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User Manual EE360

Moisture in Oil Sensor

Modbus

www.epluse.com

Content

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.

PLEASE NOTE

Find this document and further product information on our website at www.epluse.com/ee360.

1.1 Explanation of Warning Notices and Symbols

Safety precautions

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

DANGER

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

WARNING

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

CAUTION

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

NOTICE

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

Informative notes

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

INFO

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

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

1.2 Safety Instructions

1.2.1. General Safety Instructions

NOTICE

Improper handling of the device may result in its damage.

- The EE360 enclosure, the sensing probe and the sensing module shall not be exposed to unnecessary mechanical stress.
- When replacing the filter cap make sure not to touch the sensing elements.
- For sensor cleaning and filter cap replacement please see “Cleaning instructions” at www.epluse.com.
- Installation, electrical connection, maintenance and commissioning shall be performed by qualified personnel only.
- The devices are designed for the operation with class III supply (EU) and class 2 supply (NA).
- The power supply must be switched off before opening the enclosure.
- An existing Ethernet connection must be disconnected before opening the enclosure.

1.2.2. Intended Use

EE360 is optimised for reliable measurement in lubrication, hydraulic and insulation oils as well as diesel fuel. In addition to highly accurate measurement of water activity (aw) and temperature (T), EE360 calculates the absolute water content (x) in ppm. The probe can be used up to 180 °C (356 °F), 20 bar (290 psi) and is available with either ISO or NPT sliding fitting, which allows for variable immersion depth. Using the optional ball valve, the probe can be mounted or removed even without process interruption.

⚠ 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 EE360 may only be operated under the conditions described in this user manual and within the specification included in chapter 9 Technical Data.
- Any unauthorised product modifications will invalidate all warranty claims. Modifications may only be carried out with express authorisation of E+E Elektronik Ges.m.b.H.!

The moisture in oil can be expressed in absolute or relative terms:

- The **water activity aw** is the relative measure for moisture in oil. It represents the ratio between the actual amount of dissolved water and the maximum possible amount of dissolved water in the oil at a certain temperature T. Independently of the oil type, the water activity shows how close to saturation is the oil at a certain temperature.
  aw = 0 indicates completely dry oil
  aw = 1 fully saturated oil
  EE360 measures directly the water activity.
- The **water content x** is an absolute measure equal to the share of water (dissolved, emulsified or separate) in the oil. The water content is measured in ppm (parts per million) and is independent from the oil temperature. For assessing how far is the oil from saturation, x must be regarded together with T.
  EE360 calculates x out of the measured aw and T values. The calculation is oil dependent and requires a set of oil specific parameters. (Contact an E+E representative for details.)

1.2.3. Alarm Module with Voltages >50 V (Option AM2)

The optional alarm module is isolated from the low-voltage side of EE360 by a special partition; this must remain fitted at all times in the base module of the enclosure.

⚠ WARNING

An open enclosure corresponds to IP00 and exposes components carrying dangerous voltage. The EE360 enclosure must be tightly closed during operation. Any work (maintenance for instance) on the device may be performed by qualified staff only.

1.2.4. Integrated Power Supply 100 - 240 V AC (Option AM3)

⚠ WARNING

An open enclosure corresponds to IP00 and exposes components carrying dangerous voltage. The EE360 enclosure must be tightly closed during operation. Any work (maintenance for instance) on the device may be performed by qualified staff only.

1.2.5. Mounting, Start-up and Operation

The EE360 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

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.

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. The failure to do so may damage the device by electrostatic discharges when touching exposed sensitive components.

2 Scope of Supply

Items included	Version
EE360 Moisture in Oil Sensor Applications according to ordering guide	All versions
User manual	All versions
Inspection certificate according to DIN EN 10204-3.1	All versions
Two self-adhesive labels for configuration changes (see user manual at www.epluse.com/relabeling)	All versions
Mating plug for integrated power supply	AM3
Mating plug RKC 5/7	AM3 / E4 / E6 / E12
Mating plug RSC 5/7 (2 pcs. for option E12)	E5 / E6 / E12
Mating plug HPP V4 RJ45 Cat5	J4

Tab. 1 Items included in the scope of supply

3 Product Description

3.1 Product Design

Fig. 1 EE360 product design

No.	Function
1	Sensor module with electronic / display*) and probe cable
2	3.5" TFT colour display*)
3	5 push-buttons for configuration menu
4	Base module with electrical connection, alarm + supply module*) and mounting holes
5	Micro USB service interface
6	Standard cable glands / connectors*)
7	Additional cable gland / connector*)

*) Optional

Tab. 2 Parts of the EE360

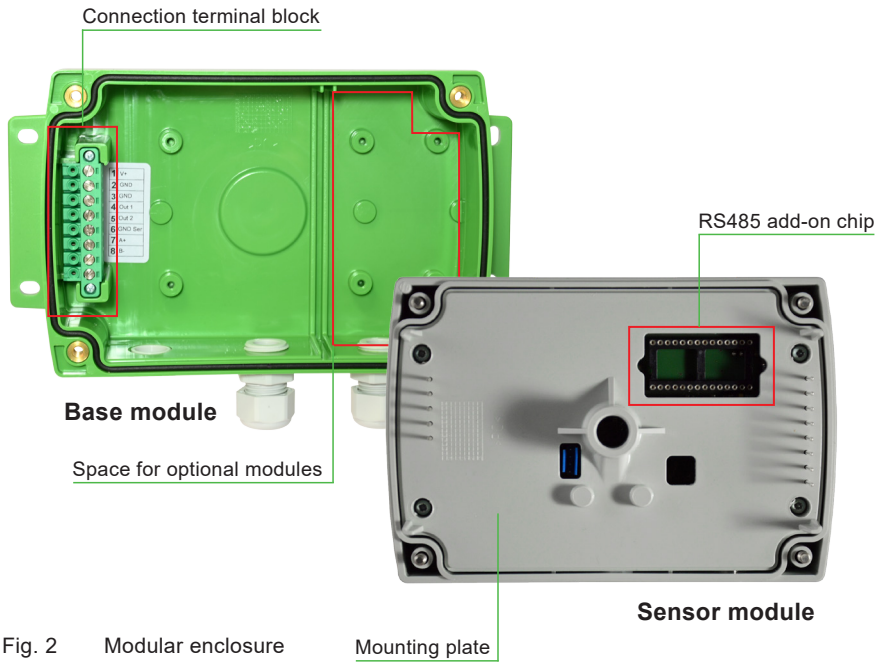


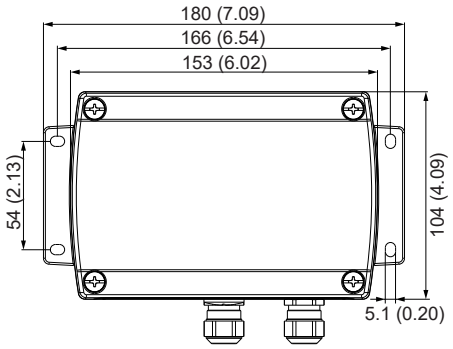
Fig. 2 Modular enclosure

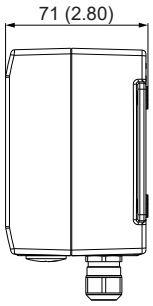
3.2 Dimensions

Values in mm (inch)

Enclosure

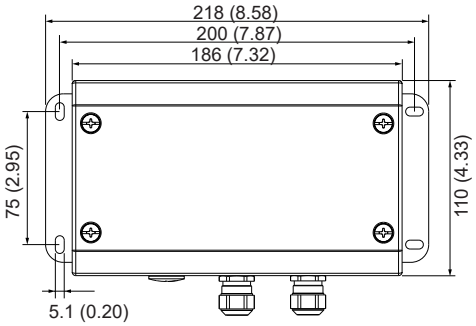
Polycarbonate

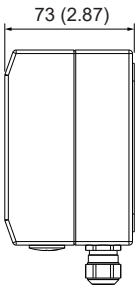




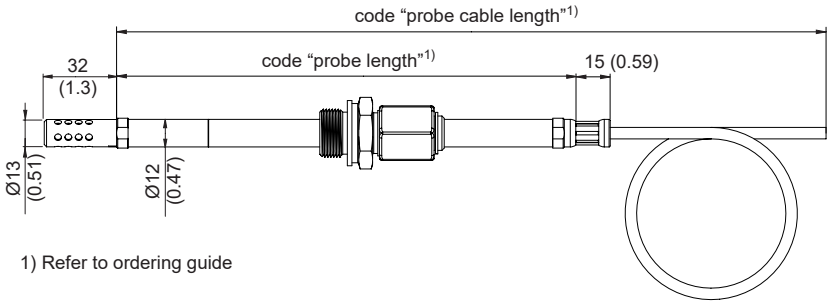
Enclosure

Stainless steel





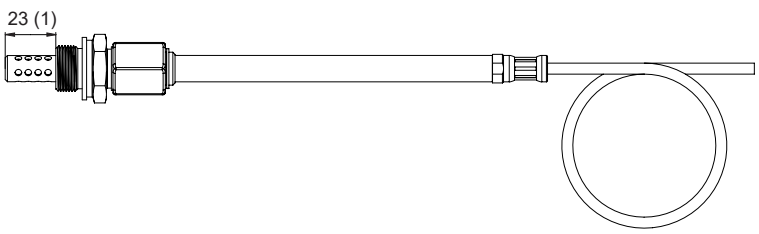
Probe



1) Refer to ordering guide

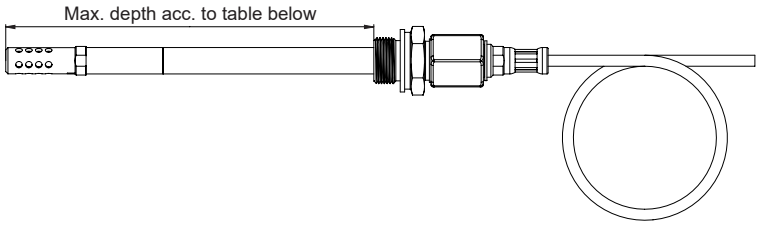
Probe

Minimum insertion depth



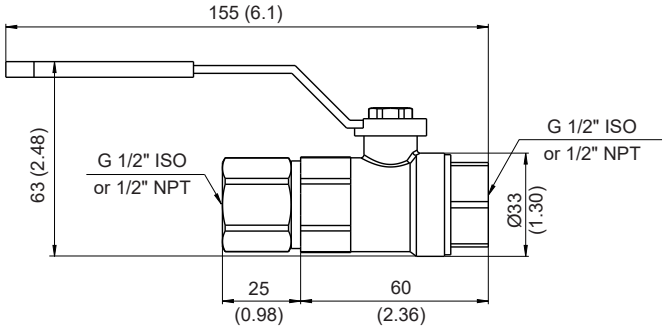
Probe

Maximum insertion depth



Probe length [mm (inch)]	Max. insertion depth [mm (inch)]
100 (2.5)	64 (3.9)
200 (6.5)	164 (7.9)
400 (14.3)	364 (15.8)
600 (22.2)	564 (23.6)
800 (30.1)	764 (31.59)
1000 (38.0)	964 (39.4)

Ball valve set G 1/2" ISO or NPT



4 Mounting and Installation

4.1 Mechanical Installation

4.1.1. Mounting of the Enclosure

- Drill the mounting holes according to the corresponding mounting pattern below.
- Mount the base module of the enclosure with 4 screws (screw diameter <4.2 mm (0.2"), not included in the scope of supply). Values in mm (inch).

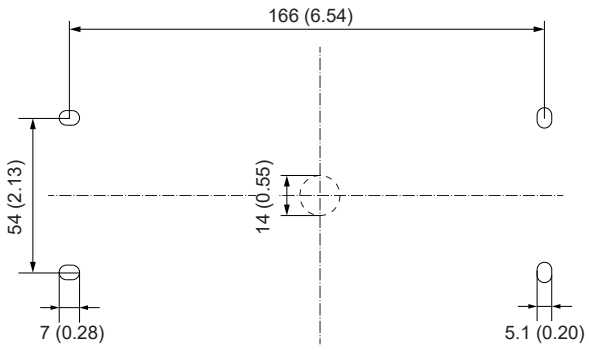


Fig. 3 Drilling pattern of polycarbonate enclosure

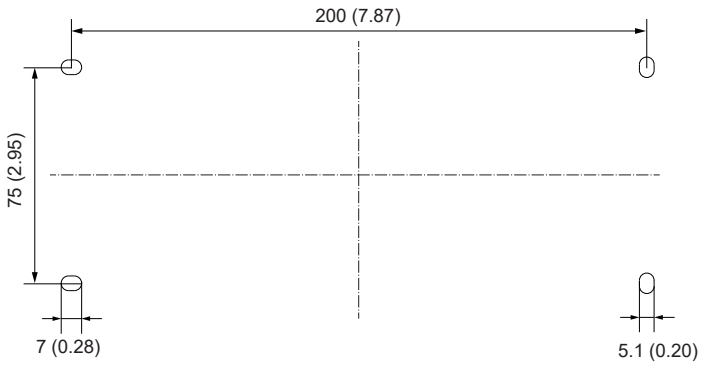


Fig. 4 Drilling pattern of stainless steel enclosure

4.1.2. DIN Rail Mounting of the Polycarbonate Enclosure

- Mount the two DIN rail brackets onto the base module.
  (to be ordered separately, see chapter 8 Spare Parts and Accessories)
- Snap in the enclosure onto the DIN rail.

