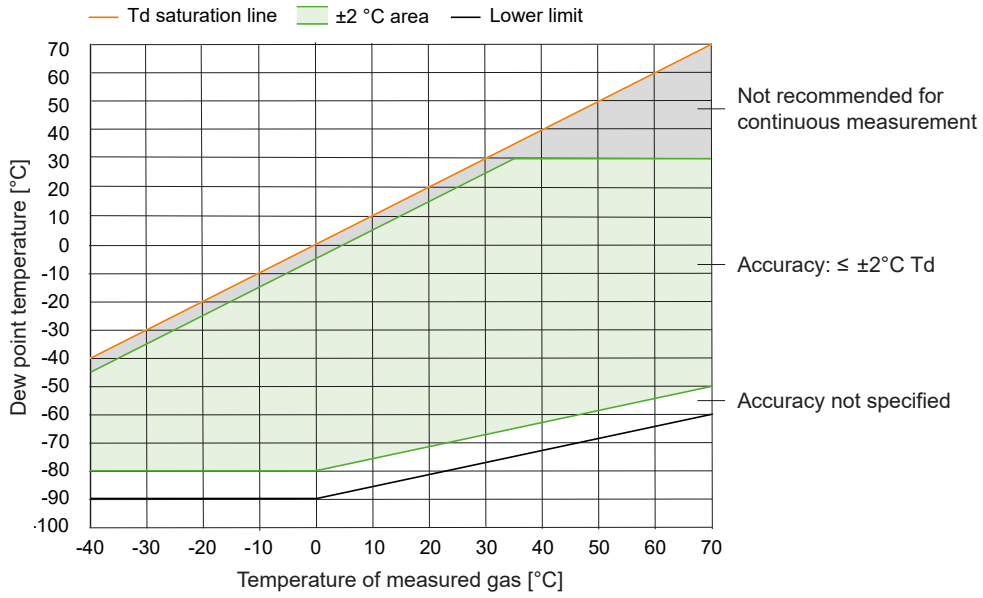
NOTICE

To meet the EMC Directive 2014/30/EU a shielded cable must be used. The connection cable mentioned above (accessory HA0108xx, 5-pole M12x1 socket – free ends, PUR insulation), has a shielding included and is available in several lengths (refer to chapter 7 Accessories).

3.6 Measuring Range and Accuracy

The TDS501 has an accuracy of ±2 °C specified within the measuring range -80...+30 °C Td (-112...86 °F Td). Depending on the medium temperature, the output range is from -90...+70 °C (-130...158 °F). During operation, an operating point within the range of 5 °C (41 °F) below saturation and Td > 30 °C (86 °F) may only be reached briefly under abnormal operating conditions.

The maximum scaling of the analogue output is -100...+80 °C (-148...+176 °F) dew point.



Tab. 2 Dew point measurement range and specified accuracy

4 Mounting and Installation

4.1 Installation Location

The location has to offer optimum measuring conditions. Air must be able to circulate freely around the sensing element.

Temperature differences between the process and the installation location have no influence on the dew point measurement. However, it should be noted that changes in the pressure of a gas also impact the dew point temperature. If there is a pressure difference between the installation site and the process, the measurement can deviate from the dew point temperature by several tens of degrees.

The exact effects of pressure changes on the dew point can be simulated using the E+E humidity calculator. Further details can be found on our website www.epluse.com.

Leakage should be avoided, as ingress of moisture from the environment will interfere with the measurement.

PLEASE NOTE

On delivery, the sensor is protected by a cap and a desiccant pill to keep the dew point sensor at a very low humidity. To prevent unnecessary sensing element humification, the cap should only be removed immediately before installation in the application.

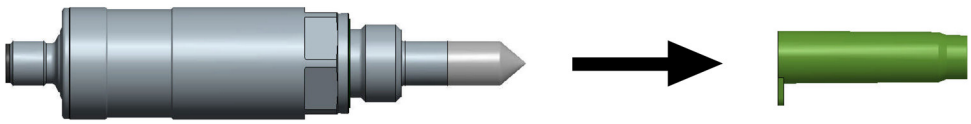


Fig. 1 Removal of the protection cap

4.2 Sensor Installation Directly into the Process

For direct installation in the pipeline, a shut-off valve should be installed on both sides of the process. The sensor can therefore be easily removed for maintenance and calibration work.

