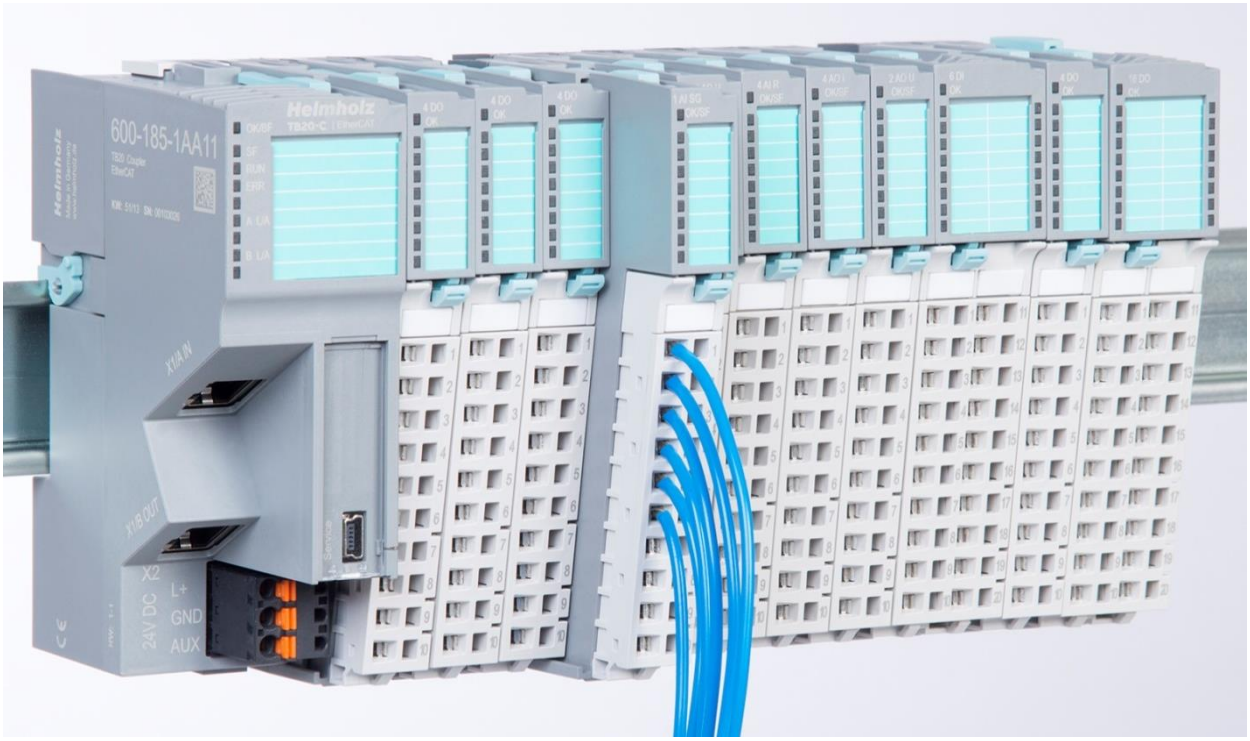

TB20 – Strain gauge weighing module

Manual

Version 1 / 21.12.2018

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Notes

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Revision Record:

Version	Date	Change
1	03/28/2017	First version

Table of contents

1 General

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

1.1 Target audience for this manual

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

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

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

1.2 Safety instructions

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

1.3 Note symbols and signal words in the manual

HAZARD

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

WARNING

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

CAUTION

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

ATTENTION

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

NOTE

Gives an indication for better understanding or preventing errors.

1.4 Intended use

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

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

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

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

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

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

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

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

1.5 Improper use

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

1.6 Installation

1.6.1 Access restriction

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

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

1.6.2 Electrical installation

Observe the regional safety regulations.

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

1.6.3 Protection against electrostatic discharges

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

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

1.6.4 Overcurrent protection

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

1.6.5 EMC protection

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

1.6.6 Operation

Operate the TB20 only in flawless condition. The permissible operating conditions and performance limits must be adhered to. Retrofits, changes, or modifications to the device are strictly forbidden.

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

1.6.7 Liability

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

1.6.8 Disclaimer of liability

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

Helmholz GmbH & Co. KG assumes no liability for any printing errors or other inaccuracies that may appear in the operating manual, unless there are serious errors of which Helmholz GmbH & Co. KG was already demonstrably aware.

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

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

1.6.9 Warranty

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

The warranty is not valid in case of:

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

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

2 System overview

2.1 General

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

It is made up of the following components:

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

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

2.2 The components of the TB20 I/O system

2.2.1 Bus coupler

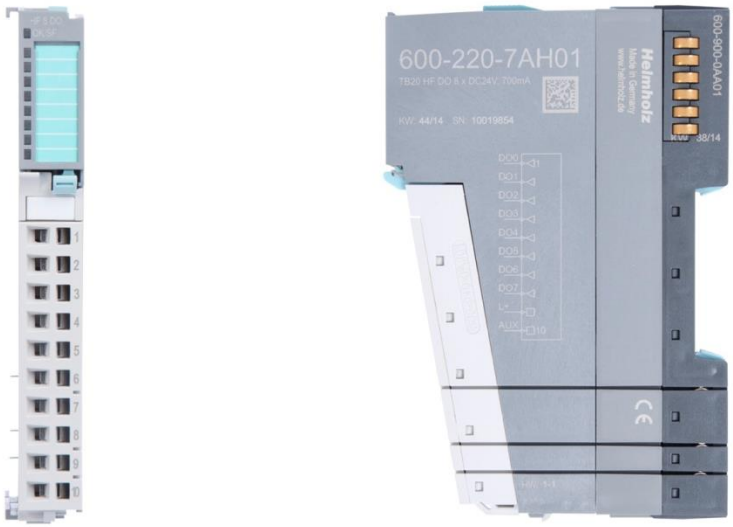
The system's bus coupler includes a bus interface and a power module. The bus interface is responsible for establishing a connection to the higher-level bus system and is used to exchange I/O signals with the automation system's CPU.

