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User Manual EE074

Temperature Probe with Modbus RTU



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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.

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PLEASE NOTE

Find this document and further product information on our website at www.epluse.com/ee074.

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 very 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 EE074 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.
- Use the EE074 only as intended and observe all technical specifications.

1.2.2 Intended Use

The EE074 temperature (T) probe is used for the highly accurate measurement of the temperature of liquids and gases. The probe is optimised for demanding process and climate control in the food and pharmaceutical industries, clean rooms and agriculture.

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 the EE074 in explosive atmosphere or for measurement in 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 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 EE074 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.!

1.2.3 Mounting, Start-up and Operation

The EE074 Modbus RTU temperature probe 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 Environmental Aspects

i 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.

2 Scope of Supply

- EE071 Temperature probe with Modbus RTU
- Inspection certificate according to DIN EN 10204-3.1
- Quick guide

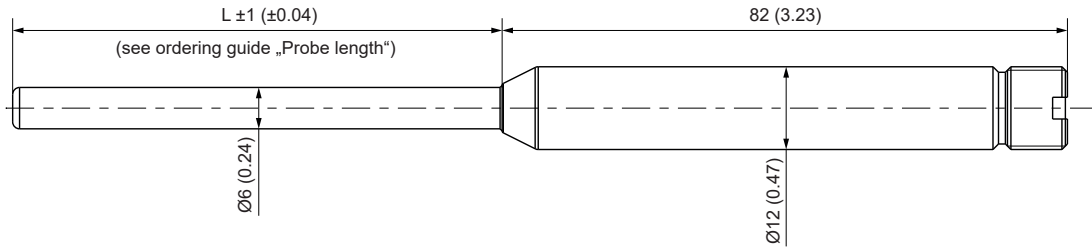
3 Product Description

3.1 General

The EE074 is designed for accurate temperature (T) measurement of air, gases and liquids. The robust stainless steel probe (protection rating IP68) is ideal for climate and process control in food and pharmaceutical industries, in clean rooms or in agriculture. It offers a high accuracy of ± 0.1 °C and a wide temperature range up to $-70...+105$ °C ($-94...+221$ °F). The measured data is available via the RS485 interface with Modbus RTU protocol.

3.2 Dimensions

Values in mm (inch)



Ordering Guide

Feature	Description	Code	
Hardware		EE074-	
	Probe length	71,5 mm (2.82")	L70
		156,5 mm (6.16")	L155
		306,5 mm (12.07")	L305

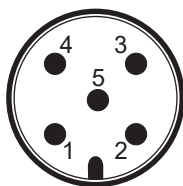
3.3 Electrical Connection

⚠ WARNING

Incorrect installation, wiring or power supply may cause overheating and result in personal injury or property damage.

For correct cabling, always observe the presented wiring diagram for the product version used.

The manufacturer cannot be held responsible for personal injury or damage to property caused by incorrect handling, installation, wiring, power supply or maintenance of the device.



M12 device plug front view

Pin number	Function	Wire colors for accessories: - Couplig flange HA010705 - Connection cable HA010819/820/821
1	Supply voltage	Brown
2	RS485 B (D-)	White
3	GND	Blue
4	RS485 A (D+)	Black
5	Not assigned	Grey

4 Mounting and Installation

4.1 Wall and Ceiling Mount



Achieve best measurement performance by placing the entire probe inside the monitored environment. Fix the EE074 to a wall using the HA010211 mounting clip (not included in the scope of supply, see datasheet "Accessories") or hang it from the ceiling on the connection cable.

4.2 Duct Mount



The probe can also be installed in a duct using the plastic flange HA401101.

4.3 Immersion Well Mount



The probe can be installed in a pressurised liquid system using an ISO or NPT ½" immersion well HA400101-04 or HA4000211-14 (not included in the scope of supply, see datasheet "Accessories").

i PLEASE NOTE

For good thermal connection between the probe and the immersion well, use a thermal paste.

The EE074 can be used at pressures of up to 15 bar (218 psi) with an E+E brass immersion well, and at pressures of up to 25 bar (363 psi) with an E+E stainless steel immersion well.

