



TB20 – ModbusTCP Coupler

Manual

Version 1 / 15.05.2014 for HW 1-1 & FW 1.00 and higher

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Notes

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1. General Information

This manual explains how to set up and use the TB20 I/O system's ModbusTCP coupler and provides technicians with all the information required to install it.

1.1. Target Group for This Manual

This manual is intended for all project engineers, design engineers, technicians (skilled workers with electrical training), and users who work with TB20 I/O systems.

1.2. Symbols Used Throughout This Manual

The following symbols are used throughout this manual:



Used for tips and general information, e.g., to point out potential sources of error.



CAUTION!

Risk of property damage or malfunction.



WARNING!

Risk of bodily injury, e.g., due to electric shock.

1.3. Safety Instructions

For your own safety, and for the safety of others in the vicinity of the equipment, please follow the safety instructions below.



WARNING!

All applicable accident prevention and safety regulations must be complied with when planning the use of, installing, and operating this equipment! The company operating the equipment is responsible for ensuring compliance with these regulations!



WARNING!

Any processes in the equipment that have the potential of resulting in property damage or bodily injury must be safeguarded with the use of additional external devices. These devices must ensure that the equipment will remain in a safe operating state even in the event of a fault or malfunction. These devices include, but are not limited to, electromechanical safety switches, mechanical interlocks, etc. (please refer to EN 954-1, Risk Assessment!).



WARNING!

*TB20 modules should only be used for the functions characteristic of a communications and signaling system. Safety-relevant functions should not be controlled solely with the coupler or with an operating terminal.
Emergency stop devices as per EN 60204/IEC 204 must remain fully functional and effective in all of the equipment's operating modes.
The equipment must not be able to restart in an uncontrolled or undefined manner!
Uncontrolled restarts must be rendered impossible by means of appropriate programming!*

2. System Overview

2.1. General Information

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

It is made up of the following components:

1. A bus coupler
2. One or more peripheral modules
3. Optionally, one or more power and isolation modules
4. Optionally, one or more 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 IP 20.

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.

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

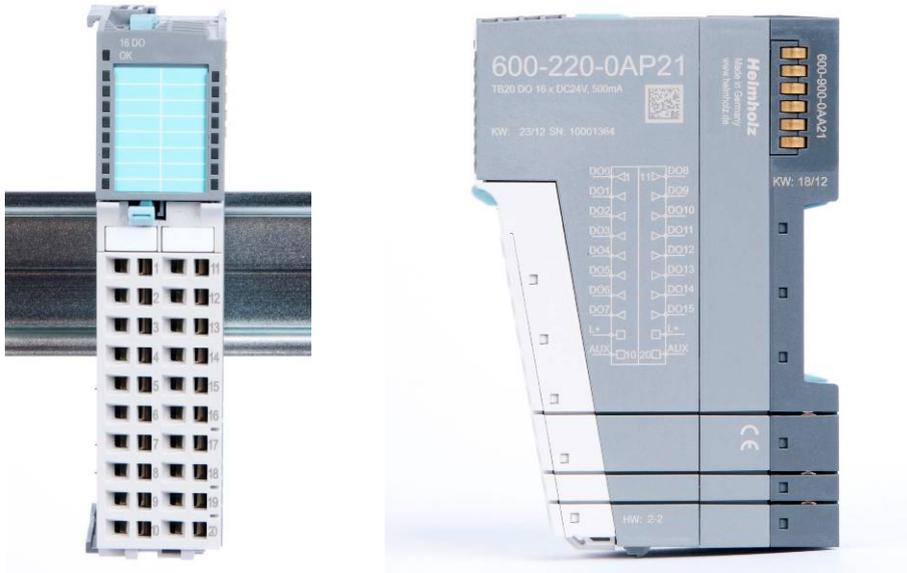
2.2.2. Peripheral Modules

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

Example: peripheral module with 10-terminal front connector



Example: peripheral module with 20-terminal 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 below).



Power and isolation modules can be recognized by the bright color of their case.

2.2.4. Power Module

The system's bus coupler provides the supply voltage for external signals (24 V, below) and for the communications bus (5 V, top). 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.

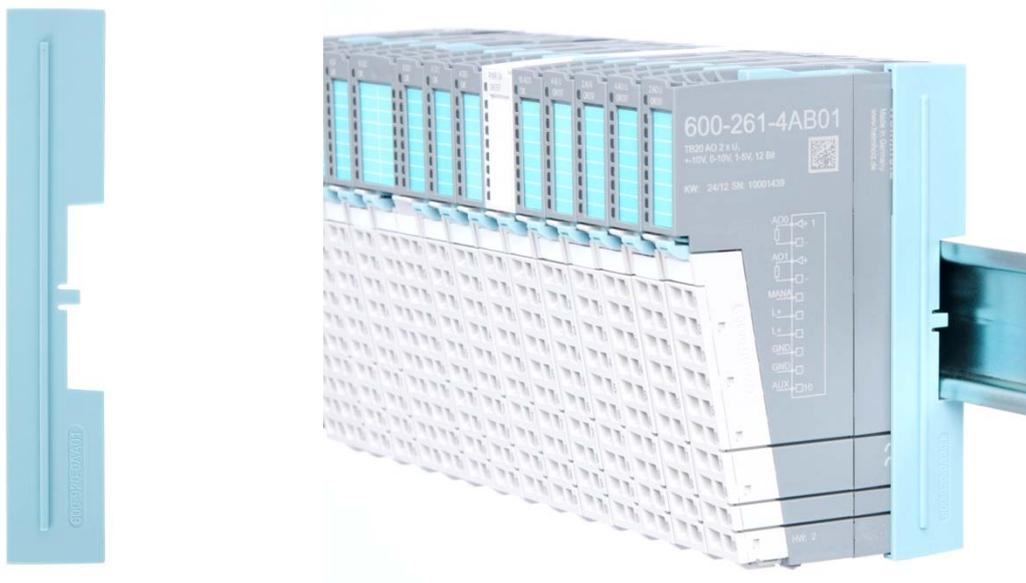
In other words, power modules deliver all the necessary power to the peripheral modules connected after them and, if applicable, all the way to the next power module or power and isolation module. This is required whenever the power supplied by the coupler alone is not sufficient, e.g., when there are a large number of modules on the bus. 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.



Power modules can be recognized by the bright color of their case.

2.2.5. Final Cover

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



2.2.6. Components in a Module

Each module consists of three parts:

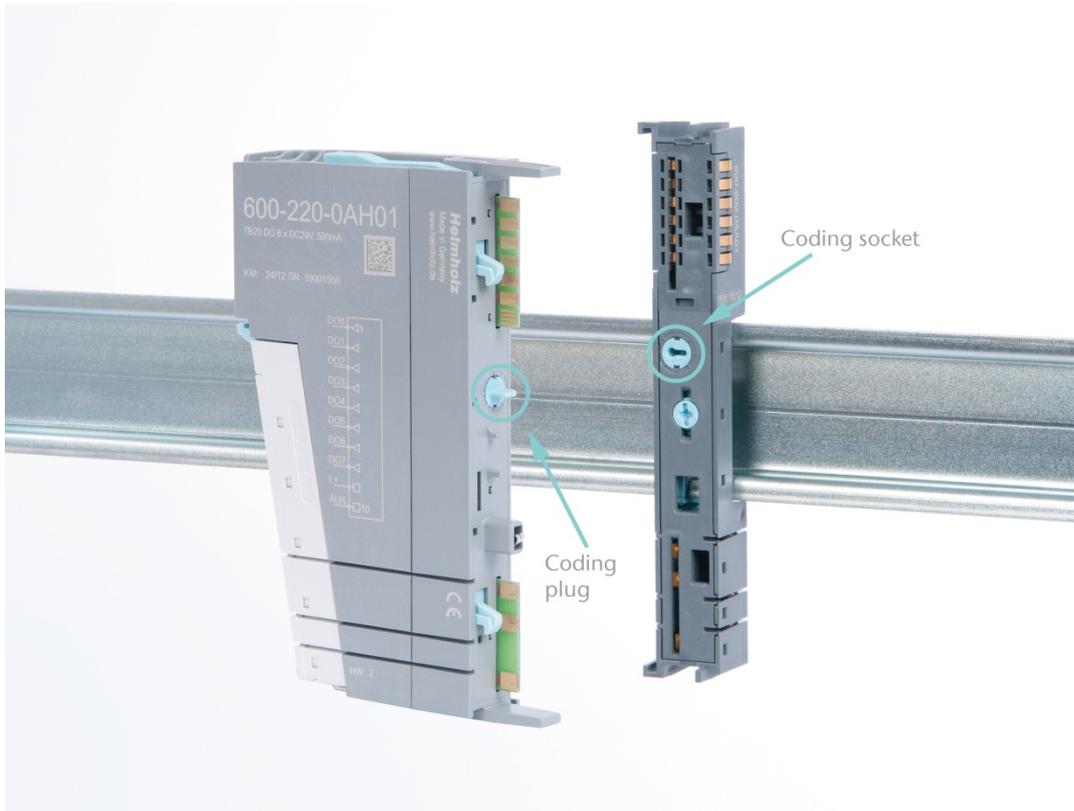
- A base module
- An electronic module
- A front connector



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 figure below).



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, power, etc.) from the TB20 I/O 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. Otherwise, the electronic module will be mechanically prevented from being plugged in.

3. Installation and Removal



WARNING!

Before starting any work on TB20 system components, make sure to de-energize all components, as well as the cables supplying them with power! Failure to do so will pose a life-threatening electric shock hazard!



CAUTION!

Installation must be carried out as per VDE 0100/IEC 364. Since the coupler and segments are modules with a protection rating of IP 20, they must be installed inside an enclosure. In order to ensure safe operation, make sure the ambient temperature does not exceed 60 °C! Also note that the maximum ambient temperature for UL applications is 50 °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 below 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 will be 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)

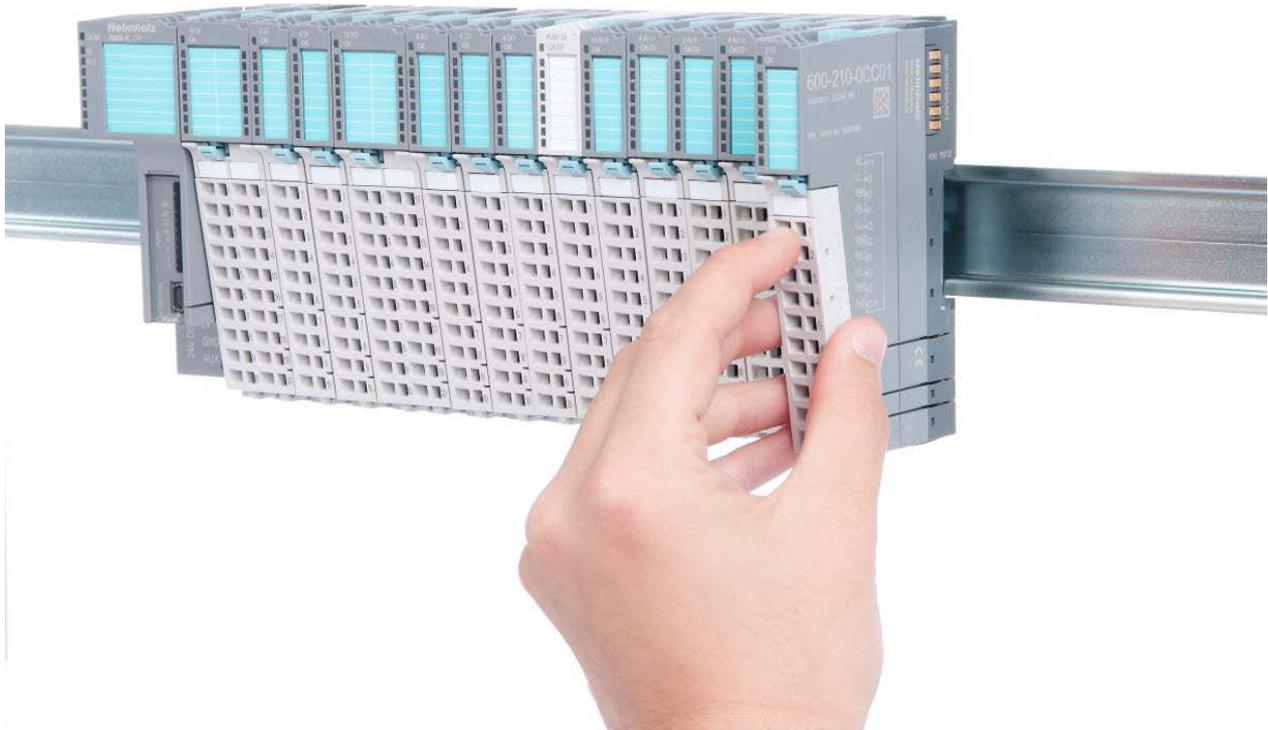
The minimum clearances for TB20 components are: 30 mm on top and on the bottom and 10 mm on each side.

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 on the inside snaps into place 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 7) on the base module in a straight line from the front 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.