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

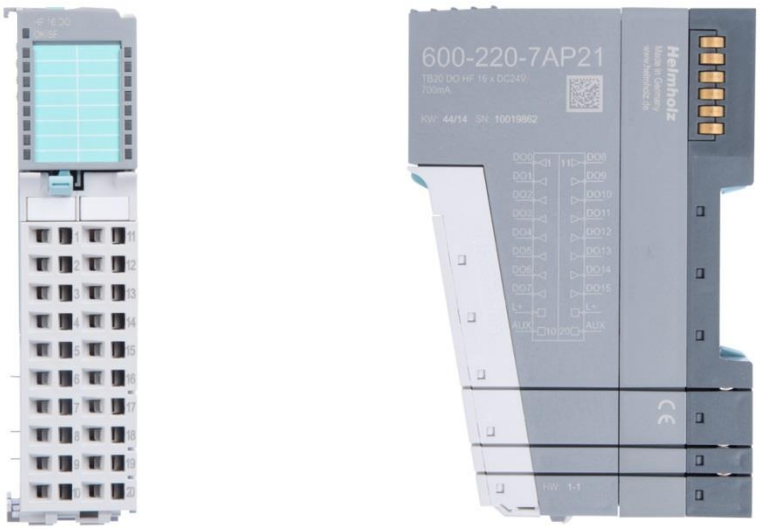
2.2.2 Peripheral modules

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

Example: Peripheral module with 10-pin front connector



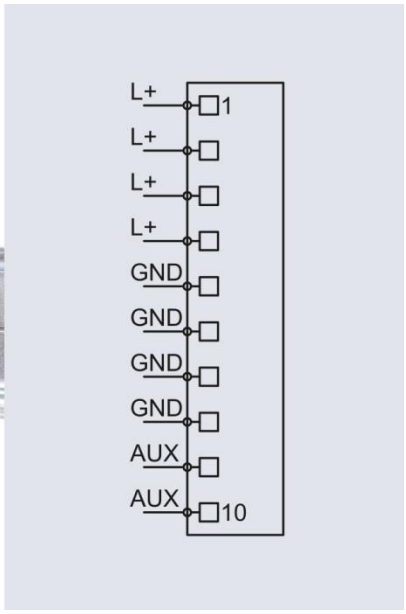
Example: Peripheral module with 20-pin front connector



2.2.3 Power and isolation module

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

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



NOTE

Power and insulation modules have a lighter body color.

2.2.4 Power module

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

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

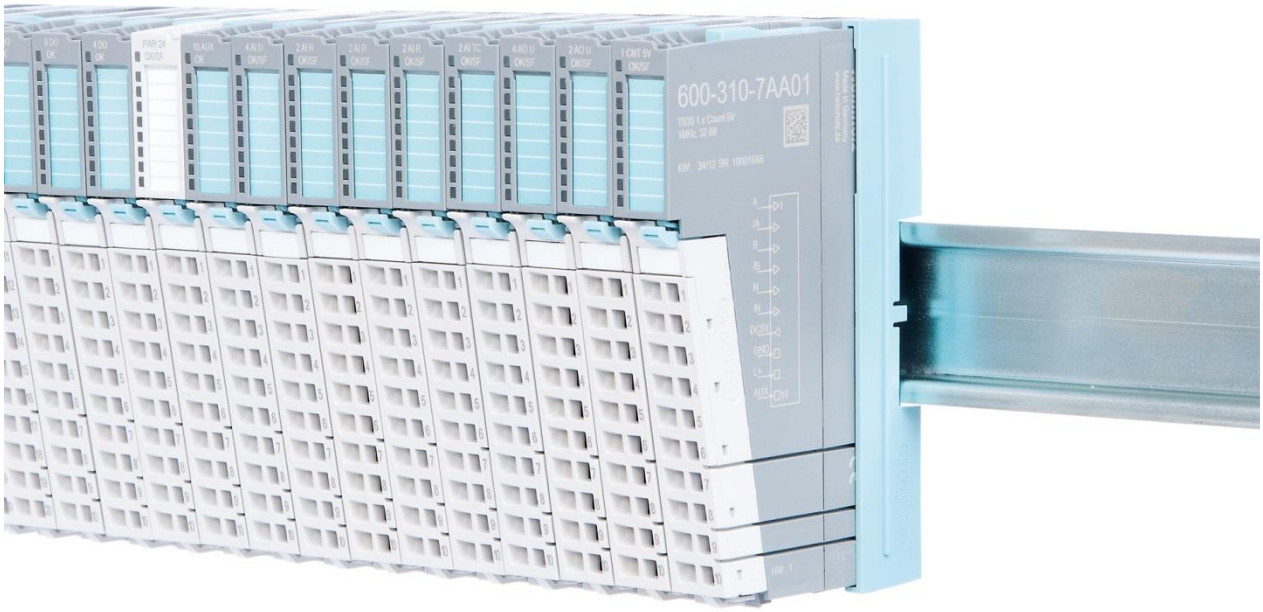
Power modules deliver all necessary power to the peripheral modules connected after them and, if applicable, all the way to the next power module or power and isolation module. A power module is required whenever the power supplied by the coupler alone is not sufficient, e.g., when there are a large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

NOTE

Power modules have a lighter body color.

2.2.5 Final 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

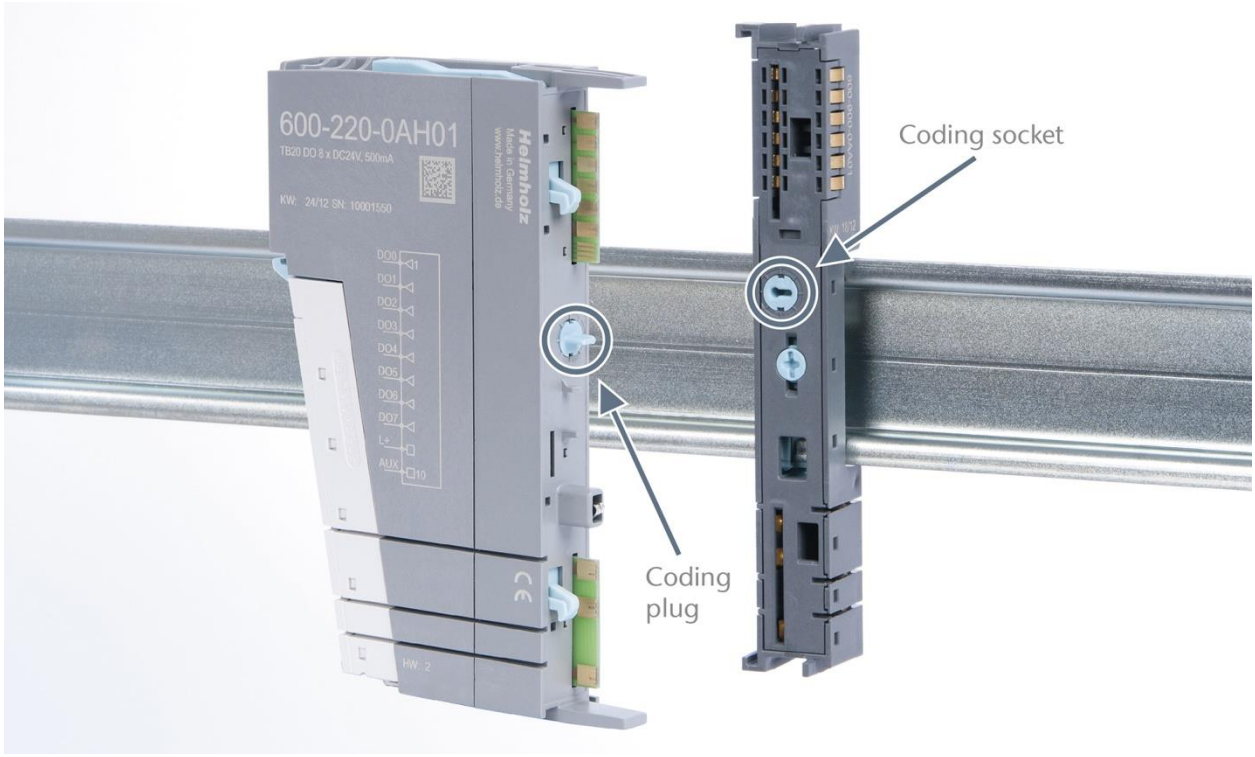
Each module consists of three parts:

- 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 following figure).



