TB20 – Energy Meter

Manual

Version 1.0 / 3/4/2016 for HW1-1 & FW 1.00.004 and higher

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Notes

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Revision Record

Version	Date	Change
1.0	3/4/2016	First version

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1 General information

This operating manual applies only to devices, assemblies, software, and services of Systeme Helmholz GmbH.

1.1 Target audience for this manual

This description is only intended for trained personnel qualified in control and automation engineering who are familiar with the applicable national standards. For installation, commissioning, and operation of the components, compliance with the instructions and explanations in this operating manual is essential.

WARNING

Configuration, execution, and operating errors can interfere with the proper operation of the TB20 devices and result in personal injury as well as material or environmental damage. Only suitably qualified personnel may operate the TB20 devices!

Qualified personnel must ensure that the application and use of the products described meet all the safety requirements, including all relevant laws, regulations, provisions, and standards.

1.2 Safety instructions

The safety instructions must be observed in order to prevent harm to living creatures, material goods, and the environment. The safety notes indicate possible hazards and provide information about how hazardous situations can be prevented.

1.3 Note symbols and signal words in the manual

HAZARD

If the hazard warning is ignored, there is an imminent danger to life and health of people from electrical voltage.

WARNING

If the hazard warning is ignored, there is a probable danger to life and health of people from electrical voltage.

CAUTION

If the hazard warning is ignored, people can be injured or harmed.

ATTENTION

Draws attention to sources of error that can damage equipment or the environment.

NOTE

Gives an indication for better understanding or preventing errors.

1.4 Intended use

The TB20 I/O system is an open, modular, and distributed peripheral system designed to be mounted on 35 mm DIN rails.

Communication with a higher-level control system is via a bus system / network and a TB20 bus coupler. Up to 64 modules from the TB20 range can be set up on a bus coupler. The bus couplers support hot-plugging for replacing modules during ongoing operation.

All components are supplied with a factory hardware and software configuration. The user must carry out the hardware and software configuration for the conditions of use. Modifications to hardware or software configurations which are beyond the documented options are not permitted and nullify the liability of Systeme Helmholz GmbH.

The TB20 devices should not be used as the only means for preventing hazardous situations on machinery and equipment.

Successful and safe operation of the TB20 devices requires proper transport, storage, installation, assembly, installation, commissioning, operation, and maintenance.

The ambient conditions provided in the technical specifications must be adhered to.

The TB20 systems have protection rating of IP20 and must have a control box/cabinet fitted to protect against environmental influences in an electrical operating room. To prevent unauthorized access, the doors of control boxes/cabinets must be closed and possibly locked during operation.

HAZARD

TB20 devices can be equipped with modules that can carry dangerously high voltages. The voltages connected to the TB20 devices can result in hazards during work on the TB20 devices.

1.5 Improper use

WARNING

The consequences of improper use may include personal injuries of the user or third parties, as well as property damage to the control system, the product, or environment. Use TB20 devices only as intended!

1.6 Installation

1.6.1 Access restriction

The modules are open operating equipment and must only be installed in electrical equipment rooms, cabinets, or housings.

Access to the electrical equipment rooms, cabinets, or housings must only be possible using a tool or key, and access should only be granted to trained or authorized personnel.

1.6.2 Electrical installation

Observe the regional safety regulations.

TB20 devices can be equipped with modules that can carry dangerously high voltages. The voltages connected to the TB20 devices can result in hazards during work on the TB20 devices.

1.6.3 Protection against electrostatic discharges

To prevent damage through electrostatic discharges, the following safety measures are to be followed during assembly and service work:

- Never place components and modules directly on plastic items (such as polystyrene, PE film) or in their vicinity.
- Before starting work, touch the grounded housing to discharge static electricity.
- Only work with discharged tools.
- Do not touch components and assemblies on contacts.

1.6.4 Overcurrent protection

To protect the TB20 and the supply line, a slow-blowing 8 A line protection fuse is required.

1.6.5 EMC protection

To ensure electromagnetic compatibility (EMC) in your control cabinets in electrically harsh environments, the known rules of EMC-compliant configuration are to be observed in the design and construction.

1.6.6 Operation

Operate the TB20 only in flawless condition. The permissible operating conditions and performance limits must be adhered to.

Retrofits, changes, or modifications to the device are strictly forbidden.

The TB20 is an operating means intended for use in industrial plants. During operation, the TB20 can carry dangerous voltages. During operation, all covers on the unit and the installation must be closed in order to ensure protection against contact.

1.6.7 Liability

The contents of this manual are subject to technical changes resulting from the continuous development of products of Systeme Helmholz GmbH. In the event that this manual contains technical or clerical errors, we reserve the right to make changes at any time without notice. No claims for modification of delivered products can be asserted based on the information, illustrations, and descriptions in this documentation. Beyond the instructions contained in the operating manual, the applicable national and international standards and regulations also must be observed in any case.

1.6.8 Disclaimer of liability

Systeme Helmholz GmbH is not liable for damages if these were caused by use or application of products that was improper or not as intended.

Systeme Helmholz GmbH assumes no responsibility for any printing errors or other inaccuracies that may appear in the operating manual, unless there are serious errors about which Systeme Helmholz GmbH was already demonstrably aware.

Beyond the instructions contained in the operating manual, the applicable national and international standards and regulations also must be observed in any case.

Systeme Helmholz GmbH is not liable for damage caused by software that is running on the user's equipment which compromises, damages, or infects additional equipment or processes through the remote maintenance connection and which triggers or permits unwanted data transfer.

1.6.9 Warranty

Report any defects to the manufacturer immediately after discovery of the defect.

The warranty is not valid in case of:

- Failure to observe these operating instructions
- Use of the device that is not as intended
- Improper work on and with the device
- Operating errors
- Unauthorized modifications to the device

The agreements met upon contract conclusion under "General Terms and Conditions of Systeme Helmholz GmbH" apply.

2 System overview

2.1 General information

The TB20 I/O system is an open, modular, and distributed peripheral system designed to be mounted on 35 mm DIN rails.

It is made up of the following components:

- Bus couplers
- Peripheral modules
- Power and isolation modules
- Power modules

By using these components, you can build a custom automation system that is tailored to your specific needs and that can have up to 64 modules connected in series to a bus coupler. All components have a protection rating of IP20.

2.2 The components that make up the TB20 I/O system

2.2.1 Bus coupler

The system's bus coupler includes a bus interface and a power module. The bus interface is responsible for establishing a connection to the higher-level bus system and is used to exchange I/O signals with the automation system's CPU.

The power module is responsible for powering the coupler's electronics and all connected peripheral modules.

2.2.2 Peripheral modules

The system's peripheral modules are electronic components to which peripheral devices such as sensors and actuators can be connected. A variety of peripheral modules with different tasks and functions are available.

Example: Peripheral module with 10-pin front connector

Example: Peripheral module with 20-pin front connector

2.2.3 Power and isolation module

The system's bus coupler provides the supply voltage for the communications bus (5 V, top) and for external signals (24 V, bottom). These voltages are passed from module to module through the base modules.

Power and isolation modules make it possible to segment the power supply for external signals into individual power supply sections that are powered separately. Meanwhile, the communications bus signals and supply voltage simply continue to be passed through, in contrast to the way they are handled by power modules (see section 2.2.4).

NOTE

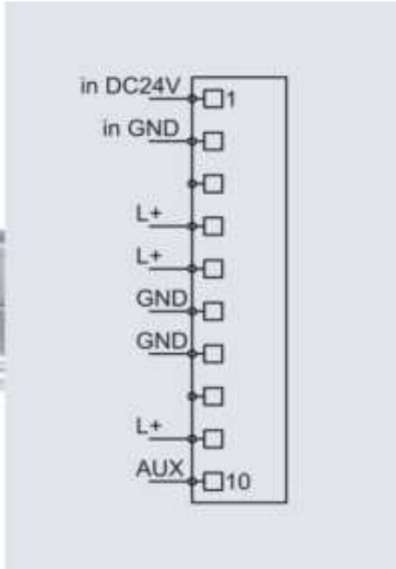
Power and insulation modules have a lighter body color.

2.2.4 Power module

The system's bus coupler provides the supply voltage for the communications bus (5 V, top) and for external signals (24 V, bottom). These voltages are passed from module to module through the base modules.

Power modules make it possible to segment the power supply for both external signals and the communication bus into individual power supply sections that are powered separately.

Power modules deliver all necessary power to the peripheral modules connected after them and, if applicable, all the way to the next power module or power and isolation module. A power module is required whenever the power supplied by the coupler alone is not sufficient, e.g., when there are a large number of modules with high power requirements. The "TB20 ToolBox" configuration program can be used to determine whether power modules are needed, as well as how many of them will be needed.

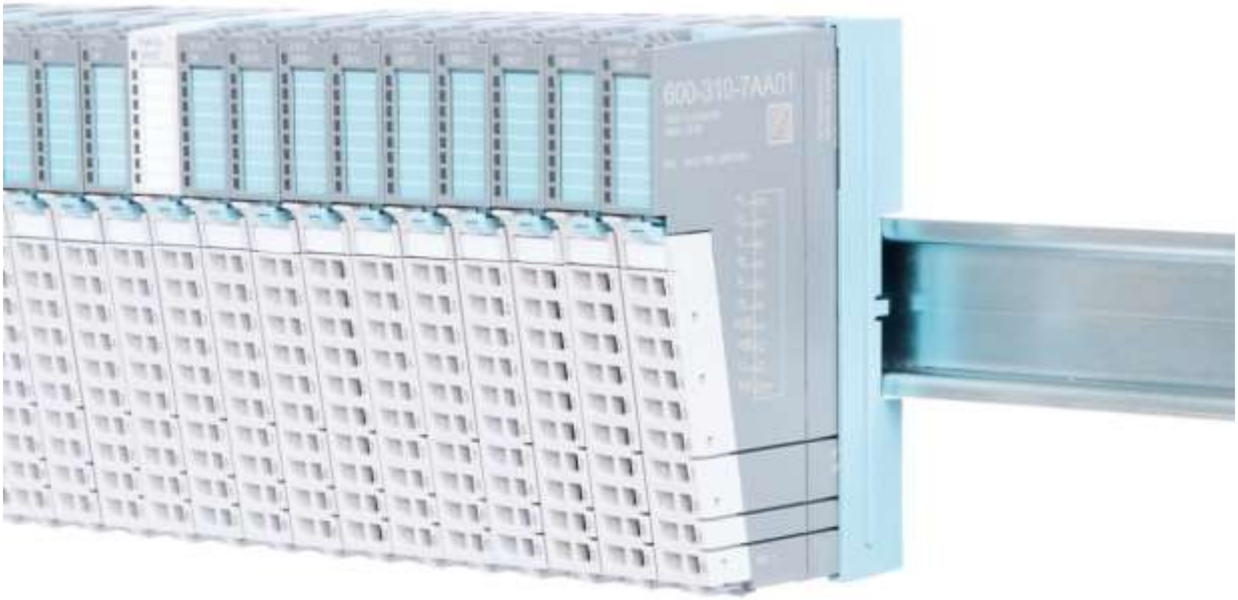


NOTE

Power modules have a lighter body color.

2.2.5 Final bus cover

The final bus cover protects the contacts on the last base module from accidental contact by covering the outer right-hand side of the base module.



2.2.6 Components in a module

Each module consists of three parts:

- Base module
- Electronic module
- Front connectors

2.2.7 Module Coding

Electronic modules and base modules feature coding elements meant to prevent the wrong spare electronic modules from being plugged in during maintenance and repairs.

These coding elements consist of a coding plug on the electronic module and a coding socket on the base module (see following figure).

The coding plug and coding socket can each be in one of eight different positions. Each of these eight positions is factory-assigned to a specific type of module (Digital In, Digital Out, Analog In, Analog Out, and Power) from the TB20 system. It will only be possible to plug an electronic module into a base module if the position of the coding plug and the position of the coding socket match. If the positions differ, the electronic module is mechanically blocked.

3 Installation and removal

HAZARD

TB20 modules can carry lethal voltage.

Before starting any work on TB20 system components, make sure to deenergize all components, as well as the cables supplying them with power! During work when the system is live, there is the risk of fatal electrocution!

ATTENTION

Insulation must be carried out according to VDE 0100/IEC 364 and performed in accordance with applicable national standards. The TB20 IO system has protection rating IP20. If a higher protection rating is required, the system must be installed in a housing or control cabinet. In order to ensure safe operation, the ambient temperature must not exceed 60 °C.

3.1 Installation position

The TB20 I/O system can be installed in any position.

In order to achieve optimum ventilation and be able to use the system at the specified maximum ambient temperature, it will, however, be necessary to use a horizontal installation layout.

3.2 Minimum clearance

It is recommended to adhere to the minimum clearances specified when installing the coupler and modules. Adhering to these minimum clearances will ensure that:

- The modules can be installed and removed without having to remove any other system components
- There is enough space to make connections to all existing terminals and contacts using standard accessories.
- There will be enough space for cable management systems (if needed)

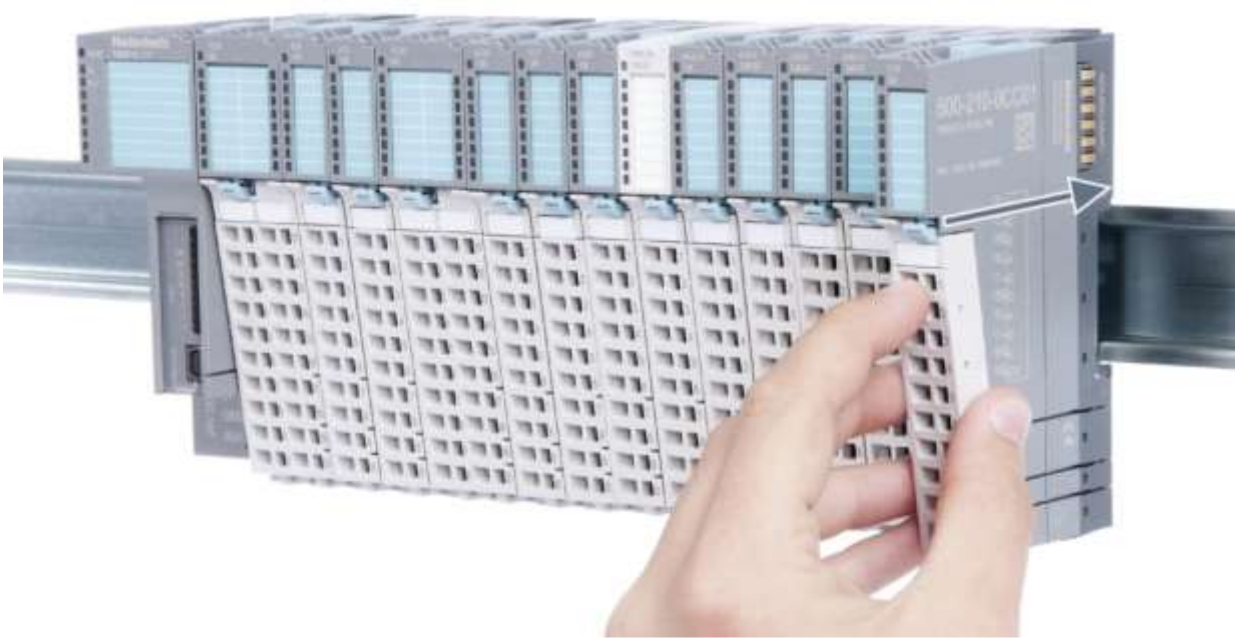
The minimum clearances for mounting TB20 components are: 30 mm on the top and on bottom and 10 mm on each side.

3.3 Installing and removing peripheral modules

3.3.1 Installation

Installing an assembled peripheral module

Place the assembled module on the DIN rail by moving it straight towards the rail. Make sure that the module engages the upper and lower guide elements of the previous module. Then push the upper part of the module towards the DIN rail until the rail fastener fastens into place on the inside snaps with a soft click.



Installing the individual parts of a peripheral module one after the other

Place the base module on the DIN rail from below in an inclined position. Then push the upper part of the base module towards the rail until the module is parallel to the rail and the rail fastener on the inside snaps into place with a soft click.

Place an electronic module with matching coding (see the "Module Coding" section on page 16) on the base module in a straight line from above and then gently push it into the base module until both modules are fully resting against each other and the module fastener snaps into place with a soft click.

Finally, place the front connector on the electronic module from below in an inclined position and then gently push it onto the electronic module until the front connector fastener snaps into place with a soft click.

3.3.2 Removal

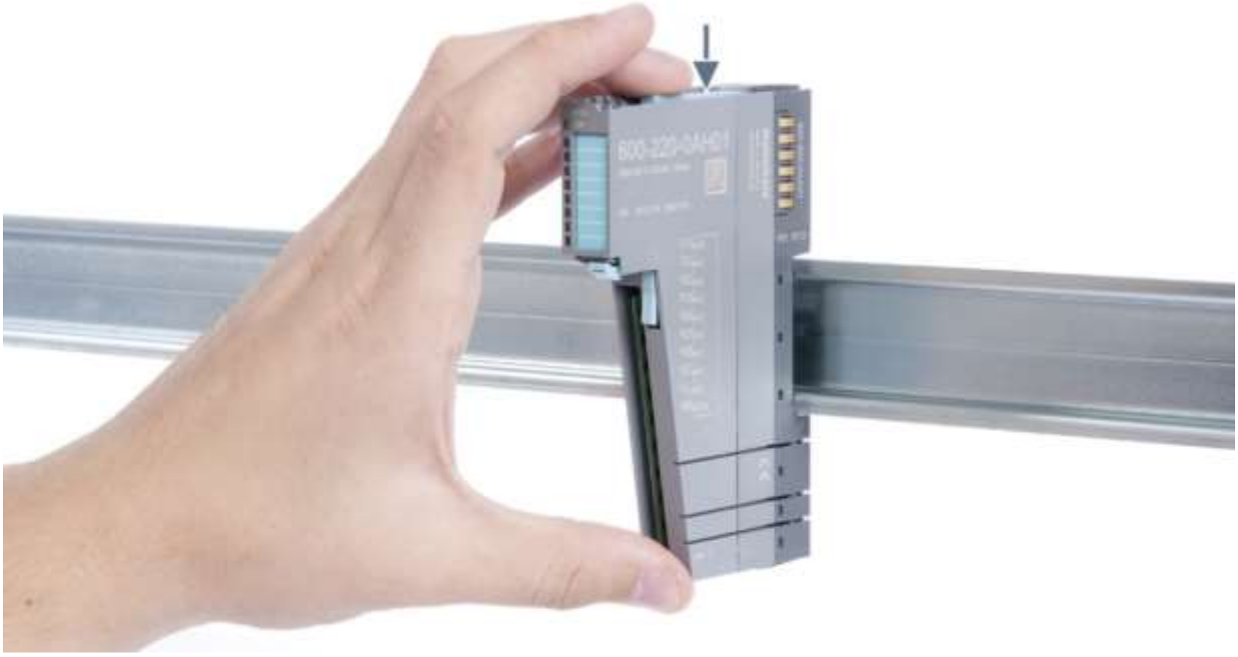
To remove a peripheral module, follow the four steps below:

Step 1: Remove the front connector

To remove the front connector, push the tab above the front connector upwards (see the picture below). This will push out the front connector, after which you can pull it out.

