

The operating instructions can be found at www.a-eberle.de



Operating instructions

Feeder measurement device

Model: **I-Sense3 / I-Sense4**

- ▶ Fitting
- ▶ Initial commissioning



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1. Notes

1.1 General information

These installation instructions contain all-important information for mounting and commissioning. Read the manual carefully and completely, it contains important information about the product. Observe the notes and follow the safety and warning instructions in particular. Keep the manual carefully and ensure that it is always available and can be viewed by the user of the product.

The company **A. Eberle GmbH & Co. KG** does not accept any liability for damage or loss of any kind resulting from failure to observe the product information or resulting from printing errors or changes in this installation guidelines. The company **A. Eberle GmbH & Co. KG** does not accept any liability for damage or loss of any kind resulting from faulty devices or from devices that have been modified by the user.

1.2 Revisions

Please note that these installation instructions may not always represent the most up-to-date information on the device. If, for example, you have changed the firmware of the device in the direction of a later firmware version, the present installation instructions may no longer be suitable in every point.

In this case, either contact us directly or use the latest version of the installation instructions available on our website (www.a-eberle.de) and the other documents available for the device.

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1.3 Disposal

The disposal of the device is handled by A. Eberle GmbH & Co. KG.

Send all components to A. Eberle:

A. Eberle GmbH & Co. KG
Frankenstraße 160
D-90461 Nuremberg



1.4 Warranty

We guarantee that every product A. Eberle GmbH & Co KG is free from material and manufacturing defects under normal use.

The detailed conditions for the warranty can be found in our general terms and conditions of business under: <https://www.a-eberle.de/en/general-terms/>.

2. Safety

2.1 Safety Instructions


IT IS IMPORTANT FOR PERSONAL SAFETY TO FOLLOW THESE INSTRUCTIONS. THESE INSTRUCTIONS MUST BE KEPT IN A SAFE PLACE!

- Observe operating instructions.
- Always keep the operating instructions with the appliance.
- Ensure that the machine is only operated in perfect condition.
- Ensure that only qualified personnel operate the device.
- Only connect the device according to instructions.
- Ensure that the device is only operated in its original condition.
- Only operate the device with recommended accessories.
- Ensure that the device is not operated above its rated data (see technical data in chapter 3).
- Ensure that the original accessories are not operated above the rated data.
- Do not operate the device in environments where explosive gases, dust or vapours are present.

The installation instructions do not represent a complete list of all safety instructions necessary for the operation of the device. Special operating conditions may require further instructions. The installation instructions contain information that you must observe for your personal safety and to prevent damage to property.





2.2 Structure of the warnings

Warnings are structured as follows:

| | |
|--|---|
|  SIGNAL WORD | <p>Nature and source of the danger! Consequences if not observed.</p> <ul style="list-style-type: none"> ➤ Steps to avoid the danger. |
|--|---|

2.3 Graduation of warnings

Warnings differ according to the type of danger as follows:

| | |
|---|--|
|  DANGER! | Warns of an imminent danger which, if not avoided, will result in death or serious injury. |
|  WARNING! | Warns of a potentially dangerous situation that can result in death or serious injuries when not avoided. |
|  CAUTION! | Warns of a potentially dangerous situation that can result in serious or minor injuries when not avoided. |
| NOTICE! | Warns of a potentially dangerous situation that if not avoided could result in material or environmental damage. |
|  | Refers to processes where there is no risk of injury or damage to property, but which must be observed for reliable operation of the device! |

2.4 Intended use

The I-Sense provides automated non-intrusive measurement of three or four independent AC current channels, with live data available via a Modbus interface. Typically, these currents will be 3-phases (plus Neutral), but the unit could equally measure any 3 or 4 unrelated AC currents.

The I-Sense is suitable for the following installation location and should only be operated in this environment.

- Feeder measurement in low voltage transformer

2.5 Other applicable

For the safe and correct use of the device, please also observe the other documents such as the datasheet as well as the relevant standards and laws.

2.6 Target group

These installation instructions are intended for trained specialist staff as well as trained and tested operating personnel. The contents of these installation instructions must be made available to the persons entrusted with the installation and operation of the system. In order to avoid damage to property and personal injury, the qualified personnel must be trained electro technically and have the following knowledge.