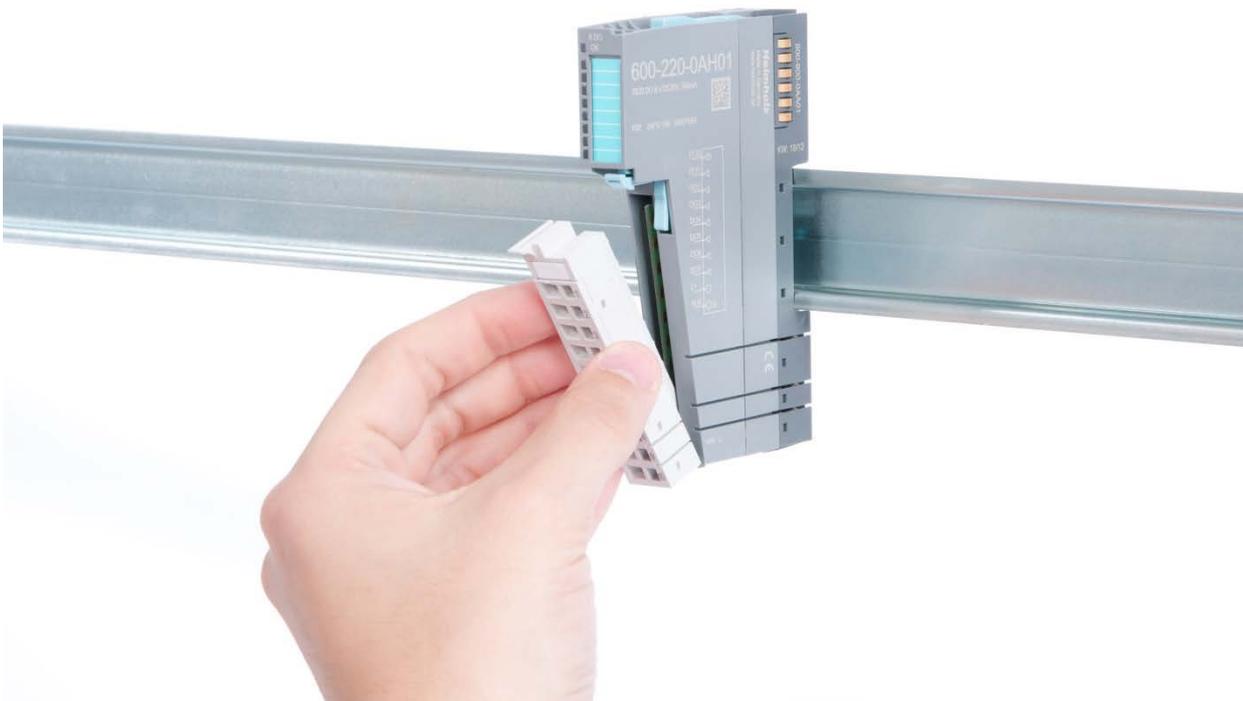
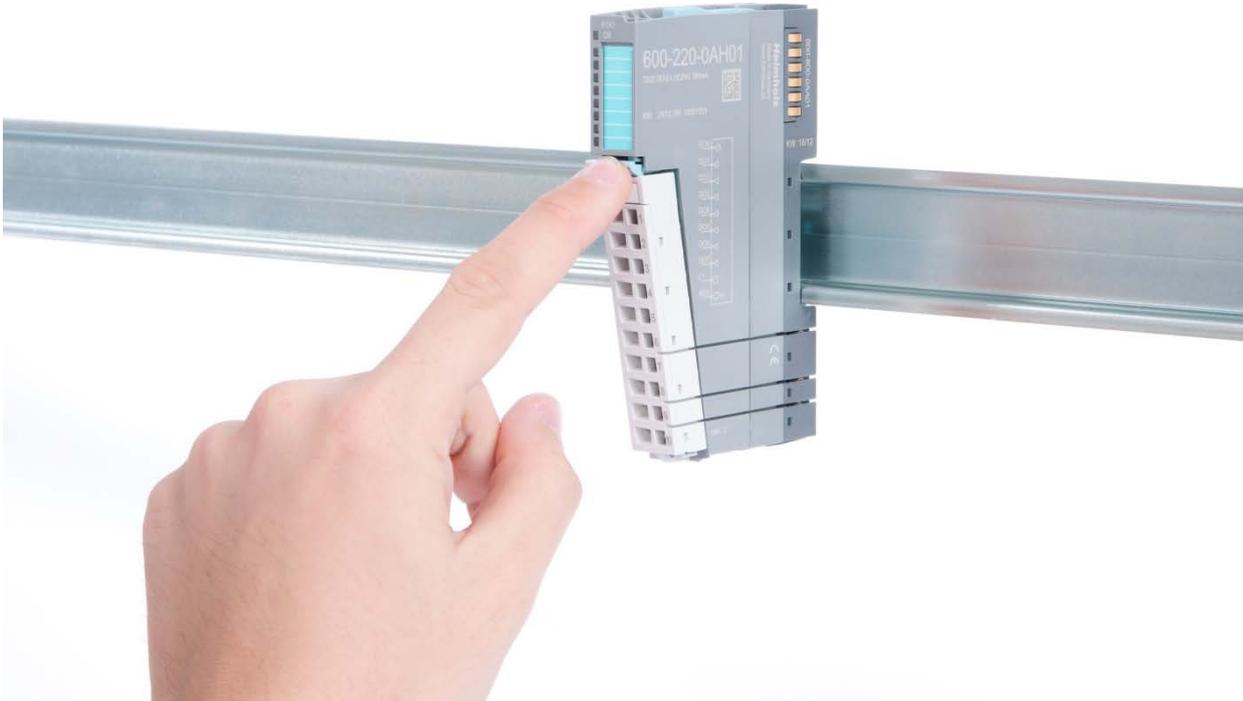
Finally, place the front connector on the electronic module from below in an inclined position and then gently push it onto the electronic module until the front connector fastener snaps into place with a soft click.

3.3.2. Removal

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

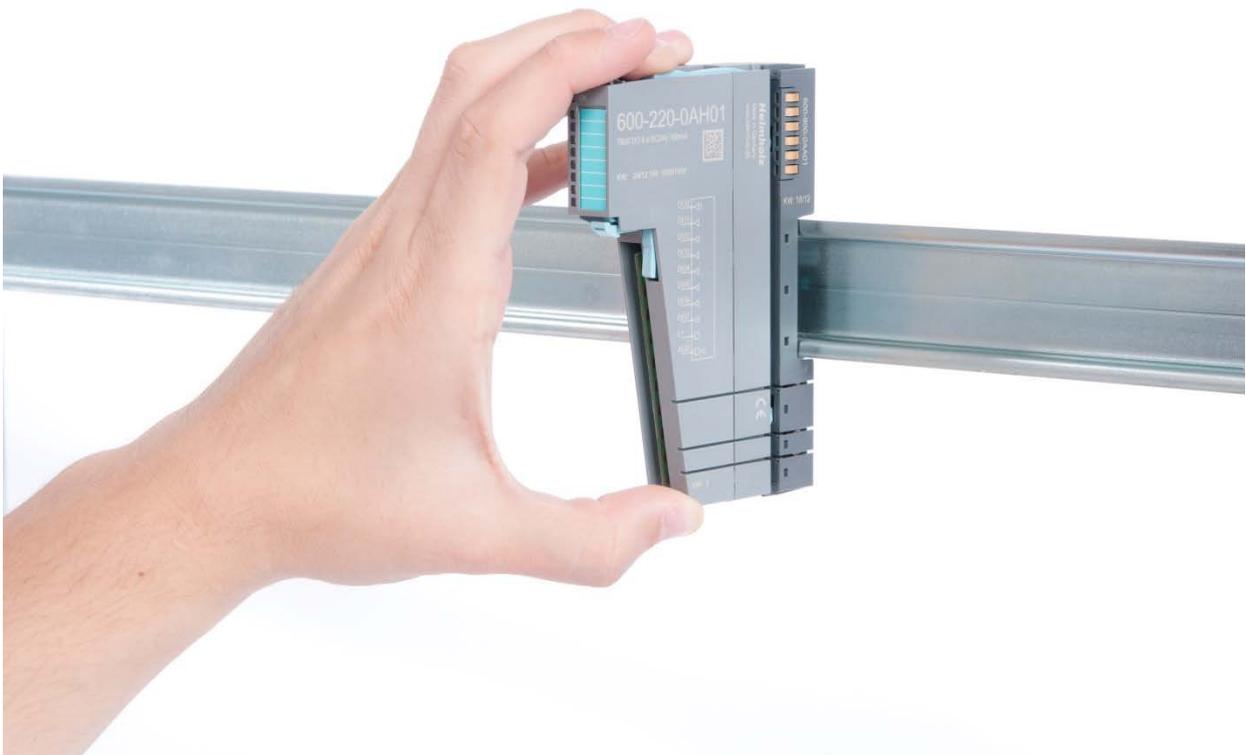
Step 1: Remove the front connector

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



Step 2: Remove the electronic module

To do so, 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.

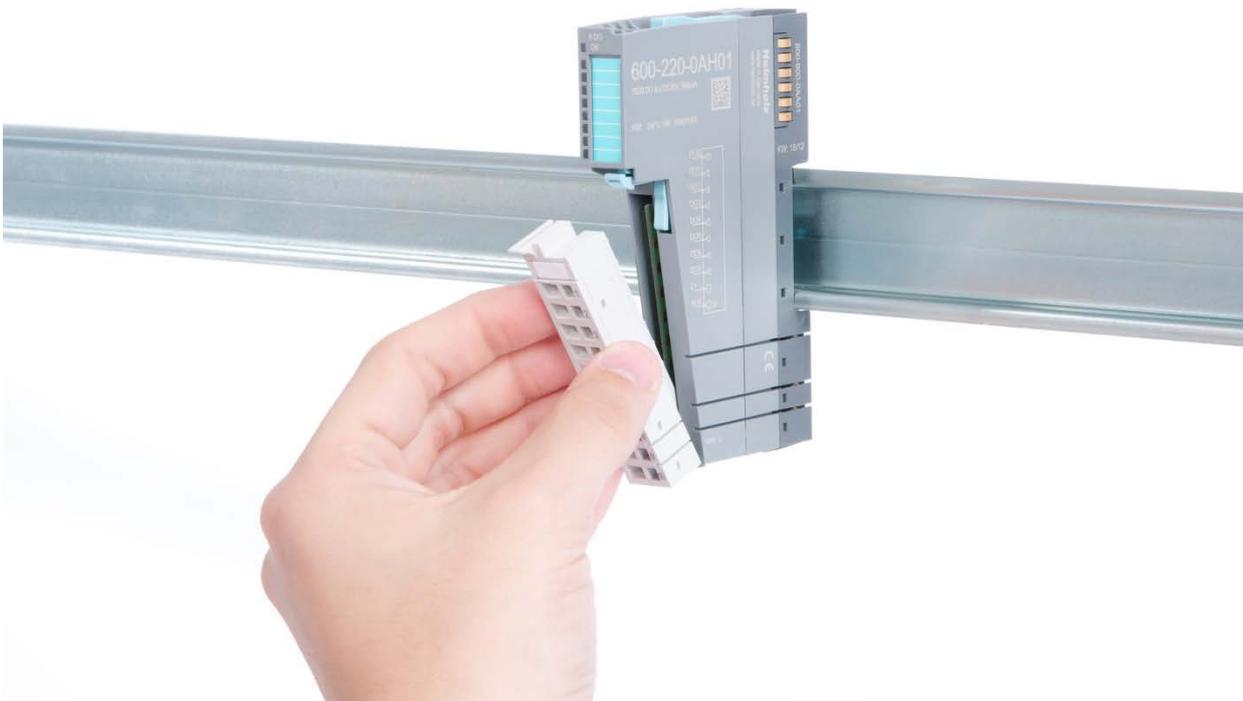
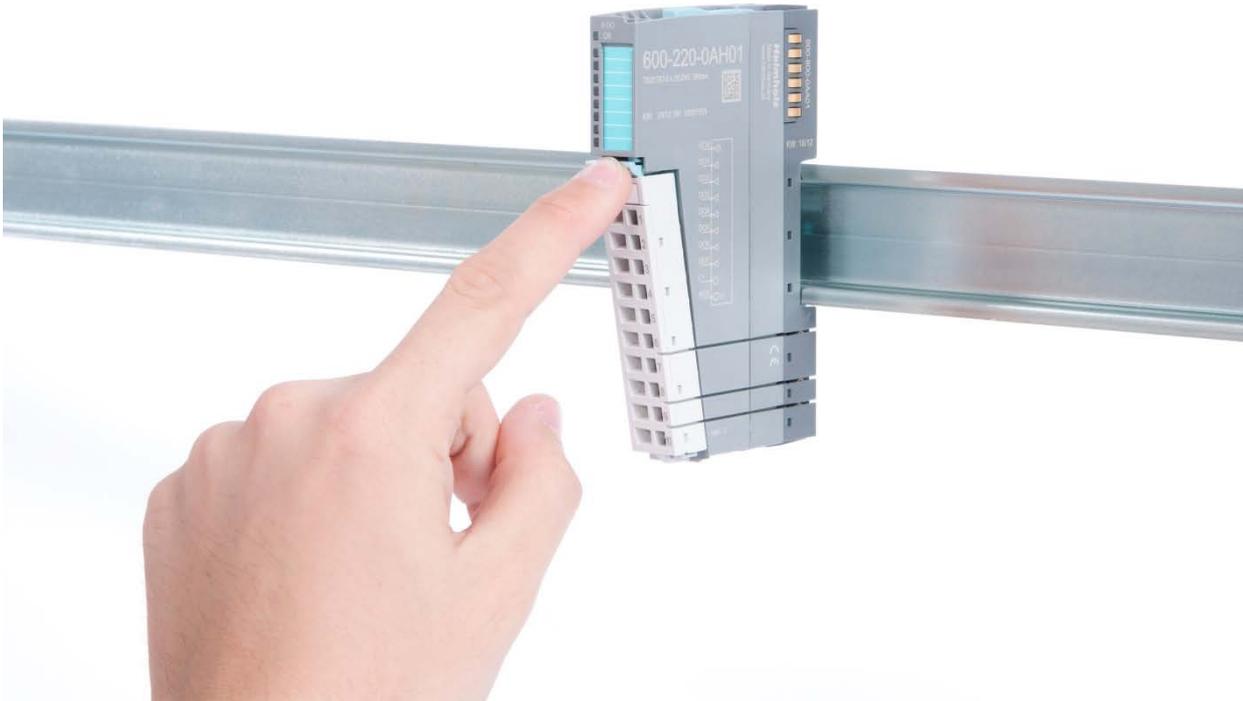
3.4. Replacing an Electronic Module

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

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

Step 1: Remove the front connector

To do so, push the tab above the front connector upwards. The front connector will come loose, after which you can pull it out.



Step 2: Remove the electronic module

To do so, 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).



Step 3: Plug in a new electronic module



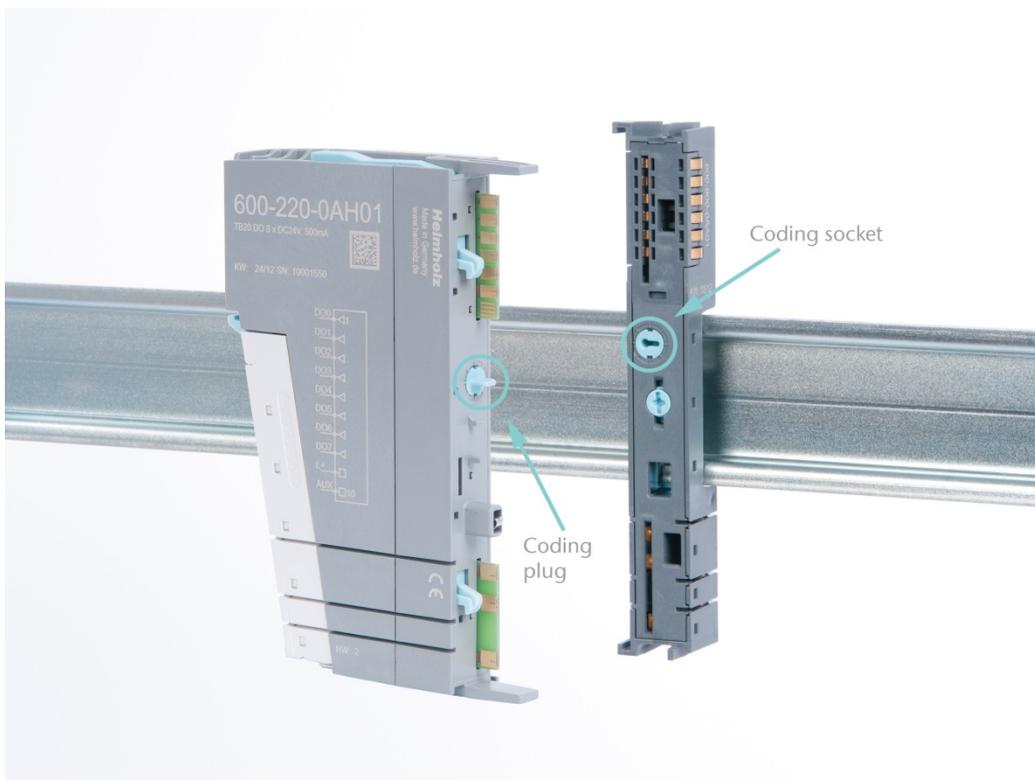
CAUTION!

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.



CAUTION!

