



Manual

econ sens3

3-Phase Multifunctional Measuring Instrument

with

Logging Function

Version 3.0

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1 General Information

1.1 About this manual

This manual describes the econ sens3 Multifunctional Measuring Instrument. It represents a part of the product and is intended for:

- Planners
- Operators
- Start-up engineers
- Service and maintenance personnel.

This manual should be read before using the product and should be kept available for reference for the entire life of the product.

For questions and/or technical support relating to the product, please contact:

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1.2 Required basic knowledge

Only qualified personnel should handle the product/system described in this documentation, taking into account the documentation relating to the respective activity, particularly the warnings and safety instructions contained therein.

Qualified personnel are persons who, based on their training and experience, are able to recognize the risks and avoid the potential hazards involved in the handling of these products/systems and who are familiar with the safety regulations and standards applicable to the assembly and connection of the products/systems.

1.3 Warnings

This handbook contains warnings that must be heeded to ensure the personal safety of the user and to avoid property damage. Warnings regarding personal safety feature a warning triangle (general warning symbol). Information concerning property damage only does not feature a warning triangle. Depending on the hazard level, the warnings are shown in descending order as follows:

 **Danger !**

Means that serious bodily harm or even death **will** occur if the relevant safety measures are not taken.

 **Warning !**

Means that serious bodily harm or even death **can** occur if the relevant safety measures are not taken.

 **Caution !**

With a warning triangle means that minor bodily harm **can** occur if the relevant safety measures are not taken.

Caution !

Without a warning triangle means that property damage **can** occur if the relevant safety measures are not taken.

Attention !

Without a warning triangle means that an adverse event can occur if the relevant safety measures are not taken.

If multiple hazard levels apply, the highest level warning will always be used. If a warning about personal injury is indicated in a warning sign with a warning triangle, a property damage warning can be included in the same warning sign.

1.4 Safety symbols on the instrument

The documentation should always be consulted if the general warning symbol is shown, as well as the warning symbol for the danger of electric shock.

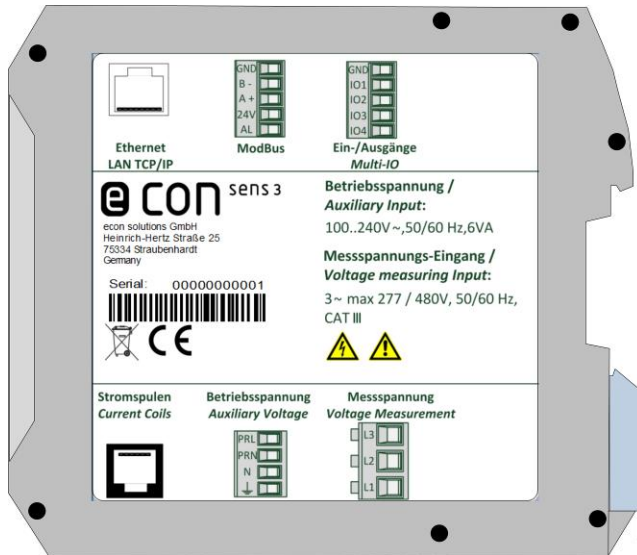


Figure 1: Safety symbols on the instrument

1.5 Explanation of symbols

Table 1 shows the safety symbols used on the instrument.

Symbole		
Nr.	Symbol	Bedeutung
1		allgemeines Warnzeichen
2		Warnung, Möglichkeit eines elektrischen Schlages
3		3-Phasen-Wechselstrom
4		Wechselstrom
5		Anschluss für Erde (Funktionserde)

Table 1: Explanation of symbols

1.6 Intended use of the product

Warning !

The econ sens3 3-phases multifunctional measuring instrument is intended exclusively for recording of electrical values such as voltage, current, output, energy, etc. in building installations and distributing systems. The measured and recorded data can be transmitted over internal interfaces to higher-level systems (e.g. monitoring systems).

It is intended for installation in stationary, weather-proof interior spaces.

The admissible operating conditions named in this documentation must be met and the instructions must be followed. Operation of the instrument outside of its specification or its intended use can compromise the protection supported by the instrument.

Voltage measurement inputs are designed for measurement in low-voltage networks in which rated voltages up to 300V conductor to earth and surge voltages of overvoltage category III can occur.

Current must be measured exclusively with the current sensors included in the scope of delivery by econ solutions GmbH (Rogowski coils, referred to in this document as „econ coils“).

1.7 Disposal instructions

The econ sens3 energy consumption meter contains a small integrated lithium battery. Used batteries should never be disposed of in household trash but should be delivered instead to a collection point for used batteries.

Disposal must be carried out in compliance with national and local regulations in the normal process for reusable material.

1.8 Warranty conditions

econ solutions GmbH assumes no liability or warranty whatsoever for consequences resulting from improper use, particularly in case of failure to follow the instructions for use and installation. The user is responsible for ensuring that the instrument is not operated outside of the specified technical parameters.

Any unauthorized change or modification of the instrument, as well as unauthorized repairs, represent “misuse” and/or “negligence” in the context of the warranty for the product and consequently excludes the warranty for coverage of potential consequential damage. The right to claim under guarantee will also be invalidated.

1.9 Disclaimer

The content of this document was compiled with great care and checked for consistency with the product in hardware and software. Nevertheless, discrepancies cannot be ruled out. Therefore, no obligation or warranty of any kind exists with regard to the information contained in this handbook. Consequently, the authors, companies, and publisher assume no resulting or other liability occurring in any manner from the use of this information or parts of it, including the infringement of patent rights and other rights of third parties that could result from such use.

1.10 Registration

Register your econ sens3 at www.econ-sens.com and receive the latest firmware updates automatically by email.

To upload firmware updates, see the *Update* submenu in Chapter 8.10.

2 Description of the instrument

econ sens3 is a compact, versatile energy consumption meter with web interface and memory function.

It measures voltage, current, and active and apparent power of the individual phase, as well as the voltage between PE and the neutral conductor.

In the calculation of output, econ sens3 can differentiate between generated and consumed power. Energy consumption values calculated from the output data are displayed for the user over the web interface.

For forwarding of measurement data to potentially connected energy monitoring systems or similar systems, the following alternative interfaces are available:

- 4 multiple IO ports that can optionally be configured as:
 - Open collector output
 - Digital pulse output
 - 4 to 20mA output
 - 4 to 20mA input
 - 0 to 10/30V input
 - Input for potential free contact
- Modbus TCP
- Modbus RTU (RS-485)

With the econ sens3 the active, reactive, and apparent power, the current, and the voltage for each phase, as well as other measurements, can be recorded via the Modbus interface (see the *Modbus* submenu in Chapter 8.10).

From each input signal (voltages and currents), 1,024 discrete measurements are recorded over the duration of 5 periods and subsequently evaluated.

At the same time, input voltages are sampled with 160 kHz. This sampling is used to record the wave form. These wave forms are stored for various event records.

The econ sens3 has a 4-GB memory for storing measured values and events. The second measured values are stored for the last 7 days; the minute measured values, for the last 39 days; the interval values (10 or 15 minutes), for the last 13 months; and the daily values, for the last 10 years. For correct documentation, the date and time must be set. The mean, the min values, and the max values are saved after each interval. The interval is expressed in seconds and can be 600s (10 min), 900s (15 min), or 1200s (20 min).

2.1 Special features

- For 1, 3, and 4-wire systems with any load
- Modbus TCP
- 4 independent multiple IO ports
- Modbus RTU (RS-485)
- Current value recording of U,I,P,Q, and power factor per phase, as well as average and total values
- Event and curve recording (PRO Version)
- Current measuring range up to 400 or 3000 A / phase (depending on coil set)
- No additional transformer required
- Integrated web interface for easy and quick data collection and for configuration
- Fast installation, even during operation*



***Warning !**

For acquisition of amperage, the consumer to be measured does not necessarily have to be shut down, as the Rogowski coils can be opened and placed around an insulated conductor.

Before connecting the voltage path, ensure that the system was disconnected from the power supply. Applicable safety regulations for working with electrical systems must be obeyed.

3 Scope of delivery and receiving inspection

Scope of delivery for base unit:

Scope of delivery for base unit		
Quantity	Art No.	Description
1	241756	econ sens3 Multifunctional Measurement Instrument (hat-rail module)
1	238281	econ sens3 Connector Kit (consisting of 4 pluggable screw terminals)

Accessories available for delivery		
	Art No.	Description
	235017	econ Coil (Rogowski coil set for current measurement), length 200mm, measuring range 3 to 400A
	235018	econ Coil (Rogowski coil set for current measurement), length 400mm, measuring range 3 to 3000A
	238281	econ sens3 Connector Kit (consisting of 4 pluggable screw terminals)
	236341	econ Standard Power Supply 24V DC for alternative supply of the instrument over protective extra-low voltage
	238975	econ sens3 V-KIT, Safety Test Lead Set for connection to the voltage path via magnetic probes (for mobile and temporary measurements)

Table 2: Scope of delivery and accessories

Receiving inspection:

The trouble-free and safe operation of this instrument requires proper transport and appropriate storage, installation, and assembly, as well as careful operation and maintenance, if needed. If it can be assumed that a safe operation of the instrument is no longer possible, the instrument should be taken out of operation immediately and secured against unintentional start-up. Unpacking and packing should be performed with the usual care without the use of force and only with appropriate tools.

Before installation, visually inspect the instrument for the following:

- Damage to the packaging
- Completeness of the package contents
- Visible outer damage to the instrument.

Please contact your econ sales partner if one or more of the above conditions are present.

 **Warning!**

Damaged instruments must not be installed or taken into operation. The result can be serious bodily harm, including death, or property damage.

It should be assumed that a safe operation is no longer possible if, for example, the instrument also

- No longer works in spite of an intact power supply
- Was exposed for an extended period to unfavorable conditions (e.g. storage outside the permissible climate limits without adjustment to the indoor climate, condensation, or similar conditions) or to transport stresses (e.g. drop from a greater height even without visible outer damage, or the like).

Attention!

Avoid condensation.

Sudden temperature changes can cause condensation, which can impair the function of the instrument. Store the instrument for at least 2 hours at the point of installation before beginning with the assembly.

4 Assembly

4.1 Tools

Flat head screwdriver

4.2 Point of installation

The econ sens3 Multifunctional Measuring Instrument is intended for stationary installation in building installations and in distributing systems in enclosed areas.

Warning!

Operate the instrument only in a safe location. Failure to comply with this rule can result in serious bodily harm, including death, or property damage.

The installer of the instrument is responsible for ensuring that the point of installation is selected in such a way that only qualified personnel have access.

4.3 Installation position

The econ sens3 energy consumption meter was designed for installation on a top-hat rail (TS35). To do this, slide the instrument onto the top-hat rail with the upper retaining collar, move the metal base bar downwards against the spring force with the flat head screwdriver, and bring the instrument into a horizontal position (see Fig. 2). The instrument latches into the top-hat rail when the metal base bar is released.

The instrument must be installed vertically so that the display elements and their captions are clearly readable in correct orientation.

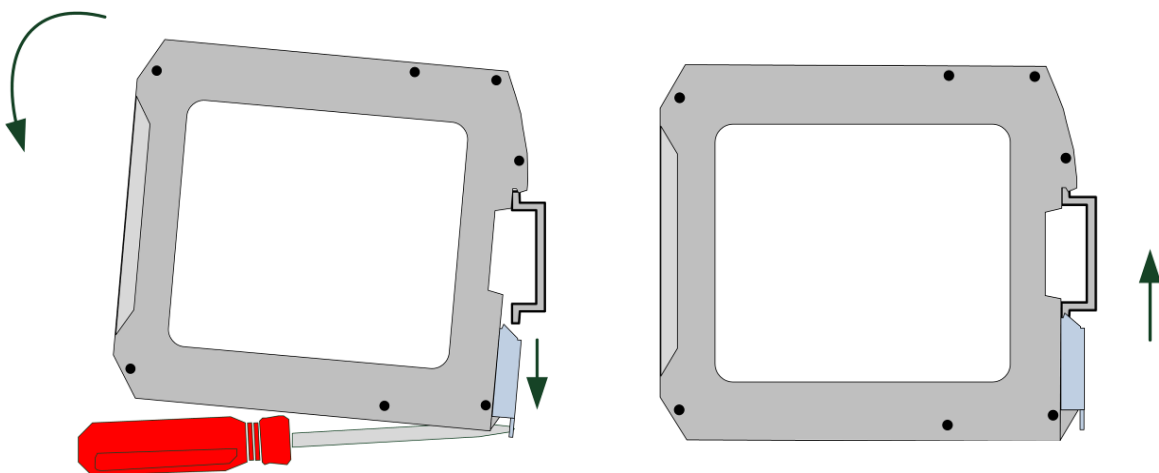


Figure 2: Installation of the econ sens3

4.4 Installation space and ventilation

To maintain the permissible operating temperature, adequate distances from adjacent components must be kept. Dimensions can be found in the Chapter entitled "Technical Data / Dimension Drawings".

Plan additional space for:

- **Ventilation:**

The econ sens3 Multifunctional Measuring Instrument corresponds, with its 22.5 mm installation depth to 1.3 subunits. Maintain a distance of 6 mm from neighboring devices on both sides of the instrument. Consequently, the instrument occupies exactly 2 subunits at 17.5 mm each.

- **Wiring**

- **Plug connectors, incl. cable feed** (e.g. RJ45 Ethernet) on the top side of the instrument

- **Plug connectors, incl. cable feed** (e.g. RJ12 coil connection) on the bottom side of the instrument

Attention!

Damage from moisture

Moisture or dampness can impair the functioning capability of the components.

Do not operate the components in very humid or wet environments. Comply with the specified ambient conditions of the instrument. These are found under Technical Data in Chapter 11.

Caution!

Ensure ventilation

Without adequate ventilation, the components can become damaged. Ensure that a minimum distance is kept from adjacent devices. Comply with the specified ambient conditions of the instrument. These are found under Technical Data in Chapter 11.

4.5 Disassembly

Decommissioning

Ensure that the instrument was shut down before beginning the disassembly.

Tools

Flat head screwdriver

Disassembly steps

Disassembly of the instrument is carried out as shown in Fig. 3. Move the metal base bar downwards against the spring force and swivel the instrument upwards and out of the horizontal position. Then take the instrument down off the top-hat rail.

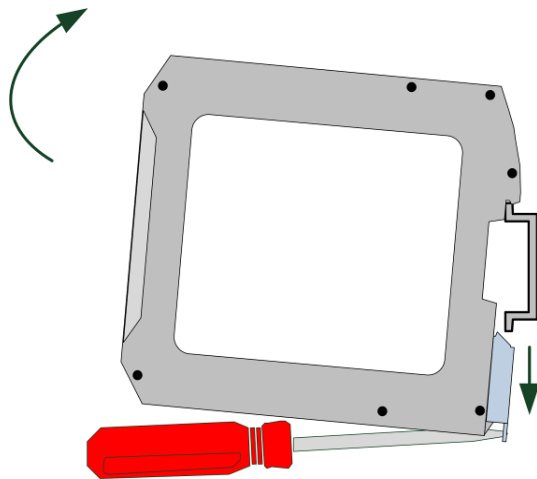


Figure 3: Disassembly of the econ sens3

Attention!

Make sure no tools or other objects that may cause a safety hazard are left behind at the installation point after assembly or disassembly!

5 Connection of the instrument

5.1 Safety instructions



 **Danger!**

Dangerous voltages

Failure to comply will result in bodily harm, including death, or property damage.

Disconnect the system from the power supply before beginning the work.

Attention!

Incorrect mains voltage can destroy the instrument

Ensure that the mains voltage agrees with the voltage specified on the nameplate before connecting the instrument.

Notice


Qualified Personnel

The term qualified personnel in the context of safety notices in the user documentation refers to persons who are familiar with the installation, assembly, commissioning, and operation of the product and have the qualifications necessary for their respective activities, e.g.:

- Training or instruction and/or authorization for operation and servicing of the instruments / systems in accordance with the safety engineering standards for electrical circuits and instruments.
- Training or instruction in accordance with the safety engineering standards for the care and use of appropriate safety equipment.
- Training in first aid.

5.2 Overview of connections

All connections of the econ sens3, with the exception of the connection for current measurement (3) and the Ethernet interface (4), are designed as pluggable screw terminals.



Warning!

Incorrect connection can result in serious bodily harm, including death, or property damage.

As a general rule, use ferrules to connect flexible wires. Also ensure that the torques specified for the individual screw terminals are not exceeded or undercut.

Figure 4 shows the arrangement of the connections of the econ sens3.

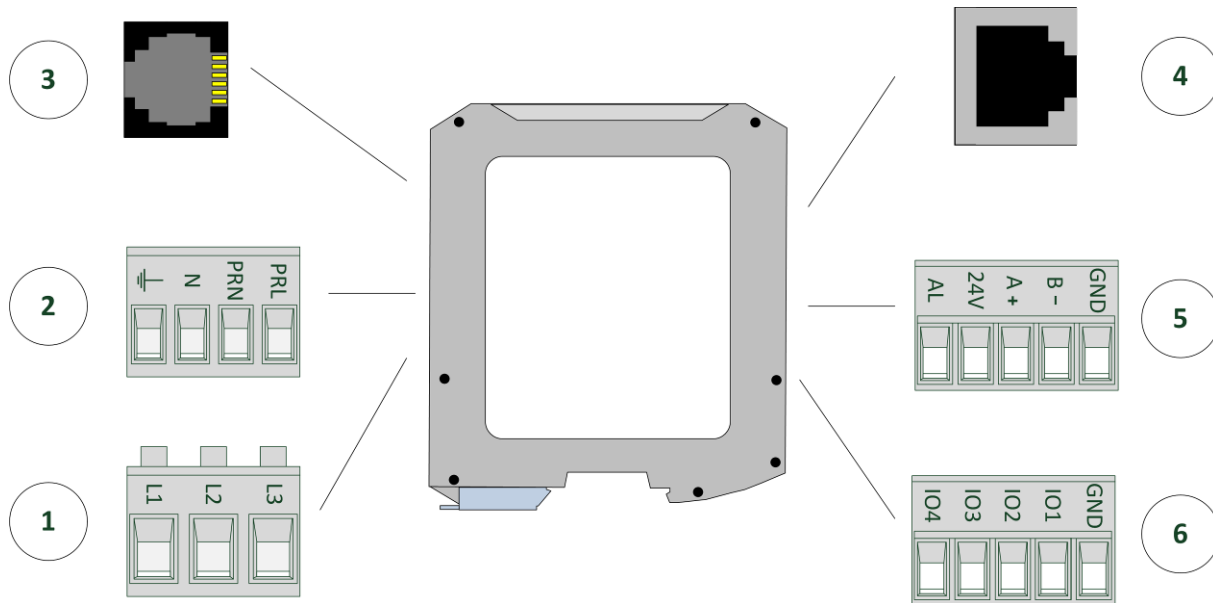
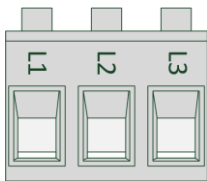


Figure 4: Connections of the econ sens3

Additional details on assignment of the individual connections can be found in subsequent chapters.

5.3 Voltage measurement connection

1 Voltage measurement connection		
Pin No.	Name	Function
1	L1	Connection for Phase L1
2	L2	Connection for Phase L2
3	L3	Connection for Phase L3



The econ sens3 Multifunctional Measuring Instrument can be used for voltage measurement in TN, TT, and IT systems. The voltage measurement is designed for overvoltage category 300V CATIII (rated surge voltage 4kV).

The econ sens3 is suited for voltage measurements in the frequency range of 45 to 65Hz. Fig. 5 shows the connection of the voltage measurement input to the network.

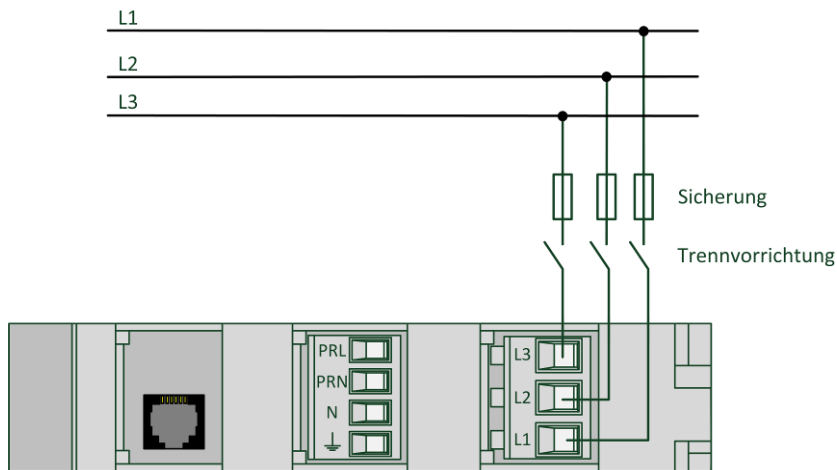


Figure 5: Connection of measuring voltage

When connecting the voltage measurement, the following must be noted:

1.) Disconnect device:

An appropriate disconnect device must be installed upstream of the econ sens3 voltage measurement input in order to disconnect the instrument from the current and voltage supply. This disconnect device must be

- Installed close to the instrument and easy for the user to access
- Marked as disconnect device for the instrument.

2.) Protection of voltage measurement inputs

 **Caution!**


Unprotected voltage measurement inputs can lead to damage to the instrument and system. Secure the instrument at all times with an IEC approved 10A fuse, an IEC approved 10A circuit breaker, or additional safety device.

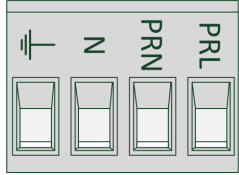
3.) Measuring voltages and measuring currents must originate from the same network.

4.) Synchronous phase connection

Phases must be connected in the same sequence as the terminals, as the terminal assignments cannot be changed in the software parameterization.

5.4 Supply voltage connection

2 Supply / auxiliary connection		
Pin No.	Name	Function
1		Connection for functional earth (PE)
2	N	Connection for neutral conductor
3	PRN	Connection for neutral conductor to current supply
4	PRL	Connection of a phase to current supply



Operation of the econ sens3 requires a supply voltage of 100 to 240 VAC. Fig. 6 shows the connection of the supply input to the network. Connection examples for 1 and 3-phase networks are found in Chapter 5.10.

