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# User Manual EE381

Moisture in Oil Sensor



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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/ee381](http://www.epluse.com/ee381).

## 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 EE381 enclosure, the sensing probe and the sensing module shall not be exposed to unnecessary mechanical stress.
- The EE381 electronics are sensitive to electrostatic discharge (ESD). Take appropriate protective measures when touching it.
- Use the EE381 only as intended and observe all technical specifications.

### 1.2.2 Intended Use

EE381 is a moisture in oil sensor for transformer, lubrication or hydraulic oil as well as for diesel fuel. It is designed for the preventive maintenance of equipment and machinery.

#### 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.

- 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 EE381 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 the 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 EE381 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.

### 1.4 ESD Protection



The sensing elements and the electronics board are ESD (electrostatic discharge) sensitive components of the device and must be handled as such. Otherwise, the device may be damaged by electrostatic discharge when touching exposed sensitive components.

## 2 Scope of Supply

- EE381 – Moisture in Oil Sensor
- Inspection certificate according to DIN EN 10204-3.1
- Quick guide

# 3 Product Description

## 3.1 General

The EE381 is designed for accurately measuring the water content in oil. The EE381 is ideal for online monitoring of moisture in lubrication or insulation oil, which is very important for the long-term performance and preventive maintenance of plants and machinery.

### Moisture in Oil Measurement

The water content in oil can be indicated by the absolute value in ppm or by the relative value aw:

- ppm (mass of water /mass of oil)
- aw (actual water content as fraction of the water content in saturated oil)

aw = 0 corresponds to water-free oil, while aw = 1 indicates saturated oil. aw measurement with the EE381 sensor is based on the outstanding long term stability and resistance to pollution of the E+E capacitive sensing elements series.

### Quantities and Units

Parameter		Measured	Calculated	Measurement Units
Water activity	aw	✓		-
Water content	x		✓	ppm
Temperature	T	✓		°C, °F

Tab. 1 EE381 scope of measured quantities and measurement units

### Configuration and Adjustment

The optional EE-PCA Product Configuration Adapter and the free PCS10 Product Configuration Software facilitate easy configuration and adjustment of the EE381. Please refer to the EE-PCA datasheet and to chapter 5.2 PCS10 Product Configuration Software.

### Supply

The EE381 is supplied via the plug according to DIN VDE 0627 /IEC 61984. For the electrical details, please refer to the “General” section of chapter 8 Technical Data.

### Output

The measured data is available on two freely selectable and scaleable analogue outputs. Both outputs are either current (0 - 20/4 - 20 mA, 3-wire) or voltage (0 - 5/0 - 10 V). Configuration can be selected at the time of order and can be changed in the field via PCS10 Product Configuration Software. For the details, please refer to the “Output” section of chapter 8 Technical Data.

### Materials

The EE381 probe and the filter cap are made of stainless steel for deployment in rough environments. The sensing element material is made of ceramic with a proprietary polymer-based coating. The robust enclosure of the evaluation unit is available in either polycarbonate or die-cast aluminium.

