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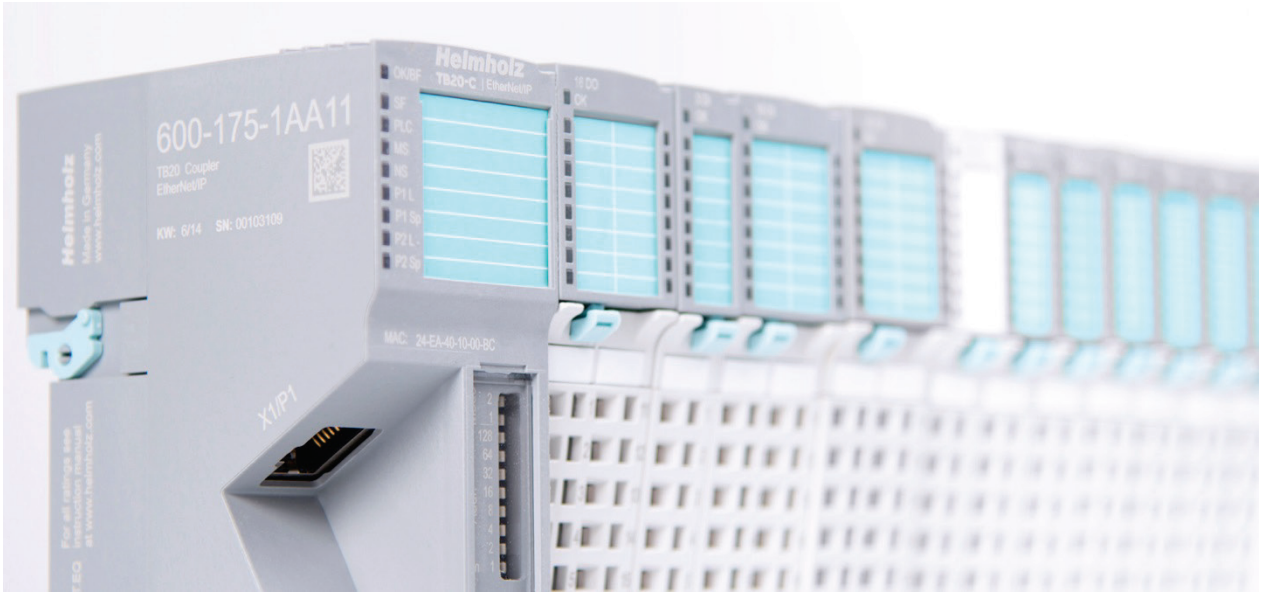

TB20 – EtherNet/IP™ Coupler

Manual

Version 2 / 28.03.2017 for HW 1-1 & FW 1.06 and higher

Manual Order No.: 960-175-1AA11/en

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Notes

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Revision record

Version	Date	Change
1	7.7.14	First version
2	13.2.17	Added new mapping options

Table of contents

1. General information

This document serves as the basis for the implementation, testing, and documentation of the EtherNet/IP™ coupler (order no. 600-175-1AA11) for the Systeme Helmholz IO system TB20.

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 the TB20 I/O system.

1.2. Symbols and signal words

The following symbols and signal words are used in this documentation. The combination of a pictogram and signal word classifies each safety warning. The symbol may vary according to the type of hazard.

	Symbol	Signal word	Explanation
Death		**Hazard**	This signal word must be used when death or irreversible health damage can result if the hazard statement is ignored.
Injury and property damage		**Warning**	This signal word indicates personal injury and property damage, including injury, accident, and health risks.
		**Caution**	This signal word indicates a risk of property damage. In addition, there is a slight risk of injury.
Property damage only		**Attention**	This signal word may be used only if no health damage can occur. It warns of damage to property.
No damage		**Note**	This signal word indicates hints for making operation easier and cross references. It excludes all risks of damage or injury.

Warnings used

Symbol	Explanation	Symbol	Explanation
	General warning sign		Electrical voltage warning

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.

Note

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.

Hazard

Risk of death by electric shock

There is residual electrical energy in pipes, equipment, and devices.

Allow work on the electrical supply to be carried out only by qualified electricians.

Hazard

Risk of death, injury, and damage to property

There are hazards if the operating instructions and all safety warnings in the device are not obeyed.

Read the operating instructions carefully before initial use. Fulfill the required security conditions before the initial start-up.

Observe the general safety instructions and the specific safety information included in the other sections.

Hazard

Risk of death and injury in case of defective safety switches

Hazards exist if the safety switches do not work.

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. (refer to EN 954-1, Risk Assessment).

Hazard

Risk of death and injury in case of improper use

Define the responsibilities of the staff.

The 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. 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

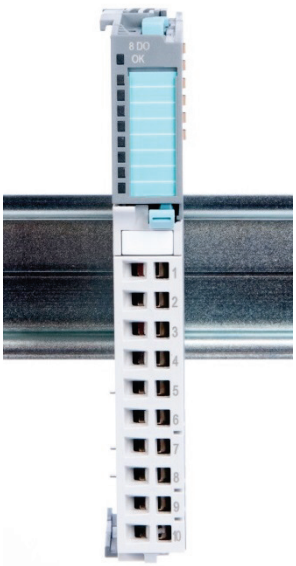
The system's bus coupler includes a bus interface and a power module. The bus interface is responsible for establishing a connection to the higher-level bus system and is used to exchange I/O signals with the automation system's CPU.

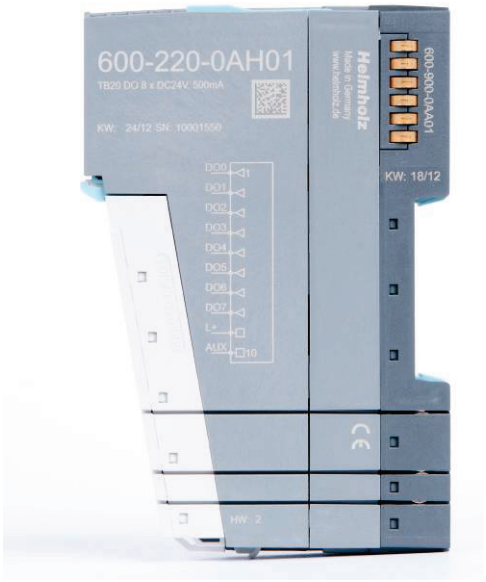
The power module is responsible for powering the coupler's electronics and all connected peripheral modules.

2.2.2. Peripheral modules

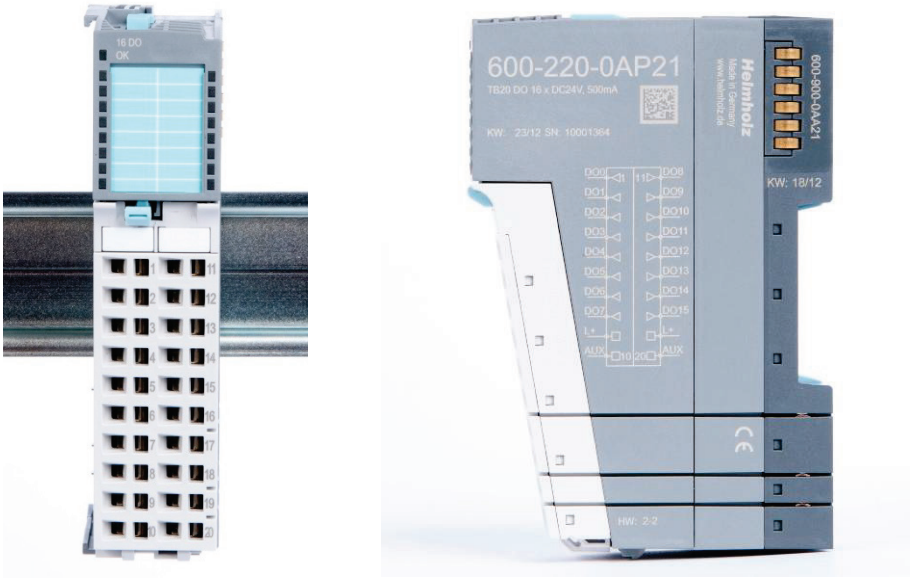
The system's peripheral modules are electronic components to which peripheral devices such as sensors and actuators can be connected. A variety of peripheral modules with different tasks and functions are available.

Example: Peripheral module with 10-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).

Note

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, bottom) 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.

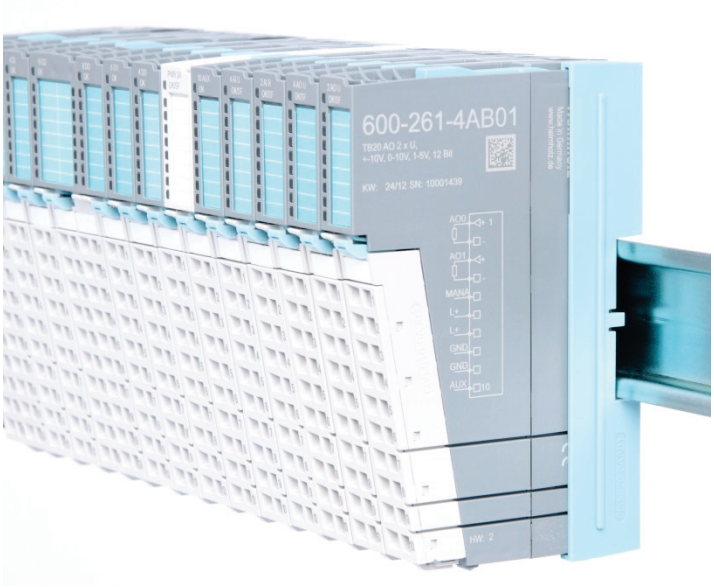
In other words, power modules deliver all the necessary power to the peripheral modules connected after them and, if applicable, all the way to the next power module or power and isolation module. This is required whenever the power supplied by the coupler alone is not sufficient, e.g., when there are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

Note

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

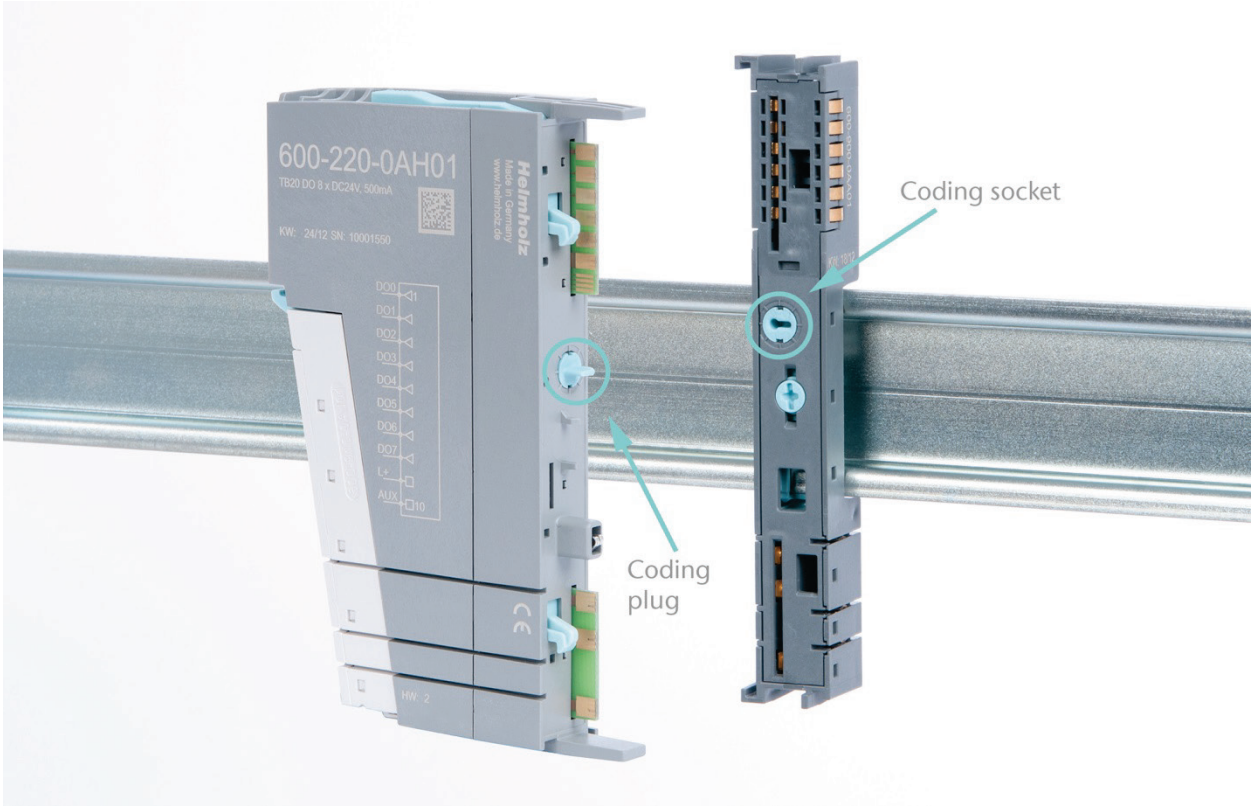
Each module consists of three parts:

- A base module
- The electronics module and
- The front connector

2.2.7. Module coding

Electronic 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 is only possible to plug an electronic module into a base module if the positions of the coding plug and the positions of the coding socket match. Otherwise, the electronic module will be mechanically prevented from being plugged in.

3. Installation and removal

Hazard

Risk of death and injury through electrical energy

Risk of death by electric shock!

Before starting any work on the TB20 system, make sure to de-energize all components as well as the cables supplying them with power.

Attention

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, the ambient temperature must 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.

However, in order to achieve optimum ventilation and be able to use the system at the specified maximum ambient temperature, it is 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)

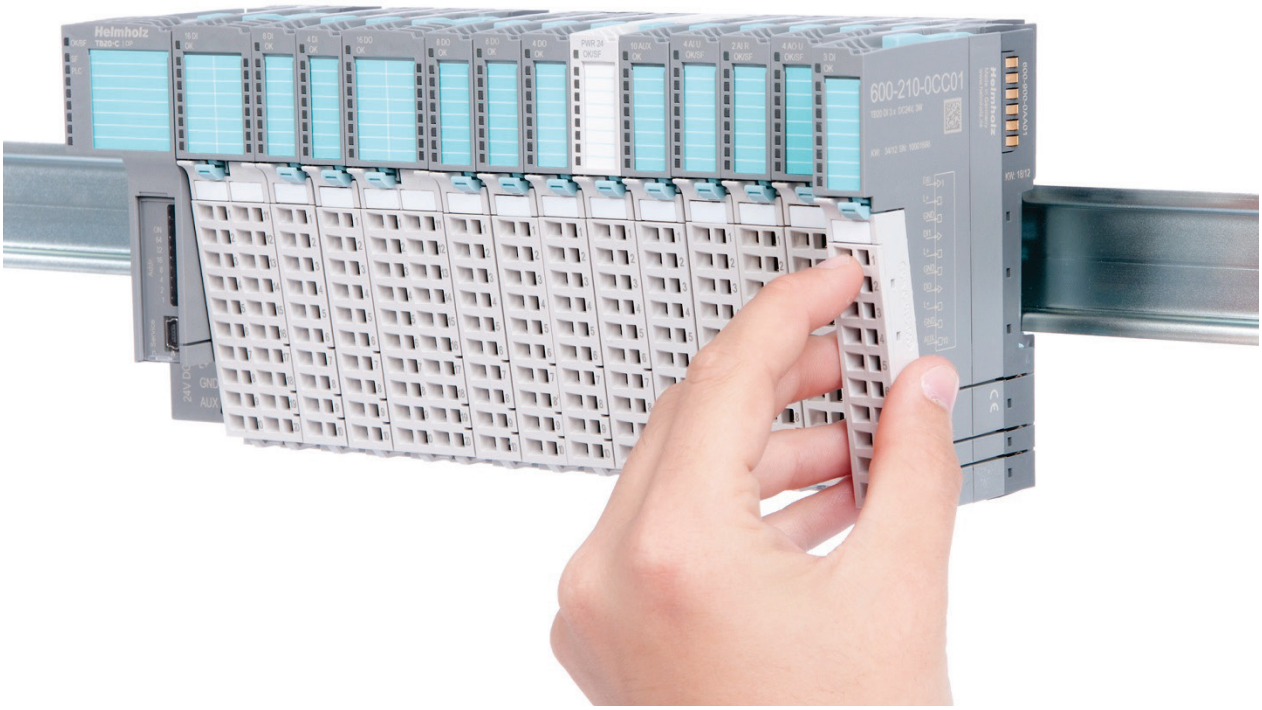
The minimum clearances for TB20 components are: 30 mm on the top and on the bottom and 10 mm on each side.

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.

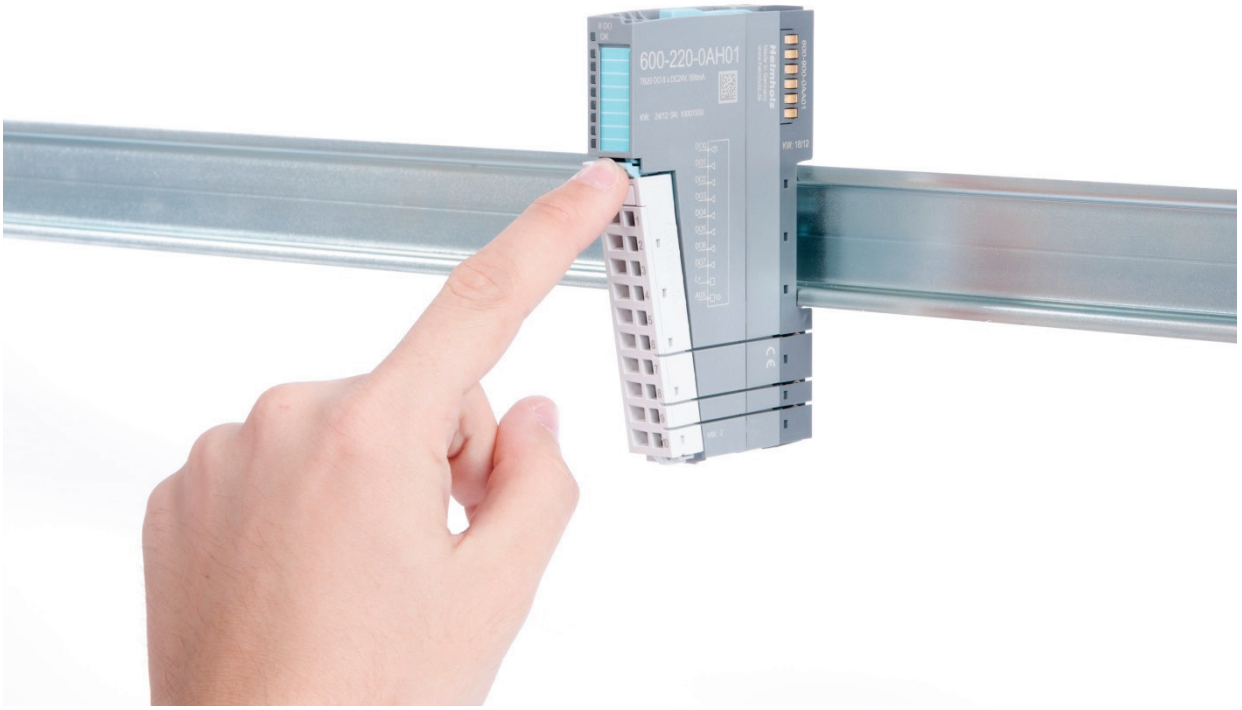
Finally, place the front connector on the electronic module from below in an inclined position and then gently push it onto the electronic module until the front connector fastener snaps into place with a soft click.