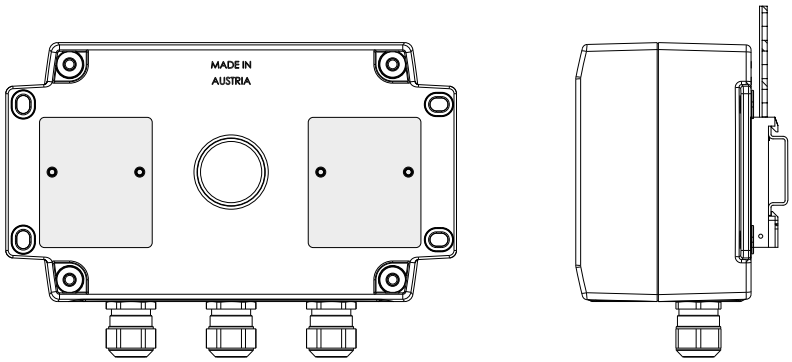


Fig. 5 DIN rail installation

4.2 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.

NOTICE

The electrical installation of the EE360 shall be performed by qualified staff only. Observe all applicable national and international requirements for the installation of electrical devices as well as for power supply according to EN 61140, class III (EU) and class 2 supply (North America).

Connection Diagram

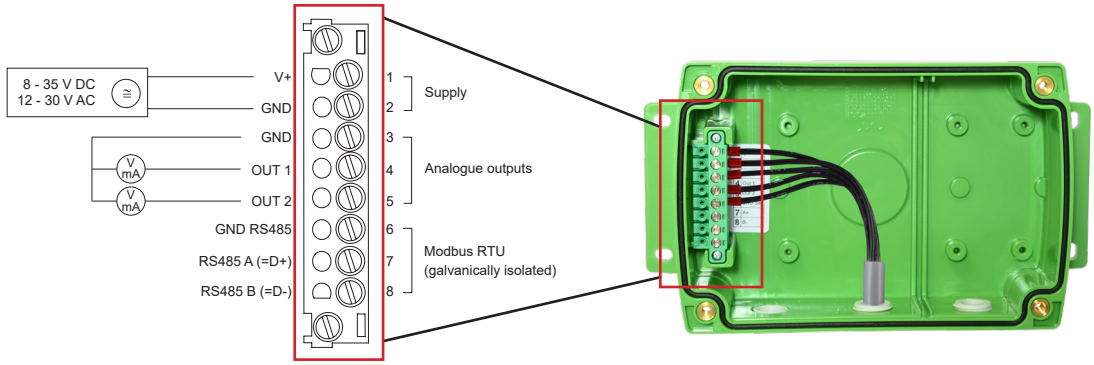


Fig. 6 Electrical connection

Analogue outputs

Both analogue outputs shall be configured to either voltage or current. Measurands, analogue output range and scaling are freely selectable. All settings can be performed via display and push buttons or using the PCS10 Product Configuration Software, see 6.1 Configuration Interface.

Error indication

The analogue outputs feature an error indication function according to NAMUR NE43. In the case of an error the output signal will freeze at 21 mA or 11 V respectively.

PLEASE NOTE

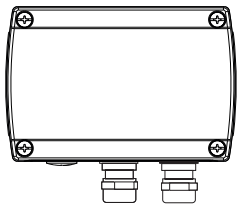
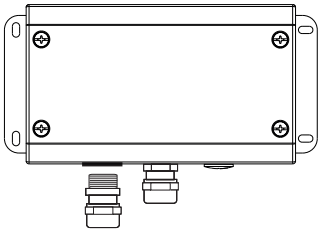
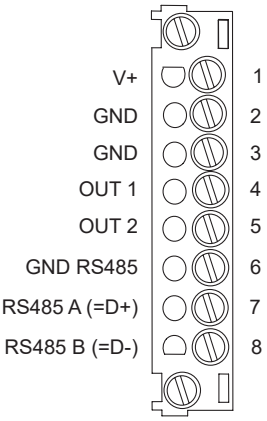
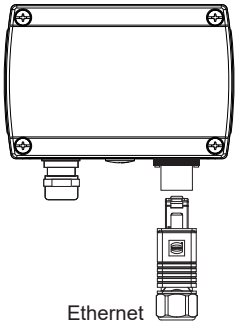
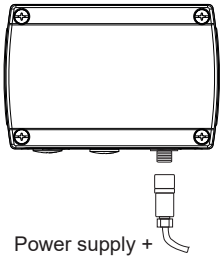
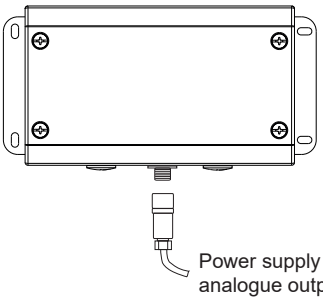
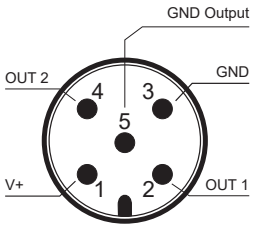
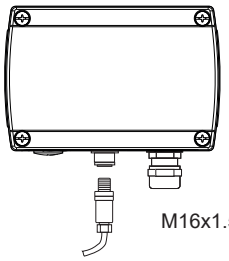
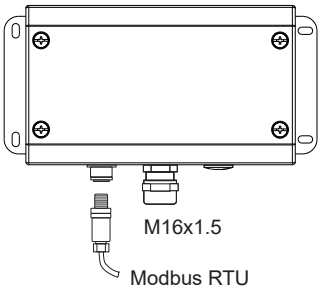
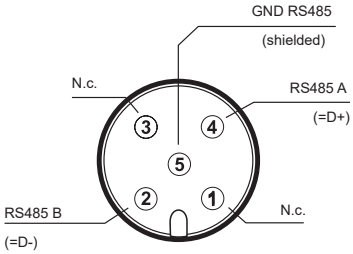
The error display is disabled by default.

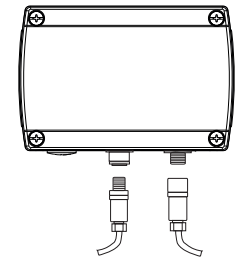
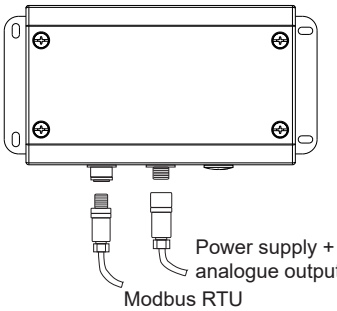
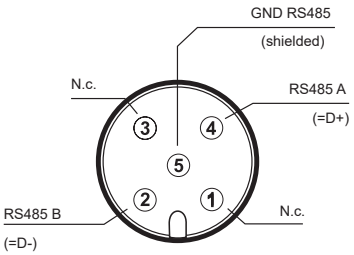
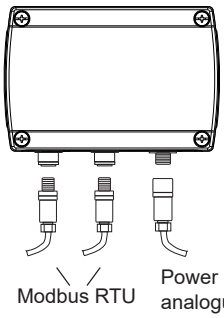
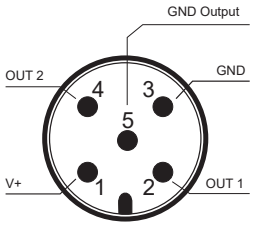
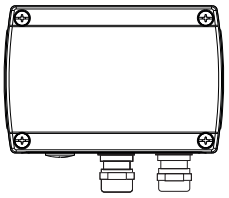
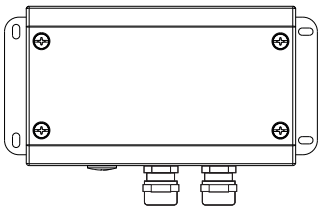
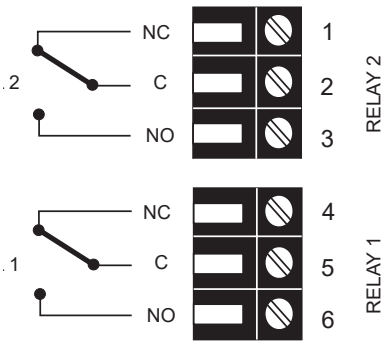
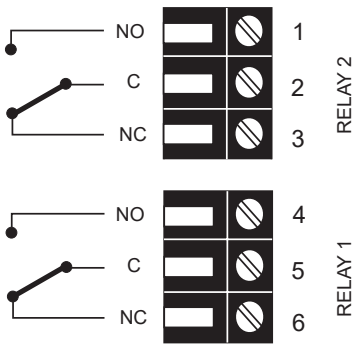
When changing one of the analogue outputs from current to voltage and vice versa, the second output will change automatically as well. The output scaling changes automatically if it is out of physical range (e.g. 20 mA will be changed to 10 V instead of 20 V).

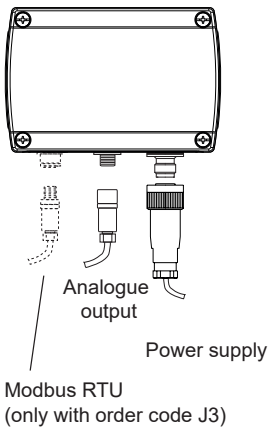
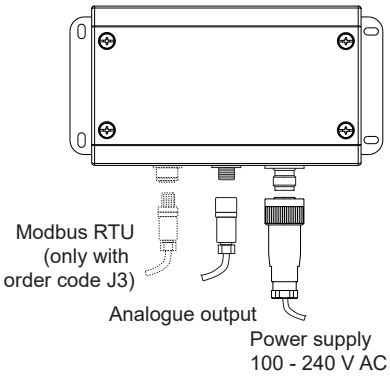
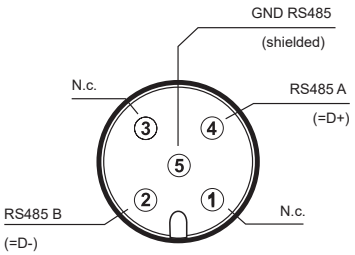
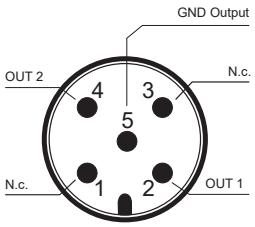
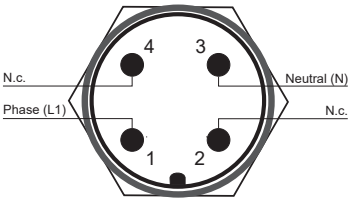
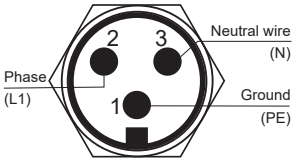
PLEASE NOTE

Check output scale after changing between voltage and current output.

4.2.1. Electrical Connection and Wiring

Option	Polycarbonate Enclosure	Stainless Steel Enclosure	Pin Assignment
Cable glands	 2x M16x1.5	 1 x M16x1.5 mounted 1 x M16x1.5 enclosed	
J4	 Ethernet Modbus TCP		
E4	 Power supply + analogue output	 Power supply + analogue output	 **Supply and analogue Output** M12 plug front view
E5	 M16x1.5 Modbus RTU	 M16x1.5 Modbus RTU	 M12 socket front view

Option	Polycarbonate Enclosure	Stainless Steel Enclosure	Pin Assignment
E6			 **Modbus RTU** M12 socket front view
E12			 **Power supply + analogue output** M12 plug front view
AM2			 **Standard operation mode**
			 **Inverted operation mode**

Option	Polycarbonate Enclosure	Stainless Steel Enclosure	Pin Assignment
AM3			 **Modbus RTU** M12 socket front view  **Analogue output** M12 plug front view  **Power supply 100 - 240 V AC** Plug, 4 poles front view  **Power supply 100 - 240 V AC** **for stainless steel enclosure** Plug, 3 poles front view

Tab. 3 Options for electrical connections and wiring

NOTICE

External diameter of the supply cable for option AM3: 10...12 mm (0.39...0.47").
Maximum wire cross section for AM3 connecting cable: 1.5 mm^2 (AWG 16) .

External diameter of the cable for Modbus RTU and analogue output female plug: 4...6 mm (0.16...0.24").
Maximal wire cross section for connecting cable: 0.5 mm^2 (AWG 21).

4.3 Probe Mounting

The probe can be installed in applications such as oil storages with almost non-moving oil or as well in circulation pipes with moving oil.

NOTICE

With moving oil, the mechanical stress on the probe is minimised by placing only the filter cap in the flow. In systems with mechanical oil contamination, the sensor may only be installed after a suitable filter.

4.4 Mounting Pressure-Tight Probe

⚠ WARNING

General safety instructions for installation

The installation, commissioning and operation of the EE360 may be performed by qualified staff only. Special attention shall be paid to the correct installation of the probe into the process. In case of inappropriate installation there is the risk for the probe to be suddenly expulsed due to the pressure in the process.

Bending over the sensing probe should be avoided under any circumstances!
Make sure that the surface of the probe is not damaged during installation. A damaged probe surface may lead to damaged seals and consequently to leakage and pressure loss.

The probe is rated with leakage rate B according to EN12266-1.