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

3 Installation and removal

HAZARD

TB20 modules can carry lethal voltage.

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

ATTENTION

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

3.1 Installation position

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

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

3.2 Minimum clearance

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

- The modules can be installed and removed without having to remove any other system components
- There 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)

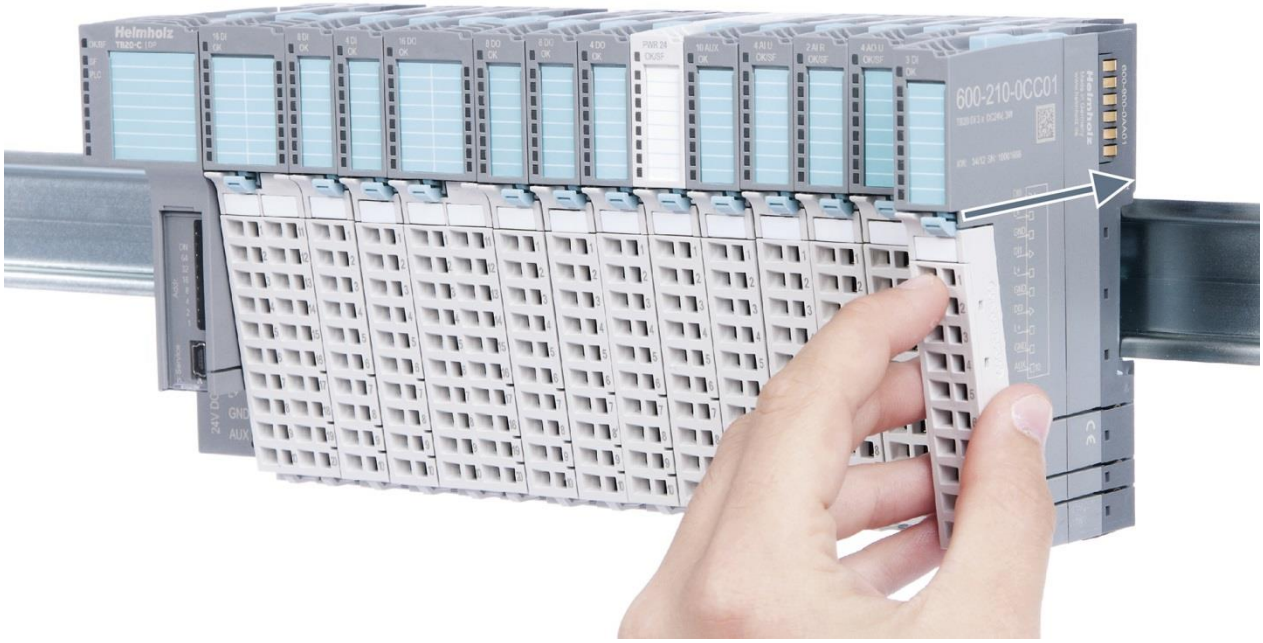
The minimum clearances for mounting TB20 components are: 30 mm on the top and on bottom and 10 mm on each side.

3.3 Installing and removing peripheral modules

3.3.1 Installation

Installing an assembled peripheral module

Place the assembled module on the DIN rail by moving it straight towards the rail. Make sure that the module engages the upper and lower guide elements of the previous module. Then push the upper part of the module towards the DIN rail until the rail fastener inside fastens 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 16) on the base module in a straight line and then gently push it onto the base module until both modules are fully resting on top of one another and the module fastener snaps into place with a soft click.

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

3.3.2 Removal

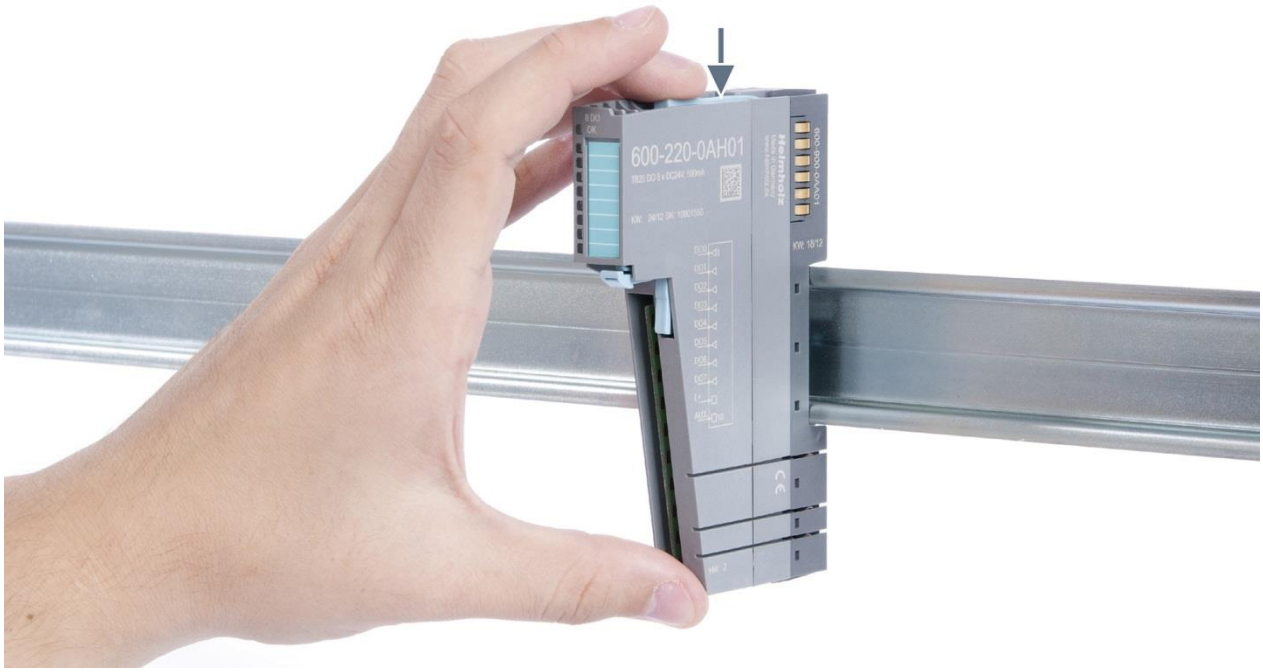
To remove a peripheral module, follow the four steps below:

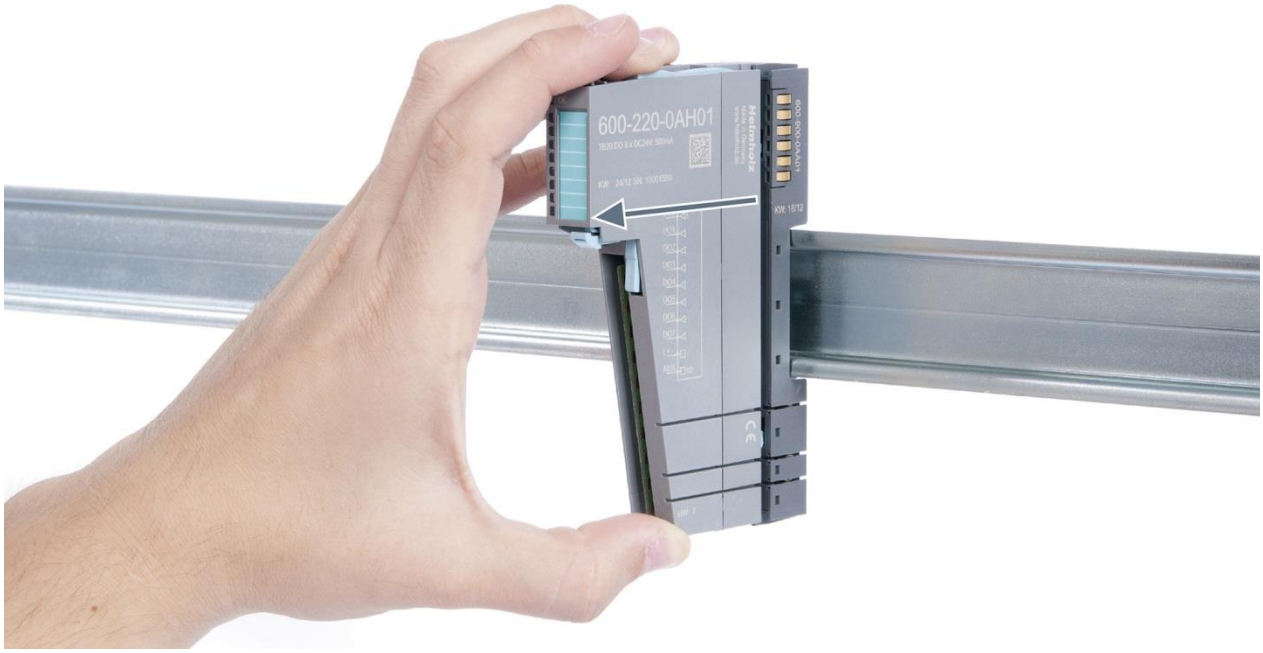
Step 1: Remove the front connector

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

Step 2: Remove the electronic module

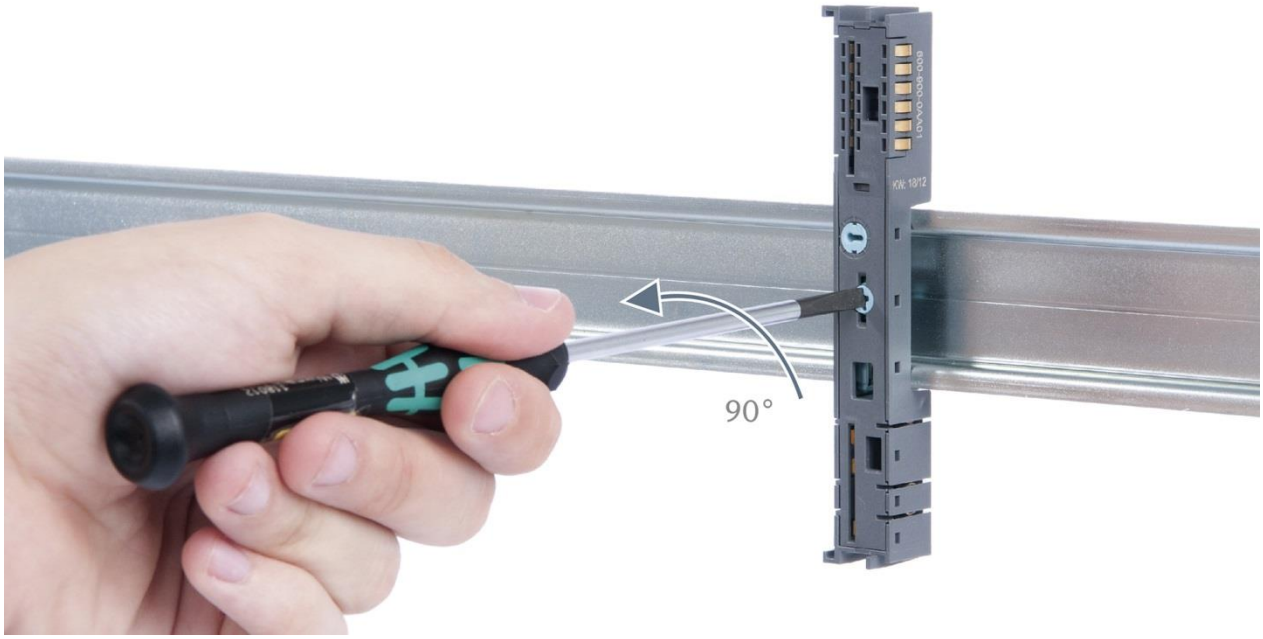
To do so, use your middle finger to push on the lever from above and then use your thumb and index finger to pull out the electronic module while holding the lever down (see the picture below).





Step 3: Release the base module

Use a screwdriver to release the base module. Turn the screwdriver 90° counterclockwise to release.



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.

HAZARD

TB20 modules can carry lethal voltage.