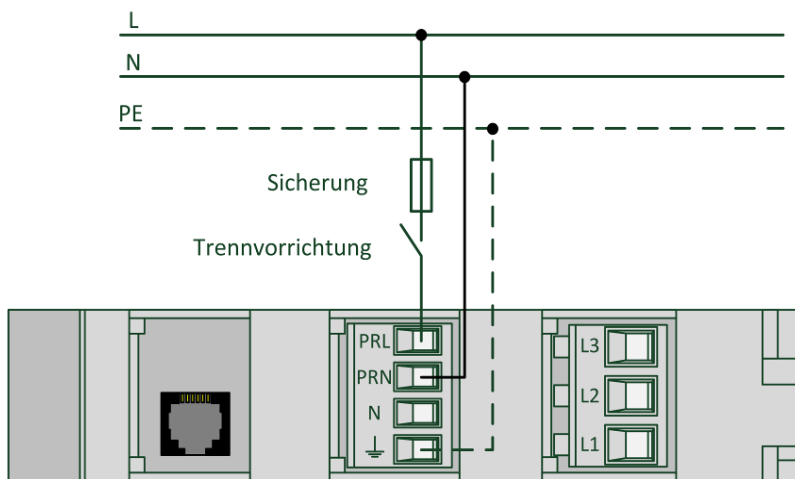


Figure 6: Connection of supply voltage

When connecting the supply voltage, the following must be noted:

1.) **Disconnect device:**

An appropriate disconnect device must be installed upstream of the econ sens3 “supply” connection in order to disconnect the instrument from the current and voltage supply.

This disconnect device must be

- Installed close to the instrument and easy for the user to access
- Marked as disconnect device for the instrument.

2.) Protection of voltage measurement inputs

⚠ Caution!

Unprotected supply voltage can lead to damage to the instrument and system. Secure the instrument at all times with an IEC approved 1A fuse, an IEC approved 1A circuit breaker, or additional safety device.

The connection is a "functional earth" connection. It diverts disturbances that act on the digital I/O and the RJ45 connector.

Connect the functional earth to the equipotential bonding bar in the control cabinet.

Alternative voltage supply with 12 to 24V DC

As an alternative to the AC voltage supply, the instrument can also be supplied with 12 to 24 VDC. However, this is not carried out over the AC supply voltage connection, but instead over the Modbus RTU interface connector. Fig. 7 shows the supply of the instrument with 24 VDC.

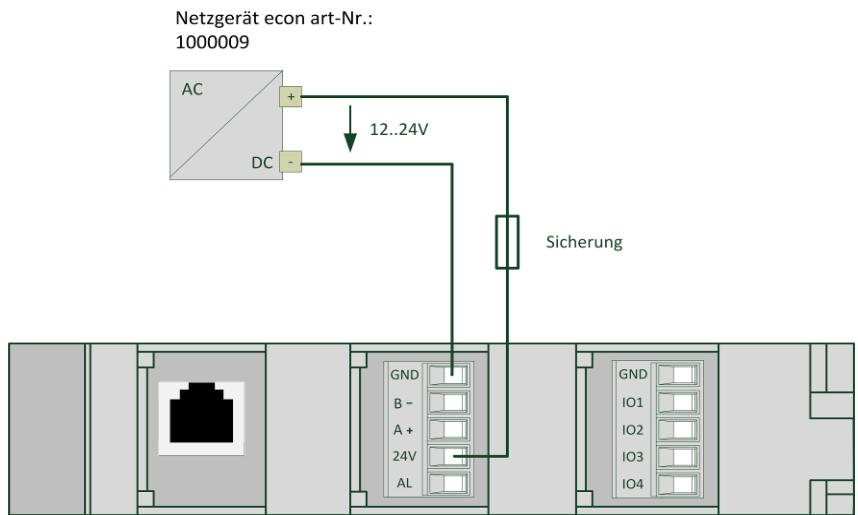


Figure 7: Alternative supply of the instrument with 24 VDC

Ensure correct polarity of the DC voltage during connection.

⚠ Caution!


Unprotected or reversed polarity supply voltage can lead to damage to the instrument or the system. Secure the instrument at all times with an IEC approved 2 A fuse or additional safety device.

5.5 Current measurement connection

Current measurement with the econ sens3 is not performed over transformers but instead over the econ sens3 coils (Rogowski coils) included in the scope of delivery.

Installation of the current sensors

To install the current sensors (Rogowski coils), place these as shown in Fig. 8 around the conductor to be measured. This can be a cable or also an **insulated** power rail.

 **Danger!**

Live parts

Failure to comply will result in bodily harm, including death, or property damage.

Never place the econ coil around a bare or uninsulated power rail!

Push the free cable end into the end of the coil until it latches in place. The coil must form a closed circuit around the conductor.

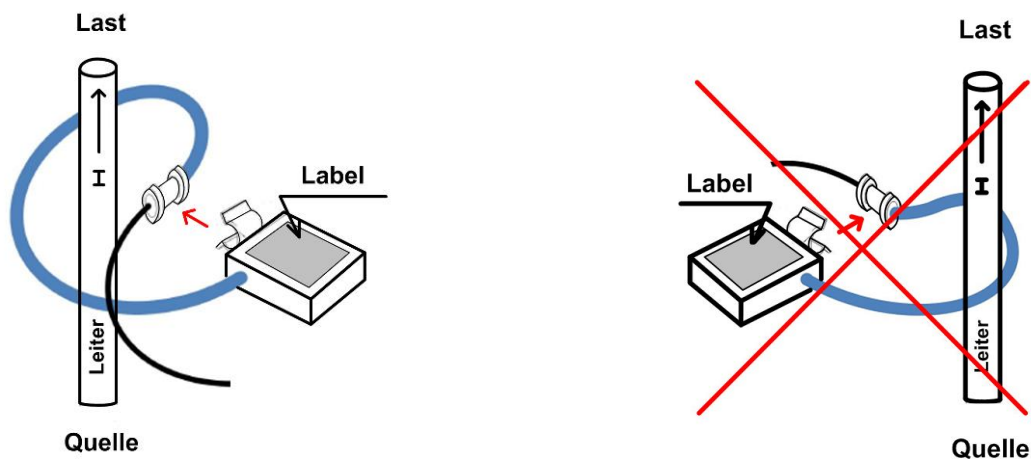


Figure 8: Installation of the current sensors

Current direction

The label affixed to the coil must be oriented in such a way that it points toward the user. This ensures correct direction of flow of the current through the coil.

Also make sure that the respective sensor matches the phase of the voltage path (coil L1 to phase L1, etc.).

Orientation of the coil relative to the current flow

If possible, secure the coil around the conductor (cable, insulated power rail, or the like) with a cable tie. Make sure that the coil does not take on too large of a phase displacement (see Fig. 9).

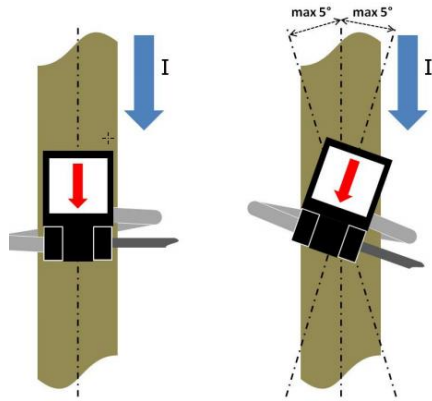


Figure 9: Phase displacement of the current sensors

With a phase displacement $> \pm 5^\circ$ the rel. measuring deviation also increases and thus the rel. deviation of the measured amperage and the resulting computed values (e.g. output).

Unlike conventional transformers, the design of the econ coils guarantees that there is no danger from open secondary connections.

5.6 Ethernet connection

The econ sens3 energy consumption meter includes a 100Base-T network connection over which the web interface can be opened. This connection can be directly established with a PC or a node, such as hubs or switches. For this purpose, connect the sens3 to a patch cable (1:1) with your hub/switch or directly to your PC (via crossover cable).

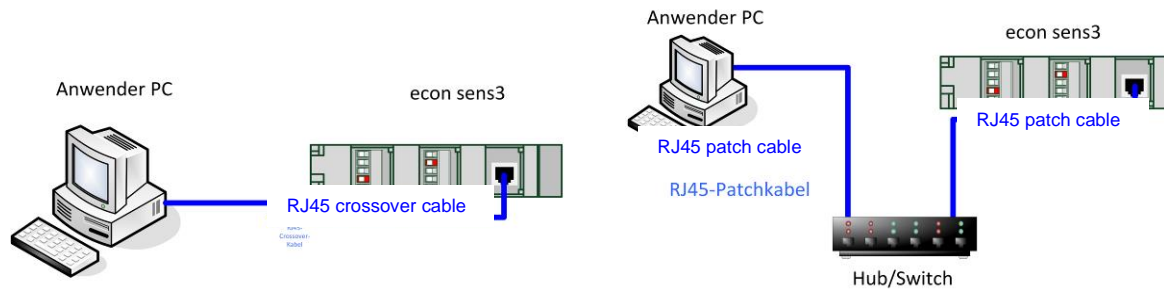


Figure 10: Ethernet connection

Further information concerning IP address settings, etc., is included under Initial Operation in Chapter 7.

Modbus TCP

Over the network connection of the econ sens3, measurement values and events (PRO version) can be retrieved via the Modbus protocol. Parameter settings are made in the *Modbus* submenu in Chapter 8.10. The associated register addresses are also found in this chapter.

Cable recommendation

A cat 5 or higher twisted pair and shielded data cable is recommended for data transfer. Additional recommendations for installation and shielding of connecting cables for all data interfaces can be found in Chapter 5.9 of this handbook.

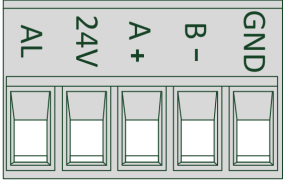
Attention!

Disturbance of other network devices from incorrect network settings

Incorrect network settings can impair or disturb the functions of other network devices. Make sure at commissioning that there are no duplicate IP addresses in the same network.

5.7 Modbus RTU connection

5 MODBUS RTU connection		
Pin No.	Name	Function
1	Alarm	
2	24V	Input for supply over 24 VDC
3	B-	Data cable B (-) MODBUS RTU
4	A+	Data cable A (+) MODBUS RTU
5	GND	Shared GND connection for A+ and B-



Over the Modbus RTU RS485 protocol, the values can be retrieved according to the *Modbus* submenu in Chapter 8.10.

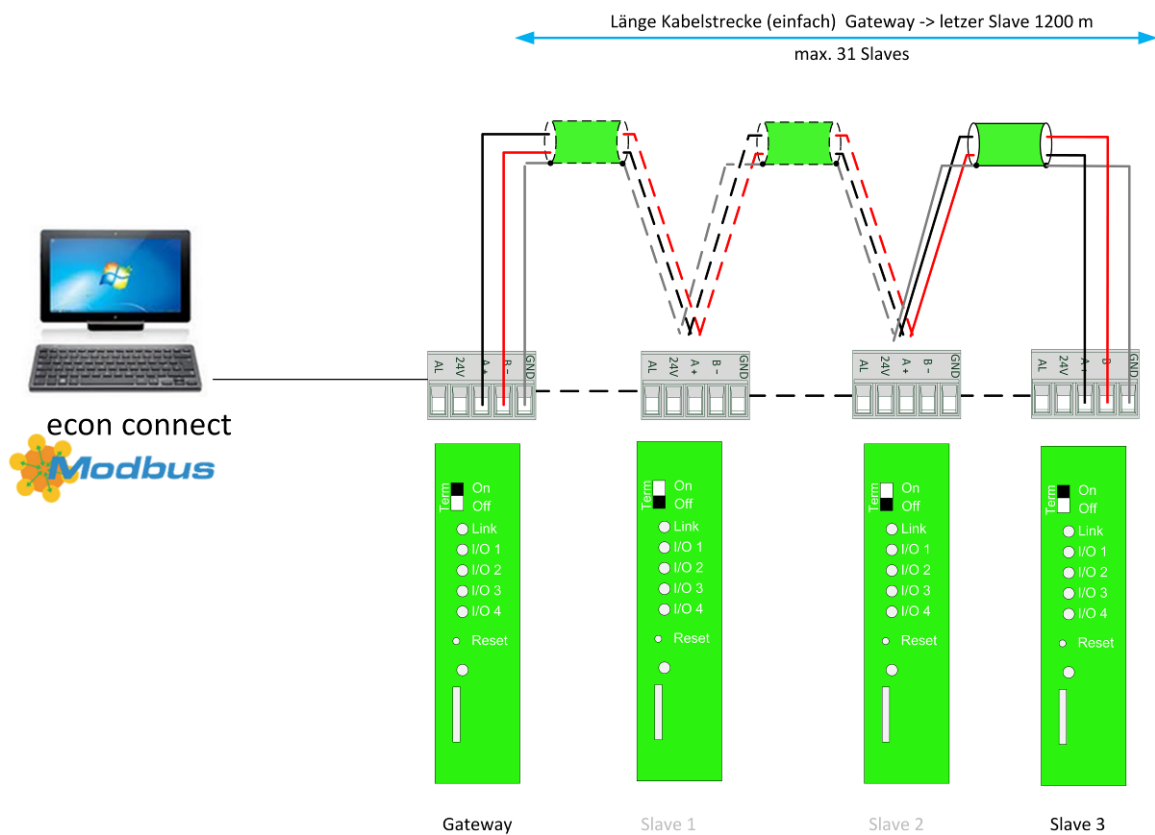


Figure 11: Assignment of Modbus RTU interfaces (here with econ sens3 as gateway)

In order to use Modbus RTU, a Modbus master is required. Up to 32 participants can be interconnected in a segment. For more than 32 participants, repeaters (line amplifiers) must be used to connect the individual segments. The devices are connected in a line structure as shown in Fig. 11. Other bus topologies, such as a star topology, are not possible.


The cable must be terminated with resistors (bus termination) at the beginning and at the end of each segment. For this purpose, a 120 Ω termination resistor should be placed between the A and B cables. To do this with the econ sens3, move the slide switch "Term" on the instrument front to "ON." The bus length must not exceed 1200 meters.

Cable recommendation

Generally a two-core, twisted, and shielded cable with a characteristic impedance of 100-130 Ohm is suitable as a transmission cable for Modbus. An EIB bus cable (e.g. Belden YE00820) can also be used for shorter transmission paths (up to 200 m simple path). Cat 5 or higher bus cables such as Unitronic Li2YCY(TP) 2x2x0.22 (Lapp Kabel) are also suitable for Modbus data transmission.

5.8 Multiple I/O connection

6 Multiple I/O connection		
Pin No.	Name	Function
1	I/O 1	Multifunctional I/O port 1
2	I/O 2	Multifunctional I/O port 2
3	I/O 3	Multifunctional I/O port 3
4	I/O 4	Multifunctional I/O port 4
5	IO_GND	GND connection for the I/O ports



The econ sens3 Multifunctional Measuring Instrument includes four independent so-called multiple I/O ports that can be used to transfer the measurement data; for example, to a higher-level energy monitoring system. The multiple I/O ports are electrically isolated from the rest of the instrument and can be defined both as inputs and outputs and represent different connection scenarios. The different input and output configurations are shown in the subsequent subchapters. The software-side configuration is found in Chapter 8.10.

The port I/O 1 is activated for use as S0 interface; further use of the multiple I/O terminal requires the LOG upgrade of econ sens3.

Attention!

Inadmissible voltages

The maximum allowable currents and voltages that can be connected to the multiple I/O ports are found in the subsequent chapters and in the technical data.

Cable recommendation for multiple I/O connections

In principle, a two core or multi core and shielded cable is suitable as transmission cable for the multiple I/Os. Cat 5 or higher network cables or an EIB cable such as Belden YE00820 are also suitable.

Attention!

Connected cables with a length >30m **must** be shielded and the shield must be connected as described in Chapter 5.9. The use of shielded cables is recommended in general.

Open collector output

The multiple I/O ports of the econ sens3 can be configured as open collector outputs (S0). Fig. 12 shows the circuit diagram for this output configuration.

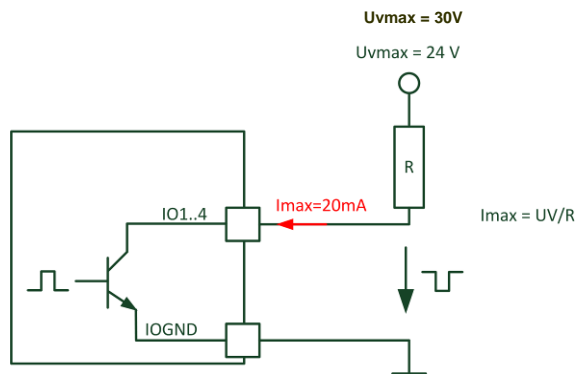


Figure 12: Open collector output

Open collector operation requires an external auxiliary voltage of up to 30 VDC. The maximum current through the transistor is limited on the hardware side to 20 mA. Select the external resistor in such a way that it does not exceed this current through the transistor!

Application example for open collector output

The consumption values measured by the econ sens3 are output as a sequence of pulses over pulse outputs IO1 to IO4 (open collector NPN outputs). Every pulse emitted has a length of 50 ms and corresponds to a specific amount of energy in Wh. This is configurable over the web interface. (See details under Operation and Parameterization in Chapter 8). The standard value for this impulse weighting is roughly 10 Wh/impulse, which corresponds to an output of 100 imp/kWh.

The pulse outputs are used for automated collection of energy consumption values via data logger; e.g., the econ unit. Fig. 13 shows the assignment of the impulse interface, as well as a possible connection diagram.

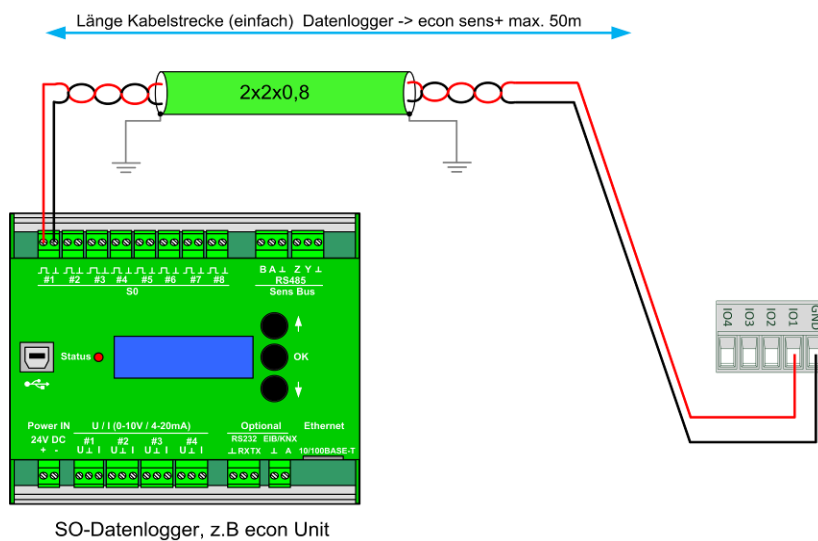
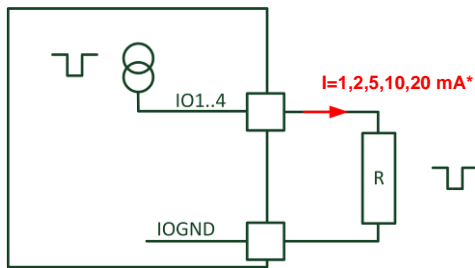


Figure 13: Multiple I/O outputs as open collector and possible connection to an external data logger

Digital output (pulse)



*konfigurierbar per Software

In the configuration as digital output the instrument supplies an external resistor with a current pulse that is configurable in the software. This can be 1, 2, 5, 10, or a maximum of 20 mA. Select the external resistor in such a way that its voltage dip does not exceed 30 VDC!

Figure 14: Digital pulse output

Caution!

Metal film resistors with a minimum power loss of 0.4 W are recommended as external resistors. Resistors with lower power dissipation can become hot during operation and cause burn injuries / skin irritation.

Attention!

The maximum cable length in the “open collector” and “digital output” configuration is 5 m.

Digital input (pulse input)

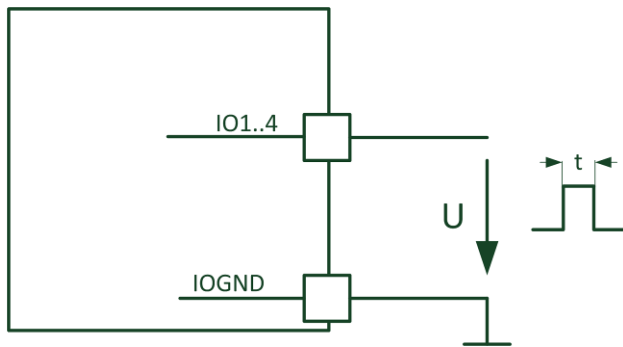


Figure 15: Pulse input

In the “pulse input” configuration, voltage pulses can be fed in from an external device. The input detects pulses with a voltage of 2 VDC and higher and a minimum pulse length of $t = 20$ ms. The voltage at the pulse input must not exceed 30 VDC.

Input for potential free contact

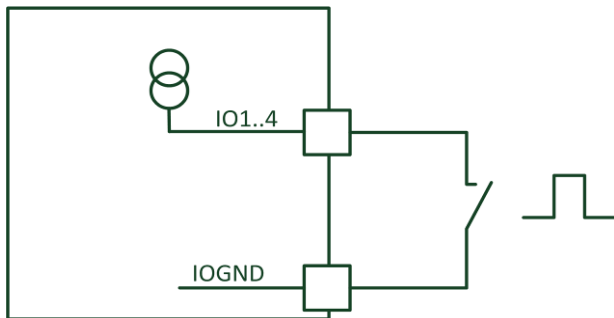


Figure 16: Input for potential free contact

In the “pulse input” configuration, voltage pulses can be fed in from an external device. The input detects pulses with a voltage of 2 VDC and higher and a minimum pulse length of $t = 20$ ms. The voltage at the pulse input must not exceed 24 VDC.