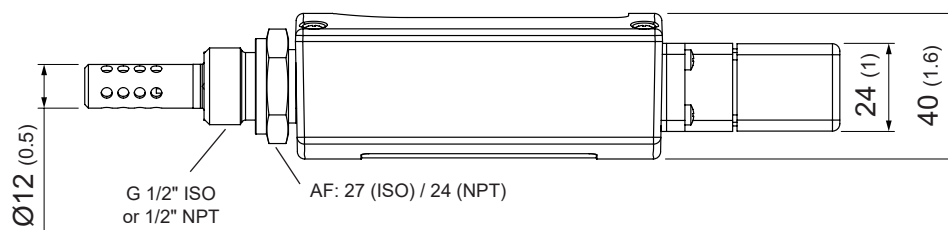
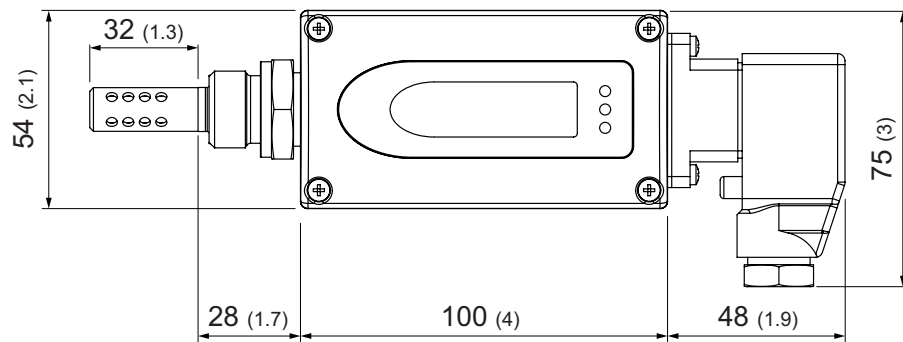
### Display

A display for on-site monitoring of the measured values provides a quick overview of the prevailing process conditions. Please refer to chapter 3.6 Display.

## 3.2 Dimensions

Values in mm (inch)

### Enclosure



## 3.3 Electrical Connection

### **⚠ WARNING**

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

Cables must not be under voltage during electrical installation and connection or disconnection, especially at terminal connections on circuit boards. 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.

For supply and output, the EE381 features an industrial connector according to DIN VDE 0627 / IEC 61984. Please refer to Fig. 1 for the pin assignment.

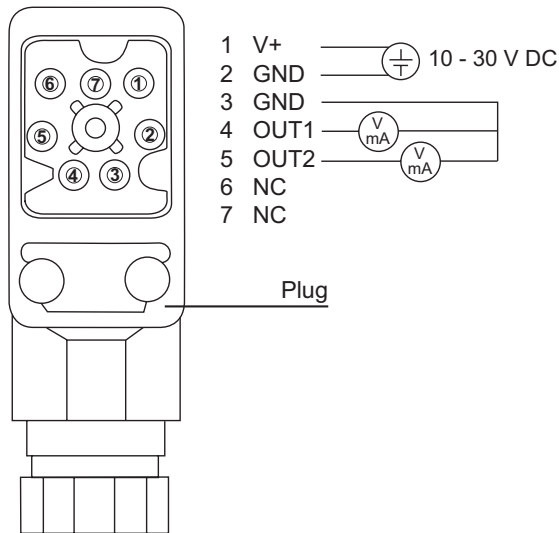


Fig. 1 EE381 connector

### 3.4 Circuit Board

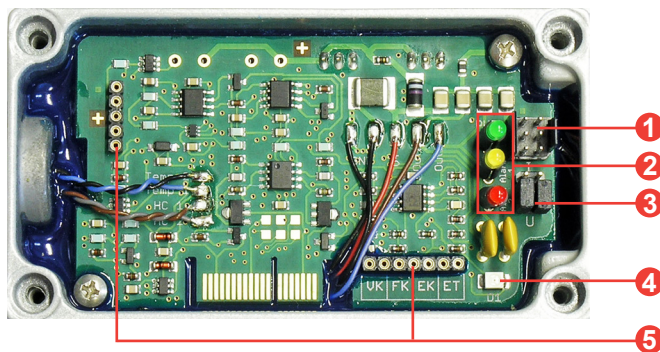
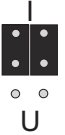
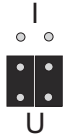
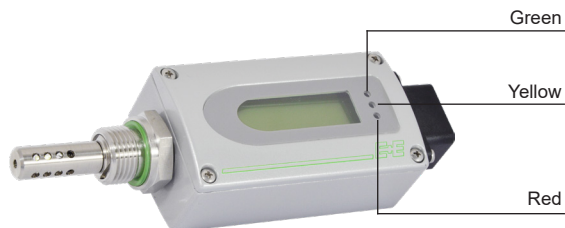