Step 2: Remove the electronic module

To remove the electronic module, use your middle finger to push on the lever from above and then use your thumb and index finger to pull out the electronic module while holding the lever down (see the picture below).



Step 3: Release the base module

Use a screwdriver to release the base module by turning the locking mechanism 90° counterclockwise.

Step 4: Remove the base module

Remove the base module by pulling it towards you.

3.4 Replacing an electronic module

The procedure for replacing the electronic module on a peripheral module consists of four steps.

If you need to replace the electronic module while the system is running, make sure to take into account the general technical specifications for the bus coupler being used.

TB20 modules can carry lethal voltage.

Before starting any work on TB20 system components, make sure to deenergize all components, as well as the cables supplying them with power! During work when the system is live, there is the risk of fatal electrocution!

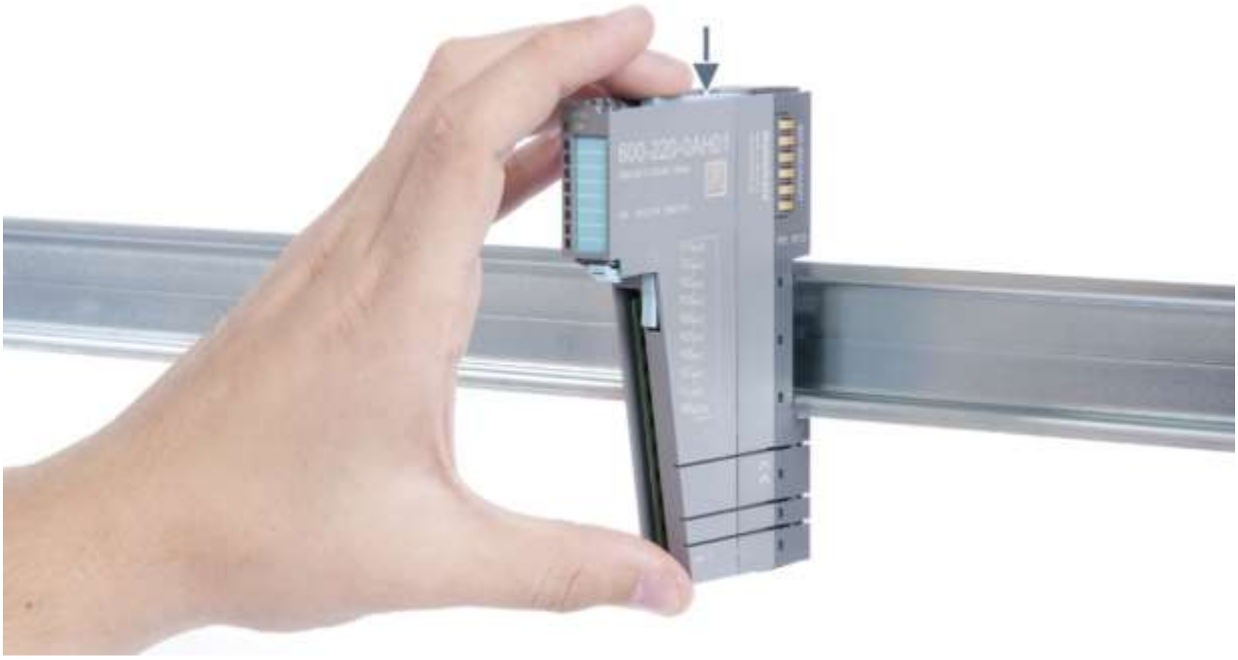
Note the wiring diagram of the system and switch off dangerous voltages before starting work!

Step 1: Remove the front connector

To remove the front connector, push the tab above the front connector upwards (see the picture below). This will push out the front connector, after which you can pull it out.

Step 2: Remove the electronic module

To remove the electronic module, use your middle finger to push on the lever from above and then use your thumb and index finger to pull out the electronic module while holding the lever down (see the picture below).



Step 3: Plug in a new electronic module

ATTENTION

The electronic module must be snapped into place on the base module with a single continuous movement. If the electronic module is not snapped into place firmly and straight on the base module, bus malfunctions may occur.

ATTENTION

If the electronic module cannot be plugged into the base module, check whether the coding elements on the electronic module and base module (see figure below) match. If the coding elements on the electronic module do not match those on the base module, you may be attempting to plug in the wrong electronic module.

For more information on coding elements, please consult section 2.2.7.

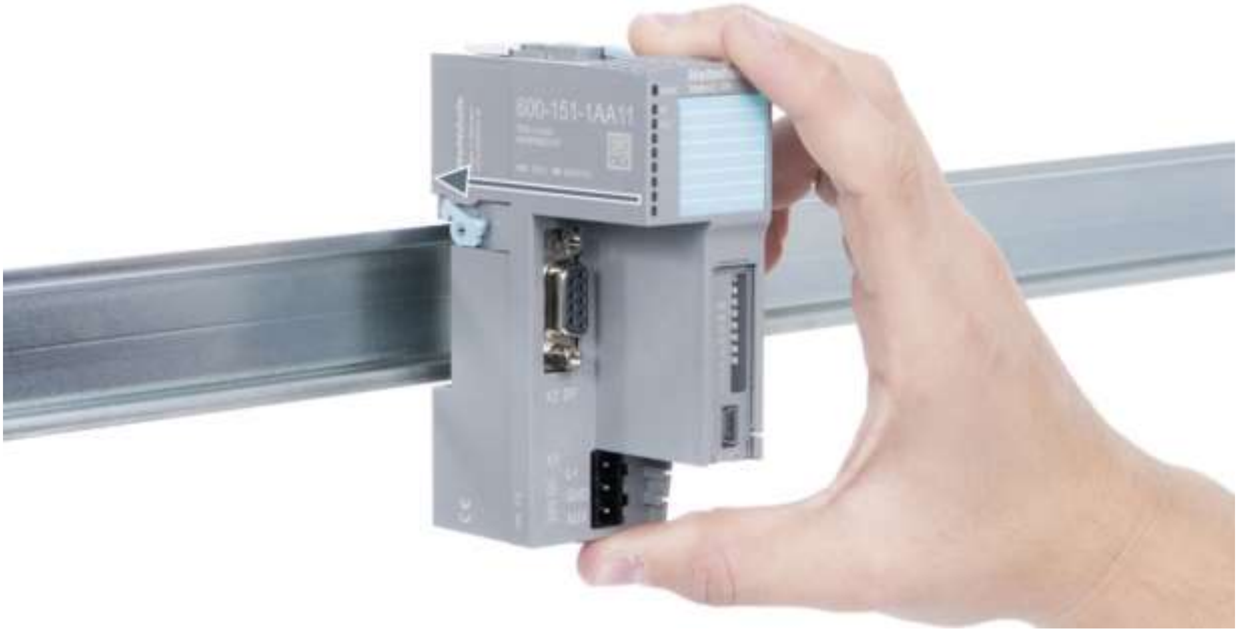
Step 4: Plug in the front connector

3.5 Installing and removing the coupler

3.5.1 Installation

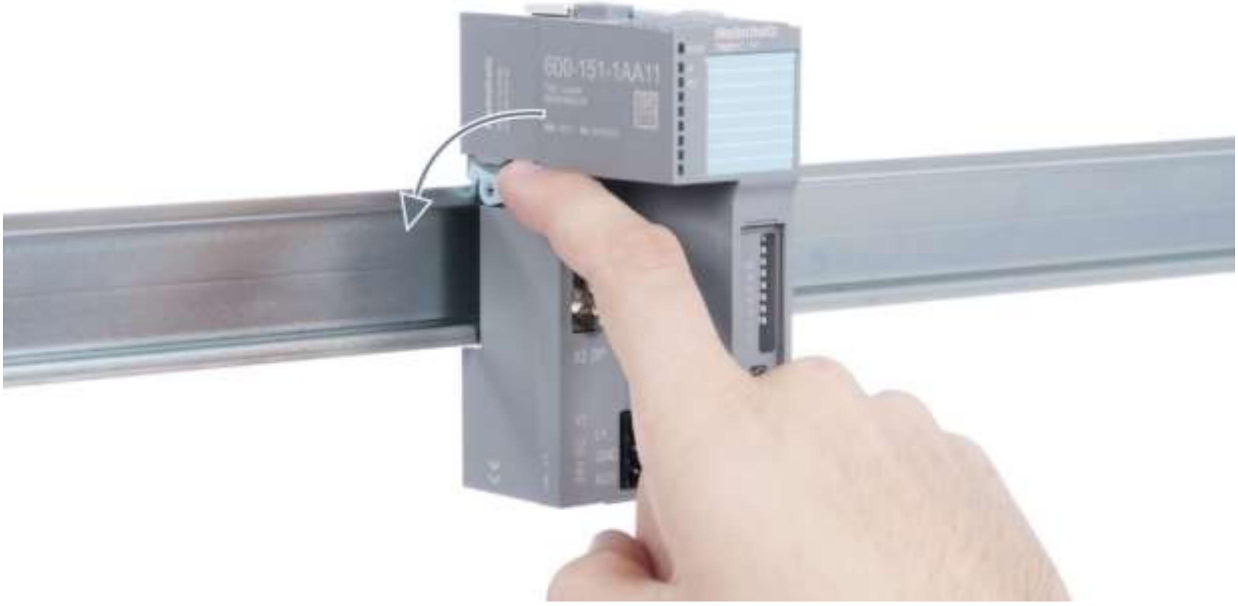
Step 1: Place the coupler on the DIN rail

Place the coupler, together with the attached base module, on the DIN rail by moving it straight towards the rail. Then push the coupler towards the rail until the base module's rail fastener snaps into place with a soft click.



Step 2: Secure the coupler on the DIN rail

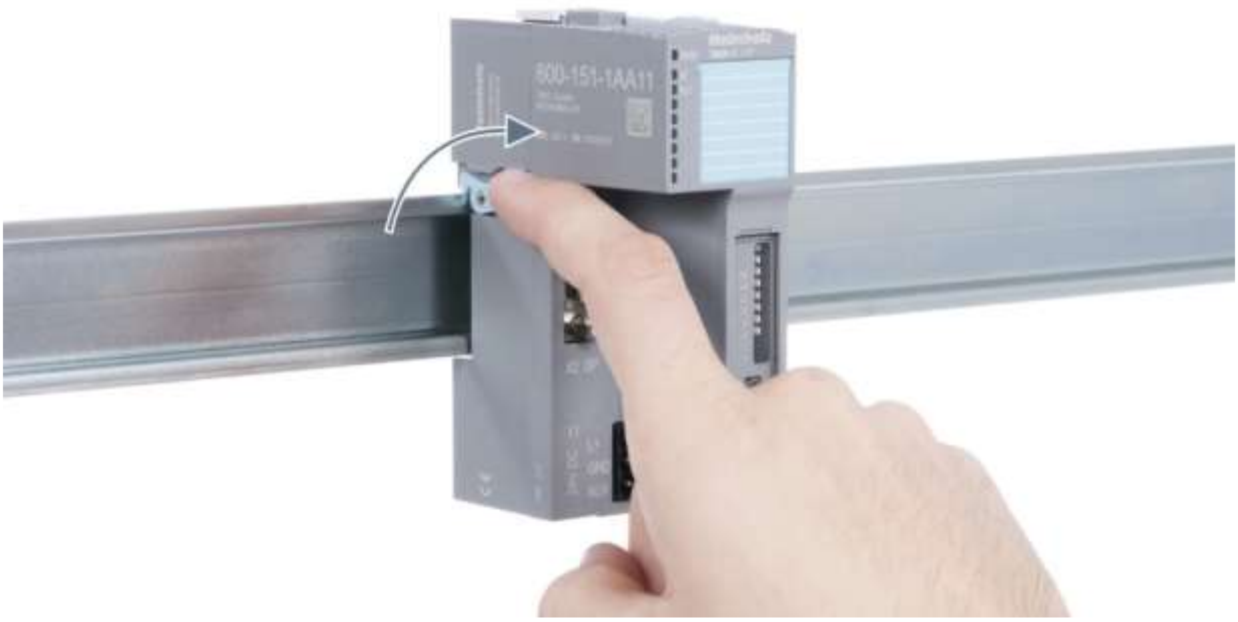
Use the locking lever on the left side of the coupler to lock the coupler into position on the DIN rail.



3.5.2 Removal

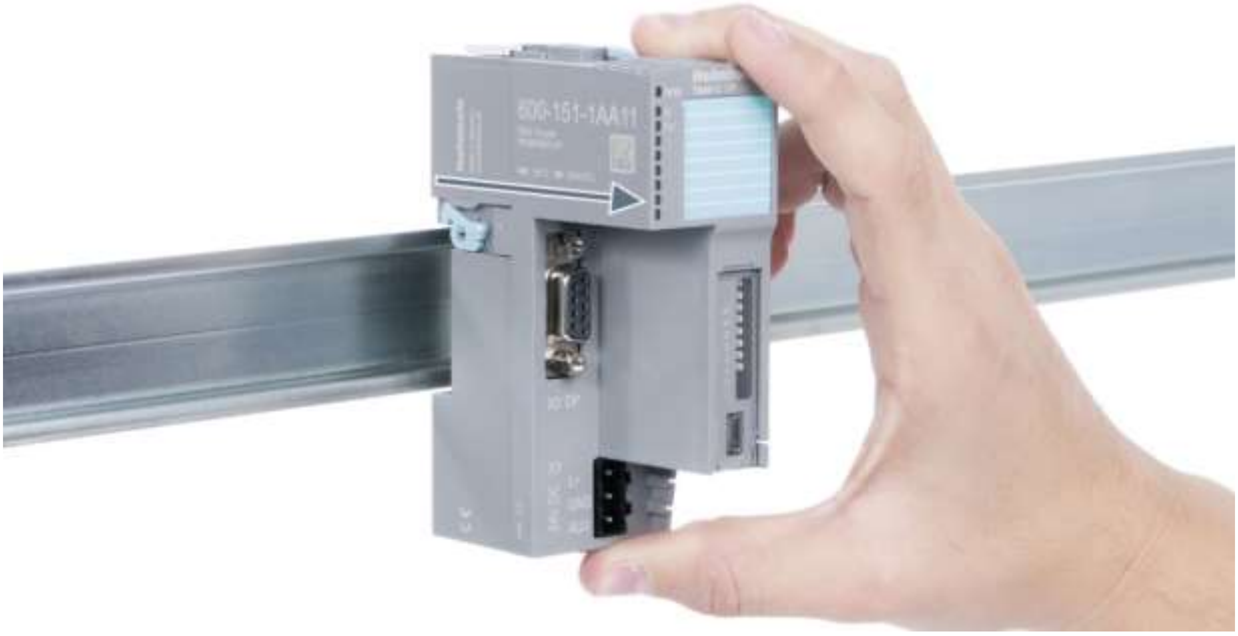
Step 1: Release the locking mechanism

Release the locking lever on the left side of the coupler in order to disengage it from the DIN rail.



Step 2: Remove the coupler

Use your middle finger to push on the lever from above and use your thumb and index finger to pull out the coupler while holding the lever down.



Step 3: Release the base module

Use a screwdriver to release the base module.

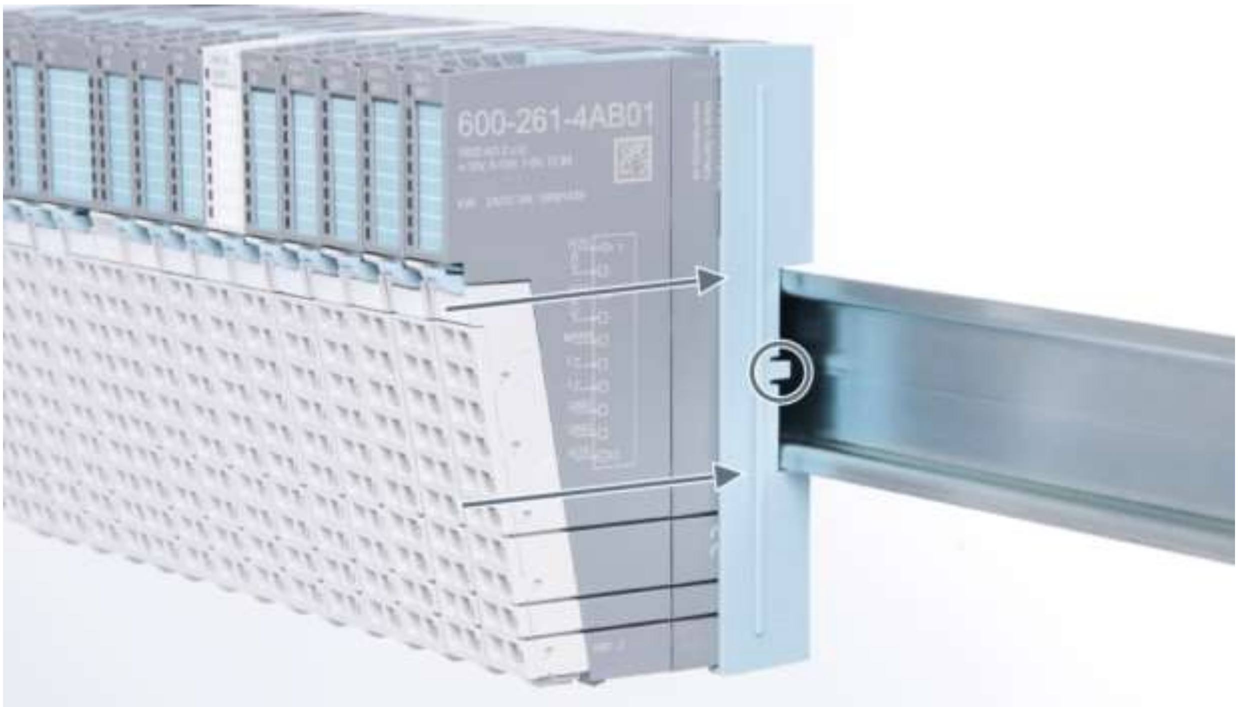
Step 4: Remove the base module

Remove the base module by pulling it towards you.