Analog output 4 to 20 mA

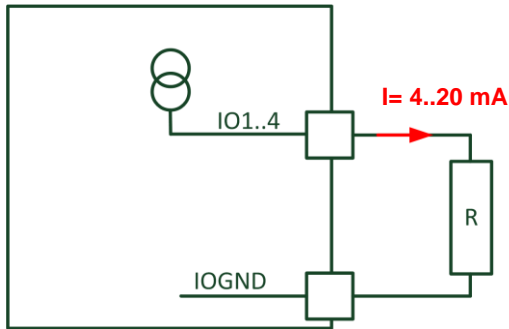


Figure 17: Analog output 4 to 20mA

Analog input 4 to 20 mA

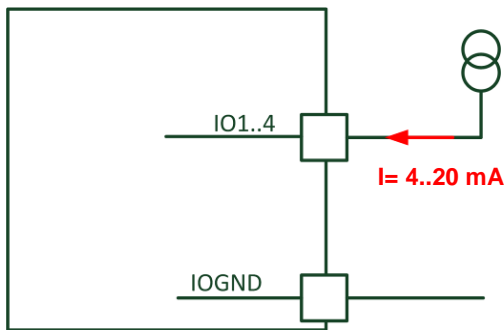
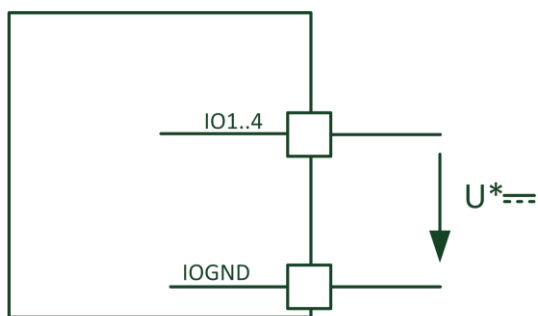


Figure 18: Analog input 4 to 20mA

Analog input 0 to 10V/30 V



Input voltage ranges configurable
 0..10 V
 0..30V

Figure 19: Analog input 0 to 10V/30V

5.9 Shielding of connection cables

Grounding of the Modbus RTU, multiple I/O port, and Ethernet cables

Shielding of connection cables described here applies to all data interfaces of the econ sens3. These are:

- Modbus RTU interface
- Multiple I/O ports
- Ethernet cable.

Ethernet cable:

A large area of the exposed Ethernet cable shield should be connected to a suitable grounding point at both cable ends with low resistance. For this, a BTR network socket, for example (see Fig. 20), can be used in the control cabinet for top-hat rail mounting. In this case, the connection to the grounding point is made over the integrated equipotential bonding plate directly on the grounded top-hat rail.



Figure 20: BTR network socket for top-hat rail mounting

Modbus RTU and Multiple I/O port cables:

The cable shields of the Modbus RTU cable and the multiple I/O port cable should also be connected at both ends of the cable over a large area and with low resistance to a suitable grounding point of the control cabinet. For this, shield clamps, for example, can be used for top-hat rail mounting, as shown in Fig. 21.



Figure 21: Shield clamps for top-hat rail mounting

Cable routing instructions

To minimize disturbances to the instrument or from the instrument to other devices, the shielding / grounding should be routed to a shared grounding point and the cables kept as short as possible. Disturbances can potentially be caused by earth or ground loops due to incorrect cable routing. Figure 22 shows one example each of good and poor cable routing.

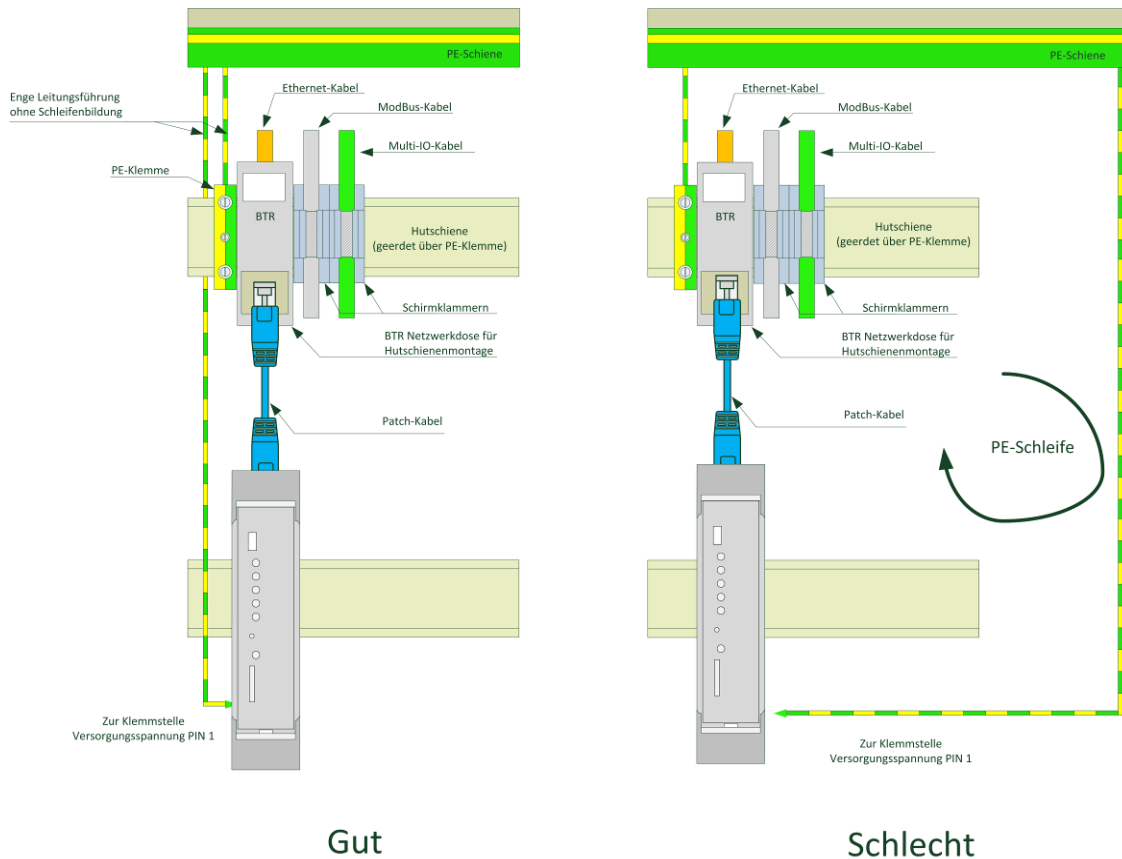


Figure 22: Example of good and poor cable routing

Attention!

Exceeding of limiting values without grounding / shielding

Adherence to the technical limiting values with respect to interference emissions and interference resistance is ensured only with properly executed grounding. The user of the system is responsible for compliance with legally prescribed limits (CE marking). Complete the required shielding as described in Fig. 22.

Shield the Ethernet connection also as described in Fig. 22.

5.10 Connection examples

3-Phase/4-conductor system with any load

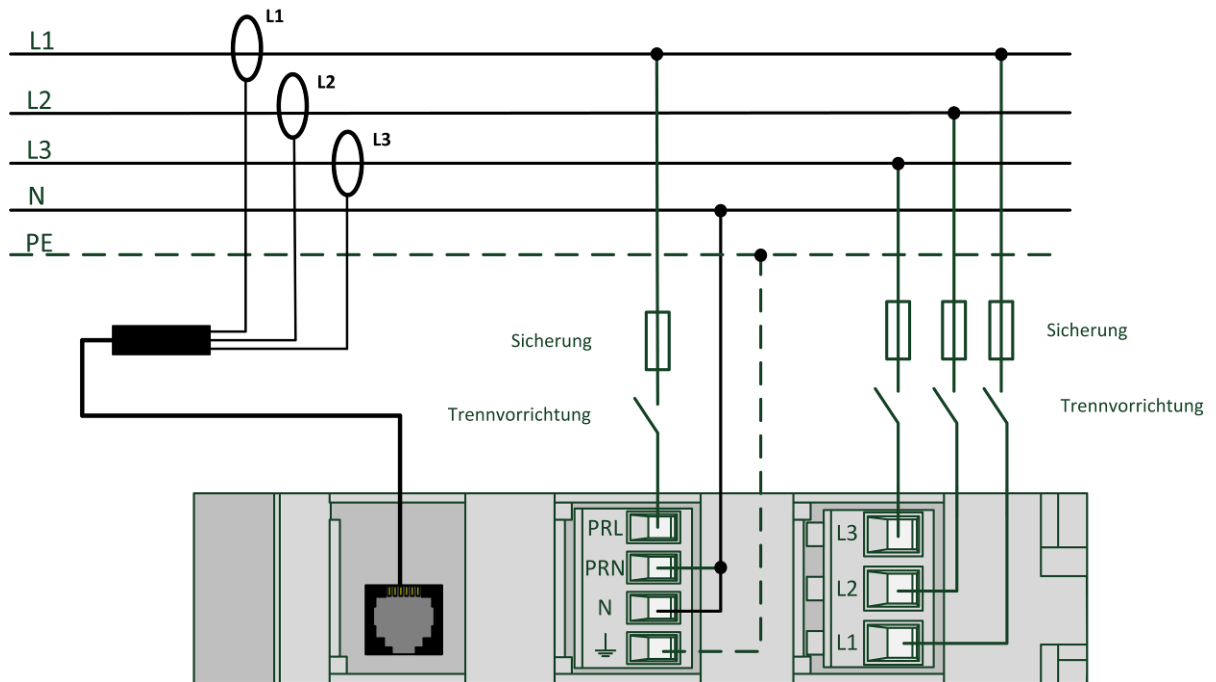


Figure 23: 3-phase/4-conductor system with any load

3-Phase/3-conductor system with any load

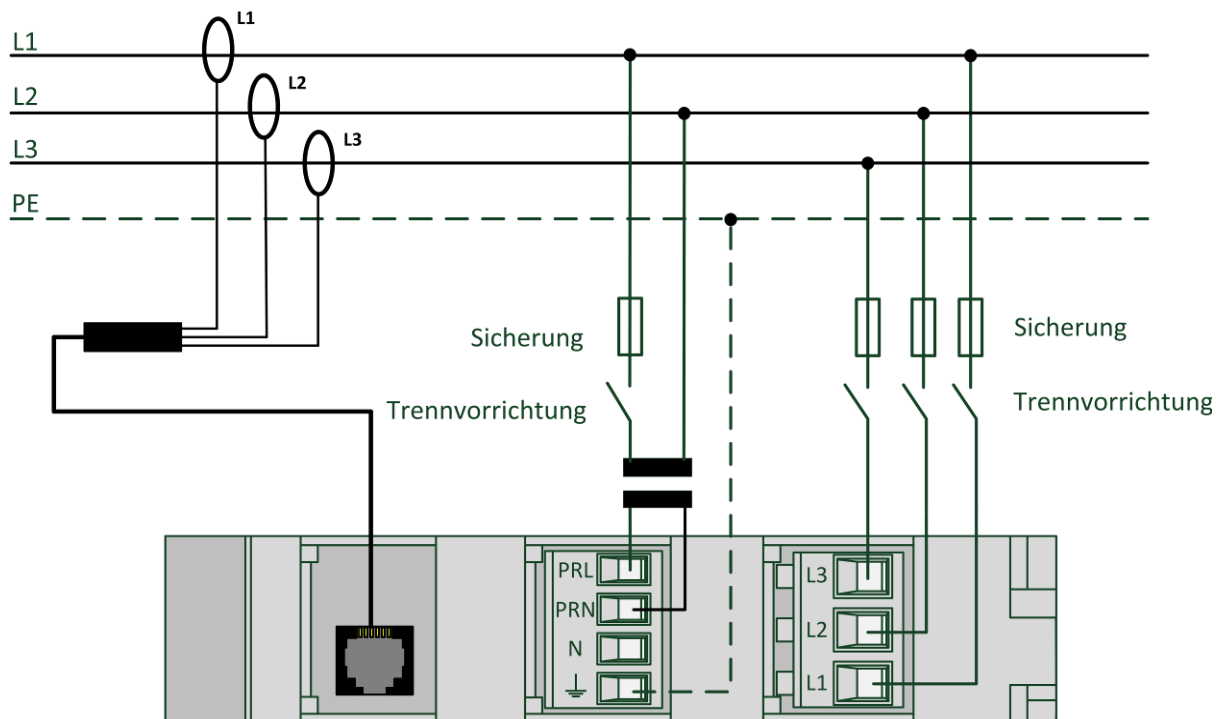


Figure 24: 3-phase/3-conductor system with any load

1-Phase system

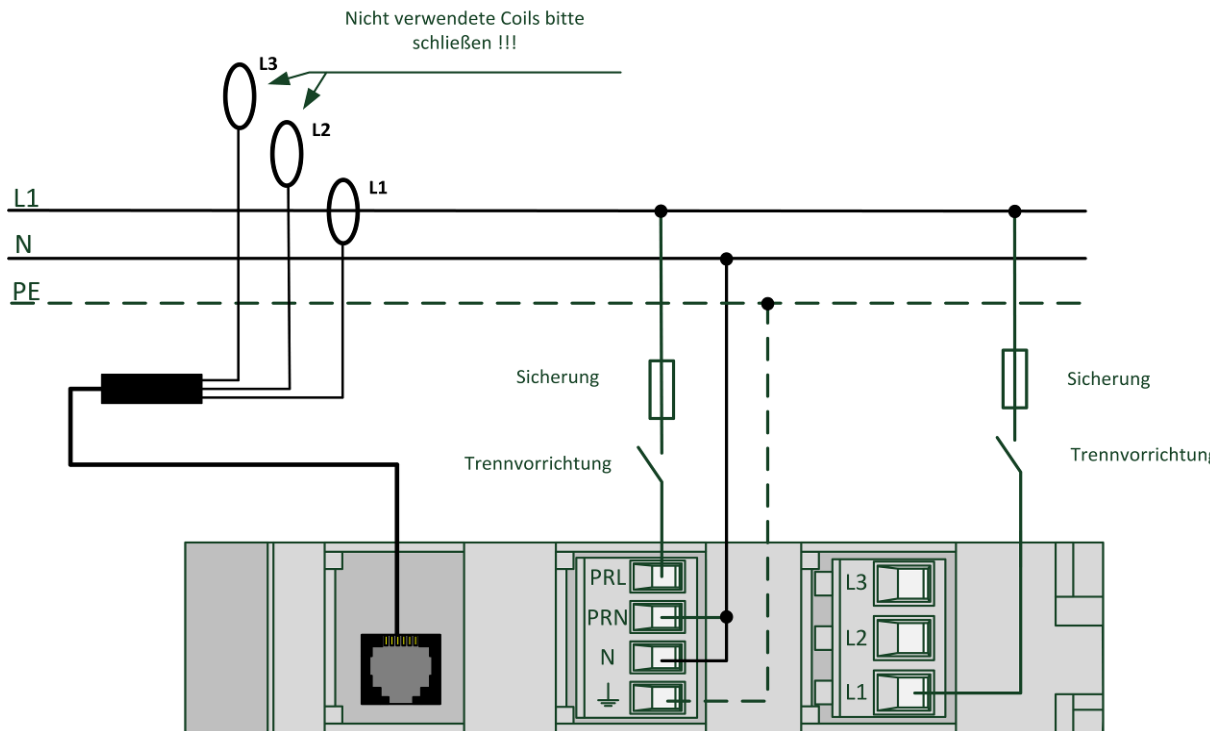


Figure 25: 1-Phase system

Functional grounding at the GND connection of the Modbus clamping point

When using the network analysis function of the instrument and to increase measurement accuracy, the secondary-side GND connection must be connected with the protective conductor at the “MODBUS” clamping point. See Fig. 26 in this regard.

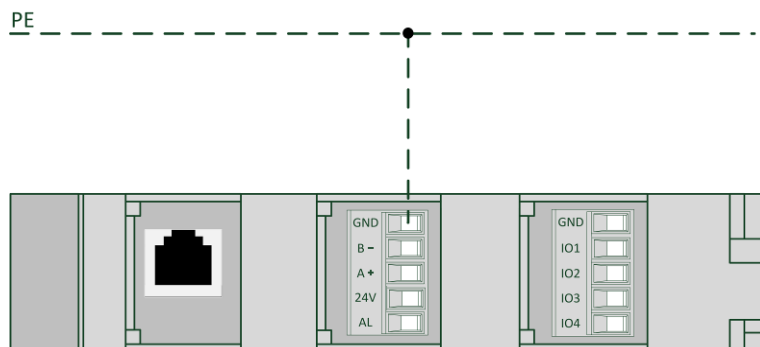


Figure 26: Functional grounding at the GND connection of the Modbus clamping point

Attention: Do not ground the GND connection at the multiple I/O port. It is electrically isolated from the GND of the MODBUS!!!

6 Display and control elements

Figure 27 shows the arrangement of the display and control elements of the econ sens3.

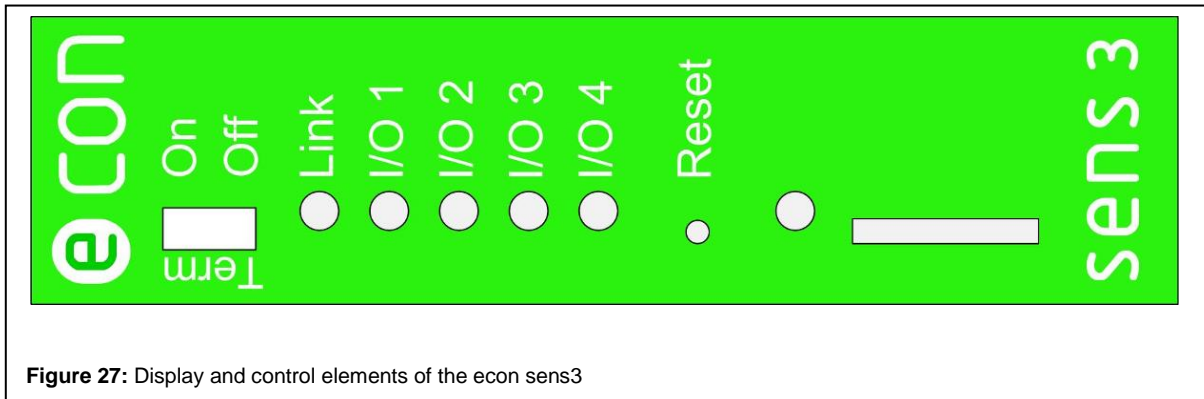


Figure 27: Display and control elements of the econ sens3

“TERM On/Off”: Activates/deactivates termination of the Modbus interface. More information on bus termination is found in Chapter 5.7.

LED “Link”: Lights up when connection to the network is active. The LED starts blinking as soon as data transfer to/from the instrument occurs.

LED “I/O1 to I/O4”: The LEDs I/O1 to I/O4 show the status of the respective I/O port.

Reset: Reset button to perform a “factory reset.”
The reset is a 4-stage reset. More information on the reset is found in Chapter 9.4.

LED “LOG”: Blinks as soon as the instrument is ready to log data.

7 Initial operation

Necessary conditions:

- The instrument has been assembled correctly as described in Chapter 5
- The instrument has been connected in accordance with the possible connection types and taking into consideration the safety measures and technical parameters contained in Chapters 5 and 11
- The Ethernet cable has been connected.

Steps for initial operation

1.) Check of connections

Before switching the instrument on, check that all cable connections to the econ sens3 were produced as described in Chapter 5.

2.) Application of supply voltage

3.) Application of the measurement voltage

4.) Application of the current measurement

5.) Parameterization of the instrument

6.) Plausibility check of measurement values

Open the web interface of the instrument (see Chapter 8.1) and check first the time settings and the display in the *Measurement* menu.

Without connected load, you should at least see the voltage there. If a load is connected, verify the measurement result if possible.

If you do not see any measurement values despite connected load, proceed according to the **Fehler! Verweisquelle konnte nicht gefunden werden.** in Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**

8 Operation and parameterization

Web interface of the econ sens3

8.1 Opening the web interface

To open the web interface, enter the IP address of the econ sens3 in the address line of the web browser (Firefox, Internet Explorer, Google Chrome, etc.). The standard network settings of the econ sens3 are as follows:

IP address: **169.254.1.1**
Subnet mask: **255.255.0.0**

In order to open the web interface, ensure that the user PC is in the same network as the econ sens3. To do this, make the following settings (e.g. in Win7):

1. Under *“Start / System control / Network and sharing center,”* select the LAN connection of the network card connected to the network
2. Click on the *“Properties”* button
3. Select *“Internet protocol (TCP/IP)”* from the list and click on *“Properties”*

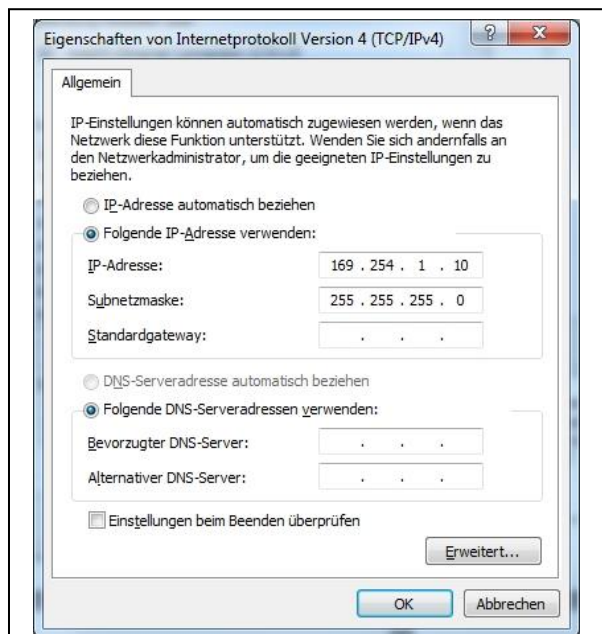


Figure 28: Characteristics of the internet protocol

4. Activate *“Use the following IP address”* and *“Use the following DNS server address.”*

5. Enter the parameters shown in Figure 15 and click *“OK”* to confirm your selection.”

The home screen of the econ sens3 should display when the above IP address is entered into the browser.

Opening the web interface in a network with DHCP server

If the econ sens3 is located in a network in which a DHCP server for automatic address allocation is provided, it will automatically assume an address allocated to it from this server. The address that the econ sens3 received can be found on the DHCP server.