Fig. 2 EE381 operating components, circuit board

No.	Function
1	<b>Serial interface:</b> Pin connector for serial interface cable (HA011063).
2	<b>Status LEDs:</b> Provide information about the status of the device. Refer to chapter 3.5 Status LEDs
3	<b>Current / voltage output:</b> If the sensor is switched from current to voltage output using the configuration software, the 2 jumpers must be positioned accordingly: <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Jumpers' position for current output</p> </div> <div style="text-align: center;">  <p>Jumpers' position for voltage outputs</p> </div> </div>
4	<b>Diagnostic LED</b> Visual indication for easy determination of the cause of error. Please refer to chapter 6.4 Self-Diagnosis and Error Messages.
5	<b>Display</b> These pin connectors are designated for the display module.

Tab. 2 Parts of the EE381 electronics board types

### 3.5 Status LEDs



LED	Description
Green (Power LED) - flashing	Power supply is applied.
Yellow / Red	The yellow and red LED's are deactivated and currently don't have any function.

Tab. 3 Status indication via LED

### 3.6 Display

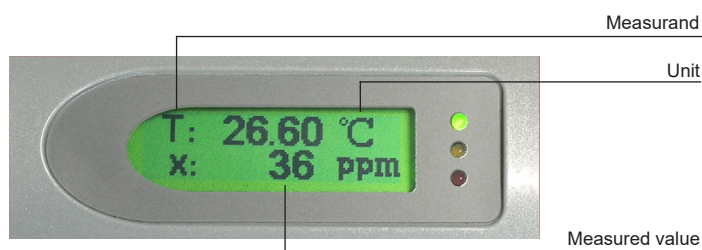


Fig. 3 EE381 display module with measured values and status LEDs

Measurand	Unit (SI)	Unit (US)
Temperature T	°C	°F
Water activity aw	-	-
Water content x	ppm	ppm

Tab. 4 Displayed measurands and units

## 4 Mounting and Installation

### 4.1 General

Select a location that offers optimum measuring conditions.

For best measurement results:

- The oil must be able to circulate freely around the sensing element.
- Mount the sensor directly into the circulating system and not into a reservoir.

### 4.2 Direct Installation into the Process

When installing a sensor directly into a process, shut-off valves should be installed on either side of the installation site. This facilitates the removal of the sensor for maintenance and calibration purposes.

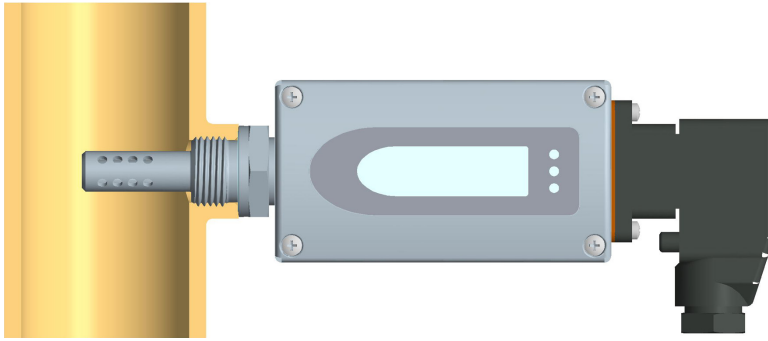


Fig. 4 Mounting example

Follow these steps to mount the EE381 in the process:

1. Install the probe with the stop valves closed. Using a sealing ring with an NPT 1/2" thread is not permitted. Use a suitable PTFE sealing tape or sealant instead.
2. Insert the probe into the process and screw it as tight as possible by hand.
3. If there is a sealing ring, check that it is centred correctly and tighten the screw connection with a torque of 30 Nm.

## 5 Setup and Adjustment

### 5.1 General

The EE381 is ready to use and does not require any further configuration. The factory setup of EE381 corresponds to the specified order code. Please refer to the datasheet at [www.epluse.com/ee381](http://www.epluse.com/ee381).