Please observe the following maximum flow speed limitations for the E+E immersion wells:

Length (L)	50 mm (1.97")	100 mm (3.94")	135 mm (5.31")	285 mm (11.22")
Brass	26 m/s (5 118 ft/min)	12 m/s (2 362 ft/min)	6 m/s (1 181 ft/min)	1 m/s (197 ft/min)
Stainless steel	29 m/s (5 709 ft/min)	15 m/s (2 953 ft/min)	9 m/s (1 772 ft/min)	2 m/s (394 ft/min)

Tab. 1 Speed limitations

4.4 Recommendations for Accurate Temperature Measurement

4.4.1 Air Temperature Measurement

The best accuracy is achieved in air with a minimum air flow of 0.2 m/s (39 ft/min) surrounding the sample. In case the EE074 probe is not entirely located in the environment to be monitored, large temperature differences along the probe will lead to temperature gradients. These will affect the accuracy. Therefore, it is of paramount importance to minimise these temperature gradients. The majority of the probe should be located within the target environment, with the remainder being thermally well insulated.

4.4.2 Air and Liquids Temperature Measurement down to -70 °C (-94 °F)

The front part of the 305 mm (12.07") probe can be immersed in a medium at temperatures down to -70 °C (-94 °F) for up to 100 mm. The temperature of the other parts, particularly those containing electronics, must not fall below -40 °C (-40 °F). The insulation design depends on the measurement task. For good thermal conductors, such as liquids or dry block calibrators, the insulation can be smaller to achieve good measurement accuracy. In contrast, for low-conductivity media such as air, the insulation must cover at least 200 mm (7.87") of the remaining probe.

5 Setup and Adjustment

The EE074 is ready to use and does not require any further configuration.

If needed, the factory setup can be modified. This chapter describes the configuration possibilities with the PCS10 Product Configuration Software and via the digital RS485 interface with Modbus RTU. Please refer to the datasheet at www.epluse.com/ee074.

With PCS10, it is possible to change the digital communication settings and to perform a T adjustment in the form of an offset or as a 2-point adjustment.

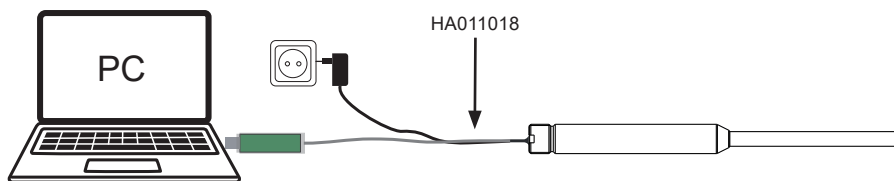


Fig. 1 EE074 connected to a PC running EE-PCS

5.1 PCS10 Product Configuration Software

The PCS10 provides a convenient graphical user interface to the EE074 for changing the factory setup via PCS10 and Modbus configuration adapter HA011018.

NOTICE

Data integrity might not be given during firmware download.

Ensure that the device is only powered by the USB 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 a PC.
2. Connect the EE074 to the PC using the Modbus configuration adapter.
3. Start the PCS10 software.
4. Follow the instructions on the PCS10 opening page to scan the ports and to identify the connected device.
5. Click on the desired setup or adjustment mode from the main PCS10 menu on the left. Follow the PCS10 online instructions that are displayed when clicking on the "Tutorial" button.
6. Upload changes to the probe by pressing the "Sync" button.

5.2 RS485 Digital Interface

5.2.1 Modbus RTU Setup (Modbus RTU Protocol Settings)

	Factory settings	Selectable values (via PCS10)
Baud rate	9600	9 600, 19 200, 38 400, 57 600
Data bits	8	8
Parity	Even	None, odd, even
Stop bits	1	1, 2
Modbus address	233	1...247

Tab. 2 Modbus RTU protocol settings

i PLEASE NOTE

- The recommended settings for multiple devices in a Modbus RTU network are 9600, 8, even, 1.
- The EE074 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 configuration adapter HA011018.
The EE-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/ee072).

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 - 0x10).

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.

i INFO

The Modbus function codes mentioned throughout this document shall be used as described in the MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, chapter 6:

www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf

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 see Application Note Modbus AN0103 (available at www.epluse.com/ee074).

Tab. 3 EE074 registers for device setup

5.3 Modbus Register Map

The measurement data are saved 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

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

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 13 500 means a value of 270.