- Knowledge of national accident prevention regulations
- Knowledge of safety engineering standards
- Knowledge of installation, commissioning, and operation

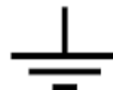
2.7 Cleaning

Use a soft, slightly moistened, and lint-free towel. Make sure that no moisture penetrates the housing. Do not use window cleaners, household cleaners, sprays, solvents, cleaners containing alcohol, ammonia solutions or scouring agents for cleaning. Please use only water for cleaning.

2.8 Meaning of the symbols used on the device



Nature and source of the danger! Read the safety instructions inside the manual!



Functional earth of the measuring device



Power Supply requirements for the device, 24V DC.



No more than 30V to be applied at the connectors.



CE marking guarantees compliance with the European directives and regulations regarding Electromagnetic Compatibility (EMC)



Alternating voltage (AC)



Direct voltage (DC)

3. Specifications

- Measuring Range: Up to 450 A AC
- Accuracy: $\pm 1\%$ of Reading ± 1 A (40-65 Hz)
- Frequency Response: 40 Hz – 3 kHz (-3dB)
- Crest Factor: up to 2.75 @450 A up to 3.00 @300 A
- Position Sensitivity: $\pm 2.5\%$ of reading
Not relevant when used with the cable clamp adaptor.
- Temperature Coefficient: $\pm 0.15\%$ of reading / °C
- External Field: $\pm 0.25\%$ of range
(cable >100 mm from the head)
- Power Supply Interface: +24 V ($\pm 10\%$) DC via RJ45 Input
- Current Consumption: 15 mA typical (20 mA max) per unit

▶ Enclosure

- Material: ABS
- Dimensions: 92 (l) x 66 (w) x 28 (d) mm

▶ Probes

- Probe Conductor Diameter: 70 mm (3 inches), double insulated
- Probe Cable Diameter: 6 mm (0.24 inches)
- Degree of Protection: IP67 Probe, IP30 Enclosure

▶ General Characteristics

- Operating Temp. -20°C to +65°C
- Storage Temp. -40°C to +75°C
- Operating Humidity 15% to 85% (non-condensing)

▶ EMC Standards

- IEC 61000-6-4
- EN 55011
- IEC 61000-6-5 Power Station Level 3 / Substation Level 2
- EN 61326-1

▶ Safety Standards

- IEC 61010-1
- IEC 62262 IK07

1000 VRMS, Category III, 600 VRMS, Category IV, Pollution Degree 2 (Probe)

Output limited to 30 V to Earth (Unterminated)

Use of the probe on **uninsulated conductors** is limited to 1000 V AC RMS or DC and frequencies below 1 kHz.

- RoHS and WEEE compliant
- Rated for continuous use

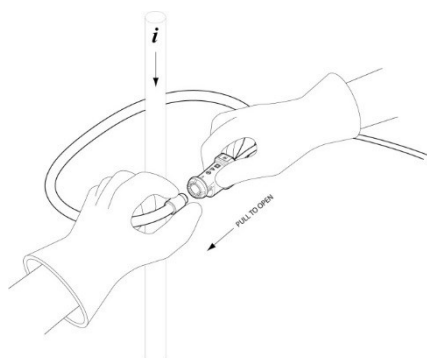
4. Commissioning

4.1 Installation

DANGER! Danger to life due to electric shock!

Incorrect connection of this measuring instrument can lead to death, serious injury or fire hazard!

- ➔ Before starting work, check that no voltage is present!
- ➔ Provide protective equipment for CAT II, CAT III, or CAT IV.
- ➔ The flexible current probes are not for use on conductors with a potential of over 1000V. Proof the voltage level!
- ➔ The only permitted cable-mounting for the body of the unit is on the outer insulation of a 4-phase or 5 phase cable. It must not be mounted on any of the internal phase cables.



Wrap each flexible probe around the conductor to be measured. Close the coupling. Locate the coupling away from nearby conductors. Position the cable clamp adaptor up against the conductor and secure with the cable-tie. Fit the attached locking clip.

WARNING! Personal injury and damage to property due to non-observance of the safety regulations

- ➔ The body of the unit has a maximum rating of 30V. It must be kept at least 25mm from any uninsulated conductor or busbar.

NOTICE!

Material damage due to non-observance of the installation instructions!