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

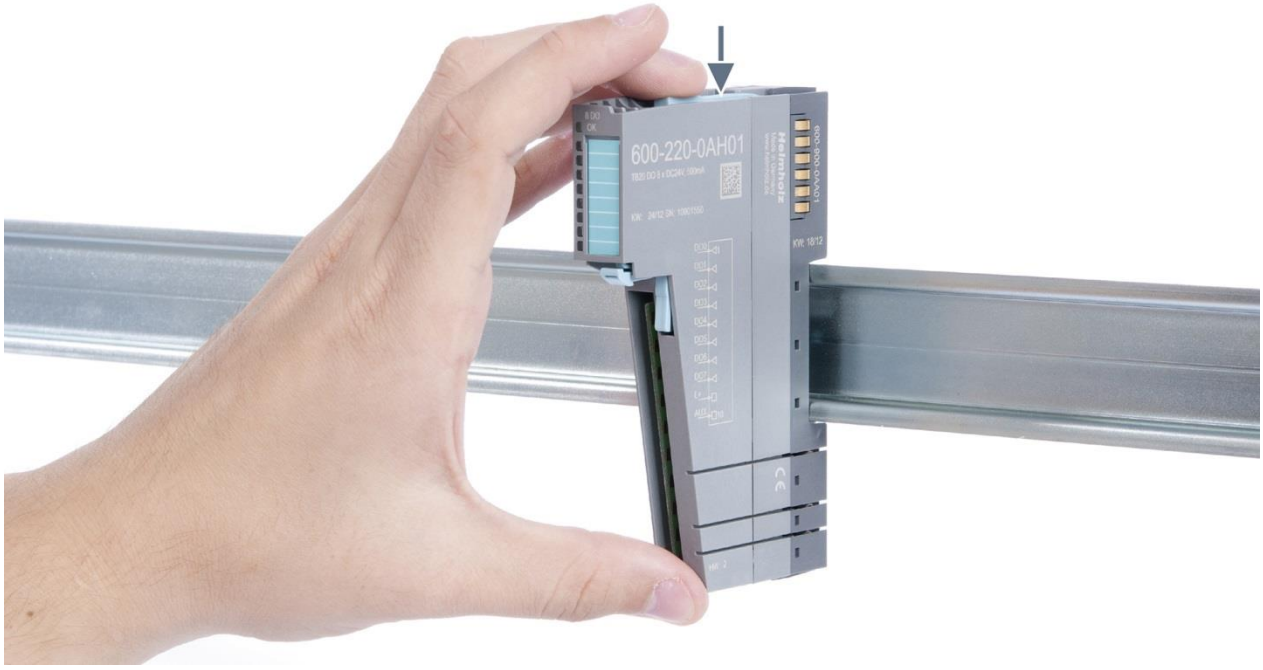
Note the wiring diagram of the system and switch off dangerous voltages before starting work!