Tab. 4 EE074 FLOAT32 and INT16 measured data registers

5.4 Device Status Indication

The EE074 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 not adjusted	Return the unit to the E+E Customer Service
Bit 1	Sensor broken	Return the unit to the E+E Customer Service
Bit 2	Temperature value invalid	Return the unit to the E+E Customer Service
Bit 3	Temperature value invalid	Return the unit to the E+E Customer Service
Bit 4	Sensor broken	Return the unit to the E+E Customer Service
Bit 5	-	-
Bit 6	-	-
Bit 7	-	-
Bit 8	-	-
Bit 9	-	-
Bit 10	-	-
Bit 11	-	-
Bit 12	-	-
Bit 13	-	-
Bit 14	-	-
Bit 15	-	-

Tab. 5 Device status indication

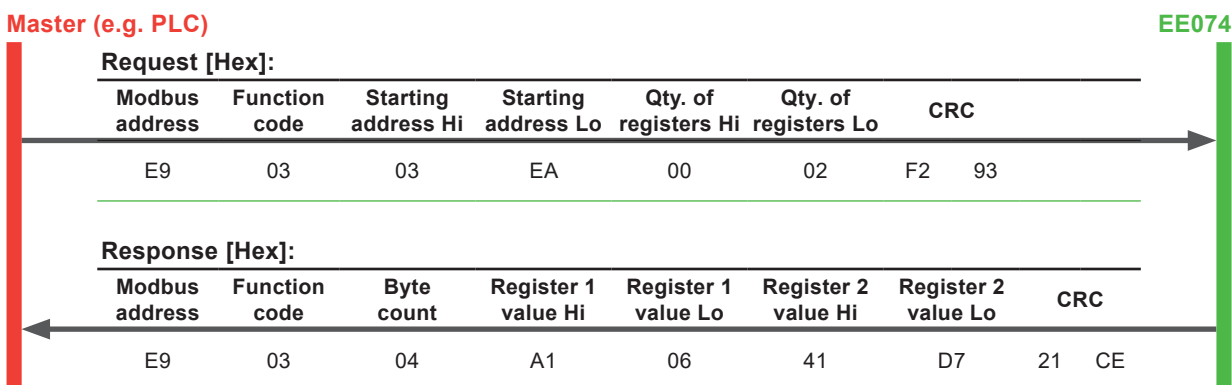
5.5 Modbus RTU Example

The EE074 Modbus address is 233 [0xE9].

Please refer to

- MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, chapter 6: www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf
- E+E Application Note Modbus AN0103 (available at www.epluse.com/ee074)

Read the temperature (FLOAT32) T = 26.953624 °C from register address 0x3EA:



Tab. 6 Example temperature query

NOTICE

To obtain the correct floating point values, both 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.

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 the T reading Modbus request/response example above):

Modbus response [Hex]			
Byte 3 (Register 1 - Hi)	Byte 4 (Register 1 - Lo)	Byte 1 (Register 2 - Hi)	Byte 2 (Register 2 - Lo)
A1	06	41	D7
MMMM MMMM	MMMM MMMM	SEEE EEEE	EMMM MMMM

Tab. 7 Modbus response

IEEE754			
Byte 1	Byte 2	Byte 3	Byte 4
41	D7	A1	06
0100 0001	1101 0111	1010 0001	0000 0110
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
Decimal value: 26.953624			

Tab. 8 Data representation according to IEEE754

6 Maintenance and Service

EE074 does not require any special maintenance, nevertheless for high accurate measurements especially over wide T ranges it is recommended to calibrate the probe every 12 months. If needed, the enclosure shall be cleaned and the device shall be re-adjusted as described in the following chapters below.

6.1 Calibration and Adjustment

The EE074 can be calibrated / adjusted with the help of the PCS10. For this purpose, the probe needs to be connected to a PC via the Modbus configuration adapter HA011018.

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 T Calibration and Adjustment

Temperature calibration and adjustment

Depending on the application and the requirements of certain industries, there might arise the need for periodical temperature calibration (comparison with a reference) or adjustment (bringing the device in line with a reference).

Calibration and adjustment at E+E Elektronik

Calibration and/or adjustment can be performed in the E+E Elektronik calibration laboratory. For information on the E+E capabilities in ISO or accredited calibration please see www.eplusecal.com and www.epluse.com/iso9001cal.

Calibration and adjustment by the user

Depending on the level of accuracy required, the humidity reference can be:

- Liquid bath calibrator
- Dry block calibrator
- Climate chamber
- Hand-held Meter (e.g. Omniport 40), please refer to www.epluse.com/omniport40.

6.3 Cleaning

Use a damp soft cloth to remove deposits of dust or dirt from the exterior of the probe. Do not use any solvents or abrasive cleaning agents.

6.4 Repairs

i PLEASE NOTE

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

7 Accessories

For further information please refer to the [Accessories](#) datasheet.