3.6 Installing and removing the final bus cover

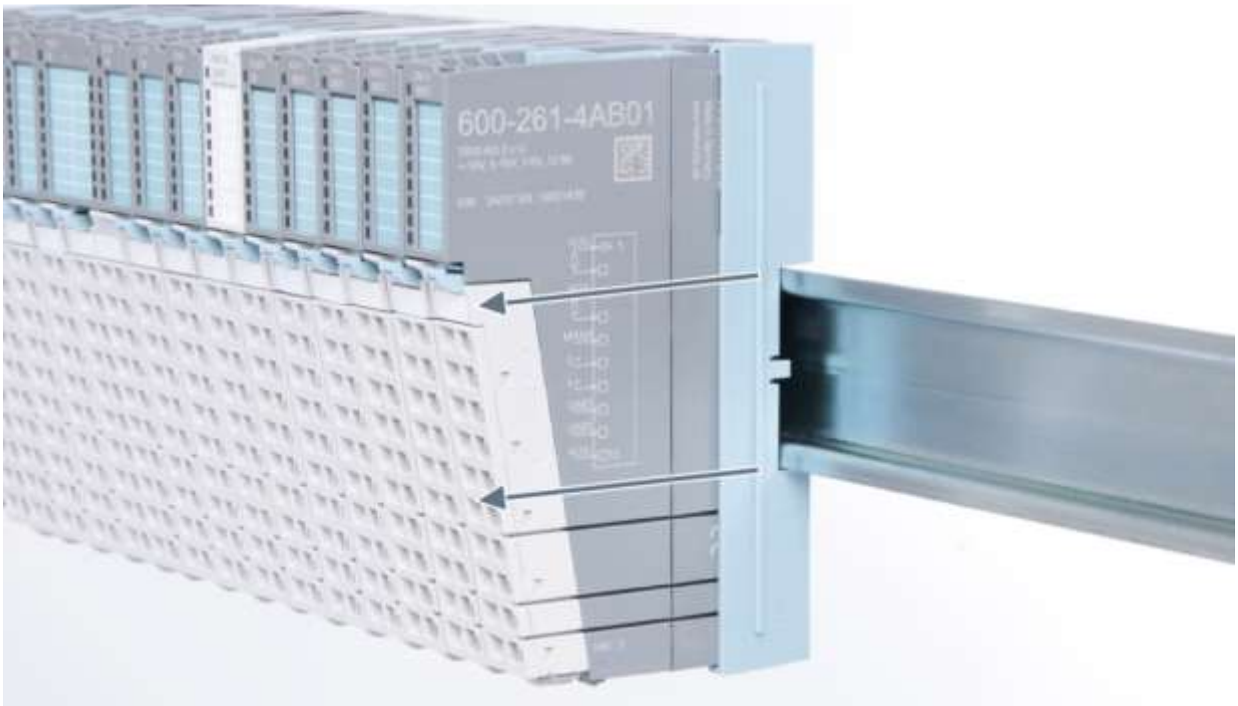
3.6.1 Installation

Slide the final bus cover onto the last module along the case, starting from the end with the front connector and moving towards the DIN rail, until the cover covers the base module's contacts and the tab snaps into place.



3.6.2 Removal

Pull the final bus cover along the module's case and away from the DIN rail in order to remove it from the module.



4 Configuration/wiring

4.1 EMC/safety/shielding

The TB20 IO system complies with EU Directive 2004/108/EC ("Electromagnetic Compatibility").

One effective way to protect against disturbances caused by electromagnetic interference is to shield electric cables, wires, and components.

ATTENTION

When putting together the system and routing the required cables, make sure to fully comply with all standards, regulations, and rules regarding shielding (please also consult the relevant guidelines and documents published by the PROFIBUS User Organization). All work must be done professionally!

Shielding faults can result in serious malfunctions, including the system's failure.

To ensure electromagnetic compatibility (EMC) in your control cabinets in electrically harsh environments, the following EMC rules are to be observed in the design:

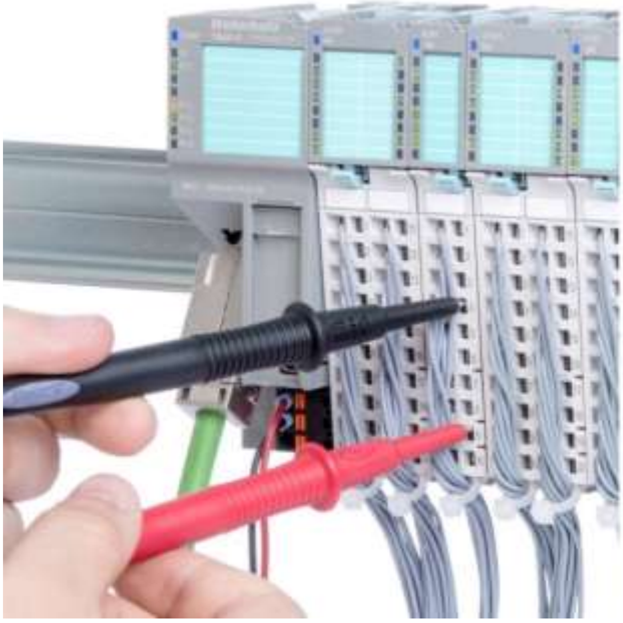
- All metal parts of the cabinet are to be connected with each other over a large area with good conductivity (no paint on paint). Where necessary, use contact washers or serrated washers.
- The cabinet door must be connected to the ground straps (top, middle, bottom) over as short a distance as possible.
- Signal cables and power cables are to be laid separated spatially by a minimum distance of 20 cm from each in order to avoid coupling paths.
- Run signal lines only from one level into the cabinet if possible.
- Unshielded cables in the same circuit (outgoing and incoming conductors) must be twisted if possible.
- Contactors, relays, and solenoid valves in the closet, or in adjacent cabinets if applicable, must be provided with quenching combinations; e.g., with RC elements, varistors, diodes.
- Do not lay wires freely in the closet; instead, run them as closely as possible to the cabinet housing or mounting panels. This also applies to reserve cables. These must be grounded on at least one end, and it is better if they are grounded on both ends (additional shielding effect).
- Unnecessary line lengths should be avoided. Coupling capacitances and inductances are kept low in this way.
- Analog signal lines and data lines must be shielded.

4.2 Front connectors

The front connector's spring-clamp terminals are designed for a cross-sectional cable area of up to 1.5 mm² (16–22 AWG) with or without ferrules.

It is also possible, for example, to connect two 0.75 mm² wires to a single spring-type terminal, provided the maximum cross-sectional cable area of 1.5 mm² per terminal is not exceeded.

The cables can be attached to the underside of the front connector with a cable tie.



4.3 Wiring the coupler

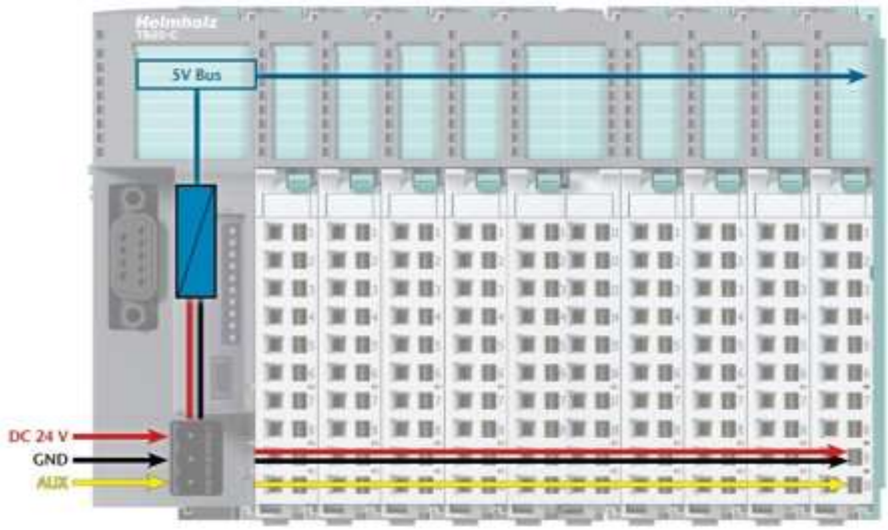
A power supply unit is integrated into the bus coupler. The power supply unit is responsible for powering the peripheral modules connected to the coupler.

In turn, it draws its own power from the three-pin connector on the front (24 VDC, GND, and AUX).

The 24 V connector is used to power two buses:

- The power bus used to power the I/O components (24 VDC, GND, AUX)
- The communications bus used to power the electronics in the peripheral modules

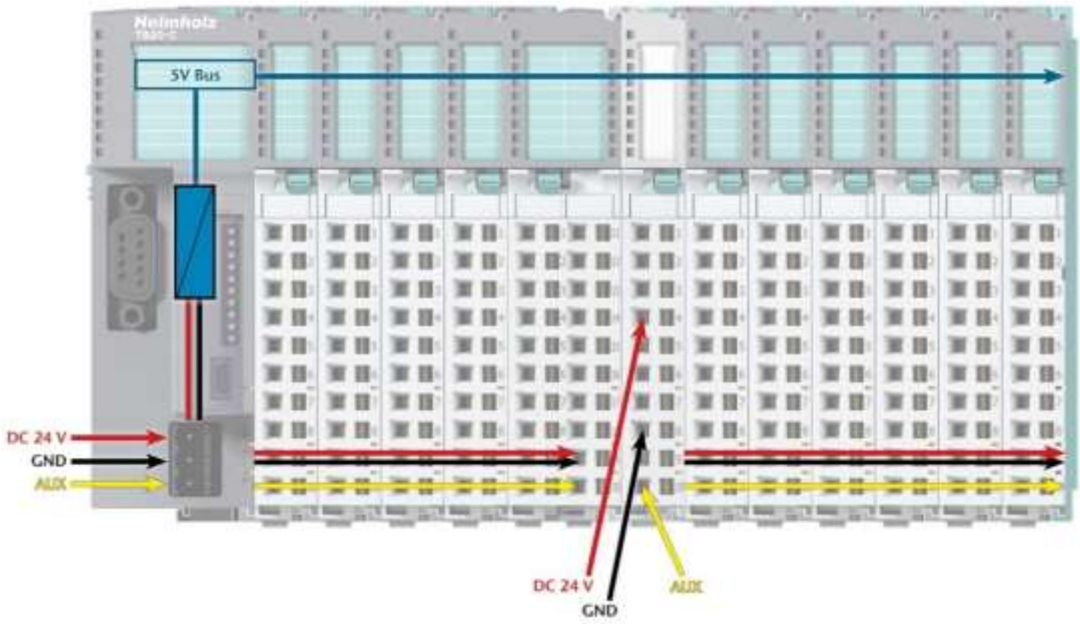
The AUX pin can be used to connect and use an additional voltage potential. Every peripheral module has an AUX terminal on its front connector (the bottommost terminal, i.e., terminals 10 and 20).



The coupler and the modules are grounded via the shield contact to the DIN rail. The DIN rail must be grounded. The surface of the DIN rail must be clean and conduct electricity well.

4.4 Using power and isolation modules

Power and isolation modules make it possible to segment the power supply for external signals (24 V, GND, and AUX) into individual power supply sections that are powered separately.

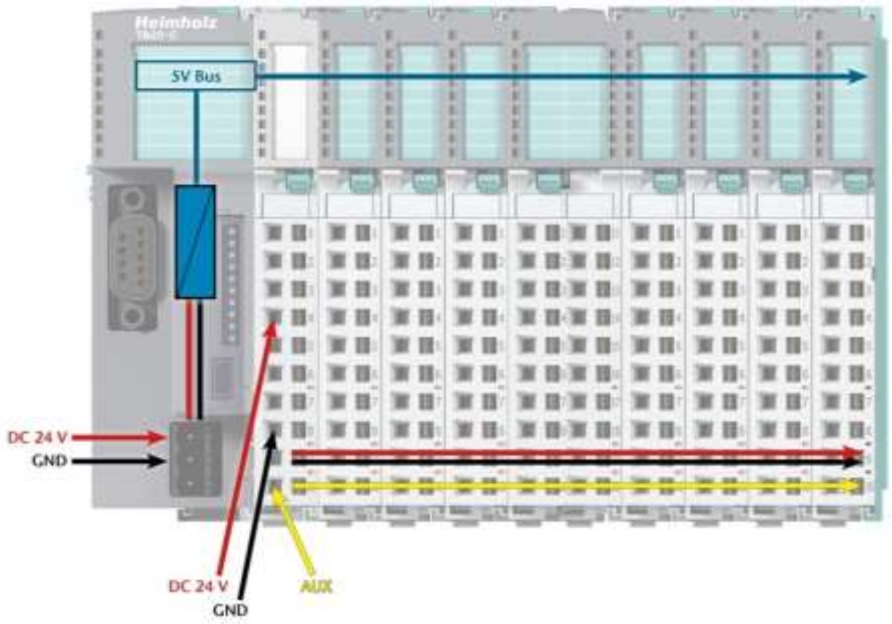


The order no. for the power and isolation module for 24 V signals is 600-710-0AA01.

Its electronic module and base module have the same light gray color as the front connector, ensuring that all power and isolation modules will stand out visually in the system and make it easy to clearly distinguish each individual power supply segment.

4.5 Separate power supply segments for the coupler and the I/O components

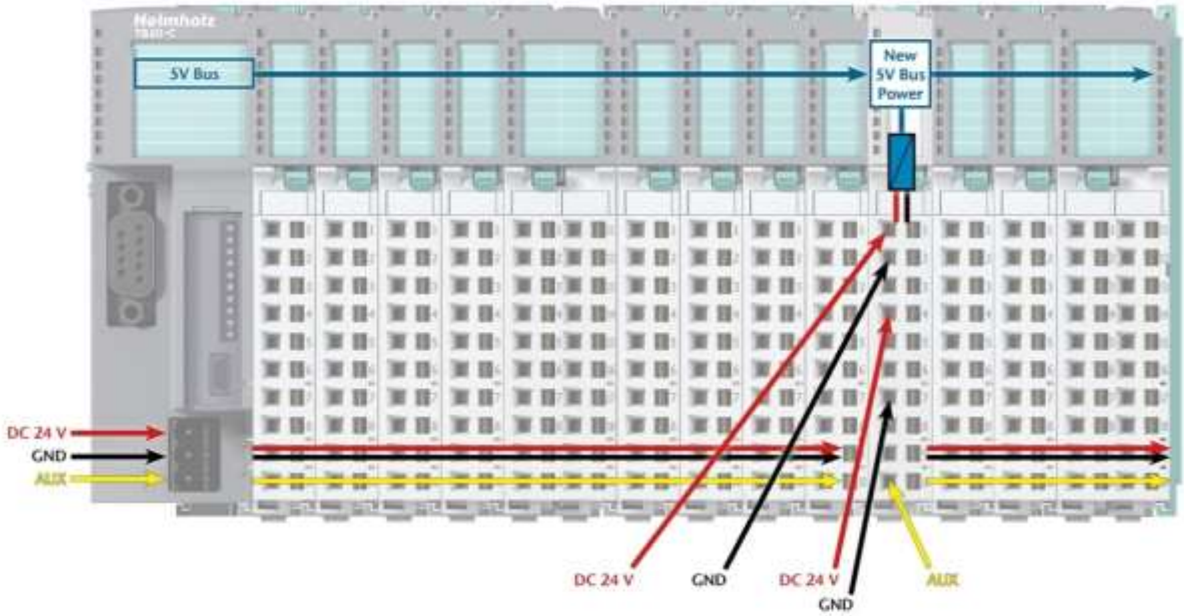
If the power supply for the coupler needs to be separate from the power supply for the I/O modules, a power and isolation module can be used right after the coupler.



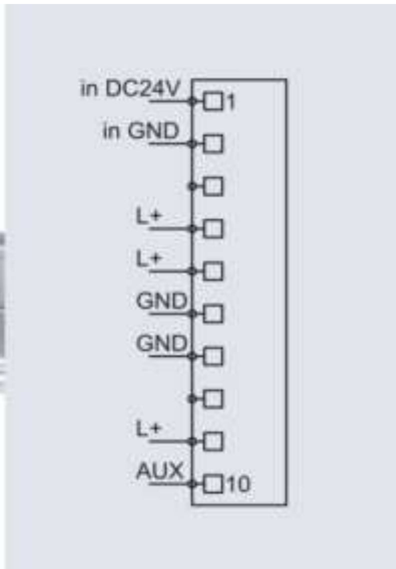
4.6 Using power modules

Power modules deliver all necessary power to the connected peripheral modules and, if applicable, all the way to the next power module or power and isolation module. Power modules must be used whenever the power supplied by the coupler alone is not sufficient, that is, when there are a large number of modules on the bus. The “TB20 ToolBox” parameter configuration and diagnosis program can be used to calculate a system’s total current draw.

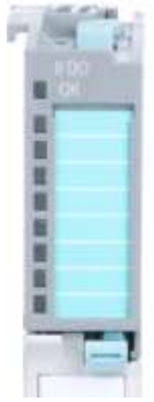
24 VDC, GND, and AUX are fed into the terminals on the front, while the connected modules are powered through the base modules’ bus system.



The order no. for the power module is 600-700-0AA01. The electronic module of the power module is light gray like the front connector. The base module of the power module is light gray with a dark top part.



4.7 Function of the OK-LED



The topmost LED (OK-LED) on every module indicates the module's current system status.

Solid blue light:	The module is running (RUN)
Slowly flashing blue light:	The module is stopped (STOP)
Quickly flashing blue light:	The module is idle (IDLE); its parameters have not been configured yet
Solid red light:	Module displays a diagnostics message
Flashing red light:	Module displays a configuration error

The red LED lights will only be shown on modules with configurable parameters or diagnosis capabilities.

4.8 Electronic nameplate

All of a TB20 module's important information can be found on its electronic nameplate. This information includes, for example, the corresponding module ID, module type, order number, unique serial number, hardware version, firmware version, and internal range of functionalities.

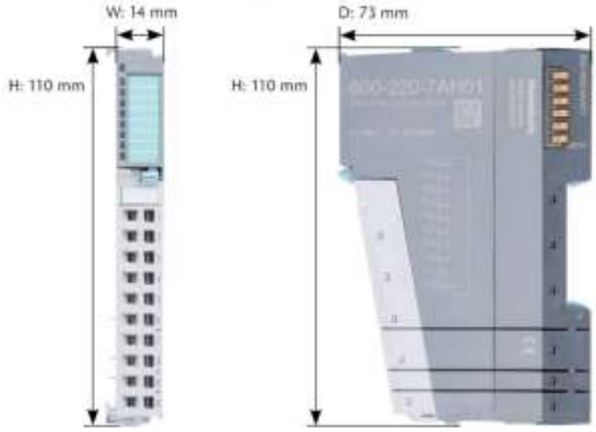
This information can be read in a number of ways, one of which is using the "TB20 ToolBox" configuration and diagnosis program. The modules' electronic nameplates not only make it possible to prevent configuration errors (setup), but also make maintenance (servicing) easier.