8.2 Home menu



Figure 29: Home screen of the econ sens3

You will find the following areas and information on the econ sens3 home screen:

1. Menu bar for navigating the individual menus of the econ sens3
2. Info table
3. Language selection
4. Info bar



Figure 30: Menu bar for navigation

Home – Start page, see above

Measurement – Measuring values of the instrument; also possible as automatically updated online display

Analysis – Graphic and tabular representation of the various measured parameters

Export - Export of the measured values via CSV file

Contact – Contact information

Help – Reference to the FAQ and the sens3 handbook

Config. – Configuration settings

Optional

Events – Display and recording of network events (PRO version)

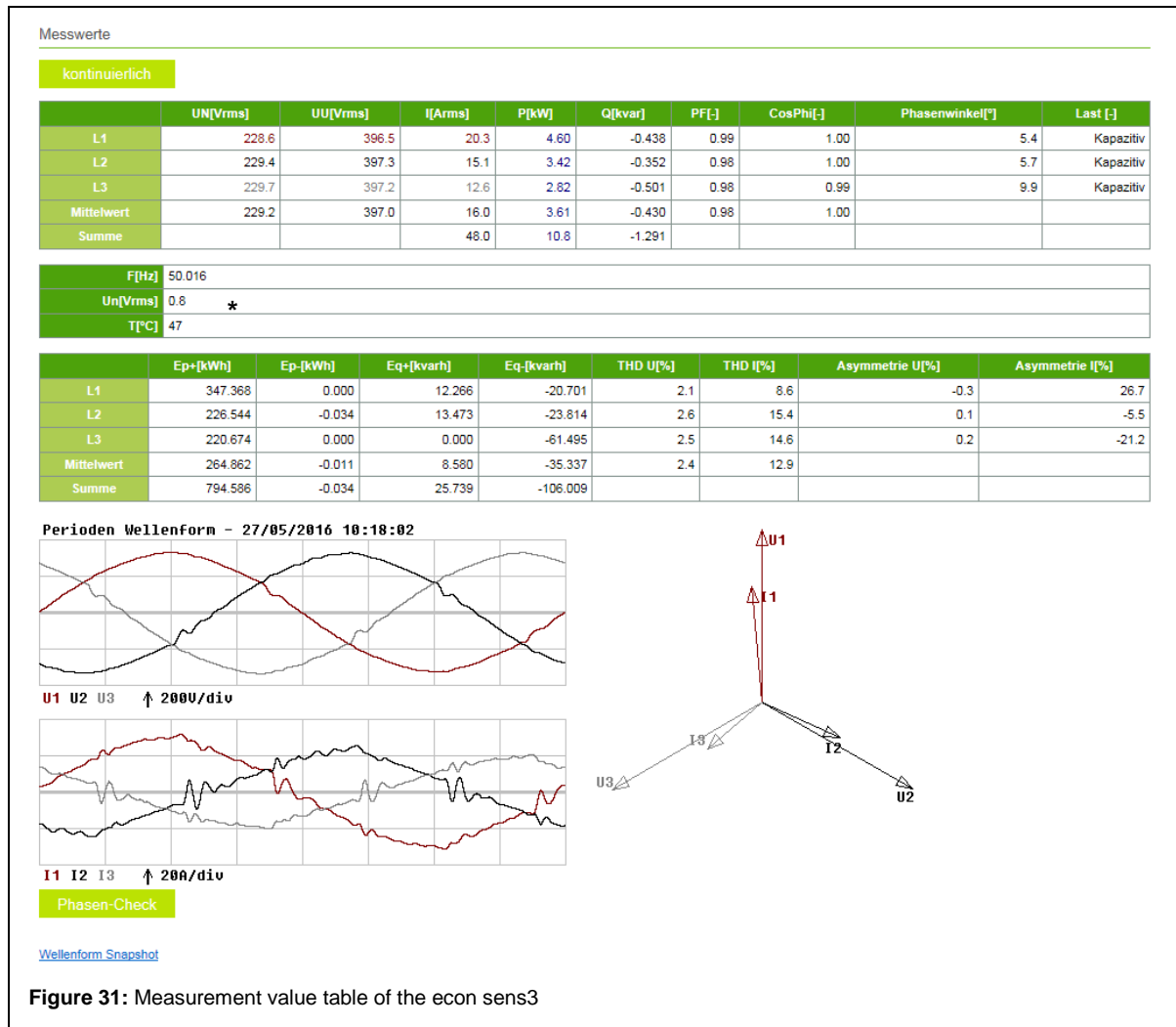
IO – Graphic and tabular representation of inputs and outputs (LOG version)

Timer¹ – Time settings for time switch of the I/Os (LOG version)

¹ The timer function is currently in development

8.3 Measurement menu

The econ sens3 displays the values it measured in the *Measurement* menu in table format. Fig. 31 shows this table.



Displayed are phase L1, L2, L3 voltages and the associated currents, as well as the active and reactive power for each phase and the “power factor” (for purely sinusoidal alternating currents, this corresponds to the generally known cos phi). The generated and returned active and reactive energy, as well as the measured values for the total harmonic distortion (voltage/current) and the asymmetry (voltage/current) are found in the second table.

You can refresh the display repeatedly by pressing the F5 key on your keyboard or pressing the arrow button next to “continuous.” Then the display will be updated in one second intervals.

The arrow graphics below the table are used to illustrate the phase shifts between the L1, L2, and L3 voltages and the associated currents.

*The statement “Un” below the table shows the so-called neutral conductor voltage (voltage difference between the neutral conductor and the protective earth). This is needed for the Events menu, which deals with network analysis. Activation of this menu is optional.

You can display the voltage and current curves on the three phases as a waveform by going to *Waveform Snapshot* at the lower left edge of the screen.

This will generate and display a one-second snapshot of the waveform (see Fig. 32). This image will be included in the list of events in the PRO version if the Snapshot Option (*Events* submenu in Chapter 8.10) is activated.

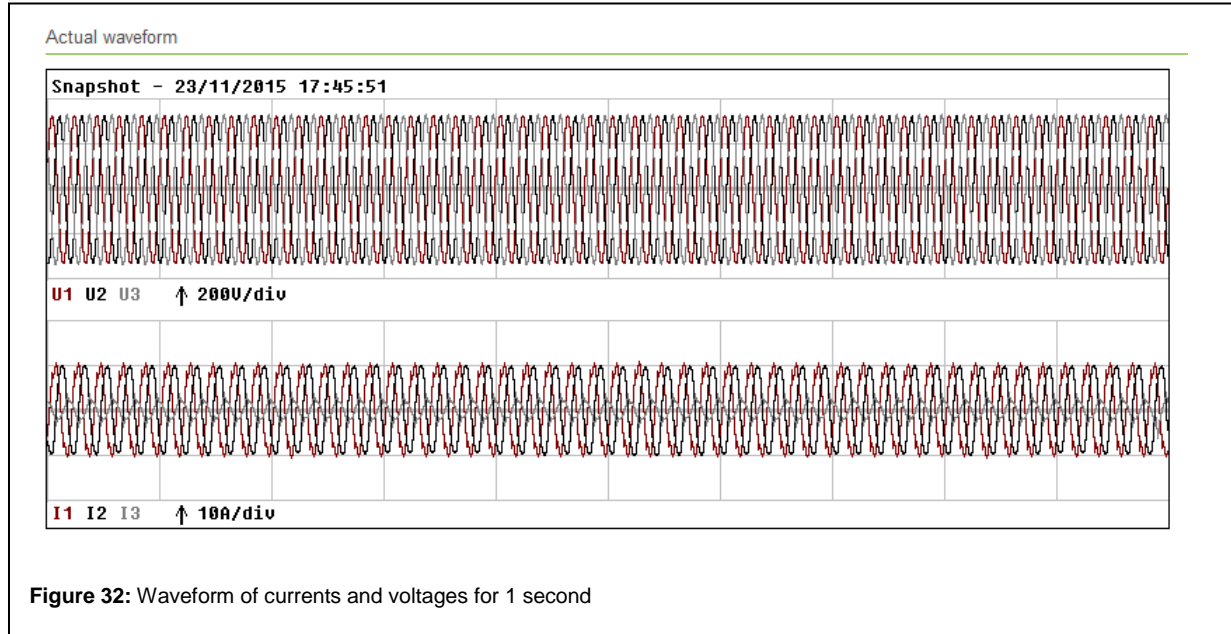


Figure 32: Waveform of currents and voltages for 1 second

The econ sens3 is able to measure and display both the generated and the consumed active power. Consumed active power is shown in blue in the table, and the generated active power is shown in red with a negative sign. If power is consumed and generated concurrently one a phase, the econ sens3 shows the sum of these two powers.

Example:

You generate with your photovoltaic system with downstream inverter on the three L1, L2, and L3 phases 1kW each and in doing so, consume 500 watts for various household appliances on phase L2. In that case, your measurement value table would look like the table in Fig. 33.

	UN[Vrms]	UU[Vrms]	I[Arms]	P[kW]	Q[kVar]
L1	227.8	386.0	4.4	-1000	36
L2	228.3	386.2	2.2	-500	7
L3	228.9	382.8	4.3	-1000	-
Mittelwert	228.3	385.0	3.6	-833	21
Summe			10.9	-2500	43

Figure 33: Measured value table for the example

“Phase check” installation test routine

The econ sens3 has a small installation test routine called “Phase check”.

Messwerte									
kontinuierlich									
	UN[Vrms]	UU[Vrms]	I[Arms]	P[kW]	Q[kvar]	PF[-]	CosPhi[-]	Phasenwinkel[°]	Last [-]
L1	227.8	395.5	20.7	4.70	-0.303	1.00	1.00	3.6	Kapazitiv
L2	229.0	396.7	15.1	3.42	-0.358	0.98	0.99	5.8	Kapazitiv
L3	229.4	396.4	12.6	2.82	-0.500	0.98	0.99	9.9	Kapazitiv
Mittelwert	228.8	396.2	16.2	3.65	-0.387	0.99	0.99		
Summe			48.5	10.9	-1.161				
F[Hz]	50.016								
Un[Vrms]	0.9								
T[°C]	47								
	Ep+[kWh]	Ep-[kWh]	Eq+[kvarh]	Eq-[kvarh]	THD U[%]	THD I[%]	Asymmetrie U[%]	Asymmetrie I[%]	
L1	347.958	0.000	12.266	-20.741	2.0	8.0	-0.4	28.3	
L2	226.971	-0.034	13.473	-23.858	2.6	15.0	0.1	-6.3	
L3	221.027	0.000	0.000	-61.557	2.5	14.2	0.3	-22.0	
Mittelwert	265.319	-0.011	8.580	-35.385	2.4	12.4			
Summe	795.957	-0.034	25.739	-106.156					

Figure 34: Measurement value table without error message

Generally, it is assumed that all measuring coils were installed correctly and the measured load has a power factor of > 0.71 (phase displacement between U and I $< 45^\circ$). The measurement value table is then displayed for the user as shown in Fig. 34.

If an error was made during installation, for example if the L2 coil was laid around the L1 conductor of the voltage path, the power factor will fall below 0.71. A phase angle check can be performed by pressing the “Phase check” button.

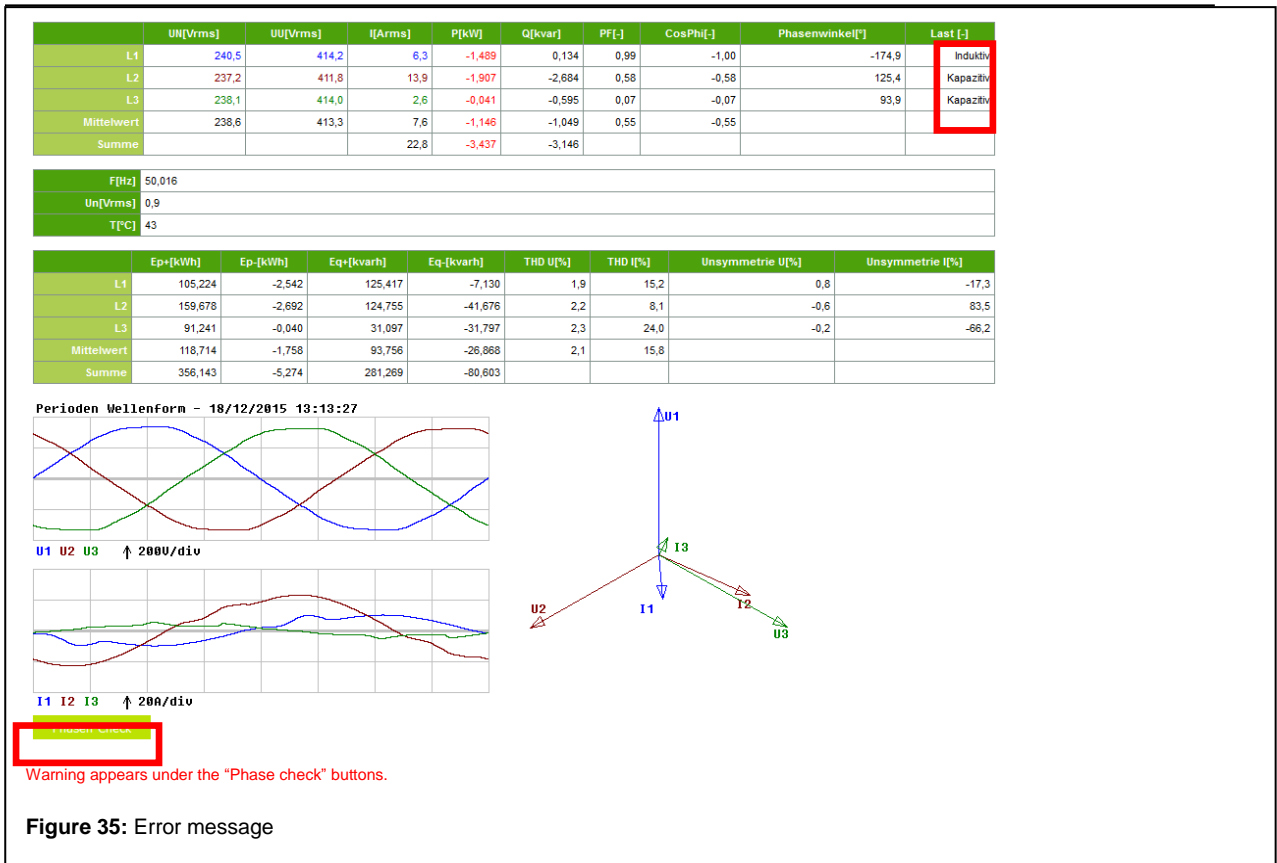


Figure 35: Error message

It can be seen in the measurement value table that the power factor of phase 2 has fallen below 0.71 and the phase displacement between U2 and I2 in the “phase angle” graphic shows 125.3°. This is a typical error pattern for the installation error mentioned above. The “Phase check” function provides an indication of this (see Figure 36).



Figure 36: Phase check

Note:

Because of the simplicity of the installation test routine, there are cases in which no installation error occurred but the routine nevertheless outputs an error message, e.g.:

- a.) In the measured network, only generated and little to no consumed power occurs
- b.) The power factor of the connected load is in fact < 0.71

Therefore, always ensure correct installation of the measuring coils and their assignment to the voltage path to prevent misunderstandings.

8.4 Analysis menu

In the Graphs menu, the measurement results are processed graphically for the user and displayed as a measurement curve. Fig. 37 shows an example of such a measurement curve.

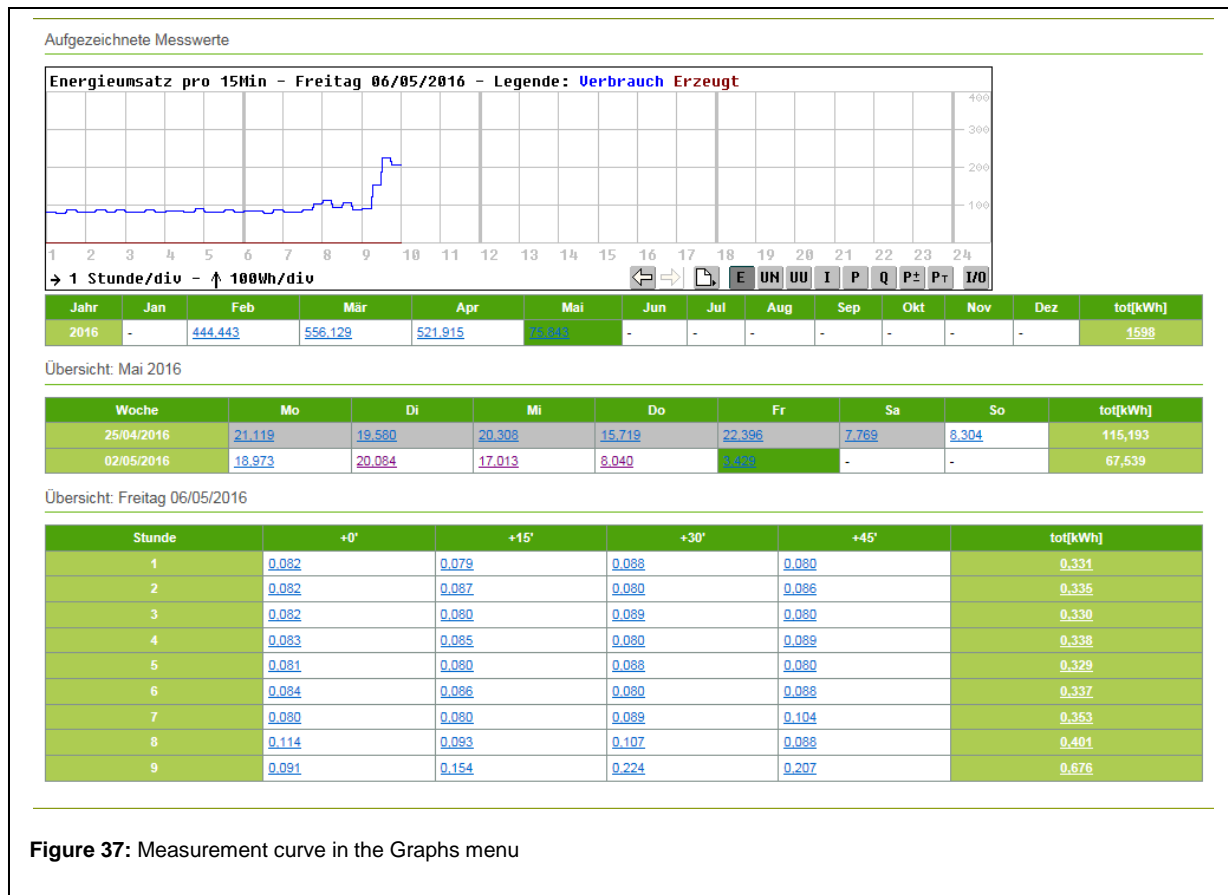




Figure 37: Measurement curve in the Graphs menu

Displayed is respectively the sum of the power/energy from the three phases over a specified period. Use the buttons next to the X-axis title to browse through the measurement curves step by step (e.g. every day of the month).

In this process, you can choose among the following views:

Monthly view:	Consumed and generated energy (kWh) per hour
Daily view:	Consumed and generated energy (kWh) per 15 min
Hourly view:	Consumed and generated energy (Wh) per minute
15 min view:	Consumed and generated energy (Wh) per second.

When a value is selected from the tables below the diagram, the values will be loaded into the corresponding view in the diagram. The *Export Measurement Values* function can be used to download the values belonging to the curves. Pressing the  button at the bottom edge of the diagram will bring you to the export menu, in which you can make various settings for exporting of your data. The settings and measurement values currently selected are taken over for export. More information on this can be found in the Export menu.

Use the other buttons  below the diagram to switch between different measurement values in the current view:

- E -> Energy turnover
- UN -> average phase voltage
- UU -> average phase to phase voltage
- I -> average current
- P -> average power
- Q -> average reactive power
- P_± -> average power (positive& negative power)
- P_τ->average total power.

Optional: if the I/O option is activated in the sens3, the I/O button is also shown in the diagram. If this button is actuated, an additional diagram will appear below the diagram, in which the I/Os can be tracked. The I/O diagram has the same time frame as the other.

A list of all measured parameters and their meaning can be found in the appendix to this handbook.

8.5 Input / output menu (LOG version)

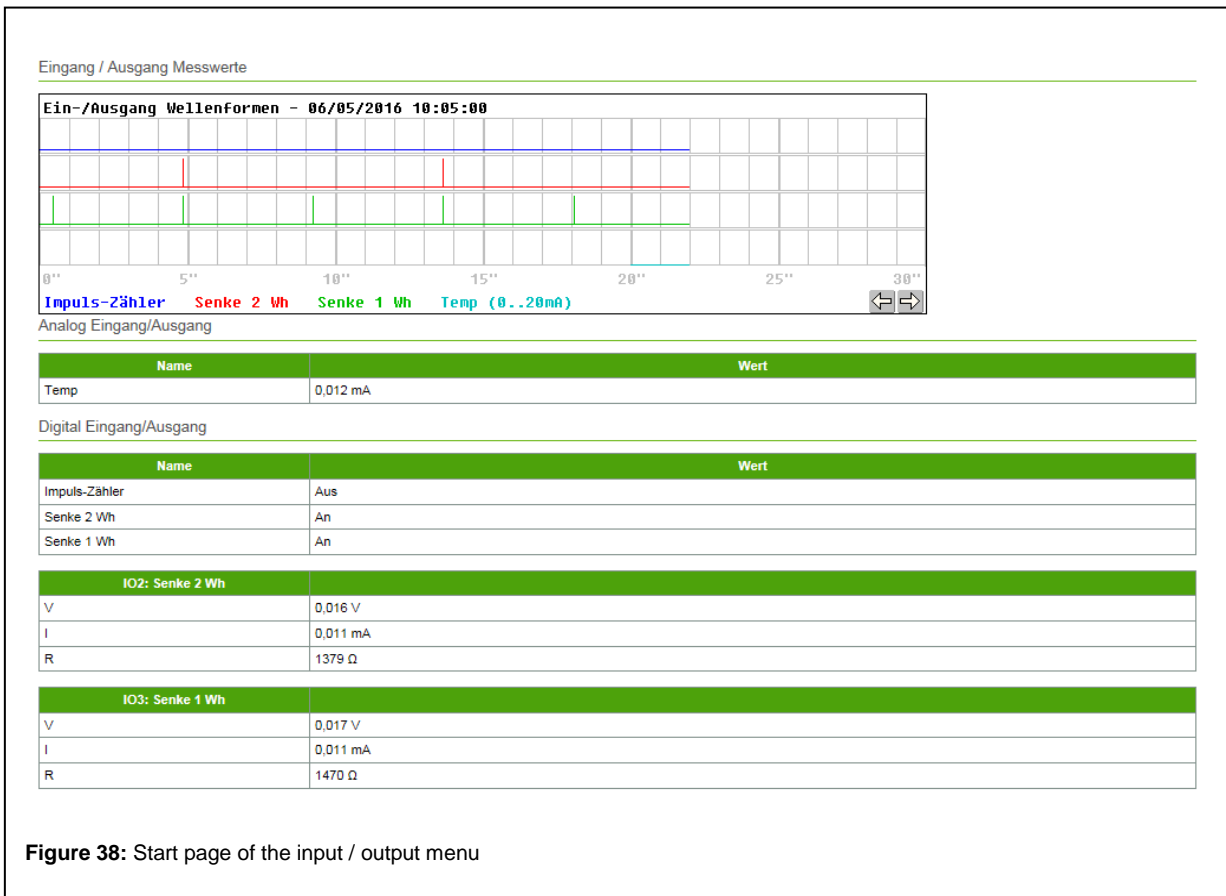


Figure 38: Start page of the input / output menu

The input / output menu is shown when inputs and outputs are configured in the LOG version of the econ sens3. **This can be enabled using the options key (see Options submenu in Chapter 8.10).** The applied values / impulses of the digital or analog inputs and outputs are displayed in the menu window.

Inputs / outputs are configured in the *Input / output* submenu in Chapter 8.10.