*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.*



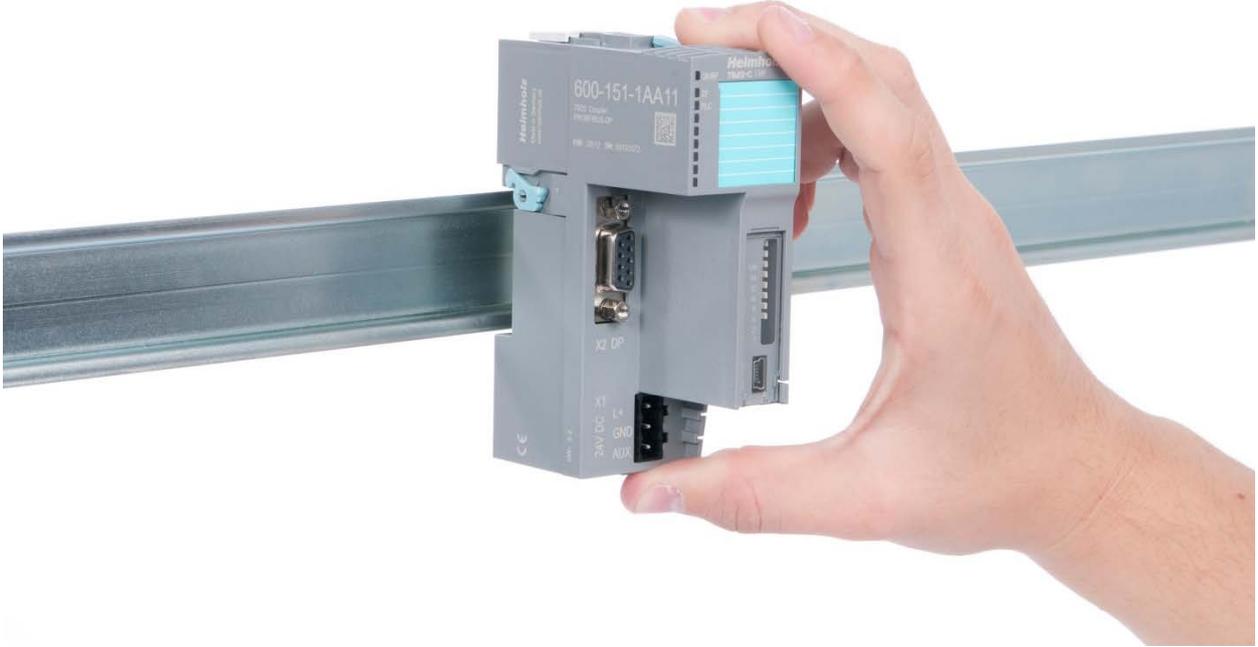
Step 4: Plug in the front connector

3.5. Installing and Removing the Coupler

3.5.1. Installation

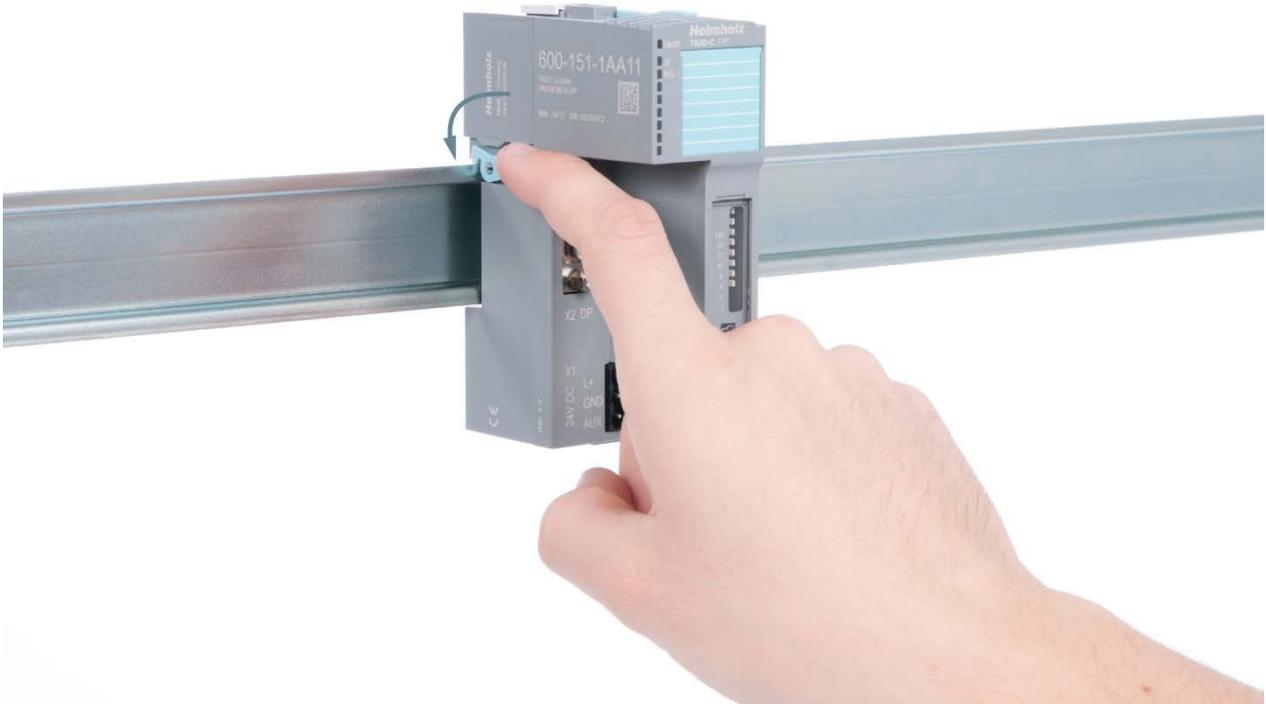
Step 1: Place the coupler on the DIN rail

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

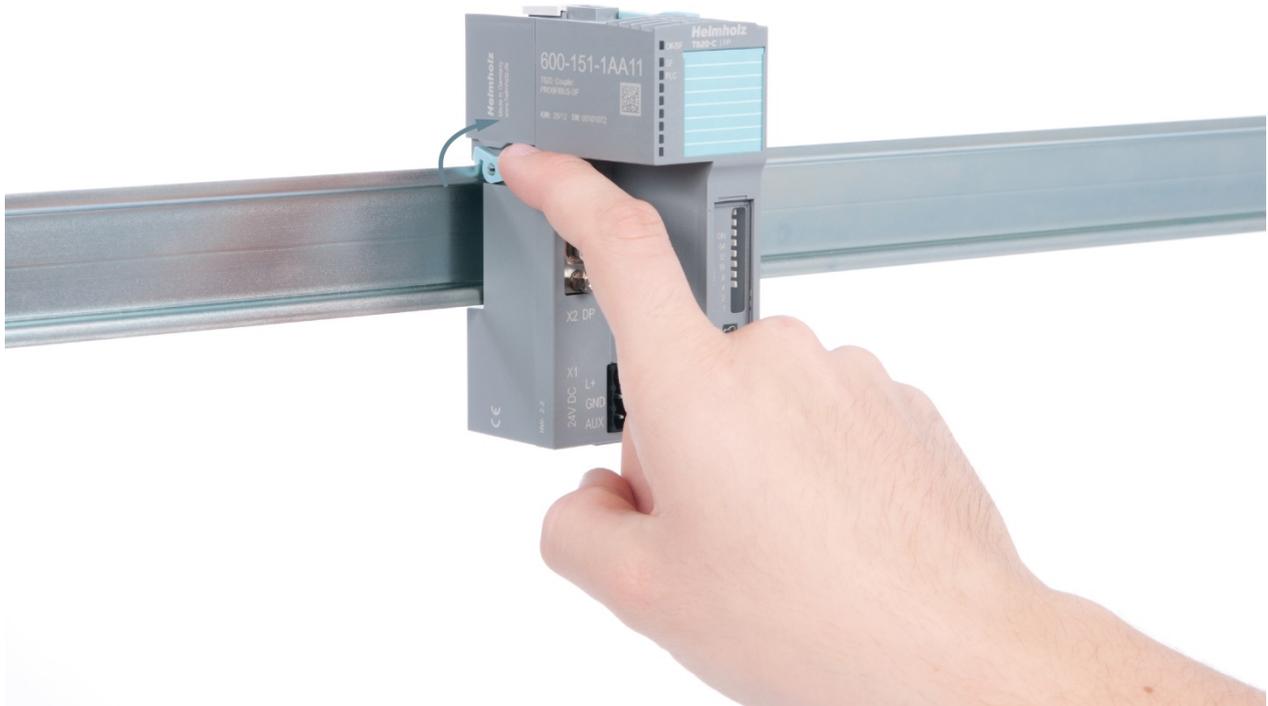
Use the locking lever on the left side to lock the coupler into position on the DIN rail.



3.5.2. Removal

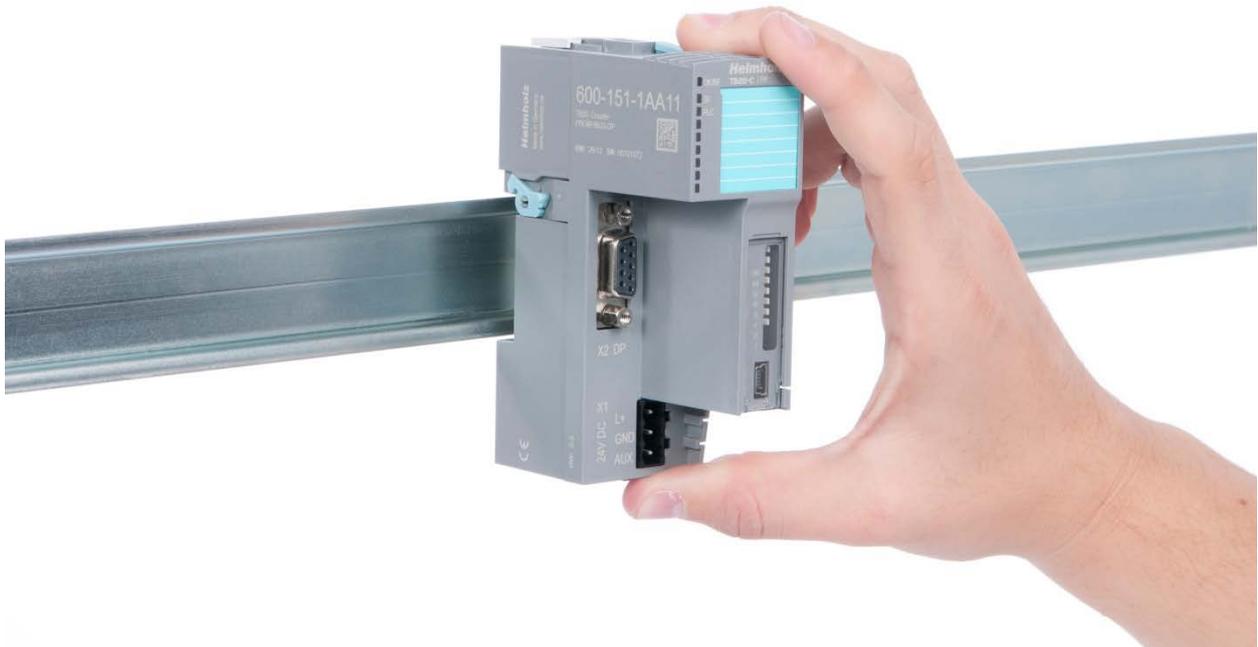
Step 1: Release the locking mechanism

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



Step 2: Remove the coupler

Use your middle finger to push on the release lever from above and then 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.



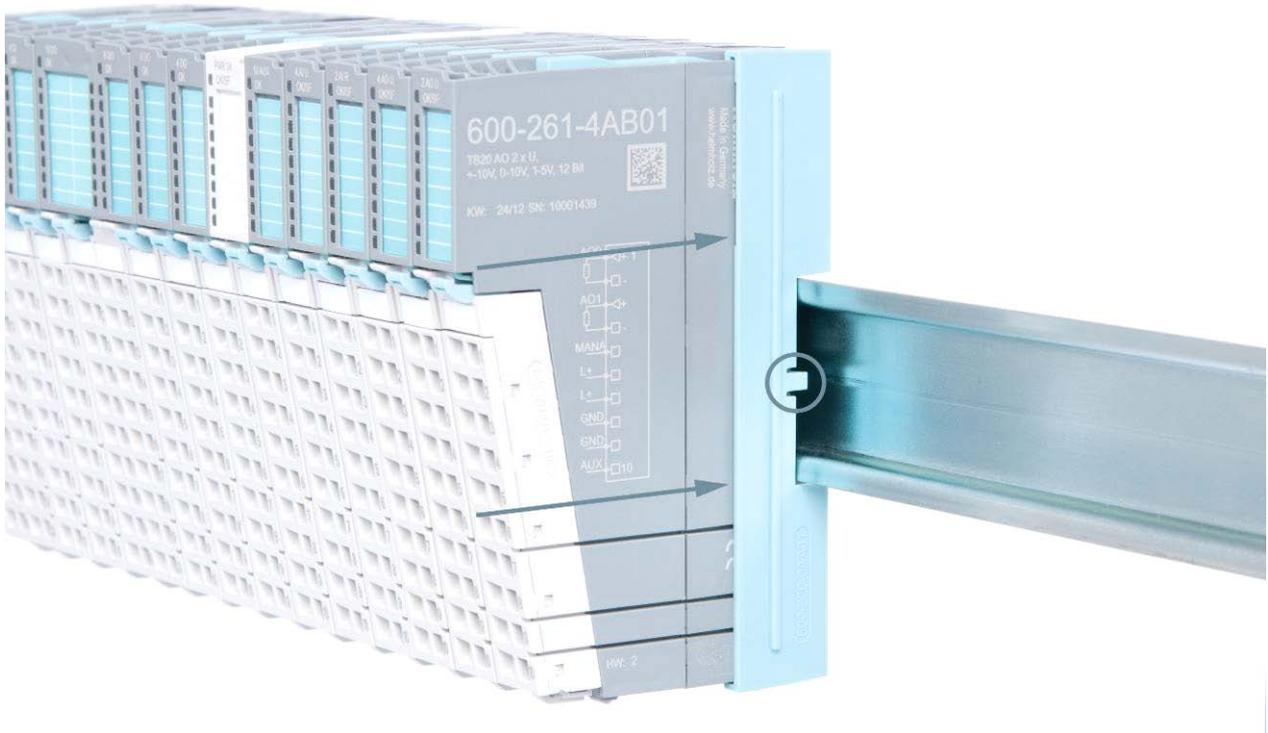
Step 4: Remove the base module

Remove the base module by pulling it towards you.

3.6. Installing and Removing the Final Cover

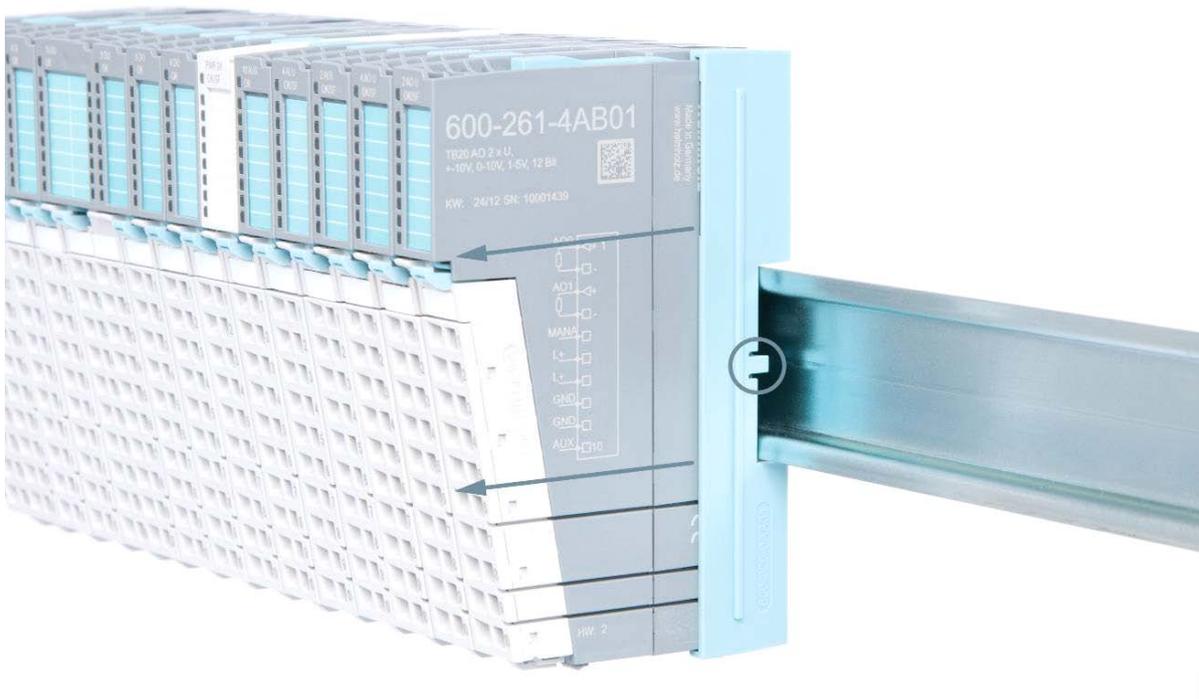
3.6.1. Installation

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



4. Wiring

4.1. EMC / Safety / Shielding

EU Directive 2004/108/EC (“Electromagnetic Compatibility”) defines which electrical devices and equipment must be designed in such a way as to not inevitably affect other neighboring devices and/or equipment with electromagnetic radiation. Within this context, the term “electromagnetic compatibility” refers to all electromagnetic factors that are relevant to the simultaneous operation of various electrical devices and/or equipment in close proximity to each other.