If needed, the factory setup can be modified. This chapter describes the configuration possibilities with the free PCS10 Product Configuration Software and the EE-PCA Product Configuration Adapter with the according connection cable (order code HA011063).

The software facilitates sensor adjustment, calibration and changes to analogue output scaling.

### 5.2 PCS10 Product Configuration Software

The PCS10 provides a convenient graphical user interface to the EE381 for changing the factory setup. The EE381 is powered via the EE-PCA and the configuration cable 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 serial configuration interface during a 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](http://www.epluse.com/pcs10) and install it on a PC.
2. Connect the EE381 to the PC using the Product 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 sensor by pressing the "Sync" button.

# 6 Maintenance and Service

## 6.1 Calibration and Adjustment

The EE381 can be calibrated/adjusted with the help of the PCS10 Product Configuration Software. For this purpose, the sensor needs to be connected to a PC via EE-PCA and connection cable HA011063.

### 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 Filter Cap Exchange

In a polluted measurement environment it might be necessary to replace the filter cap occasionally. In most cases, visible contamination or dirt indicate a clogged filter. Longer response time of the measurement also indicates a clogged filter cap. In these cases, replace the filter by a new, original one, please refer to chapter 7 Accessories / Spare Parts.

### Procedure:

1. Turn the filter cap counter-clockwise to remove it.
2. Install the new filter cap finger-tight by turning it clockwise.

### NOTICE

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

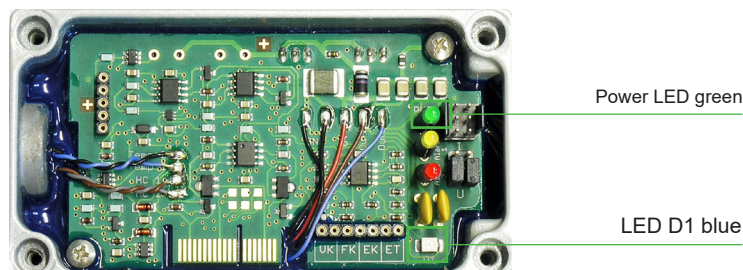
- While replacing the filter cap, take very good care not to touch or rub the sensing elements.

## 6.3 Cleaning the Sensing Head

If required, the sensing head can be cleaned. Please find the E+E Cleaning Instructions at [www.epluse.com/ee381](http://www.epluse.com/ee381).

## 6.4 Self-Diagnosis and Error Messages

### 6.4.1 Self-Diagnosis via LED on the Curcuit Board



#### Power LED (green)

LED state	Description
Flashing	Supply voltage applied / the microprocessor is active

**Diagnostic LED (D1, blue)**

LED state	Description
Flashing	The sensing element is bedewed (condensation)
Constantly lit	The sensing element is damaged

**6.4.2 Self-Diagnosis via Display**

Error	Reason
Error 1	Humidity sensing element is damaged
Error 2	Humidity sensing element bedewed (condensation)
Error 3	Temperature sensing element is damaged
Error 4	Short circuit on the temperature sensing element

**6.4.3 Further Self-Diagnosis****Display shows incorrect values**

Possible cause	Measures / help
Error during re-adjustment of the sensor	Reset to factory calibration and repeat the calibration routine
Output configured incorrectly	Check output range and output signals in the configuration

**Sensor failure**

Possible cause	Measures / help
No supply voltage	Reset to factory calibration and repeat the calibration routine
Green LED is illuminated continuously	Electronics defect, contact the manufacturer