PLEASE NOTE

It is not permitted to use a sealing ring with a NPT 1/2" thread. Appropriate PTFE (Polytetrafluoroethylene) sealing tape or sealant should be used instead.

1. Insert the sensor into the process and tighten it by hand as far as possible.
2. If available, check the sealing ring for correct centring.
3. Tighten the screw connection to a defined torque of 30 Nm.

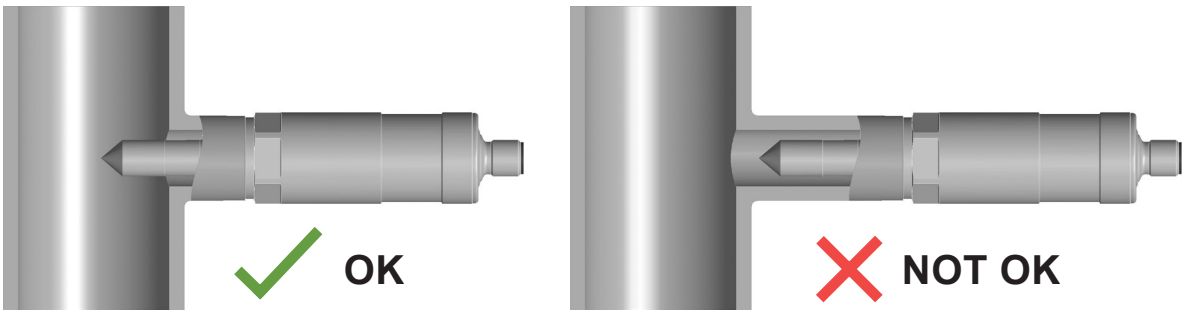


Fig. 2 Direct installation into the pipe

4.3 Sensor Installation in a Sampling System

Sampling is necessary if a direct installation of the sensor in the process is not possible or not required. Reasons may be:

- Process temperature is too high
- Sensor shall be protected against contamination.
- Removing the sensor must not interrupt the process.

PLEASE NOTE

In order to obtain a representative sample of the process gas and to avoid measurement errors, the following must be observed:

- Differences in pressure between the process and the sampling chamber will result in significant measuring errors.
- Measurements at low dew point temperatures are sensitive to humidity diffusing from the environment due to leaks. Therefore, the sampling system must be pressure-tight.
- Non hygroscopic materials must be used.
- The sampling line should be as short as possible.
- The response time increases if the gas flow is <1 l/min (0.25 gpm).
- A too low gas flow can result in back-diffusion of humidity from the environment and distort the measurement.

The pipe material has a significant influence on the response time and the lowest reachable dew point. Fig. 3 illustrates how different tubing materials give off moisture over time when flushed with very dry gas after being at ambient humidity.

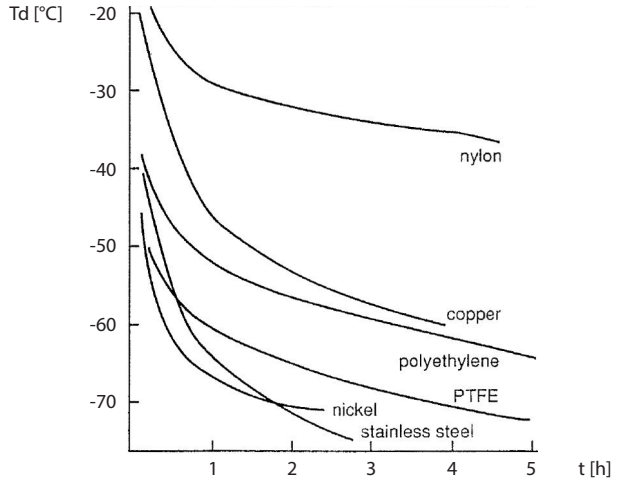


Fig. 3 Moisture given off by different tubing materials (© National Physical Laboratory)

Several sampling cells are optionally available:

- Basic sampling cell
- Sampling cell with quick connector and bleed screw
- Sampling cell for atmospheric dew point

Please refer to chapter 7 Accessories in this document and to the TDS501 datasheet.

5 Setup and Configuration

The TDS501 is ready to use and does not require any configuration. The factory setup of the TDS501 corresponds to the specified order code. Please refer to the datasheet at www.epluse.com/tds501.