The directive requires, on one hand, for electrical devices and equipment to function flawlessly in an existing environment that exerts an electromagnetic influence within its area, and, on the other, for said devices and equipment not to produce impermissible levels of electromagnetic interference within said environment.

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



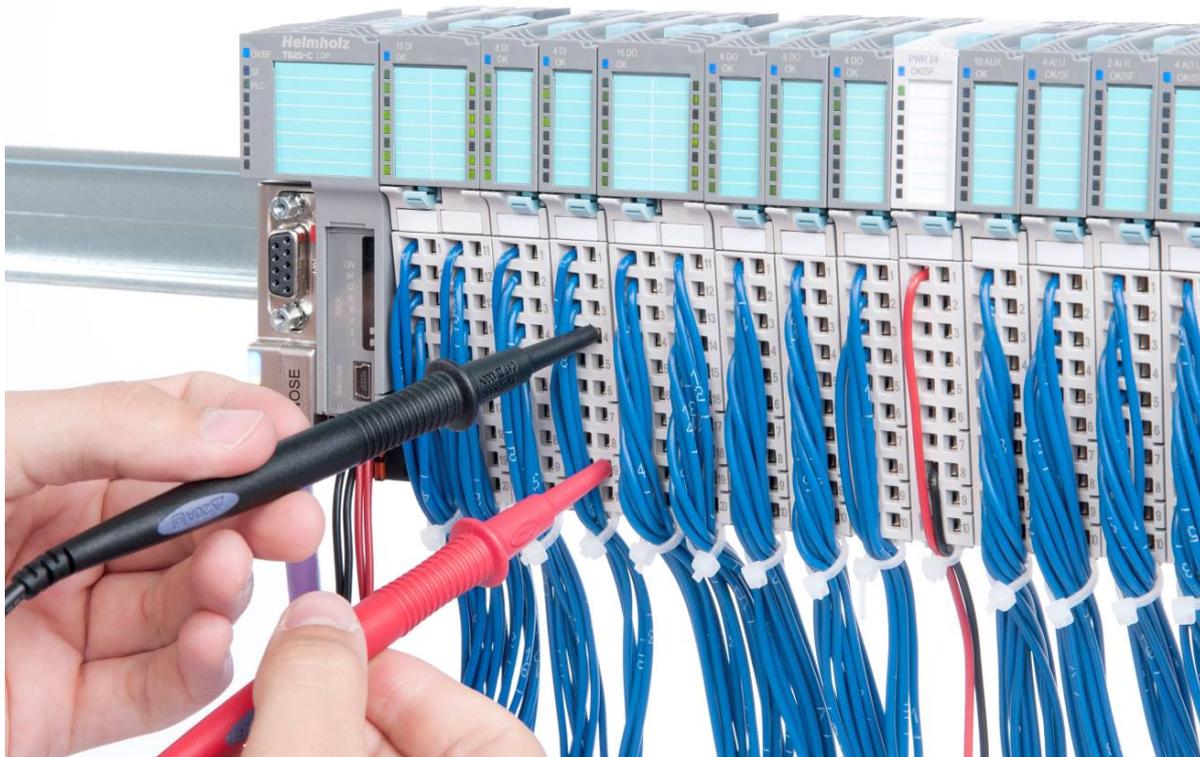
CAUTION!

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

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

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.



4.3. Wiring the Coupler

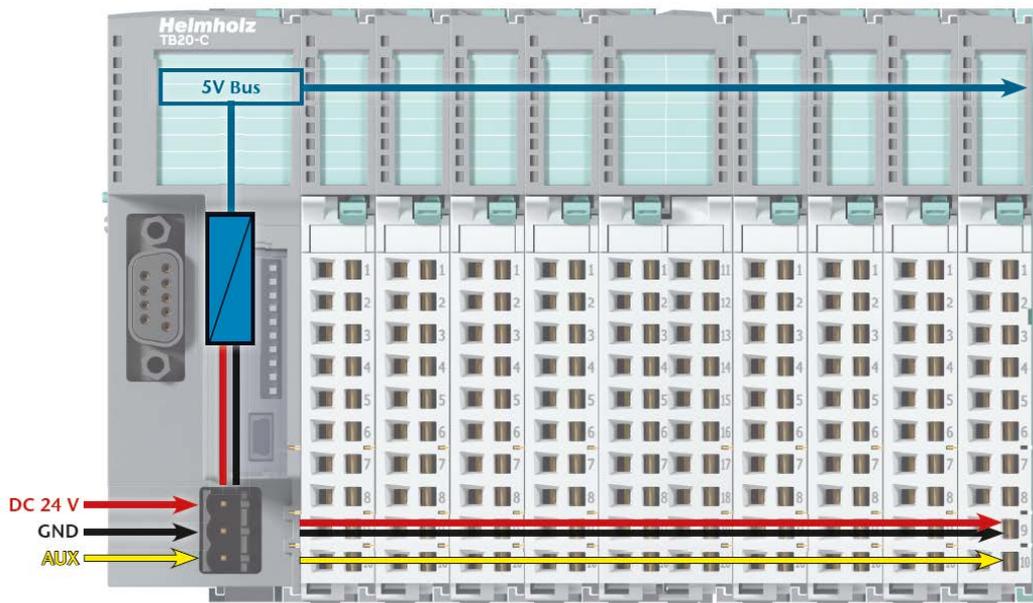
A power supply unit is integrated into the bus coupler. This unit is responsible for powering the peripheral modules connected to the coupler.

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

The L+ 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 set up and use an additional wiring channel. Every peripheral module has an AUX terminal on its front connector (the bottommost terminal, i.e., terminals 10 and 20).

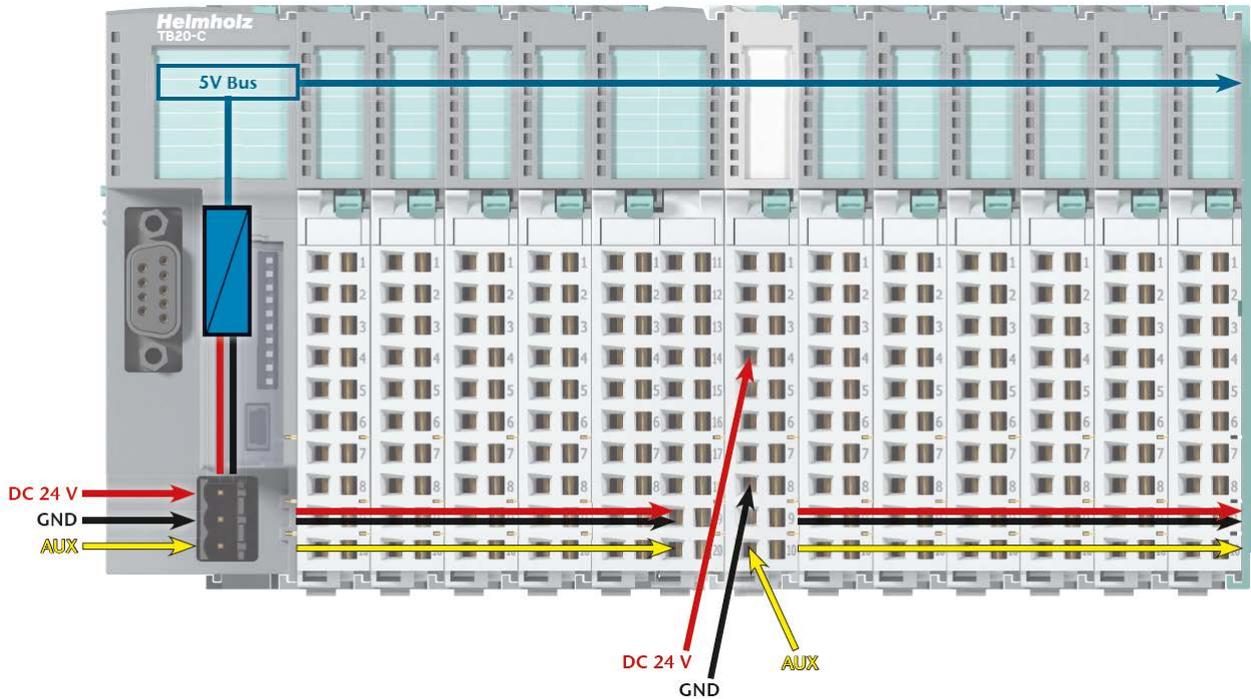


Shielding/grounding is achieved with a corresponding shield contact on the DIN rail:



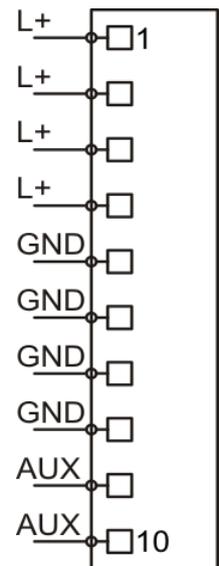
4.4. Using Power and Isolation Modules

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



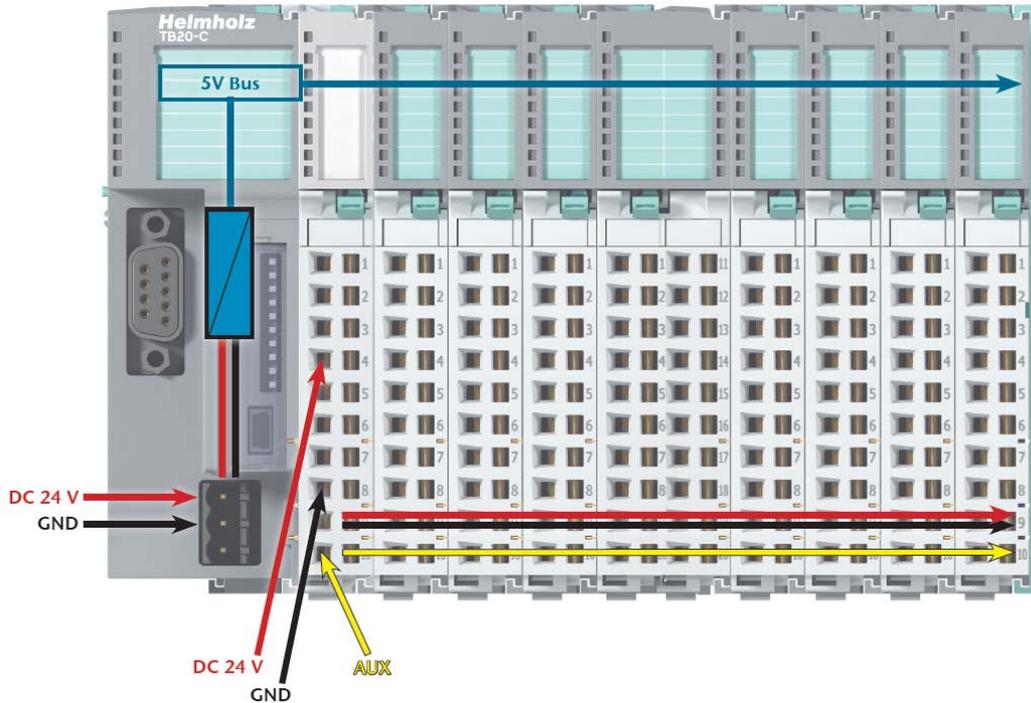
The order No. for the power and isolation module for 24-V signals is 600-710-0AA01.

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

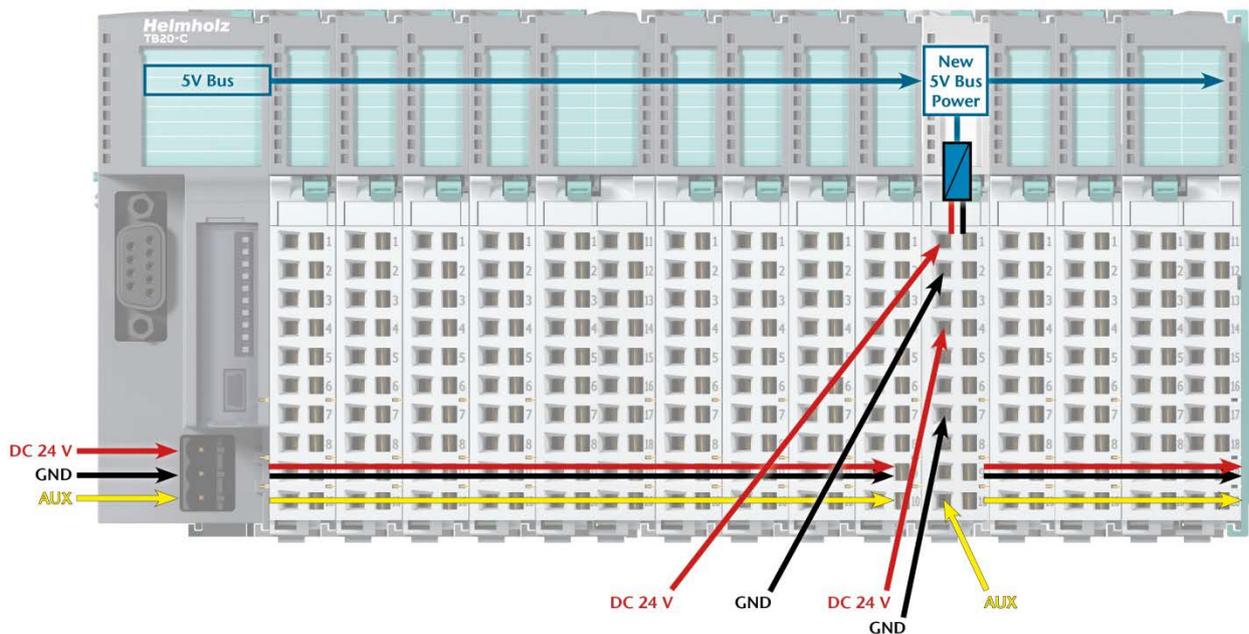
If the power supply for the coupler needs to be separate from the power supply for the I/O modules, a power and isolation module can be used right after the coupler.



4.6. Using Power Modules

Power modules deliver all necessary power to the peripheral modules connected after them 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, e.g., when there are a large number of modules on the bus. The “TB20-ToolBox” 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-OAA01. Its electronic module has the same light gray color as the front connector, while its base module is light gray with a dark core.