3.3.2. Removal

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

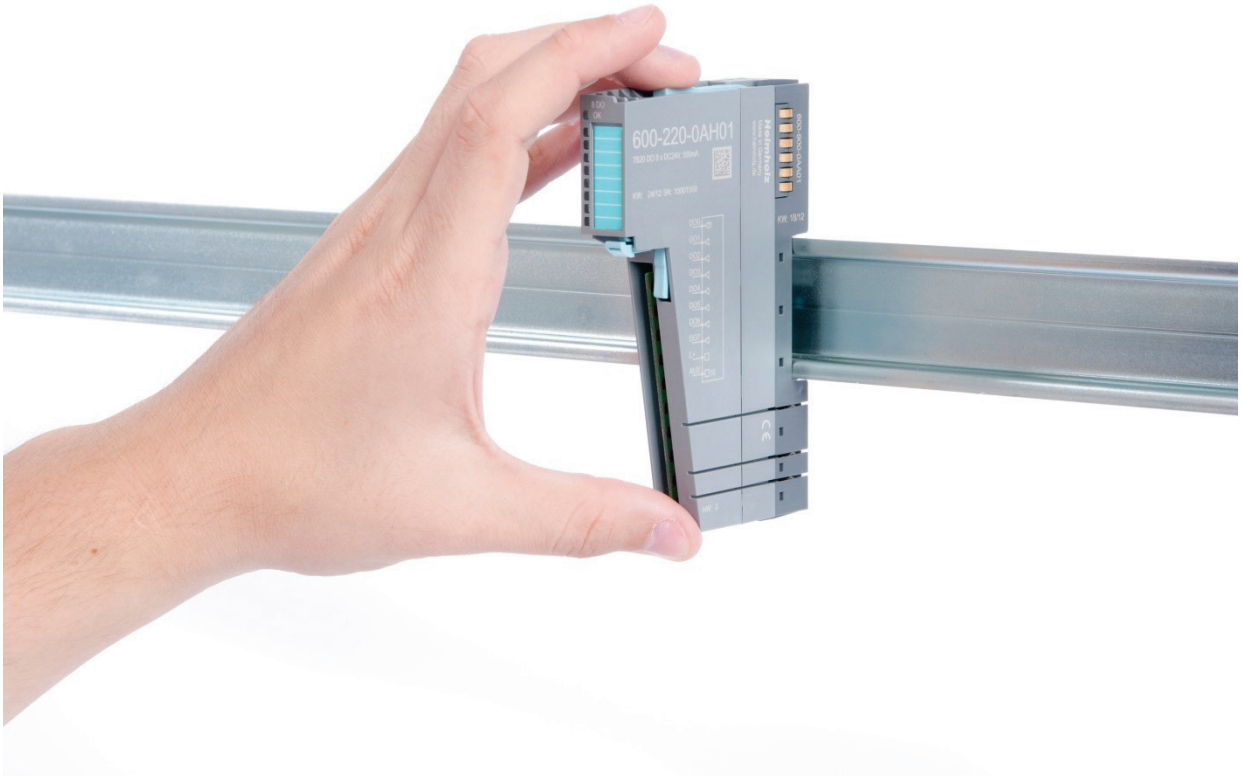
Step 1: Remove the front connector

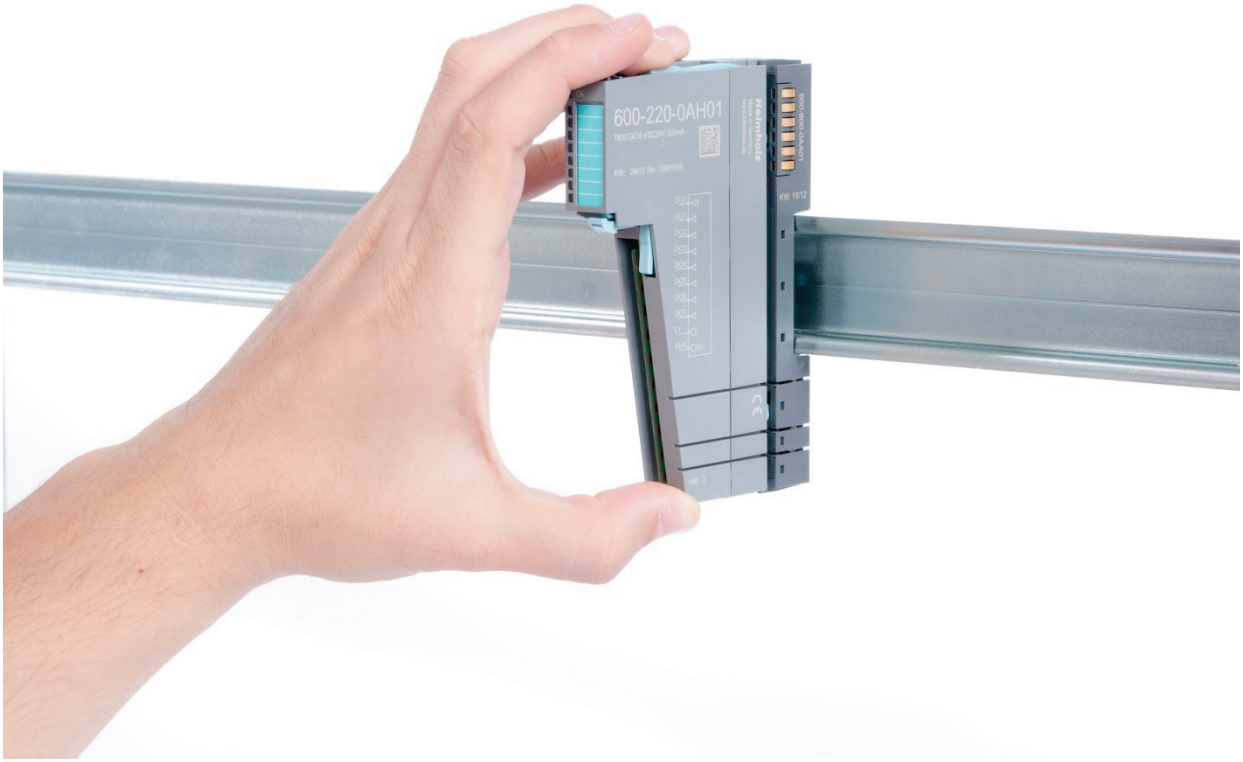
To do so, push the tab above the front connector upwards (see the picture below). This will push out the front connector, after which you can pull it out.



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.

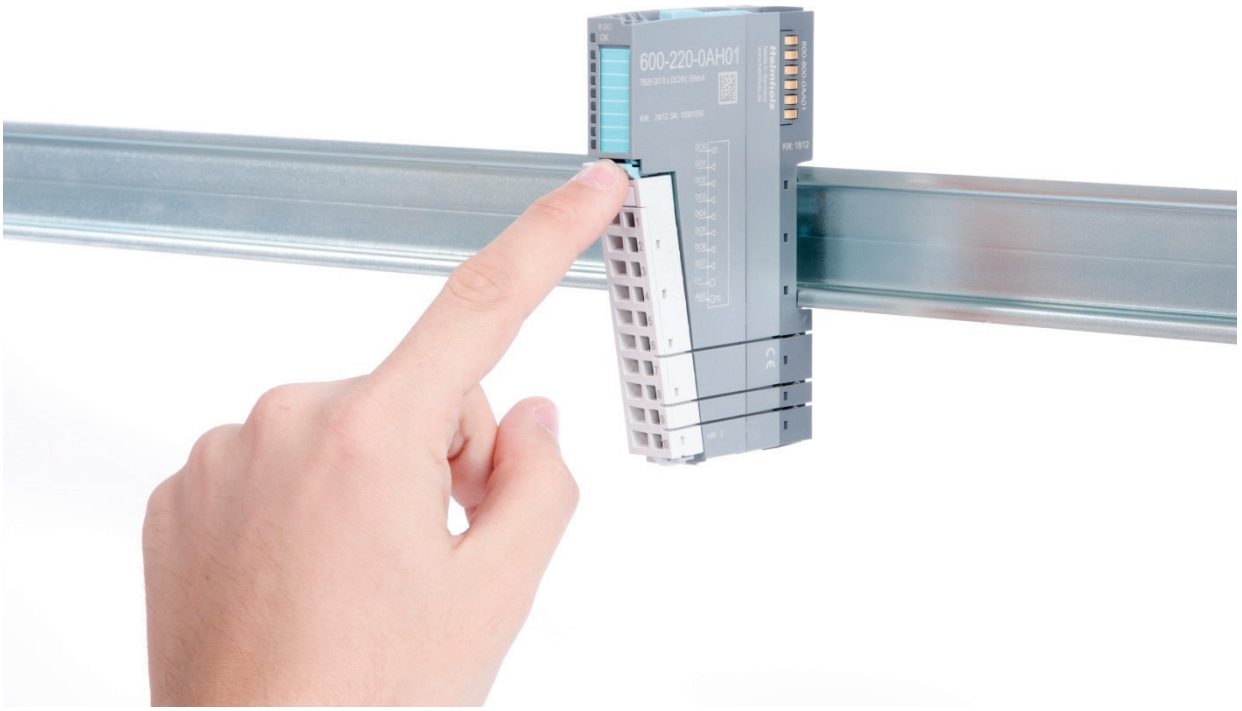
3.4. Replacing an electronic module

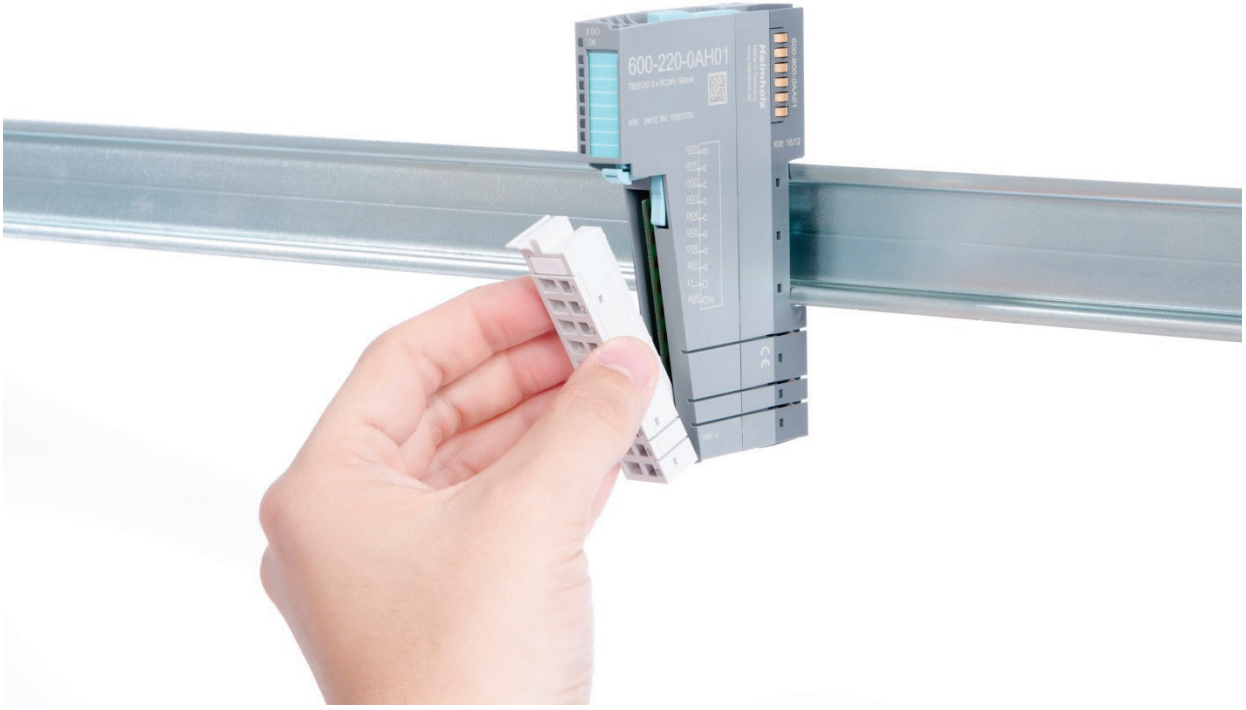
The procedure for replacing the electronic module on a peripheral module consists of four steps.

If you need to replace the 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

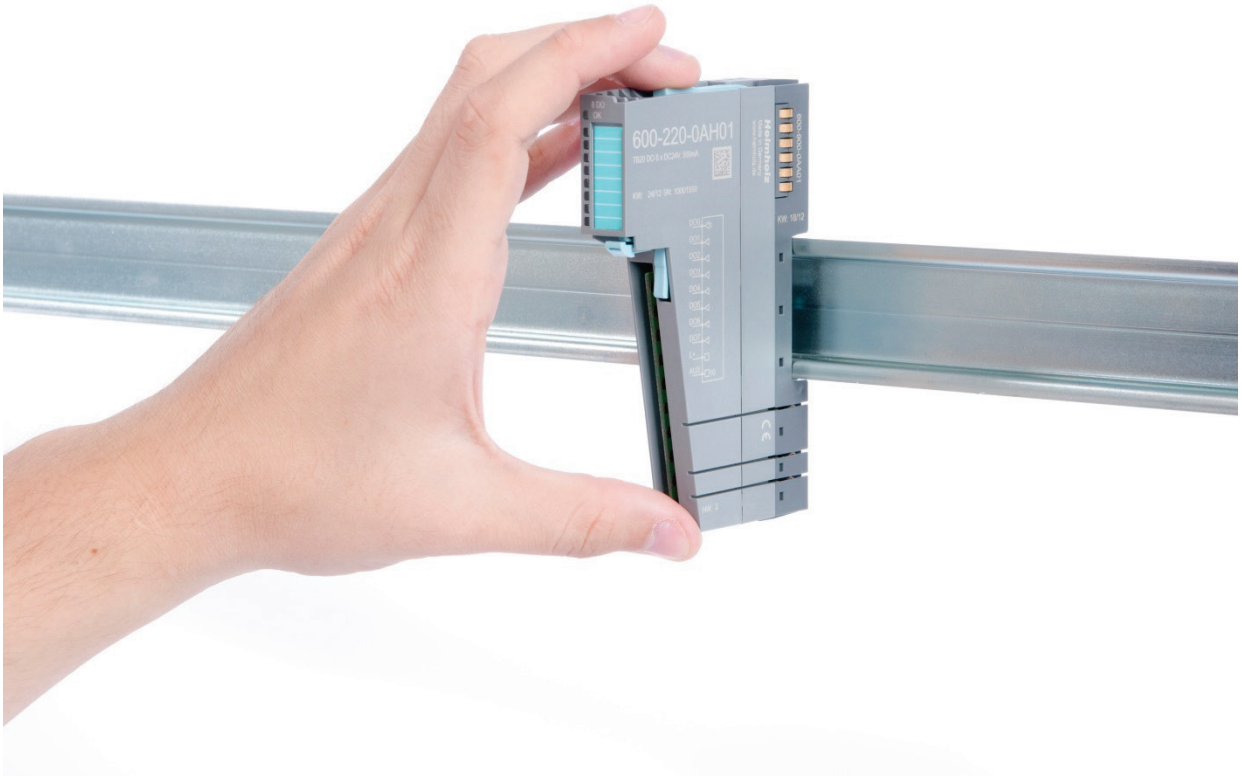
To do so, push the tab above the front connector upwards. The front connector will come loose, after which you can pull it out.

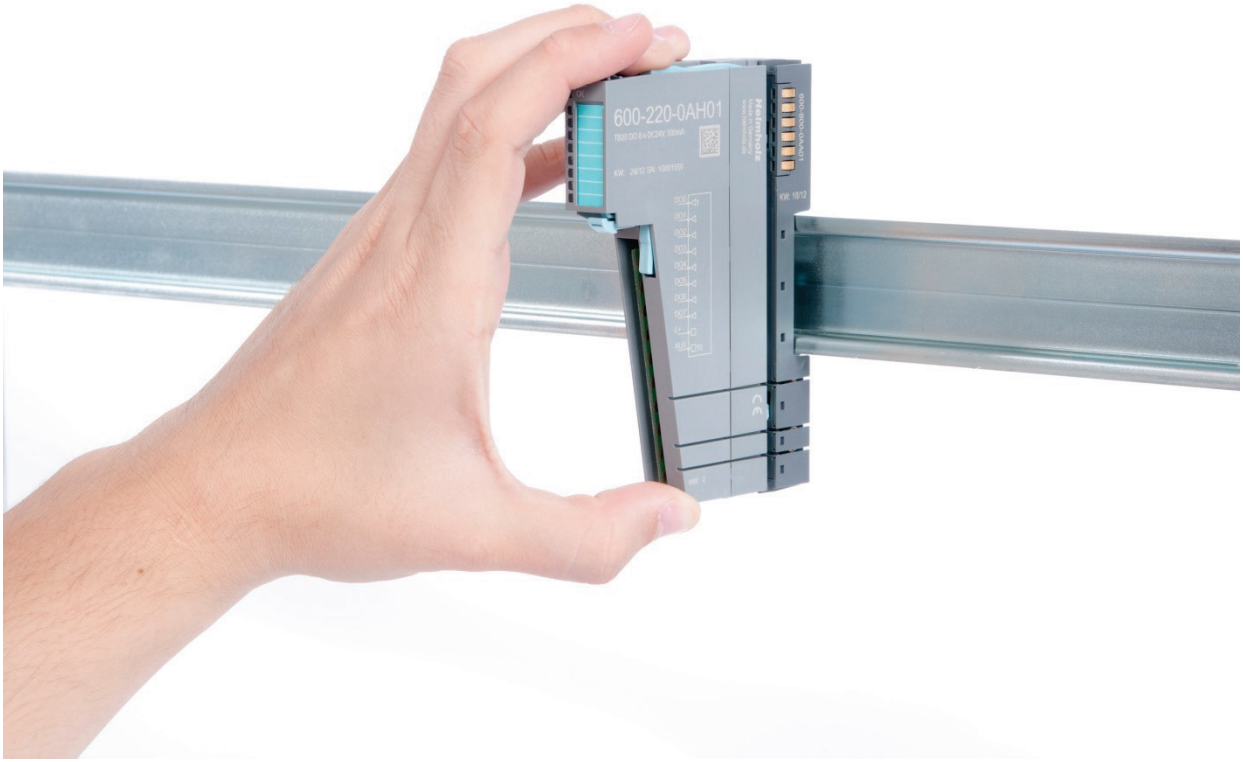




Step 2: Remove the electronic module

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

Attention

The electronic module must be snapped into place on the base module with a single continuous movement.

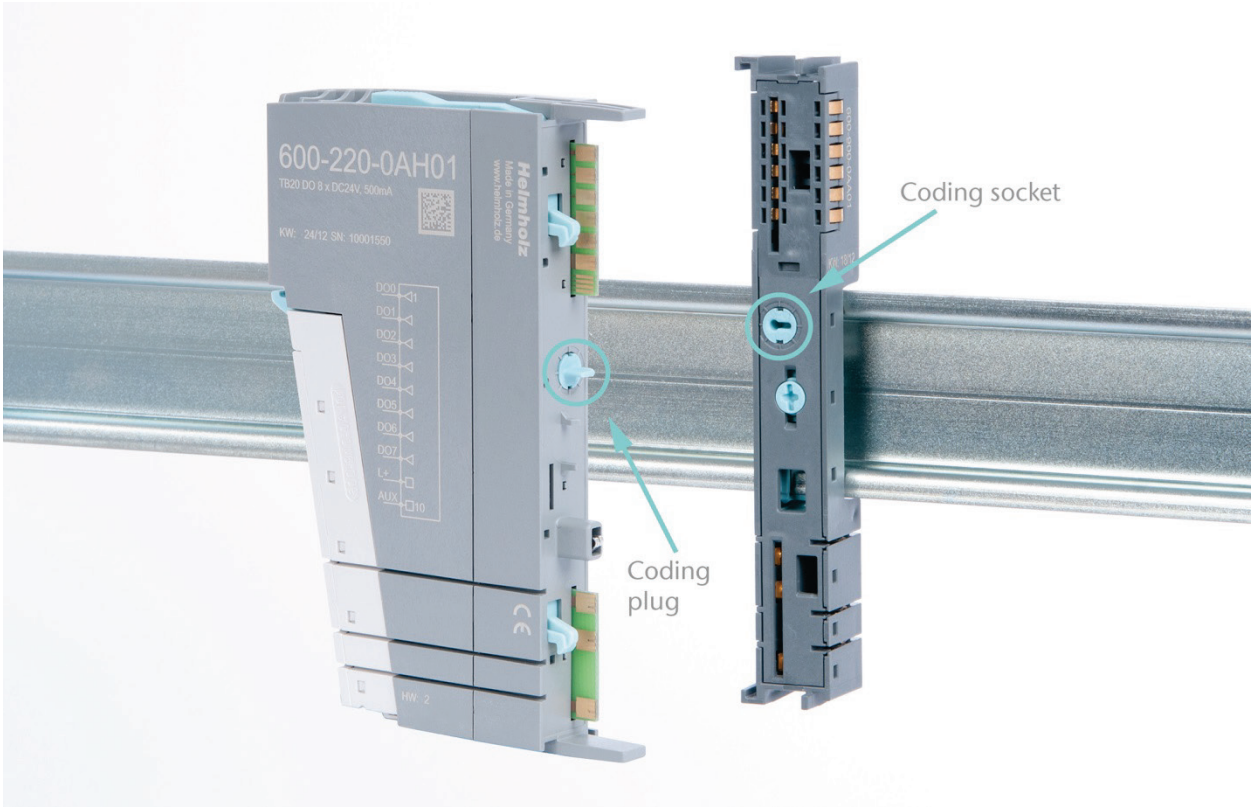
If the electronic module is not snapped into place firmly and straight on the base module, bus malfunctions may occur.

Note

If the electronic module cannot be plugged into the base module, check whether the coding elements on the electronic module and base module (see picture 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*.