4.9 Fusing

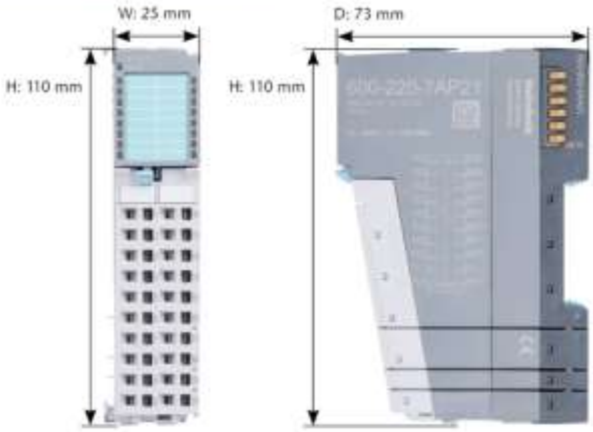
The TB20 coupler's and power modules' power supply must be externally fused with a slow-blowing fuse, maximum 8 A, appropriate for the required maximum current.

4.10 Dimensions

Module with standard width



Module with double width



Communication Module

Bus Coupler

5 TB20 – Energy Meter

5.1 Purpose

Special electrical power measurement devices are required to determine the energy consumption of machinery and systems.

The TB20 – Energy Meter on the other hand enables the measurement of 38 energy measuring values in the 1 or 3-phase network up to 400 V AC.

The energy measuring values are forwarded to the internal bus of the TB20 system and can be read out over the available TB20 bus couplers by the master control. The TB20 Energy Meter can be operated as an individual module or in combination with additional Energy Meter and I/O modules on the TB20 bus coupler.

With the TB20 – Energy Meter, the energy consumption can be determined and load profiles can be created with suitable software. Energy management applications can use the measurement data of the Energy Meter to generate energy consumption profiles in the industry and in industrial systems, of buildings or groups of buildings and of operating sequences.

With the Energy Meter, detailed alternating current measurement values can be determined for each phase and as a total value, see chapter 5.2.1

With the Energy Meter, the energy consumption of a system can be determined in order to estimate energy efficiency and create consumption forecasts.

Load management is possible with precise knowledge of the power input, and necessary repairs can be recognized.

Inferences about the CO_2 emissions caused are possible with precise knowledge of the energy consumption values.

5.2 Measuring values

With the Energy Meter it is possible to record the electrical data of a one or three phase supply network:

- Voltages root mean square (RMS)
- Currents root mean square (RMS)
- Meter with gate circuit and non-volatile storage
- Phase angle between the voltages or between voltage and current or between the currents
- Apparent/active/reactive power
- Energy consumption
- Limit value monitoring for overvoltages and undervoltages
- Limit value monitoring for overcurrents
- Monitoring of phase zero crossing

The Energy Meter module supports the following functions:

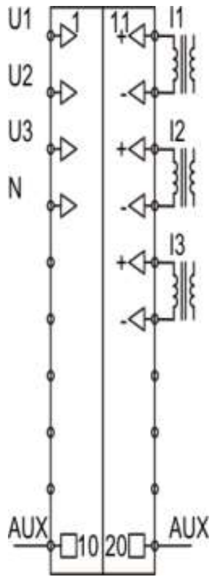
The energy values are measured for a mains frequency of 50 Hz or 60 Hz. The sampling rate is 8 KHz.

5.2.1 Functions of the Energy Meter

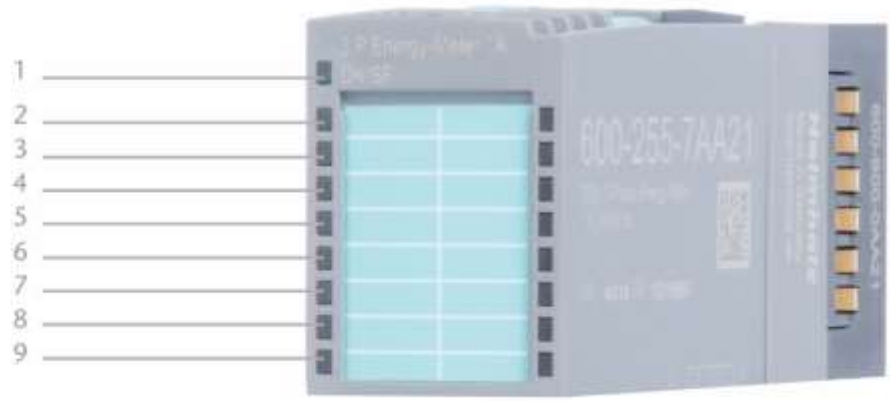
Energy Meter 1 A	600-255-7AA21
Maximum current	1 A current transformer / -20 dB/decade AA filter
Shunt resistances	150 mOhm
Energy Meter 5 A	600-255-7BA21
Maximum current	5 A current transformer / -20 dB/decade AA filter
Shunt resistances	66 mOhm
Maximum input voltage	389 V_{RMS}
Max. rated voltage	Outer cable voltage U_{LL}=480 VAC String voltage U_{LN}=230 VAC
Input resistance typ.	>1 MΩ
Connection	20-terminal front connector
N inputs	Joint N inputs for voltage phases
	Current phases individually electrically isolated
Display of the module operating status	Red: (lit/flashing) phase error/configuration error
	Green: Phase OK
Diagnoses	Defeatable
Zero transition timeout detection for all U and I inputs	Timeout can be configured in ms
Phase angle measurement	U -> I: U1/I1, U2/I2, U3/I3
	U: U1/U3, U2/U3, U1/U2
	I: I1/I3, I2/I3, I1/I2
Phase sequence	Diagnostics
Period duration / frequency	Measurement
Overvoltage / undervoltage	Detection above/below limit value
Root mean square (RMS)	U /I for L1, L2, L3
Apparent/active/reactive power	Phase L1, L2, L3 individually
Apparent/active/reactive power	Phase L1, L2, L3 collectively
Apparent/active/reactive energy	Phase L1, L2, L3 individually
Apparent/active/reactive energy	Phase L1, L2, L3 collectively
Energy values	Storage in non-volatile storage
Signal sampling	8 kHz
Phase delay of current transformer	Phase compensation for phase L1, L2, L3 (compensation for current transformer delay)
Mains frequency	50 Hz or 60 Hz
Primary current	Current to be measured
Secondary current/voltage	Output current of the current transformer
Current/voltage gain (PGA)	Configurable
Zero transition timeout	Configurable
Overvoltage / undervoltage limit values	Configurable
Diagnostics	Zero transition timeout (missing phase)
	Incorrect phase sequence
	Invalid parameter, false parameter length

5.2.2 Pin assignment

Terminal	Assignment	Terminal	Assignmen t
1	U1	11	I1+
2	U2	12	I1-
3	U3	13	I2+
4	N	14	I2-
5	-	15	I3+
6	-	16	I3-
7	-	17	-
8	-	18	-
9	-	19	-
10	AUX	20	AUX



5.2.3 LEDs of the Energy Meter



LED	Name	Display	Description
1	OK/SF LED	Solid blue light	The module is running (RUN)
		Slowly flashing blue light	The module is stopped (STOP)
		Quickly flashing blue light	The module is idle (IDLE); module's parameters have not been configured yet
		Solid red light	The module is indicating a diagnostic error
		Flashing red	The module is indicating a parameter assignment error
2	L1	Solid green light	Phase OK
		Solid red light	Phase error
		Flashing red	Configuration error L1
3	L2	Solid green light	Phase OK
		Solid red light	Phase error
		Flashing red	Configuration error L2
4	L3	Solid green light	Phase OK
		Solid red light	Phase error
		Flashing red	Configuration error L3
5-9	Reserved		

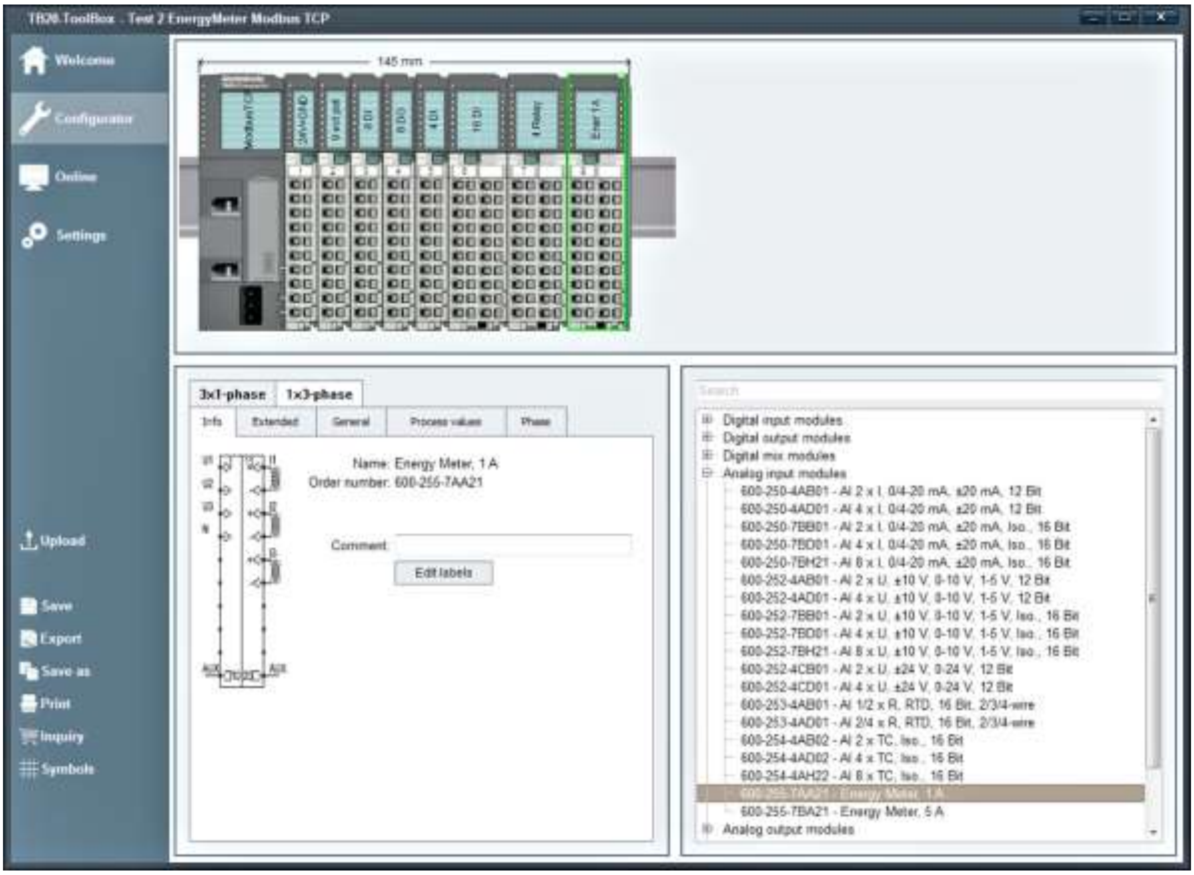
For diagnostics see chapter 7.2.2.

NOTE

IDLE mode (quickly flashing blue LED) indicates modules that have not been added to ongoing system operation by the coupler. One of the reasons that can cause this is an incorrect configuration (wrong module model in the slot).

6 Commissioning

6.1 TB20-ToolBox



In the TB20-ToolBox, positioning and configuration of the parameters of the components for the planning of a system is possible.

The Energy Meter is configured using the user program of the bus master, see chapter 8, when using the following couplers:

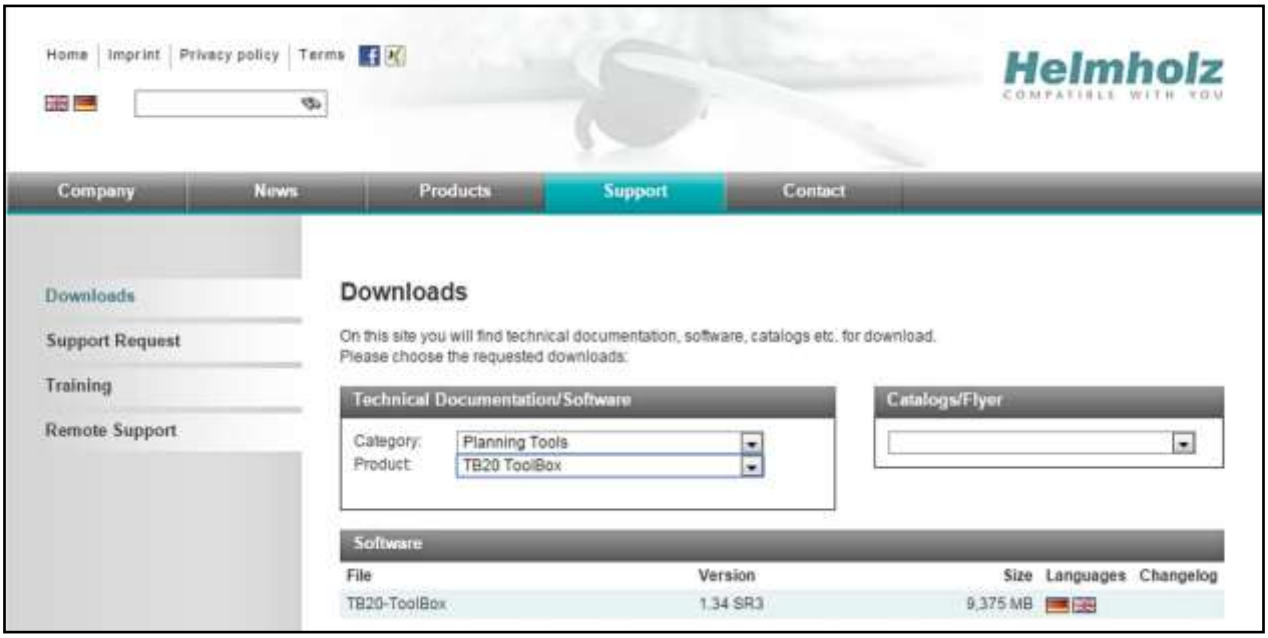
- PROFIBUS
- PROFINET

The Energy Meter is configured using the TB20 ToolBox when using the following couplers:

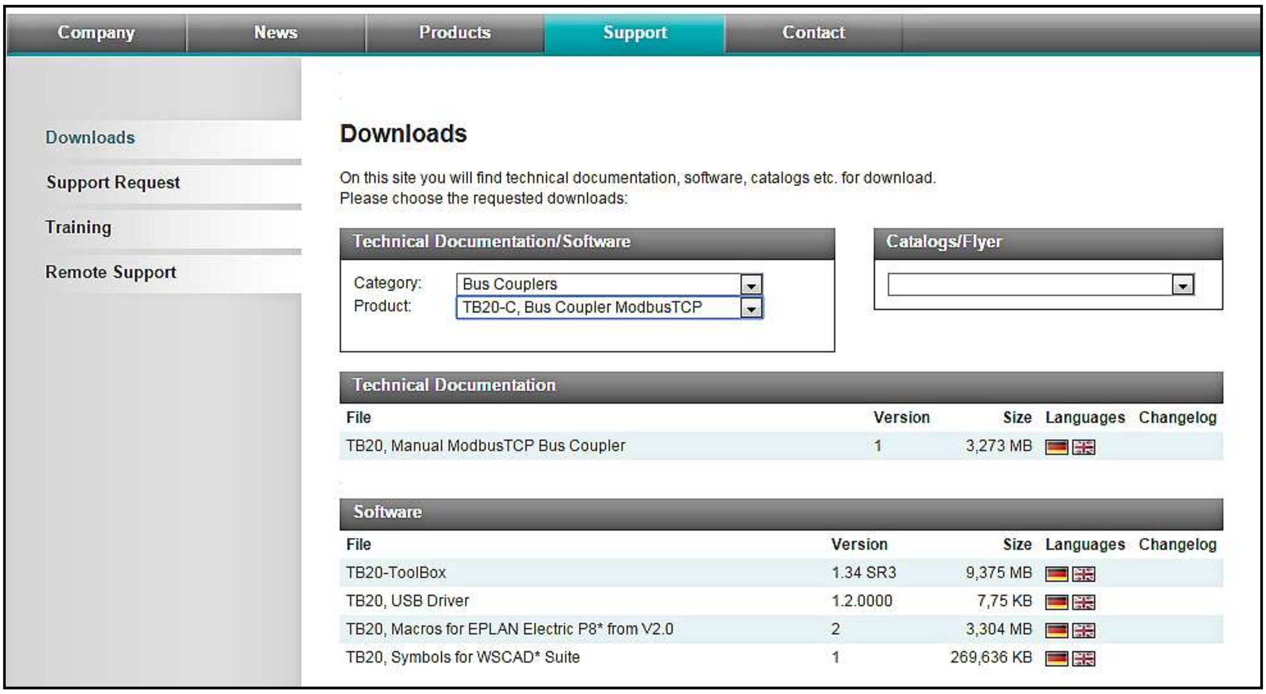
- CANopen®
- EtherNet/IP
- ModBusTCP
- EtherCAT

6.1.1 Install TB20 ToolBox

Load the ToolBox from the Helmholz homepage in the area Support - TB20 - Planning Tools. TB20 ToolBox runs on Windows* 7, 8, 8.1, 10.



A cable with USB 2.0 A plug to USB Mini B plug is required for communication with a TB20 bus coupler. The Helmholz USB driver must be installed once on the computer under Windows* 7, 8, 8.1. Windows* 10 requires no additional USB driver. The Helmholz USB driver is contained in the installation file as of ToolBox version 1.36. It is also possible to download the USB driver from the Support page:



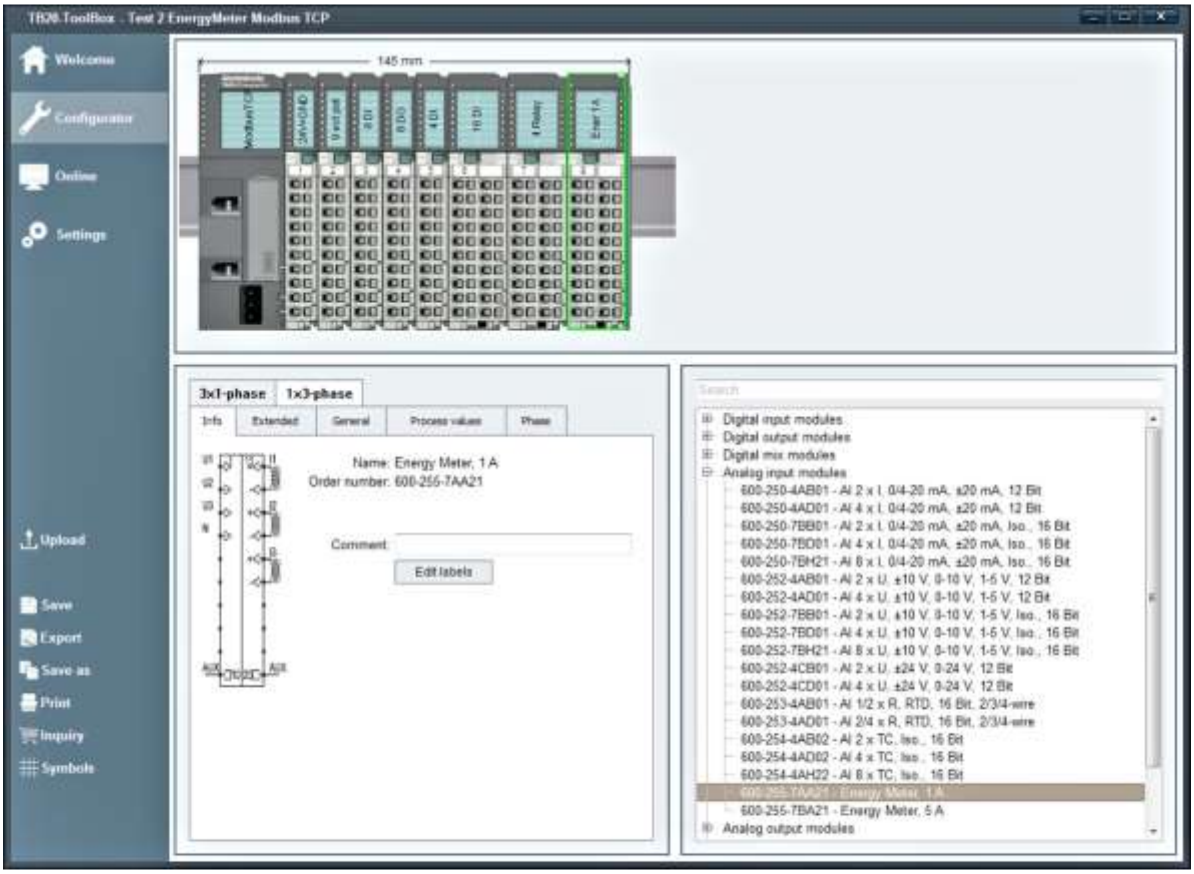
*Windows is a registered trademark of Microsoft Corporation.