4.7. Fusing

The coupler's and power modules' power supply must be externally fused with a fast-blow fuse appropriate for the required maximum current.

4.8. Electronic Nameplate

Every TB20 peripheral module features an electronic nameplate containing all of the module's important information. This information includes, for example, the corresponding module ID, module model, 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 by using the "TB20-ToolBox" program. The modules' electronic nameplates not only make it possible to prevent configuration errors (setup), but also make maintenance (servicing) easier.

5. ModbusTCP Coupler Characteristics

The TB20 ModbusTCP coupler has the following characteristics:

- ModbusTCP protocol
- Modbus watchdog for monitoring the connection
- Integrated two-port switch
- Access from up to 10 stations simultaneously (TCP connections)
- A maximum of 64 modules
- Two RJ45 connectors
- 2,084 bytes of input data / 2,084 bytes of output data
- 126 bytes of parameter data per module
- With the help of "TB20 ToolBox", modules can be freely configured
- The coupler's behavior can be configured using control registers
- The coupler's state can be read from status registers
- Supports module diagnostics
- Supports hot-plugging
- 24 VDC power supply
- Integrated power supply unit for powering peripheral modules (2.5 A)
- Supplies the system's I/O voltage (24 VDC)
- Seven LEDs, one of them bi-color
- USB device port for online diagnostics, configuring parameters, setup, and firmware updates with "TB20-ToolBox"
- Concealed switch for "factory reset" function



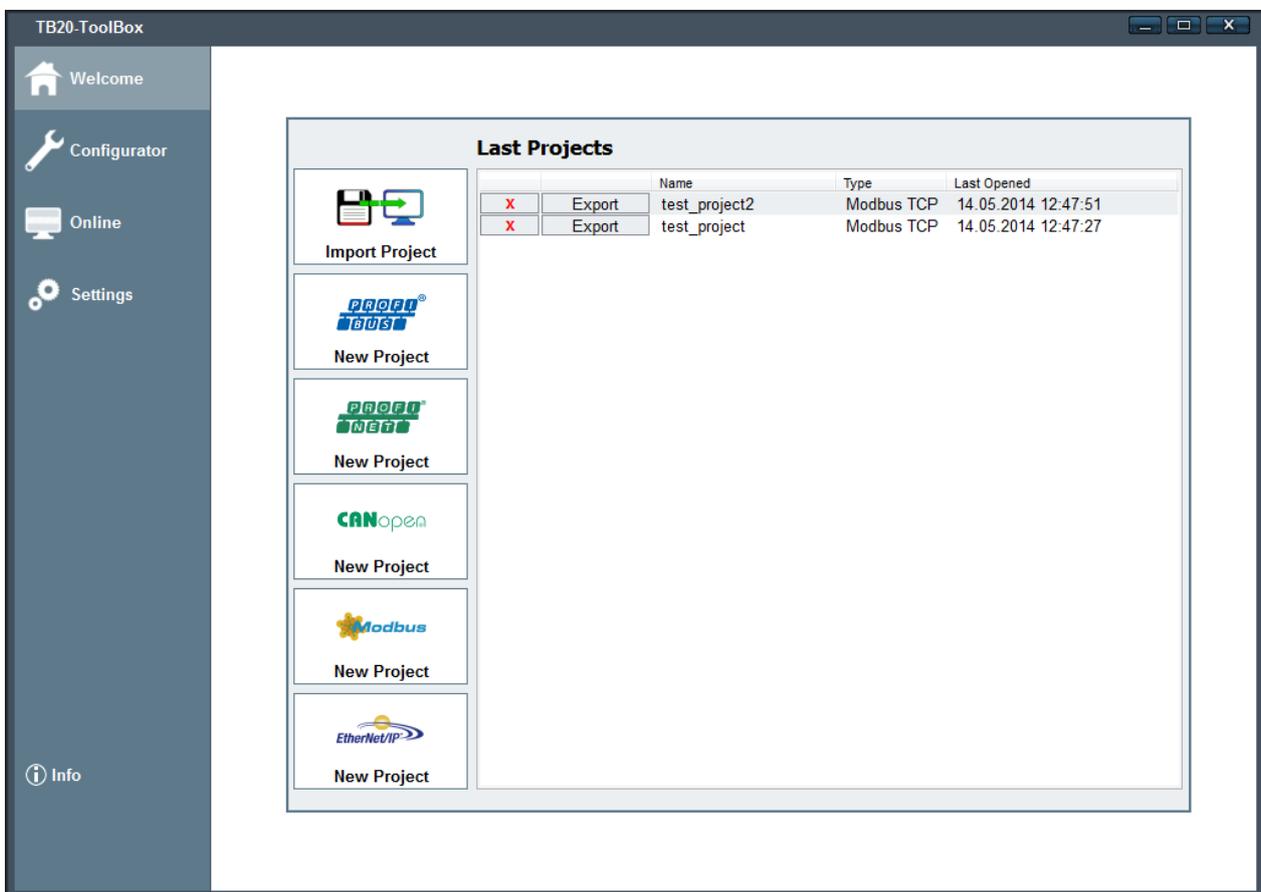
6. Setup and Use

6.1. Using TB20-ToolBox to Configure and Manage the Coupler

Systeme Helmholtz GmbH has designed its TB20-ToolBox program, which is available for free, specifically for setting up, configuring the parameters of, and diagnosing TB20 I/O systems. The software's latest version is available for download at www.helmholtz.de. TB20-ToolBox can be installed on any computer with a Windows operating system (Windows XP, 32-bit/64-bit Windows 7 with SP1 or higher, Windows 8). Moreover, the installation routine asks for input from the user installing the program, making it possible to set up TB20-ToolBox as necessary for your specific environment. Please note that the program requires at least one enabled USB port.

In order to conveniently configure and update the couplers and monitors, as well as monitor them in real time, you will need a standard USB 2.0 cable (Type A plug to Mini-B plug) with a maximum length of 5 m (not included).

Once you are done installing TB20-ToolBox, you can simply use the corresponding program icon to start the program. When you do so, the project management tool start screen will appear:

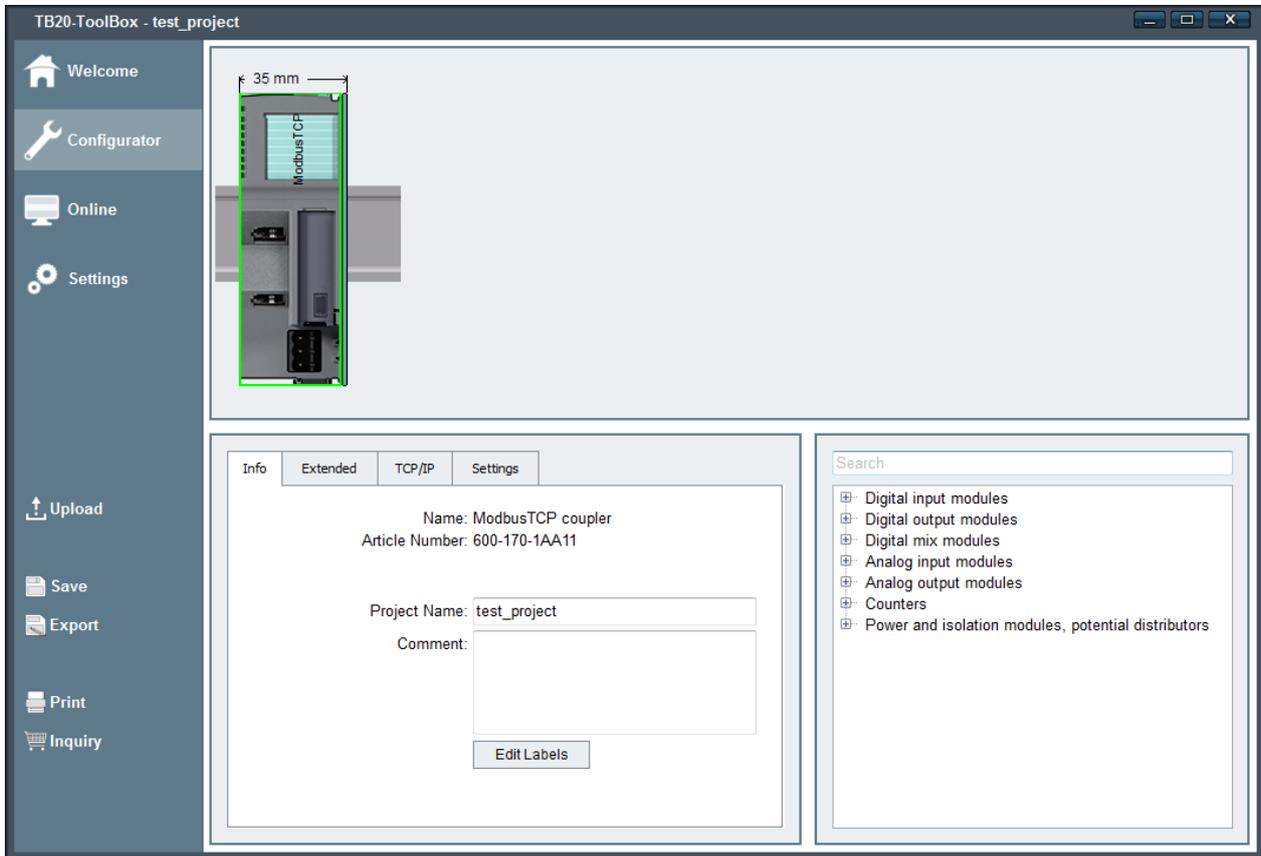


The buttons on this screen can be used to create new projects for the TB20 coupler you want or import an existing project from file.

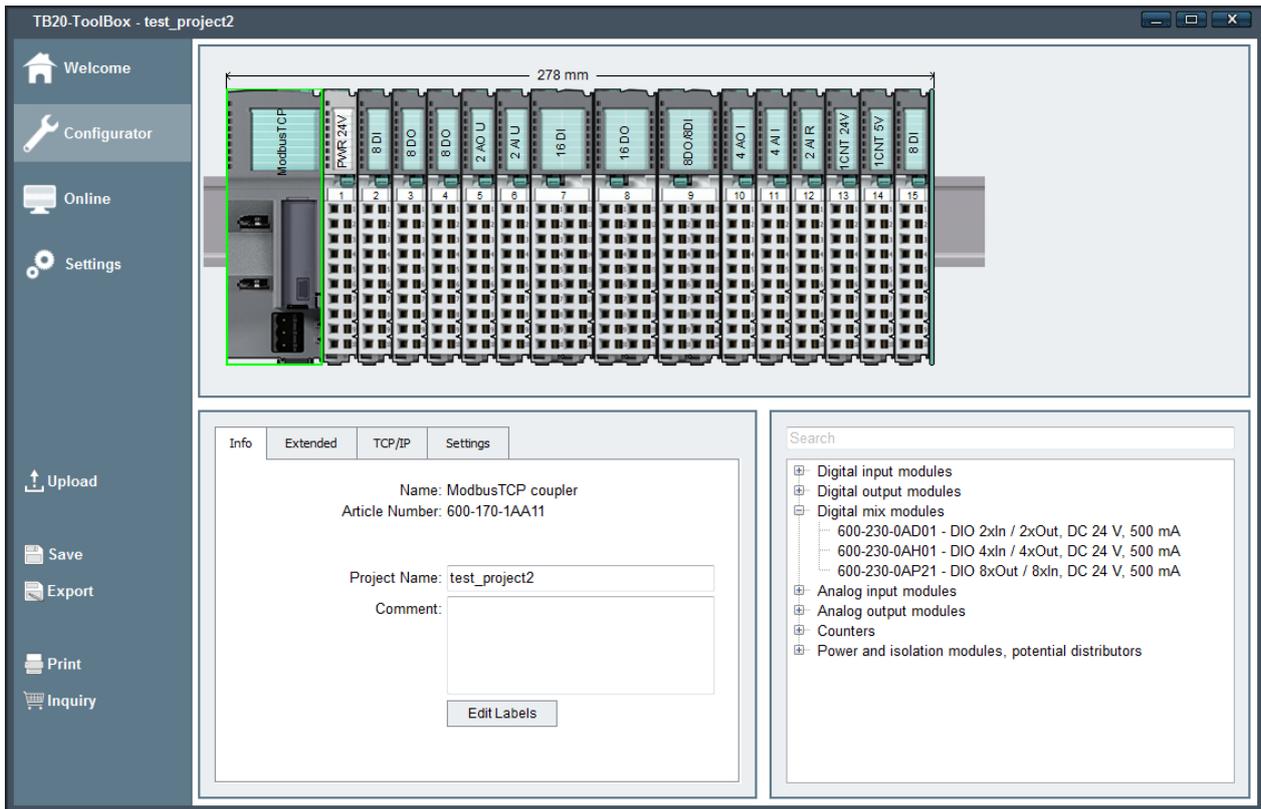
Each project will be identified with a unique name assigned by the user and can be opened by double-clicking on it in the project selection pane.

6.1.1. Configuration

Once you open or create a project, the program will open the configuration screen, which will always start by showing the coupler type you selected previously in the layout pane. In addition, the screen will show an information pane containing a variety of status information on module-specific parameters in the lower left pane. This pane can be used for a variety of purposes, such as clicking on the "Edit labels" button under the "Info" tab in order to access the editing field used to add and edit labels.



Meanwhile, the module catalog pane on the lower right can be used to select the modules that you want to configure and add them to the coupler module by double-clicking on them or dragging and dropping them. Finally, the layout pane can be used to click on any of the modules found in it. Once you click on one of these modules, the information pane will show all the relevant information for that module. Moreover, clicking on the modules will allow you to configure them as necessary.



Once you have configured all the relevant settings for all the modules (e.g., coupler IP addresses, other communication parameters, general and channel-specific module parameters) you can click on "Upload." This will transfer the configuration to the coupler, where it will be stored in non-volatile memory. You can also save the project's data on the computer or click on "Export" to transfer it to other storage media.

Meanwhile, clicking on "Print" will open a selection field that will enable you to print either the labels you created or documentation concerning the project.

Finally, clicking on "Request quote" will provide you with a list of all the project components in the form of a CSV file that you can save, print out as a fax form, or send directly to Systeme Helmholtz GmbH's Sales Team by e-mail.

6.1.2. Real-Time Diagnosis (Online Mode)

The real-time diagnosis function, which can be accessed by clicking on "Online," will become available as soon as the appropriate TB20 hardware is connected to the PC using a USB cable. This function not only provides simulation mode (please refer to 6.1.3) and firmware update (please refer to 6.1.4) options, but can also be used to import the project stored in the module by clicking on "Load from device." If you use this option, you will be asked to give the project a new name and the project will be saved on your computer.

The actual diagnosis can be started and stopped manually. All relevant LED states will be shown visually on the layout view the same way they would appear on the physical devices, i.e., the LEDs will light up and turn off the same way. Once you select a module, the Info pane will display the App status and you will be able to use the I/O diagnostic pane on the bottom right to monitor, for example, individual input/output values or analog states.