If needed, the factory setup can be modified. This chapter describes the configuration possibilites with the PCS10 Product Configuration Software and via the digital RS485 interface with Modbus RTU.

5.1 PCS10 Product Configuration Software

The PCS10 provides a convenient graphical user interface to the TDS501 for changing the factory setup via PCS10 and Modbus configuration interface. The TDS501 is powered via the configuration interface then, no additional power supply shall be applied.

NOTICE

Data integrity might not be provided during a firmware download.

Ensure that the device is only powered by the Modbus configuration interface during firmware update, otherwise the update may fail.

Use the software to change the settings and proceed as follows:

1. Download the PCS10 Product Configuration Software from www.epluse.com/pcs10 and install it on the PC.
2. Connect the TDS501 to the PC using the Modbus 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.

5.2 Digital Interface RS485 with Modbus RTU Protocol

PLEASE NOTE

- The TDS501 can be used in Modbus networks based on RS485. Therefore, the RS485 specifications have to be observed, especially regarding unit loads and bus termination.
- For proper function, the power supply must be strong enough to ensure supply voltage within the specified range (refer to chapter 8 Technical Data) at any time and at all devices in the bus. This is particularly relevant when using long and thin cables which can cause high voltage drop.

5.2.1. Modbus RTU Protocol Settings

	Factory settings	Selectable values (via PCS10)
Baud rate	9 600	9 600, 19 200, 38 400,57600, 76800 and 115200
Data bits	8	8
Parity	Even	Even, odd, none
Stop bits	1	1, 2
Modbus address	229 (0xE5)	1...247

Tab. 3 Modbus RTU protocol settings

PLEASE NOTE

- The recommended settings for multiple devices in a Modbus RTU network are 9600, 8, even, 1.
- The TDS501 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 Modbus configuration adapter HA011013.
  The PCS10 can be downloaded free of charge from www.epluse.com/pcs10.
- Modbus protocol in the register 1 (0x00) and 2 (0x01).
  See Application Note Modbus AN0103 (available at www.epluse.com/tds501).

The serial number as ASCII-code is located in read-only registers 1 - 8 (0x00 - 0x07).
The firmware version is located in read-only register 9 (0x08) (bit 15...8 = major release; bit 7...0 = minor release).
The sensor name as ASCII-code is located in read-only registers 10 - 17 (0x09 - 0x11).

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, all related registers have to be read within the same read 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)[5]	10	09	8
State of auto-calibration 0 ... normal operation 1 ... auto-calibration active	501	1F4	1

Application parameter (FLOAT32)

Parameter	Unit[1]	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Read register: function code 0x03/04 / Write register: function code 0x10				
Working pressure, p[5]	mbar	5001	1388	2

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 see Application Note Modbus AN0103 (available at www.epluse.com/tds501).
5) The working pressure is expressed in mbar, with 2 decimal digits (e.g. 1008.25), default value 1013.25 mbar.
   Example of Modbus frame to be sent to write Working pressure 1008.25 mbar:
   Request [Hex]: F3 10 13 88 00 02 04 10 00 44 7C 1D C3
   Response [Hex]: F3 10 13 88 00 02 D0 74.

Tab. 4 TDS501 registers for device setup

5.3 Modbus Register Map

The measurement data is stored as 32 bit floating point values (data type FLOAT32). Depending on the measurement unit selected, the measurements are saved in SI or US/GB units. Measurement unit selection is made by means of the ordering code or with the help of the PCS10 Product Configuration Software.

FLOAT32

Parameter	Unit[1)]	Register number[2)] [DEC]	Register address[3)] [HEX]
Read register: function code 0x03 / 0x04			
Dew point temperature, Td	°C	1105	450
	°F	1107	452
	°K	1147	47A
Frost point temperature, Tf	°C	1131	46A
	°F	1133	46C
	°K	1149	47C
Volume concentration, Wv	ppm	1151	47E
Water vapour partial pressure, e	mbar	1101	44C
	psi	1103	44E

Tab. 5 TDS501 FLOAT32 measured data registers

INFO

If the volume concentration Wv is to be measured and the working pressure differs from the ambient pressure. The working pressure must be set via the PCS10 Product Configuration Software or via Modbus protocol at register 5001 to obtain the correct Wv value.