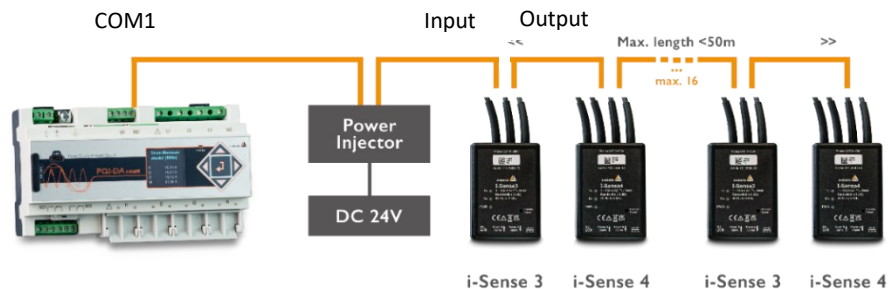
Non-observance of the installation instructions or incorrect installation can damage the device!

- ➔ Do not connect the I-Sense directly to any computer network, only to other I-Sense units and to a suitable approved Modbus Master. The I-Sense uses the same connectors and cables as Ethernet. However, the signal types and levels are very different. Connecting I-Sense to a computer network may result in damage to the unit, the network, or both.
- ➔ All RJ45 (data) cables and connectors must be kept at least 25mm from any uninsulated conductor or busbar at all times.

5. Quick Installation I-Sense with PQI-DA smart & PQI-DE

5.1 Hardware

The devices PQI-DA smart and PQI-DE are able to record the data of the I-Sense devices over Modbus RTU to provide the data to the evaluation software! Therefore a Modbus master / RS 485 at the Com Interface 1 is available. The I-Sense devices have to be connected to the Modbus master in a daisy chain by means of the article *Power Injector I-Sense PQI-DA smart / PQI-DE (Art. No.) 111.7080.15.3* via RJ45 cable – like shown inside the figure below. The left RJ45 socket is the input of the chain on the I-Sense device, the right RJ45 socket is the output. The supply voltage (24V) is also provided for the devices via the RJ45 cables. For this purpose, the PowerInjector 111.7080.15.3 has two open ends, which can provide the required power for up to 16 x I-Sense devices either with the help of the *power supply unit 111.7080.15.2* or another sufficiently dimensioned supply source.



NOTICE! Malfunction due to undersized power supply unit or wrong cables

Non-observance of the technical data

- Always calculate the correct dimension of the power supply
- All RJ45 cables must be at least AWG23
- All RJ45 cables together should not be longer than 50m

5.2 Software



The Modbus master recording function is licensed via feature **P3**, which can be acquired additionally for PQI-DA smart and PQI-DE devices starting with firmware v2.14

The settings inside PQI-DA smart and PQI-DE are described in chapter “Parameterization of the I-Sense - A. Eberle feeder measurement” inside the manual “PQI-DA smart / PQI-DE”

Generally, the following settings must be set up at the devices

- Controlling of Modbus RTU Settings
- Activation of Modbus RTU
- Activation and designation of the feeders

6. General device Functions

6.1 LEDs

I-Sense has three LEDs visible on the top of the case:

▶ **PWR (Green)**

This LED will glow steadily when the unit has power and is operating normally. If it does not light up, check the power supply and cables.

During a Factory Reset this LED flashes for a few seconds to confirm reset then returns to a steady glow.

▶ **Rx (Green)**

This LED will be lit for 0.5 s after the unit has received any data from the Modbus Master, regardless of the target device.

If the Rx light is not lighting up while other devices on the same Modbus line are reacting, this may be an indication of defective wiring or incorrect Modbus Interface Configuration settings.

▶ **Tx (Yellow)**

This LED will be lit for 0.5 s after the unit has transmitted a response to the Modbus Master.

If the Tx light is not lighting up while the Modbus Master is sending data to it, this strongly indicates an incorrect Modbus address has been set, assuming the Rx LED comes on when the Master is transmitting.

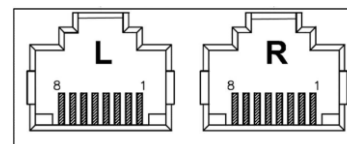
6.2 Reset Button

This button is recessed in the case to avoid accidental activation and resets the Modbus Configuration Settings (chapter 7.4.2).

Press and hold the button for approximately 10s to reset the device to factory defaults. The Green (PWR) LED will flash for a few seconds to indicate the device has been reset.

6.3 RJ45 connectors

Each I-Sense has 2 RJ45 connectors for power, addressing and connecting to a Modbus Master.



RJ45 Connectors

| Pin | Description |
|-----|-------------|
| 1 | A1 |
| 2 | A2 |
| 3 | A3 |
| 4 | Modbus B |
| 5 | Modbus A |
| 6 | A4 |
| 7 | +24 V DC |
| 8 | Common |

Terminal Connector Layout

Multiple units (up to 16) can be daisy-chained, sharing power and Modbus connections, by connecting the output RJ45 socket (right) of one unit to the input RJ45 socket (left) of the next unit.