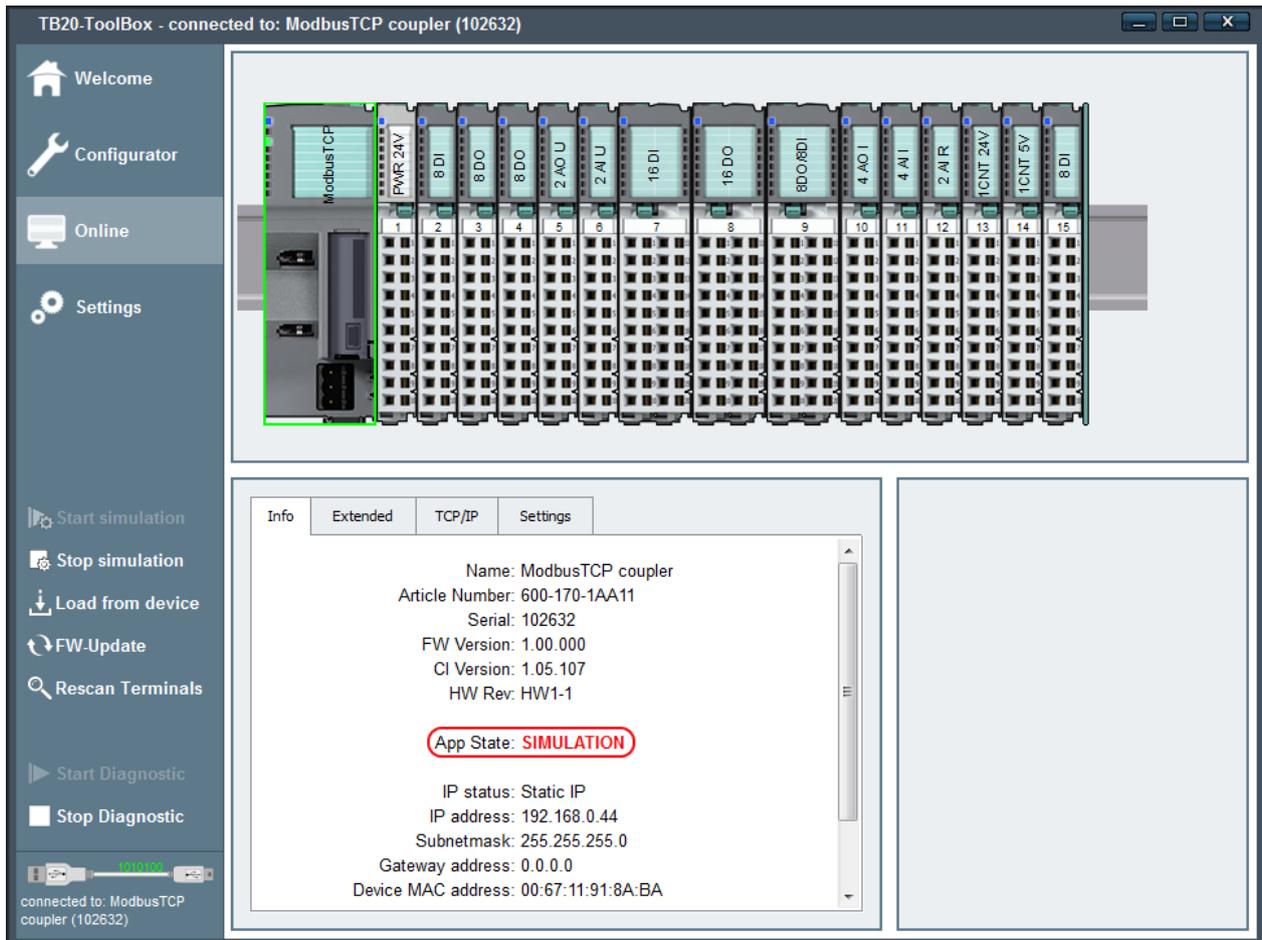
The screenshot shows the TB20-ToolBox software interface. The title bar reads "TB20-ToolBox - connected to: ModbusTCP coupler (102632)". The interface is divided into several sections:

- Left Sidebar:** Contains navigation icons and buttons: Welcome, Configurator, Online (highlighted), Settings, Start simulation, Stop simulation, Load from device, FW-Update, Rescan Terminals, Start Diagnostic, Stop Diagnostic, and a USB connection icon.
- Top Panel:** Displays a rack of 15 modules. The 8th slot is highlighted with a green border. The modules are: ModbusTCP, PWR 24V, 8 DI, 8 DO, 8 DO, 2 AO U, 2 AO U, 16 DI, 16 DO (highlighted), 8 DO/8 DI, 4 AO I, 4 AO I, 2 AI R, 1 CNT 24V, 1 CNT 5V, and 8 DI.
- Info Panel (Bottom Left):** Shows details for the selected module. The "Info" tab is active, displaying:
 - Name: DO 16x DC 24 V, 500 mA
 - Article Number: 600-220-0AP21
 - Serial: 10001336
 - FW Version: 1.02.000
 - CI Version: 1.02.000
 - HW Rev: HW0
 - App State: **RUN**The "Extended" tab is also visible, showing a terminal diagram with inputs D001-D015 and outputs L+, AUX, and 24V.
- I/O Diagnostic Panel (Bottom Right):** A grid of 16 output status indicators, labeled Output 0 through Output 15. Each indicator consists of a small square and a label. Outputs 0, 5, 7, and 14 are shown with a green light, indicating they are active. All other outputs (1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13, 15) are shown with a grey light, indicating they are inactive.

6.1.3. Simulation Mode

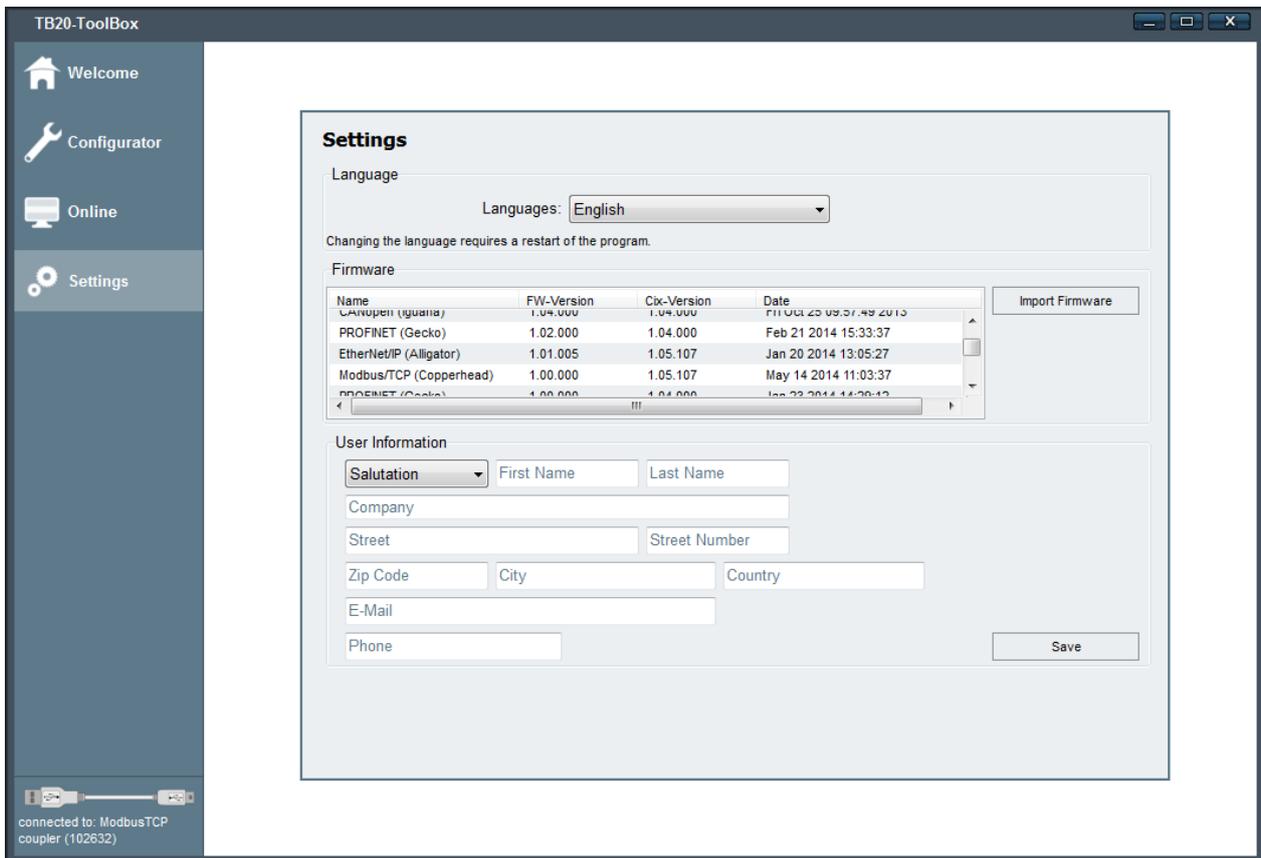
In order to be able to run a simulation, you must be in online mode, the hardware must be connected, and you must explicitly select the coupler by clicking on it. Simulating individual output addresses can come in handy when setting up a system or attempting to troubleshoot an issue. To ensure that this does not lead to accidents or malfunctions in the physical system and the higher-level controllers, the TB20 terminal will remove itself from the bus system and TB20-ToolBox will show a message to this effect once the simulation starts.

The status shown in the Info pane will change from "Run" to "Simulation," after which you will be able to test each individual module.

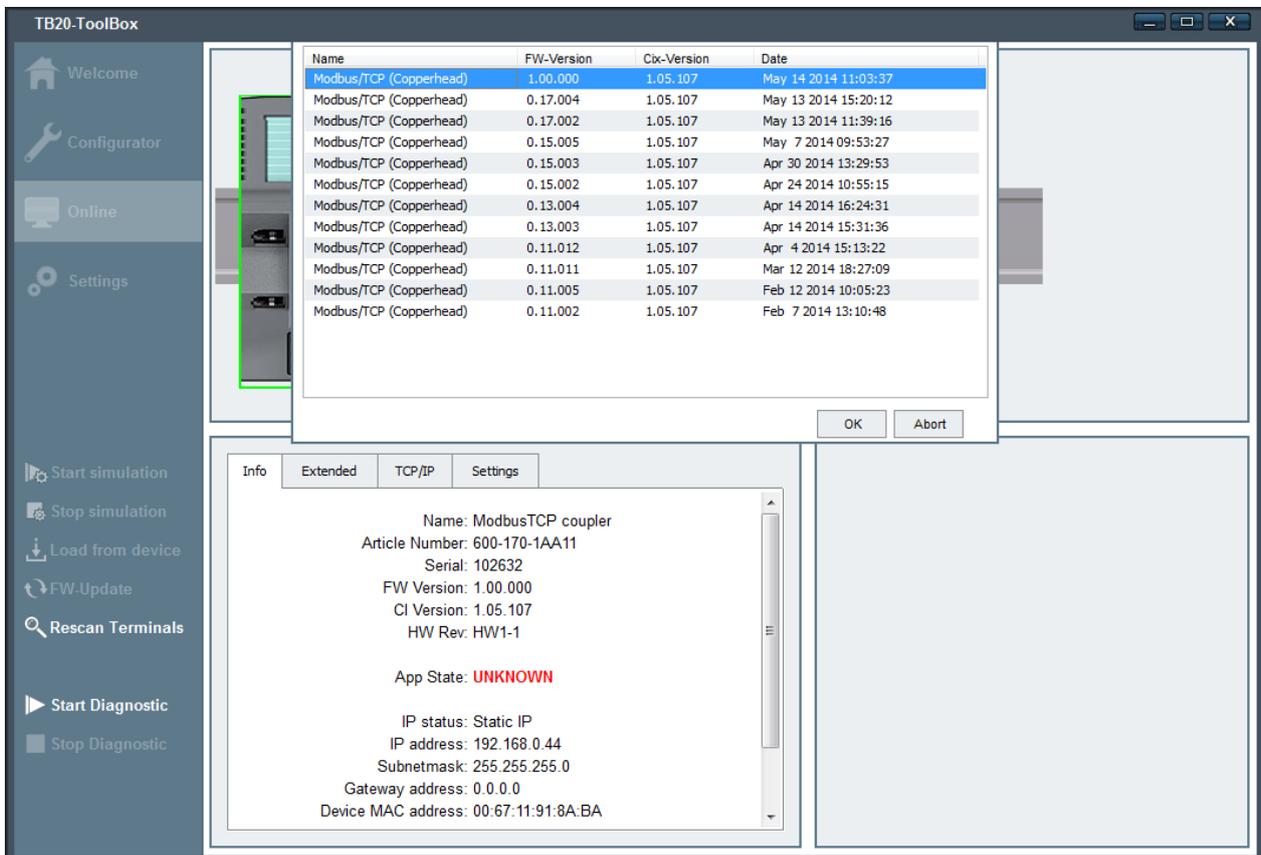


6.1.4. Firmware Updates

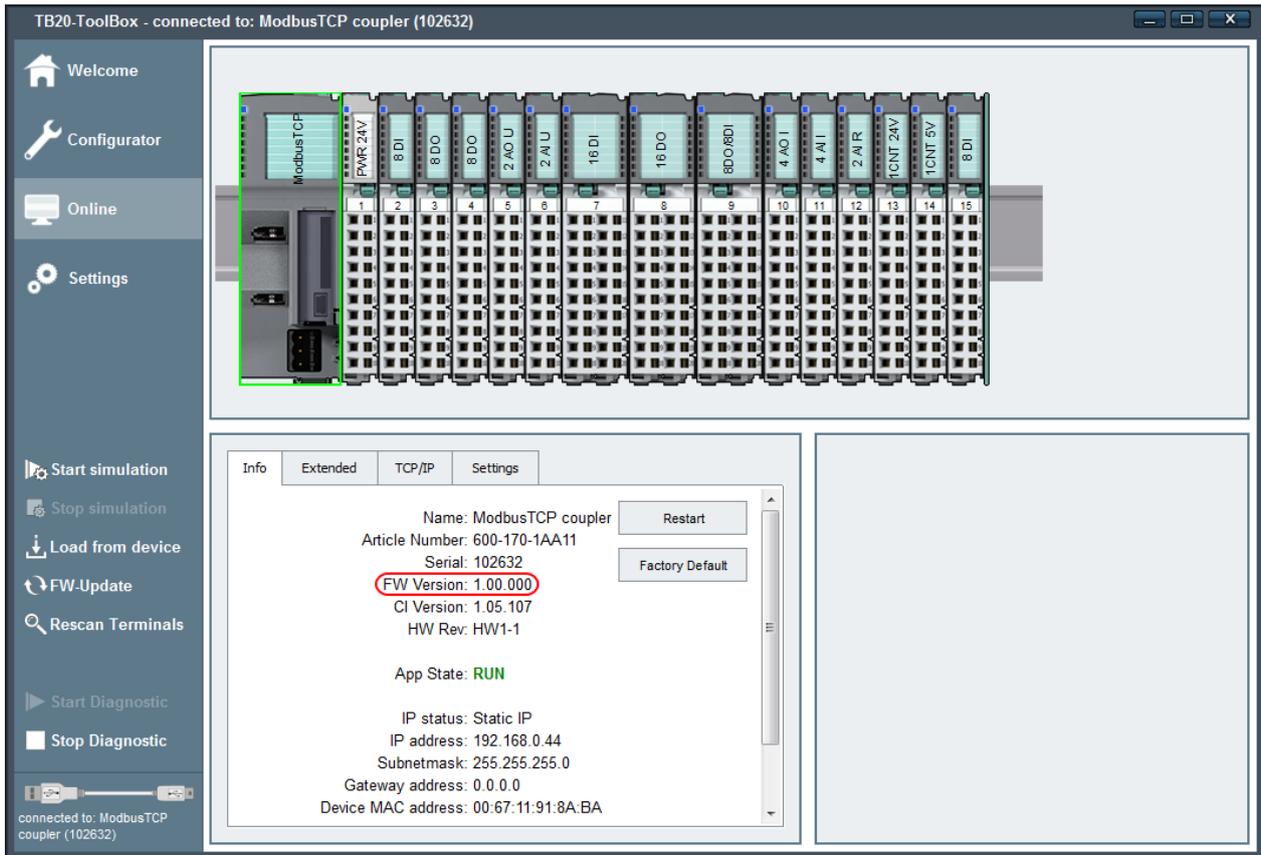
The latest firmware files will be automatically installed after setting up TB20-ToolBox and will be available so that the TB20 coupler's operating system can be updated through a USB connection. The TB20-ToolBox program can be downloaded at any time from the Downloads area at www.helmholz.de. To get an overview of the firmware files currently available, click on the "Settings" menu option.