Set the working pressure via the PCS10 Product Configuration Software or via Modbus protocol at register 5001 to obtain the correct Wv value if the working pressure differs from the ambient pressure.

5.4 TDS501 Modbus Backwards Compatibility to EE355

The TDS501 can directly replace an EE355 sensor. This is valid for Modbus types as well as for all types with analogue output.

The TDS501 with digital interface provides the EE355 legacy Modbus map. The measurement data is stored as 32 bit floating point values (data type FLOAT32).

PLEASE NOTE

Full backwards compatibility requires the correct selection of measurement units via ordering code.

FLOAT32

Parameter	Unit	Register number[1)] [DEC]	Register address[2)] [HEX]
Read register: function code 0x03 / 0x04			
Dew point temperature, Td	°C	32	1F
Frost point temperature, Tf	°C	42	29
Volume concentration, Wv	ppm	60	3B
Water vapour partial pressure, e	mbar	30	1D
Relative humidity (Uw), RH	%	28	1B
Temperature, T	°C	26	19

1) Register number (decimal) starts from 1.
2) Register address (hexadecimal) starts from 0.

Tab. 6 TDS501 legacy Modbus map

5.5 Modbus RTU Example

The TDS501 Modbus address is 229 [0xE5].

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/tds501)

Read the dew point temperature Td (FLOAT32) = -45.96927642822265625 °C from register address 0x450:

Master (e.g. PLC) **TDS501**

Request [Hex]:

Modbus address	Function code	Starting address Hi	Starting address Lo	Qty. of registers Hi	Qty. of registers Lo	CRC	
E5	03	04	50	00	02	D2	CE

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	
E5	03	04	E0	8A	C2	37	58	A1

Tab. 7 Example dew point 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 (numbers taken from Td 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]
E0	8A	C2	37
MMMMMMMM	MMMMMMMM	SEEEEEEE	EMMMMMMM

Tab. 8 Modbus response

IEEE754

Register 2 Hi [1]	Register 2 Lo [2]	Register 1 Hi [3]	Register 1 Lo [4]
C2	37	E0	8A
1100 0010	0011 0111	1110 0000	1000 1010
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
Decimal value: -45.96927642822265625			

Tab. 9 Data representation according to IEEE754

Read the dew point temperature (FLOAT32) Td = -39.451320648193359375 °C from legacy Modbus map, register address 0x1F:

Master (e.g. PLC) → **TDS501**

Request [Hex]:

Modbus address	Function code	Starting address Hi	Starting address Lo	Qty. of registers Hi	Qty. of registers Lo	CRC	
E5	03	00	1F	00	02	E2	29

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	
E5	03	04	93	B4	C2	38	63	ED

Tab. 10 Example dew point temperature query, from legacy Modbus map

NOTICE

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

6 Maintenance and Service

6.1 Calibration and Adjustment

The TDS501 can be calibrated / adjusted with the help of the PCS10. For this purpose, the probe needs to be connected to a PC via a Modbus configuration adapter.

Definitions

- **Calibration** documents the accuracy of a measurement device. The device under test (specimen) is compared with the reference and the deviations are documented in a calibration certificate. During the calibration, the specimen is not changed or improved in any way.
- **Adjustment** improves the measurement accuracy of a device. The specimen is compared with the reference and brought in line with it. An adjustment can be followed by a calibration which documents the accuracy of the adjusted specimen.

6.2 Dew Point Adjustment by the User

Dew point adjustment by the user is only possible at low dew points. The adjustment can only be carried out if the difference between the ambient temperature and the reference dew point temperature is >60 °C.

Example:
Ambient temperature = 20 °C

Reference dew point temperature must be lower than -40 °C.

6.3 Filter Replacement

In a dusty, polluted environment, it may be necessary to replace the filter cap occasionally. In most cases, visible contamination or dirt indicate a clogged filter. A longer response time of the measurement also indicates a clogged filter cap. In this cases the filter cap should be replaced with a new one. The order code for new filters is HA010103.

The following aspects must be observed when replacing the filter.

Procedure:

1. Unscrew the filter cap very carefully to avoid damaging the sensing element.
2. Handling the filter can clog the pores. Use gloves when screwing on the new filter.