 Start ToolBox

A new project can be created without connected hardware. A new project is created in the "Welcome" area by clicking on a bus coupler. The name of the project is assigned to the coupler and is the file name under which the project is saved. The project can be cloned to save project versions.

6.1.2 Configuration of the Energy Meter in a project

Modules are installed with drag and drop or a double-click from the modules catalog.



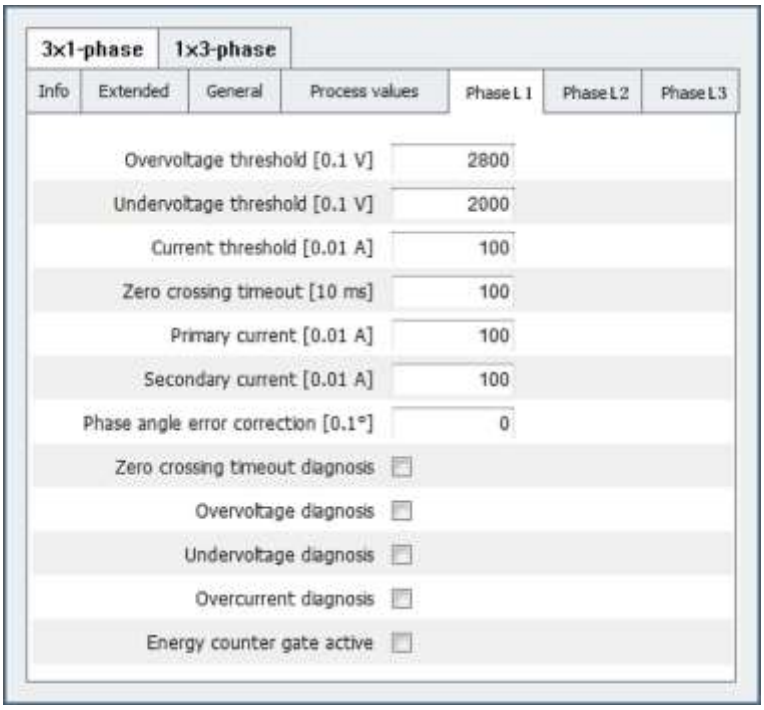
The Energy Meter is found under Analog input modules. Select the Energy Meter appropriate for the current transformer and the mode and insert it with a double-click or drag and drop.

After clicking on the installed Energy Meter, a comment can be entered and the label prepared. The firmware according to the catalog is shown under Advanced.

When using PROFIBUS or PROFINET and a Siemens PLC as bus master, configuration takes place in the user program, see chapter 6.1 and chapter 9.

When using CANopen®, EtherNet/IP, ModBusTCP, or EtherCAT, configuration takes place under "Advanced".

Select mode



Operating mode 3x1-phase

Measurement of up to 3 independent consumers of 3 one-phase alternating current grids. No measurement of the phase angle takes place, and thus also no calculation of the reactive and apparent power.

Info

- Name of the module according to the catalog
- Order number according to Helmholz catalog
- Comment
  Free comment text of the user

Edit labels

A print template can be created for the module label.

Extended

- Display of the firmware according to hardware catalog

General

- Diagnosis alarm
  ☐ - Diagnostics of internal module events
  ☑ - Diagnostics are forwarded to the bus master.
- Mains frequency
  Frequency of the of the voltage to be measured and of the current of a phase as a reference value for all 3 phases with 1-phase measurement
- Continued counting when stopped
  ☐ - Energy counting is paused with STOP
  ☑ - Energy counting is also continued with STOP
- Phase mains frequency
  Selection of the phase for which the mains frequency is set
- Current amplification
  A current amplification factor can be set for all 3 measurement inputs.

Process values

Process value 1 - 7 Index x
The Energy Meter determines up to 38 measuring values depending upon the measuring connections. 7 measuring values can be forwarded as process values to the bus coupler via an index.
For index assignment see chapter 8.1.4.

L1 | L2 | L3

- Undervoltage threshold value
  The configured diagnostics are initiated when this voltage is not reached.
- Overvoltage threshold value
  The configured diagnostics are initiated when this voltage is exceeded.
- Overcurrent threshold value
- Zero crossing timeout
  The diagnostics are initiated if the phase had no voltage zero crossing upon expiration of the set time. The diagnostics are also initiated when no voltage is present.
- Primary current
  Primary current of the current transformer used
- Secondary current
  Secondary current of the current transformer used

- Phase angle error correction
  for 50 Hz mains from -62 to 6
  Corresponds to the value of -6.2° to 0.6° with a resolution of 0.1°.
  for 60 Hz mains from -76 to 9
  Corresponds to the value of -7.6° to 0.9° with a resolution of 0.1°.
- Diagnostics of zero crossing
  The diagnostics of zero crossing can be activated.
- Diagnostics of overvoltage
  The diagnostics of overvoltage can be activated.
- Diagnostics of undervoltage
  The diagnostics of undervoltage can be activated.
- Diagnostics of overcurrent
  The diagnostics of overcurrent can be activated.
- Energy meter gate active
  The energy meter can be interrupted with an active energy meter gate by closing the energy meter gate.

Operating mode 1x3-phase

Measurement of a consumer on the 3-phase alternating current grid. The phase angle is measured and the reactive and apparent power calculated from this.

Info

- Name of the module according to the catalog
- Order number according to Helmholz catalog
- Comment
  Free comment text of the user

Extended

- Display of the firmware according to hardware catalog

General

- Diagnosis alarm
  ☐ - Diagnostics of internal module events
  ☑ - Diagnostics are forwarded to the bus master.
- Diagnostics of phase sequence
  ☐ - No diagnostics of the phase shift
  ☑ - The phase shift L1- L2 - L3 is tested and configured diagnostics are initiated in the event of errors.
- Phase angle measurement
  Phase angle between the voltages or between voltage and current or between the currents

- Mains frequency
  Frequency of the voltages and currents to be measured for 3-phase measurement
  50 Hz or 60 Hz valid for all phases
- Continued counting when stopped
  ☐ - Energy counting is paused with STOP
  ☑ - Energy counting is also continued with STOP
- Phase mains frequency
  Selection of the phase at which the mains frequency is measured
- Current amplification
  A current amplification factor (gain) can be set for all 3 measurement inputs.

Process values

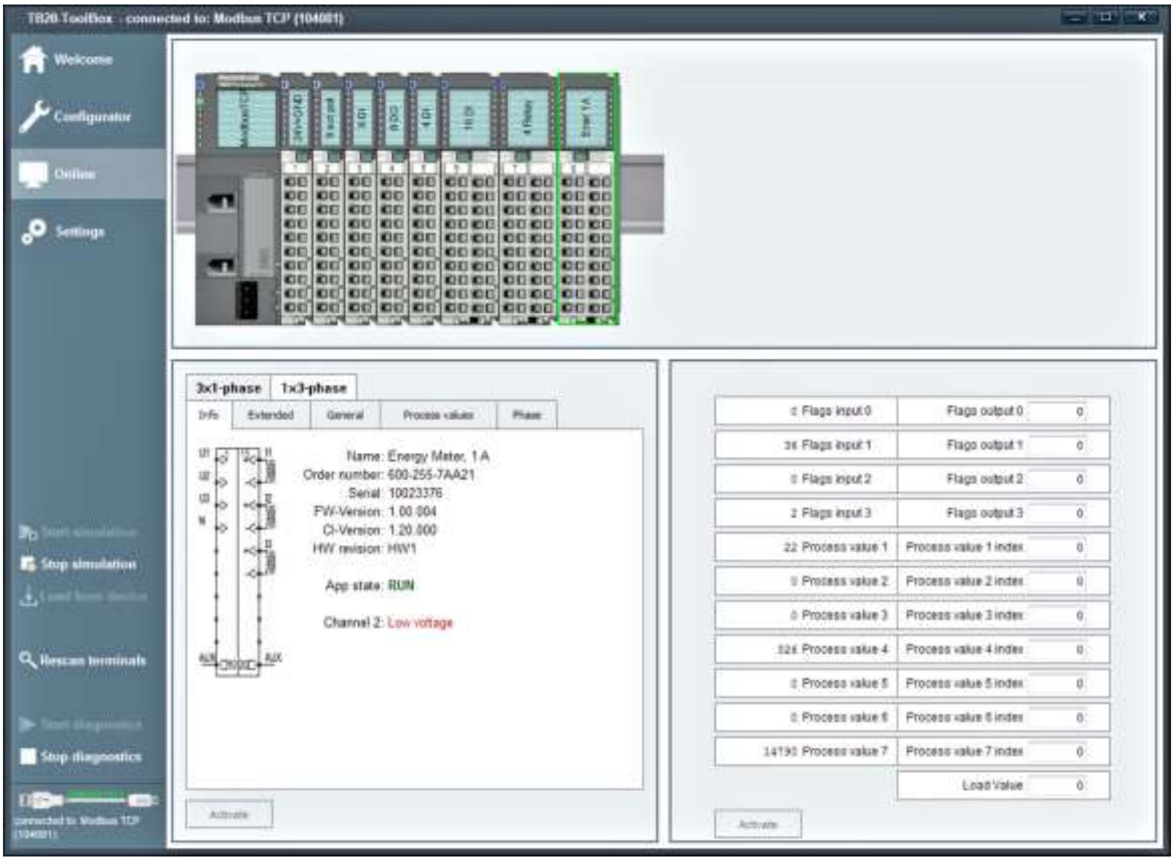
Process value 1 - 7 Index x
The Energy Meter determines up to 38 measuring values depending upon the measuring connections. 7 measuring values can be forwarded simultaneously as process values to the bus coupler via an index.
For index values see chapter 8.1.4.

Phase

- Undervoltage threshold value
  The configured diagnostics are initiated when this voltage is not reached.
- Overvoltage threshold value
  The configured diagnostics are initiated when this voltage is exceeded.
- Overcurrent threshold value
- Zero crossing timeout
  The diagnostics are initiated if a phase had no zero crossing upon expiration of the set time. The diagnostics are also initiated when voltage is present at one or more phases.
- Primary current
  Primary current of the current transformer used
- Secondary current
  Secondary current of the current transformer used
- Phase angle error connection Phase x
  Current transformers can cause a phase angle error. This measurement error can be corrected with the parameter "Phase angle error correction"
  for 50 Hz mains from -62 to 6
  Corresponds to the value of -6.2° to 0.6° with a resolution of 0.1°.
  for 60 Hz mains from -76 to 9
  Corresponds to the value of -7.6° to 0.9° with a resolution of 0.1°.
- Diagnostics of zero crossing
  The diagnostics of zero crossing can be activated.
- Diagnostics of overvoltage
  The diagnostics of overvoltage can be activated.
- Diagnosis of undervoltage
- Diagnostics of overcurrent
  The diagnostics of overcurrent can be activated.

- Energy meter gate active
  The energy meter can be interrupted with an active energy meter gate by closing the energy meter gate.

6.1.3 Diagnostics of the Energy Meter



The diagnostics start by clicking following selection of the coupler. The currently active parameter values are displayed when the Energy Meter is clicked.

Info

Displays:

- Name of the module according to the hardware catalog
- Order number according to Helmholz catalog
- Serial number of the installed module
- FW version of the installed module
- CI version of the installed module
- HW revision of the installed module
- App Status
- Display of errors detected by the Energy Meter
  The messages of the measuring channels are displayed:
  Channel 0 = Phase L1
  Channel 1 = Phase L2
  Channel 2 = Phase L3

Extended

Displays:

- Firmware of the Energy Meter
- Input data length, output data length and parameter length
- Diagnoses

The configuration of the planned hardware takes place in online operation

General

Displays:

- Diagnosis alarm active/inactive
- Configured mains frequency
- Continued counting with stop active/inactive
- Phase for which the mains frequency is configured
- Current amplification of the current transformer input

Process values

Displays:

- Process value Index 1 … 7 configured values

L1 **L2** **L3**

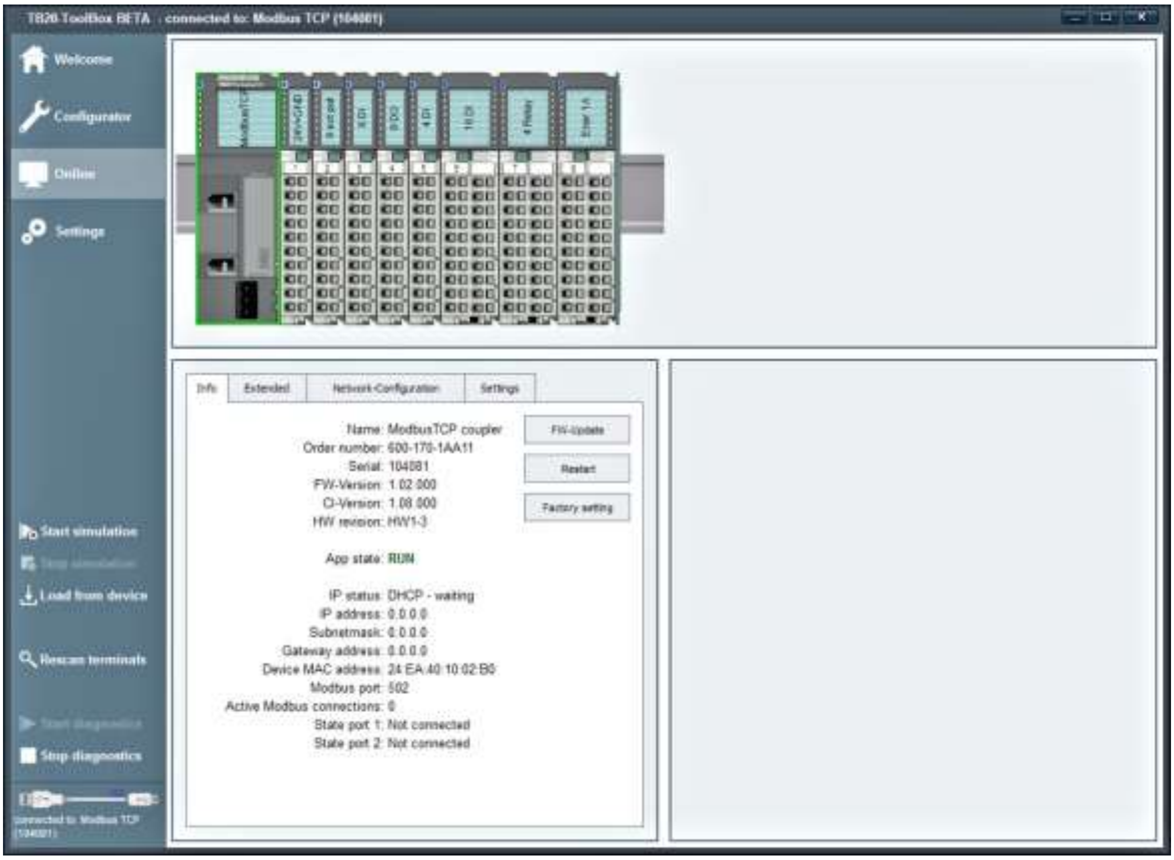
Display of active parameters:

- Undervoltage configured threshold value
- Overvoltage configured threshold value
- Overcurrent configured threshold value
- Zero crossing timeout configured value
- Primary current configured value
- Secondary current configured value
- Phase angle error correction Phase x configured value
- Diagnostics for zero crossing active/inactive
- Diagnostics for overvoltage active/inactive
- Diagnostics for undervoltage active/inactive
- Diagnostics for overcurrent active/inactive
- Energy meter gate active/inactive

Displays in the right window

- 4 input flags -> display of the current values IB0 - IB3
- 4 output flags -> display of the current values QB0 - QB3
- Load value of current value QB4 - QB7
- Display of process value 1 … 7 current values IB4 - IB7
- Display of process value index 1 … 7 current values QB8 - QB14

6.1.4 Reading the measurement values without a connection with the bus master



With the simulation via the TB20 ToolBox it is possible to configure and test a TB20 installation without a connection with a bus master and thus also without a user program.

The ToolBox must be connected with the coupler via USB and online when starting the simulation.

If no appropriate project is saved in the ToolBox, the currently connected configuration can be read out and saved as a project:

ATTENTION

Don’t switch off the computer during the simulation or set Windows to standby or sleep mode. Don't disconnect the USB connection.

Values and outputs set in the simulation are only active when the ToolBox is running on the connected computer. If Windows goes to sleep mode or is ended, all simulated values are reset to the configured values and the outputs are deactivated. Simulated settings are not saved.

The hardware and the configuration are read out. The project must be named and saved.

Going online again

The USB bus connection with the bus master is dismantled with the start of the simulation!