Firmware can only be uploaded in online mode (please refer to 6.1.2). Clicking on the "FW Update" button will open a selection list like the one shown in the screenshot below. Once you get to this list, simply select the firmware version you want and click on "OK."



A progress bar will indicate the transfer's progress. Once the update is successfully completed, the active firmware version will be shown in the Info pane in online mode.



6.2. Startup Flow

The three following events will all trigger a ModbusTCP coupler (re)start.

1. Power on
2. "Reset" command from the ModbusTCP bus (see coupler control bits) or TB20-ToolBox
3. A change to the module configuration

There are two different possible startup flows for the ModbusTCP coupler:

Startup flow 1: A project is already stored in the coupler's non-volatile memory.

1. The coupler carries out a basic initialization routine and assigns all required addresses
2. The coupler scans the modules
3. The coupler compares the results from the bus scan with the modules stored in its configuration.

The coupler will first wait to make sure that the entire module configuration is present, i.e., starting with a gap in the module configuration (even with hot plugging enabled) is not permitted.

As soon as the coupler determines that there are no gaps in the module configuration and the modules match the ones in the stored list, mapping will be activated, after which point all mapping assignments can be read and written to.

The remaining startup flow will depend on how the "Autostart" and "Connection timeout" parameters are configured. These parameters are described in section 8.1.6.

Startup flow 2: The coupler will be obtaining the module list from the backplane bus and will use this information to go online.

1. The coupler carries out a basic initialization routine and assigns all required addresses
2. The coupler scans the modules
3. If the coupler detects a gap in the configuration, all modules remain **IDLE**.

If there are no gaps, the modules will be switched to **STOP** and then start running (**RUN**) with their standard configuration.

Once this is done, the coupler will carry out its mapping routine based on the modules that are plugged in. The remaining startup flow will depend on how the "Autostart" and "Connection timeout" parameters are configured. These parameters are described in section 8.1.6.

6.3. Hot Plugging

Modules can be hot swapped while the ModbusTCP coupler is running. There are a number of scenarios in which hot swapping can prove to be very useful, one of them being when a module starts malfunctioning due to a defect (e.g., a defective input caused by overvoltage). In a case such as this, the defective modules can be swapped during ongoing operation and the remaining modules will continue to work normally.

If a module is removed, the coupler's "SF" LED will start flashing.

If a replacement module of the same model is plugged in, it will be configured automatically and added to the system's cyclic operation.

Hot plugging will only be enabled if the configured configuration (module layout) matches the existing module layout and the ModbusTCP coupler has switched to cyclic operation.



CAUTION!

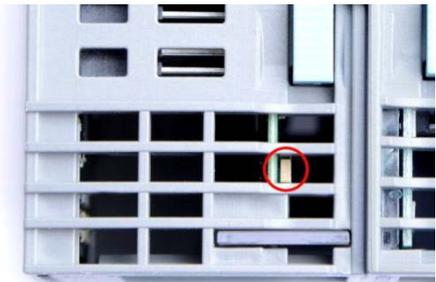
Do not remove more than one module at any one time. Removing a second module will cause the system to stop!

6.4. Factory Reset (Restoring the Coupler to Its Factory Settings)

The ModbusTCP coupler's factory settings can be restored by pressing a purposefully hard-to-find button. If you press this button, all coupler parameters, as well as the project, will be deleted and the coupler will be restored to its original system state.

The button can be accessed from above through the case's ventilation opening (see the picture on the right) To restore the unit to its factory settings, press the button and hold it down while the power is on. As soon as the first three LEDs light up, you can let go of the button.

At this point, the coupler will restart with its factory settings.



6.5. LED-Based Diagnosis

6.5.1. ModbusTCP Coupler LEDs

The blue "OK" LED is used to indicate the coupler's general status:

Solid light: correct configuration, system running

Flashing light: The coupler is starting up or is unable to switch to cyclic operation due to its module configuration (gaps, wrong modules)

The red "BF" LED (bus error) is used for diagnostic module messages:

Solid light: There is a diagnostic module message.

Flashing light: There are no modules plugged in

The yellow "SF" LED is used to indicate the module bus' status:

Flashing light: Modules missing (startup) / Module removed (hot swap)

Solid light: The wrong module is plugged in

The green "PLC" LED is used to indicate the Modbus connection's state:

Off: A Modbus client has not been connected

Solid light: There is at least one Modbus connection and the system is running (**RUN**)

Flashing light: There is at least one Modbus connection and the system is stopped (**STOP**)

Quickly flashing light: The coupler has been switched to simulation mode with the TB20-ToolBox program. All Modbus connections have been terminated.

The yellow "P1L" and "P2L" LEDs are used to indicate the link status for the ports.

Off: No link

Solid light: Link established

Flashing light: Link established and ongoing activity

The green "P1 Sp" and "P2 Sp" LEDs are used to indicate the ports' speed.

Solid light: 100 Mbps

Off: 10 Mbps



6.5.2. Module LEDs

The topmost LED ("**OK/SF**") 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); substitute values (if any) are being applied

Quickly flashing blue light: The module is idle (IDLE); its parameters have not been configured yet

Solid red light: The module is indicating a diagnostic error

Flashing red light: The module is indicating a parameter assignment error

The red "**SF**" LED light will only be shown on modules with configurable parameters or diagnostic capabilities.



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 on the slot).



7. ModbusTCP

7.1. Introduction

The Modbus protocol is a client-server protocol in which only the server can initiate communications.

The Modbus protocol can be used both for bit-based and register-based data transfers (with each register containing 16 bits). These data transfers are controlled using function codes.

7.2. General Frame Format

ModbusTCP ADU (Application Data Unit) frames are made up of the following blocks:

MBAP header	Function code	Data
7 bytes	1 byte	n bytes

- MBAP header (Modbus Application Protocol Header):
 - Bytes 0,1: Transaction identifier - ID No. when there are multiple requests active at the same time.
 - Bytes 2,3: Protocol identifier - always 0 (Modbus protocol)
 - Byte 4: Number of data bytes that follow (high byte) - always 0 (since all messages are shorter than 256 bytes)
 - Byte 5: Number of data bytes that follow (low byte)
 - Byte 6: Unit identifier (previously "device address"). Since the devices are addressed directly via their IP addresses, this parameter serves no purpose and should be set to 0xFF.
- Function code:
 - The standard Modbus protocol's function code (please consult the ModbusTCP specification).
- Data:
 - Bytes 8..n: The range is the same as the one for the standard Modbus protocol (please refer to Section 1) However, the CRC checksum is omitted, since it is implemented at the TCP/IP protocol level.

7.3. Communications Management

Modbus communications require for a TCP connection to be established between a client (e.g., computer) and the server.

TCP port 502, which is reserved for Modbus, is normally used for communications, but you can configure a different port if necessary.

If there is a firewall between the server and client, you will need to make sure that the configured TCP port is open.

Up to 10 clients can be connected at the same time.

7.4. ModbusTCP function codes

Function codes are used to define the meaning of each frame, as well as the frame's remaining syntax.

Function code	Function as per Modbus	Function in the PLC (for client)
01 / 02	Read discrete outputs/inputs	Read coils
03 / 04	Read multiple registers / input registers	Read
05	Write single output	Write ON/OFF
06	Write single registers	Write to register
15	Write multiple output	Write ON/OFF to multiple coils
16	Write multiple registers	Write block to registers (1 – 123 registers)
22	Mask write register	Write to register using a combination of an AND mask and OR mask
23	Read/write multiple registers	Write to/read multiple registers

7.5. Sample Frames

Function 01H : Read discrete outputs/inputs

Example: The following example reads (digital) output states 2 to 11, i.e., 10 states that can be represented using two data bytes.

Request

Master → Slave

Address	Function	Data			
		Starting address		Number of states	
Addr	01H	High byte	Low byte	High byte	Low byte

Response

Slave → Master

Address	Function	Data		
		Number of data bytes	States 9–2	States 11–10
Addr	01H	8 bits	8 bits	8 bits

Example (Hex): >>> FF 01 00 01 00 0A

<<< FF 01 02 11 01

11H = 00010001b: outputs 6,2 ON; outputs 9,8,7,5,4,3 OFF

01H = 00000001b: output 10 ON; output 11 OFF

Note:

As per the Modbus specification, starting address 1 is addressed as register 0.

8. Registers

Modbus register address	Modbus bit address	Section	Permitted Modbus function codes
0x0000 - 0x03FF	0x0000 - 0x3FFF	Inputs 64 * 32 bytes	1, 2, 3, 4, 23*
0x0400 - 0x07FF	0x4000 - 0x7FFF	Outputs 64 * 32 bytes	1, 2, 3, 4, 5, 6, 15, 16, 22, 23
0x0800 - 0x0803	0x8000 - 0x803F	Diagnostic status bits 8 bytes	1, 2, 3, 4, 23*
0x0804 - 0x0807	0x8040 - 0x807F	Process alarm status bits 8 bytes	1, 2, 3, 4, 23*
0x0808 - 0x080B	0x8080 - 0x80BF	Module status bits 8 bytes	1, 2, 3, 4, 23*
0x080C	0x80C0 - 0x80CF	Coupler control bits 2 byte	1, 2, 3, 4, 5, 6, 15, 16, 22, 23
...			
0x1000 - 0x1FFF	-	Module parameters 64 * 128 bytes	3, 4, 6, 16, 22, 23
...			
0x3000 - 0x33FF	-	Diagnostic status 64 * 32 bytes	3, 4, 23*
...			
0x4000 - 0x40FF	-	Coupler parameters 1 * 256 bytes	3, 4, 6, 16, 22, 23
0x4100 - 0x41FF	-	Coupler status 1 * 256 bytes	3, 4, 23*
...			
0x5000 - 0x57FF	-	Module list 64 * 64 bytes	3, 4, 23*
0x6000 - 0x60BF	-	Input/Output/Parameter mapping information 3 * 64 registers	3, 4, 23*



23* - Read access only

8.1. Inputs / Outputs

The ModbusTCP coupler has an address space of 2,084 bytes for inputs and 2,084 bytes for outputs. These inputs and outputs are automatically assigned to the address space (what is referred to as "mapping") when the coupler starts, and the corresponding assignments cannot be manually changed or otherwise configured.

The space required by the modules is stored, in the order in which the modules are plugged in, in the mapping input and output space.

Modules can only be mapped to even addresses (since each register contains 16 bits)

Rules:

- All the modules will be mapped in ascending order starting from the first register or first bit address from left to right.
- The input space and output space are separate from each other (e.g., if a module has both input and output data, each will be stored in different addresses).
- The system will not distinguish between digital and analog data, i.e., the ModbusTCP coupler will generate a continuous array for input data and a continuous array for output data based on all the modules.

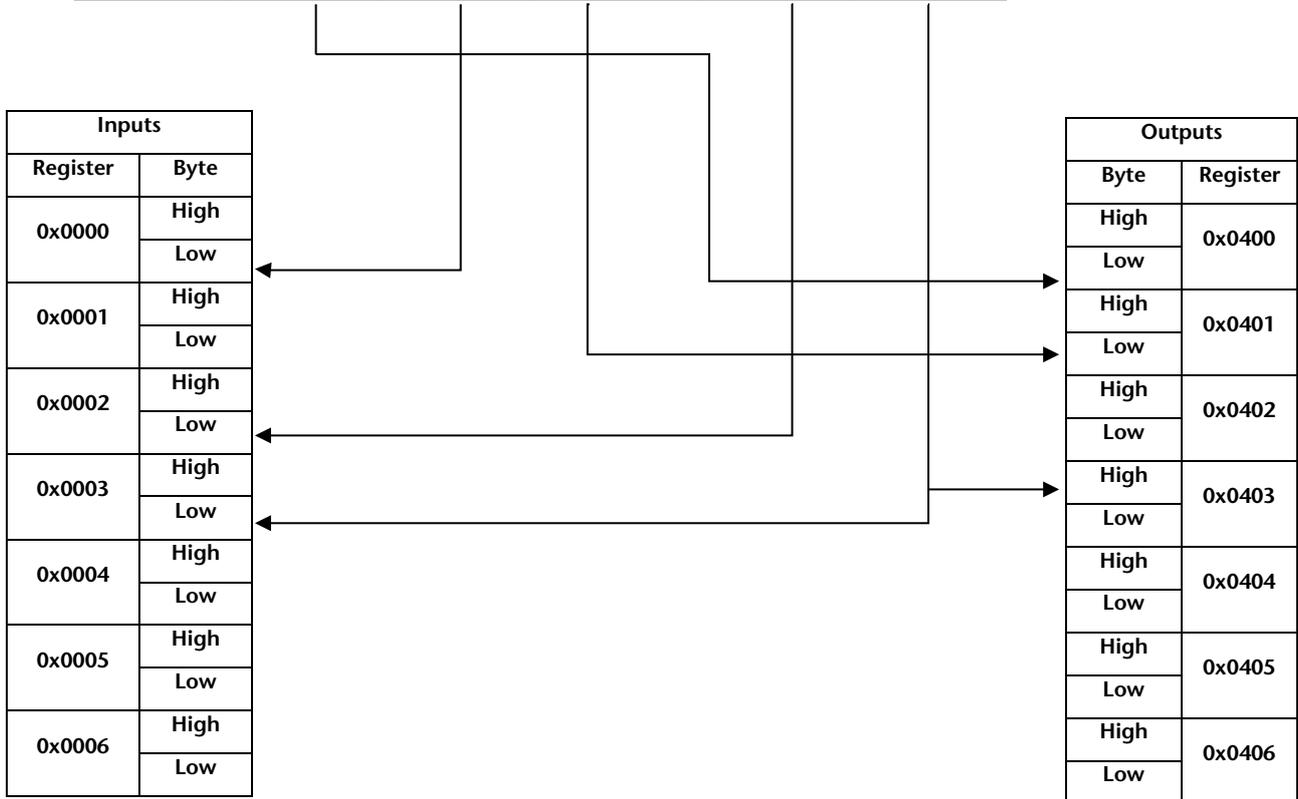
You can read the mapping assignments by using

- the TB20-ToolBox program. You can find the mapping information for each module under the "Extended" tab either in the "Configurator" or in "Online Diagnostic Mode".
- the "Input/Output/Parameter mapping information" section (please refer to section 8.1.9).

For a description of the input and output space that a module will take up, please consult the manual for that module.

Note: Outputs can only be written to, when the coupler is running (**RUN**).

-	Slot 1	Slot 2	Slot 3	Slot 4	Slot 6
Modbus TCP Coupler	2 DO x 24 VDC	2 AO x 24 VDC	2 AI/TC x 24 VDC	2 DI x 24 VDC	1 CNT x 24 VDC
	I data: 0 byte	I data: 0 byte	I data: 4 byte	I data: 1 byte	I data: 8 byte
	O data: 1 byte	O data: 4 byte	O data: 0 byte	O data: 0 byte	O data: 8 byte
600-170-1AA11	600-220-0AB01	600-260-4AB01	600-254-4AB01	600-210-0AB01	600-300-7AA01



8.1.1. Section: Diagnostic Status Bits

Shows the diagnostic status for the individual modules bit by bit following the order in which the modules are plugged in. This space makes it easier to evaluate diagnoses.