8.6 Events menu (PRO version)

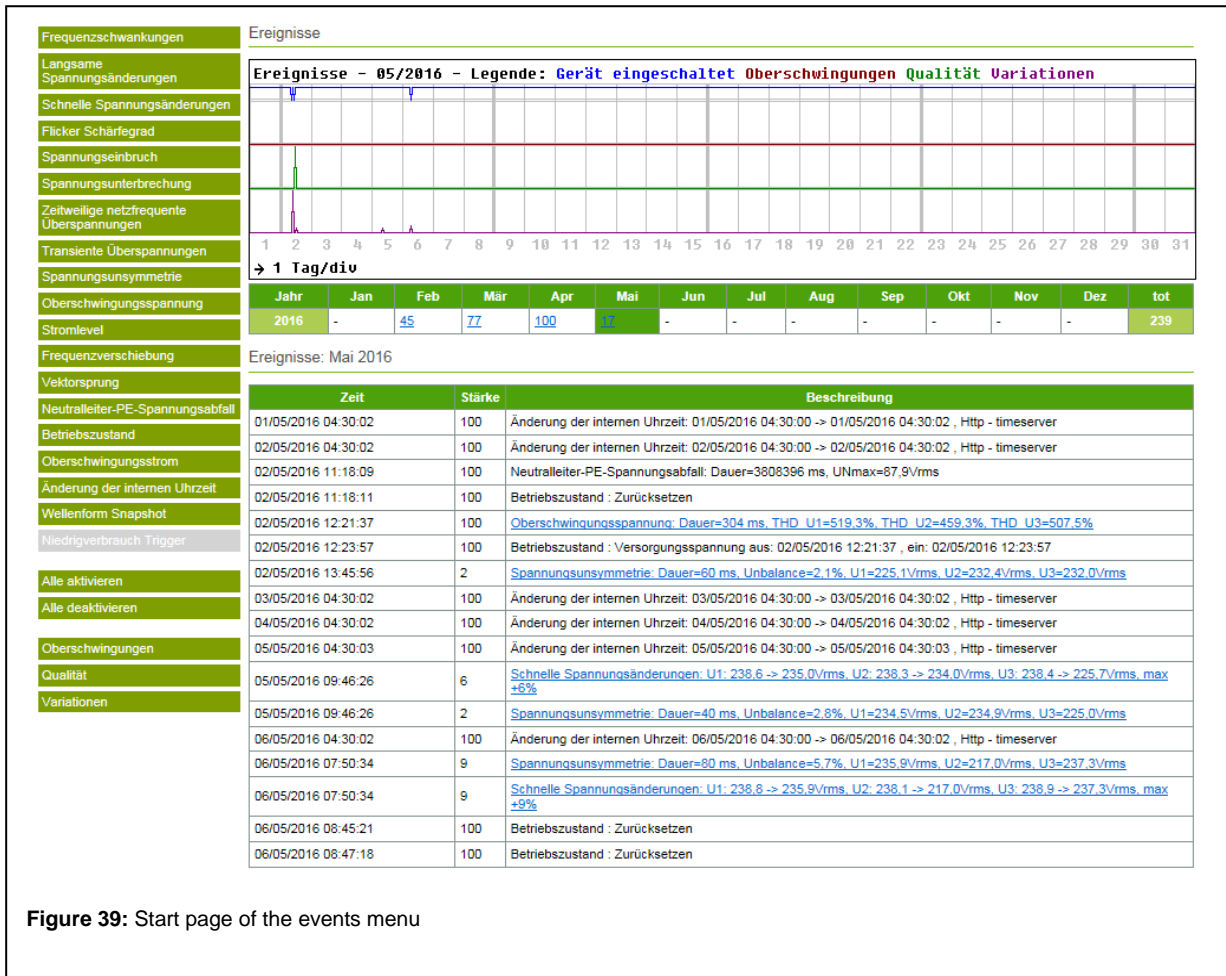


Figure 39: Start page of the events menu

The events menu is used to configure the recording of network events. These are needed within the scope of a network analysis in accordance with EN 50160. This function is optional (PRO version) and activated via the options key, see submenu *Options* in Chapter 8.10. Further explanations of the individual events can be found in the *Events* submenu in Chapter 8.10.

8.7 Export menu

In the export menu, various configurations can be made that affect the format and the scope of the data in the export file.

Messwerte exportieren

Name	Wert
Startzeitpunkt	<input type="text" value="06/05/2016 00:00:00"/>
Endzeitpunkt	<input type="text" value="07/05/2016 00:00:00"/>
Schritt	<input type="radio"/> 100ms <input type="radio"/> Sekunde <input type="radio"/> Minute <input checked="" type="radio"/> Intervall <input type="radio"/> Tag
Datenauswahl	<input checked="" type="checkbox"/> alle Daten (Nicht verfügbar für 100ms) <input type="checkbox"/> Gesamt-Energieverbrauch (Nicht verfügbar für 100ms) <input type="checkbox"/> Phasenspannung (U-N) <input type="checkbox"/> Netzspannung (U-N) (Nicht verfügbar für 100ms) <input type="checkbox"/> Ströme <input type="checkbox"/> Wirkleistung (P1,P2,P3) <input type="checkbox"/> Blindleistung (Q1,Q2,Q3) (Nicht verfügbar für 100ms) <input type="checkbox"/> Wirkleistung je Phase (P1+,P2+,P3+,-,P1-,P2-,P3-) <input type="checkbox"/> Eingang/Ausgang (Nicht verfügbar für 100ms) <input type="checkbox"/> Gesamtwirkleistung (Ptot+/-Ptot-) <input type="checkbox"/> Ereignisse (Nicht verfügbar für 100ms) <input type="checkbox"/> Asymmetrie
Leerzeilen einbeziehen	<input type="checkbox"/>
Für nicht selektierte Spalten Leerzeichen einfügen	<input type="checkbox"/>
Anzeige Sommerzeit / Winterzeit einschalten	<input type="checkbox"/>
IO Dummy-Wert	<input checked="" type="radio"/> leere Spalte <input type="radio"/> 0
Komma	<input type="radio"/> . <input checked="" type="radio"/> ,
Trennzeichen	<input checked="" type="radio"/> TAB <input type="radio"/> ;
Leistungsgrenze	<input checked="" type="radio"/> keine Grenze <input type="radio"/> Leerzeile weglassen wenn verbrauchte/erzeugte Leistung kleiner ist als <input type="text" value="0"/> W

✓ Übernehmen

Figure 40: Export menu

Start and end time are used to define the timing of the exported data.

The different increments (second, minute, interval, etc.) are used to define the granularity of the values within the export file.

Under data selection, you can determine which data will be exported in the file. If there are blank lines in the data pool, these can be hidden using the next point.

If you don't choose all of the data, you can insert blank spaces for unselected columns. Check the menu item "Insert blank spaces for unselected columns" to confirm.

Select the menu point “Enable daylight savings/standard time” to insert a column in the export file that adds a daylight savings or standard time designation to the time stamp.

The I/O dummy value enables the choice between blank column or 0 value in case of non-signals on or from the I/Os.

Floating point numbers can be separated with a period according to the American metric system or with a comma according to the European system.

The export is performed either in text or CSV format. The menu point “separator” is used to configure the separation of values in the file with a semicolon or a tab space.

If the export file should not show any blank lines below a specified threshold value, a power limit can be configured, below which the blank lines are omitted.

8.8 Contact menu

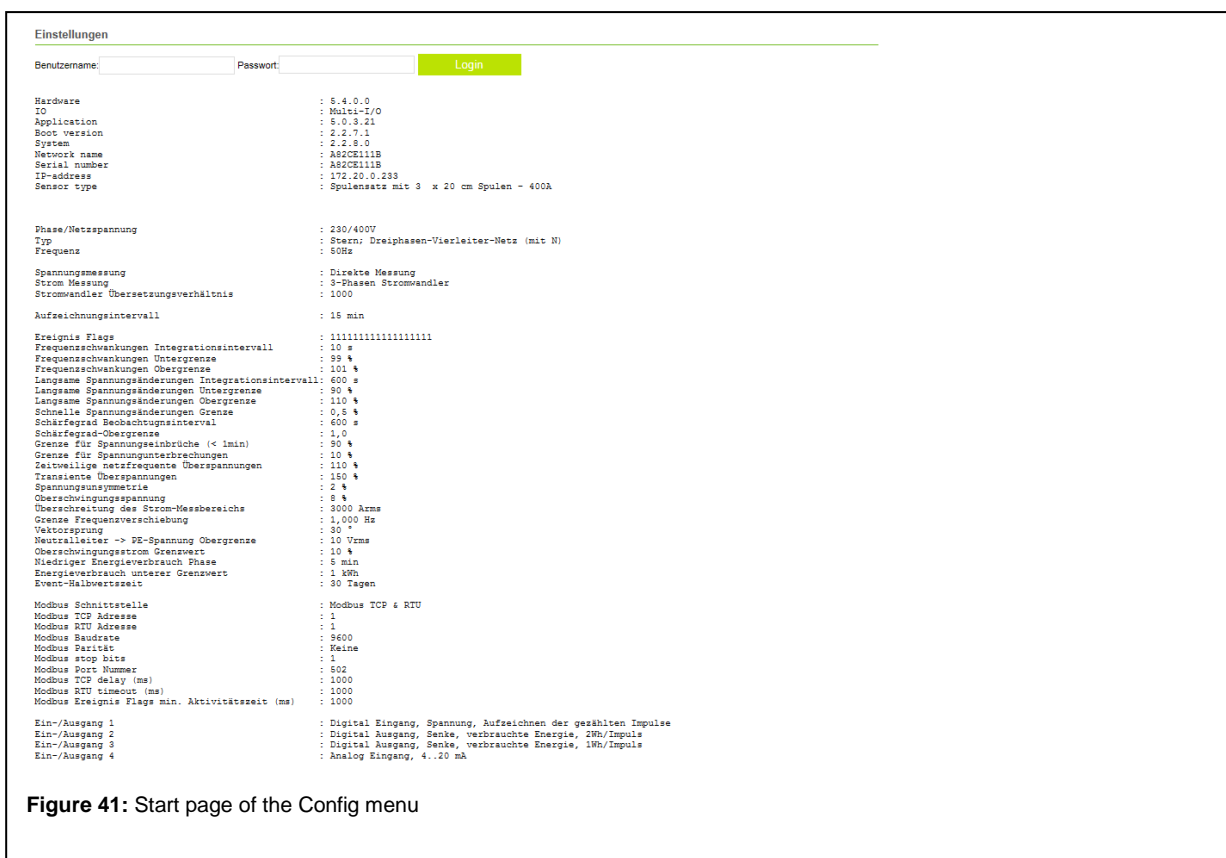
Clicking on the *Contact* menu takes you automatically to the official website of econ solutions GmbH, <http://www.econ-solutions.de>, where you will find information on other products from econ-solutions and of course also on the econ sens3.

8.9 Help menu

Clicking on the *Help* menu takes you automatically to the support area of the product website <http://www.econ-sens.com>, where this handbook and other support tools are available online.

8.10 Config menu

The *Config* menu is used for parameterization of the econ sens3. All of the settings required for operation of the instrument can be made in the associated submenus. Status information is displayed for the user on the start page of the menu. In case of a complaint, if possible, please attach a printout (or screenshot) of this menu start page to the RMA form, as the main settings of the instrument are shown here.



The screenshot shows the 'Einstellungen' (Settings) page of the econ sens3. It features a login form at the top with fields for 'Benutzername:' and 'Passwort:', and a 'Login' button. Below the login form, there is a list of system and configuration parameters. The parameters are organized into several sections: Hardware and System information, Phase/Netzspannung (Phase/Network Voltage), Spannungsmessung (Voltage Measurement), Strommessung (Current Measurement), Aufzeichnungsintervall (Recording Interval), Ereignis Flags (Event Flags), Modbus Schnittstelle (Modbus Interface), and Ein-/Ausgang (Input/Output). Each parameter is followed by its current value or status.

Parameter	Value
Hardware	: 5.4.0.0
IO	: Multi-I/O
Application	: 5.0.3.21
Boot version	: 2.2.7.1
System	: 2.2.8.0
Network name	: A82CE111B
Serial number	: A82CE111B
IP-address	: 172.20.0.233
Sensor type	: Spulensatz mit 3 x 20 cm Spulen - 400A
Phase/Netzspannung	: 230/400V
Typ	: Stern: Dreiphasen-Vierleiter-Netz (mit N)
Frequenz	: 50Hz
Spannungsmessung	: Direkte Messung
Strom Messung	: 3-Phasen Stromwandler
Stromwandler Übersetzungsverhältnis	: 1000
Aufzeichnungsintervall	: 15 min
Ereignis Flags	: 11111111111111111111
Frequenzschwankungen Integrationsintervall	: 10 s
Frequenzschwankungen Untergrenze	: 99 %
Frequenzschwankungen Obergrenze	: 101 %
Langsame Spannungsänderungen Integrationsintervall	: 600 s
Langsame Spannungsänderungen Untergrenze	: 90 %
Langsame Spannungsänderungen Obergrenze	: 110 %
Schnelle Spannungsänderungen Grenze	: 0.5 %
Schärfegrad Beobachtungsintervall	: 600 s
Schärfegrad-Obergrenze	: 1.0
Grenze für Spannungseinbrüche (< 1min)	: 90 %
Grenze für Spannungserhöhungen	: 110 %
Zeitweilige netzfrequente Überspannungen	: 150 %
Spannungsumschwelle	: 2 %
Überschwingungsspannung	: 8 %
Überschreitung des Strom-Messbereichs	: 3000 Arms
Grenze Frequenzüberschreitung	: 1,000 Hz
Vektorsprung	: 30 °
Neutralleiter -> TT-Spannung Obergrenze	: 10 Vrms
Überschwingungsstrom Grenzwert	: 10 %
Niedriger Energieverbrauch Phase	: 5 min
Energieverbrauch unterer Grenzwert	: 1 kWh
Event-Halbwertszeit	: 30 Tagen
Modbus Schnittstelle	: Modbus TCP & RTU
Modbus TCP Adresse	: 1
Modbus RTU Adresse	: 1
Modbus Baudrate	: 9600
Modbus Paritäts	: Keine
Modbus stop bits	: 1
Modbus Port Nummer	: 502
Modbus TCP delay (ms)	: 1000
Modbus RTU timeout (ms)	: 1000
Modbus Ereignis Flags min. Aktivitätszeit (ms)	: 1000
Ein-/Ausgang 1	: Digital Eingang, Spannung, Aufzeichnen der geschnitten Impulse
Ein-/Ausgang 2	: Digital Ausgang, Senke, verbrauchte Energie, ZWh/Impuls
Ein-/Ausgang 3	: Digital Ausgang, Senke, verbrauchte Energie, kWh/Impuls
Ein-/Ausgang 4	: Analog Eingang, 4...20 mA

Figure 41: Start page of the Config menu

You gain access to the submenus by entering your user name and password. Default values are as follows:

User name: user Password: pass

After login you will be forwarded to the submenus and taken automatically to the *Date* submenu.

General information on saving settings

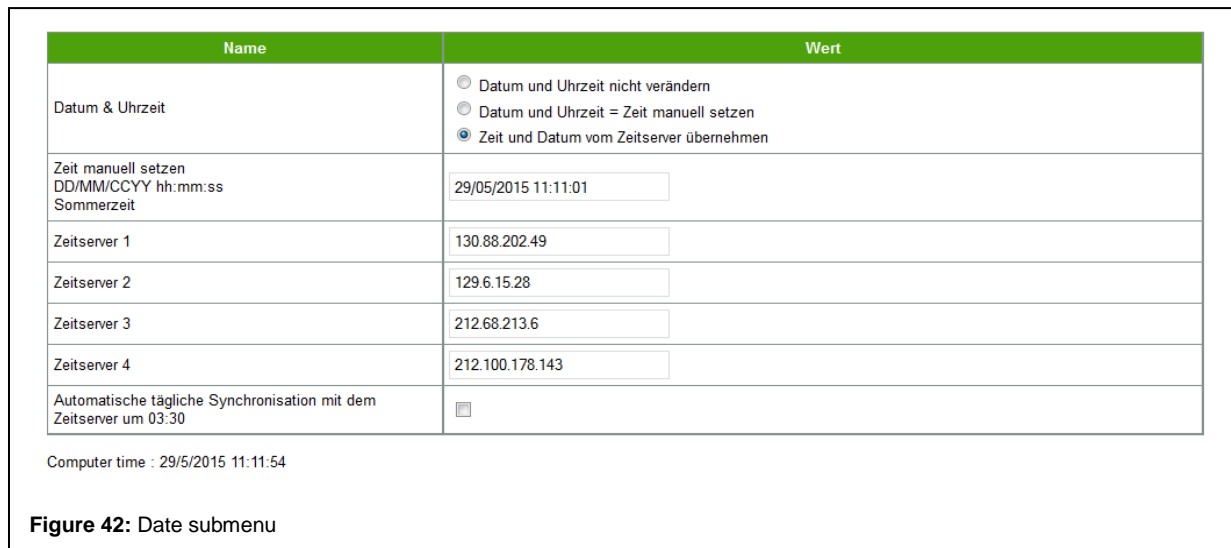
The entire configuration process of the econ sens3 is divided into multiple menus and various input windows.

There is an *Accept* button on each menu page that is used to save your input on the respective page; i.e., if you switch to a different menu page without pressing *Accept*, your entries are reset to the default values. To save your settings permanently at the end of the entire configuration process, select *Save* from the navigation bar on the right and press *Save* again to confirm. A saved change is confirmed with the message: Save under <Date><Time>.

The message “Don’t forget to save your changes permanently” will display on each menu page to remind you to save your settings permanently.

Date submenu

The *Date* submenu is used to configure the time and date settings of the econ sens3.



The following options are available for this:

1. Time setting over NTP time server

If the econ sens3 is located in a network with available time server with NTP protocol, the instrument can take over the time and date from this server. To do this, activate the selection field *Assume time and date from time server*.

You can define up to four NTP time servers. To do this, enter the IP address or the name of the respective server in the fields NTP Time Server 1 to 4; e.g. *ptbtime1.ptb.de* or *192.53.103.108*.

When you click on *Accept* econ sens3 checks first the connection to the specified server. In case of multiple servers, the instrument automatically selects the one with the shortest response time.

2. Setting the time manually:

If no NTP time server is available, the time settings of the instrument can also be made manually. Activate the selection *Date and time = Set time manually*. When you click on *Accept* the system time and date of the econ sens3 is compared to the values from the field *Set time manually*. Copy into this field for example the time setting of your PC displayed below.

Network submenu

In the *Network* submenu you can make the basic network settings of the econ sens3.

The screenshot shows the network settings interface. On the left is a vertical menu with options: Datum, Netzwerk, Elektrisch, Elektr. Erweitert, Eingang / Ausgang, Ereignisse, Modbus, Sprache / Messdetails, Alarmer, Autosave, Passwort, Speichern, Settings Datei, System, Optionen, and Update. The main area displays 'Verwendete Netzwerk einstellungen laut DHCP-Server:' with the following values: IP-Adresse: 172.20.0.233, Subnetzmaske: 255.255.255.0, Gateway: 172.20.0.1, Aktuelle Domäne: , DNS Server: 172.20.0.1, WINS Server: 0.0.0.0, and NTP Server: 0.0.0.0. Below this is a table with two columns: 'Name' and 'Wert'. The table contains settings for IP address assignment, standard IP address (169.254.1.1), standard subnet mask (255.255.0.0), standard gateway (0.0.0.0), DNS server (0.0.0.0), network device name (A82CE111B), and a checkbox for 'FTP-Zugriff auf das Gerät ermöglichen' which is checked. At the bottom are two buttons: 'Übernehmen' (green) and 'Abbruch' (red).

Name	Wert
Welche IP-Adresse soll verwendet werden?	<input checked="" type="radio"/> Wenn möglich, IP-Adresse per DHCP beziehen, ansonsten Standardwerte verwenden <input type="radio"/> Standardeinstellungen verwenden
Standard IP-Adresse	169.254.1.1
Standard Subnetzmaske	255.255.0.0
Standard Gateway	0.0.0.0
DNS Server	0.0.0.0
Netzwerk Geräte name	A82CE111B
FTP-Zugriff auf das Gerät ermöglichen	<input checked="" type="checkbox"/>

Figure 43: Start screen of the network menu

Displayed are the network settings according to the DHCP server, if the IP address assignment was made via DHCP. These include the choice between manual assignment of the IP address or assignment of the address via DHCP server. The factory default setting is the function *Obtain IP address via DHCP if possible*.

If the instrument does not detect a DHCP server, the values are taken automatically from the fields IP address, subnet mask, default gateway, DNS server, and network device name. The values shown in Fig. 43 represent the default settings of the instrument.

Electrical submenu

The *Electrical* submenu is used to configure the connection network of the econ sens3.

Name	Wert
Vorauswahl Dreieck; Dreiphasen-Dreileiter-Netz (ohne N) Stern; Dreiphasen-Vierleiter-Netz (mit N)	<input checked="" type="radio"/> Durch den Benutzer festgelegte Einstellungen <input type="radio"/> 130/230V 50Hz Dreieck., Aufzeichnungsintervall= 15min <input type="radio"/> 130/230V 50Hz Stern., Aufzeichnungsintervall= 15min <input type="radio"/> 230/400V 50Hz Dreieck., Aufzeichnungsintervall= 15min <input type="radio"/> 230/400V 50Hz Stern., Aufzeichnungsintervall= 15min
Wert für Vorauswahl 0	
Name	Wert
Frequenz	<input checked="" type="radio"/> 50Hz
Phase/Netzspannung	<input checked="" type="radio"/> 130/230V <input type="radio"/> 230/400V
Typ	<input checked="" type="radio"/> Stern; Dreiphasen-Vierleiter-Netz (mit N) <input type="radio"/> Dreieck; Dreiphasen-Dreileiter-Netz (ohne N) <input type="radio"/> 1-phasig
Aufzeichnungsintervall	<input type="radio"/> 10 min <input checked="" type="radio"/> 15 min <input type="radio"/> 20 min
<input checked="" type="button" value="Übernehmen"/> <input type="button" value="Abbruch"/>	

Figure 44: Start screen of the Electrical menu

The econ sens3 can be used in various networks; e.g., in 2-wire, 3-wire, and 4-wire networks with any load. The instrument can be used in networks with rated voltages of 120V or higher (e.g. in the USA) and in networks with 230/400 V. The network frequency is 50 Hz.

Only a few settings are needed to configure the network in which the econ sens3 is used.

You can either use a preselected setting or put together all of the parameters yourself with the user-defined settings.

Explanation of user-defined settings:

In Europe, primarily 230/400 V networks are used. The 130/230 V setting should be used for networks in the USA; 400 V networks are used in large industrial plants or wind turbines.