Description	Code				
E+E Product Configuration Software (Free download: www.epluse.com/pcs10)	PCS10				
Modbus configuration adapter, M12 4 poles ↔ USB	HA011018				
Sensor connection cable, shielded, 5 poles, M12x1 socket ↔ wire ferrules	1.5 m (4.9 ft)	HA010819			
	5 m (16.4 ft)	HA010820			
	10 m (32.8 ft)	HA010821			
Y-style splitter, M12x1, 1 plug ↔ 2 sockets, 5 poles	HA030204				
Connector, M12x1 socket, 4 poles, for self assembly	HA010707				
Protection cap for M12 socket	HA010781				
Protection cap for M12 plug	HA010782				
Plastic mounting flange for probes with Ø6 mm (0.24"), with alignment notch	HA401101				
Stainless steel mounting flange Ø12 mm (0.47")	HA010201				
Wall mounting clip Ø12 mm (0.47")	HA010211				
Immersion well - thread R ½" ISO	Length in mm (inch)	50 (1.97")	100 (3.94")	135 (5.31")	285 (11.22")
	Brass	HA400101	HA400104	HA400102	HA400103
	Stainless steel	HA400201	HA400204	HA400202	HA400203
Immersion well - thread ½" NPT	Length in mm (inch)	50 (1.97")	100 (3.94")	135 (5.31")	285 (11.22")
	Brass	HA400111	HA400114	HA400112	HA400113
	Stainless steel	HA400211	HA400214	HA400212	HA400213

8 Technical Data

Measurands

Temperature (T)

Measuring range	Probe¹⁾	-40...+80 °C (-40...+176 °F)
Accuracy²⁾ incl. hysteresis, non-linearity, temperature dependency of electronics and repeatability		<p>The graph plots accuracy $\pm \Delta T$ in °C against temperature T in °C. The x-axis ranges from -40 to 80 °C with major ticks every 10 units. The y-axis ranges from 0 to 0.48 °C with major ticks every 0.1 units. A shaded triangular area represents the accuracy range, which is 0.48 °C at -40 °C and 80 °C, and reaches its minimum of 0.1 °C at 20 °C.</p>
Response time t_{63}, typ.	In air @ 3.0 m/s In liquid	75 s 21 s
Measuring interval		1 s

1) Extended temperature measuring range -70...+105 °C at the probe tip of version EE074-L305.

2) Traceable to international standards, administrated by NIST, PTB, BEV, ...

The accuracy statement includes the uncertainty of the factory calibration with an 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).

The accuracy is defined at a 24 V DC supply, 9 600 Baud, without termination resistor and a polling interval of ≥ 1 second. For the accurate measurement in air, please observe the installation note in the User Manual.




Outputs

Digital

Digital interface	RS485 (EE074 = 1 unit load)
Protocol	Modbus RTU
Factory settings	9 600 Baud, parity even, 1 stop bit, Modbus address 233
Supported Baud rates	9 600, 19 200, 38 400, 57 600
Measured data types	FLOAT32 and INT16

1) Modbus map and communication settings: see User Manual and Modbus application note at www.epluse.com/ee074.

General

Power supply class III  USA & Canada: Class 2 supply necessary	10 - 28 V DC
Current consumption , typ.	3 mA
Electrical connection	M12x1, 5 poles, stainless steel
Humidity working range	0...100 %RH
Temperature working range	
Probe¹⁾	-40...+80 °C (-40...+176 °F)
Electronics	-40...+80 °C (-40...+176 °F)
Storage conditions	-40...+80 °C (-40...+176 °F) 0...90 %RH
Enclosure material	Stainless steel 1.4404 (AISI 316L)
Protection rating	
Probe	IP68
Electrical connection²⁾	IP67
Electromagnetic compatibility	EN 61326-1 EN 61326-2-3 Industrial environment FCC Part15 Class B ICES-003 Class B
Conformity	 
Configuration and adjustment	PCS10 Product Configuration Software (free download) and configuration adapter

1) Extended temperature working range -70...+105 °C at the probe tip of version EE074-L305.

2) The IP67 protection rating applies when plugged into an appropriate M12x1 socket.

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:



European directives and standards.

and



UK statutory instruments and designated standards.

Please refer to the product page at www.epluse.com/ee074 for the Declarations of Conformity.

9.2 Electromagnetic Compatibility

EMC for industrial environment.

The probe is a group 1 device and corresponds 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 the receiver 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.



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