Register	Bits															
0x0800	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8
...	...															
0x0803	55	54	53	52	51	50	49	48	63	62	61	60	59	58	57	56

8.1.2. Section: Module Status Bits

Shows whether a module is plugged in bit by bit following the order in which the modules are plugged in.

Register	Bits															
0x0808	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8
...	...															
0x080B	55	54	53	52	51	50	49	48	63	62	61	60	59	58	57	56

8.1.3. Section: Coupler Control Bits

The bits must be set to 1 by the user, and will be reset by the coupler once the requested action is successfully completed.

Since the actions triggered by some of the control bits may be the exact opposite of the actions triggered by others, only one single bit should be set at a time.

Register	Bits								
0x080C	Reserved	Reserved	Reserved	Start modules	Stop modules	Save parameters	Delete module parameters	Restart	

Restart: Restarts the coupler and applies any changes made to the coupler parameters.

Important: Restarting the coupler will terminate all existing Modbus connections!

Delete module parameters: Deletes stored module parameters from the coupler's non-volatile memory. After the coupler is de-energized, all modules will be restored to their default parameter values.

Save parameters: Writes the current module and coupler parameters to the coupler's non-volatile memory.

Start modules: Switches all modules to the **RUN** operating state. Will be ignored in **IDLE**.

Stop modules: Switches all modules to the **STOP** operating state. Will be ignored in **IDLE**.

8.1.4. Section: Module Parameters

Module parameters are mapped one after the other following the order in which the modules are plugged in. Regardless of the actual length of a module's parameter data, each module will always take up 128 bytes (64 register) when mapped. The starting address of each module can be calculated using the following formula:

$$0x1000 + 0x40 * (\text{slot number}_{\text{HEX}} - 1)$$

If the number for the parameter byte you want is odd, use the next higher even number.

The first byte of a module's first register contains the length of the module's parameter data.

Writing to this space will cause the new parameters to be applied immediately.

Register	Module	Parameters	
0x1000	1	-	Parameter length (bytes)
0x1001		Parameter byte 0	Parameter byte 1
...		...	
0x103F		Parameter byte 124	Parameter byte 125
0x1040	2	...	Parameter length (bytes)
0x1041		Parameter byte 0	Parameter byte 1
...		...	
0x107F		Parameter byte 124	Parameter byte 125
...			
0x10C0	64	...	Parameter length (bytes)
0x10C1		Parameter byte 0	Parameter byte 1
...		...	
0x1FFF		Parameter byte 124	Parameter byte 125

8.1.5. Section: Diagnostic Status

Diagnostic data is mapped in succession following the order in which the modules are plugged in. Regardless of the actual length of a module's diagnostic data, each module will always take up 16 bytes (8 register) when mapped. The starting address of each module can be calculated using the following formula:

$$0x3000 + 0x10 * (\text{slot number}_{\text{HEX}} - 1)$$

Register	Module	Diagnoses	
0x3000	1	Diagnostic byte 0	Diagnostic byte 1
...		...	
0x300F		Diagnostic byte 30	Diagnostic byte 31
0x3010	2	Diagnostic byte 0	Diagnostic byte 1
...		...	
0x301F		Diagnostic byte 30	Diagnostic byte 31
...			
0x33F0	64	Diagnostic byte 0	Diagnostic byte 1
...		...	
0x33FF		Diagnostic byte 30	Diagnostic byte 31

8.1.6. Section: Coupler Parameters

This space is used to map all of the coupler's configurable properties.

To apply newly written parameters, you have to restart the coupler via the “Restart” bit in the “Coupler Control Bits”. However, to save in non-volatile memory use the “Save Parameter” bit.

Register	Parameters	Bytes	
0x4000	IP address	Octet 0	Octet 1
0x4001		Octet 2	Octet 3
0x4002	Subnet mask	Octet 0	Octet 1
0x4003		Octet 2	Octet 3
0x4004	Default gateway	Octet 0	Octet 1
0x4005		Octet 2	Octet 3
0x4006	Settings	Configuration bits	<i>Reserved</i>
0x4007		Modbus port	
0x4008		Connection timeout	

Configuration bits

7	6	5	4	3	2	1	0
<i>Reserved</i>	<i>Reserved</i>	<i>Reserved</i>	<i>Reserved</i>	<i>Reserved</i>	Autostart	Hot plugging	DHCP

DHCP:

The coupler will get its network configuration via DHCP (IP/SNMP/gateway settings will be ignored).

Hot plugging:

Means that a module can be replaced during ongoing operation without the coupler stopping (**STOP**).

Autostart:

If 1: The coupler will start running (**RUN**) after a successful module configuration check. If Connection timeout monitoring is enabled, the modules will not start running (**RUN**) until after the first correct Modbus packet is received

If 0: The modules will remain stopped (**STOP**) until they are commanded to start running (**RUN**) using coupler control bits.

Modbus port:

Used to define which port should be used to establish Modbus connections to the coupler (from 0 to 65535, Default is 502).

Connection timeout:

Used to specify the time, in seconds, after which TCP connections will be terminated if they are inactive. If a valid Modbus packet is not received during the specified time, all the modules will be stopped (**STOP**).

8.1.7. Section: Coupler Status

This space is used to map all of the coupler's properties that cannot be modified.

Register	Parameters	Bytes	
0x4100	Order number	Char 0	Char 1
...	
0x4109		Char 18	Char 19
0x410A	Serial number	Byte 0	Byte 1
0x410B		Byte 2	Byte 3
0x410C	Firmware version	Major	Minor
0x410D		Beta	0
0x410E	Hardware version	Char 0	Char 1
...	
0x4117		Char 18	Char 19
0x4118	The coupler's MAC address	Octet 0	Octet 1
0x4119		Octet 2	Octet 3
0x411A		Octet 4	Octet 5
0x411B	Reserved		
0x411C	Active IP address	Octet 0	Octet 1
0x411D		Octet 2	Octet 3
0x411E	Active subnet mask	Octet 0	Octet 1
0x411F		Octet 2	Octet 3
0x4120	Active gateway	Octet 0	Octet 1
0x4121		Octet 2	Octet 3

8.1.8. Section: Module List

This space is used to map all the module properties (of the 64 modules) that cannot be modified.

Register	Parameters	Bytes		
0x5000	Module ID	Byte 0	Byte 1	
0x5001	Order number	Char 0	Char 1	
...				
0x500B		Char 18	Char 19	
0x500C	Serial number	Byte 0	Byte 1	
0x500D		Byte 2	Byte 3	
0x500E	Firmware version	Major	Minor	
0x500F		Beta	0	
0x5010	Hardware version	Char 0	Char 1	
...				
0x5019		Char 18	Char 19	
0x501A	I/O length in bytes	Output data length		Input data length
0x501B	Data length in bytes	Diagnosis length	Process alarm length	Parameter length
0x501C - 0x501F	Reserved	0		0

This structure will be repeated a maximum of 64 times.

8.1.9. Section: Mapping Information

This is where the input/output/parameter register addresses for all the modules are stored.

If a module does not have any input, output, or parameter data, 0xFFFF will be shown instead.

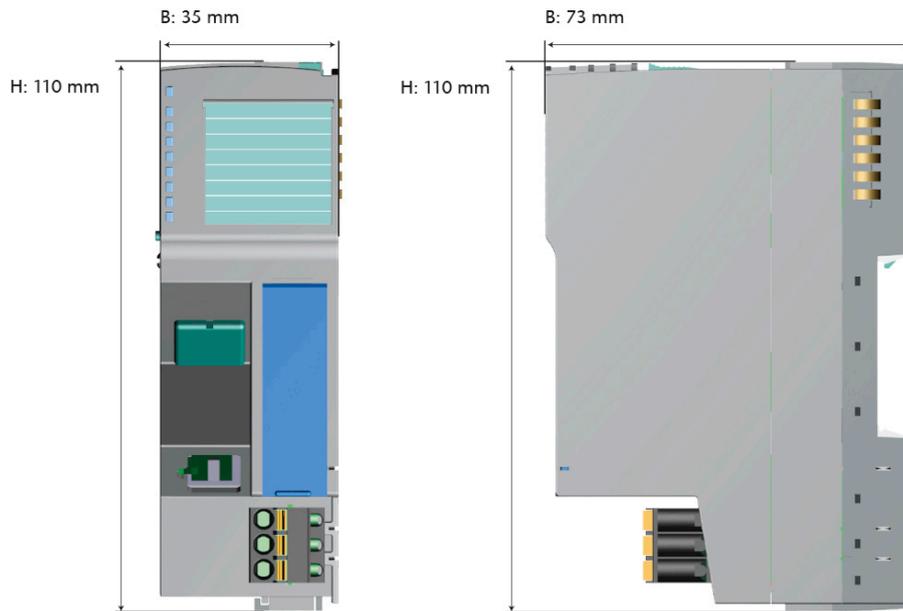
Register	Parameters	Bytes	
0x6000	Input address for module 1	Byte 0	Byte 1
...	
0x603F	Input address for module 64	Byte 0	Byte 1
0x6040	Output address for module 1	Byte 0	Byte 1
...	
0x607F	Output address for module 64	Byte 0	Byte 1
0x6080	Parameter address for module 1	Byte 0	Byte 1
...	
0x60BF	Parameter address for module 64	Byte 0	Byte 1

9. Technical Specifications

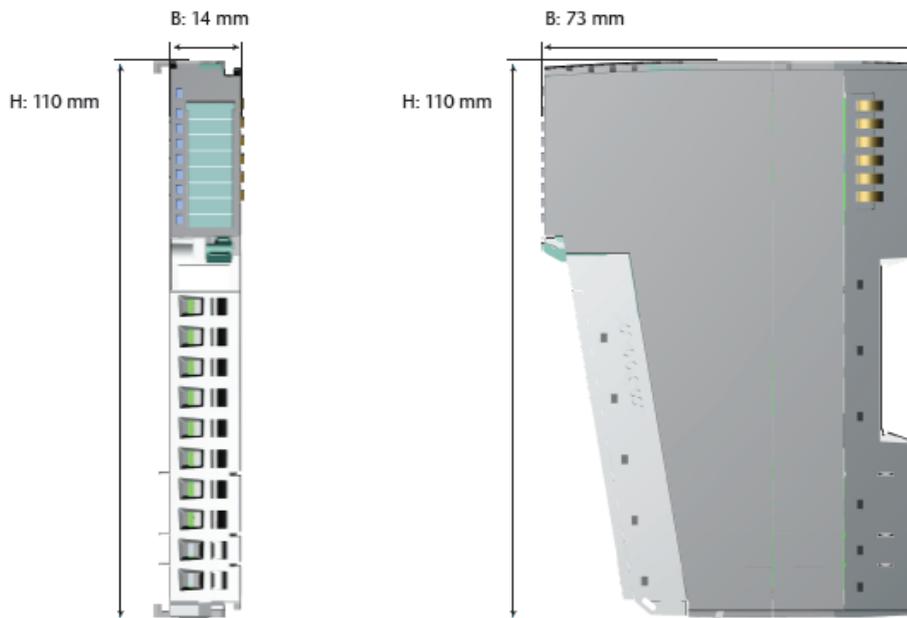
Order No.	600-170-1AA11
Module designation	ModbusTCP coupler
Ethernet port	
Protocol	ModbusTCP
Transmission rate	10/100 Mbps, automatic detection (auto-negotiation, auto-crossover)
I/O image size	1,024 / 1,024 bytes
Parameters per module	126 bytes
Connector	2x RJ45, integrated switch
Supports Modbus function codes	1, 2, 3, 4, 5, 6, 15, 16, 22, 23
TCP connections	10 stations
USB port	
Protocol	Full-speed USB 2.0 Device
Connector	mini-USB
Isolation voltage	1.5 kV
Electrical isolation	Yes
Number of modules that can be connected in series	64, all products
Voltage supply	24 VDC, 18–28 VDC
Current draw without modules (internal)	75 mA
Power dissipation	Max. 8 W
Power supply for modules	5 VDC, max. 2.5 A
Dimensions (H x W x D)	110 mm x 35 mm x 73 mm
Weight	115 g
Certifications	CE, UL
Noise 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 60068-27:2010 "Shock"
Protection rating	IP 20
Relative humidity	95% without condensation
Installation position	Any
Permissible ambient temperature	0 °C to 60 °C For UL applications: 0 °C to 50 °C
Transport and storage temperature	-20 °C to 80 °C
Pollution degree	2

10. Dimensions

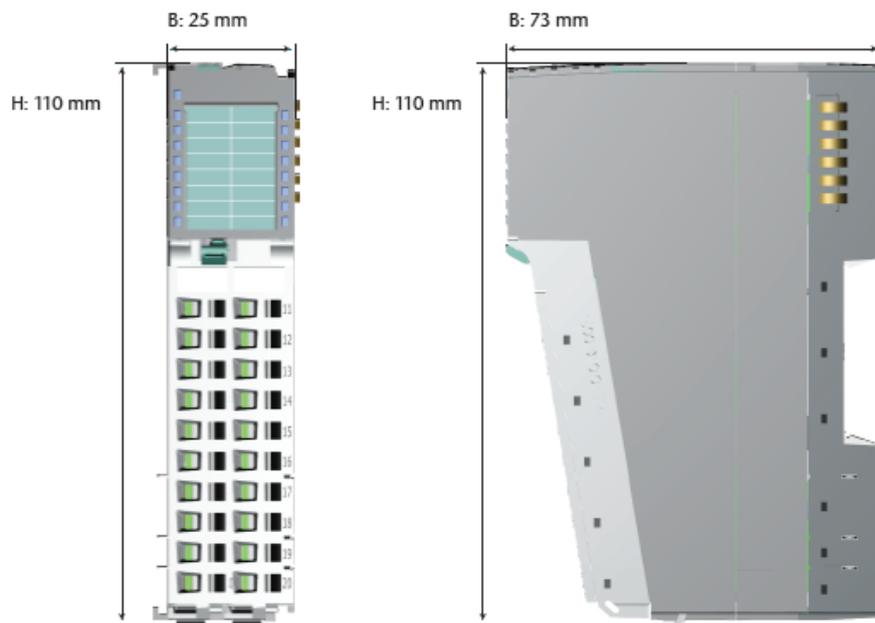
10.1. ModbusTCP Coupler



10.2. 14-mm Module



10.3. 25-mm Module



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

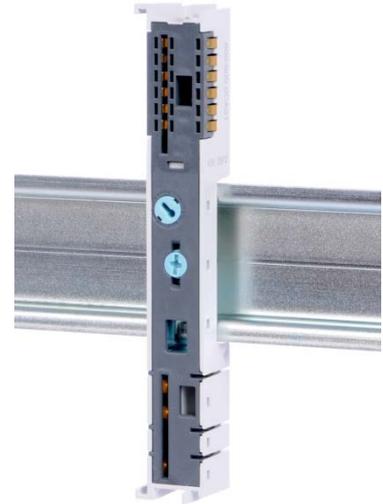
The power and isolation base module is available in sets of five with order No. 600-900-9BA01.



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

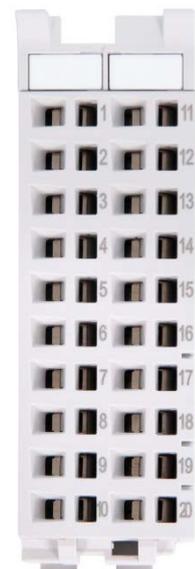
11.2.1. 10-Terminal Front Connector

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



11.2.2. 20-Terminal Front Connector

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



11.3. Electronic Modules

To order spare electronic modules, simply use the order No. for the original product. Electronic modules are always sent as a complete assembly, including the corresponding base module and front connector.

11.4. Final Cover

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