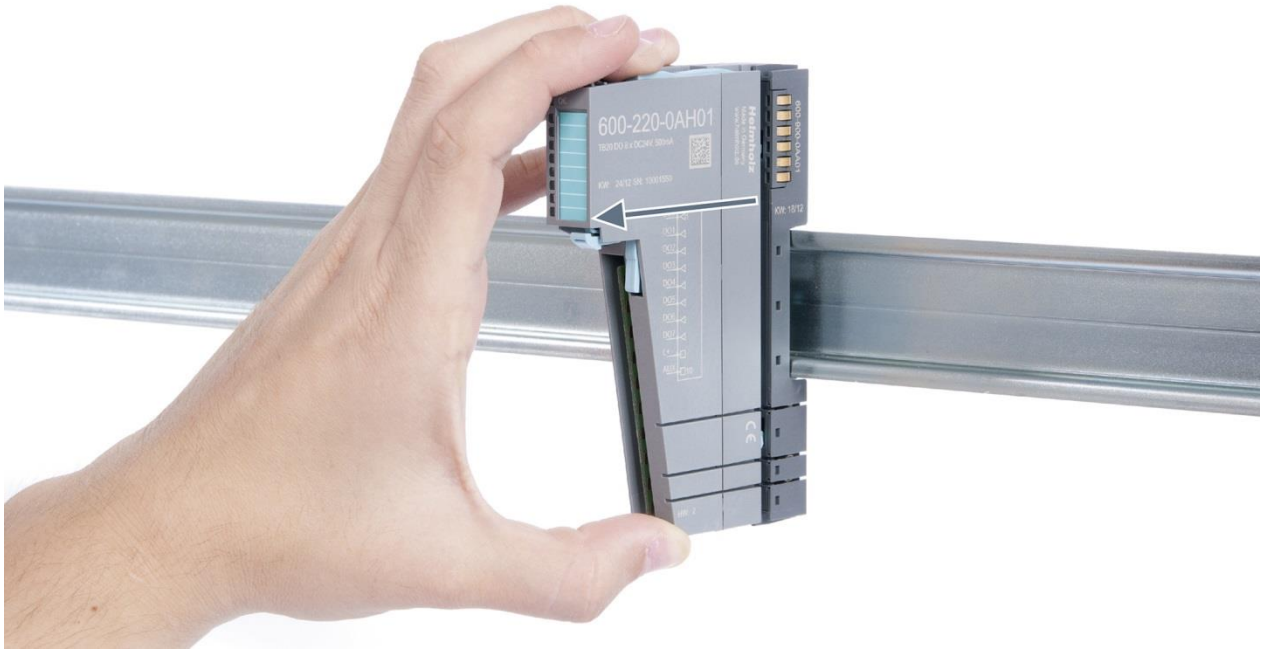
Step 1: Remove the front connector

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

Step 2: Remove the electronic module

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





Step 3: Plug in a new electronic module

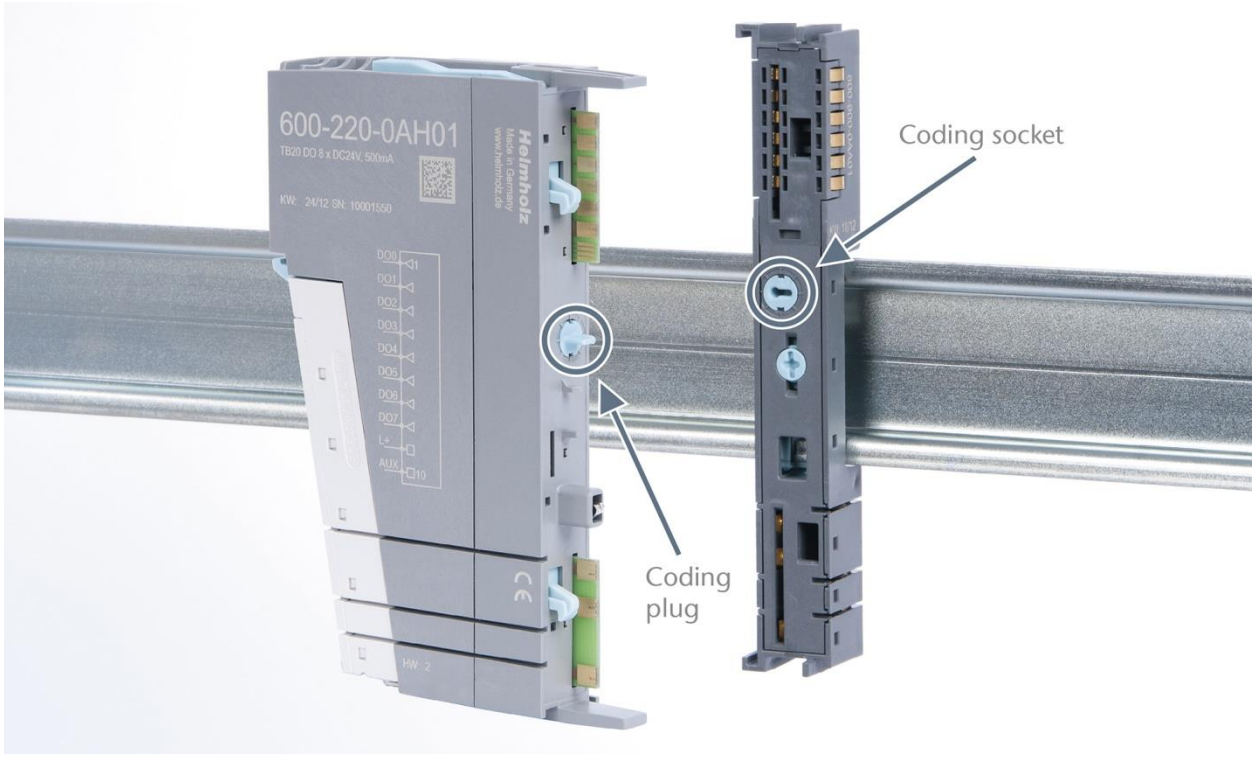
ATTENTION

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

ATTENTION

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

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

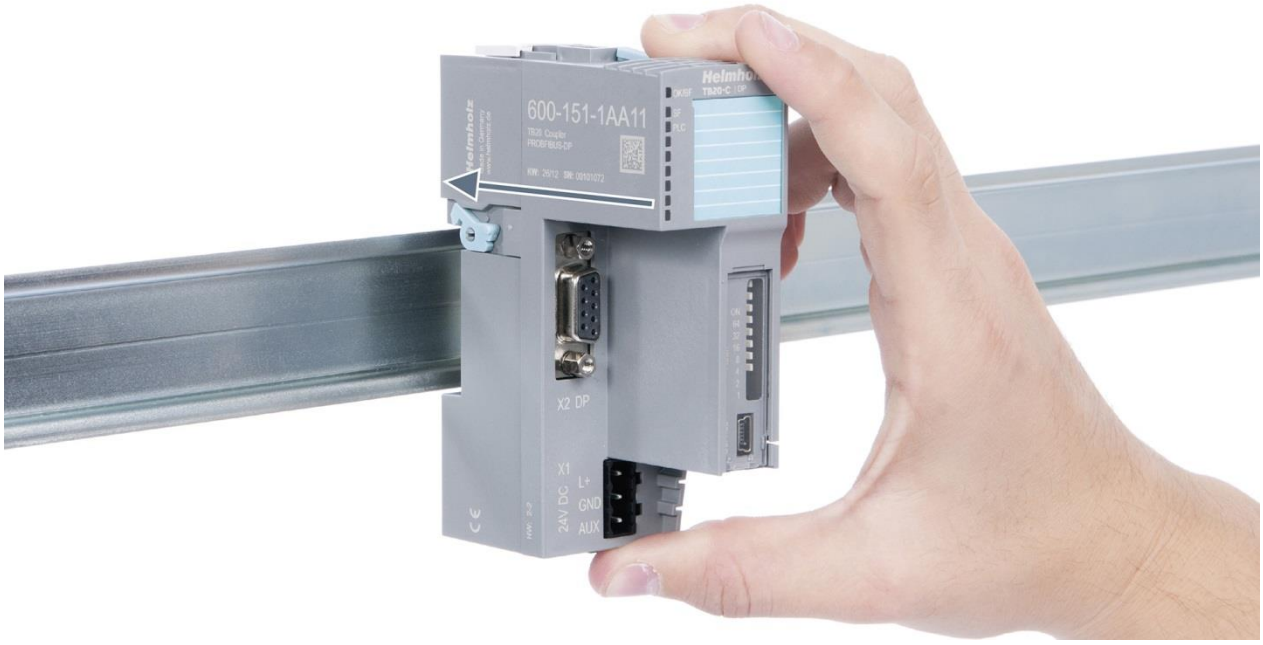


Step 4: Plug in the front connector

3.5 Installing and removing the coupler

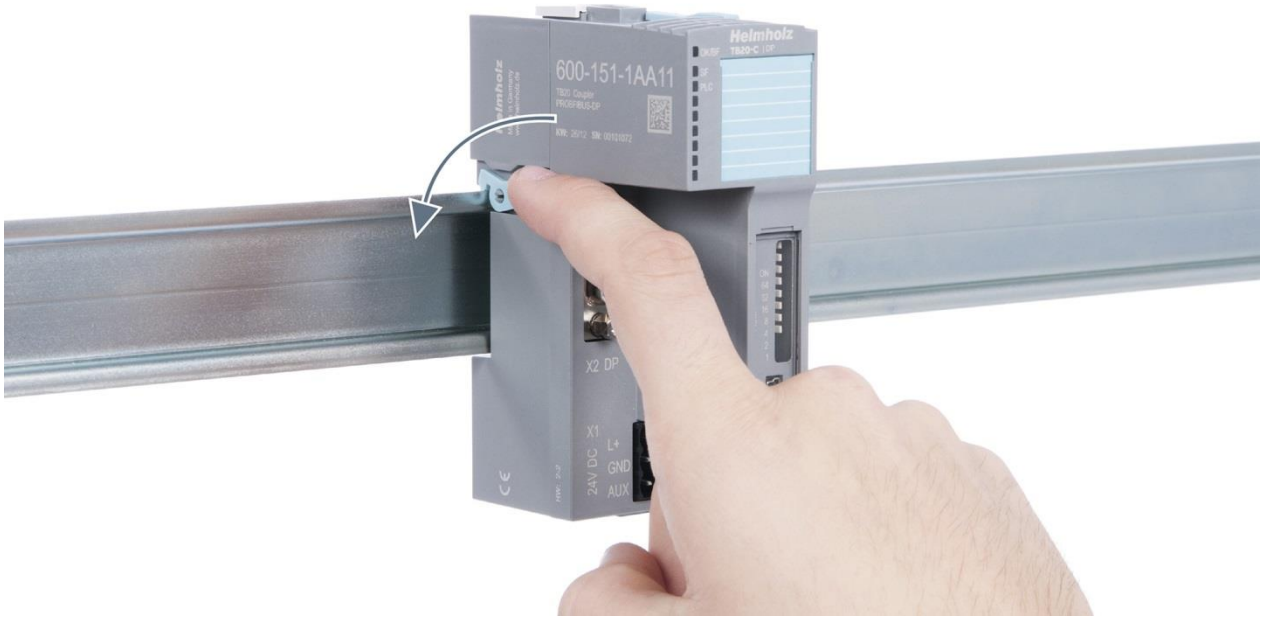