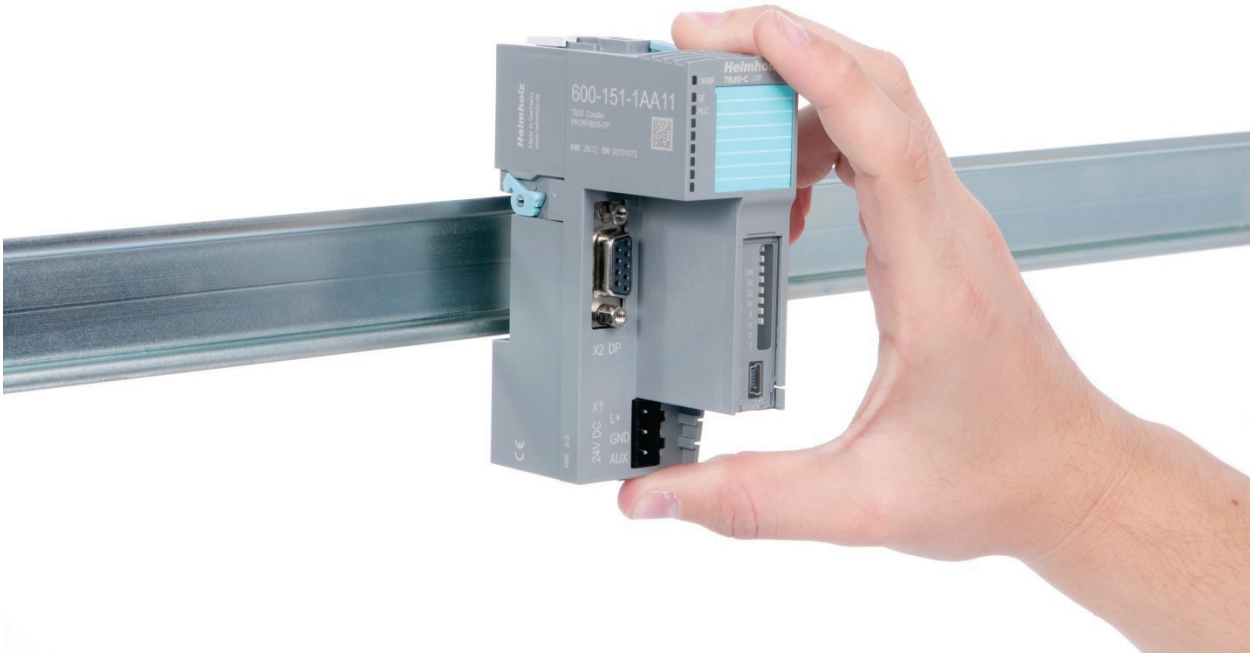
Step 4: Plug in the front connector

3.5. Installing and removing the coupler

3.5.1. Installation

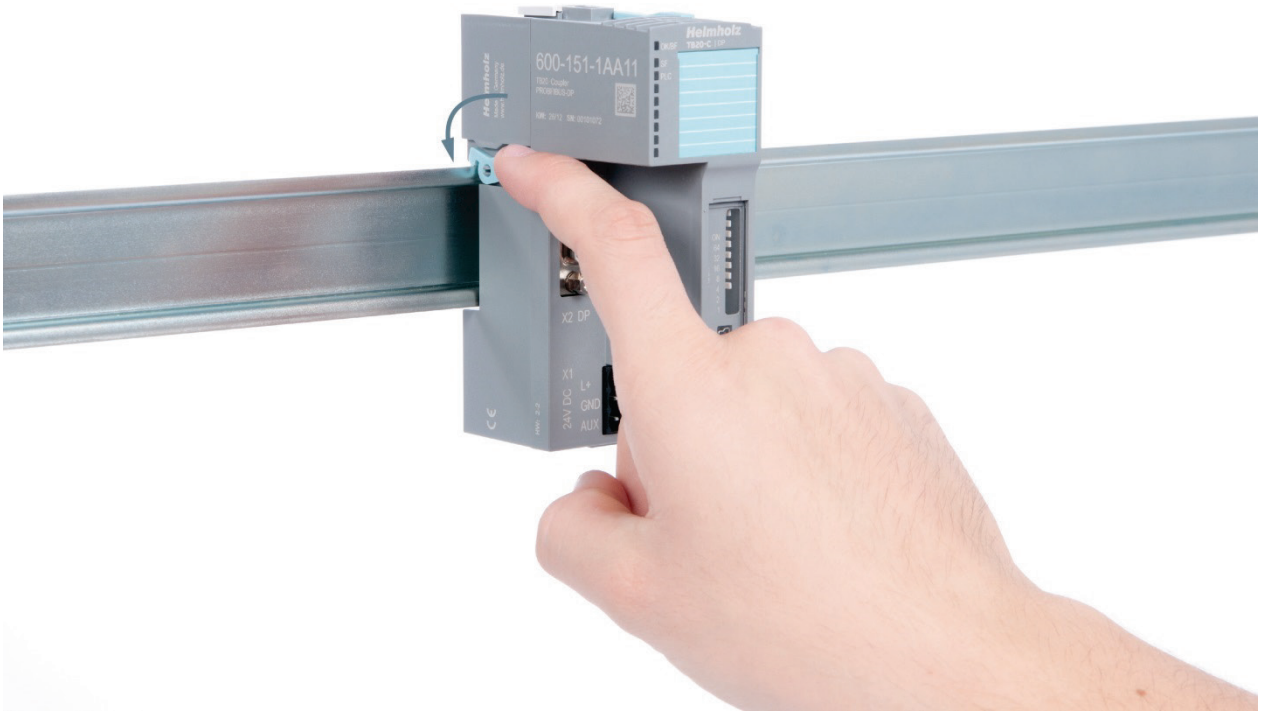
Step 1: Place the coupler on the DIN rail

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

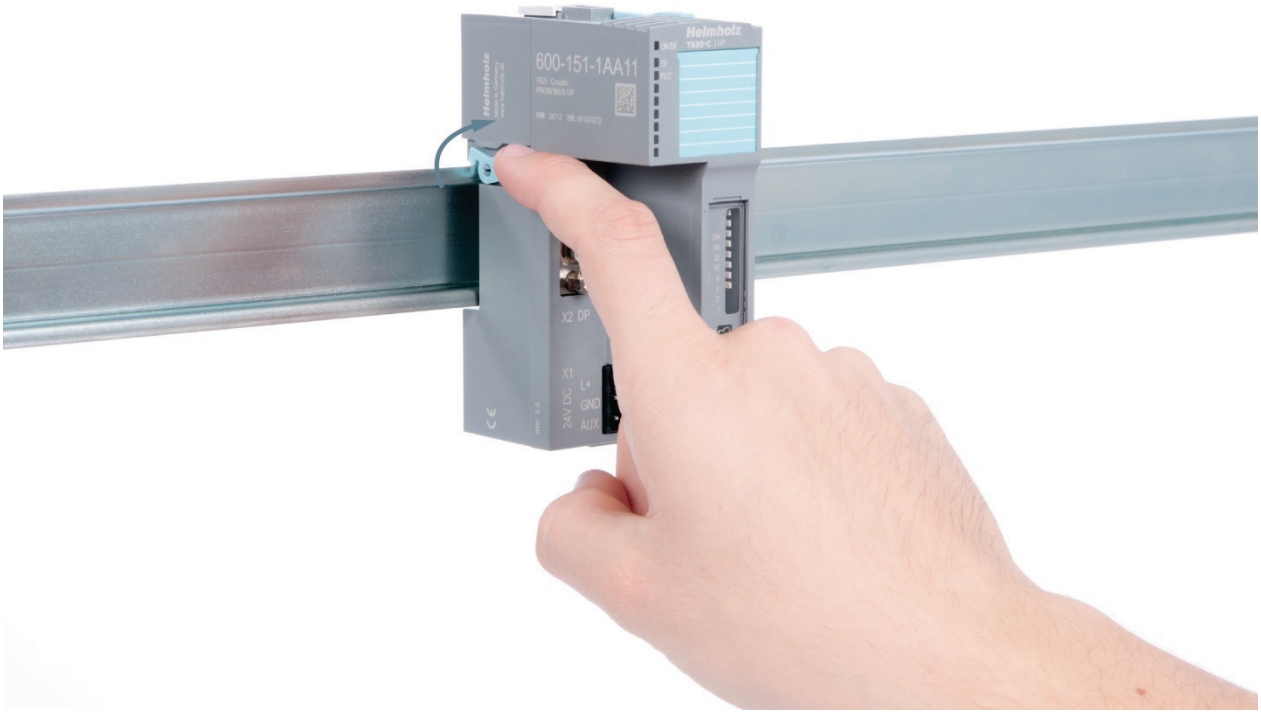
Use the locking lever on the left side to lock the coupler into position on the DIN rail.



3.5.2. Removal

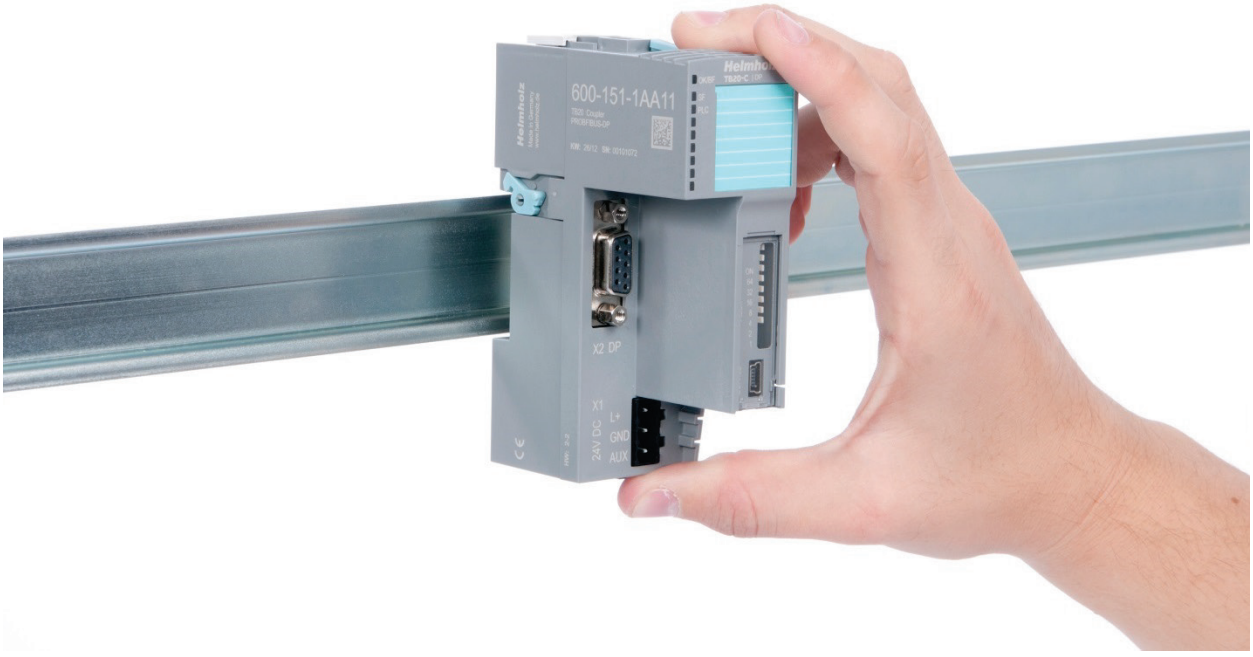
Step 1: Release the locking mechanism

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.

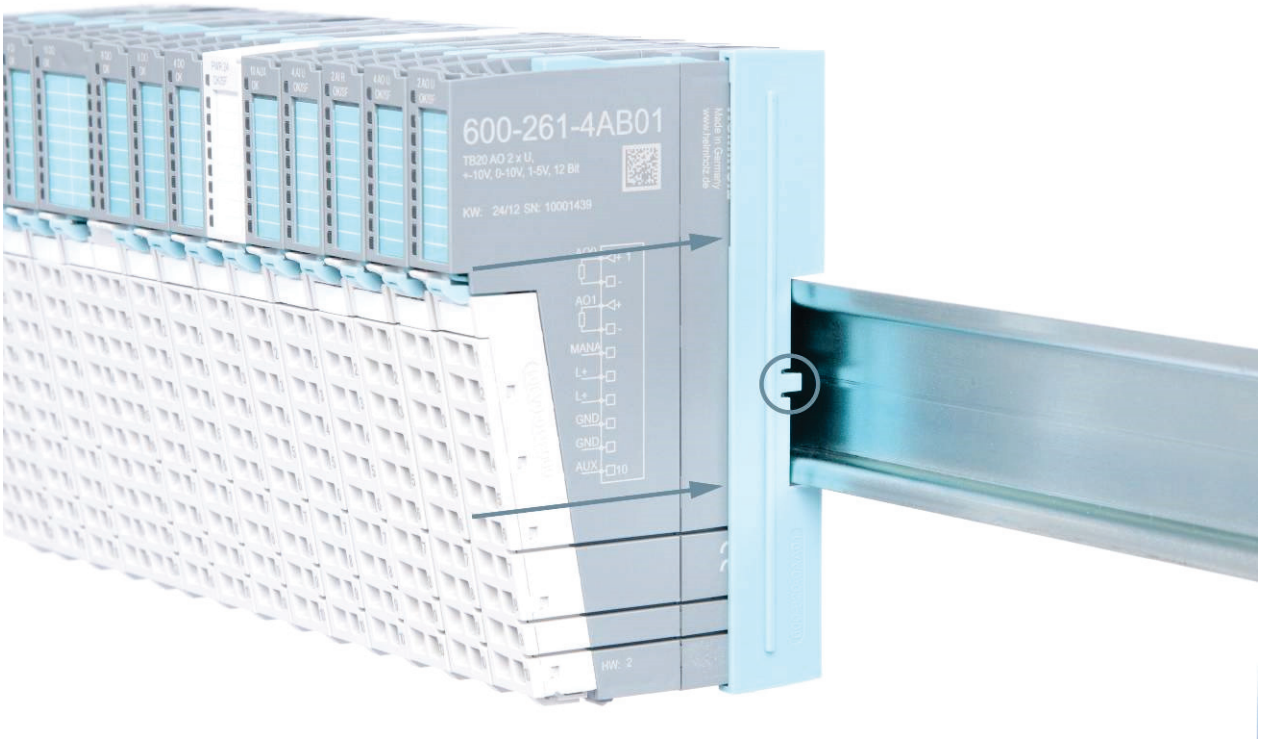
Step 4: Remove the base module

Remove the base module by pulling it towards you.

3.6. Installing and removing the final cover

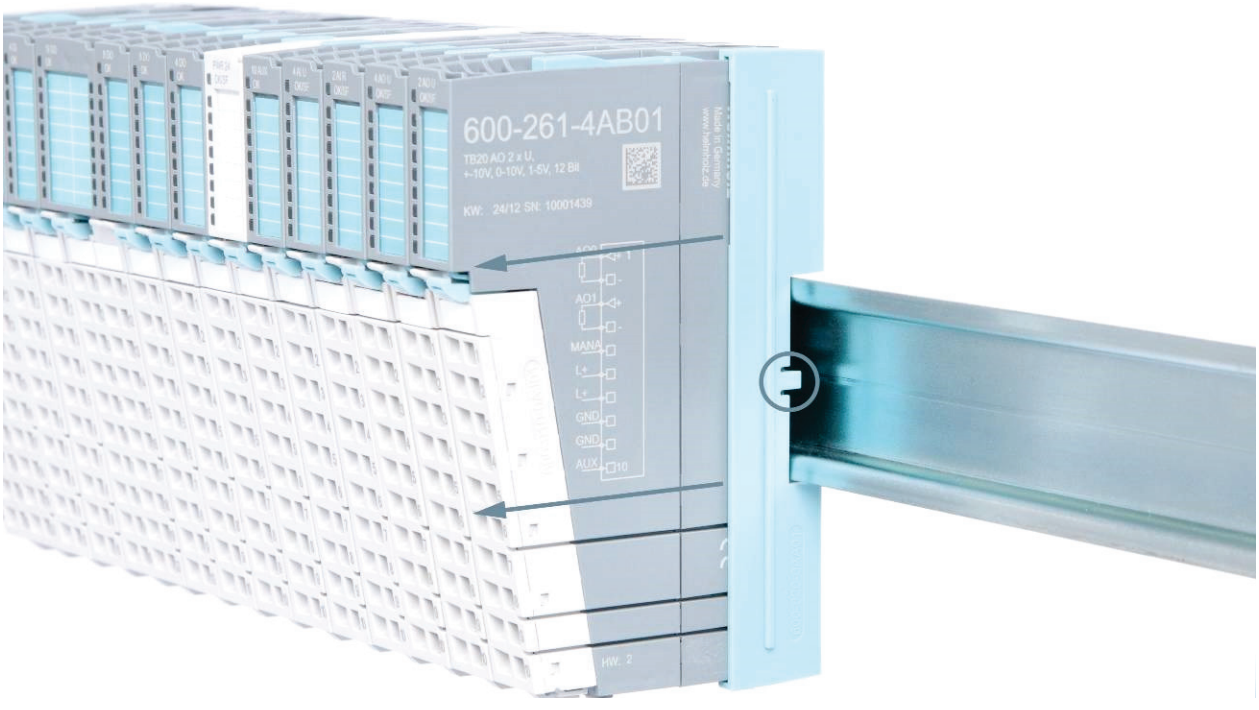
3.6.1. Installation

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.

On the one hand, the directive requires that electrical devices and equipment function flawlessly in an existing environment that exerts an electromagnetic influence within its area, and on the other hand, that said devices and equipment not 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.

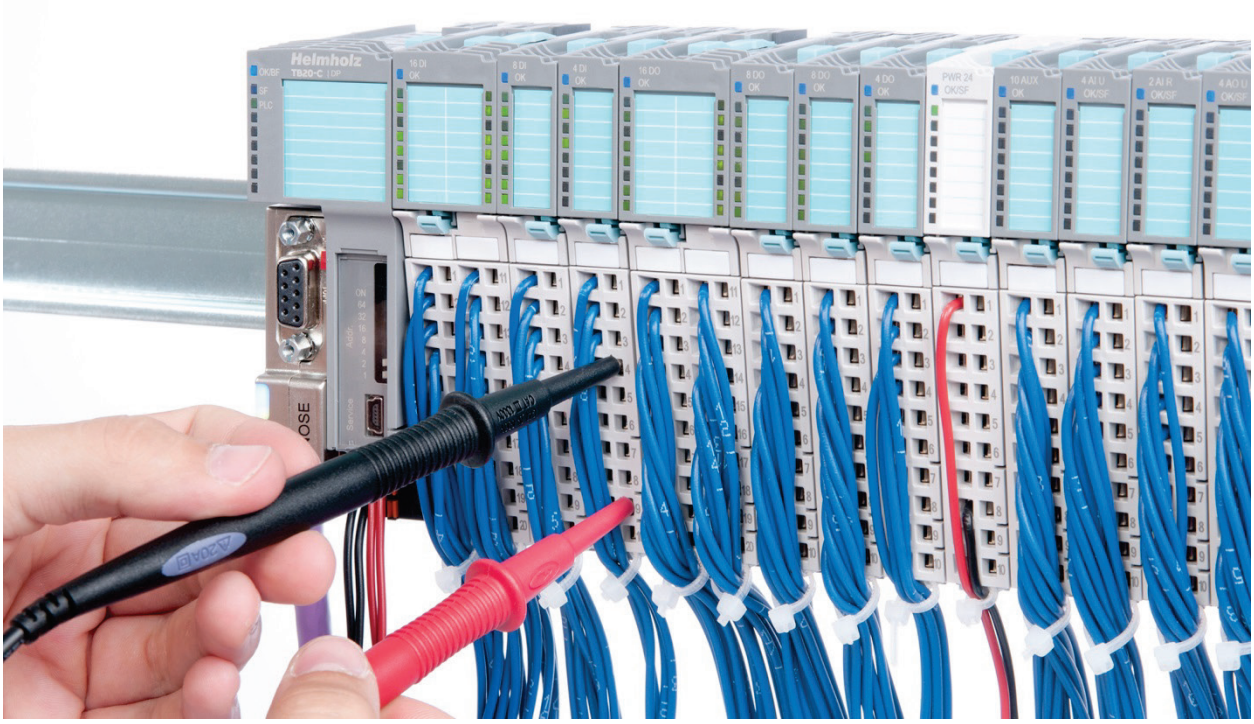
Warning

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 connector

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

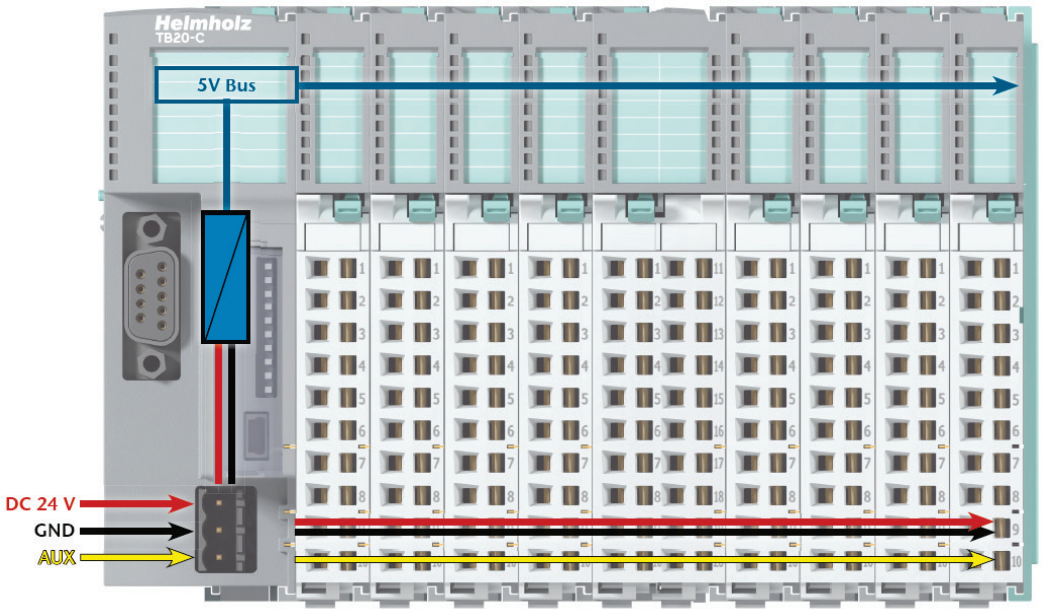
A power supply unit is integrated into the bus coupler. This unit is responsible for powering the peripheral modules connected to the coupler.