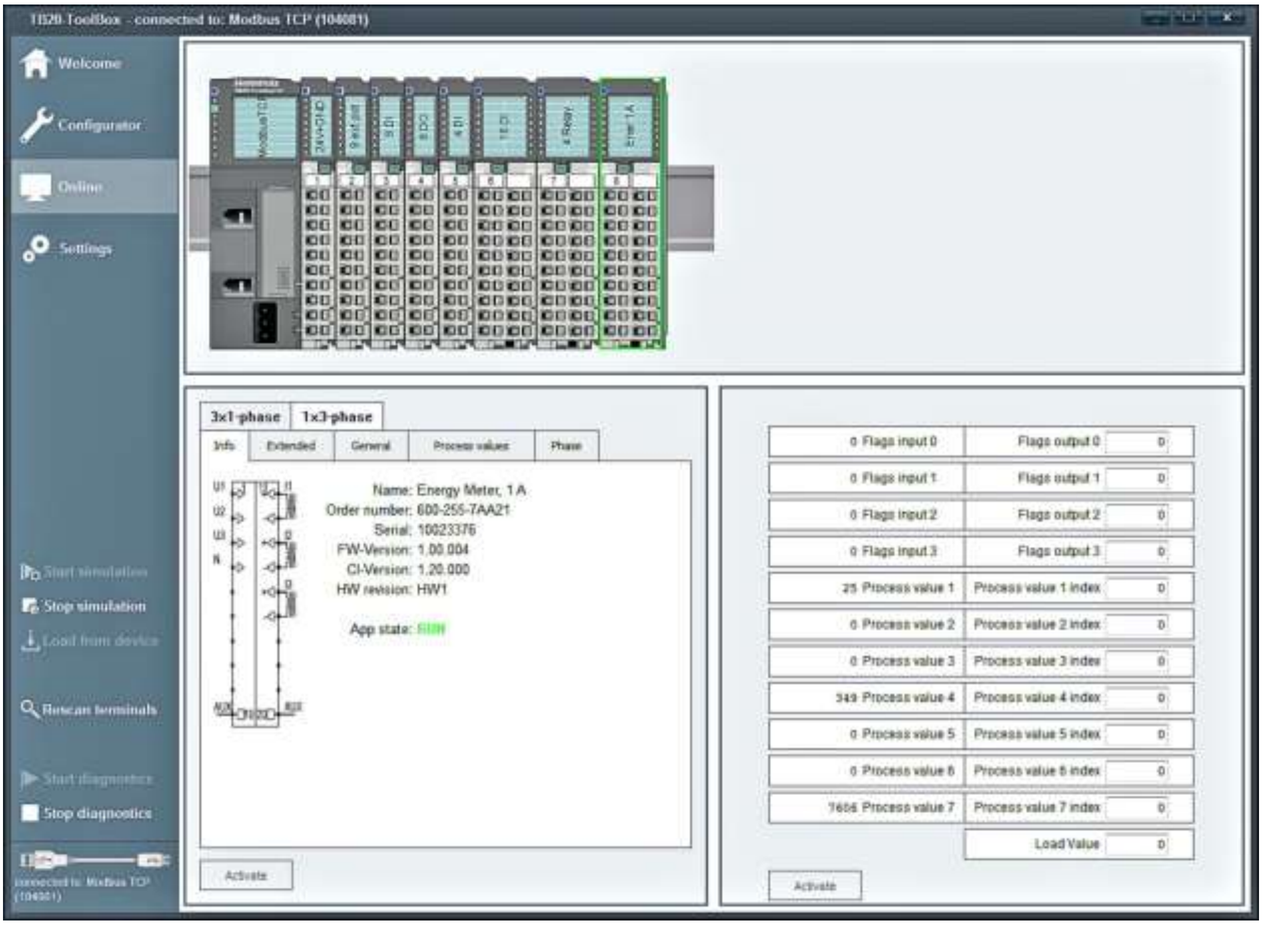
Mark the coupler by clicking it and start the simulation.

- Click on module
- Change parameter values
- Input is monitored and a warning is issued when the value ranges are exceeded or fallen short of:

- Changes are marked yellow but do not yet take effect
- Several changes can be made simultaneously

Accepts the entries. A green background is visible during acceptance, and the yellow marking then disappears.

The operating mode must be set in the Energy Meter configurator and cannot be changed in the simulation.



Display of process values: Possible to read out measuring values without CPU

6.1 Using the Energy Meter with PLCs

Depending upon the coupler type, the Energy Meter can be parameterized with the TB20 ToolBox or with coupler-specific methods. The data exchange with the Energy Meter is described in chapter 9. For configuration see chapter 8.

6.2 Using the Energy Meter with STEP7

The Energy Meter can be incorporated into the project and parameterized with a GSD file (PROFIBUS) or GSDML file (PROFINET). The GSD and GSDML files can be downloaded in the download area under www.helmholz.de.
The Energy Meter can be configured and read out with the STEP7 program.

The data exchange with the Energy Meter is described in chapter 9. For configuration see chapter 8.

7 Measuring connections

7.1 Specific safety instructions

HAZARD Risk of injury by electric shock and damage to the device possible!

The Energy Meter carries potentially fatal voyage.

Set the TB20 system to a safe, deenergized state before starting with the installation, disassembly or wiring of the connection terminals!

Note the applicable occupational safety regulations for carrying out work on live components.

HAZARD Danger. High voltage!

The secondary circuits of current transformers may never be operated open. Dangerously high voltages can occur on unwired output terminals of the current transformers when no load impedance has been connected. When pulling off the front plug of the Energy Meter, the load impedances of the current inputs are disconnected from the current transformers. Dangerously high voltages can occur on the unconnected front plug.

Deenergize the current paths in which the connected current transformers are operated before working on the Energy Meter!

Note the regulations for use of the current transformer manufacturer!

ATTENTION Equipment damage due to incorrect wiring!

Current measurements must take place using transducers. The current path may not be guided directly through the Energy Meter.

Use current transformers suitable for the input current range of the Energy Meter for your measuring connection.

7.2 Measuring procedures

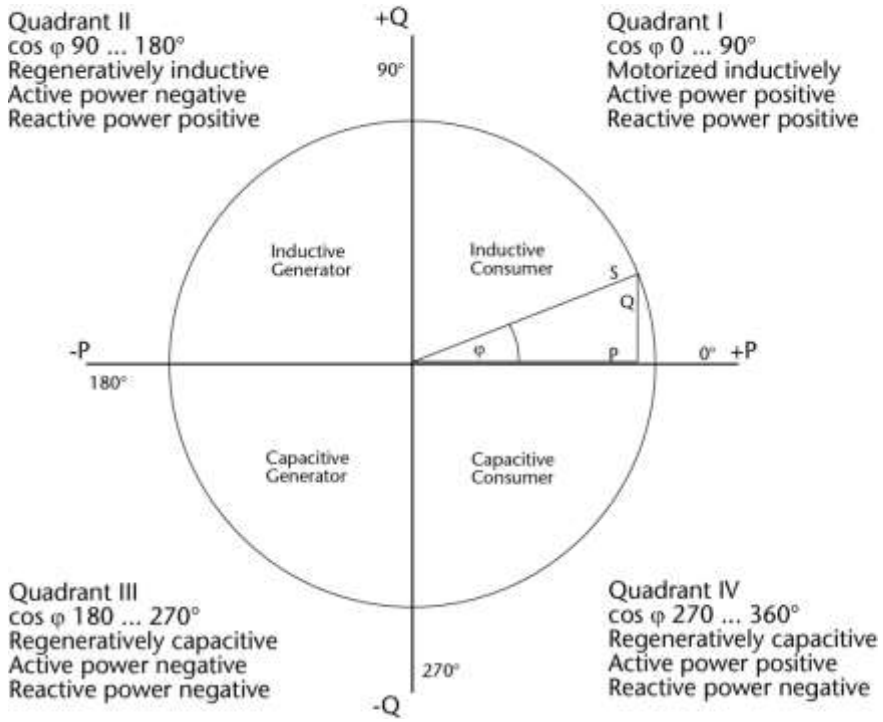
The 3-phase measurements are possible in Y or delta connections with 3 or 4-conductor connection. 1-phase measurement is only possible on one phase of a current path, or two or three 1-phase measurements can be carried out in different current paths simultaneously.

The Energy Meter is supplied with voltage electrically isolated via the back wall bus independently of the voltage to be measured.

The measuring error for currents and voltages is 0.5 % in relation to the measuring range end value.

The measurements take place via electrically isolated inputs. Voltages are measured against a common N conductor or functional ground. No grounding of the Energy Meter via PE is necessary. The current inputs are electrically isolated from each other and from N/PE. The current measurement must take place with current transformers. Phase angle errors of the current transformer can be compensated for. The amplification factor of the current inputs can be configured.

The measurement of the power factor cosφ for the definition of quadrants and for defining phase delays can take place between voltages and currents, between voltages and between currents.



Quadrant 1 cosφ 0° … 90°	Quadrant 2 cosφ 90° … 180°	Quadrant 3 cosφ 180° … 270°	Quadrant 4 cosφ 270° … 360°
Reactive energy Inductive (+)		Reactive energy Capacitive (-)	
Active energy Reference (+)	Active energy Delivery (-)	Active energy Delivery (-)	Active energy Reference (+)

Assignment of the active and reactive energy in the 4 quadrants

7.2.1 Measuring values

The following values are calculated from the measured voltages and currents, and the cosφ:

Apparent/active/reactive power per phase

Apparent/active/reactive power total

Apparent/active/reactive energy per phase

Apparent/active/reactive energy total

Power factor PF per phase

Power factor PF total

The power calculation does not provide evaluable values for only voltage or only current measurements.

The counting of the consumption values can be set via the energy meter gate. Reactive, apparent and active energy are stored every 15 minutes or via a control bit in non-volatile memory in the Energy Meter. The memory can be overwritten with load values.

The process input image can be configured.

7.2.2 Diagnoses

The diagnosis alarm can be configured and the following diagnostics are possible.

Module:

- Incorrect phase sequence Diag-ID: 21
- Invalid parameter Diag-ID: 18
- Invalid parameter length Diag-ID: 20

When configuring in the ToolBox, the input is tested for invalid parameters and incorrect parameter length.

Channel:

- Zero crossing - missing phase Diag-ID: 23
  Timeout can be configured
- Overvoltage Diag-ID: 3
  Value can be configured
- Undervoltage Diag-ID: 2
  Value can be configured
- Overcurrent Diag-ID: 22
  Value can be configured

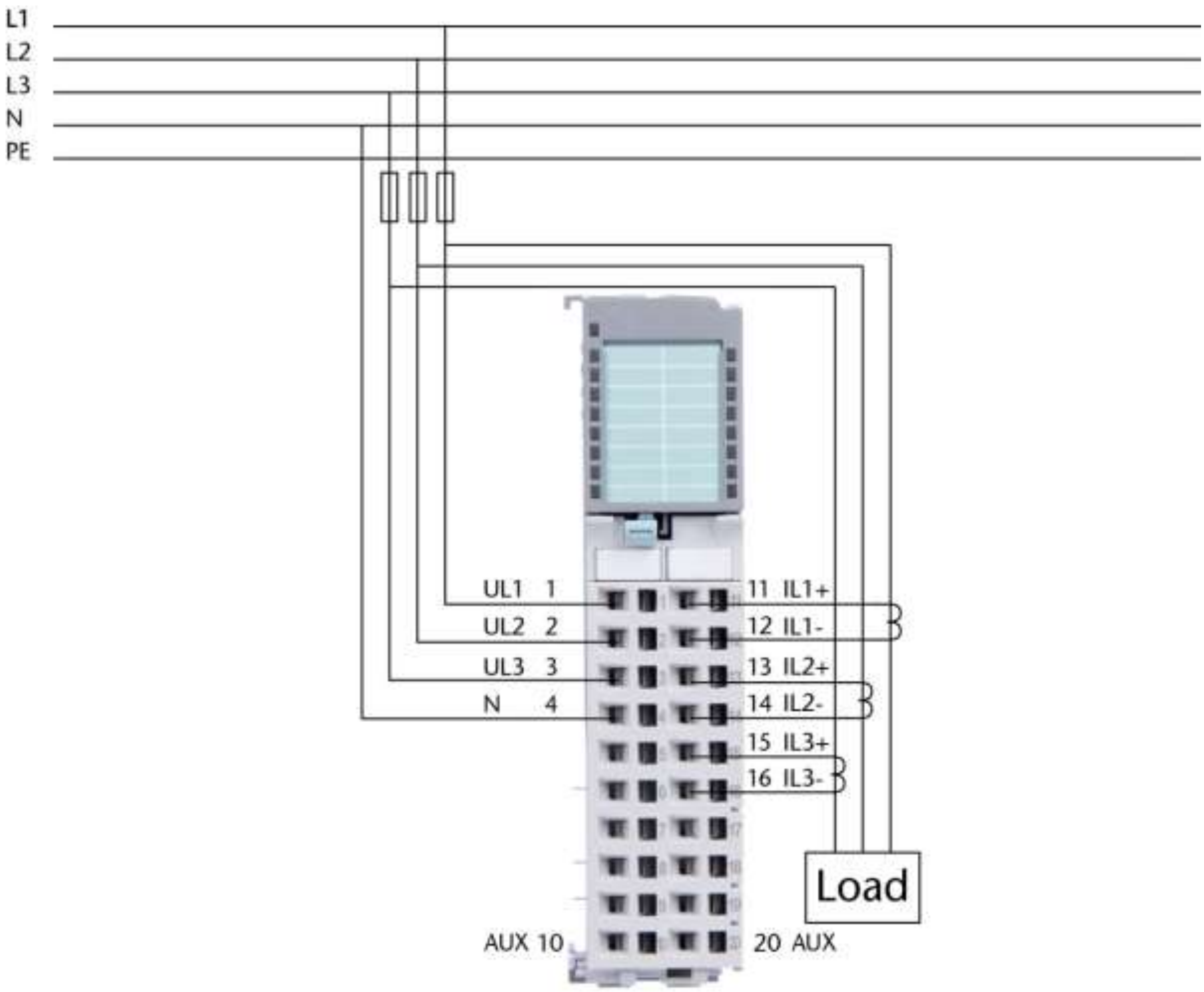
The diagnostics on the Energy Meter can be switched on or off for each measurement channel when configuring the operating mode.

7.2.3 Power measurement on a 3-phase load

Operating mode 1x3 phases

The voltage measurement takes place via the connections UL1, UL2, and UL3. The current measurement takes place with the three current transformers via the connections IL1, IL2, and IL3.

All values can be measured or calculated, see Process values index, page 67.



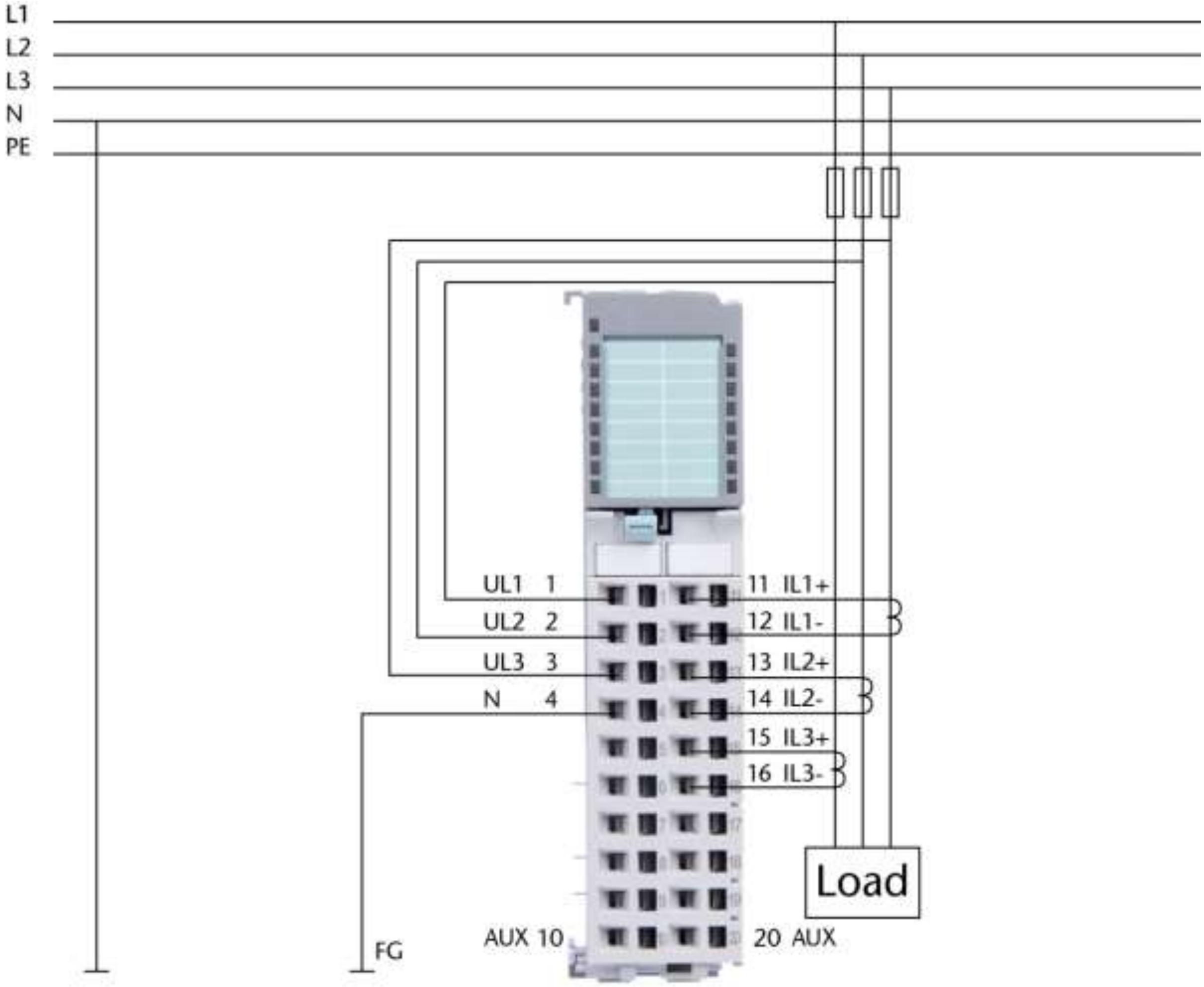
7.2.4 Power measurement at a load without neutral conductor

Operating mode 1x3 phases

The voltage measurement takes place via the connections UL1, UL2, and UL3. The current measurement takes place with three isolated current transformers via the connections IL1, IL2, and IL3.

In the case of a grounded neutral conductor and a negligible load on the grounding path, the neutral conductor connection of the Energy Meter can be grounded (functional ground FG).

All values can be measured or calculated, see Process values index, page 67.