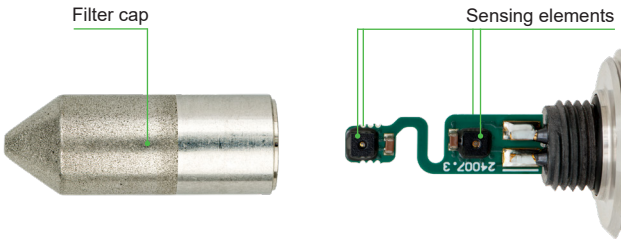


Fig. 4 TDS501 Filter and Sensor

6.4 Cleaning the Sensing Element

NOTICE

- Never touch the sensing element
- Any attempt to clean the sensing element mechanically such as rubbing or brushing will certainly lead to its irreversible damage.

For cleaning instructions refer to www.epluse.com/tds501.

6.5 Error Indication on the Analogue Output (NAMUR)

The TDS501 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
4 - 20 mA	21 mA

Tab. 11 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.

6.6 Repairs

PLEASE NOTE

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

6.7 Spare Parts

Description	Code
Stainless steel sintered filter	HA010103
Stainless steel perforated filter for accelerated response time in clean environments (e.g. clean room, semiconductor production, compressed air class 251 or better)	HA010110

7 Accessories

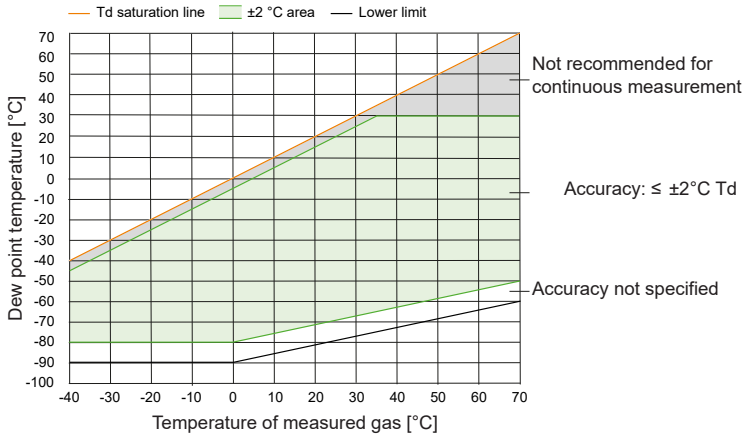
For further information please refer to the Accessories datasheet.

Description	Code
PCS10 Product Configuration Software (free download: www.epluse.com/pcs10)	PCS10
Modbus configuration adapter for analogue TDS501	HA011013
Modbus configuration adapter for digital TDS501	HA011018
Sensor connection cable, shielded, 5 poles, M12x1 socket ←→ wire ferrules, PUR insulation **1.5 m (4.9 ft)** **5 m (16.4 ft)** **10 m (32.8 ft)**	 HA010819 HA010820 HA010821
Sampling cell G 1/2" with quick connector	HA050102
Sampling cell NPT with bleed screw	HA050107
Sampling cell G 1/2" for atmospheric dew point	HA050106
Basic sampling cell G 1/2"	HA050103
Basic sampling cell NPT	HA050105

8 Technical Data

Measurands

Dew Point Temperature (Td)

Measuring range	-70...+30 °C Td (-94...86 °F Td)
Accuracy[1)]	
Response time t_{63} (t_{90}), typ. **With stainless steel sintered filter cap** **With perforated stainless steel filter cap** (available as accessory)	 Step dry (-70 °C/-94 °F Td) → wet (-20 °C/-4 °F Td): <15s (<30s) Step wet (-20 °C/-4 °F Td) → dry (-70 °C/-94 °F Td): <1 min 30 s (<5 min) Step dry (-70 °C/-94 °F Td) → wet (-20 °C/-4 °F Td): < 5s (< 10s) Step wet (-20 °C/-4 °F Td) → dry (-70 °C/-94 °F Td): < 25s (< 40s)

1) Traceable to international standards, administrated by NIST, PTB, BEV,....
The accuracy statement includes the uncertainty of the factory calibration with a coverage factor k=2 (2-times standard deviation).
The accuracy was calculated in accordance with EA-4/02 and with regard to GUM (Guide to the Expression of Uncertainty in Measurement).

Volume Concentration (Wv)[1)]

Measuring range @ 1 013 mbar (14.7 psi)	0.1...42 000 ppm
Accuracy @ 20 °C (68 °F) and 1 013 mbar (14.7 psi)	±(1.5 ppm + 12 % from measured value)

1) The measurand derives from the dew point temperature and can be determined with the E+E Humidity Calculator.