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

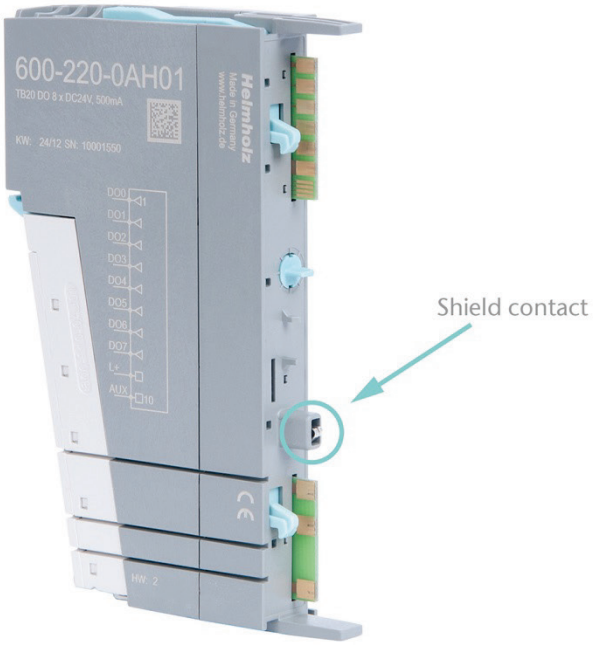
The L+ connector is used to power two buses:

- 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).

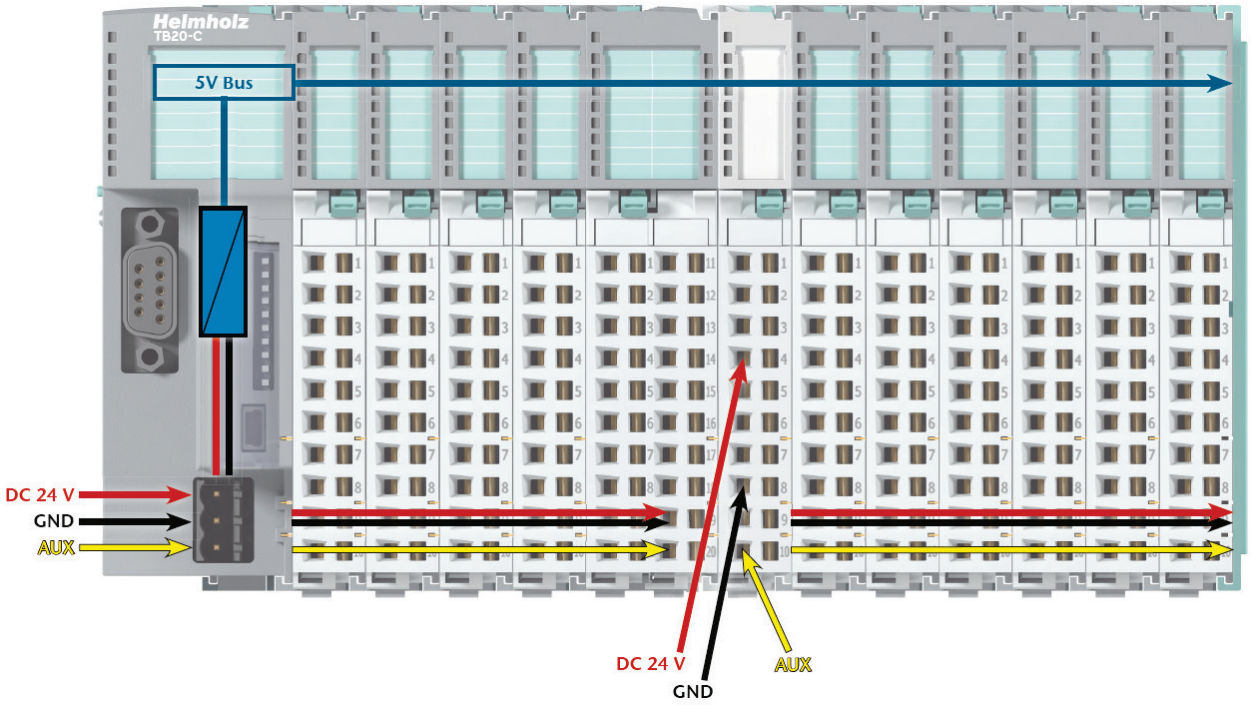


Shielding/grounding is achieved with a corresponding shield contact on the DIN rail:



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.

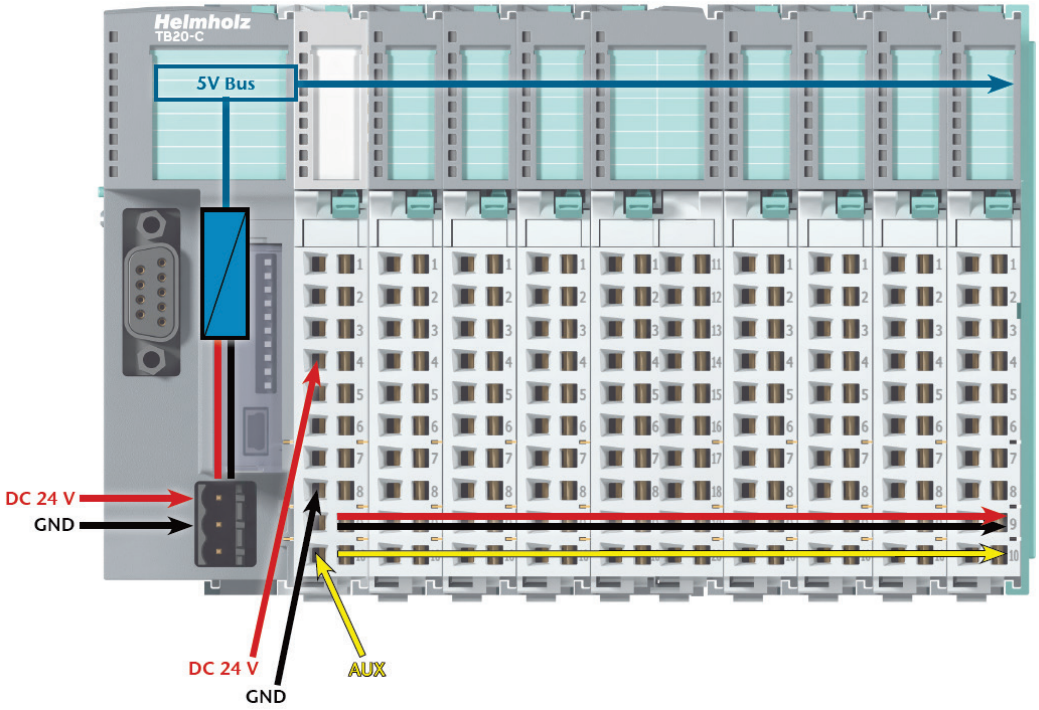


The order no. for the power and isolation module for 24 V signals is 600-710-0AA01.

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

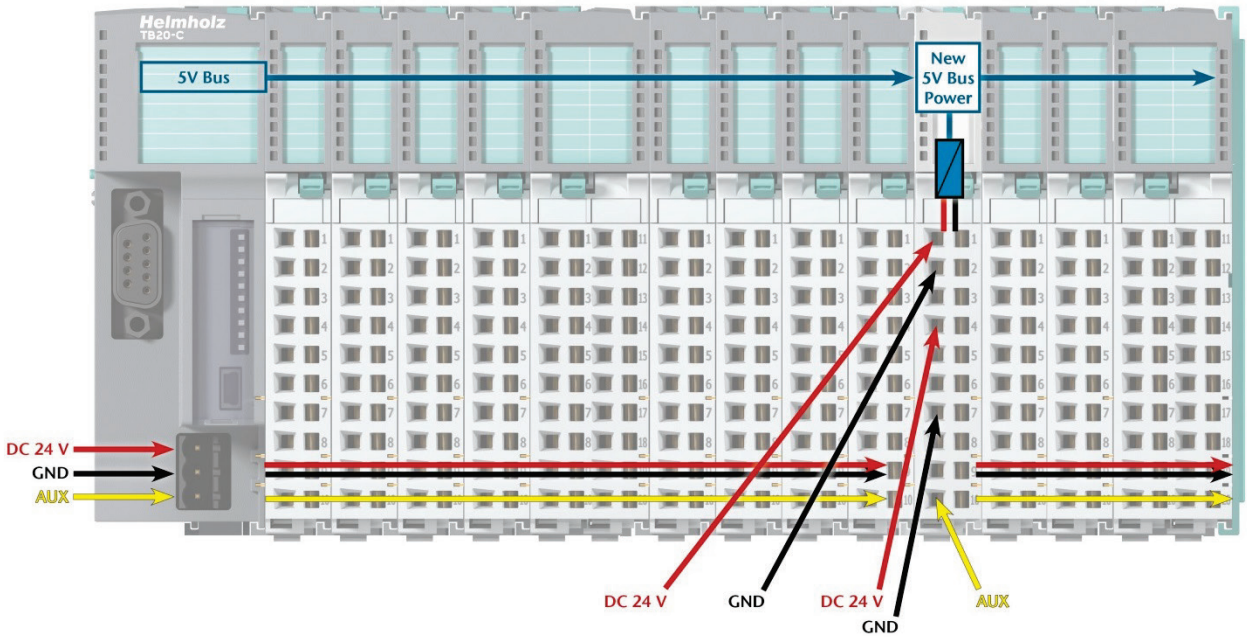
If the power supply for the coupler needs to be separate from the power supply for the I/O modules, a power and isolation module can be used right after the coupler.



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 600-700-0AA01. 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. Characteristics of the EtherNet/IP™ coupler

The TB20 EtherNet/IP™ coupler has the following characteristics:

- Use in star and bus topologies
- Support of unicast and multicast CIP connections
- Up to 511 bytes of input assembly data and up to 511 bytes of output assembly data. Easy access to assembly sizes and the structure of the memory map within the assemblies using TB20 ToolBox
- Implicit messaging (transport class 1); explicit messaging (transport class 3)
- TCP watchdog
- IP address adjustable relative to a base IP address using concealable DIP switches
- DHCP (Dynamic Host Configuration Protocol) for assigning the IP address (selectable by DIP switch)
- Integrated 2-port switch with 2 x RJ45 connectors
- Up to 64 modules can be managed on the bus
- Automatic assignment of module process data to the Ethernet/IP mapping
- Module configuration, parameterization, and diagnostics with TB20 ToolBox on the USB service port
- Replacement of modules during operation (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)
- 9 LEDs, including 3 two-tone LEDs, for module and network status
- USB service port for online diagnostics, parameter configuration, initial start-up, and firmware update with "TB20 ToolBox"
- Simulation mode for independent tests carried out by the bus operation of each module, including the module parameters via TB20 ToolBox
- Reset to factory settings using hidden switch (Factory Reset)

6. Setup and use

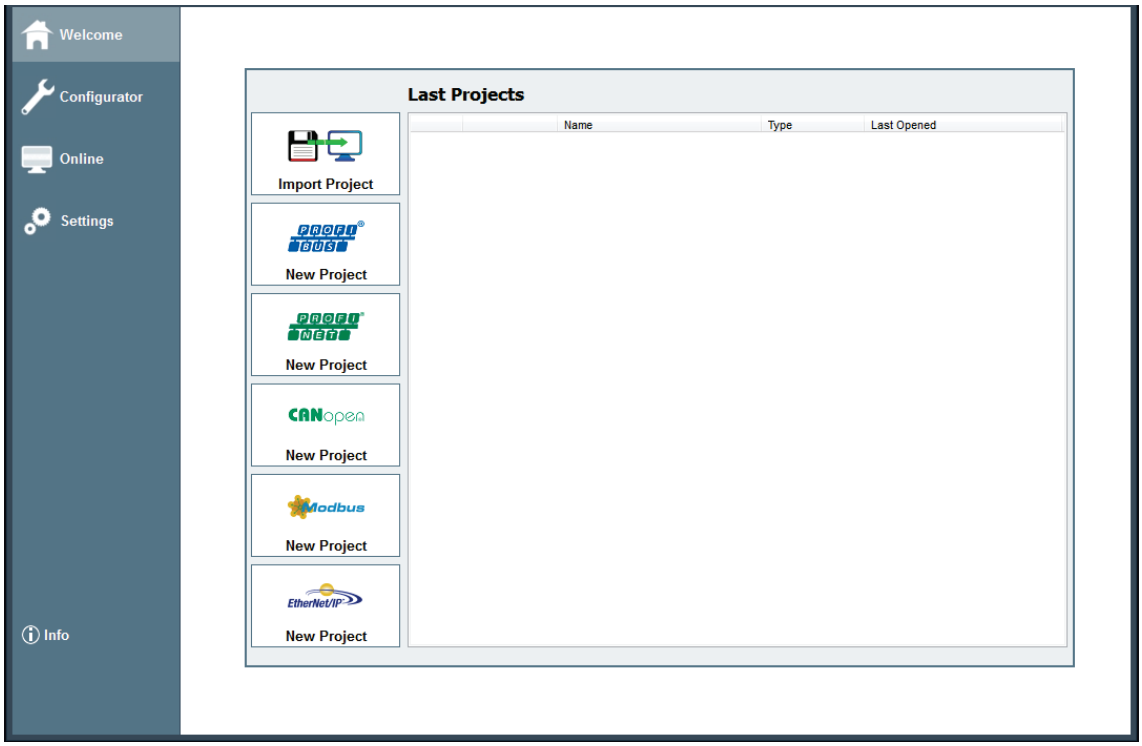
6.1. Project planning using TB20 ToolBox

Systeme Helmholz 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.helmholz.de. Installation of the ToolBox is performed with user dialogs and can be carried out on any computer with a Windows operating system (Windows XP from SP3, Windows 7 32/64bit, Windows 8/8.1 32/64bit).

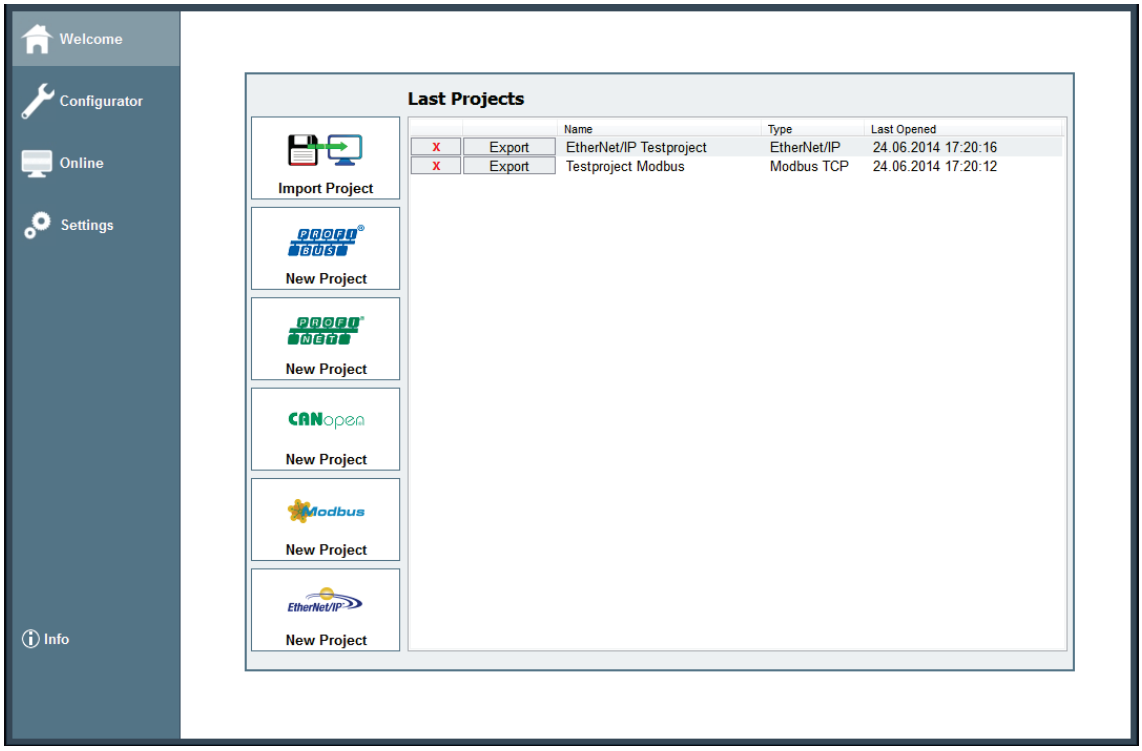
In order to conveniently configure and update the couplers and monitors, as well as monitor them in real time, you will need a standard USB 2.0 cable (Type A plug to Mini-B plug) with a maximum length of 5 m (not included).

Installation of the necessary USB driver for TB20 ToolBox is performed separately. The driver can also be found on www.helmholz.de.

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:



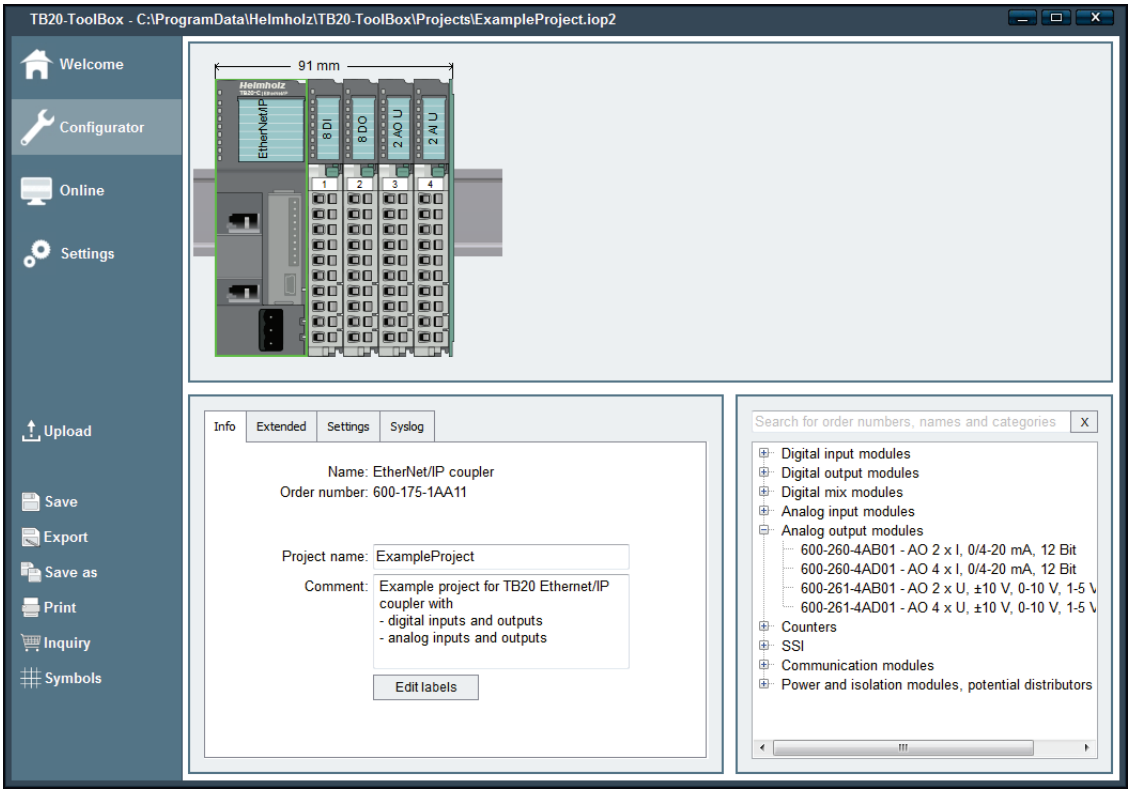
The buttons on this screen can be used to create new projects for the TB20 coupler you want or to import an existing project in the form of a file.



Each project has a name and can be opened in the project selection box with a double click.

6.1.1. Configuration screen

Once you open or create a project, the program will open the configuration screen,

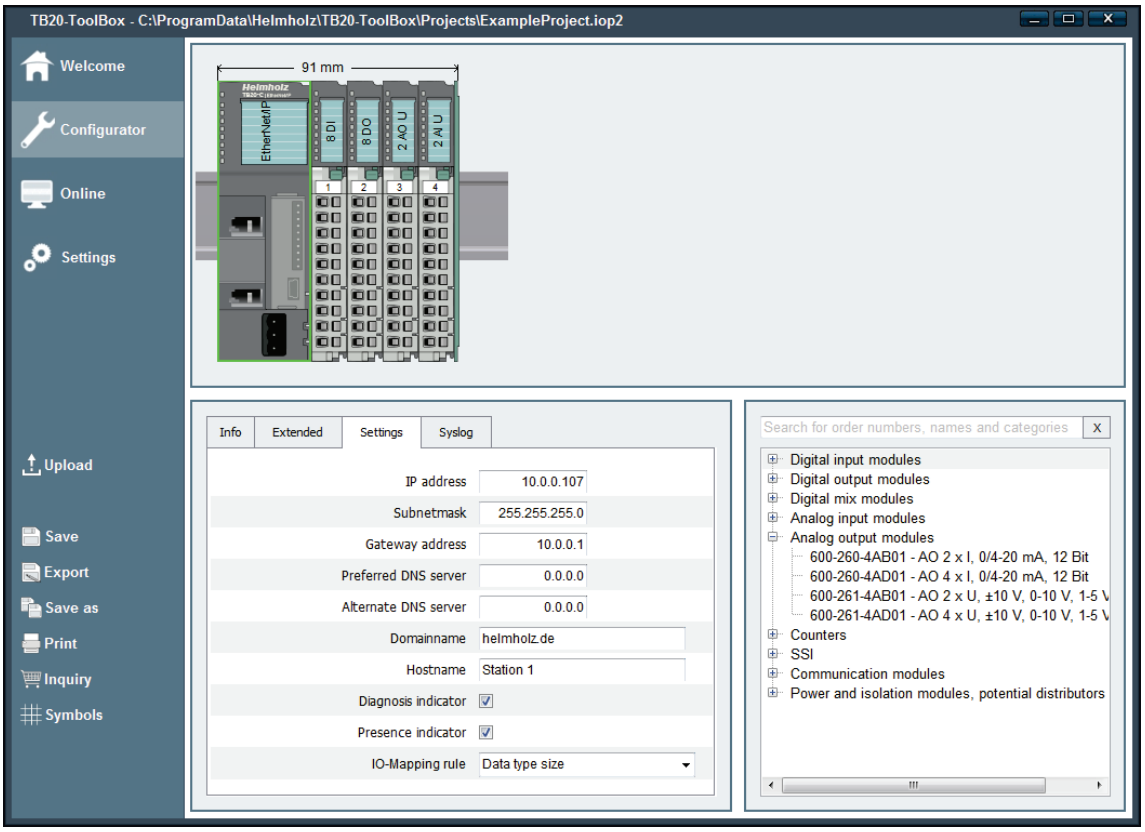


The structure view shows the selected coupler and the TB20 modules. At the bottom left, there are tabs for the module-specific information and for parameters of the selected

component. With the “Upload” button, you can activate the parameters set in the configuration and store them permanently in the device. Labels for labeling the coupler and the modules can be edited on the “Info” tab.