The network frequency in Europe is 50 Hz. Before you make any change to these parameters, you should first determine what setting should be selected.

Generally speaking, you will use the econ sens3 in a network, or measure the power consumption of a user, that is supplied with three phases and a neutral conductor. Exceptions are symmetrical users; e.g., large electrical motors; these are only linked over three phases.

Therefore, you can still choose among the triangle option (three-phase, three-wire network without neutral conductor) and the star option (three-phase, four-wire network with neutral conductor) or a one-phase network.

Name	Wert
Frequenz	<input checked="" type="radio"/> 50Hz
Phase/Netzspannung	<input type="radio"/> 130/230V <input checked="" type="radio"/> 230/400V
Typ	<input type="radio"/> Stern; Dreiphasen-Vierleiter-Netz (mit N) <input type="radio"/> Dreieck; Dreiphasen-Dreileiter-Netz (ohne N) <input checked="" type="radio"/> 1-phasig
Aufzeichnungsintervall	<input type="radio"/> 10 min <input checked="" type="radio"/> 15 min <input type="radio"/> 20 min

Figure 45: User-defined settings in the Electrical menu

The setting for *recording interval* defines whether you receive 15-minute or 20-minute mean values when exporting the energy consumption data, as described in the *Export* menu in Chapter 6.

Calculation of pulse weights:

Every pulse output over the two pulse outputs corresponds to an energy amount in Wh.

This is required because the pulse output can deliver a **maximum pulse frequency of 10 Hz**; this corresponds to 36,000 pulses/h.

The following equation can be used to calculate the maximum permissible pulse weighting factor.

$$X = \frac{(P * 1h)}{36000}$$

P = connected maximum load in watts

X = pulse weighting factor in Wh/pulse

Example: The user to be measured is a machine with $P_{Total} = 100 \text{ KW}$

$$X = \frac{100.000W * 1h}{36000} \approx 2,8 \frac{Wh}{imp}$$

In practice, with electricity meters there is often a pulse constant (referred to here as K) in imp/kWh. Conversion from X to this constant K is calculated by:

$$K = \frac{1}{X} * 1000$$

For our example, this means:

$$K = \frac{1}{2,8} * 1000 = 357 \frac{imp}{kWh}$$

Practice has shown that a pulse rate of **100 imp/kWh (= 10 Wh/imp)** is completely adequate. This calculation is the same as in setting the relationship with the input / output setting.

Electrical advanced submenu

The settings on this page should only be changed if current or voltage transformers are used. At this time, it is possible (on request) to connect econ split current transformers (5A transformers). Additional functions and settings are currently still in development.

Die Einstellungen auf dieser Seite sollten nur geändert werden, wenn Strom-, Spannungs- oder Leistungswandler eingesetzt werden

Name	Wert
Spannungsmessung	<input checked="" type="radio"/> Direkte Messung <input type="radio"/> Spannungswandler: Die Spannungen der Primärseite des Wandlers werden berechnet aus den Messwerten der Sekundärseite
Spannungswandler-Verhältnis (primär/sekundär)	1
Phasenverschiebung Primär/Sekundär	<input checked="" type="radio"/> Primär- und Sekundärseite in Phase <input type="radio"/> Die Sekundärseite eilt um 30° nach <input type="radio"/> Die Sekundärseite eilt um 30° vor
Nominalspannung Primärseite für Ereignis-Berechnungen	100

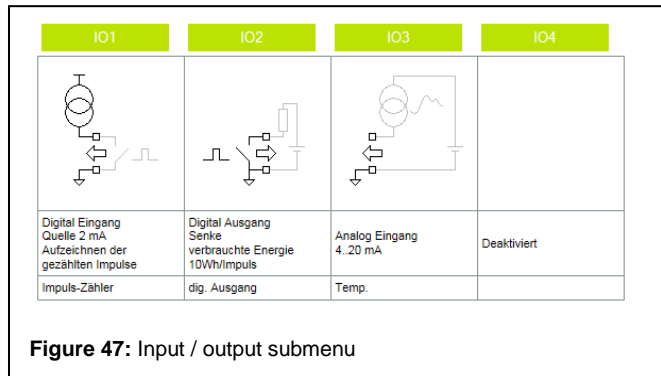
Name	Wert
Strom Messung	<input type="radio"/> Direkte Messung <input checked="" type="radio"/> 3-Phasen Stromwandler <input type="radio"/> 2-Phasen Stromwandler (Aron-Schaltung)
Stromwandler Übersetzungsverhältnis	1000

Strommessungen mit Wandlungsfaktor sind nur mit 5A-Wandlern möglich
 Warnung: Kein korrekter Strom-Sensor angeschlossen

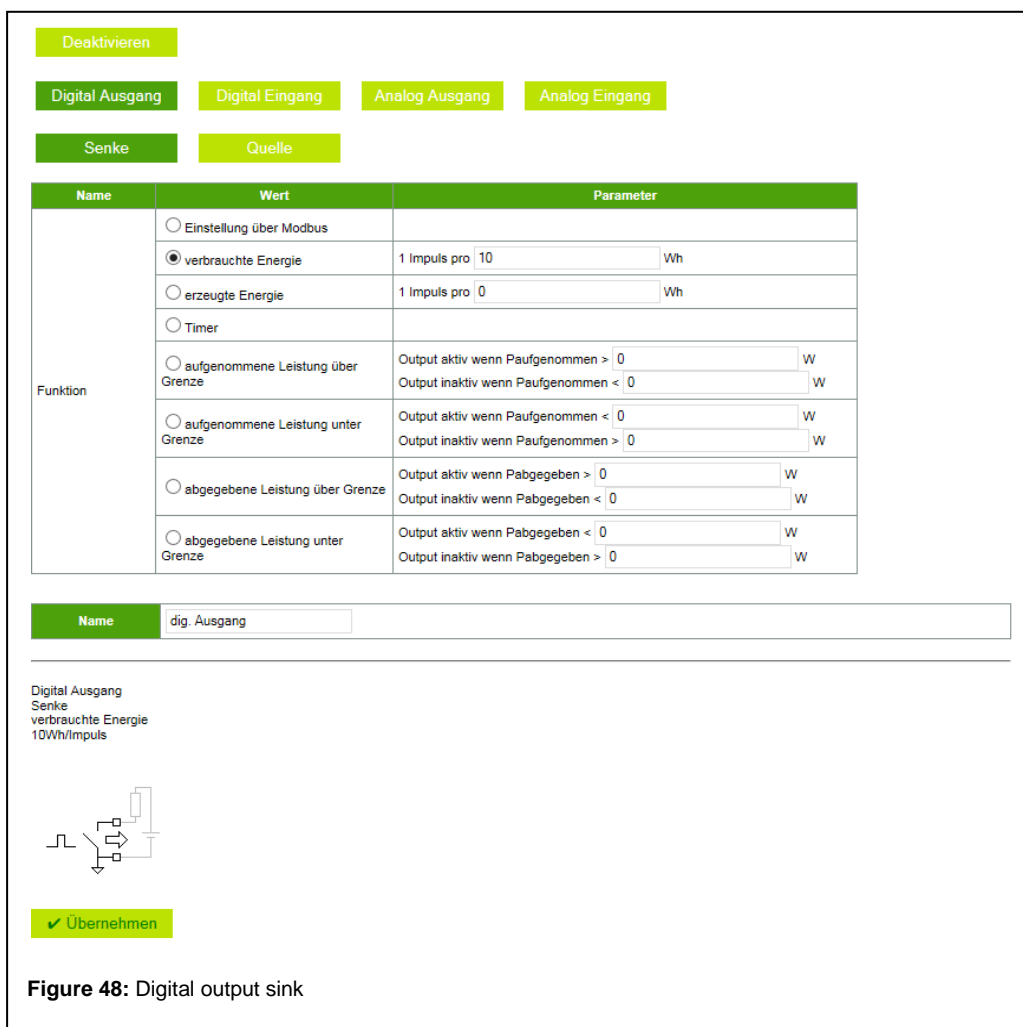
Figure 46: Electrical advanced submenu

Input / Output submenu (LOG version)

In the input / output submenu the additional interfaces of the sens3 can be activated or deactivated as inputs / outputs. Once you have selected an interface and activated it, various settings must still be made (see Fig. 47).



Digital output



Function	Description
Setting over Modbus	The value at the output is set or deleted in the Modbus register (see Chapter on Modbus Register). The value at the output is updated in 5 ms intervals.
Consumed energy	The sens3 sends the amount of consumed energy as number of pulses over the output. The user must define the factor for the number of Wh per pulse. Each pulse is 50 ms long and has a minimum interruption between two pulses of 50 ms. Therefore a maximum of 10 pulses per second can be sent. An example for determination of the factor below the table.
Generated energy	The same as for consumed energy, only that the pulses transmit the amount of generated energy.
Timer (currently in development)	The output can be activated/deactivated at certain times using a timer. The resolution of the timer is approximately 1 s.
Power input above/below limit	The output becomes active if the power input exceeds or falls below a set limit.
Power output above/below limit	The output becomes active if the power output exceeds or falls below a set limit.

An example of setting the factor for consumed energy:

Assumption: measurement with the sens3 of a machine with a consumption of 100 kWh. The sens3 transmits a maximum of 10 pulses per second; i.e., at 3,600 seconds / hour, a total of 36,000 pulses. This means with a factor of 1 that 36,000 Wh are transmitted. Therefore, with a measurement of 100,000 Wh (= 100 kWh), the factor should be increased. This would be, with 100,000 Wh / max. 36,000 pulses per hour = 2.778 a factor of at least 3.

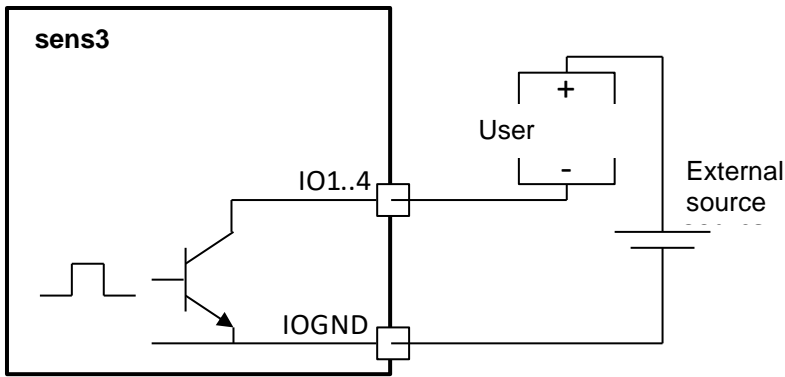
Sink

To use the output as sink requires an external source and an external user, as shown in the circuit diagram below.

If the output of the sens3 is active, a NPN transistor pulls the output to low. The emitter of the transistor is connected to the IOGND.

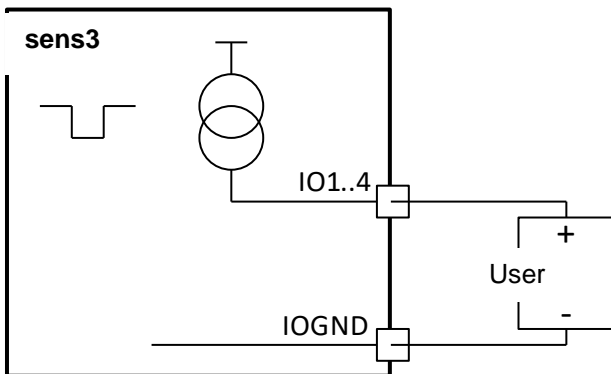
Important: the current of the output cannot be used to drive any inductive loads or relays. Only driving of an optocoupler is possible.

The current is limited to 21 mA and is monitored. If the current exceeds 21 mA it is deactivated for 5 seconds.



Source (pulse output)

Setting the output as source applies a current to the output. The consumer connected to it must be connected to the IOGND. The current can be set to 1 mA, 2 mA, 5 mA, 10 mA, or 20 mA. If the output is activated, the user draws the current.



Digital input

Deaktivieren

Digital Ausgang
Digital Eingang
Analog Ausgang
Analog Eingang

Spannung (Aktiv)
Quelle (Passiv)

Name	Wert
Aufzeichnungstyp	<input checked="" type="radio"/> Impuls-Zähler <input type="radio"/> Zustand

Name

Digital Eingang
 Spannung
 Aufzeichnen der gezählten Impulse

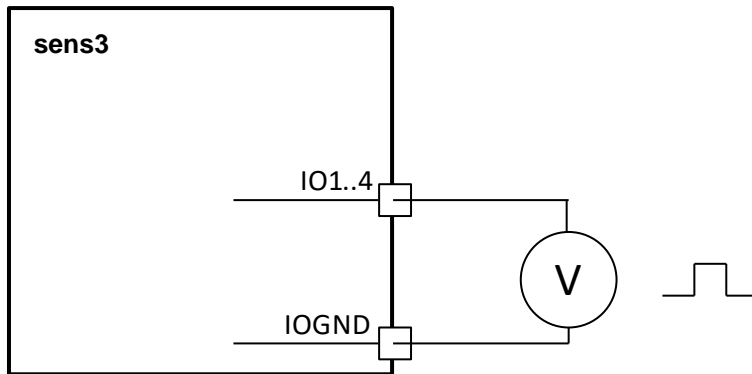
✓ Übernehmen

Figure 49: Digital input

If the interface of the sens3 is activated as input, the instrument counts the pulses applied to the input. The pulses can be both voltage-controlled (active) as well as current-controlled (passive).

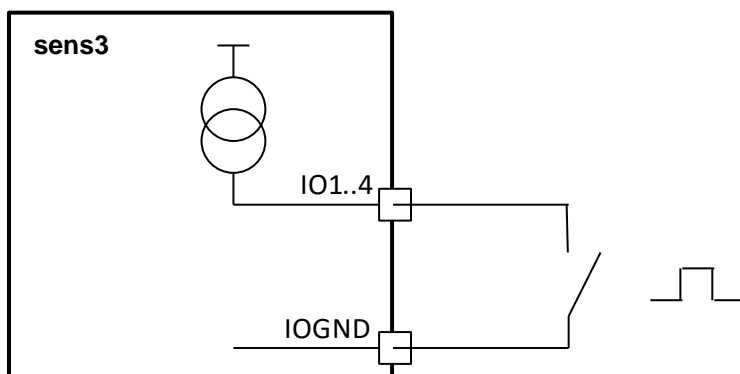
Active pulse (voltage-controlled)

The input is controlled by a voltage source. The counter increments on an active high input signal.



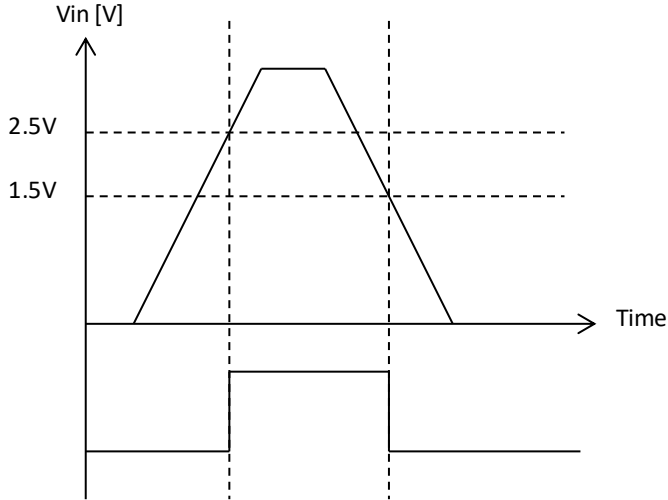
Passive pulse (current-controlled)

The sens3 applies a current supply to the input. This can be set to 1 mA, 2 mA, 5 mA, 10 mA, or 20 mA. The counter increments on an active low input signal. For this, an external switch can be connected. In the opened state, no current flows and the counter is incremented.

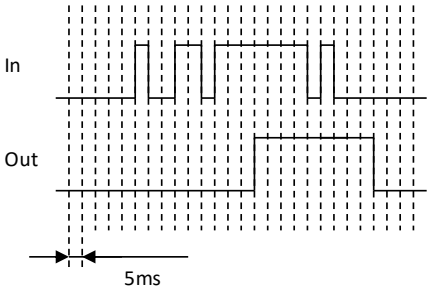


Input signal

For a digital input the voltage is measured on the input contact. A “high level” is present if the voltage is over 2.5 V. A “low level” is detected on the input if the voltage falls below 1.5 V. For voltage between 1.5 V and 2.5 V, the status of the input does not change.



The input is scanned in 5 ms intervals. The collected scans are debounced and only if 3 consecutive scans are stable will the recognized level be changed. The following image shows the debouncing process. Peaks for the time from one or two scans are filtered out.



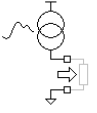
Analog output

Deaktivieren
Digital Ausgang
Digital Eingang
Analog Ausgang
Analog Eingang

Name	Wert	Parameter
Funktion	<input type="radio"/> Einstellung über Modbus	
	<input checked="" type="radio"/> aufgenommene Leistung	4mA für 0 W 20mA für 1000 <input type="text"/> W
	<input type="radio"/> abgegebene Leistung	4mA für 0 W 20mA für 0 <input type="text"/> W
	<input type="radio"/> Stromquelle	0 <input type="text"/> mA
	<input type="radio"/> Gesamtwirkleistung	4mA für 0 <input type="text"/> W 20mA für 0 <input type="text"/> W Gesamtwirkleistung = aufgenommene Leistung - abgegebene Leistung

Name

Analog Ausgang
 aufgenommene Leistung
 4mA = 0W, 20mA = 1000W



✓ Übernehmen

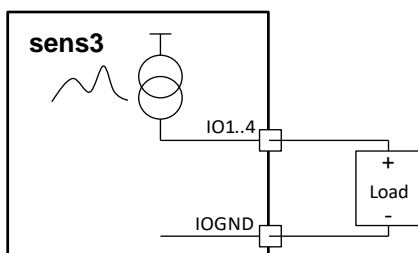
Figure 50: Analog output

Through setting of the interface as analog output, the sens3 supplies the output with a current between 4 and 20 mA.

This current cannot drive any inductive loads or relays.

Different functions are available for this:

Function	Description
Setting over Modbus	The current on the output is set by the value in the Modbus register. The output is updated in 5 ms intervals.
Power input	The current on the output is proportional to the power input. The user must determine how many watts (W) form the upper limit and are equal 20 mA.
Power output	The same as with the power input, only that the upper limit for the power output is entered.
Current source	Current source with fixed value x mA
Total active power	The current on the output is proportional to the total active power. The upper and lower limit must be configured (4 mA = xW; 20 mA = yW).



User

Analog input

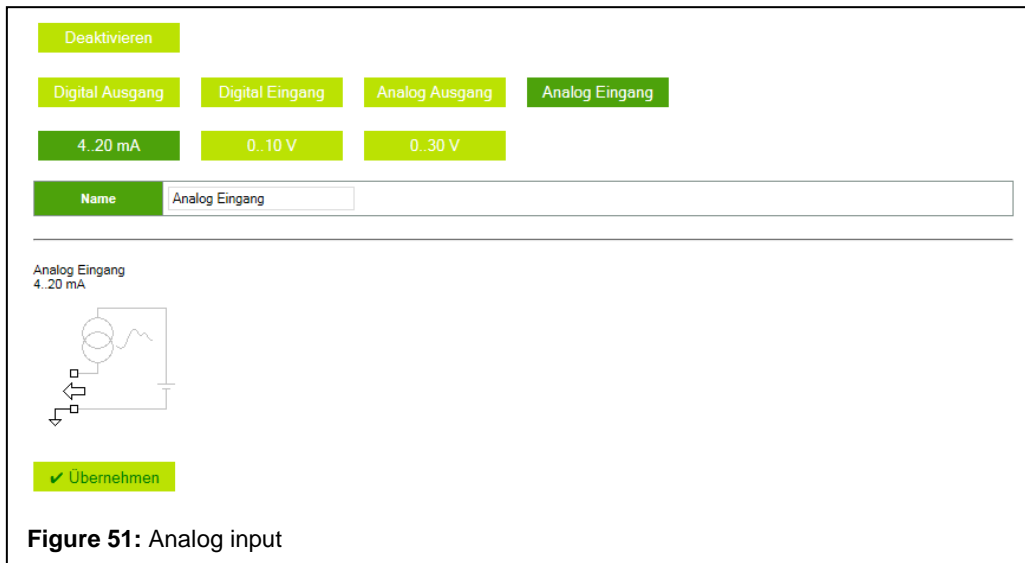
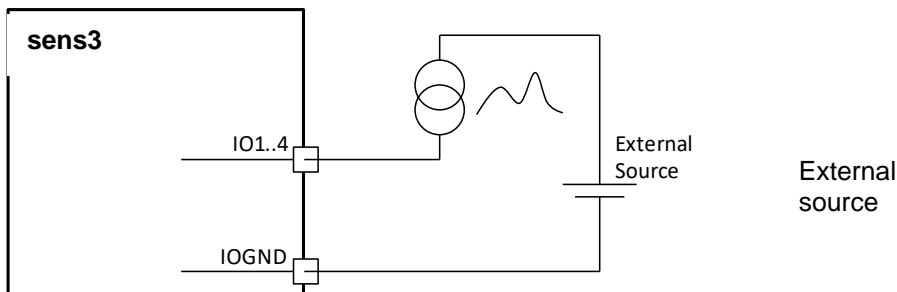


Figure 51: Analog input

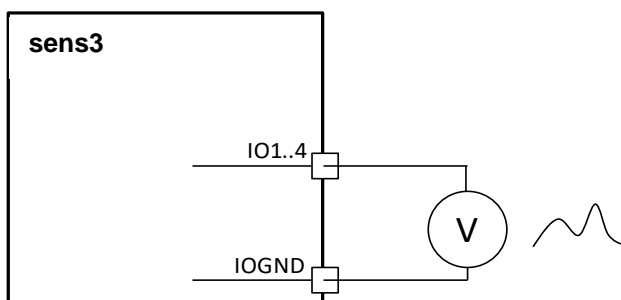
The analog input measures currents from 4 to 20 mA on the input contact.

Important: the current on the input contact is limited to 21 mA. An electronic fuse protects the input by checking it every 5 seconds. If the current of 21 mA is exceeded, the fuse is opened. If the current is below 21 mA again during the next check, the fuse is closed again.



Voltage

The voltage on the input contact is measured in V. There are two selectable operating ranges, 0 to 10 V and 0 to 30 V.