4.4.1. Probe Installation Directly in the Process

NOTICE

For direct probe installation shut-off valves shall be placed on both sides of the probe insert (see Fig. 7 Installation of the EE360 probe directly into the process). This allows the sensor probe to be easily removed for maintenance and calibration.

For direct installation into a pressure chamber make sure that the pressure in the chamber and the ambient pressure are equal before removing the probe. The temperature during probe installation may deviate by max. ±40 °C (±72 °F) from the regular temperature during normal operation.

Replace the metal sealing ring (see Fig. 7) by a new one every time before re-installing the probe.

Probe installation steps

1. Close both shut-off valves.
2. Place the sensor probe into the probe insert and adjust the immersion depth.
3. Tighten the lock nut with a torque of 30 Nm.
4. Open the shut-off valves.

⚠ WARNING

Observe strictly the tightening torque. A torque lower than 30 Nm results in a smaller retention force of the clamping sleeve. This leads the risk of sudden expulsion of the sensing probe due to the pressure. A torque higher than 30 Nm may lead to permanent deformation of the clamping sleeve and the sensing probe. This would make the removal and re-installation of the probe difficult or even impossible.

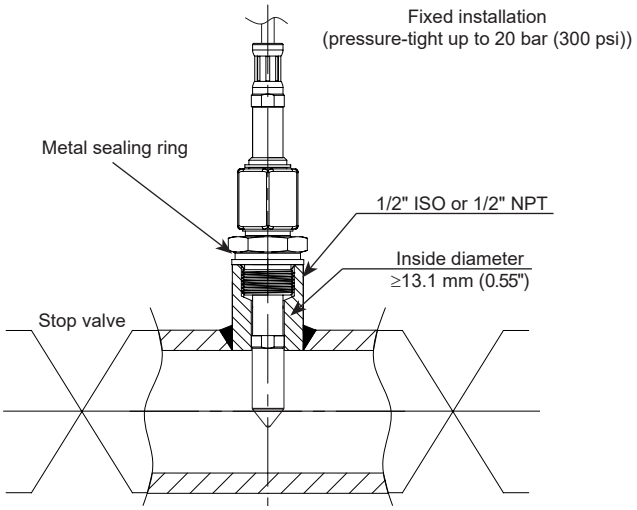


Fig. 7 Installation of the EE360 probe directly into the process

4.4.2. Probe Installation with Ball Valve Set

The ball valve set allows the probe to be installed and removed without interrupting the process. When mounting into a duct, the ball valve shall be installed perpendicular to the flow direction.

NOTICE

The two metal sealing rings (see Fig. 8 Installation of the probe by utilizing the ball valve set) shall be replaced every time prior to re-installing the probe.

The temperature when installing the probe may deviate by a maximum of ±40 °C (±72 °F) from the regular temperature in normal operation.

Installation of the probe (see Fig. 8)

1. Install the probe into the ball valve while the ball valve is closed.
2. Open the ball valve.
3. Slide the probe through the ball valve to the desired immersion depth. Depending on the process pressure additional tools may be necessary for pushing the probe into the process. Take care not to damage the probe and the cable.
4. Tighten the lock nut with a torque of 30 Nm.

⚠ WARNING

Observe strictly the tightening torque. A torque less than 30 Nm results a lower retention force of the clamping sleeve. This leads the risk of sudden expulsion of the sensing probe due to the pressure. A torque higher than 30 Nm may lead to permanent deformation of the clamping sleeve and the sensing probe. This would make the removal and re-installation of the probe difficult or even impossible.

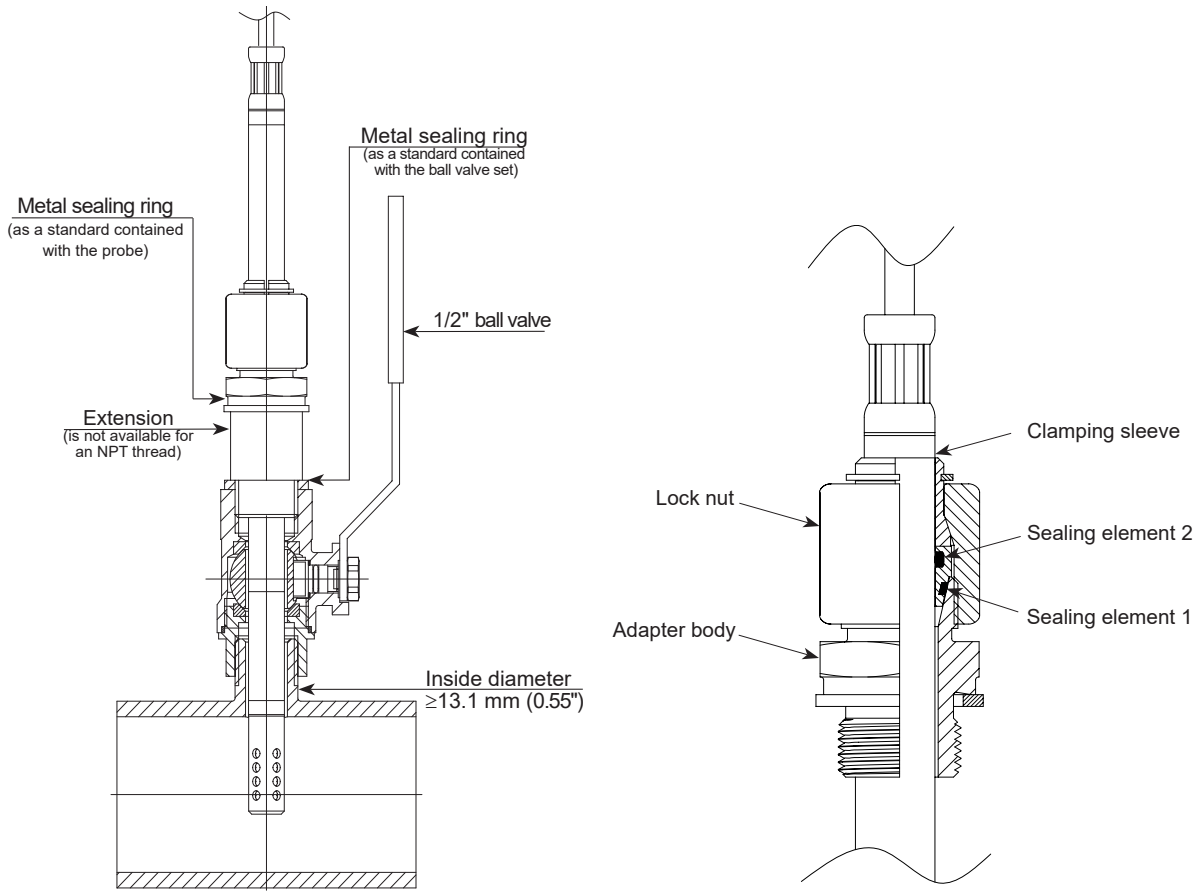


Fig. 8 Installation of the probe by utilising the ball valve set

Probe removal procedure

1. Hold the probe firmly to avoid it being suddenly expulsed when releasing the lock. Do not bend or damage the probe cable.
2. Loosen slowly the lock nut with a spanner (spanner width 24) only till the probe is pushed out by the overpressure in the process. Do not loosen the lock nut completely, but only enough to allow the probe to slide.
3. After the probe has been pushed out of the process up to the stop, close the ball valve.
4. Remove the probe from the ball valve.

NOTICE

Observe the correct positioning of the sealing element 1 before reinstalling the probe.

Replacement of the sealing element

Repeated installation and removal can damage the sealing element 1. It can be replaced by the user.

Sealing element 1

O-ring seal 13x1.5 mm
FPV3588 Sh A 60±5

5 Optional Modules

5.1 Alarm Module (Option AM2)

The module offers two freely configurable relay outputs for alarm or control purposes. Various operation modes are available including switch hysteresis, switch window and error indication. The error modes can be configured independently from each other. The measurands at the outputs as well as switching points, hysteresis and the normal state (standard / inverted) can be set via PCS10 Product Configuration Software or using the push-buttons (see chapter 11.3 Optional Menus, Fig. 39 Alarm output).

Electrical Connection and Switch Load

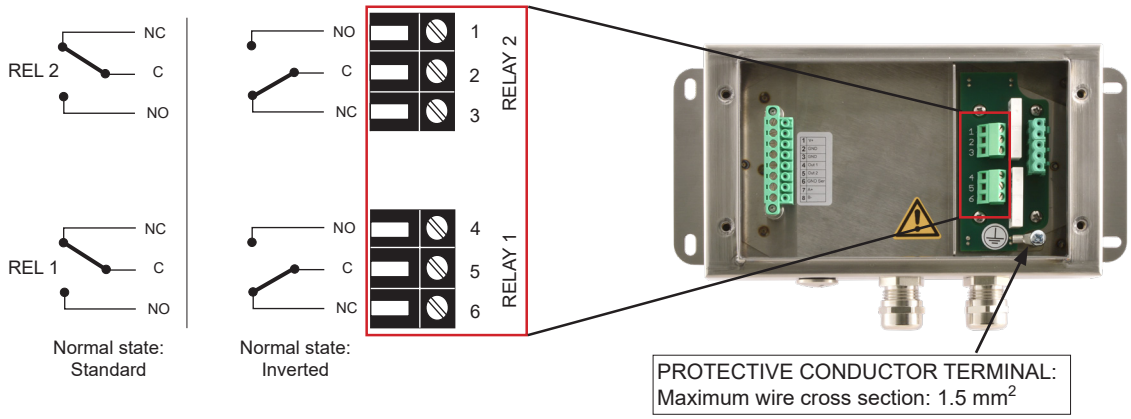


Fig. 9 Alarm module (option AM2)

⚠ WARNING

The metal enclosure must be grounded during operation. National regulations for installation must be observed!

Switch Load

Max. switch load	250 V AC / 6 A 28 V DC / 6 A
Min. switch load	12 V / 100 mA

Tab. 4 Maximum and minimum switch loads

⚠ WARNING

No overcurrent and short-circuit protection. Both relays shall be connected to either high or low voltage.

Switch Hysteresis Mode

The switching behavior is determined by entering a switching point and an associated hysteresis value.

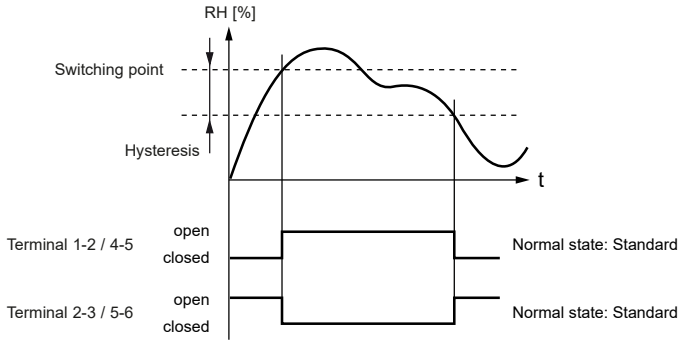


Fig. 10 Example of hysteresis mode on both alarm outputs using normal state standard

Additionally, detected errors are signaled at the alarm output.

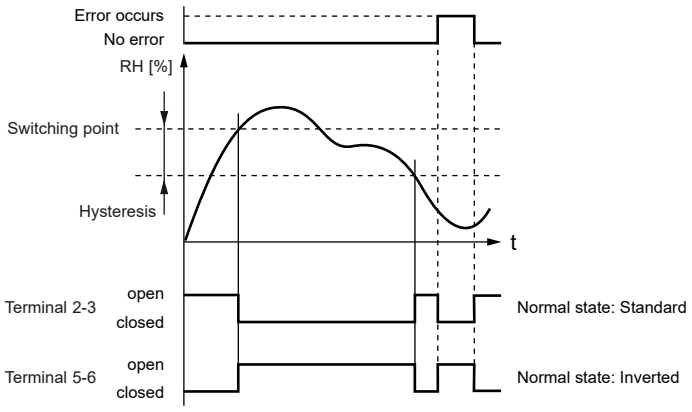


Fig. 11 Example of hysteresis mode with error occurring.

Switch Window Mode

The switching behavior is determined by entering two switching points and two associated hysteresis values.

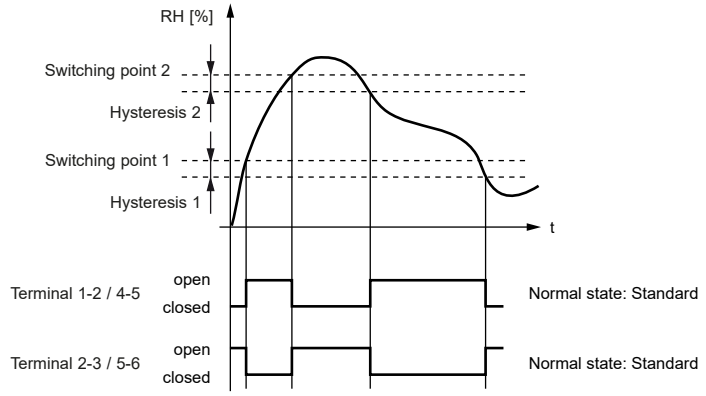


Fig. 12 Example of window mode on both alarm outputs using normal state standard

Additionally, detected errors are signaled at the alarm output.

Error Indication Mode

When error indication mode is selected, various errors will trigger the alarm output.