6.1.2. Configuration

The configuration of the TB20 coupler consists of the IP address, network mask, and gateway IP, the IP address of a preferred and an alternate DNS server, a domain name, a host name, diagnosis and presence indicators and mapping options.



The **IP address** indicates the address under which the coupler is to be reached on the IP network.

The **subnet mask** is a bit mask indicating which part of the IP address the network prefix represents. In conjunction with the IP address of the device, the subnet mask defines which IP addresses the coupler looks for in its own network and which it can reach via routers/gateways in other network segments.

The **gateway address** is required if the coupler is to communicate with devices that are not in the same network segment. If this is not the case, “0.0.0.0” can be used as the gateway.

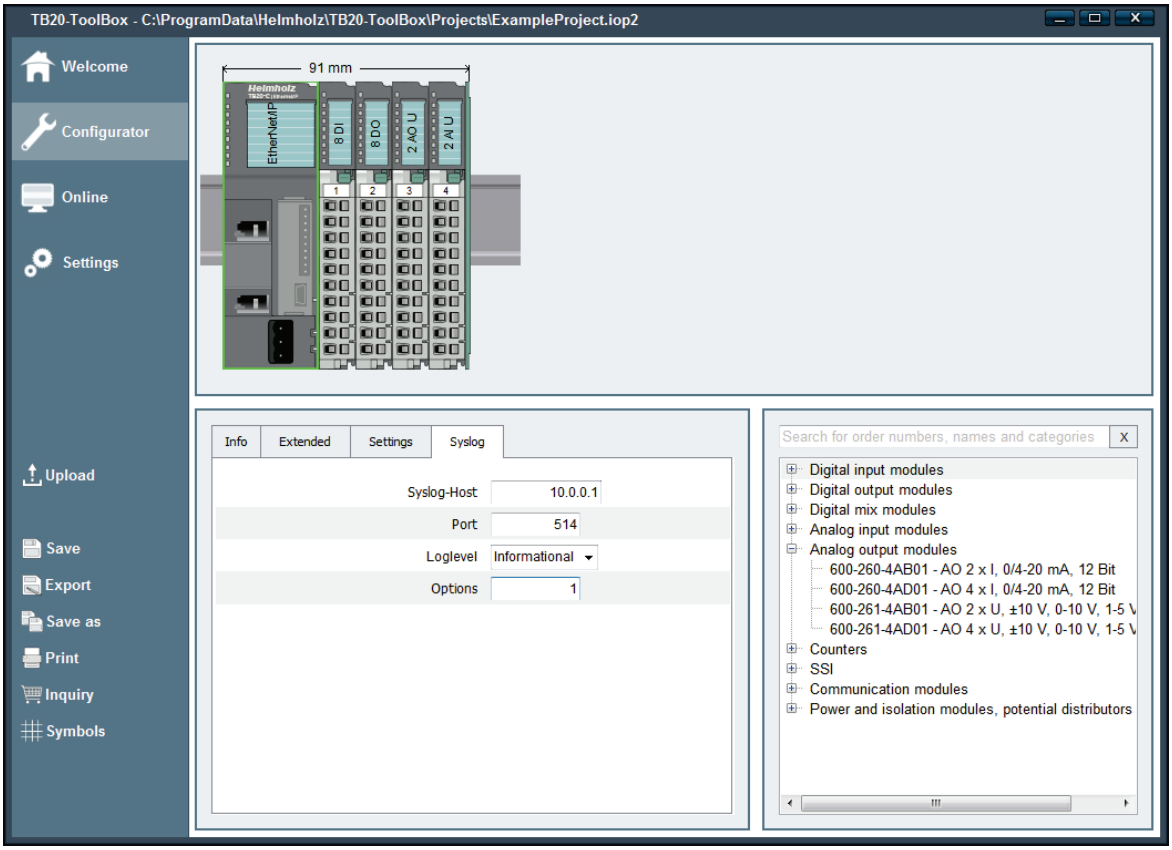
The two items of information in regard to the DNS server (name server) so far have no function. They should be set to “0.0.0.0”.

The **domain name** and **host name** also have no function. However, they can be set and retrieved as attributes of the CIP™ identity instance.

For **presence and mapping indicators** refer to chapter 7.2.2.
For **mapping options** refer to chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.

6.1.3. Syslog

Syslog (RFC 3164) is available for tracking relevant events. Syslog allows log messages to be sent via UDP to another computer on the IP network, where they can be provided with a time stamp and kept available. You can configure the host and port of the syslog server and what types of messages are to be sent. The sending of syslog messages can also be turned on and off.



Syslog host specifies the IP address of the computer on which a syslog service is running.

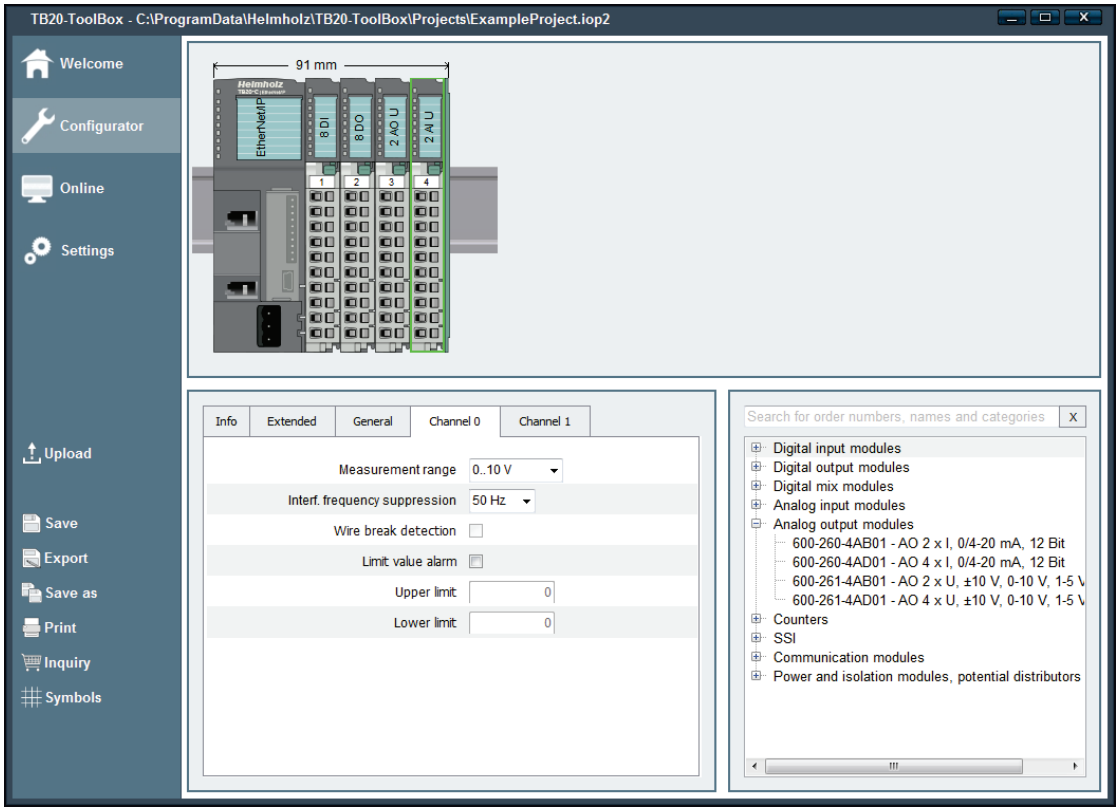
The **port** specifies the UDP port on which the syslog service receives messages. Usually port 514 is used.

The **log level** specifies which messages are sent to the syslog service. The selection is performed on a graduated basis, that is, in the less critical messages, the more critical messages are already included. In normal operation, no more than “warnings” should be necessary.

Options can be used to enable and disable sending of log messages. Enter “1” to enable and “0” to disable.

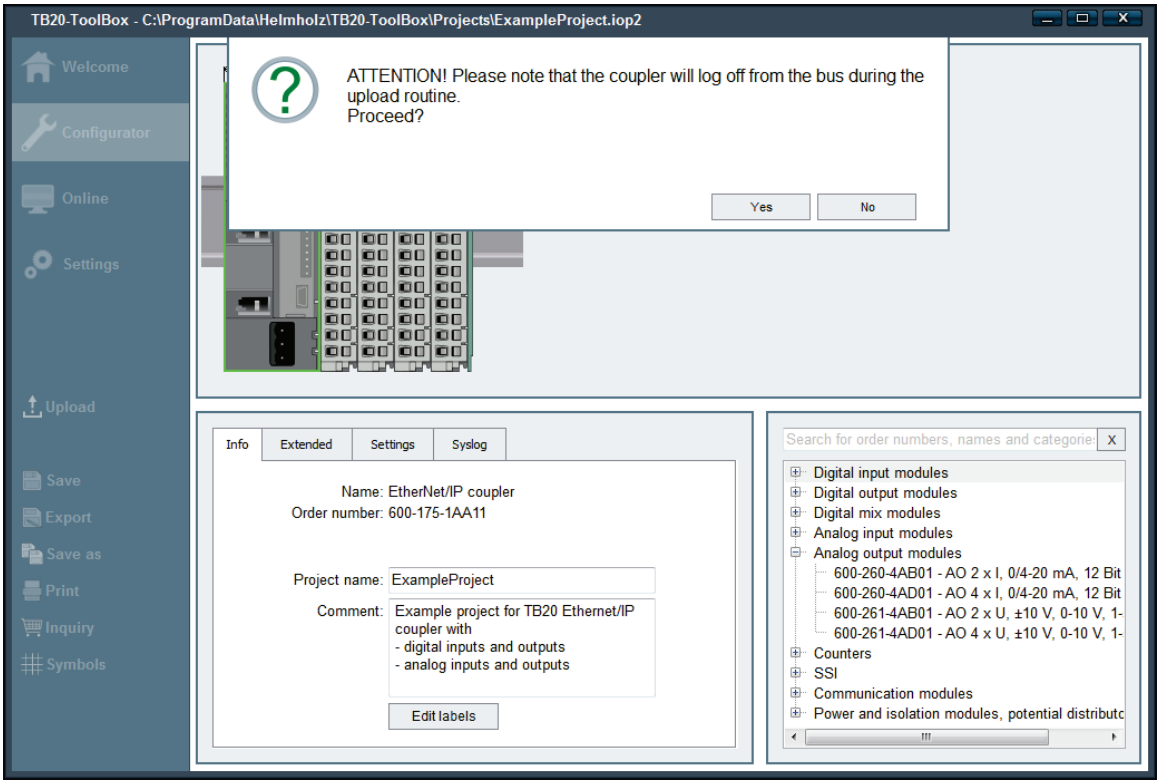
6.1.4. Setting parameters for the I/O modules

Parameters can be set for a module by clicking on them in the structure view. Tabs appear in which specific settings can be made for modules for which parameters can be set.



6.1.5. Transferring the configuration

After all settings have been made in the coupler and the modules, you transfer and save this configuration on the coupler using the upload button.



6.1.6. Other configuration functions

The data of the project created can be exported as a file using the **Export** button in order to send it by e-mail or archive it, for example.

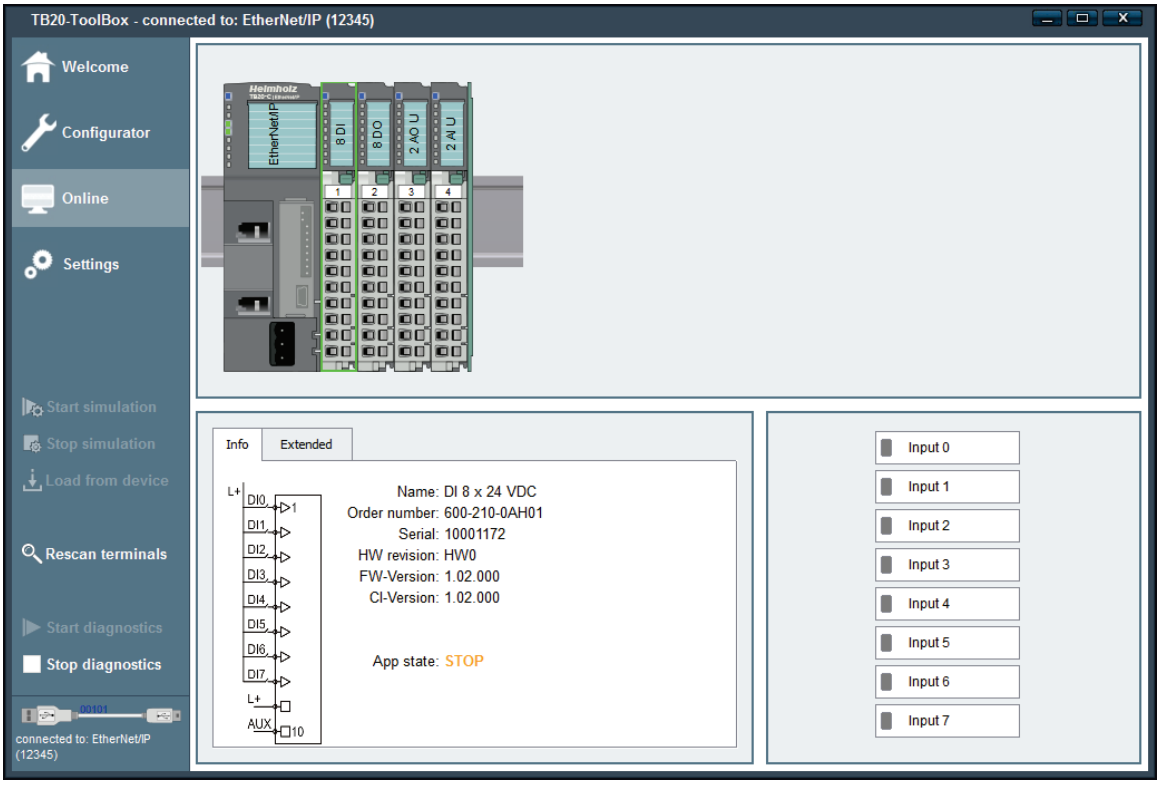
Clicking **Print** will open a selection field that will enable you to print either the labels you created or all documentation concerning the project.

Finally, the **Inquiry** function can provide you with a list of all the project components in the form of a CSV file that you can export, print out as a fax form, or send directly to Systeme Helmholz GmbH's Sales Team by e-mail.

6.1.7. Online diagnosis

The online diagnosis function is available as soon as the appropriate TB20 hardware is connected to the PC using a USB cable. This function not only provides simulation mode and firmware update options but can also be used to import the project stored in the coupler module by clicking “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 are shown visually on the structure view. After you select a module, the app status is displayed in the info box. In the I/O diagnostics box (bottom right), input and output values are displayed.



6.1.8. Simulation mode

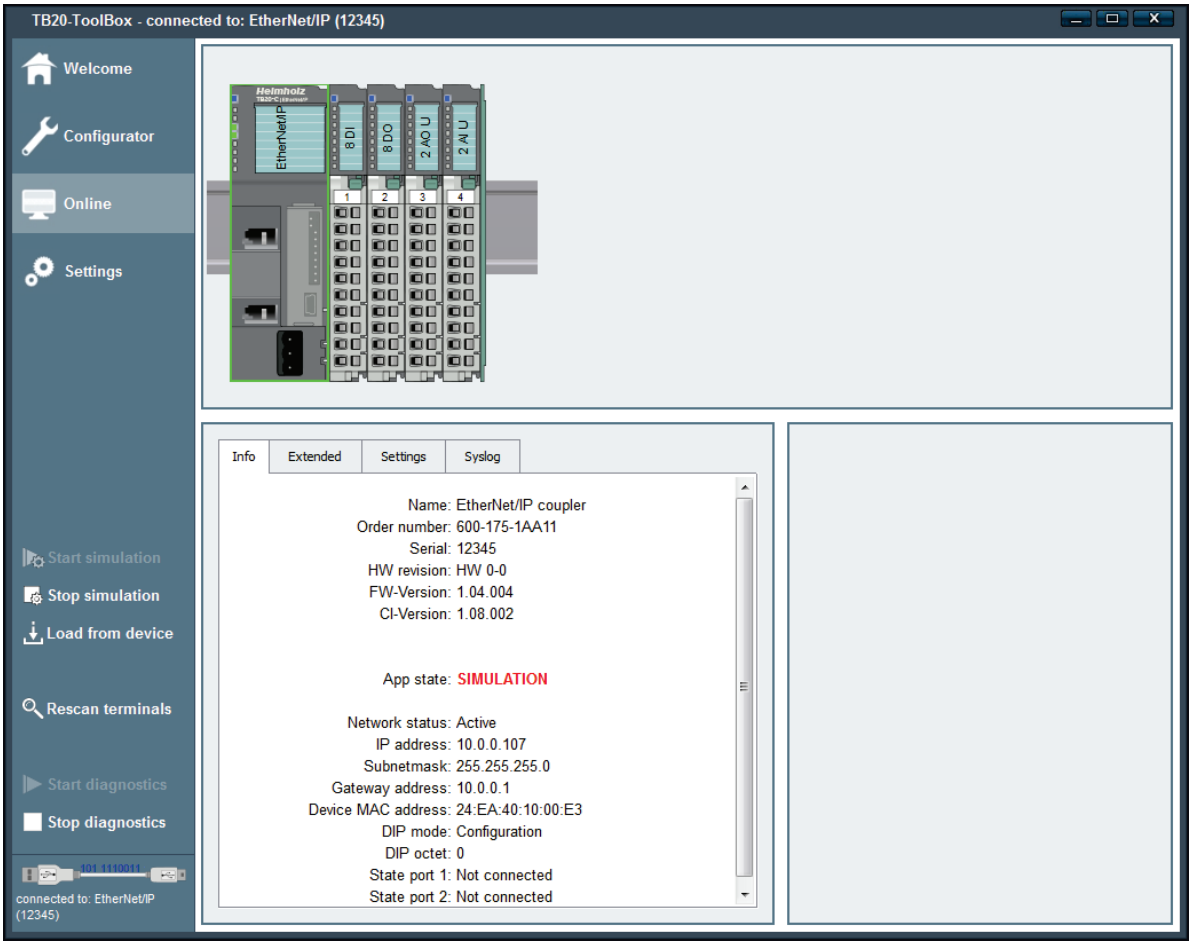
For inspection of a TB20 structure, the coupler supports a simulation mode. In simulation mode, the outputs of the modules can be checked directly with TB20 ToolBox. Simulation mode is indicated by rapid flashing of the green “PLC” LED.

Bus mode and simulation mode are mutually exclusive:
As long as the coupler is in simulation mode, no CIP connections can be established. Write access to the memory map through assembly instances is also not possible.