3.5.1 Installation

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



Step 2: Secure the coupler on the DIN rail

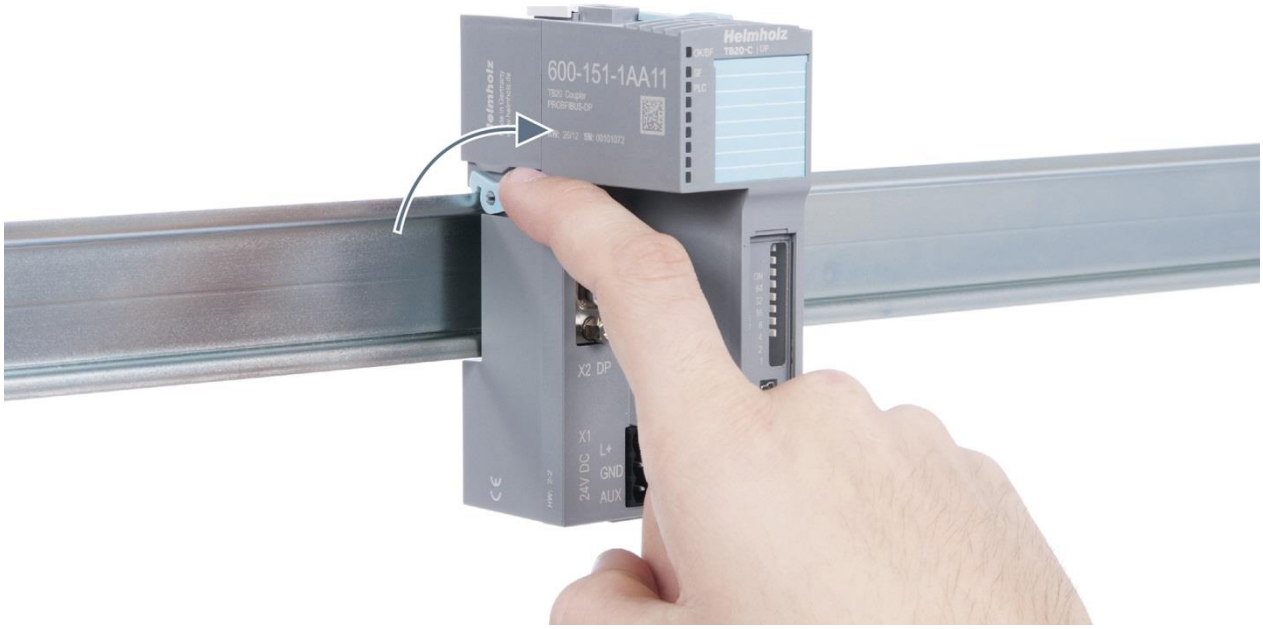
Use the locking lever on the left side of the coupler to lock the coupler into position on the DIN rail.



3.5.2 Removal

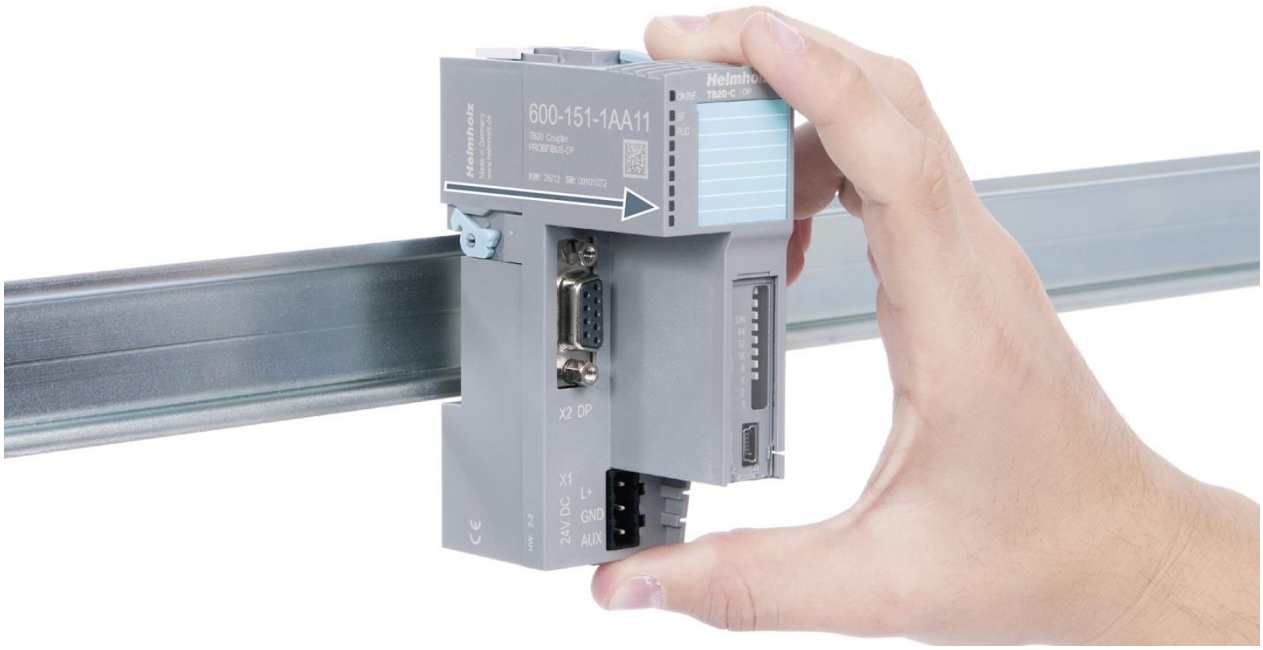
Step 1: Release the locking mechanism

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



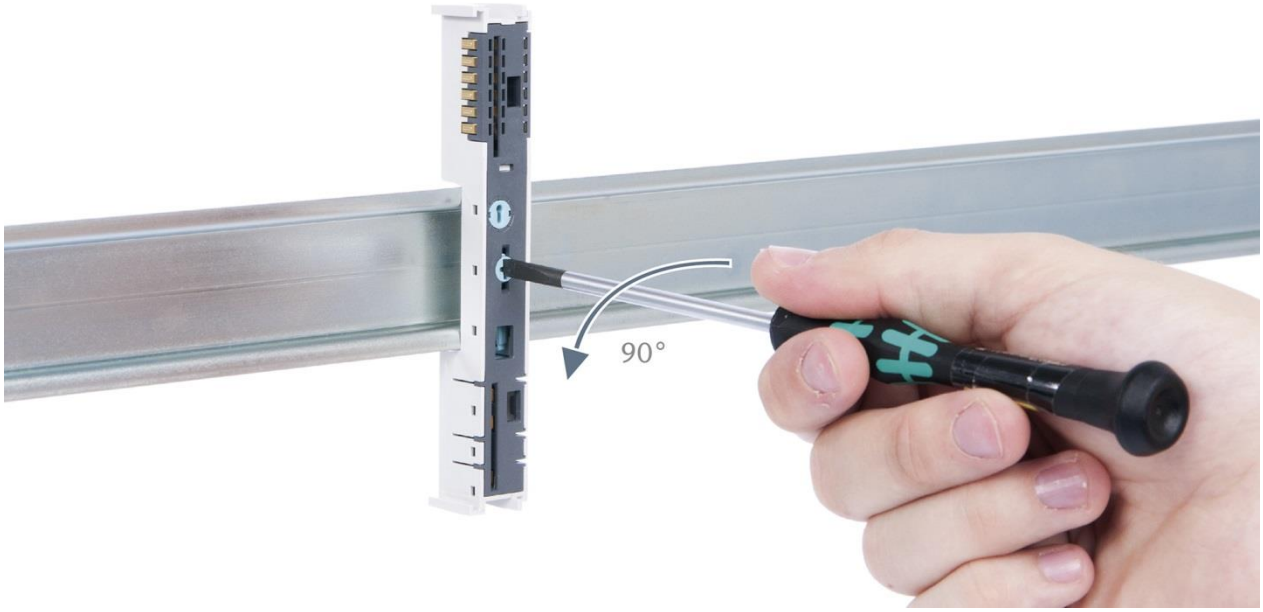
Step 2: Remove the coupler

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



Step 3: Release the base module

Use a screwdriver to release the base module.