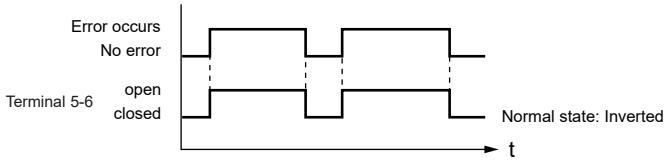


Fig. 13 Example of an error mode on relay 1 with inverted normal state.

PLEASE NOTE

When the error indication mode is selected, various errors will trigger the alarm output. In this operating mode, an alarm output is only used to indicate errors (no combination with switching points possible).

5.2 Integrated Power Supply 100 - 240 V AC (Option AM3)

This module allows the EE360 to be powered with 100 - 240 V AC (50/60 Hz), 2 VA.

Enclosure

Polycarbonate

Stainless steel

Fig. 14 Power supply module (option AM3)

Pin assignment of the plug connection: please refer to chapter 4.2.1 Electrical Connection and Wiring.

WARNING

The AM3 option includes a 1.25 A fuse on the 100 - 240 V side. This fuse may not be replaced by the user, only by the E+E after sales service.

The protection of the supply cable against excess current and short-circuit must be designated to a wire cross section of 0.8 mm^2 (AWG 18) (6A fuse).

The metal enclosure must be grounded during operation.

All national regulations for installation shall be observed!

5.3 RS485 Module - Modbus RTU (Option J3)

The device represents a unit load of 1, i.e. up to 32 EE360 sensors with Modbus RTU interface can be connected in an RS485 bus system.

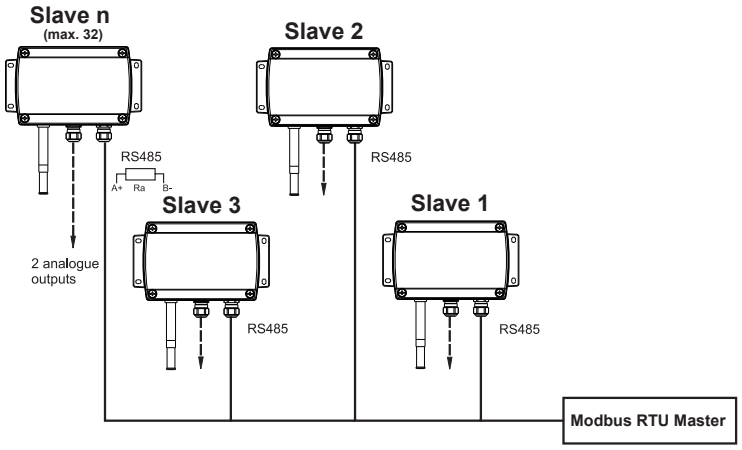


Fig. 15 2-wire RS485 bus

PLEASE NOTE

Both ends of the bus shall be terminated with a resistor R_a=120 Ω.

The setup of the Modbus RTU communication can be performed via PCS10 Product Configuration Software or via display and push buttons (see chapter 11 Appendix, Fig. 40 Modbus settings).

5.3.1. Modbus RTU Protocol Settings

	Factory settings	Selectable values (via PCS10)
Baud rate	9600	300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 38 400, 57 600, 76 800
Data bits	8	8
Parity	Even	None, odd, even
Stop bits	1	1 or 2
Modbus address	231	1…247

Tab. 5 Modbus RTU Protocol Settings

PLEASE NOTE

- The recommended setting for multiple devices in a Modbus RTU network is 9600, 8, Even, 1.
- The EE360 represents 1 unit load on an RS485 network.

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

- PCS10 Product Configuration Software.
  The PCS10 can be downloaded free of charge from www.epluse.com/pcs10.
- Modbus protocol in register 1 (0x00) and 2 (0x01).
  See Application Note Modbus AN0103 (available at www.epluse.com/ee360).

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, both registers have to be read within the same read cycle. The measured value can change between two Modbus requests, exponent and mantissa may get inconsistent then.

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	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/ee360).

Tab. 6 EE360 registers for device setup

5.4 Modbus Register Map

The measured data is saved as a 32 bit floating point values (data type FLOAT32).

FLOAT32

Parameter	Unit	Register number[1)] [DEC]	Register address[2)] [HEX]
Read register: function code 0x03 / 0x04			
Water activity aw	-	1135	46E
Water content x	ppm	1141	474
Temperature T	°C	1003	3EA
	°F	1005	3EC
Saturation	%	1137	470
Oil parameter A	-	0224	DF
Oil parameter B	-	0226	E1
Oil parameter C[3)]	-	0228	E3
Oil parameter D[3)]	-	0230	E5
Oil parameter E[3)]	-	0232	E7
Write register: function code 0x10			
Oil parameter A[4)]	-	0101	64
Oil parameter B[4)]	-	0103	66
Write register: function code 0x10 (with sensor firmware V1.0.51 or higher)			
Oil parameter A[5)]	-	0224	DF
Oil parameter B[5)]	-	0226	E1
Oil parameter C[5)]	-	0228	E3
Oil parameter D[5)]	-	0230	E5
Oil parameter E[5)]	-	0232	E7

1) Register number (decimal) starts from 1.
2) Register address (hexadecimal) starts from 0.
3) New register in device with firmware version 1.0.51 or higher.
4) If parameters A and B are written with these addresses, parameters C, D and E are automatically set to 0.
Example: Writing Parameters A and B -1663.30005 and 7.3705 decimal: E7 10 00 64 00 04 08 E9 9A C4 CF DB 23 40 EB AB 61
If two parameters are to be uploaded, it is recommended to write them with a single command.
5) Example: A= -100, B=10, C=-110, D=11, E=1
E7 10 00 DF 00 0A 14 00 00 C2 C8 00 00 41 20 00 00 C2 DC 00 00 41 30 00 00 3F 80 22 2E.

Tab. 7 EE360 FLOAT32 measured data registers

5.5 Modbus RTU Example

The EE360's Modbus address is 231 [E7 in HEX].

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/ee360)

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

Master (e.g. PLC) → **EE360**

Request [Hex]:

Modbus address	Function code	Starting address Hi	Starting address Lo	Qty. of registers Hi	Qty. of registers Lo	CRC	
E7	03	03	EA	00	02	F3	BD

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	
E7	03	04	A1	06	41	D7	CE	0E

Tab. 8 Example temperature query

Decoding of floating point values:

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

Modbus response [Hex]

Register 1 Hi	Register 1 Lo	Register 2 Hi	Register 2 Lo
A1	06	41	D7
MMMMMMMM	MMMMMMMM	SEEEEEEE	EMMMMMMM

Tab. 9 Modbus response

IEEE754

Register 2 Hi	Register 2 Lo	Register 1 Hi	Register 1 Lo
41	D7	A1	06
0100 0001	1101 0111	1010 0001	0000 0110
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
Decimal value: 26.953624725341796875			

Tab. 10 Data representation according to IEEE754

5.6 Ethernet Module - Modbus TCP (Option J4)

The Ethernet module features power over Ethernet (PoE) and RJ45 connector with IP65 protection rating.

PLEASE NOTE

The Ethernet connection shall be disconnected before opening the enclosure.

5.6.1. Available TCP and UDP Ports

Modbus TCP (Port 502)

See “Modbus TCP/IP implementation guide” available at www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf.

The unit identifier of the MBAP header is not used and can be any value from 0 to 255.

HTTP-Webserver (Port 80)

For a quick communication check enter the desired IP in a web browser and connect with the EE360 Ethernet Module’s Webserver.

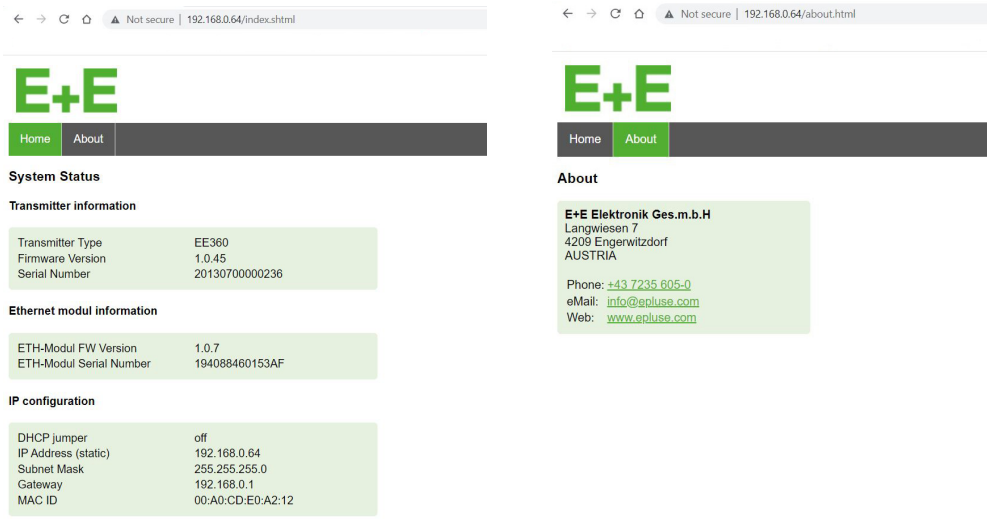


Fig. 16 Image from the E+E net web interface

Alternatively, send an ICMP echo request (“ping”) to check correct communication settings.

UDP (Port 5234)

Backwards compatible communication protocol with EE36. Ethernet communication uses UDP packets

Communication via Ethernet takes place by means of UDP packets, which transport a command or a command response in EE36 protocol format as payload data. See “Ethernet - communication protocol” available at www.epluse.com/en/service-support/download-center.

5.6.2. IPv4 Settings

Factory setting	
IP Address	192.168.0.64
Subnet Mask	255.255.255.0
Gateway	192.168.0.1
DNS	192.168.0.1

Tab. 11 IPv4 settings

DHCP options can be set with jumper on the PCB.
Factory setting: DHCP disabled (static IP). Please refer to Fig. 17 below.

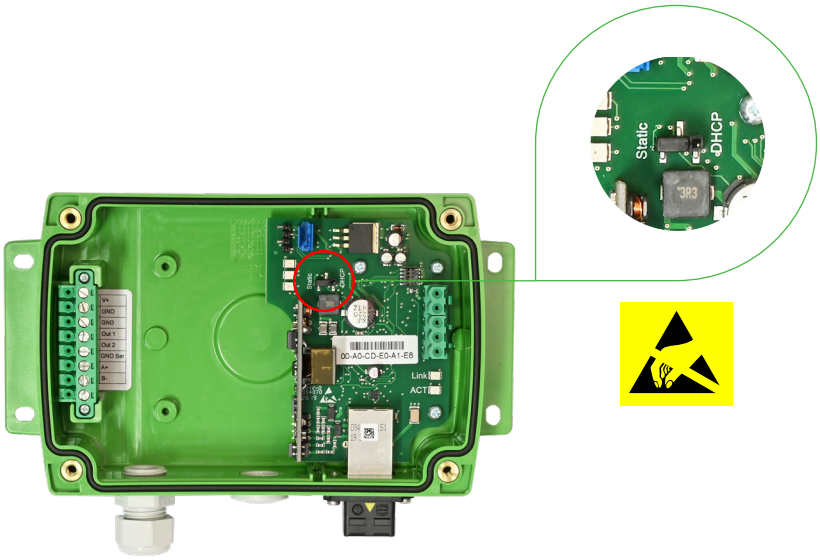


Fig. 17 Ethernet Module - DHCP setting

The setup of the Modbus TCP communication can be performed via PCS10 Product Configuration Software or via display and push buttons (see 11 Appendix, Fig. 41 IP settings).

Changing the IP address via PCS10 or the display is only possible if the DHCP jumper is set to “Static”. Otherwise the IP settings are read-only.

NOTICE

Supported Ethernet standard: 802.3i/u/x and af. IPv6 is not supported.

5.6.3. Retrofit with Ethernet Module

The EE360 can be retrofitted with an Ethernet module. Before retrofitting, please make sure that the EE360 firmware is updated to the latest version by using the PCS10 Product Configuration Software.

- Firmware for sensor: V 1.0.22 or higher
- Firmware for display: V 1.0.9 or higher

Description	Order Code
Ethernet Module for remote probe	HA010606

Tab. 12 Accessories order code

5.7 Pluggable Probe (Option PC4)

EE360 sensors are optionally available with pluggable sensing probe, which is attached to the EE360 enclosure by a push-pull plug. If the probe or the probe cable gets damaged it is possible to easily replace the probe without humidity and temperature adjustment. The replacement probe (see 8 Spare Parts and Accessories) is supplied with a set of 7 individual parameters.

PLEASE NOTE

When using two or more devices at the same time, do not mix up the sensors. The serial number of the connected sensor can be read by scanning the barcode on the basic unit.