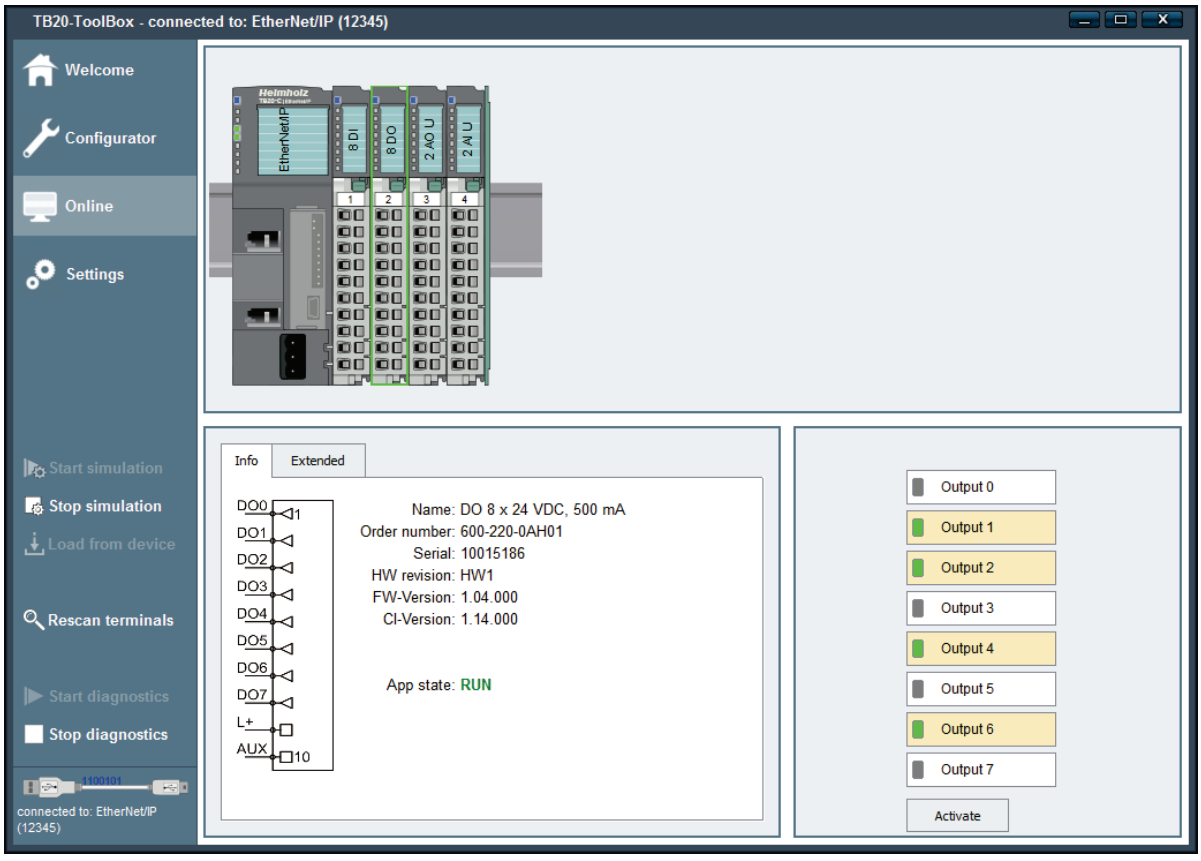
When you switch to simulation mode, the previous module configuration and module parameter settings are applied. Changes to module parameters during simulation mode are not applied automatically.

For simulation mode, the coupler must be in operating condition (see “Module configuration”). Replacement of modules (see “Replacing modules”) is also possible in simulation mode.

Upon cancellation of the USB connection to TB20 ToolBox, the coupler exits simulation mode.

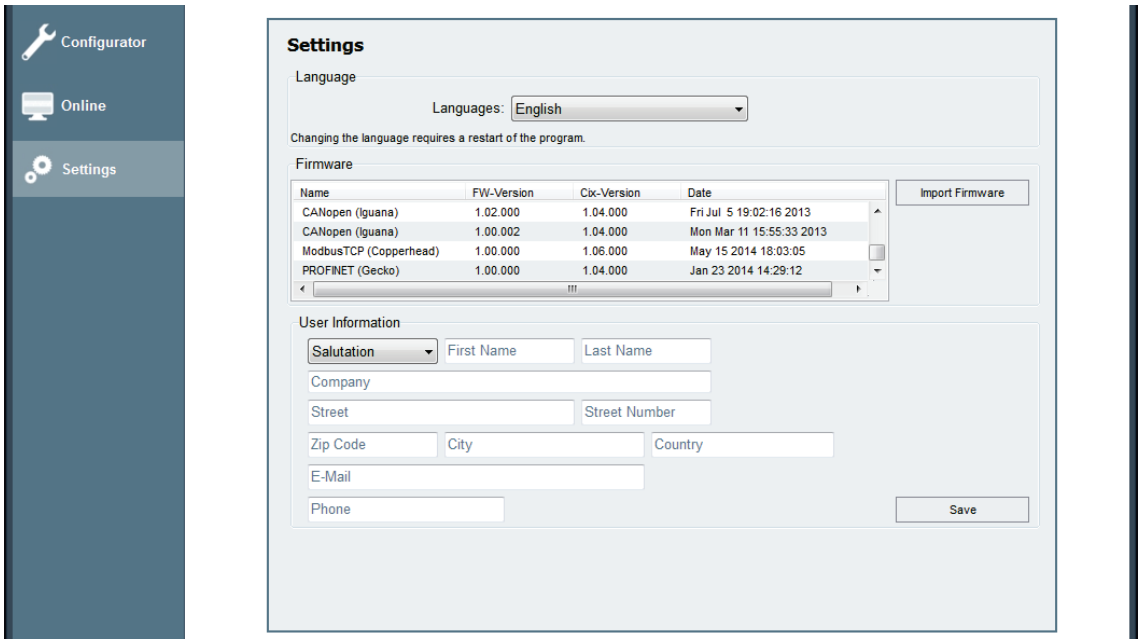


Output values of all modules can be changed in simulation mode.

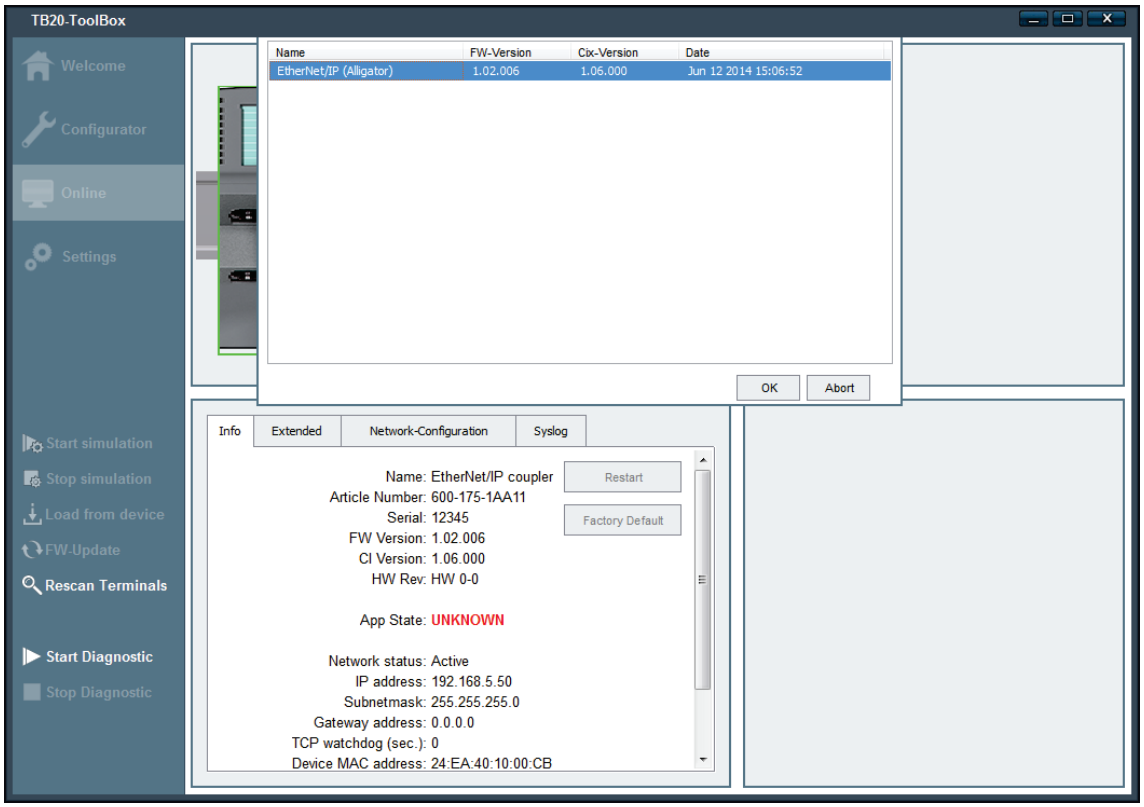


6.1.9. Firmware updating

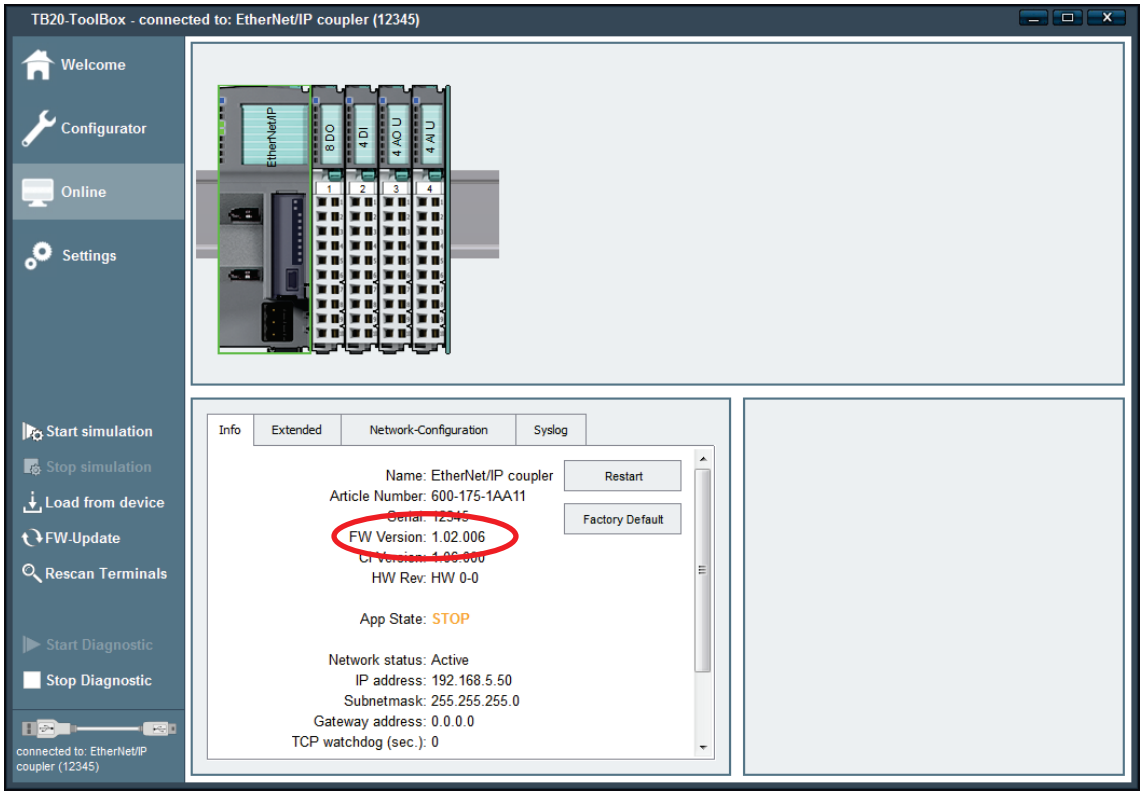
With installation of TB20 ToolBox, the latest coupler firmware is available for updating via USB connection. The TB20 ToolBox software can be downloaded from the download area at www.helmholz.de. To get an overview of the firmware files currently available, click the "Settings" menu option.



Firmware can only be uploaded in online mode. Clicking 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 "OK."



A progress bar will indicate the transfer's progress. Once the update is successfully completed, in Online mode the new firmware version is displayed in the info box.

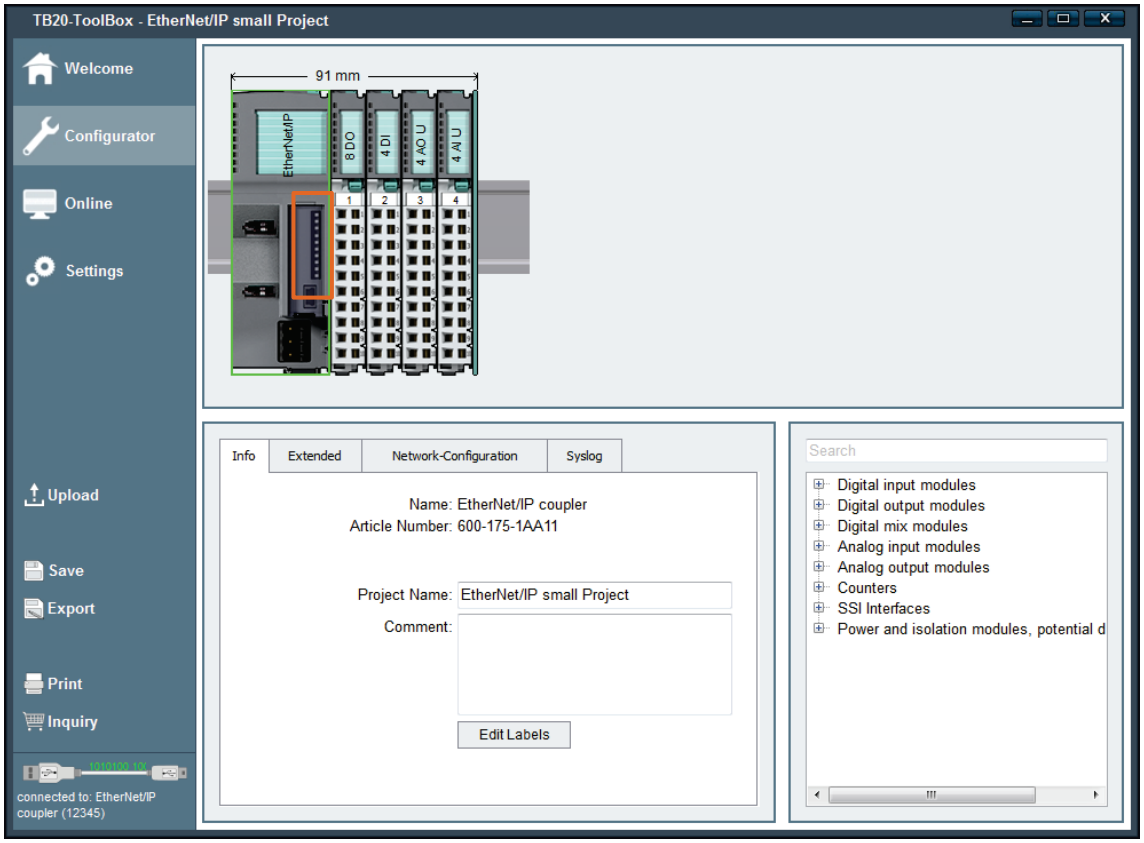

TB20-ToolBox - connected to: EtherNet/IP coupler (12345)
Welcome
Configurator
Online
Settings
Start simulation
Stop simulation
Load from device
FW-Update
Rescan Terminals
Start Diagnostic
Stop Diagnostic
connected to: EtherNet/IP coupler (12345)
EtherNet/IP
8 DO
4 DI
4 AO U
4 AI U
1
2
3
4
Info
Extended
Network-Configuration
Syslog
Name: EtherNet/IP coupler
Article Number: 600-175-1AA11
Serial: 12345
FW Version: 1.02.006
CI Version: 1.00.000
HW Rev: HW 0-0
App State: STOP
Network status: Active
IP address: 192.168.5.50
Subnetmask: 255.255.255.0
Gateway address: 0.0.0.0
TCP watchdog (sec.): 0
Restart
Factory Default

6.3. DIP switches

In addition to the values configured with Toolbox, the DIP switches located on the front of the Ethernet/IP™ coupler can be used to influence the network configuration directly on the device. There are two DIP switches that allow the configuration mode to be set in binary format. They have the following meaning:

Value/mode	Meaning
0	IP address, network mask, and gateway IP are determined via DHCP
1	The configuration saved in the device is used with the numerical value (eight DIP switches) as the last octet of the IP address
2	*Reserved*
3	The configuration saved in the device is used

Eight other DIP switches are used in mode 1 to overwrite the lowest byte of the network address configured in the device. This allows a new network address to be set without use of TB20 ToolBox being necessary.



6.5. Startup flow

The three following events will all trigger a TB20 EtherNet/IP™ coupler (re)start.

1. Power on
2. “Restart” command from TB20 ToolBox
3. Module configuration change

The TB20 IO system can be in three different states:

IDLE: TB20 is not yet ready to operate

STOP: TB20 is ready to operate, but the outputs are inactive or have replacement values

RUN: TB20 in cyclic operation, outputs are switched, inputs are read

The condition of the coupler or the module can be read from the operating LEDs (see also section 6.8.1 and 6.8.2).

There are two different possible startup flows for the TB20 EtherNet/IP™:

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 initially waits for a complete module structure; startup is not possible with a gap in the module structure or a faulty module assignment, and the coupler switches to **IDLE**.

Note

In cases where the modules actually available do not match the configured modules, the status LEDs of the modules indicate which modules are inserted incorrectly. Properly inserted modules flash slowly. From the position of the first incorrectly inserted or missing module, all modules flash rapidly. For this reason, you should search for the incorrect modules from left to right.

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, and the coupler goes into **STOP** mode and is ready for operation. Once an exclusive owner connection is established and the RUN/IDLE flag included in the IP data has the value for RUN, the coupler switches to **RUN**. This always happens when the PLC is switched to RUN, after which all mapping assignments can be read and written to.

Startup flow 2: There is no project in the non-volatile memory of the coupler or the coupler has been reset to factory settings. The coupler reads the list of modules from the backplane bus. The result can be read with the Toolbox by clicking the button “Load from Device”.

1. The coupler carries out a basic initialization routine and assigns all required addresses
2. The coupler scans the modules

Note

This behavior can be used for configuration using the Toolbox in order to avoid having to carry out the configuration of the modules manually.

The coupler switches into **IDLE** regardless of the module structure and cannot switch to **RUN** or **STOP** unless a project has been transferred to the non-volatile memory of the coupler.

6.6. Replacement of modules during operation (hot plugging)

The coupler supports replacement of modules during operation (hot plugging). However, no more than one module should be unplugged. Once a module is removed, the coupler returns the value 0 for all inputs.

The coupler remains operational as long as no more than one module is removed. Removal of more than one module leads to termination of CIP connections with all EtherNet/IP scanner devices. Establishing a new CIP connection is only possible when the coupler is ready for operation, that is, when all configured modules are again plugged in.

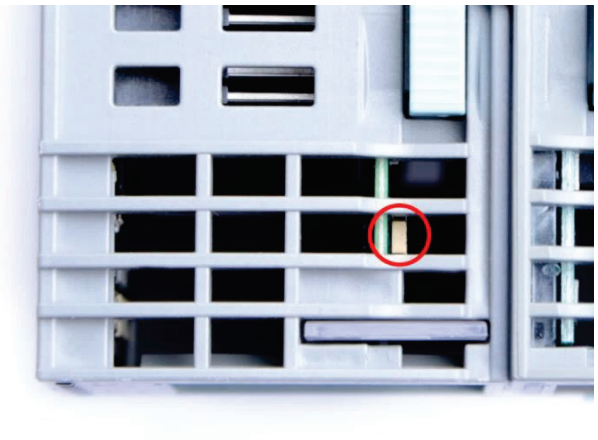
Attention

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

6.7. Resetting to factory settings

There is a hidden button on the top of the coupler. The coupler can be reset to factory settings by holding down this button during power up and then releasing it.

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 device is being powered up. 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.

Resetting to factory settings can also be accomplished in TB20 ToolBox.

6.8. Diagnosis using LED indicators

6.8.1. Diagnostic LED indicators of the EtherNet/IP™ coupler

Overview of the diagnostic LED indicators

There are three groups of LEDs:

The first group includes the usual LEDs for the TB20 product line:

- Blue/red **OK/BF** LED for the coupler status
- Yellow **SF** LED for backplane bus error
- Green **PLC** LED for the status of the PLC

The second group consists of the LEDs specified for EtherNet/IP™ devices:

- Red/green **MS**
- Red/green **NS**

The third group provides diagnostic information on the level of the Ethernet connection:

- 2x yellow P1 L / P2 L
- 2x green P1 Sp / P2 Sp

Meaning of the diagnostic LED indicators

The blue/red "**OK/BF**" LED indicates the basic status of the coupler.