Supported quantities

Parameter		from	to	Unit
Dew point temperature	Td	-70 (-94)	30 (86)	°C (°F)
Frost point temperature[1)]	Tf	-65 (-85)	0 (32)	°C (°F)
Volume concentration	Wv	0.1	42 000	ppm
Water vapor partial pressure	e	0.001 ($1.45 \cdot 10^{-5}$)	50 (0.73)[2)]	mbar (psi)

1) Equals Td above 0 °C (32 °F).
2) Ambient pressure / customer setting.

Outputs

Analogue

Scalable output **Td, Tf or Wv**	4 - 20 mA 3-wire R_L < 600 Ω R_L = load resistance
Max. configurable scaling	-100...+80 °C Td (-148...+176 °F Td) 0...200 000 ppm
Resolution	0.4 µA
Accuracy of current output @ 20 °C (68 °F)	±4 µA
Temperature coefficient, typ.	<50 ppm of the measuring range / °C deviation from 20 °C (68 °F)

Digital

Digital interface	RS485 (TDS501 = 1 unit load)
Protocol **Factory settings**[1)] **Supported Baud rates** **Measured data types**	Modbus RTU 9600 Baud, parity even, 1 stop bit, Modbus address 229 (0xE5) 9600, 19200, 38400, 57600, 76800 and 115200 FLOAT32

1) Find more details about communication setting in the User Manual and the Modbus Application Note at www.epluse.com/tds501.

General

Power supply class III USA & Canada: Class 2 supply necessary **TDS501 with current output** **TDS501 with digital Interface**	 13 - 30 V DC 10 - 30 V DC
Power consumption @ 24 V DC	<30 mW + load (max. 240 mW @ 600 Ω and 20 mA) + 200 mW during auto-calibration
Electrical connection **TDS501 with current output** **TDS501 with digital Interface**	 M12x1, 5 poles, stainless steel 1.4404 M12x1, 4 poles, stainless steel 1.4404
Filter	Stainless steel sintered
Pressure working range	0...80 bar (0...1 160 psi)
Humidity working range	0...100 %RH
Temperature working range	-40...+70 °C (-40...+158 °F)
Storage conditions (as delivered ex works with protective cap and drying tablet)	-40...+60 °C (-40...+140 °F) 0...95 %RH, non-condensing
Enclosure **Material** **Protection rating**	Stainless steel 1.4404 (AISI 316L) IP65 / NEMA 4X (when plugged into an appropriate M12x1 socket)
Electromagnetic compatibility	EN 61326-1 EN 61326-2-3 Industrial environment FCC Part15 Class B ICES-003 Class B
Conformity	CE UKCA
Configuration and adjustment	PCS10 Product Configuration Software (free download: www.epluse.com/pcs10) and configuration adapter

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/tds501 for the Declarations of Conformity.

9.2 Electromagnetic Compatibility

EMC for industrial / basic environment.
Our sensors are group 1 devices and correspond to class B.

9.3 FCC Part 15 Compliance Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the installation manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which thereceiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

9.4 ICES-003 Compliance Statement

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

Cet appareil numérique de la classe B 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.

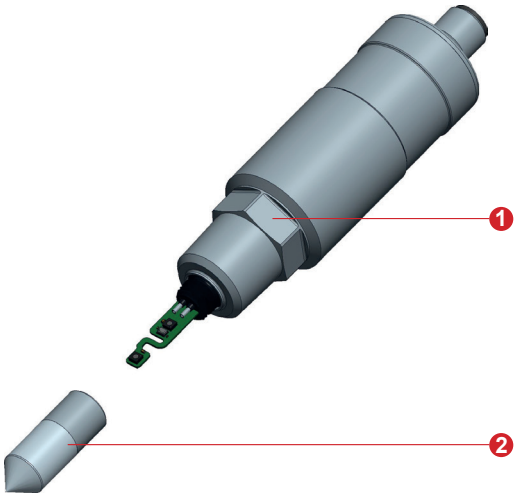


Fig. 5 TDS501 disassembled

No.	Part	Material	Recycling Type
1	Probe	Various materials	Electrical and Electronics waste
2	Filter cap	Stainless steel	Metal waste

Tab. 12 Recycling of TDS501 parts

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