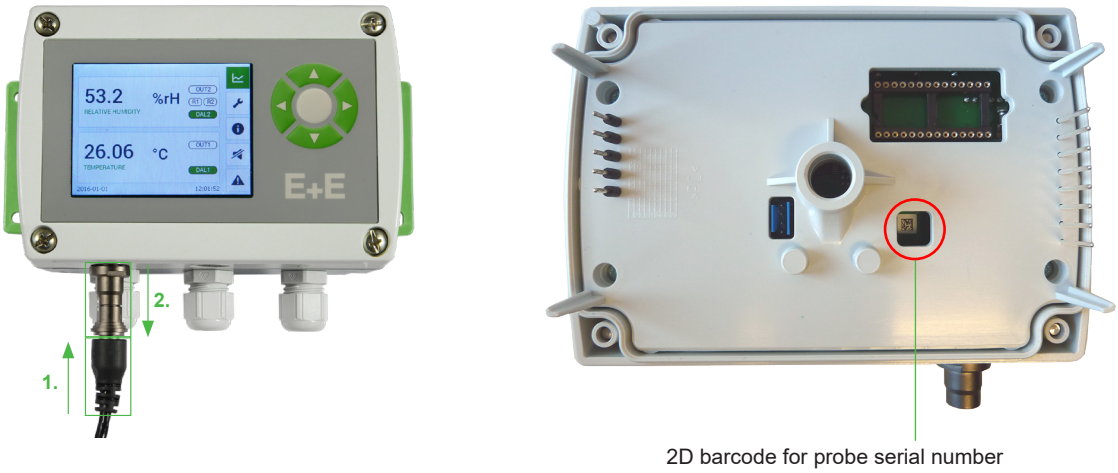


Fig. 18 Pluggable probe

Probe replacement procedure

1. Plug off the damaged probe
2. Plug on the new probe
3. Update the 7 parameters with PCS10 Product Configuration Software or via display and push buttons (see chapter 11 Appendix, Fig. 37 Device settings).

PLEASE NOTE

When replacing the probe, the factory calibration loses its validity. A calibration to verify accuracy is recommended but not mandatory.

6 Setup and Configuration

The EE360 is ready to use and does not require any configuration by the user. The factory setup of EE360 corresponds to the type number ordered. For ordering guide please see datasheet at www.epluse.com/ee360. This chapter describes how to customize the device.

6.1 Configuration Interface

Factory setup can be changed by using a USB-A to micro USB-C cable and the PCS10 Product Configuration Software. The EE360 is powered by the PC via the USB interface, no additional power supply shall be applied.

The scaling of the analogue outputs, the settings of the alarm module, the digital settings can be changed and a T and RH adjustment can be performed.

In addition, it is possible to enable or disable the NAMUR error indication (factory setting: disabled).

The PCS10 offers a convenient graphical user interface for the moisture in oil sensor. To use the software for performing adjustments and changes in settings, please proceed as follows:

1. Download the PCS10 Product Configuration Software from www.epluse.com/pcs10 and install it on the PC.
2. Connect the EE360 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 sensor by pressing the “Sync” button.

Fig. 19 USB serial interface

Fig. 20 Plugged USB cable and LED indication

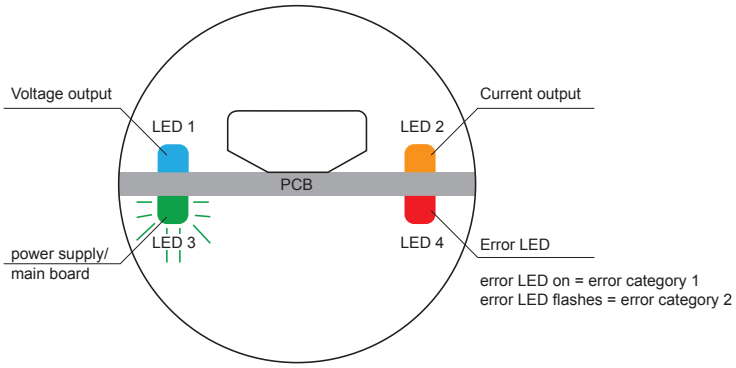


Fig. 21 Status LEDs are located at the USB port

NOTICE

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

6.2 3.5" TFT Colour Display (optional)

The EE360 display includes a data logger and push buttons for full configuration of the device. Upon start-up of an EE360 with display, the data logger and the configuration menu will be initialized during the first 5 seconds.

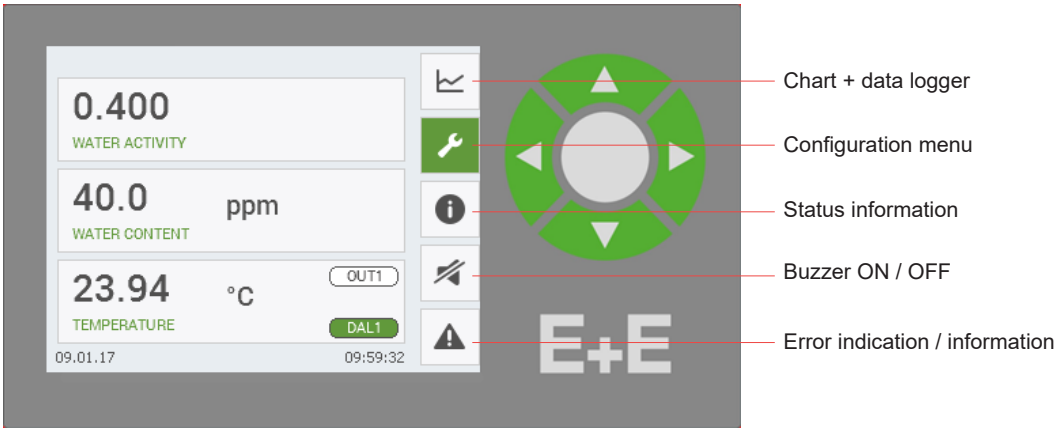


Fig. 22 Display with push buttons

6.3 Chart and Data Logger

The TFT display with the integrated data logging function saves all measured and calculated values to the internal memory. The data logger has a real time clock (UTC time) with a battery back-up.

NOTICE

Changing the UTC time erases all stored data.

The data logger can save 20 000 values for each measurand. The logging interval is user configurable from 1 second to 12 hours. The data logger menu is also used to select the data points that make up the graph and for scaling, please refer to chapter 11 Appendix, Fig. 23 Data logging.

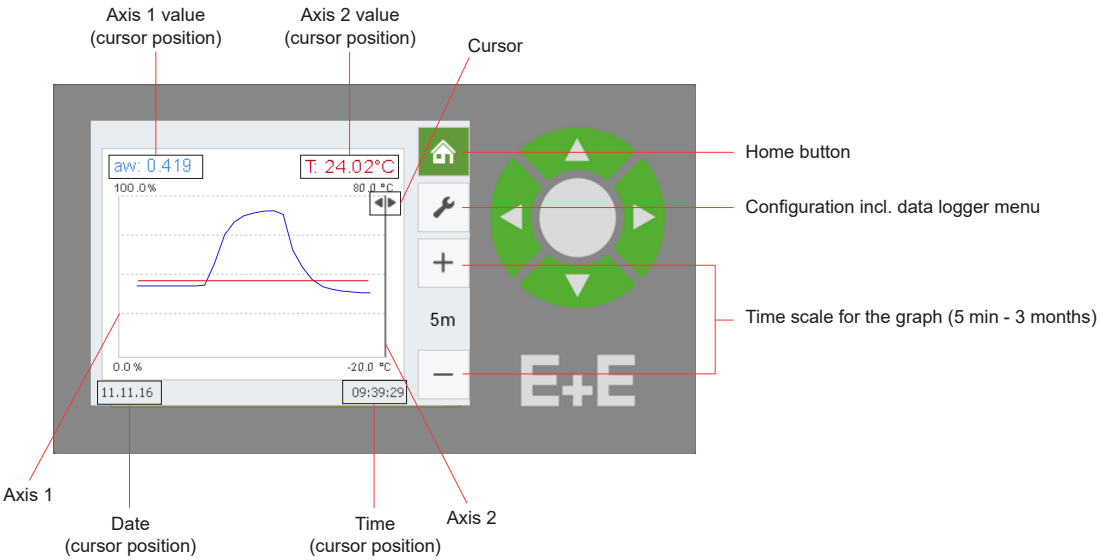


Fig. 23 Data logging

Each point in the graph represents a logged value. The points are connected by a linear interpolation.

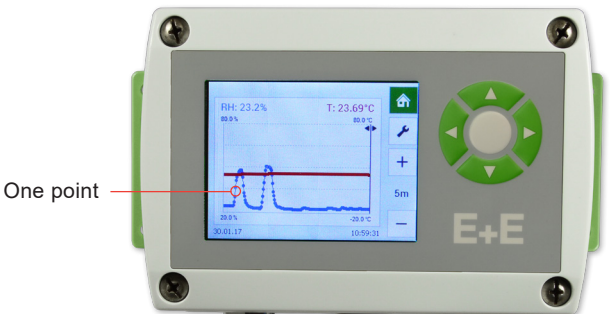


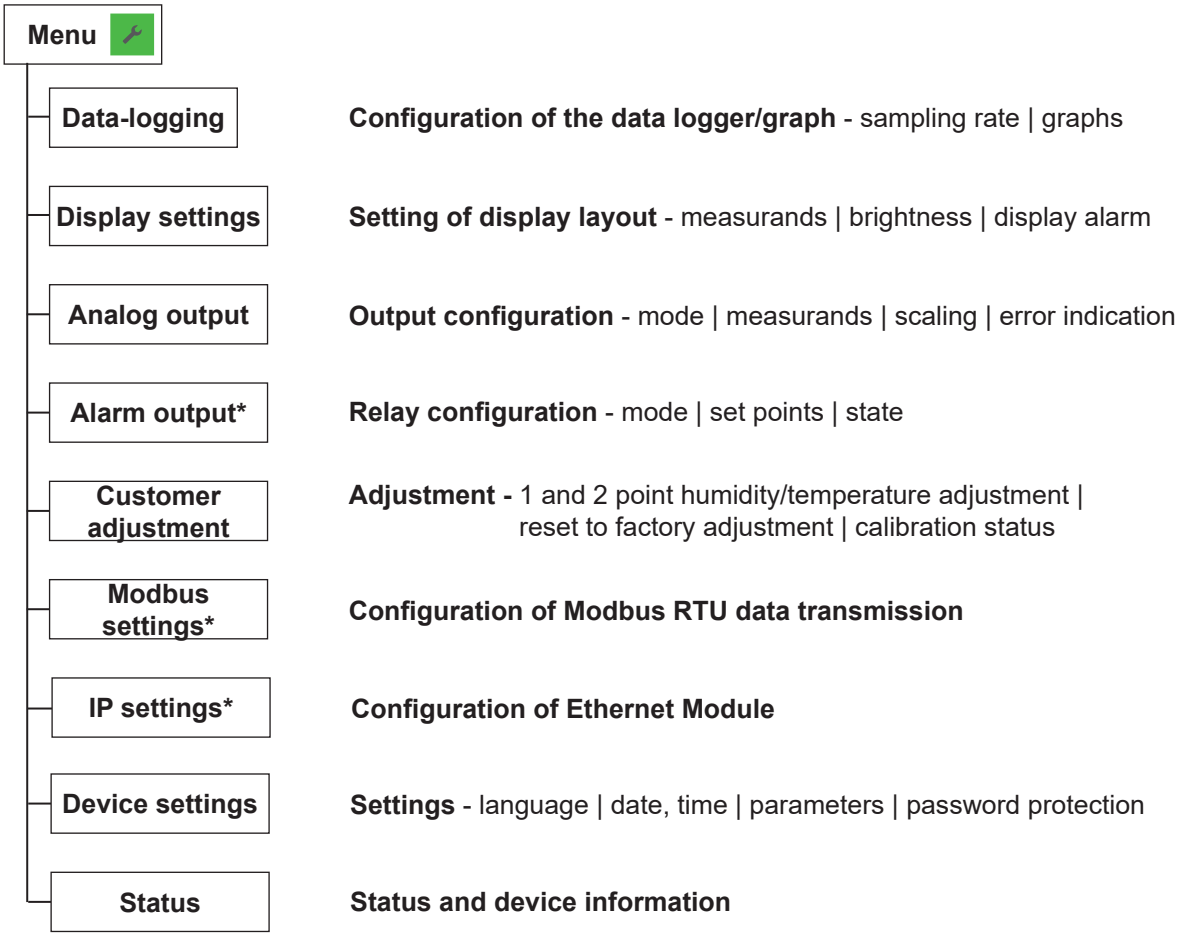
Fig. 24 Logging graph

The data logging continues even when the data memory is full; new data is stored while the oldest data is deleted (first in first out memory). The last 20 000 logged values are available in the internal memory.

The logged data can be downloaded with PCS10 Product Configuration Software as **.csv file** by choosing the measurands and the time period.

6.4 Configuration Menu

Detailed information to the configuration menu (see chapter 11 Appendix).



* Menu only available with the corresponding optional modules.

Fig. 25 Configuration Menu

6.5 Status Information

The status information shows all actual EE360 settings.

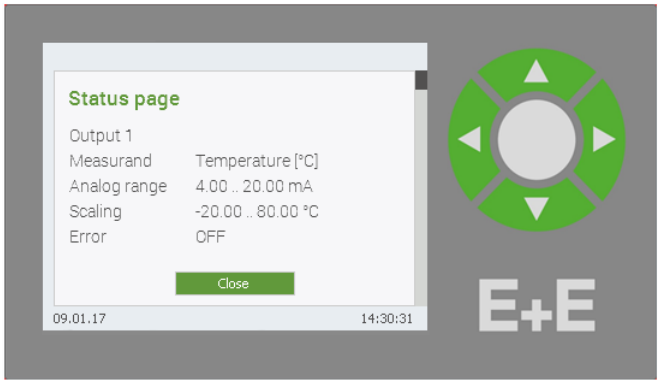


Fig. 26 Status information

6.6 Buzzer ON / OFF

Icon	Function
	Buzzer ON
	Buzzer OFF

Tab. 13 Explanation of the icons

6.7 Error Indication

When an error occurs, the error indication shows the error code.