**6.5 Repairs**** PLEASE NOTE**

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

# 7 Accessories / Spare Parts

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

Description	Code
<b>PCS10 Product Configuration Software</b> (Free download: <a href="http://www.epluse.com/pcs10">www.epluse.com/pcs10</a> )	<b>PCS10</b>
<b>EE-PCA Product Configuration Adapter</b> please refer to datasheet <a href="http://www.epluse.com/ee-pca">www.epluse.com/ee-pca</a>	<b>EE-PCA</b>
<b>EE-PCA connection cable for EE381</b>	<b>HA011063</b>
<b>Stainless steel filter cap for flow &lt;1 m/s (&lt;3.3 ft/s)</b>	<b>HA010110</b>
<b>Stainless steel filter cap for flow &gt;1 m/s (&gt;3.3 ft/s)</b>	<b>HA010111</b>
<b>Display<sup>1)</sup></b>	<b>D08-EE381</b>

1) For replacement only, not for retrofitting an EE381 without display

# 8 Technical Data

## Measurands

### Water Activity (aw) / Water Content (x)

<b>Measuring range</b>	0...1 aw 0...100 000 ppm; actual range depends on the oil type, for non-mineral transformer oil, specific solubility parameters are needed (ppm output is valid in the range 0...100 °C (32...212 °F))		
<b>Accuracy<sup>1)</sup></b> including hysteresis, non-linearity and repeatability <b>(0...0,9 aw)</b> <b>(0,9...1 aw)</b>	±0.02 aw ±0.03 aw		
<b>Temperature dependency</b>	<b>aw</b> <b>T</b>	±(0.00022 + 0.0002 • aw) • ΔT [°C] ±0.0003 °C/°C	ΔT = T - 20 °C
<b>Response time t<sub>63</sub>, typ.</b> @ 20 °C (68 °F) in still mineral transformer oil	10 min.		

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).

### Temperature (T)

<b>Oil temperature</b>	-40...120 °C (-40...+248 °F)
<b>Accuracy<sup>1)</sup></b>	<p>The graph plots accuracy ΔT [°C] on the y-axis (ranging from -0.4 to 0.4) against temperature T [°C] on the x-axis (ranging from -40 to 120). A shaded gray area represents the uncertainty range, which is narrowest at 20 °C (±0.02 °C) and widens to ±0.03 °C at 120 °C.</p>

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).




## Outputs

### Analogue

<b>Two freely selectable and scaleable outputs</b> <b>aw, T or x [ppm]</b>	0 - 5 V 4 - 20 mA (3-wire)	0 - 10 V <sup>1)</sup> 0 - 20 mA (3-wire)	-1 mA < I <sub>L</sub> < 1 mA R <sub>L</sub> < 500 Ω <sup>1)</sup>	I <sub>L</sub> = load current R <sub>L</sub> = load resistance
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1) Minimum supply voltage 15 V DC

## General

<b>Power supply</b> class III  USA & Canada: Class 2 supply necessary, max. voltage 30 V DC	10 - 30 V DC
<b>Current consumption</b> , typ. @ 24 V DC	<b>Voltage output</b> <b>Current output</b>
<b>Electrical connection</b>	<b>7-pole industrial plug</b> <b>wire cross-section</b> <b>cable outlet</b>
<b>Filter</b>	Stainless steel
<b>Pressure working range</b>	0...20 bar (0...300 psi) 0...100 bar (0...1 450 psi)
<b>Temperature working range</b>	<b>Probe</b> <b>Electronics</b> <b>Display</b>
<b>Storage condition</b>	-40...+60 °C (-40...+140 °F)
<b>Enclosure</b>	<b>Material</b> <b>Protection rating</b>
<b>Electromagnetic compatibility</b>	EN 61326-1      EN 61326-2-3      Industrial environment FCC Part15 Class B      ICES-003 Class B
<b>Conformity</b>	 
<b>Configuration and adjustment</b>	PCS10 Product Configuration Software (free download: <a href="http://www.epluse.com/pcs10">www.epluse.com/pcs10</a> ) and EE-PCA Product 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:



European directives and standards.

and



UK statutory instruments and designated standards.

Please refer to the product page at [www.epluse.com/ee381](http://www.epluse.com/ee381) for the Declarations of Conformity.

## 9.2 Electromagnetic Compatibility

EMC for industrial environment.

The sensor 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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