The final unit in the daisy-chain will have no connection to the right (output) RJ45 socket. This empty socket should be fitted with the supplied protective blanking plug.

7. Modbus Interface

A Modbus Master communicates with I-Sense units.

The unit supports a subset of the Modbus Application Protocol Specification, v1.1b3, i.e.

| | Section | Title |
|----------|---------|------------------------------------|
| Reading: | 6.3 | 03 (0x03) Read Holding Registers |
| Writing: | 6.12 | 16 (0x10) Write Multiple Registers |

The Modbus Address Code can also be set using the internal DIP switch on the PCB (see section 7.3.1).

Whenever the Modbus Address is changed by any means (including re-ordering the daisy-chain), the new address and any other Modbus setting changes (e.g. Baud rate, Parity) will only take effect after the power to the unit is cycled.

7.1 MODBUS Connection Paramters

Modbus addresses must lie in the range 1..247.

Slave address, baud rate and parity settings for each device are User-configurable via the Configuration registers (see 7.3) and take effect when the device is power cycled. The Modbus interface uses 8 data bits and 1 stop bit. The parity may be set to Even, Odd or None.

7.2 MODBUS Termination

The Modbus should be terminated at both ends with a 120Ω resistor. For the last unit in the daisy-chain, an internal termination resistor may be connected by setting the 'TERM' switch on the PCB (see section 7.3.1).

7.3 MODBUS Addressing

The Modbus Address of each unit must be unique from other devices connected to the Modbus Master on the same bus. The default address is set automatically to 1 to 16 based on the position in the daisy chain. If this default address is not suitable for any given unit in an installation, it may be changed by setting the 8-bit Modbus Address Code value as follows:

| Modbus Address Code | Modbus Address |
|---------------------|--|
| 0 (default) | Determined by unit position (1 to 16) |
| 1 | Determined by unit Serial Number (see below) |
| 2 to 247 | Address = Modbus Address Code |
| >247 | Determined by unit position (1 to 16) |

7.3.1 Internal switch settings

In rare circumstances, it may be necessary to open the unit, prior to installation, to adjust some configuration switch settings, either to connect an internal termination resistor or to physically set a non-default Modbus Address (this can also be done electronically using the Modbus Address Code register – see section 7.4.2)

To adjust the internal DIP configuration switch:

- If the unit has already been installed for current monitoring, completely disconnect the unit from all conductors and equipment and remove it to a safe place before opening the case.
- Remove the cable ties from the underside of the body and remove the 4 screws using a Philips No.2 screwdriver.
- Locate the 8-way DIP switch as shown in Figure.



- If the yellow film is still in place over the switch, carefully remove it.
- To connect the 120Ω Modbus termination resistor, set the switch labelled TERM to the **ON** position.

- To set the **Modbus Address Code** in the range 0-127, set the 7 switches labelled with MODBUS ADDRESS 6..0 (on the green PCB background) to **ON** for binary 1, or **OFF** for binary 0. The Picture below shows the termination resistor connected and Modbus Address Code set to 0101011 binary (43 decimal). This would set the Modbus address to 43.



- Before refitting the lid, check that the 3 vertical LED stands are straight and that the LEDs align with the holes in the case lid. Ensure that the long plastic stem of the push-button switch is aligned with the hole in the case lid and does not become trapped under the lid during reassembly.
- Refit the case screws through the cable tie mounts. Do not over-tighten the screws. Replace the cable ties.

7.4 Modbus Registers

I-Sense has three banks of Modbus holding registers to allow access to:

- ▶ Recent readings
- ▶ Averaging Interval and Modbus configuration settings
- ▶ Product Information

7.4.1 Current readings

Readings from the Current sensors are accessible through the following holding registers:

| Address | Phase | 16-bit words | Data Type |
|------------------|-----------|--------------|--------------|
| Immediate | | | |
| 0x0000 | L1 | 2 | float32 (RO) |
| 0x0002 | L2 | | |
| 0x0004 | L3 | | |
| 0x0006 | N | | |
| Minimum | | | |
| 0x0008 | L1 | 2 | float32 (RO) |
| 0x000A | L2 | | |
| 0x000C | L3 | | |
| 0x000E | N | | |
| Maximum | | | |
| 0x0010 | L1 | 2 | float32 (RO) |
| 0x0012 | L2 | | |
| 0x0014 | L3 | | |
| 0x0016 | N | | |
| Average | | | |
| 0x0018 | L1 | 2 | float32 (RO) |
| 0x001A | L2 | | |
| 0x001C | L3 | | |
| 0x001E | N | | |