Events submenu (PRO version)

Name	Ereignisse aufzeichnen	Einstellungen	Wert
Frequenzschwankungen	<input checked="" type="checkbox"/>	Frequenzschwankungen Integrationsintervall	10 s
		Frequenzschwankungen Untergrenze	99 %
		Frequenzschwankungen Obergrenze	101 %
Langsame Spannungsänderungen	<input checked="" type="checkbox"/>	Langsame Spannungsänderungen Integrationsintervall	600 s
		Langsame Spannungsänderungen Untergrenze	90 %
		Langsame Spannungsänderungen Obergrenze	110 %
Schnelle Spannungsänderungen	<input checked="" type="checkbox"/>	Schnelle Spannungsänderungen Grenze	5 %
Flicker Schärfegrad	<input checked="" type="checkbox"/>	Schärfegrad Beobachtungsintervall	600 s
		Schärfegrad-Obergrenze	10
Spannungseinbruch	<input checked="" type="checkbox"/>	Grenze für Spannungseinbrüche (< 1min)	90 %
Spannungsunterbrechung	<input checked="" type="checkbox"/>	Grenze für Spannungsunterbrechungen	10 %
Zeitweilige netzfrequente Überspannungen	<input checked="" type="checkbox"/>	Zeitweilige netzfrequente Überspannungen	110 %
Transiente Überspannungen	<input checked="" type="checkbox"/>	Transiente Überspannungen	150 %
Spannungsunsymmetrie	<input checked="" type="checkbox"/>	Spannungsunsymmetrie	2 %
Oberschwingungsspannung	<input checked="" type="checkbox"/>	Oberschwingungsspannung	8 %
Stromlevel	<input checked="" type="checkbox"/>	Überschreitung des Strom-Messbereichs	3000 Arms
Frequenzverschiebung	<input checked="" type="checkbox"/>	Grenze Frequenzverschiebung	1000 %
Vektorsprung	<input checked="" type="checkbox"/>	Vektorsprung	30 °
Neutralleiter-PE-Spannungsabfall	<input checked="" type="checkbox"/>	Neutralleiter -> PE-Spannung Obergrenze	10 Vrms
Betriebszustand	<input checked="" type="checkbox"/>	-	-
Oberschwingungsstrom	<input checked="" type="checkbox"/>	Oberschwingungsstrom Grenzwert	10 %
Änderung der internen Uhrzeit	<input checked="" type="checkbox"/>	-	-
Wellenform Snapshot	<input checked="" type="checkbox"/>	-	-
Niedrigverbrauch Trigger	<input type="checkbox"/>	Niedriger Energieverbrauch Phase	5 min
		Energieverbrauch unterer Grenzwert	1 kWh
-	-	Event-Halbwertszeit	30 Tagen

Einstellungen nach EN50160 anwenden

Figure 52: User-defined settings in the Events submenu (PRO version)

Over an optional activation key (option key, see *Options* in Chapter 8.10) the econ sens3 can be expanded to the PRO version. The limiting values for the event recording are executed in this table (Figure 52).

Through selection of “Use settings according to EN50160” the limits are set to default values in accordance with the stated standard. The event log and the waveforms are opened over the **Events** menu item.

The requirements for event recording are described below:

Frequency fluctuations

The average network frequency is checked every 10 seconds for deviations greater than +/-1% of the nominal frequency. The default values are: lower limit 99% / upper limit 101%.

Slow voltage changes

The average supply voltage is checked every 10 minutes for deviations greater than +/-10% from the nominal supply voltage. The default values are: lower limit 90% / upper limit 110%.

Fast voltage changes

The measuring voltages of the 3 phases are checked for sudden voltage changes of more than 5% of the nominal measuring voltage. The default value is 5%

Flicker sharpness level

The measuring voltages of the 3 phases are checked. The method for calculating flicker is an approximation of the standard method. The default value is the limit value x10.

Voltage dip

The measuring voltages of the 3 phases are checked for voltages below 90% of the nominal voltage and under 1 minute duration. A waveform for this event is saved. The default value is 90%.

Voltage interruption

The measuring voltages of the 3 phases are checked for voltages below 10% of the nominal voltage and under 3 minutes duration. A waveform for this event is saved. The default value is 10%.

Short overvoltages

The measuring voltages of the 3 phases are checked for overvoltages above 110% of the nominal voltage and under 3 minutes duration. A waveform for this event is saved. The default value is 110%.

Transient overvoltages

The measuring voltages of the 3 phases are checked for overvoltages above 150% of the nominal voltage and under 1 minute duration. A waveform for this event is saved. The default value is 150%.

Voltage asymmetries

The measuring voltages of the 3 phases are checked for asymmetries above 2%. A waveform for this event is saved. The default value is 2%.

Harmonic voltage

The measuring voltages of the 3 phases are checked for total harmonic distortions of voltage over 8%. Harmonics up to the 15th are detected. A waveform for this event is saved. The default value is 8%.

Current limit

The currents of the 3 phases are checked for currents above the maximum current range. A waveform for this event is saved. The default value is 3000Arms.

Frequency shift

The network frequency is checked for sudden changes in frequency of more than 1 Hz of the nominal measurement voltage. A waveform for this event is saved. The default value is 1000mHz.

Vector jump

The measuring voltages of the 3 phases are checked for whether the voltage angle exceeds 30°. A waveform for this event is saved. The default value is 30°.

Neutral conductor voltage

The neutral conductor voltage is checked for voltages over 10% of the nominal measurement voltage. The default value is 10%.

Switch on and switch off time

The last switch on and switch off times are documented.

Harmonic current

The measuring voltages of the 3 phases are checked for THDs over 2%. The default value is 100%.

Clock time change

Changes to the internal clock time are documented.

Waveform snapshot

With this function, snapshots (see *Measurement* submenu in Chapter 8.3) are saved and displayed in the events list.

Low consumption trigger

With this function, phases of low energy consumption can be defined. In this process, the time restriction as well as a value limit can be set.

In the Events submenu up to 6 parameters are recorded for each event. The description is found in the following table (unused parameter=0):

Event	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
Frequency fluctuations	Measured frequency [mHz]	Ratio to measured nominal frequency [%]	0	0	0	0
Slow voltage changes	Measured voltage L 1 [dVrms]	Measured voltage L 2 [dVrms]	Measured voltage L 3 [dVrms]	Ratio of maximum measured voltage to nominal voltage [%]	0	0
Fast voltage changes	Voltage change L 1 [dVrms]	Voltage change L 2 [dVrms]	Voltage change L 3 [dVrms]	0	0	0
Flicker sharpness level	Short term flicker L 1 [-/10]	Short term flicker L 2 [-/10]	Short term flicker L 3 [-/10]	0	0	0
Voltage dip	Lowest ratio to measured nominal voltage for L1 [%]	Lowest ratio to measured nominal voltage for L2 [%]	Lowest ratio to measured nominal voltage for L3 [%]	Duration [ms]	0	0
Voltage interruption	Lowest voltage L1 [dVrms]	Lowest voltage L2 [dVrms]	Lowest voltage L3 [dVrms]	Duration [ms]	0	0
Temporary transient overvoltage	Highest ratio to measured nominal voltage L1 [%]	Highest ratio to measured nominal voltage L2 [%]	Highest ratio to measured nominal voltage L3 [%]	Duration [ms]	0	0
Transient overvoltages	Overvoltage L1 [dVrms*s]	Overvoltage L2 [dVrms*s]	Overvoltage L3 [dVrms*s]	Duration [ms]	0	0
Voltage asymmetry	Maximum asymmetry L1 [%]	Maximum asymmetry L2 [%]	Maximum asymmetry L3 [%]	Duration [ms]	0	0
Harmonic voltage	Maximum harmonic distortion L1 [%]	Maximum harmonic distortion L2 [%]	Maximum harmonic distortion L3 [%]	Duration [ms]	0	0
Current limit	Overcurrent L1 [dArms*s]	Overcurrent L2 [dArms*s]	Overcurrent L3 [dArms*s]	Duration [ms]	0	0
Frequency shift	Frequency before change [mHz]	Frequency before change [mHz]	0		0	0
Vector jump	Vector jump L1 [°]	Vector jump L2 [°]	Vector jump L3 [°]		0	0
Neutral conductor voltage	Highest neutral conductor voltage [dVrms]	Duration [ms]	0	0	0	0
Supply voltage on/off	1=on, 0=off	0	0	0	0	0
Harmonic current	Maximum harmonic distortion L1 [%]	Maximum harmonic distortion L2 [%]	Maximum harmonic distortion L3 [%]	Duration [ms]	0	0
Change to internal clock time	Time difference [s]	0	0	0	0	0
Low consumption trigger	Energy consumption limit [kWh]	Duration of low energy consumption [min]				

Modbus submenu

The settings for the Modbus communications option are made in this section.

Name	Wert
Modbus Schnittstelle	<input type="radio"/> Keine <input type="radio"/> Modbus TCP (Ethernet) <input type="radio"/> Modbus RTU (RS485) <input checked="" type="radio"/> Modbus Gateway <input type="radio"/> Modbus TCP & RTU
Modbus TCP Adresse	1
Modbus RTU Adresse	1
Modbus Baudrate	<input type="radio"/> 9600 <input type="radio"/> 19200 <input type="radio"/> 38400 <input type="radio"/> 57600 <input checked="" type="radio"/> 115200
Modbus Parität	<input checked="" type="radio"/> Keine <input type="radio"/> ungerade <input type="radio"/> gerade
Modbus stop bits	<input checked="" type="radio"/> 1 <input type="radio"/> 2
Modbus Port Nummer	502
Modbus TCP delay (ms)	1000
Modbus RTU timeout (ms)	1000
Modbus Ereignis Flags min. Aktivitätszeit (ms)	1000

Figure 53: Modbus submenu (Example: Modbus TCP)

Modbus settings

The setup must be executed over the HTML side.

Parameter	Description
Modbus interface	Protocol selection: - None - Modbus TCP - Modbus RTU (RS485) - Modbus Gateway
Modbus address	Instrument address, applies to Modbus: 0 to 255
Modbus baud rate	Baud rate, RS485: 9600, 19200, 38400, 57600, and 115200
Modbus parity	Parity, RS485: none, odd, even
Modbus stop bits	Stop bits: 1 or 2
Modbus port number	Port number for Modbus over TCP/ IP. Default value: 502. Other values are possible.
Modbus TCP delay	This parameter is only used if the econ sens3 is used as Modbus gateway. Values: 0 to 3600000 ms
Modbus RS 485 time-out	This parameter is only used if the econ sens3 is used as Modbus gateway. Values: 0 to 3600000 ms
Modbus event flag min. Activity time (ms)	This parameter is used to set a minimum activity time of the event flag. For this time (in ms), the event flag is held at 1. Values: 0 to 3600000 ms

Modbus register addresses

Address range	Description	Data type
2 to 110	Measurement – current value	32 bit, float
120 to 126	Measurement – current value	32 bit, float
200 to 217	Event flag	1 bit
300 to 340	Event settings	32 bit, integer
400 to 406	System	16 bit, integer
410 to 416	System	32 bit, integer
500 to 510	Event – measured value	32 bit, float
600 to 603	IO measured values	16 bit, integer
1002 to 1110	Measurement – current value	32 bit, float, switched
1120 to 1126	Measurement – current value	32 bit, float, switched
1300 to 1340	Event settings	32 bit, integer, switched
1500 to 1510	Event – measured values	32 bit, integer, switched

Included in the table are all register addresses that can be read over Modbus. All data are offered in data type: float with 2 registers and a total of 4 bytes.

The data are located in registers 2 to 110 and 1002 to 1110. The data in the Modbus registers can be retrieved in the format:

- Big endian (high byte before low byte) - Register 2 to 110
- Little endian (low byte before high byte) - Register 1002 to 1110.

The Modbus functions “Read Holding Registers” (0x03) and “Read Input Registers” (0x04) are supported. Register 2 to 110 (1002 to 1110) are addressed as 1 to 109 (1001 to 1119).

An example: if the register for the counter status active power of phase L3 is to be read out, register 7 is input for big endian byte order and 1007 for little endian.

Name	Register	Address	Description	Phase	Unit
Ptot	2	1002	Active power (counter status)	L1,L2,L3	kWh
P L1	4	1004	Active power (counter status)	L1	kWh
P L2	6	1006	Active power (counter status)	L2	kWh
P L3	8	1008	Active power (counter status)	L3	kWh
Qtot	10	1010	Reactive power (counter status)	L1,L2,L3	kvarh
Q L1	12	1012	Reactive power (counter status)	L1	kvarh
Q L2	14	1014	Reactive power (counter status)	L2	kvarh
Q L3	16	1016	Reactive power (counter status)	L3	kvarh
u(L1)	18	1018	Voltage (current value)	L1-L2	V
u(L2)	20	1020	Voltage (current value)	L2-L3	V
u(L3)	22	1022	Voltage (current value)	L3-L1	V
un(L1)	24	1024	Voltage (current value)	L1-N	V
un(L2)	26	1026	Voltage (current value)	L2-N	V
un(L3)	28	1028	Voltage (current value)	L3-N	V
i(L1)	30	1030	Current (current value)	L1	A
i(L2)	32	1032	Current (current value)	L2	A

i(L3)	34	1034	Current (current value)	L3	A
p(L1)	36	1036	Active power (current value)	L1	kW
p(L2)	38	1038	Active power (current value)	L2	kW
p(L3)	40	1040	Active power (current value)	L3	kW
q(L1)	42	1042	Reactive power (current value)	L1	kvar
q(L2)	44	1044	Reactive power (current value)	L2	kvar
q(L3)	46	1046	Reactive power (current value)	L3	kvar
s(L1)	48	1048	Apparent power (current value)	L1	kVA
s(L2)	50	1050	Apparent power (current value)	L2	kVA
s(L3)	52	1052	Apparent power (current value)	L3	kVA
PF tot	54	1054	Power factor (current value)	L1,L2,L3	
PF(L1)	56	1056	Power factor (current value)	L1	
PF(L2)	58	1058	Power factor (current value)	L2	
PF(L3)	60	1060	Power factor (current value)	L3	
Hdu(L1)	62	1062	Voltage distortion (current value)	L1-N; THD	%
Hdu(L2)	64	1064	Voltage distortion (current value)	L2-N; THD	%
Hdu(L3)	66	1066	Voltage distortion (current value)	L3-N; THD	%
Hdi(L1)	68	1068	Current distortion (current value)	L1; THD	%
Hdi(L2)	70	1070	Current distortion (current value)	L2; THD	%
Hdi(L3)	72	1072	Current distortion (current value)	L3; THD	%
Temp	74	1074	Temperature (current value)		°C
Freq	76	1076	Frequency (current value)		Hz
P+tot	78	1078	Active power, recovery (counter status)	L1,L2,L3	kWh
P+ L1	80	1080	Active power, recovery (counter status)	L1	kWh
P+ L2	82	1082	Active power, recovery (counter status)	L2	kWh
P+ L3	84	1084	Active power, recovery (counter status)	L3	kWh
P-tot	86	1086	Active power, feed-back (counter status)	L1,L2,L3	kWh
P- L1	88	1088	Active power, feed-back (counter status)	L1	kWh
P- L2	90	1090	Active power, feed-back (counter status)	L2	kWh
P- L3	92	1092	Active power, feed-back (counter status)	L3	kWh
Q+tot	94	1094	Reactive power, recovery (counter status)	L1,L2,L3	kvarh
Q+ L1	96	1096	Reactive power, recovery (counter status)	L1	kvarh
Q+ L2	98	1098	Reactive power, recovery (counter status)	L2	kvarh
Q+ L3	100	1100	Reactive power, recovery (counter status)	L3	kvarh
Q-tot	102	1102	Reactive power, feed-back (counter status)	L1,L2,L3	kvarh
Q- L1	104	1104	Reactive power, feed-back (counter status)	L1	kvarh
Q- L2	106	1106	Reactive power, feed-back (counter status)	L2	kvarh
Q- L3	108	1108	Reactive power, feed-back (counter status)	L3	kvarh
U (N)	110	1110	Voltage (current value)	N	V

Modbus register – current values/counter statuses Part 1

Name	Register	Description	Phase	Unit
i tot	120	Current, total (current value)	L1,L2,L3	A
p tot	122	Active power, total (current value)	L1,L2,L3	kW
q tot	124	Reactive power, total (current value)	L1,L2,L3	kvar
s tot	126	Apparent power, total (current value)	L1,L2,L3	kVA

Modbus register – current values/counter statuses Part 2

Modbus events (statuses)

The following list contains all of the statuses that can be read over the Modbus. Each event has a unique bit (flag). When the event commences, the bit (flag) is set by the econ sens3. The event flag remains set at least for the minimum activity time and at the most until the end of the event. The commands “Read Coils” (0x01), “Read Discrete Inputs” (0x02) Bit Register 200 to 216 are parameterized as 199 to 215.

Name	Register
Frequency fluctuations	200
Slow voltage changes	201
Fast voltage changes	202
Flicker sharpness level	203
Voltage dip	204
Voltage interruption	205
Temporary power frequency overvoltages	206
Transient overvoltages	207
Voltage asymmetry	208
Harmonic voltage	209
Current level	210
Frequency shift	211
Vector jump	212
Neutral conductor – PE voltage drop	213
Supply voltage on/off	214
Harmonic current	215
Change of internal clock time	216

Table - Modbus events

Modbus events settings

The events settings must be read out over register 300 to 400 or 1300 to 1340.

Name	Register
Frequency fluctuations interval	300
Frequency fluctuations lower limit	302
Frequency fluctuations upper limit	304
Slow voltage changes interval	306
Slow voltage changes lower limit	308
Slow voltage changes upper limit	310

Fast voltage changes limit	312
Flicker sharpness level interval	314
Flicker sharpness level limit	316
Voltage dip limit	318
Voltage interruption limit	320
Temporary power frequency overvoltages limit	322
Transient overvoltages limit	324
Voltage asymmetry limit	326
Harmonic voltage limit	328
Current level	330
Frequency shift limit	332
Vector jump limit	334
Neutral conductor – PE voltage drop limit	336
Harmonic current limit	338
Event half-life period	340

Modbus system register

Name	Register
Serial number	400
Year	401
Month	402
Day	403
Hour	404
Minute	405
Second	406

Table - Modbus system register

Modbus I/O register

Name	Register
I/O 1	600
I/O 2	601
I/O 3	602
I/O 4	603

Table – Modbus I/O register

Events measurement register

Short term flicker strength (Pst) is measured over a time interval of ten minutes (variable). Long term flicker strength (Pt) is calculated from a sequence of 12 Pst values over a 2-hour interval.

Name	Register
Short term flicker strength Pst L1	500
Short term flicker strength Pst L2	502
Short term flicker strength Pst L3	504
Long term flicker strength Plt L1	506
Long term flicker strength Plt L2	508
Long term flicker strength Plt L3	510

Table - Modbus events measurement register

Modbus TCP

If the econ sens3 is used as Modbus slave over TCP/IP, the Modbus TCP specification suggests the port number 502 for use. Other values are possible.

Modbus RTU

If the econ sens3 is used as Modbus slave over RS485, the serial interface parameters are required.

Modbus gateway

If the econ sens3 is used as Modbus gateway, all parameters are required.

The Modbus TCP specification suggests use of port number 502. Other values are possible.

If the Modbus gateway receives a query over TCP/IP with a non-proprietary Modbus address, it will function as Modbus server. In this way, a device can serve simultaneously as both gateway and server. All queries with a different Modbus address are sent to the RS485 bus.

The TCP delay is the time in milliseconds after which the gateway sends a query to the RS485 bus.

During the TCP delay, no new requests are placed on the TCP/IP input. This functionality is deactivated by setting the TCP delay to 0.

The RS485 timeout is the time that the gateway waits for a response over the RS485 line. If no response is received within this time, it sends an exception code 0xB "Gateway target device does not respond" to the master. 0 deactivates this function.

Language / Measurement Details submenu

Various basic settings for the sens3 can be made in the language / measurement details submenu, as explained in the table below:

Function	Description
Language	Sets the language displayed in the sens3 web interface
Phase color	Changes the color used to display the phases in the "Measurement" menu
Display UU column in "Measurement"	Displays or omits the column with the voltage of the phases against each other
Display energy table in "Measurement"	Activates or deactivates display of the energy table in the "Measurement" menu
Decimal separator	Designates the use of a period or a comma to designate the floating point

Name	Wert
Sprache	<input type="radio"/> English <input type="radio"/> Nederlands <input checked="" type="radio"/> Deutsch <input type="radio"/> Français
Phase Farbe	<input checked="" type="radio"/> Rot/Grün/Blau <input type="radio"/> Braun/Schwarz/Grau
UU Spalte in "Messung" anzeigen	<input checked="" type="checkbox"/>
Energie-Tabelle in "Messung" anzeigen	<input checked="" type="checkbox"/>
Dezimaltrennzeichen	<input type="radio"/> . <input checked="" type="radio"/> ,

Figure 54: Language / Measurement Details submenu

Alarms² submenu

If set limit values under *Events* are exceeded or undercut, an alarm can be triggered and saved to a specified FTP server.

² Alarm pin function: currently in development

The FTP server must be defined in order to use the function.

Name	Alarm Pin	FTP
Frequenzschwankungen	<input type="checkbox"/>	<input type="checkbox"/>
Langsame Spannungsänderungen	<input type="checkbox"/>	<input type="checkbox"/>
Schnelle Spannungsänderungen	<input type="checkbox"/>	<input type="checkbox"/>
Flicker Schärfegrad	<input type="checkbox"/>	<input type="checkbox"/>
Spannungseinbruch	<input type="checkbox"/>	<input type="checkbox"/>
Spannungsunterbrechung	<input type="checkbox"/>	<input type="checkbox"/>
Zeitweilige netzfrequente Überspannungen	<input type="checkbox"/>	<input type="checkbox"/>
Transiente Überspannungen	<input type="checkbox"/>	<input type="checkbox"/>
Spannungsunsymmetrie	<input type="checkbox"/>	<input type="checkbox"/>
Oberschwingungsspannung	<input type="checkbox"/>	<input type="checkbox"/>
Stromlevel	<input type="checkbox"/>	<input type="checkbox"/>
Frequenzverschiebung	<input type="checkbox"/>	<input type="checkbox"/>
Vektorsprung	<input type="checkbox"/>	<input type="checkbox"/>
Neutralleiter-PE-Spannungsabfall	<input type="checkbox"/>	<input type="checkbox"/>
Betriebszustand	<input type="checkbox"/>	<input type="checkbox"/>
Oberschwingungsstrom	<input type="checkbox"/>	<input type="checkbox"/>
Änderung der internen Uhrzeit	<input type="checkbox"/>	<input type="checkbox"/>
Wellenform Snapshot	<input type="checkbox"/>	<input type="checkbox"/>
Niedrigverbrauch Trigger	Ereignis ist deaktiviert	

Name	Wert
Alarm Pin Minimum in Zeit (ms)	<input type="text" value="0"/>
Alarm Pin Minimum nicht in Zeit (ms)	<input type="text" value="0"/>

Name	Wert
FTP server	<input type="text"/>
Benutzername	<input type="text"/>
Passwort	<input type="text"/>
Pfad Name	<input type="text"/>

✓ Übernehmen
✗ Abbruch

Figure 55: Alarms submenu

Autosave submenu

The *Autosave* submenu offers the option of having the data exports written to an FTP server or the integrated SD memory card.