7 Maintenance and Service

7.1 Self Diagnosis and Error Messages

7.1.1. Error Messages via Display

Error Description	Error Code (Display)	Error Category	Recommended Action
Voltage out short circuit - output 1 only*	1.1	1	Check the wiring of the outputs
Voltage out short circuit - output 2 only*	1.2		
Voltage out short circuit - both outputs*	1.3		
Current loop open - output 1 only	2.1		Check the wiring of the outputs
Current loop open - output 2 only	2.2		
Current loop open - both outputs	2.3		
RH sensor polluted	3.x		Clean the sensor
Hardware error	5.x	2	Return the faulty unit to E+E for service
	6.x		
	8.x		
Temperature measurement failure	7.x		
Humidity measurement failure	9.x		
	10.x		

* not available with 0 - 1 V output

Tab. 14 Overview of error codes

Error Category	Description
1	**Non-critical error**, can be solved by the user. ▪ The display blinks and the buzzer beeps every 10 seconds. ▪ The red status LED lights continuously.
2	**Critical error**, return the device to E+E for service. ▪ The display blinks and the buzzer beeps continuously. ▪ The red status LED flashes.

Tab. 15 Explanation of the error category

7.1.2. Error Messages via LEDs

Four status LEDs placed on both sides of a PCB are located close to the USB service interface, under a blind cover.

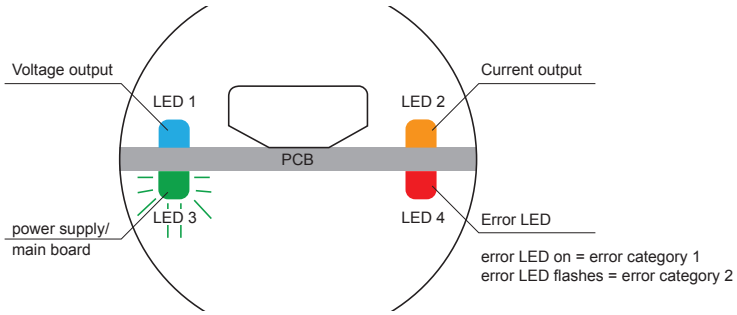


Fig. 27 Status LEDs

LED (Color)	Description
1 (blue)	Analogue output one set to voltage.
2 (orange)	Analogue output one set to current.
3 (flashing green)	Supply voltage applied (microprocessor is active).
4 (red) **permanently lit** **flashes**	Error category 1 Error category 2

Tab. 16 Explanation of the LED colours

7.1.3. Solving Typical Problems

Error description	Likely causes and solutions
Display shows incorrect values	Error during re-adjustment of the sensor. → Reset to factory calibration and repeat the adjustment routine.
	Filter soiled → Replace filter
	Output configured incorrectly → Check configuration
Long response time	Filter soiled → Replace filter
	Inappropriate filter type → Contact E+E representative for advice.
High humidity values - red LED blinks	Water in sensing head → Investigate the cause for water / condensation. Contact E+E representative for advice.
	Inappropriate filter type → Contact E+E representative for advice.

Tab. 17 Self diagnosis

7.2 Sensor Replacement

A damaged capacitive humidity sensing element can be replaced by the user against an E+E replacement sensor (see chapter 8 Spare Parts and Accessories)

Sensor replacement procedure

1. Switch off supply voltage.
2. Loose the lock of the filter cap with an appropriate tool (see Fig. 28 Loosen the lock of the filter cap).
3. Remove the filter cap from the tip of the probe with utmost care not to touch the sensors.
4. Solder off the damaged humidity sensing element.
5. Shorten the leads of the replacement sensor from 10 mm (0.39") to 6 mm (0.24").
6. Solder in the new humidity sensor, the active side shall face the temperature sensor.
7. Screw on a new filter cap with upmost care not to touch the sensors.
8. Bend the filter cap's locking mechanism to the inside.
9. Perform a 2-point humidity adjustment of the EE360 with the PCS10 Product Configuration Software or with the display and push buttons.

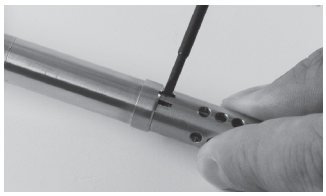


Fig. 28 Loosen the lock of the filter cap

NOTICE

- When replacing the humidity sensor element the factory calibration is not any longer valid.
- The humidity sensor element is an Electro Static Discharge (ESD) sensitive components and shall be handled as such.
- Hold the humidity sensor element only by the leads. Never touch the active surface of the sensor.

PLEASE NOTE

The replacement of the humidity sensor element may be performed by qualified staff only. Since the performance of the instrument after the sensor exchange depends on the overall accuracy of the adjustment procedure, it is strongly recommended to return the device to E+E for sensor replacement.

7.3 Cleaning the Sensing Head and Filter Replacement

If needed, the sensing head can be cleaned. For cleaning instructions please see www.epluse.com/ee360.

7.4 Moisture and Temperature Calibration and Adjustment

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

The EE360 can be calibrated / adjusted with the help of the PCS10. For this purpose, the probe needs to be connected to a PC using a USB-A to micro USB-C cable (refer to chapter 6.1 Configuration Interface).

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.

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.epluse.com.

Calibration and adjustment by the user

PLEASE NOTE

Moisture calibration and adjustment is to be carried out for the measurand “relative humidity” and shall be performed in air.

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

- Humidity Calibrator (e.g. Humor 20), please see www.epluse.com/humor20.
- Handheld Device (e.g. Omniport 40), please see www.epluse.com/omniport40.
- Humidity Calibration Kit (e.g. E+E Humidity Standards), please see www.epluse.com/ee360.

Perform 1 or 2-point adjustment via PCS10 Product Configuration Software or via display (see below).

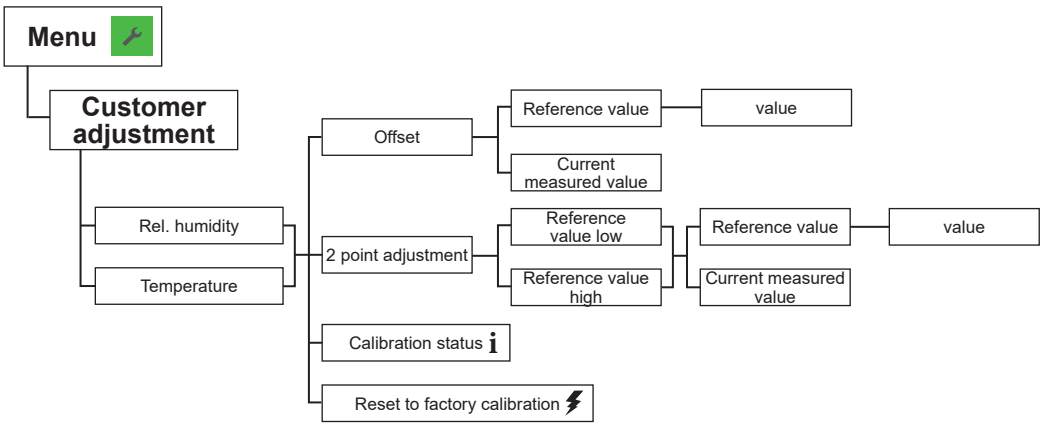


Fig. 29 Adjustment menu

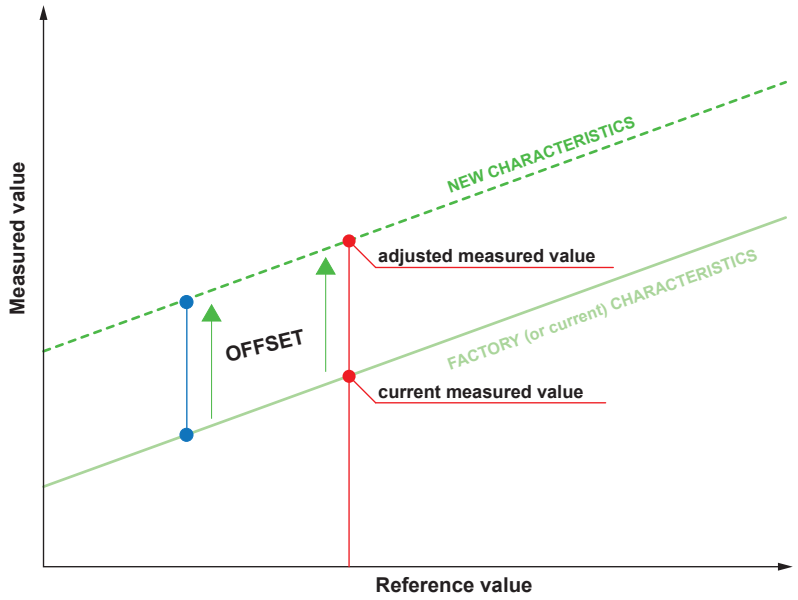


Fig. 30 Offset adjustment

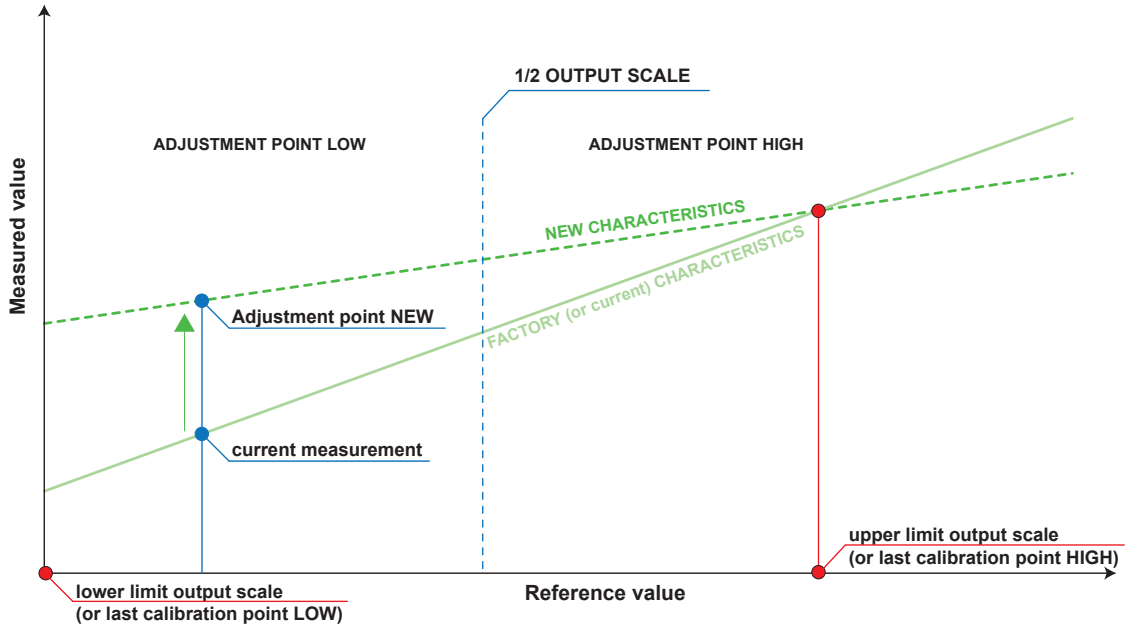


Fig. 31 2-point adjustment procedure

8 Spare Parts and Accessories

For further information please refer to the Accessories datasheet.

Description	Code
PCS10 Product Configuration Software (Free download: www.epluse.com/pcs10)	**PCS10**
Bracket for DIN rail mounting[1)]	**HA010203**
Humidity calibration kit	**See datasheet** Humidity Calibration Kit
Ball valve G 1/2" ISO	**HA050101**
Ball valve 1/2" NPT	**HA050104**
Replacement filter cap, stainless steel, for flow <1 m/s (<3.3 ft/s)	**HA010110**
Replacement probe[2)]	**See chapter 5.7 Pluggable Probe (Option PC4)**
Replacement humidity sensor	**FE09**
RS485 kit for retrofitting	**HA010605**
Ethernet retrofit module for remote probe	**HA010606**

1) For polycarbonate enclosure only. Two pieces are necessary for each EE360.
2) Only for devices with pluggable probe option PC4.