Status	Summary	Meaning
Steady blue	Coupler ready for operation	When the coupler has correctly detected the backplane bus.
Flashing blue	Coupler waiting for the backplane bus	If the backplane bus does not have a defined status after a restart/reset, for example, there is a gap in the structure or the structure does not match the stored structure, then the coupler is not ready for operation.
Flashing red	Fatal error	An internal fatal error has occurred. Please contact our support team.
Off	No power	The indicator goes out only if the device has no power

The yellow "**SF**" LED indicates system failure errors. It is used to diagnose problems on the backplane bus:

Status	Summary	Meaning
Off	No error	If there is no error on the backplane bus, the indicator is off
Steady yellow	Incorrect module types	If the wrong module types are plugged into the backplane, the indicator illuminates steady yellow
Flashing yellow	Modules are missing, a module is removed	If the backplane bus modules are missing or a module has been removed, the indicator blinks yellow

The green "**PLC**" LED is used to indicate the status of the PLC:

Status	Summary	Meaning
Off	Unknown status	The status of the PLC cannot be determined (not yet connected to a PLC)
Steady green	PLC in RUN mode	The PLC is in the "RUN" status
Flashing green	PLC in STOP mode	The PLC is in the "STOP" status
Quickly flashing green	Simulation mode	The outputs of the coupler are monitored by TB20 ToolBox

The red/green "**MS**" indicator displays the module status. It shows the overall status of the coupler:

Status	Summary	Meaning
Off	No power	If the device has no power, the indicator is off
Steady green	Device in operation	When the device is fully ready for operation, the indicator lights up steady green
Flashing green	Standby	If the device has not been configured, the indicator flashes green
Flashing red	Minor error	If the device has detected a recoverable minor error, the LED flashes red. An incorrect or inconsistent configuration is considered a minor fault.
Steady red	Major error	If the device has detected a non-recoverable major error, the indicator lights up steady red
Red/green, flashing	Self-test	During the self-test after powering up, the indicator flashes red/green

The red/green "**NS**" indicator displays the network status. It shows the status of the network interface of the coupler:

Status	Summary	Meaning
Off	No IP address	If no IP address is configured for the device, the indicator is off
Flashing green	No connections	If an IP address is configured, but no CIP connection is established, the indicator flashes green
Steady green	Connected	If at least one CIP connection is established and no exclusive owner connection has a timeout, the indicator lights up steady green
Flashing red	Connection timeout	When an exclusive owner connection whose target is the device has a timeout, the indicator flashes red. The display does not change back to steady green until all exclusive owner connections have been re-established
Steady red	IP address already assigned	If the device detects that the configured IP address is already assigned, the indicator lights up steady red
Red/green, flashing	Self-test	During the self-test after powering up, the indicator flashes red/green

The yellow **"P1 L"** / **"P2 L"** indicator shows whether port 1/2 is connected and whether the data exchange is working on the IP level:

Status	Summary	Meaning
Off	No network connection	The port is no longer connected to the network
Steady yellow	Network connection	The port is connected to the network
Flashing yellow	Network connection and data traffic	The port is connected to the network and data is being sent and received

The green **"P1 Sp"** / **"P2 Sp"** indicator shows the speed of the connection for port 1/2:

Status	Summary	Meaning
Off	10 Mbps	Data is being transmitted at 10 Mbps
Steady green	100 Mbps	Data is being transmitted at 100 Mbps

6.8.2. Diagnostic LED indicators of the modules

The topmost OK/SF LED on every module indicates the module's current system status.

Solid blue light: Module is in **RUN mode**

Slowly flashing blue light: The module is in **STOP mode**; substitute values (if any) are being applied

Quickly flashing blue light: The module is in **IDLE mode**; 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 lights will only be shown on modules with configurable parameters or diagnostic capabilities.

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).

7. EtherNet/IP™ functionality and mapping

7.1. Introduction

The EtherNet Industrial Protocol (EtherNet/IP™ or EIP) is an Ethernet-based fieldbus which is mainly used in automation technology.

EtherNet/IP™ is an open industry standard based on a method for using the Common Industrial Protocol (CIP) on Ethernet.

The Common Industrial Protocol (CIP) is a network- and transfer media-independent protocol for automation applications that supports the transition of fieldbusses to Industrial Ethernet and IP networks.

A unicast connection is the transfer of messages between a transmitter and a single receiver.

A multi-cast connection is the transfer of messages between a transmitter and a group of receivers.

7.1.1. EDS file

EtherNet/IP™ uses EDS (Electronic Data Sheet) files as device description files. In addition to basic information such as the manufacturer and version of the device, it can include information about the supported CIP™ objects (attributes and methods). The EDS file for the EtherNet/IP™ TB20 coupler is available for download at www.helmholz.de. It is used for projecting tools such as RSLogix / Studio 5000 (Rockwell Automation, Inc.).

7.1.2. Application options

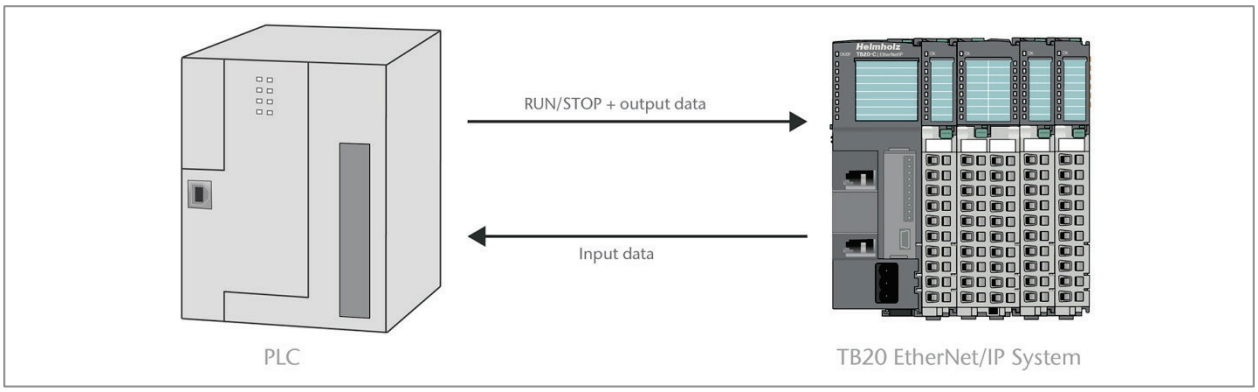
The TB20 coupler can be used in a variety of application options. These are listed in the EDS file as “Connection” and can therefore also be used very easily in project planning when the EDS file is used.

In terms of EtherNet/IP™, the coupler is a communication adapter. For programmable logic controllers (PLCs) and production data acquisition systems, scanner is used as the generic term.

7.1.3. Exclusive owner connection

In this application option, the scanner is the exclusive owner of the coupler, that is, it alone controls the outputs. The input values can be sent to the scanner either as unicast or multicast.

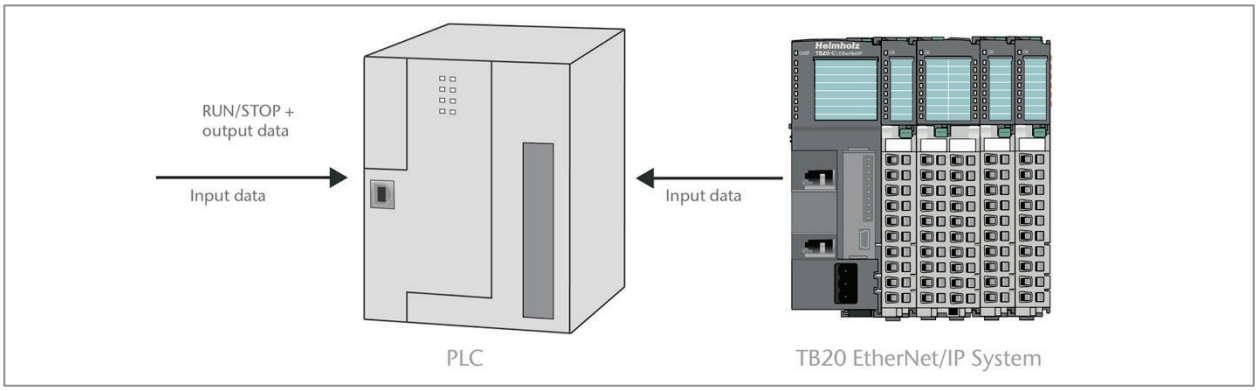
The scanner is typically a PLC.

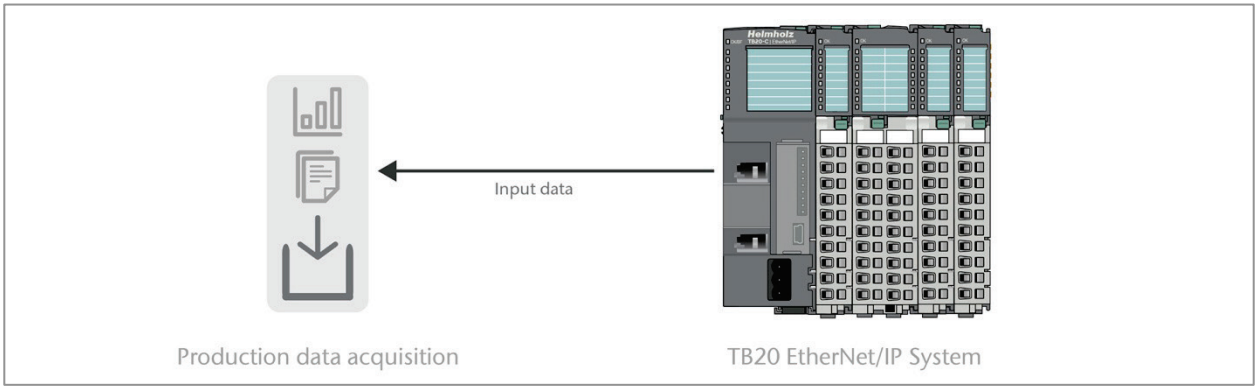


7.1.4. Input-only connection

In this scenario, the scanner cannot control the outputs; it only receives the input data of the coupler. The input values can be sent to the scanner either as unicast or multicast.

Often the scanner involves systems for production data acquisition.

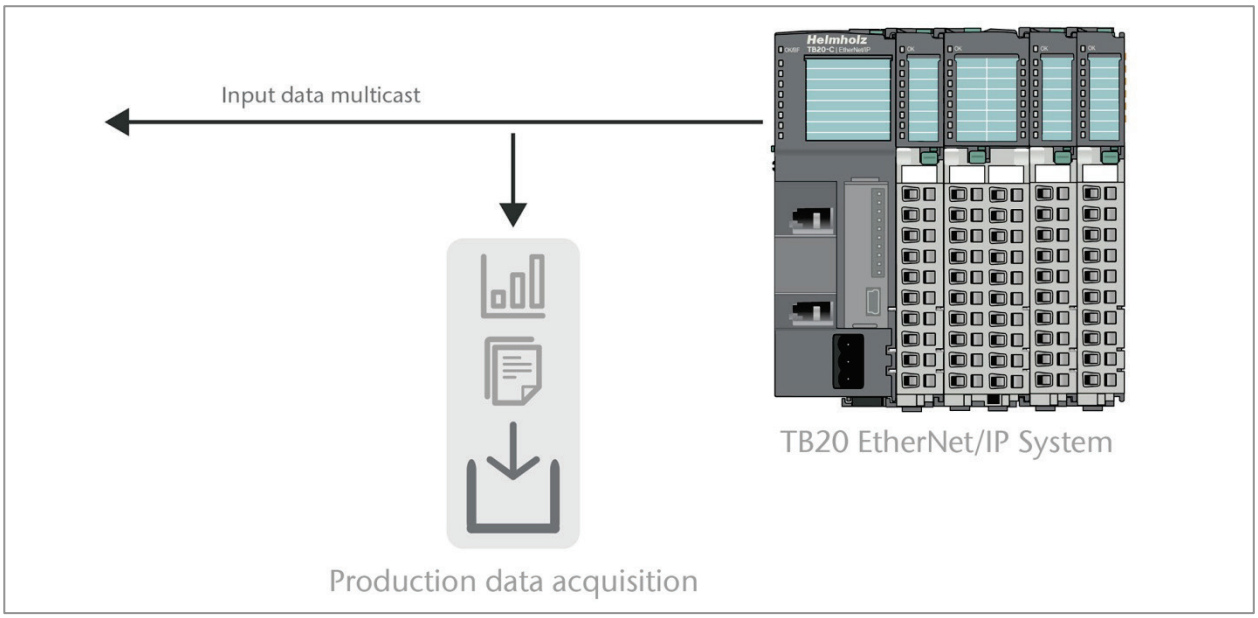




7.1.5. Listen-only connection

In this scenario, the scanner cannot control the outputs; it only listens to the input data sent to another device as multicast. This means establishing a listen-only connection requires an existing multicast connection (exclusive owner or input only).

Usually the scanner involves systems for production data acquisition.



7.2. Mapping of I/O data

The I/O data is mapped in EtherNet/IP™ by what are known as assembly instances. The mapping is unambiguous and occurs automatically.

7.2.1. Attributes of the assembly instances

Attribute ID	Access	Name	Data type	Description
3	Get/Set	Data	ARRAY OF BYTE	Memory map
4	Get	Size	UINT	Size of the memory map in bytes

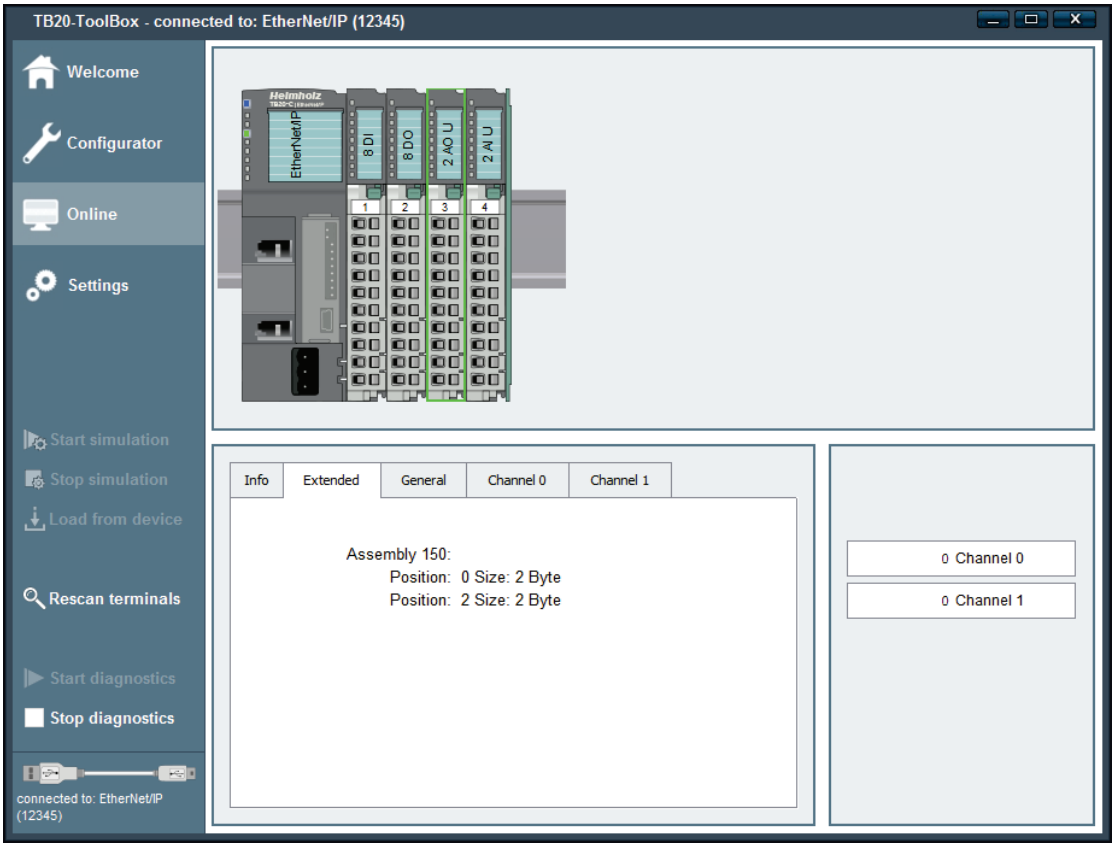
The memory map and its size can be queried with Get_Atttribute_Single (0x0E). The memory map of assembly 150 can also be changed with Set_Attribute_Single (0x10).

7.2.2. Static assembly instances

Instance 100 (0x64) – read input data

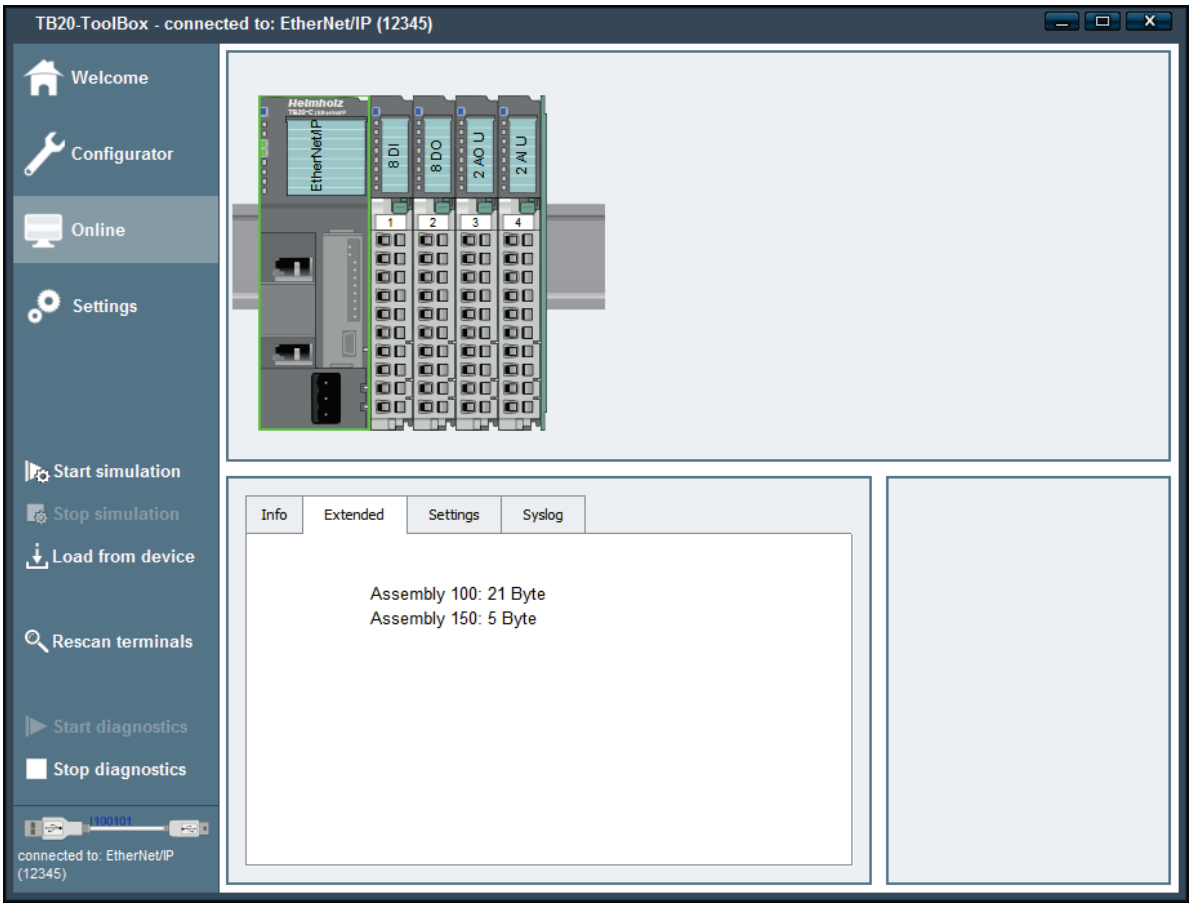
Read access to digital and analog input data is available through this assembly.

The relative position in the memory map and the size of the input data of a module are displayed in TB20 ToolBox on the “Extended” tab of each module.



The size of the memory map depends on which modules are plugged in. Information on the size and format of the input data of the modules can be found in the manual of the respective TB20 module. 16- and 32-bit values are shown as “Big Endian”. Here, the byte with the highest value is stored first, that is, at the smallest memory address.

The total size of the memory map in bytes is indicated by the TB20 ToolBox “Extended” tab of the coupler.



The total size can also be queried with attribute 4 of assembly 100.

The maximum size of the assembly is 511 bytes.

Diagnosis indicator:

When the option “diagnosis indicator” is activated a 64bit (8 byte) sized area is mapped to the beginning of assembly 100, containing the diagnosis status of a module in its respective bit.

0 = No pending diagnosics

1 = Pending diagnostics

Presence indicator:

When the option “diagnosis indicator” is activated a 64bit (8 byte) sized area is mapped to the beginning of assembly 100. Each bit represents the connection status of a module.

0 = no or wrong module connected to this slot

1 = module detected and checked

Read/write instance 150 (0x96) output data

Read and write access to digital and analog output data is available through this assembly.

In the map of this assembly, the 32-bit values of all modules are in the order in which the modules are inserted. Next come the 16-bit values of all modules in the order in which the modules are inserted. Then come the 8-bit values of all modules in the order in which the modules are inserted.

The relative position in the memory map and the size of the output data of a module are displayed in TB20 ToolBox on the “Extended” tab of each module.

The size of the memory map depends on which modules are plugged in. Information on the size and format of the input data of the modules can be found in the manual of the respective TB20 module. 16- and 32-bit values are shown as “Big Endian”. Here, the byte with the highest value is stored first, that is, at the smallest memory address.

The maximum size of the assembly is 511 bytes.

Instance 151 (0x97) configuration data

This assembly is provided for configuration data. Currently no configuration data is supported. Its size is always 0.

Instance 152 (0x98) heartbeat for input-only connections

This assembly is used for input-only connections as a heartbeat. Its size is always 0.