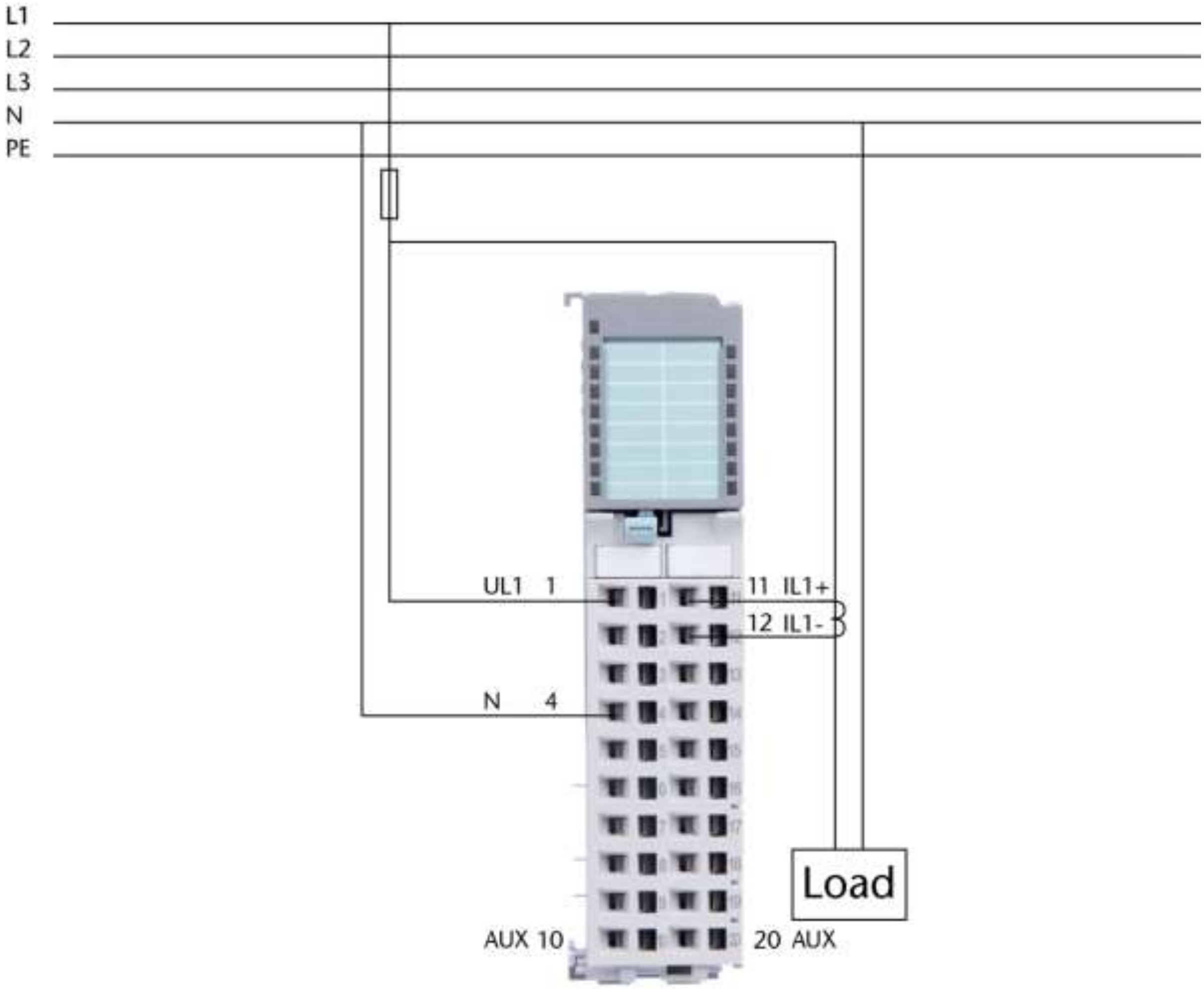


7.2.5 Power measurement on a single-phase load

Operating mode 3x1-phase

The voltage measurement takes place via connection UL1. The current measurement takes place with a current transformer via the connections IL1 + IL-.

All values for phase L1 can be measured or calculated, see Process values index, page 67.



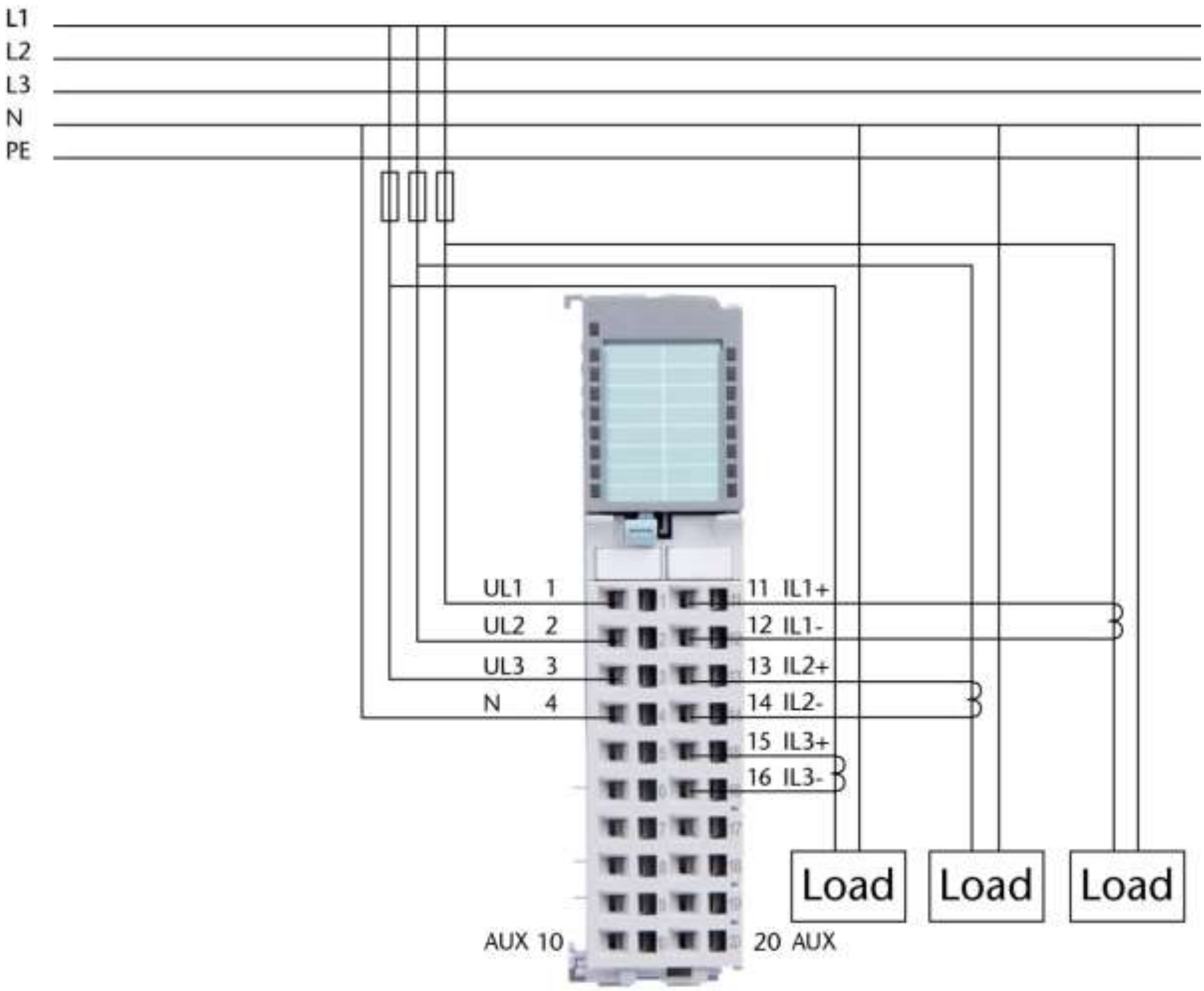
7.2.6 Power measurement of 3 loads with the Energy Meter

Operating mode 3x1-phase

The values

- Root mean square (RMS) of U/I
- Apparent/active/reactive power
- Apparent/active/reactive energy

can be determined for each phase individually, and thus also for three isolated consumers. The consumers can be connected to any phases. All phases must have the same frequency.

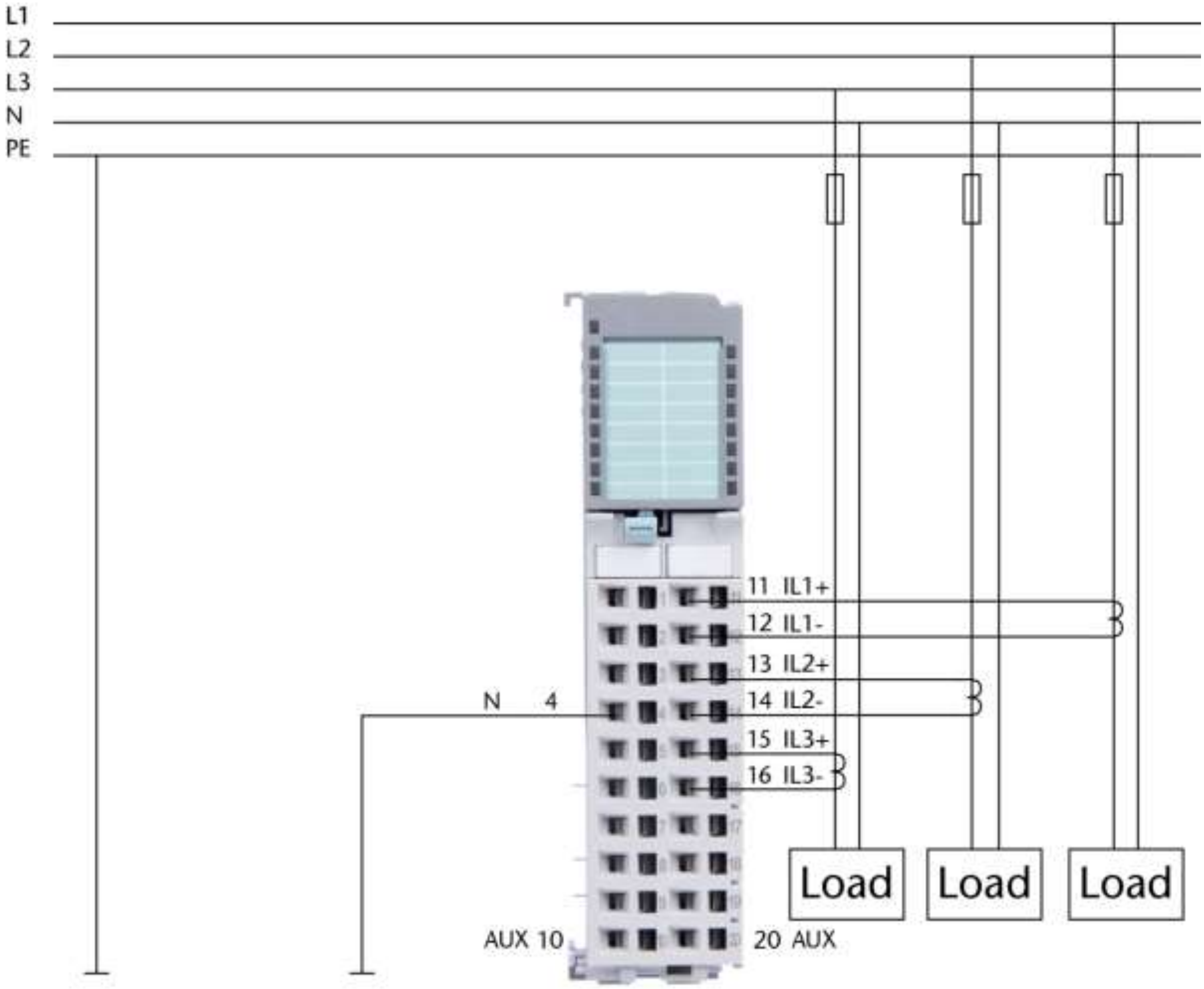


7.2.7 Current measurement at a load

Operating mode 3x1-phase

The current measurement takes place with three isolated current transformers via the connections IL_1, IL_2, and IL_3 for three isolated loads.

The loads can be connected to any phase. All phases must have the same frequency.



8 Parameterization

8.1 Operating modes

8.1.1 Operating mode 1x3 phases

Measurement of a load on the 3-phase network. The Energy Meter is configured over a data range of 25 bytes.

<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Par 0</td><td colspan="8">Mode = 21</td></tr>
<tr><td>Par 1</td><td>Diagnosis alarm</td><td>Diagnostics Phase order</td><td></td><td colspan="2">Phase angle measurement</td><td>0</td><td>1</td><td>Mains frequency</td></tr>
<tr><td>Par 2</td><td></td><td></td><td colspan="3">Current amplification</td><td>Continued counting with STOP</td><td colspan="2">Mains frequency phase</td></tr>
<tr><td>Par 3</td><td colspan="8">Zero crossing timeout [10 ms]</td></tr>
<tr><td>Par 4-5</td><td colspan="8">Undervoltage threshold value [0.1 V]</td></tr>
<tr><td>Par 6-7</td><td colspan="8">Overvoltage threshold value [0.1 V]</td></tr>
<tr><td>Par 8-9</td><td colspan="8">Current threshold value [0.01 A]</td></tr>
<tr><td>Par 10-11</td><td colspan="8">Primary current [0.01 A]</td></tr>
<tr><td>Par 12-13</td><td colspan="8">Secondary current [0.01 A]</td></tr>
<tr><td>Par 14</td><td>Diagnostics Zero crossing</td><td>Diagnostics Overvoltage</td><td>Diagnosis of undervoltage</td><td>Diagnostics Overcurrent</td><td>Energy meter gate active</td><td></td><td></td><td></td></tr>
<tr><td>Par 15</td><td colspan="8">Phase angle error correction [0.1°] Phase L1</td></tr>
<tr><td>Par 16</td><td colspan="8">Phase angle error correction [0.1°] Phase L2</td></tr>
<tr><td>Par 17</td><td colspan="8">Phase angle error correction [0.1°] Phase L3</td></tr>
<tr><td>Par 18</td><td colspan="8">Process value 1 Index</td></tr>
<tr><td>Par 19</td><td colspan="8">Process value 2 Index</td></tr>
<tr><td>Par 20</td><td colspan="8">Process value 3 Index</td></tr>
<tr><td>Par 21</td><td colspan="8">Process value 4 Index</td></tr>
<tr><td>Par 22</td><td colspan="8">Process value 5 Index</td></tr>
<tr><td>Par 23</td><td colspan="8">Process value 6 Index</td></tr>
<tr><td>Par 24</td><td colspan="8">Process value 7 Index</td></tr>
</table>

8.1.2 Operating mode 3x1-phase

Measurement of up to 3 independent single-phase loads. The Energy Meter is configured over a data range of 49 bytes.

	7	6	5	4	3	2	1	0	
Par 0	Mode = 20								
Par 1	Diagnosis alarm							Mains frequency	
Par 2			Current amplification			Continued counting with STOP	Mains frequency phase		
Par 3	Zero crossing timeout [10 ms]								
Par 4-5	Undervoltage threshold value [0.1 V]								
Par 6-7	Overvoltage threshold value [0.1 V]								
Par 8-9	Current threshold value [0.01 A]								Phase L1
Par 10-11	Primary current [0.01 A]								
Par 12-13	Secondary current [0.01 A]								
Par 14	Diagnostics Zero crossing	Diagnostics Overvoltage	Diagnosis of undervoltage	Diagnostics Overcurrent	Energy meter gate active				
Par 15	Zero crossing timeout [10 ms]								
Par 16-17	Undervoltage threshold value [0.1 V]								
Par 18-19	Overvoltage threshold value [0.1 V]								
Par 20-21	Current threshold value [0.01 A]								Phase L2
Par 22-23	Primary current [0.01 A]								
Par 24-25	Secondary current [0.01 A]								
Par 26	Diagnostics Zero crossing	Diagnostics Overvoltage	Diagnosis of undervoltage	Diagnostics Overcurrent	Energy meter gate active				
Par 27	Zero crossing timeout [10 ms]								
Par 28-29	Undervoltage threshold value [0.1 V]								
Par 30-31	Overvoltage threshold value [0.1 V]								
Par 32-33	Current threshold value [0.01 A]								Phase L3
Par 34-35	Primary current [0.01 A]								
Par 36-37	Secondary current [0.01 A]								
Par 38	Diagnostics Zero crossing	Diagnostics Overvoltage	Diagnosis of undervoltage	Diagnostics Overcurrent	Energy meter gate active				
Par 39	Phase angle error correction [0.1°] Phase L1								
Par 40	Phase angle error correction [0.1°] Phase L2								
Par 41	Phase angle error correction [0.1°] Phase L3								
Par 42	Process value 1 Index								
Par 43	Process value 2 Index								
Par 44	Process value 3 Index								
Par 45	Process value 4 Index								
Par 46	Process value 5 Index								
Par 47	Process value 6 Index								
Par 48	Process value 7 Index								

8.1.3 Parameters

The default settings are underlined.

Parameters	Description	Value range
Operating mode	Measurement 1 or 3-phase	20 = 3x1 phase 21 = 1x3 phases
Mains frequency	Frequency of the voltages and currents to be measured for 3-phase measurement	0 = 50Hz 1 = 60Hz
Mains frequency phase	Frequency of the phase of the voltage and the current to be measured for 1-phase measurement	00 = Phase L1 01 = Phase L2 10 = Phase L3
Phase angle measurement	Measurement of cos phi for each phase or measurement of the phase angle of voltages or currents of phase to phase.	00 => PW1 = U->I(L1) / PW2 = U->I(L2) / PW3 = U->I(L3) 01 => PW1 = L1->L2(U) / PW2 = L2->L3(U) / PW3 = L1->L3(U) 10 => PW1 = L1->L2(I) / PW2 = L2->L3(I) / PW3 = L1->L3(I) 11 => reserved
Energy meter gate active		0 = Energy is always accumulated . 1 = Energy accumulation can be stopped by closing the energy meter gate.
Diagnostic alarm		0 = Diagnostics are not forwarded to the bus system. 1 = Diagnostics are forwarded to the bus system.
Diagnostics of phase sequence		0 = Diagnostics not active. 1 = Diagnostics are initiated when the phases are not run through in the correct sequence (L1->L2->L3)
Continued counting with STOP		0 = Energy accumulation is paused in STOP. 1 = Energy accumulation is continued in STOP.
Primary current	Primary current of the current transformer used	1A: Default: 100 [0.01A] (1-65535) 5A: Default: 500 [0.01A] (1-65535)
Secondary current	Secondary current of the current transformer used	1A: Default: 100 [0.01A] (1-65535) 5A: Default: 500 [0.01A] (1-65535)
Undervoltage threshold value	Diagnostics are initiated when this voltage is not reached.	Default: 2000 [0.1V] (0-4000)
Overvoltage threshold value	Diagnostics are initiated when this voltage is exceeded.	Default: 2800 [0.1V] (1-4000)
Overcurrent threshold value	Diagnostics are initiated when this current level is exceeded.	1A: Default: 100 [0.01A] (1-65535) 5A: Default: 500 [0.01A] (1-65535)

Phase angle error correction value	For 50 Hz mains from -62 to 6 (corresponds to the value of -6.2° to 0.6° with a resolution of 0.1°).	Default: 0
	For 60 Hz mains from -76 to 9 (corresponds to the value of -7.6° to 0.9° with a resolution of 0.1°).	Default: 0
Zero transition timeout	The diagnostics are initiated if a phase had no zero crossing upon expiration of the set time.	Default: 100 (1-255)
Current amplification for all phases	A current amplification factor can be set for all 3 measurement inputs.	000 = Gain 1 001 = Gain 2 010 = Gain 4 011 = Gain 8 100 = Gain 16
Diagnostics for overcurrent	The diagnostics of overcurrent can be activated.	0 = Diagnostics not active. 1 = The diagnostics are initiated when more current is present at the phase than that set.
Diagnosis of undervoltage	The diagnostics of undercurrent can be activated.	0 = Diagnostics not active. 1 = The diagnostics are initiated when less voltage is present at the phase than that set.
Diagnostics of undervoltage	The diagnostics of undervoltage can be activated.	0 = Diagnostics not active. 1 = The diagnostics are initiated when less voltage is present at the phase than that set.
Diagnostics of zero crossing	The diagnostics of zero crossing can be activated.	0 = Diagnostics not active. 1 = The diagnostics are initiated if a phase had no zero crossing upon expiration of the set time.
Process value 1 Index	The index of the respective standard process value.	Defaults: 4, 5, 6, 7, 8, 9, 37 (1 - 38)

ATTENTION

If the transformer ratios of the phases are changed during reconfiguration, the saved energy values are worthless and must be reset to "0" with "Load energy value" and "Save energy values".