Ordering code for replacement probe

	Feature	Description	Code
Hardware Configuration			**PE360-**
	Probe cable length	2 m (6.6 ft)	**K2**
		5 m (16.4 ft)	**K5**
		10 m (32.8 ft)	**K10**
		20 m (65.6 ft)	**K20**
	Probe length	100 mm (3.94")	**L100**
		200 mm (7.84")	**L200**
		400 mm (15.75")	**L400**
	Process connection	G1/2" ISO - sliding fitting, Ø13 mm (0.51")	**PA23**
		1/2" NPT - sliding fitting, Ø13 mm (0.51")	**PA25**

9 Technical Data

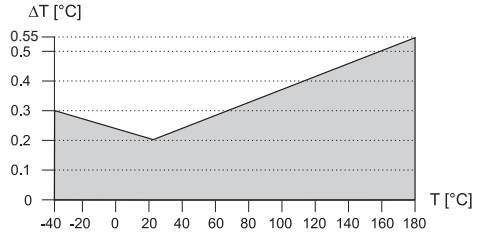
Measurands

Water Activity (aw) / Water Content (x)

Measuring range	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))
Accuracy[1)] **-15...+40 °C (5...+104 °F) (0...0.9 aw)** **-15...+40 °C (5...+104 °F) (0.9...1 aw)** **-25...+70 °C (-13...+158 °F)** **-40...+180 °C (-40...+356 °F)**	 ±(0.013 + 0.3%*mv) aw mv = measured value ±0.023 aw ±(0.014 + 1%*mv) aw ±(0.015 + 1.5%*mv) aw
Temperature dependency of electronics, typ.	±0.0001 aw/°C (±5.6 * 10^{-5} aw/°F)
Response time t_{90}, typ. @ 20 °C (68 °F) in still oil	10 min.

1) Including hysteresis, non-linearity and repeatability, traceable to intern. 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).

Temperature (T)

Probe measuring range	-40...+180 °C (-40...+356 °F)
Accuracy[1)]	
Temperature dependency of electronics, typ.	±0.005 °C/°C (±0.016 °F/°F)

1) 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).

Outputs

Analogue

Two analogue outputs freely selectable and scalable	0 - 1 / 5 / 10 V 4 - 20 mA 3-wire 0 - 20 mA 3-wire	-1 mA < I_L < 1 mA R_L < 500 Ohm R_L < 500 Ohm	I_L = load current R_L= load resistance

Digital

Digital interface		RS485 (EE360 = 1 unit load)
Protocol **Factory settings** **Supported Baud rates** **Measured data types**	**Option J3**	Modbus RTU 9 600 Baud, parity even, 1 stop bit, Modbus address 231 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 76800 FLOAT32 and INT16
Protocol	**Option J4**	Ethernet-PoE Modbus TCP

General

Power supply class III USA & Canada: Class 2 supply necessary, max. voltage 30 V DC	8 - 35 V DC 12 - 30 V AC 100 - 240 V AC, 50/60 Hz with Option AM3[1)]
Current consumption, typ. @ 24 V DC/AC **for 2 voltage outputs** **for 2 current outputs** **additional for display** **additional for Ethernet**	 15 mA and 40 mA_{rms} 35 mA and 100 mA_{rms} 50 mA and 150 mA_{rms} 30 mA and 90 mA_{rms}
Electrical connection	Screw terminals max. 1.5 mm^2 (AWG 16)
Cable glands **for polycarbonate enclosure** **for metal enclosure**	 M16x1.5, for cable Ø3 - 7 mm (0.12 - 0.28") M16x1.5, for cable Ø4.5 - 10 mm (0.18 - 0.39")
Pressure working range with pressure-tight probe	0.01...20 bar (0.15...300 psi)
Temperature range **Operation** **Storage**	 -40...+60 °C (-40...+140 °F) without display -20...+50 °C (-4...+122 °F) with display
Material **Probe** **Enclosure**	Stainless steel 1.4404 (AISI 316L) PC (Polycarbonate), UL94-V0 approved Stainless steel 1.4404 (AISI 316L)
Protection rating	IP65 / NEMA 4X
Electromagnetic compatibility	EN 61326-1 EN 61326-2-3 Industrial environment FCC Part15 Class A ICES-003 Class A
Conformity	CE UKCA
Two alarm outputs, with option AM2[1)]	Changeover contact 250 V AC / 6 A 28 V DC / 6 A
Configuration software	E+E PCS10 Product Configuration Software Free download from www.epluse.com/pcs10

1) Degree of pollution 2, overvoltage category II, altitude up to 3000 m (9843 ft).

10 Conformity

10.1 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/ee360 for the Declarations of Conformity.

10.2 Electromagnetic Compatibility

EMC for industrial environment.
The sensor is a group 1 devices and correspond to class A.

⚠ WARNING

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

10.3 FCC Part 15 Compliance Statement

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

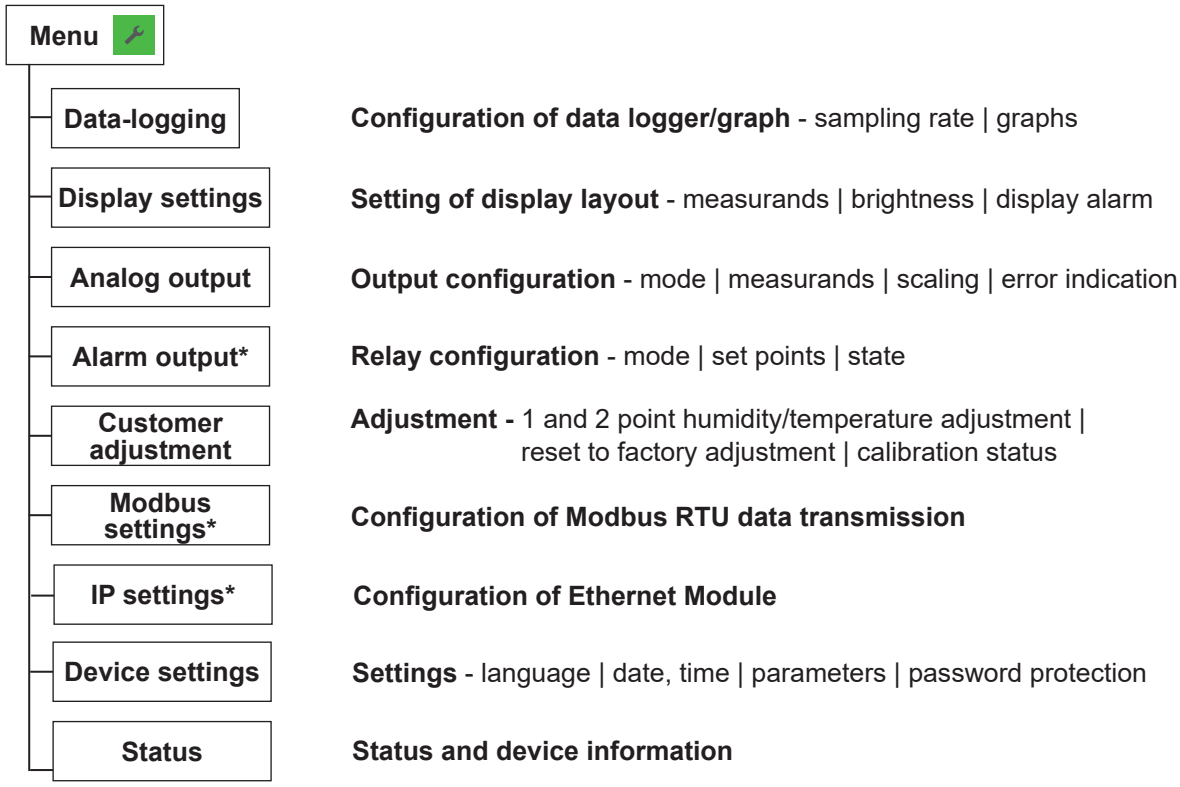
10.4 ICES-003 Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003, Issue 5.

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

11 Appendix

11.1 Overview



* Menu only available with connected modules.