Instance 153 (0x99) heartbeat for listen-only connections

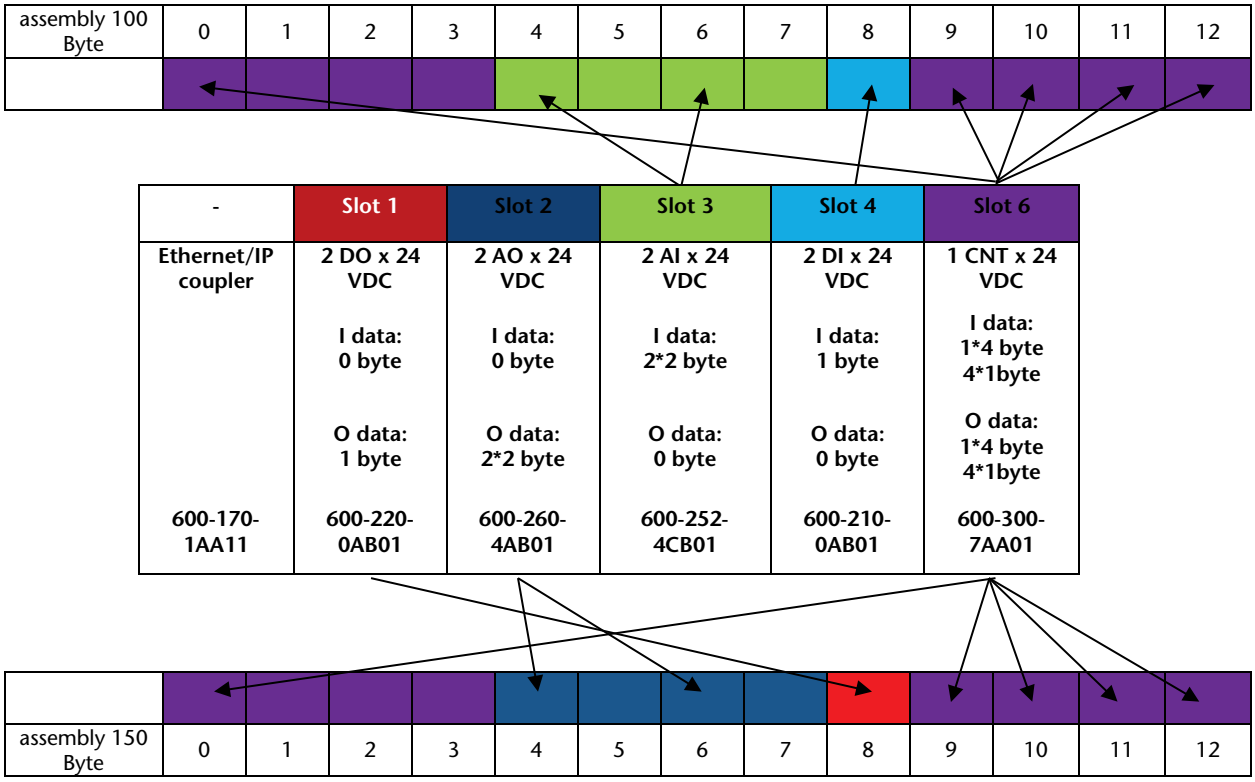
This assembly is used for listen-only connections as a heartbeat. Its size is always 0.

7.2.3. Mapping options

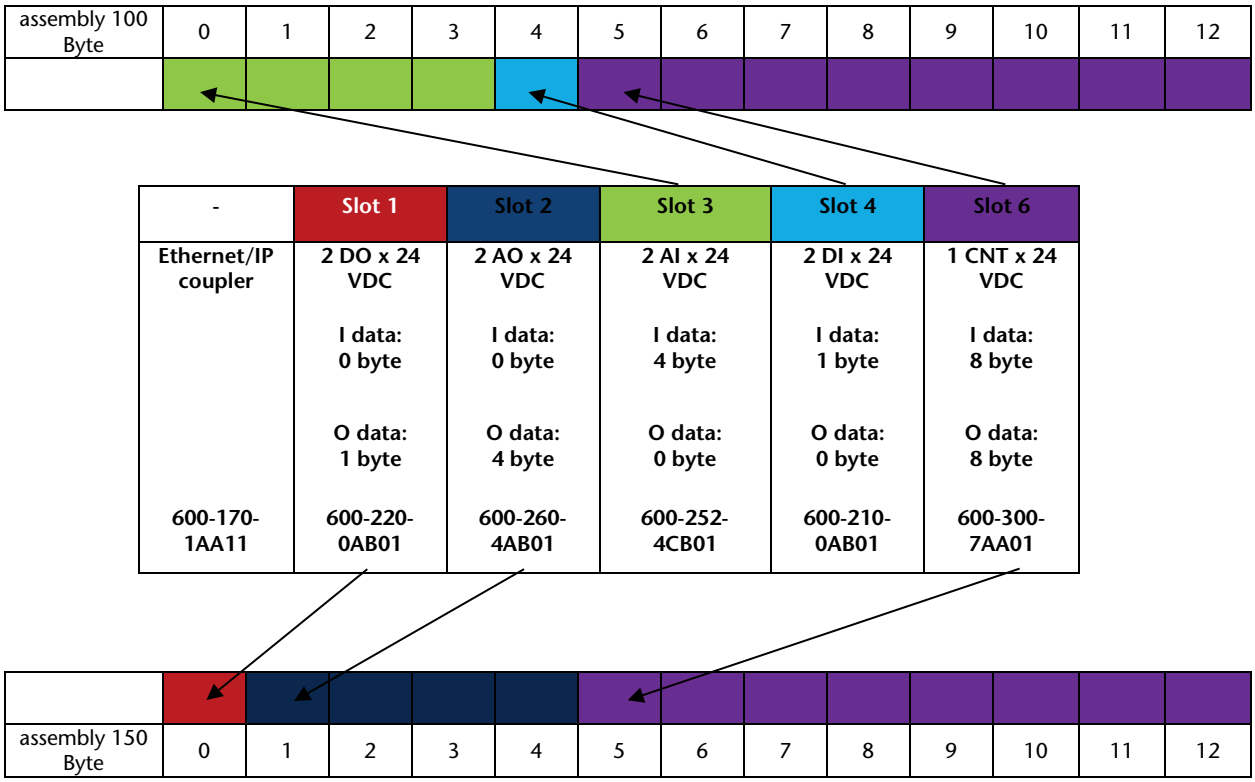
The way the module data is mapped to the input and output data assembly instances can be changed with the option “IO-Mapping rule”

Four different options are available:

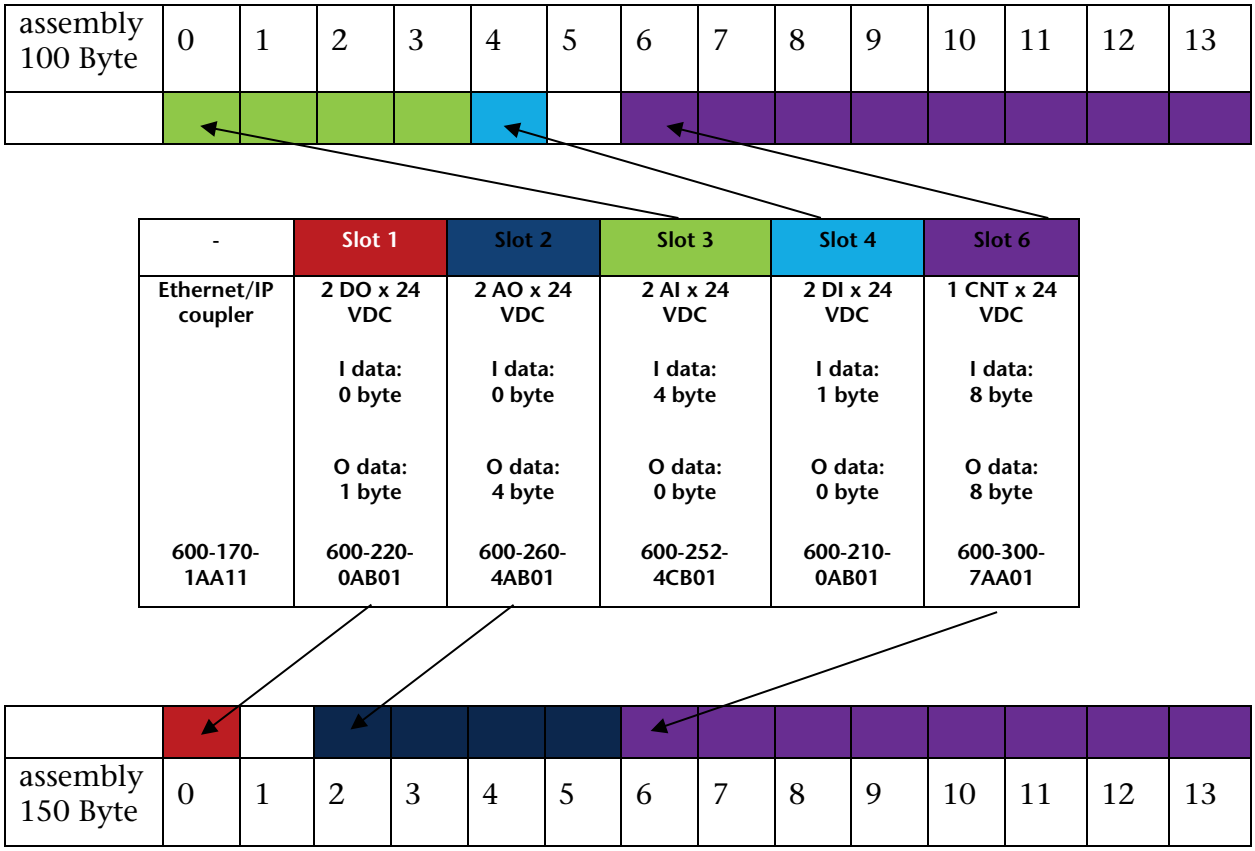
1. Data type size:
   In the map of this assembly, the 32-bit values of **all** modules are in the order in which the modules are inserted. Next are the 16-bit values of **all** modules in the order in which the modules are inserted. Last of all, the 8-bit values of **all** modules come in the order in which the modules are inserted.



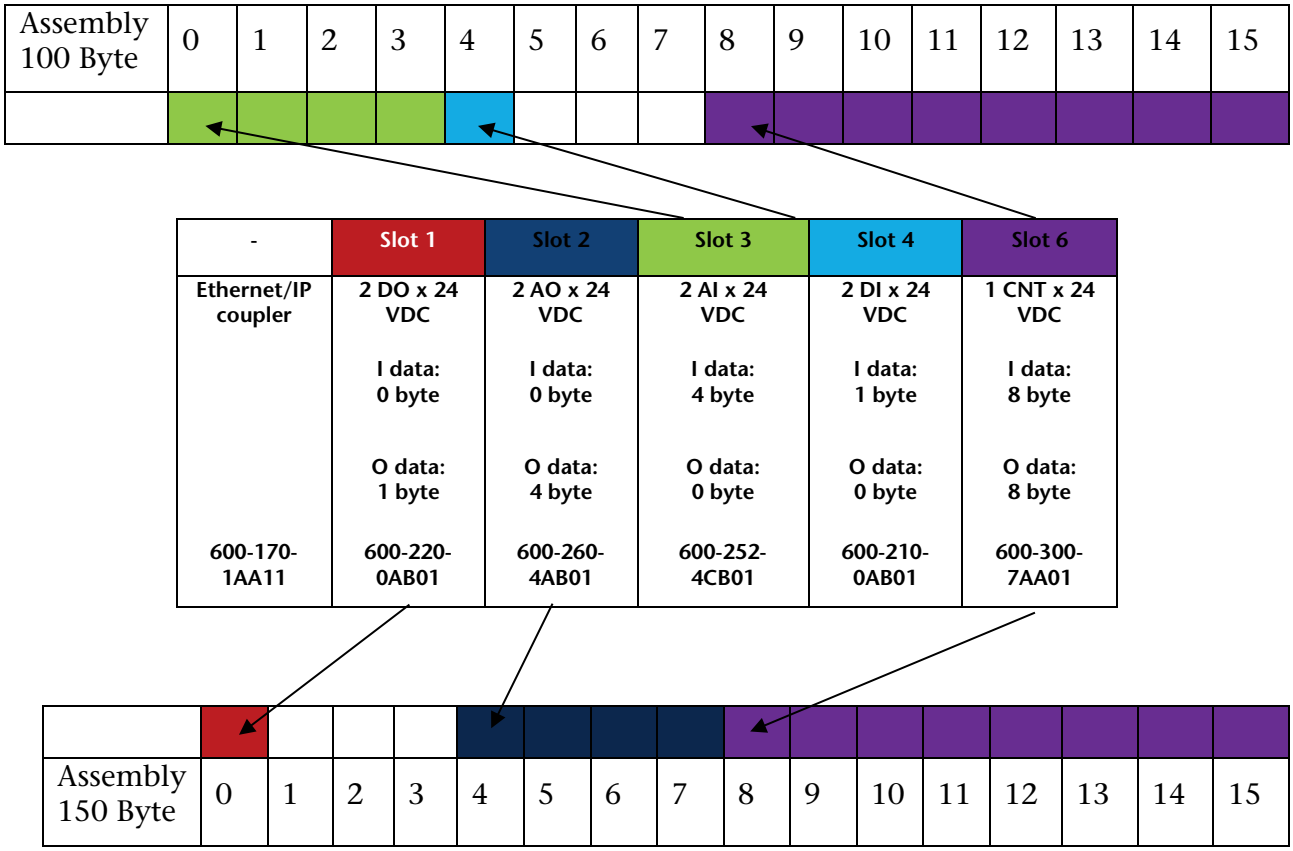
2. Module order (no alignment)
   The I/O image off all modules is mapped to the assembly in module order.



3. Module order (word alignment)
   The I/O image off all modules is mapped to the assembly in module order, but a module can only be mapped to even addresses. This can lead to 1 byte sized gaps in the mapping. This option is recommended, if data is accessed by word in the projecting tool.



4. Module order (double word alignment)
   The I/O image off all modules is mapped to the assembly in module order, but a module can only be mapped to addresses, that are divisible through 4 without remainder. This can lead to 3 byte sized gaps in the mapping. This option is recommended, if data is accessed by double word in the projecting tool.

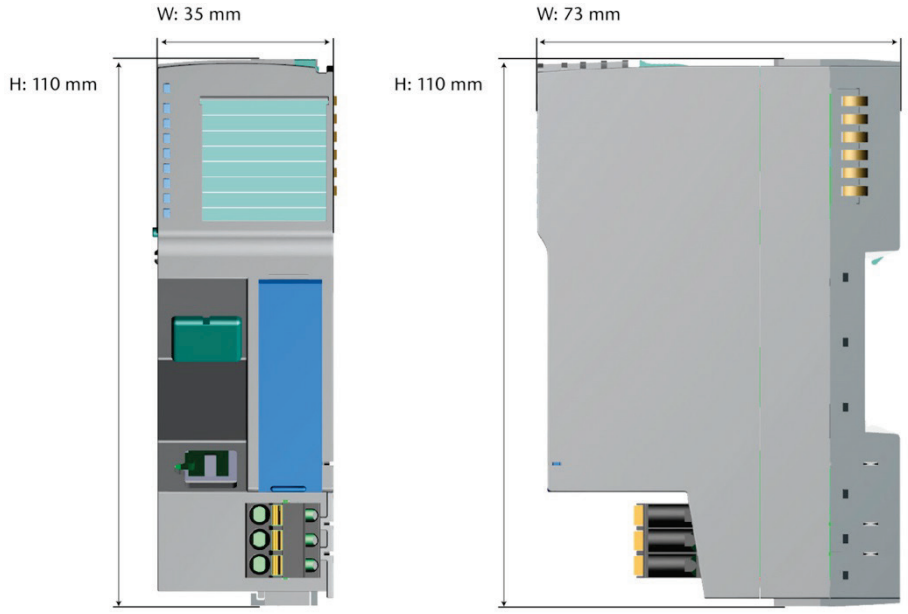


7.2.4. Technical specifications

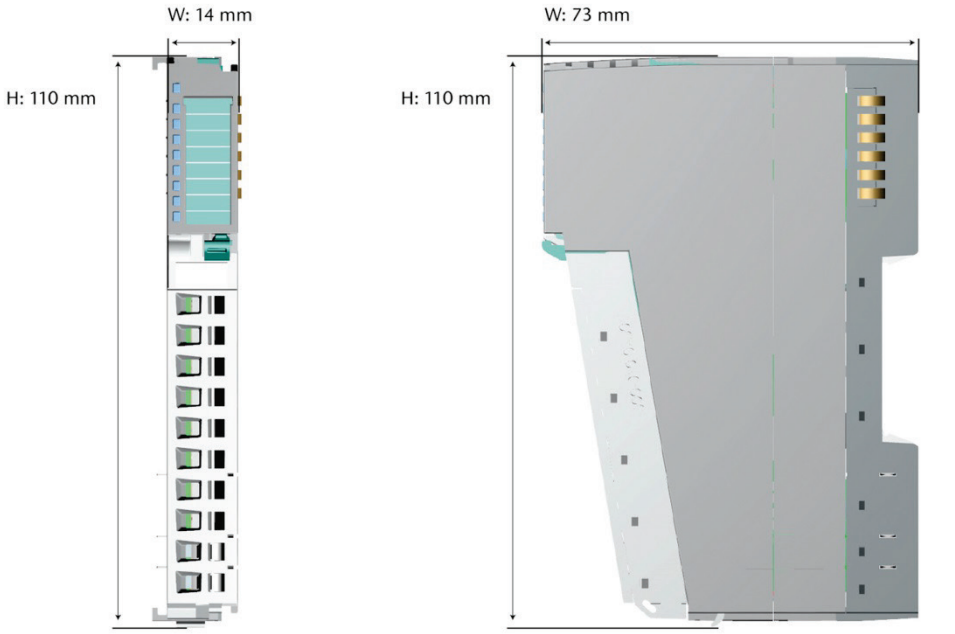
Order no.	**600-175-1AA11**
Module designation	EtherNet/IP™ coupler
Ethernet port	
Protocol	EtherNet/IP
Transmission rate	10/100 Mbps, automatic detection (auto-negotiation, auto-crossover)
Size of input and output assembly	511 / 511 bytes
Protocol transmission model	Implicit messaging (transport class 1) Explicit messaging (transport class 3)
IP address	Adjustable by software and/or DIP switch
DHCP	Yes, selection using DIP switch
Connector	2x RJ45, integrated switch
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 EN 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

8. Dimensions

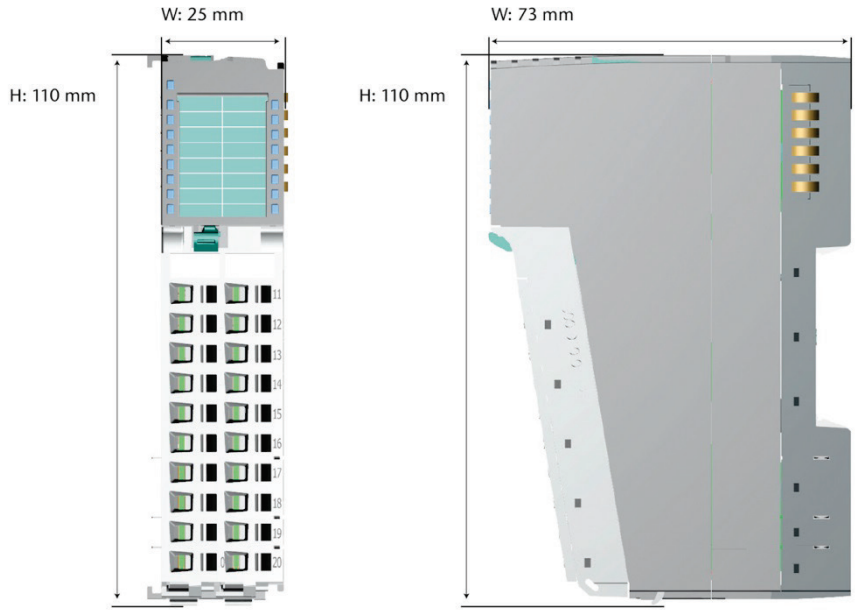
8.1. EtherNet/IP™ coupler



8.2. 14 mm module



8.3. 25 mm module



9. Spare parts

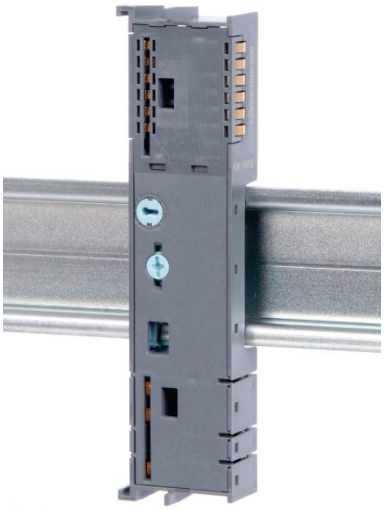
9.1. Base modules

9.1.1. 14 mm width standard base module

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

9.1.2. 25 mm width base module

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



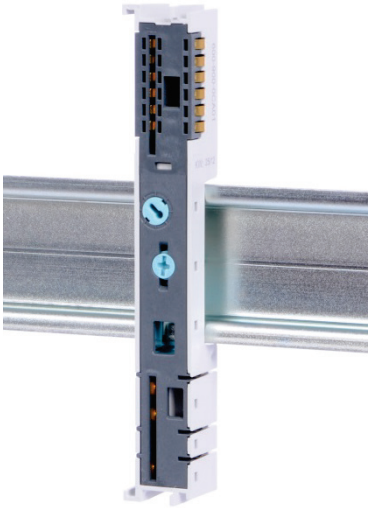
9.1.3. Power and isolation base module

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

9.1.4. 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.



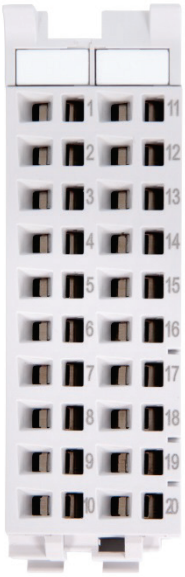
9.2. Front connectors

9.2.1. 10-terminal front connector

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

9.2.2. 20-terminal front connector

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



9.3. 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.

9.4. Final cover

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