The files to be saved are first selected; this is performed analogously to the export function (see *Export* submenu in Chapter 8.6). Additionally, determination is made to save to the SD card or the FTP server. The FTP server must be defined accordingly.

Name	Wert
Schritt	<input checked="" type="radio"/> Minute <input type="radio"/> Intervall
Intervall speichern	<input checked="" type="radio"/> Minute <input type="radio"/> Intervall <input type="radio"/> Stunde <input type="radio"/> Tag
Datenauswahl	<input type="checkbox"/> alle Daten <input checked="" type="checkbox"/> Gesamt-Energieverbrauch <input type="checkbox"/> Phasenspannung (U-N) <input type="checkbox"/> Netzspannung (U-U) <input type="checkbox"/> Ströme <input type="checkbox"/> Wirkleistung (P1,P2,P3) <input type="checkbox"/> Blindleistung (Q1,Q2,Q3) <input type="checkbox"/> Wirkleistung je Phase (P1+,P2+,P3+,P1-,P2-,P3-) <input checked="" type="checkbox"/> Eingang/Ausgang <input type="checkbox"/> Gesamtwirkleistung (Ptot+/Ptot-) <input type="checkbox"/> Ereignisse
Leerzeilen einbeziehen	<input type="checkbox"/>
Für nicht selektierte Spalten Leerzeichen einfügen	<input type="checkbox"/>
Anzeige Sommerzeit / Winterzeit einschalten	<input type="checkbox"/>
IO Dummy-Wert	<input checked="" type="radio"/> leere Spalte <input type="radio"/> 0
Dezimaltrennzeichen	<input checked="" type="radio"/> . <input type="radio"/> ,
Trennzeichen	<input checked="" type="radio"/> TAB <input type="radio"/> ;
Leistungsgrenze	<input checked="" type="radio"/> keine Grenze <input type="radio"/> Leerzeile weglassen wenn verbrauchte/erzeugte Leistung kleiner ist als <input type="text" value="0"/> W

Name	Wert
Datei speichern auf SD Karte (*)	<input type="checkbox"/>
Datei senden über FTP	<input type="checkbox"/>

(*) Nur die 100 letzten Einträge werden auf der SD-Karte gespeichert, ältere Einträge werden gelöscht.

Name	Wert
FTP server	<input type="text"/>
Benutzername	<input type="text"/>
Passwort	<input type="text"/>
Pfad Name	<input type="text"/>

Figure 56: Autosave submenu

Password submenu

You can change the password and the user name in the *Password* submenu.

Name	Wert
Benutzername	user
Passwort	
Passwort Verifizierung	

Figure 57: Password submenu

The current active user name is shown in the user name field when entering this menu. To change the password or user name, proceed as follows:

Enter the new name and password in the user name and password fields and repeat the password in the confirm password field. When you click on *Accept* the following screen appears:

Benutzernamen und Passwort ändern (Geben Sie den alten Benutzernamen und das alte Passwort ein)

Benutzername: Passwort:

Diese Meldung läuft ab in 56 s

Figure 58: Confirmation of password change

Enter the old user name and the old password within 60 s. When you click on *Accept* the new name and, if applicable, the user name will be saved. You will be directed automatically to the *Config* start page and can log in by entering the new user name and password.

Settings File submenu

The settings of the sens3 instrument can be saved in an XML file with the button “Write settings to file.”

The XML configuration file can be selected through “Browse” and uploaded again into the sens3 instrument with “Load file settings.”

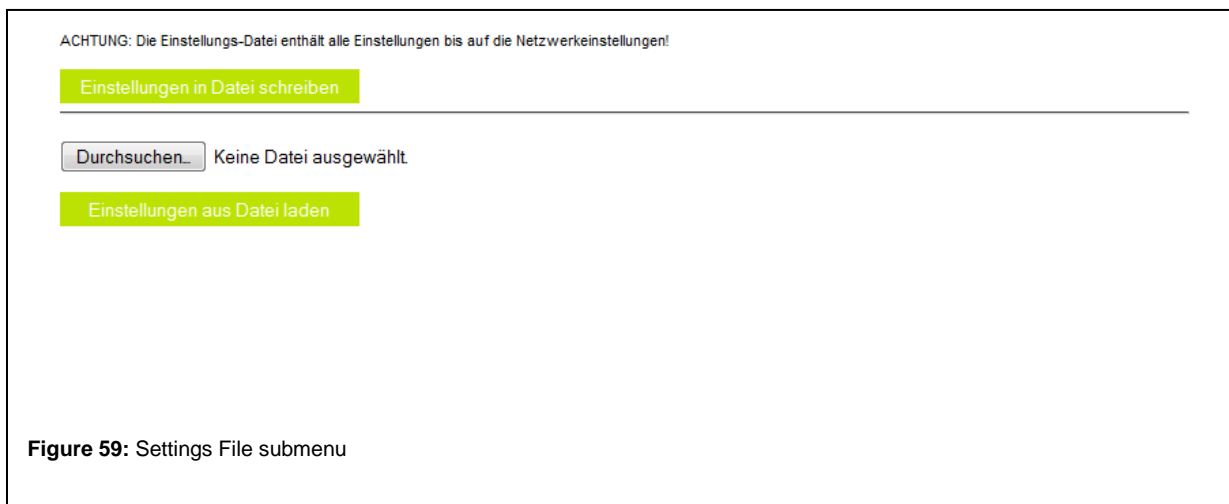


Figure 59: Settings File submenu

System submenu

The following functions are available in the system submenu:

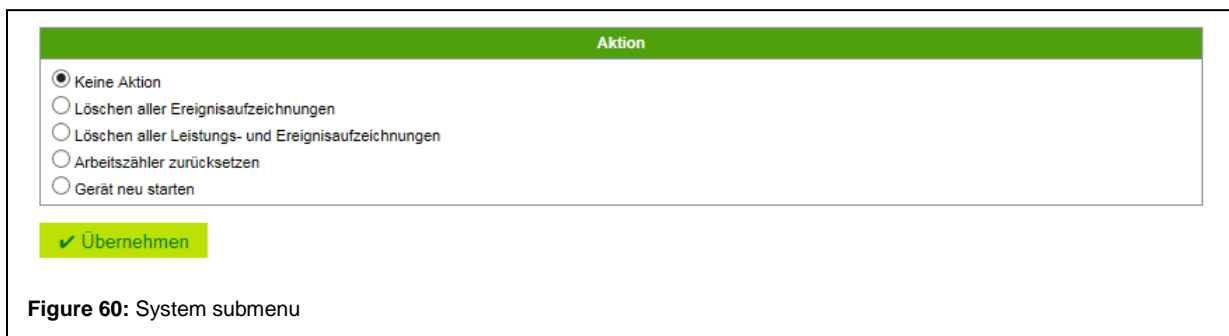


Figure 60: System submenu

Deleting all event recordings:

Deletes all data from the instrument that were created from event recordings (in the network analysis). The network analysis function can be activated optionally.

Deleting all power and event recordings:

Deletes all measured power and event records from the instrument.

Reset work meter

This resets the total counter of the active power of the sens3 and the instrument can be used at a different location.

Restart instrument

Restarts the econ sens3 (not a reset).

Options submenu

In the options submenu, the option keys can be used to enable the PRO or LOG expanded versions. The display shows the date (month/year) until which the options are enabled.



Figure 61: Options submenu

Update submenu

Firmware updates of the sens3 can be downloaded in two ways. The firmware update file can be selected using "Browse" and uploaded into the instrument with "Upload" or the content of the file can be copied and pasted into the text field "Program update" and transmitted to the sens3 using "Send file."



Figure 62: Update submenu

9 Maintenance and Service

9.1 Adjustment / Calibration

The instrument was adjusted / calibrated by the manufacturer prior to delivery. If the required ambient conditions are maintained, no subsequent adjustment is needed.

9.2 Cleaning

If necessary, the exterior of the instrument can be cleaned with a **dry** cloth.

Caution!**Damage from cleaning agents**

Cleaning agents can damage the instrument. Do not use any cleaning agents.

Attention!**Damage from moisture**

Moisture or dampness can impair the function of the components. Make sure that no moisture or dampness gets into the instrument. Use only a dry, lint-free cloth to clean the components.

9.3 Firmware update

The econ sens3 Multifunctional Measuring Instrument supports the updating of firmware (firmware update). See the *Update* submenu in Chapter 8.10 for information on installing updates. Like all write access, the update function can be password-protected. As a registered user (see Chapter 1.10) you will automatically receive the latest firmware via email.

9.4 Reset

The econ sens3 has a four-stage reset logic. If the reset button on the instrument is pressed and held, the LED of the IO 1 begins to flash and sequences consecutively through the other LEDs. Each LED has its own reset functionality that can be seen in the following table. The reset taste should be released when the desired reset stage is reached.

LED	Reset function
IO 1	The instrument is restarted.
IO 2	The IP address is reset to the factory default.
IO 3	The IP address and the password of the instrument are reset to the factory default.
IO 4	The instrument boots into a rescue system. (In case the main system no longer responds)

9.5 Repair

Attention!

Loss of certification and warranty

Opening the instrument or an accessory part included in the delivery will invalidate the certification and the warranty from econ solutions GmbH for the instrument or the accessory part.

Repairs to the instrument or accessory parts must be performed only by the manufacturer. Return defective or damaged instruments or accessory parts to econ-solutions for repair or replacement.

If the instrument or an accessory part is defective or damaged, proceed as follows:

1. Remove the instrument or the accessory part.
2. Package the instrument or the accessory part ready for shipment (use the original packaging if possible) so that it cannot be damaged during transport.
3. Return the instrument or the accessory part, including completed RMA form, to econ-solutions. The address is found on the RMA form (<http://static.econ-sens.com/de/RMA-Formular.pdf>).

10 Troubleshooting

Comprehensive help is available to you in case of problems with the installation or functions of the econ sens3:

10.1 FAQ

You can access a list of the most frequently asked questions at <http://faq3.econ-solutions.de/>.

10.2 Email contact

For additional assistance, please contact our support team by email at sens3-support@econ-solutions.de.

10.3 RMA

In case of an instrument defect, please complete the RMA form (see <http://static.econ-sens.com/de/RMA-Formular.pdf>) and send it, together with the faulty instrument, to econ solutions. Before doing this, please review the FAQ (see Chapter 10.1) and contact econ solutions (see Chapter 10.2) if necessary.

11 Technical Data

11.1 econ sens3 basic instrument

Conditions for transport and storage	
The following information applies to instruments transported and/or stored in their original packaging.	
Temperature	-25°C to +70°C
Relative humidity	0 to 90% RH

Ambient operating conditions	
The econ sens3 power meter is intended for weather-protected, stationary operation in enclosed areas.	
Nominal temperature range	-10°C to +55°C
Relative humidity	0 to 75% (non condensing)
Operating altitude above NN	max. 2000m
Degree of contamination	2
Installation position	Horizontal on carrier rail*
Ventilation	Distance to neighboring devices on both sides 6 mm*
Protection class according to IEC 60529	IP20

*Details are found in Chapter 5 of this handbook

AC supply voltage	
Installation overvoltage category	300V OC3
Protection of the supply voltage (fuse)	1A, Type C (UL/IEC approved)
Nominal range	100V - 240V (45 to 65Hz)
Operating range	+/-10% of nominal range
Power consumption	max. 6VA / 5W

Connection capacity of the „AC supply voltage” clamping point		
Plug connector: pluggable MSTBT 2.5HC/4 screw terminal		
Rigid, stranded, or fine-wire conductors without ferrule [mm ²]	0.2	2.5
Fine wire with ferrule with/without plastic collar [mm ²]	0.25	2.5
Fine-wire with TWIN ferrule with plastic collar [mm ²]	0.5	1.5
Min/max AWG conductor cross sections	24	12
Stripping length	7mm	
Min/max tightening torque [Nm]	0.5	0.6

Voltage measurement	
Protection of the measuring voltage (fuse)	10A
Three-phase 4-wire system with nominal voltages up to	277V/400V (+-10%)
Three-phase 3-wire system, unearthed, with nominal voltages up to	IT 400V (+-10%)
Overvoltage category	300V CAT III
Rated surge voltage	4kV
L-N measuring range	0 to 300Vrms
L-L measuring range	0 to 520Vrms
Dissolution	0.1V
Crest factor	2.45 (with regard to the measuring range)
Impedance	3 MOhm/phase
Power consumption	approx. 0.1VA
Sampling frequency	160 KHz for each measuring channel
Fundamental frequency	45Hz to 65Hz
Dissolution	0.01Hz
Rel. measuring deviation, voltage	0.5%

Connection capacity of the "voltage measurement" clamping point		
Plug connector: pluggable GMSTBT 2.5HV/3-ST-7.25 screw terminal		
Rigid, stranded, or fine-wire conductor without ferrule [mm ²]	0.2	2.5
Fine-wire with ferrule with/without plastic collar [mm ²]	0.25	2.5
Fine-wire with TWIN ferrule with plastic collar [mm ²]	0.5	1
Min/max AWG conductor cross sections	24	12
Stripping length	8mm	
Min/max tightening torque [Nm]	0.5	0.6

Current measurement interface	
Only for connection to alternating current systems via the Rogowski coils ("econ coils") included with delivery	
Plug connector: RJ12 (6P6C)	
Measuring range	Dependent on the connected coil
Dissolution [A]	0.1
Rel. measuring deviation, current	1% of 8 to 400/3000A, 2% of 3 to 8A (of the displayed value)
Crest factor	1.98
Sampling frequency	10 KHz for each measuring channel

*The rel. measuring deviation depends significantly on the correct installation of the coils. Information on this is found in Chapter 6.3.

Ethernet interface	
Plug connector: RJ45 (8P8C)	
Usable cable types	100-Base-TX (Cat 5)
Supported protocols	Modbus TCP
Transmission rate	10/100 Mbit fix

MODBUS	
Function	1 master and max. 31 slaves
Baud rate [Bd]	9600,19200,38400,57600, 115200 (Modbus)
Supported protocols	Modbus RTU
Max line length [m]	1200

Connection capacity of the "MODBUS" clamping point		
Plug connector: pluggable MC 1.5/5-ST terminal screw		
Rigid, stranded, or fine-wire conductor without ferrule [mm ²]	0.14	1.5
Fine-wire with ferrule without plastic collar [mm ²]	0.25	1.5
Fine-wire with ferrule with plastic collar [mm ²]	0.25	0.5
Fine-wire with TWIN ferrule with plastic collar [mm ²]	0.5	0.5
Min/max AWG conductor cross sections	28	16
Stripping length	7mm	
Min/max tightening torque [Nm]	0.22	0.25

Multiple I/O	
Open collector output	
Switching voltage	<i>max. 30 VDC</i>
Switching current	<i>max. 20 mA DC</i>
Maximum switching frequency	<i>10 Hz</i>
Digital input	
Minimum voltage	<i>2 VDC</i>
Maximum voltage	<i>30 VDC</i>
Minimum pulse length	<i>20 ms</i>
Input for potential-free contact	
Minimum pulse length	<i>20 ms</i>
Analog voltage input	
Switching voltage	<i>max. 30 VDC</i>

Connection capacity of the “multiple I/O” clamping point		
<i>Plug connector: pluggable MC 1.5/5-ST screw terminal</i>		
<i>Rigid, stranded, or fine-wire conductor without ferrule [mm²]</i>	<i>0.14</i>	<i>1.5</i>
<i>Fine-wire with ferrule without plastic collar [mm²]</i>	<i>0.25</i>	<i>1.5</i>
<i>Fine-wire with ferrule with plastic collar [mm²]</i>	<i>0.25</i>	<i>0.5</i>
<i>Fine-wire with TWIN ferrule with plastic collar [mm²]</i>	<i>0.5</i>	<i>0.5</i>
<i>Min/max AWG conductor cross sections</i>	<i>28</i>	<i>16</i>
<i>Stripping length</i>	<i>7mm</i>	
<i>Min/max tightening torque [Nm]</i>	<i>0.22</i>	<i>0.25</i>

DC supply voltage	
Protection of the supply voltage (fuse)	<i>2A</i>
Nominal range	<i>12 to 28V</i>
Operating range	<i>+ -10% of nominal range</i>
Power consumption	<i>max. 6W</i>

Dimensions in mm

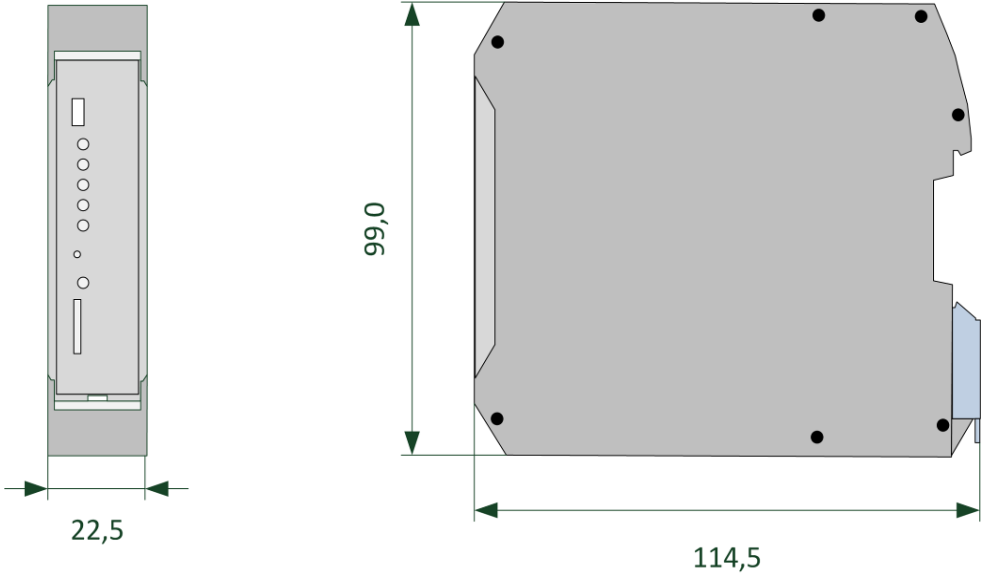


Figure 63: Dimensions

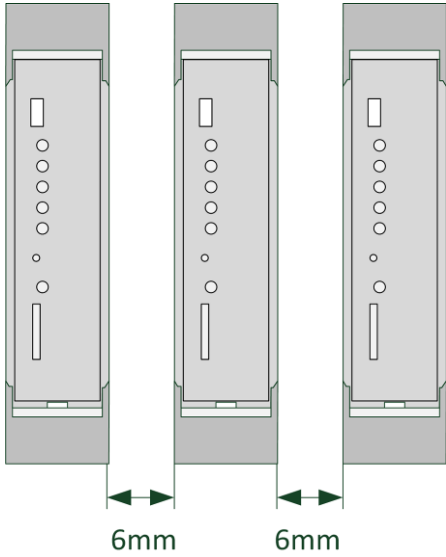


Figure 64: Distance to neighboring devices

11.2 econ sens3 measuring coils

		Coil 200	Coil 400
Mechanical			
Total coil length	[mm]	200	400
Measurable cable diameter	[mm]	40	65
Maximum bend radius	[mm]	35	
Length of connecting cable	[m]	2	
Electrical			
Measuring range	[A _{rms}]	3 to 400	3 to 3000

11.3 Storage capacity of the measurement data memory

The econ sens3 has 4 GB of internal data memory. This storage capacity is adequate to record 1-minute values over a period of 39 days. The 15-minute values are calculated dynamically from the 1-minute values.

11.4 Factory settings

Network

The econ sens3 normally looks for a DHCP server; if no DHCP server is available in the network, the following applies:

IP address: 169.254.1.1
Subnet mask: 255.255.0.0

Date/time settings

Time / date: Assume time and date from time server

Network settings

Network topology: Three-phase 4-wire network (230/400V, 50 Hz)

Pulse weighting

Pulse weighting [Wh/pulse]: 10 Wh/pulse = 100 imp/kWh

User name: user

Password: pass

12 Appendix

12.1 Measuring parameters and their meaning

Measuring parameter	Description
Time	Time stamp
Samples	Number of values for average value calculation
Frequency	Network frequency
Temp	Temperature in the sensor housing
Code	Data record error code
L1 Urmsavg	L1 average voltage
L1 Urms min	L1 minimum voltage
L1 Urmsmax	L1 maximum voltage
L1 U THD avg	L1 voltage average harmonic distortion
L1 Irmsavg	L1 average current
L1 Irms min	L1 minimum current
L1 Irmsmax	L1 maximum current
L1 I THD avg	L1 current average harmonic distortion
L1 Pactiveavg	L1 average active power
L1 Qreactiveavg	L1 average reactive power
L1 Pactiveposavg	L1 average active power consumption
L1 Pactivenegavg	L1 average active power generation
L1 PF avg	L1 power factor
L2 Urmsavg	L2 average voltage
L2 Urms min	L2 minimum voltage
L2 Urmsmax	L2 maximum voltage
L2 U THD avg	L2 voltage average harmonic distortion
L2 Irmsavg	L2 average current
L2 Irms min	L2 minimum current
L2 Irmsmax	L2 maximum current
L2 I THD avg	L2 current average harmonic distortion
L2 Pactiveavg	L2 average active power
L2 Qreactiveavg	L2 average reactive power
L2 Pactiveposavg	L2 average active power consumption
L2 Pactivenegavg	L2 average active power generation
L2 PF avg	L2 power factor
L3 Urmsavg	L3 average voltage
L3 Urms min	L3 minimum voltage
L3 Urmsmax	L3 maximum voltage
L3 U THD avg	L3 voltage average harmonic distortion
L3 Irmsavg	L3 average current
L3 Irms min	L3 minimum current
L3 Irmsmax	L3 maximum current
L3 I THD avg	L3 current average harmonic distortion

L3 Pactiveavg	L3 average active power
L3 Qreactiveavg	L3 average reactive power
L3 Pactiveposavg	L3 average active power consumption
Qreactive total avg	Total average reactive power (over L1, L2, L3)
N Urmsavg	Average neutral conductor voltage
N Urms min	Minimum neutral conductor voltage
N Urmsmax	Maximum neutral conductor voltage

12.2 Revision History

Revision	Date	Changes
3.0	May 2016	Various changes and additions; description of new functions for firmware of 5.0.3.21 and later