Fig. 32 Menu overview

11.2 Detailed Information

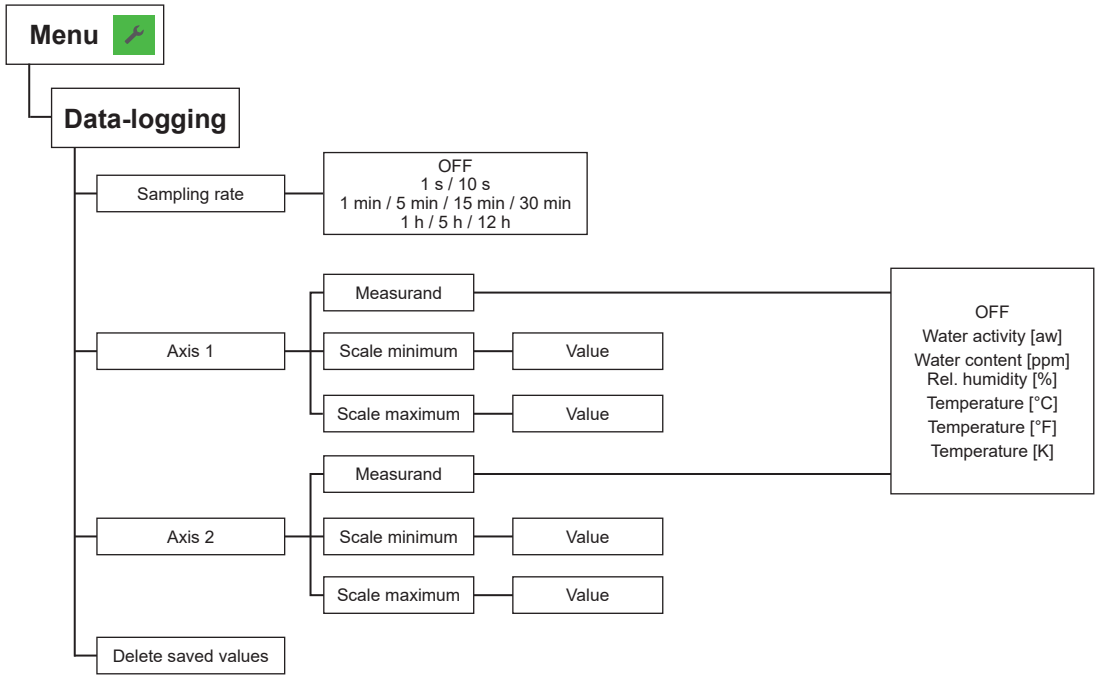


Fig. 33 Data logging

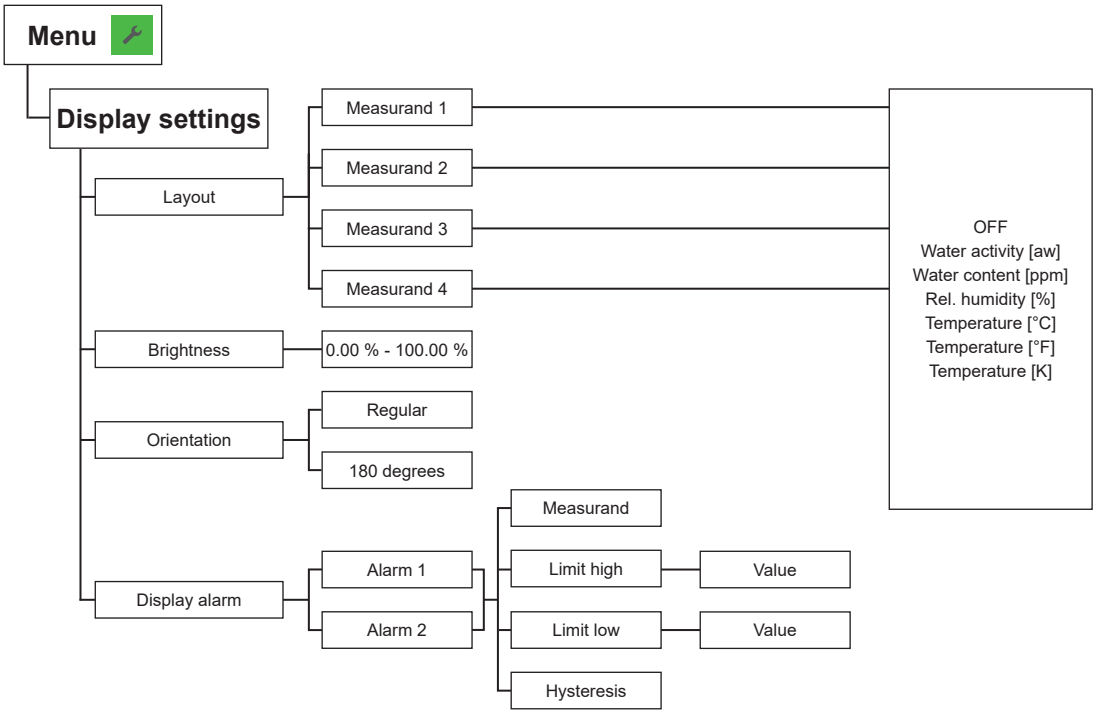


Fig. 34 Display settings

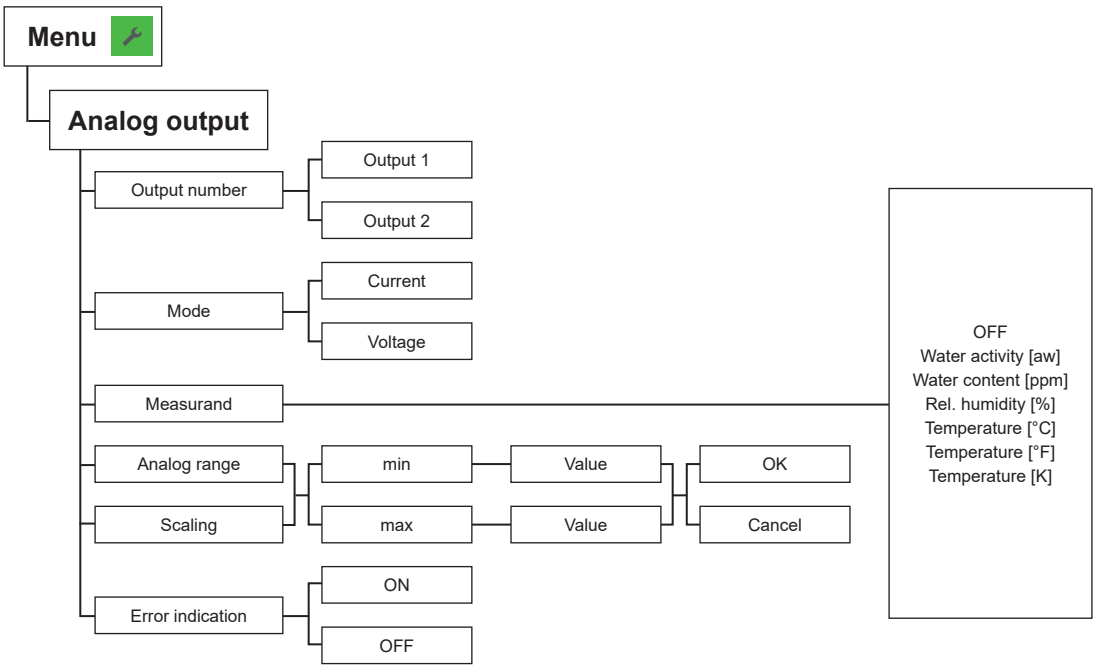


Fig. 35 Analogue output

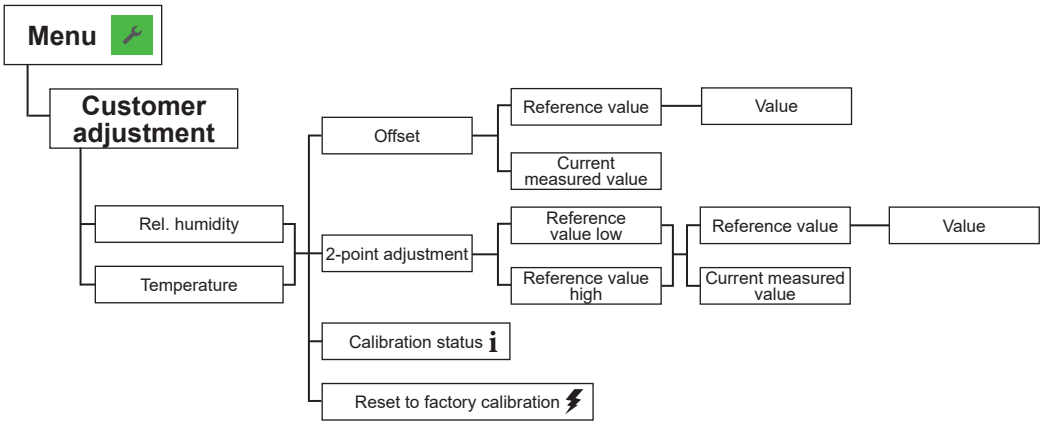
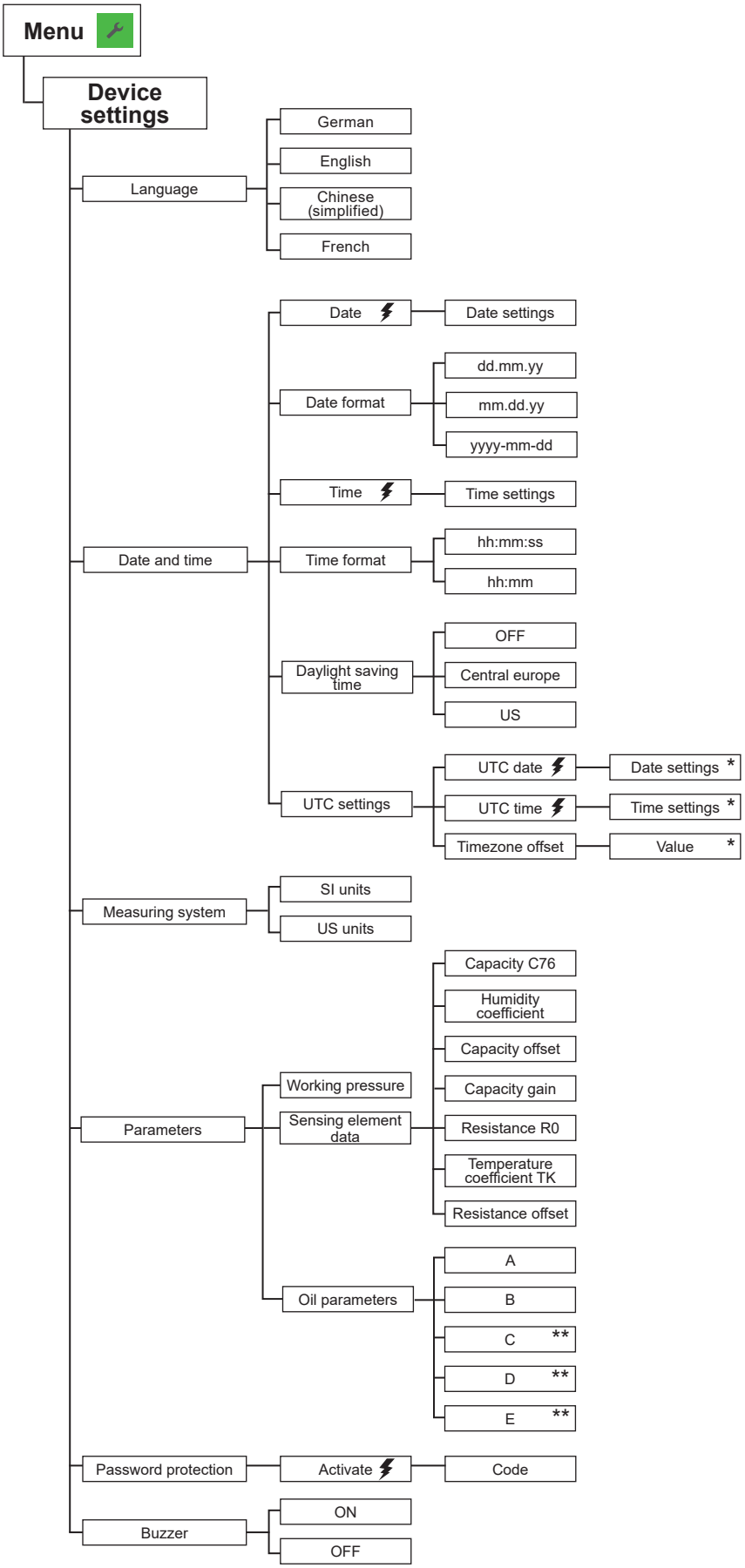


Fig. 36 Customer adjustment



* Changing the UTC time will delete measurment data!
** This oil parameter requires at least device FW (firmware version) V1.0.51 and display FW V1.1.13.

Fig. 37 Device settings

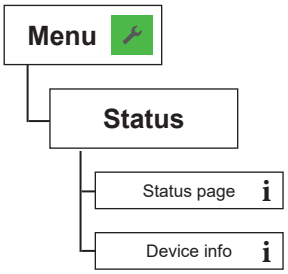
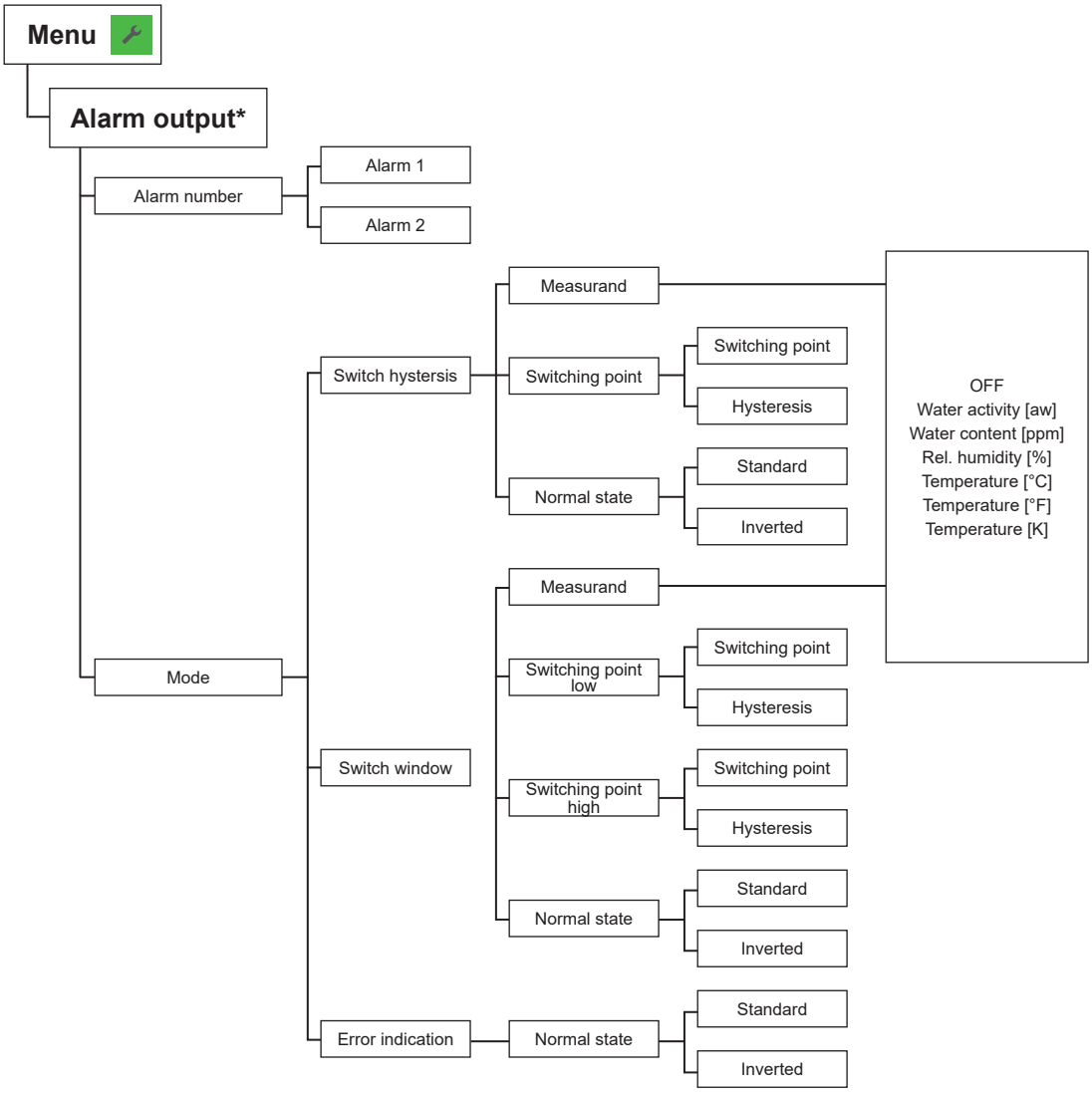


Fig. 38 Device settings

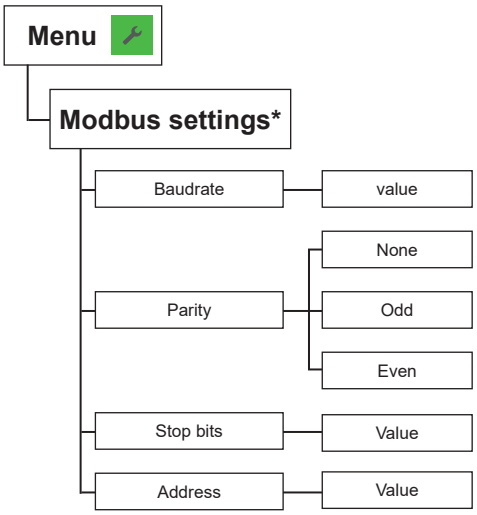
11.3 Optional Menus

Each of these menus is only available if the according module is plugged in during the start up procedure.



* Menu only available with connected alarm module during EE360 start-up

Fig. 39 Alarm output



* Menu only available with connected Modbus RTU module during EE360 start-up.

Fig. 40 Modbus settings

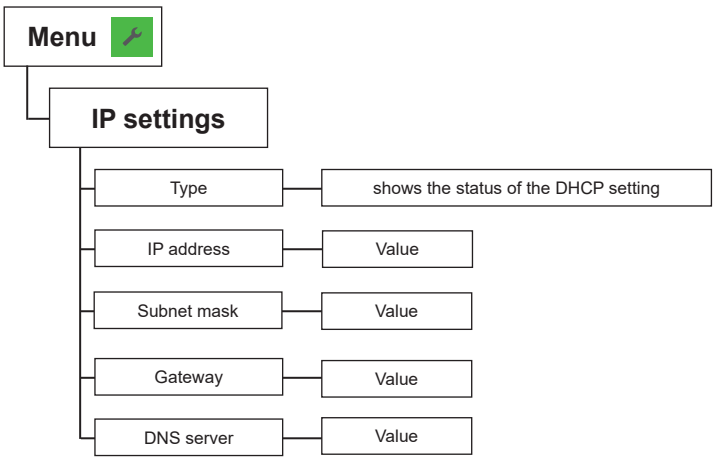


Fig. 41 IP settings

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