ATTENTION

In the case of reconfiguration, the energy values return to the most recently saved status.

8.1.4 Process values index

Index	Function	Display Metric
0	The process value set in the parameters is displayed	
1	RMS voltage Phase L1	0.001 V
2	RMS voltage Phase L2	0.001 V
3	RMS voltage Phase L3	0.001 V
4	RMS current Phase L1	0.001 A
5	RMS current Phase L2	0.001 A
6	RMS current Phase L3	0.001 A
7	Active power Phase L1	0.01 W
8	Active power Phase L2	0.01 W
9	Active power Phase L3	0.01 W
10	Active power total	0.01 W
11	Reactive power Phase L1	0.01 var
12	Reactive power Phase L2	0.01 var
13	Reactive power Phase L3	0.01 var
14	Reactive power total	0.01 var
15	Apparent power Phase L1	0.01 VA
16	Apparent power Phase L2	0.01 VA
17	Apparent power Phase L3	0.01 VA
18	Apparent power total	0.01 VA
19	Active energy Phase L1	0.1 Wh
20	Active energy Phase L2	0.1 Wh

Index	Function	Display Metric
21	Active energy Phase L3	0.1 Wh
22	Active energy total	0.1 Wh
23	Reactive energy Phase L1	0.1 varh
24	Reactive energy Phase L2	0.1 varh
25	Reactive energy Phase L3	0.1 varh
26	Reactive energy total	0.1 varh
27	Apparent energy Phase L1	0.1 VAh
28	Apparent energy Phase L2	0.1 VAh
29	Apparent energy Phase L3	0.1 VAh
30	Apparent energy total	0.1 VAh
31	Frequency	0.01 Hz
32	Power factor Phase L1*	0.01
33	Power factor Phase L2*	0.01
34	Power factor Phase L3*	0.01
35	Power factor total**	0.01
36	Phase angle 1 phase delay of current and voltage	0.01°
37	Phase angle 2 phase delay of current and voltage	0.01°
38	Phase angle 3 phase delay of current and voltage	0.01°

* The power factor PF is the exact cos phi as a quotient of active and apparent power. The sign is determined by the sign of the active power. Positive active power for power input, negative active power for power output. The apparent power itself has no sign.

** The power factor PF serves to represent the type of load. Only the amount of active power (P) is incorporated into the calculation. The energy flow direction remains unconsidered. The sign of the power factor is positive for inductive load and negative for capacitive load.

9 Reference data for communication with bus masters

9.1 Data exchange between the master and the Energy Meter

The user must program function modules in the master control program for operation of the Energy Meter behind a TB20 bus coupler. The master writes data into the outputs and reads data from the inputs of the bus coupler.

Inputs:

	7	6	5	4	3	2	1	0
IB 0 - 3	Status bits							
IB 4 - 7	Process value 1							
IB 8 - 11	Process value 2							
IB 12 - 15	Process value 3							
IB 16 - 19	Process value 4							
IB 20 - 23	Process value 5							
IB 24 - 27	Process value 6							
IB 28 - 31	Process value 7							

Process value X:
Display of the process value set with the control interface or parameters

Status bits:

	7	6	5	4	3	2	1	0
IB 0	Saving of energy value complete	Loading of energy value complete	Overcurrent Phase L3	Overcurrent Phase L2	Overcurrent Phase L1	Overvoltage Phase L3	Overvoltage Phase L2	Overvoltage Phase L1
IB 1	Active energy Phase L2 full	Active energy Phase L1 full	No zero crossing Phase L3	No zero crossing Phase L2	No zero crossing Phase L1	Undervoltage Phase L3	Undervoltage Phase L2	Undervoltage Phase L1
IB 2	Process values accepted	Apparent energy Phase L3 full	Apparent energy Phase L2 full	Apparent energy Phase L1 full	Reactive energy Phase L3 full	Reactive energy Phase L2 full	Reactive energy Phase L1 full	Active energy Phase L3 full
IB 3	Apparent energy total full	Reactive energy total full	Active energy total full	Meter gate L3 status	Meter gate L2 status	Meter gate L1 status	Incorrect phase sequence	Parameter error

Saving of energy value complete:
The energy values have been successfully secured in non-volatile memory.

Loading of energy value complete:
The energy value in the "load value" has been loaded via a "Load energy value Phase Lx" bit.

Overcurrent Phase Lx:
The configured value for overcurrent has been exceeded.

Overvoltage Phase Lx:
The configured value for overvoltage has been exceeded.

Undervoltage Phase Lx:
The configured value for undervoltage has not been reached.

No zero crossing Phase Lx:
No crossing has been determined for the time configured in "Zero crossing timeout".

Active, reactive, apparent energy Phase Lx full:
An energy registry has reached more than half of its maximum value. It should be reset via "Load energy value" and the value saved in the control system.

Process values accepted: The process values indicated in the control interface have been accepted into the input image via the "Accept process values" bit.

Configuration error:
The module was configured incorrectly with an incorrect length or due to inconsistency of the parameter data.

Incorrect phase sequence:
The zero crossings of the phases were not in the L1->L2->L3 sequence. (Only operating mode "3x1-phase").

Meter gate Lx status:
Indicates whether the energy accumulation is active at present.

0 = Energy accumulation active"
1 = Energy accumulation stopped

This function must be activated in the parameters.

Control interface (Outputs)

Outputs: 15 bytes

	7	6	5	4	3	2	1	0
QB 0 - 3	Control bits							
QB 4 - 7	Preset count							
QB 8	Process value 1 Index							
QB 9	Process value 2 Index							
QB 10	Process value 3 Index							
QB 11	Process value 4 Index							
QB 12	Process value 5 Index							
QB 13	Process value 6 Index							
QB 14	Process value 7 Index							

Process value X Index:

0 = The process value set in the parameters is displayed

1-n = The process value with the number n is displayed

Load value:
The value entered here is accepted as an energy value when it is queried by a "Load …energy Phase Lx" bit.

Control bits:

	7	6	5	4	3	2	1	0
QB 0	Load apparent energy Phase L2	Load apparent energy Phase L1	Load reactive energy Phase L3	Load reactive energy Phase L2	Load reactive energy Phase L1	Load active energy Phase L3	Load active energy Phase L2	Load active energy Phase L1
QB 1			Accept process values	Save energy values	Meter gate L3 On/Off	Meter gate L2 On/Off	Meter gate L1 On/Off	Load apparent energy Phase L3
QB 2								
QB 3								

Load active, reactive, apparent energy Phase Lx:
The content of "Load value" is assigned as the actual value of the assigned energy value. It is advisable to write the new values into the non-volatile memory after loading using "Save energy values", as these changes will otherwise be lost in the event of a power-off reset.

The respective "...energy Phase Lx" bit may only be reset when "Loading of energy value complete" is '1', see status bits.

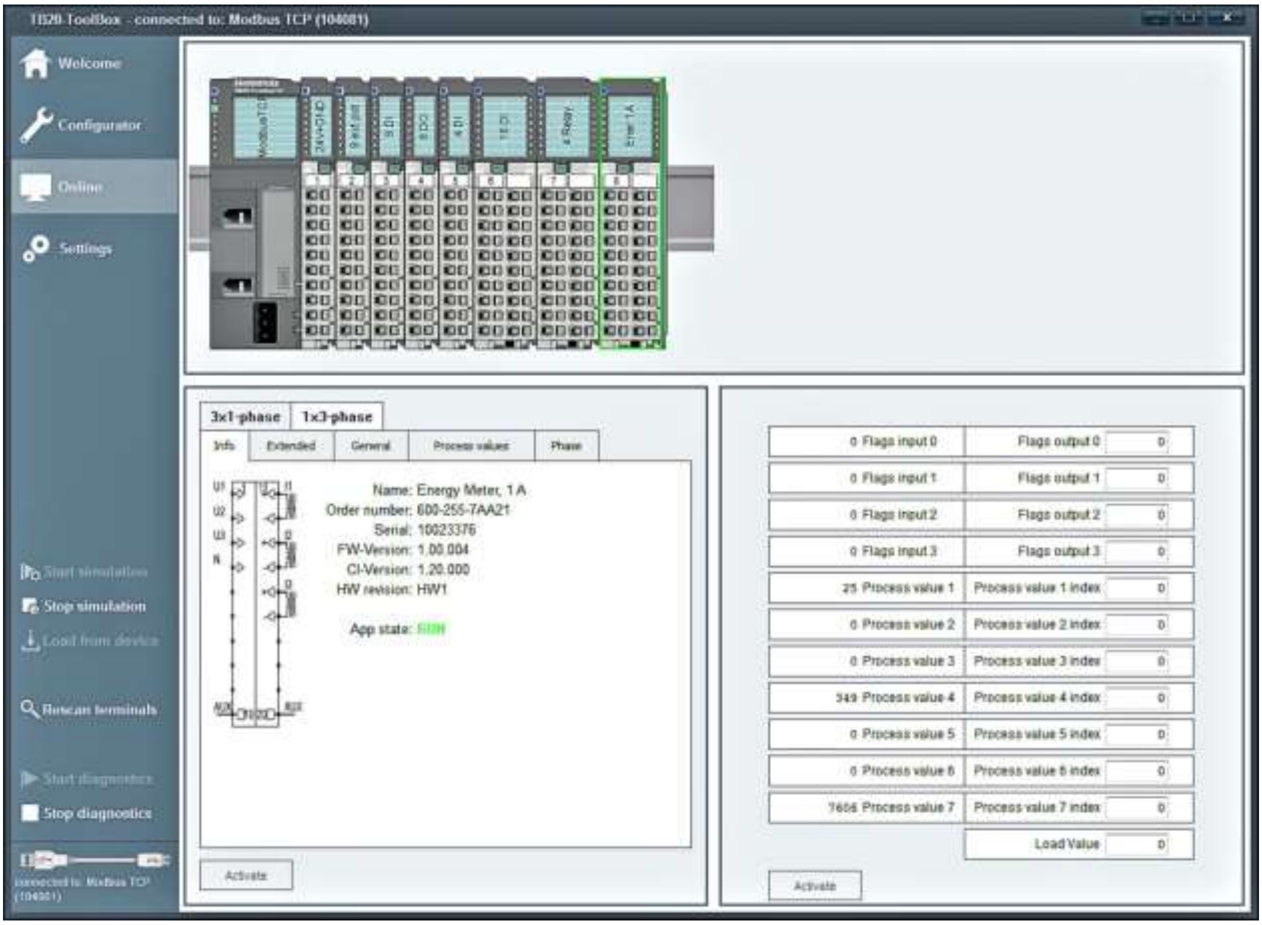
Meter gate Lx On/Off:
If the meter door is activated for this phase in the parameters, the energy accumulation can be paused '0' or continued '1' via this bit. Recording can only take place with 0.1Wh precision. When the meter gate is closed and the accumulated energy consumption amounts to less than the named 0.1Wh, this is not recorded.

Save energy values:
When this bit is set, the module begins to write the energy values into the non-volatile memory. When the process is completed, the "Saving of energy value completed" bit is set to '1'. The bit can now be deleted again.

Accept process values:
The process value indexes from the output interface are activated with this bit and displayed in the input reproduction.

9.1.1 Read out process values with the ToolBox

All energy values can also be displayed without a connected master control with the help of the TB20 ToolBox. The Energy Meter must be configured and the coupler must run in simulation mode; see chapter 6.1.4.



Display of process values:

In the right window:

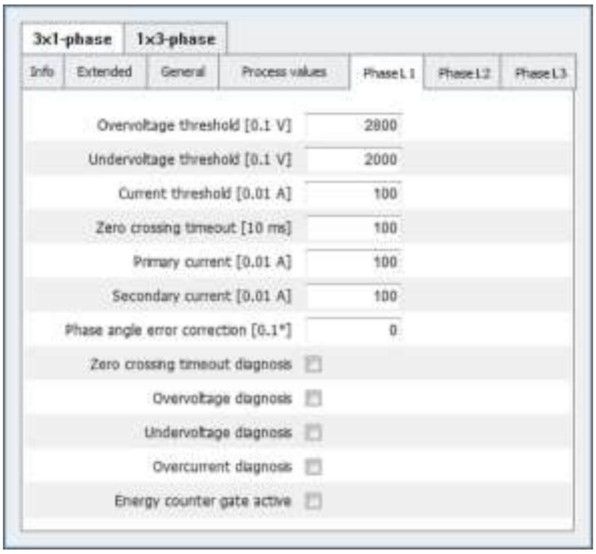
- Enter the index numbers for the process values to be displayed; see chapter 8.1.4.
- 

  the configured process value index numbers are overwritten
- "Accept process values" by setting QB1 Bit 5 (Dec 32)
- 

- When "Process values accepted" IB2 Bit 7 (Dec 128) appears, process values 1 -7 can be read out.
- Reset QB1 Bit 5 (Dec 0)
- 

- The selected process values continue to be updated and displayed

In the left window:



When reconfiguring in the left window during running simulation, the process value display is set to the process values configured in this window.

9.1.2 Read out process values with the master control

A cyclical query can be programmed in the master program for reading out all 38 process values.

Example:

- Index values transmit QB8 to QB14 (see chapter 9.1 "Outputs")
- "Accept process values" by setting QB1 Bit 5 (see chapter 9.1 "Control bits")
- Reset of QB1 Bit 5 upon receipt of "Process values accepted" IB2 Bit 7 (see chapter 9.1 "Outputs")
- Read out process values from IB4 to IB31 (see chapter 9.1 "Inputs") and save
- transmit new index values QB8 to QB14
- "Accept process values" by setting QB1 Bit 5
- Reset of QB1 Bit 5 upon receipt of "Process values accepted" IB2 Bit 7
- Read out process values from IB4 to IB31
- additional cycles with other index values

Thanks to the cyclical query, 7 permanently configured process values can be periodically read out or any 7 process values cyclically, see chapter 8.1.4.

9.2 General technical specifications

Order no.	600-255-7AA21
Module type	Energy Meter 3-phase U and I
Electrically isolated from backplane bus	Yes
Power dissipation	Max. 2.0 W
Power supply for modules	5 VDC, max. 130 mA Voltage supply via back wall bus, irrespective of voltage to be measured
Isolation voltage	500 V
Protection rating	IP 20
Relative humidity	95% r H without condensation
Installation position	Any
Permissible ambient temperature	0 °C to 60 °C
Transport and storage temperature	-20 °C to 80 °C
Dimensions (H x W x D)	110 mm x 25 mm x 73 mm Double housing width
Weight	Approx. 120 g
Hot-pluggable	Yes

9.3 Certifications

The following approvals have been issued for the Energy Meter 600-255-7AA21 and 600-255-7BA21:

CE marking

UL pending

9.4 Standards and guidelines

Interference immunity:	DIN EN 61000-6-2 “EMC Immunity”
Interference emission:	DIN EN 61000-6-4 “EMC Emission”
Vibration and shock resistance	DIN EN 60068-2-8:2008 "Vibration" DIN EN 60068-27:2010 "Shock"

10 Usage instructions

Current transformer:

The precision class of the current transformer influences the measurement precision of the Energy Meter.

Measurement:

- Secondary rated current: 1 A or 5 A

The input current may not exceed 8 A. Due to the increased power dissipation at the shunt, permanent overload > 1.3 * I_N results in the destruction of the Energy Meter.

Provide for the shortest possible wiring between current transformer and Energy Meter in order to minimize transmission losses. In the case of long connection lines, wiring with the largest possible cross-section until up close to the Energy Meter.

Secondary current [A]	Cross-section [mm²]	Cable length Cable apparent power				
		0.5 m [VA]	1.0 m [VA]	2.5 m [VA]	5 m [VA]	10 m [VA]
5	1.5	0.3	0.6	1.5	2.9	5.8
1	1.0	0.02	0.04	0.09	0.18	0.35
1	1.5	0.01	0.03	0.06	0.12	0.23

Table: Standard values for the cable apparent power (VA) as a function of the cable length and the cross-section

Danger. High voltage!

The secondary circuits of current transformers may never be operated open. Dangerously high voltages can occur on unwired output terminals of the current transformers when no load impedance has been connected. When pulling off the front plug of the Energy Meter, the load impedances of the current inputs are disconnected from the current transformers. Dangerously high voltages can occur on the unconnected front plug.

Deenergize the current paths in which the connected current transformers are operated before working on the Energy Meter!

Note the regulations for use of the current transformer manufacturer!

Exception: Current transformer with internal load impedance and overvoltage protection (electronic current transformer).

11 Spare parts

11.1 Base modules

11.1.1 14 mm width standard base module

The 14 mm standard base module is available in sets of five with order no. 600-900-9AA01.

11.1.2 25 mm width base module

The 25 mm standard base module is available in sets of five with order no. 600-900-9AA21.

11.1.3 Power and isolation base module

The power and isolation base module is available in sets of five with order no. 600-900-9BA01.

11.1.4 Power base module

The power base module is available in sets of five with order no.600-900-9CA01.

It can be used with the power module (600-700-0AA01) and with all bus couplers.

11.2 Front connectors

11.2.1 Front connector, 10-pin

The 10-terminal front connector is available in sets of five with order no. 600-910-9AJ01.

11.2.2 Front connector, 20-pin

The 20-pin front connector is available in sets of five with order no. 600-910-9AT21.

11.3 Electronic modules

Electronic modules can be ordered as spare parts with the order number of the original product. Electronic modules are always sent as a complete assembly, including the corresponding base module and front connector.

11.4 Final bus cover

The final bus cover is available in sets of five with order no. 600-920-9AA01.

References

Family	TB20
Module	Energy Meter
Order number 1A	600-255-7AA21
Order number 5A	600-255-7BA21
Manual	960-255-7AA21
FW status	1.00.004
HW status	x