Current is reported as an unsigned RMS quantity in Amps, with a resolution of 0.5A. This is reported in the IEEE754 single precision floating point format as Float32. RMS currents are averaged (and the Minimum and Maximum monitored) over a given period, defined by the averaging interval in register 0x0100. The 3-phase unit (I-Sense3) will report “NaN” (Not a Number) in every 4th current register, which is reserved for the neutral current N.

If the readings are taken before the first averaging interval has elapsed, or if a current overload occurs the affected registers will report a “NaN” (Not a Number) to indicate that valid readings are not yet available.

7.4.2 Configuration Registers

The following registers allow the change of averaging Intervals for the sensor readings and the Modbus Interface configurations to be modified. The Bold marked parameters are the default values.

| Address | Content | 16-bit words | Data Type | Notes | | | | | | | | | | | | | | | | | | | | |
|--|----------------------------|--------------|-------------|--|-------|--------|---|------|---|------|----------|-------------|---|-------|----------|--------------|---|--------|---|-------|---|-------|---|--------|
| Sensor Settings <i>(Effective immediately)</i> | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0100 | Averaging Interval | 1 | uint16 | Supported intervals, in seconds: 1, 2, 5, 10, 30, 60 120, 300, 600, 900, 1800, 3600. | | | | | | | | | | | | | | | | | | | | |
| 0x0101 | Unit Position | 1 | uint16 (RO) | Unit position, 1 to 16 in the daisy-chain | | | | | | | | | | | | | | | | | | | | |
| 0x0102 | Uptime | 2 | uint32 (RO) | Time in milliseconds since the unit booted. (NB. will wrap-around after approx. 7 weeks). | | | | | | | | | | | | | | | | | | | | |
| Modbus Interface Configuration <i>(Effective after power cycling the device)</i> | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1000 | Modbus Address Code | 1 | uint16 | see section 7.3 default is 0. | | | | | | | | | | | | | | | | | | | | |
| 0x1001 | Baud Rate | 1 | uint16 | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Value</th> <th>Baud</th> </tr> </thead> <tbody> <tr><td>0</td><td>1200</td></tr> <tr><td>1</td><td>2400</td></tr> <tr><td>2</td><td>4800</td></tr> <tr><td>3</td><td>9600,</td></tr> <tr><td>4</td><td>19200</td></tr> <tr><td>5</td><td>38400,</td></tr> <tr><td>6</td><td>57600</td></tr> <tr><td>7</td><td>76800</td></tr> <tr><td>8</td><td>115200</td></tr> </tbody> </table> | Value | Baud | 0 | 1200 | 1 | 2400 | 2 | 4800 | 3 | 9600, | 4 | 19200 | 5 | 38400, | 6 | 57600 | 7 | 76800 | 8 | 115200 |
| Value | Baud | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1200 | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2400 | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 4800 | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 9600, | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 19200 | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 38400, | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 57600 | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 76800 | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 115200 | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1002 | Parity | 1 | uint16 | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Value</th> <th>Parity</th> </tr> </thead> <tbody> <tr><td>0</td><td>None</td></tr> <tr><td>1</td><td>Odd</td></tr> <tr><td>2</td><td>Even</td></tr> </tbody> </table> | Value | Parity | 0 | None | 1 | Odd | 2 | Even | | | | | | | | | | | | |
| Value | Parity | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | None | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Odd | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Even | | | | | | | | | | | | | | | | | | | | | | | |

7.4.3 Product Information Registers

The following read-only holding registers provide product-specific identification information about the sensors:

| Address | Content | 16-bit words | Data Type | Notes |
|---------|-------------------|--------------|-------------|---------------------------------|
| 0x1005 | Part Number | 5 | char (RO) | Eg. P-22.490.0 |
| 0x100A | Serial Number | 6 | char (RO) | Serial Number (12 characters) |
| 0x1010 | Firmware Revision | 1 | uint16 (RO) | MSByte: Major LSByte: Minor |
| 0x1011 | Sensor Count | 1 | uint16 (RO) | Number of sensor heads (3 or 4) |
| 0x1014 | Item Number | 6 | char (RO) | Eg. 111.7080.14 |

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