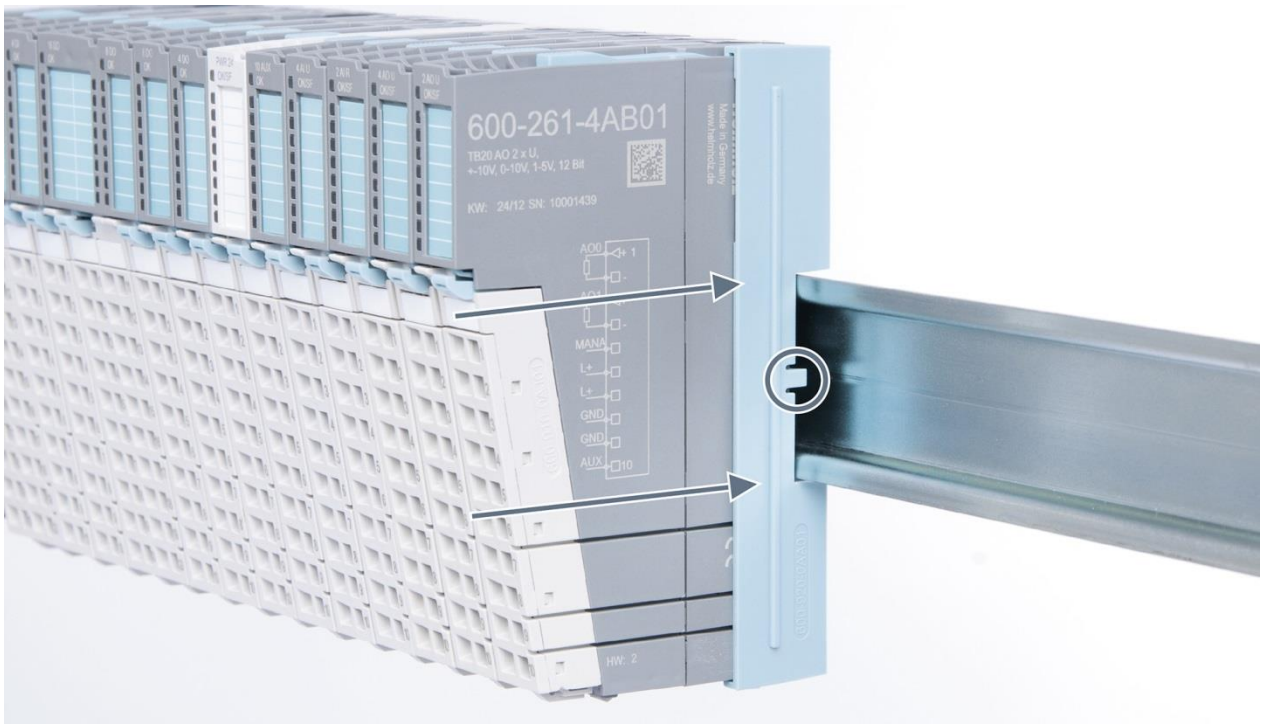
Step 4: Remove the base module

Remove the base module by pulling it towards you.

3.6 Installing and removing the final cover

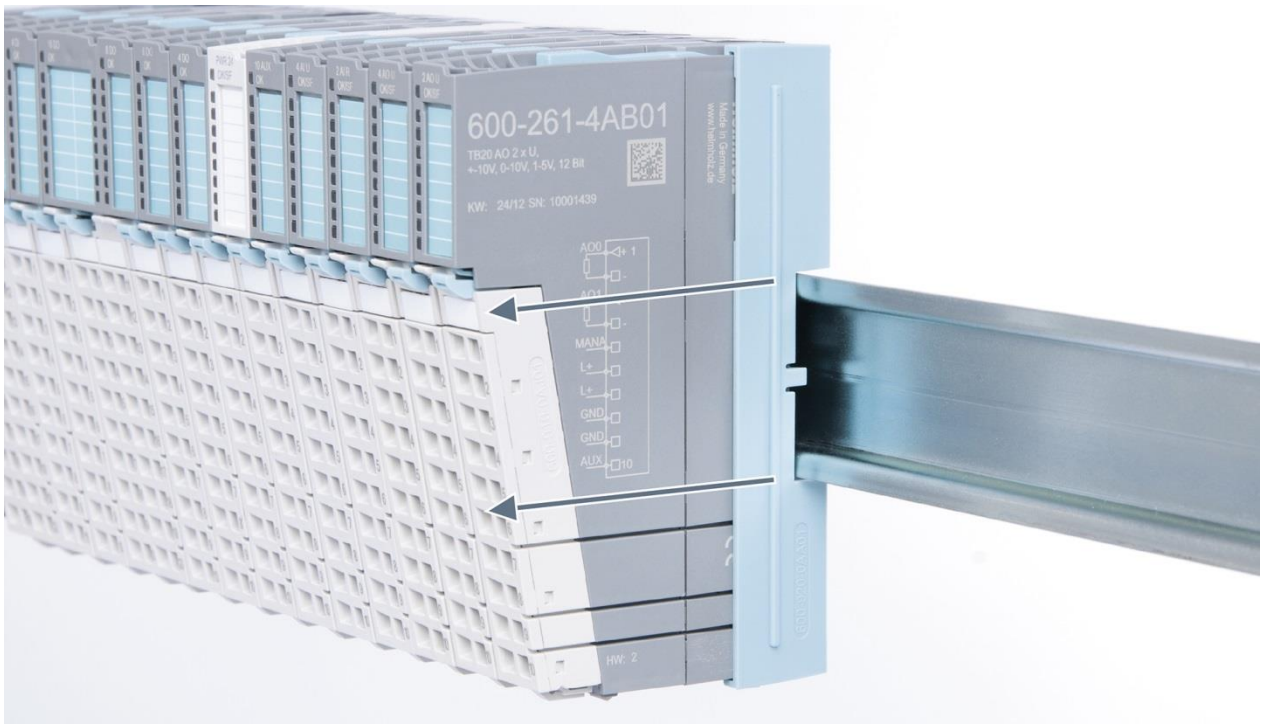
3.6.1 Installation

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 bus cover upward along and off of the module.



4 Setup and wiring

4.1 EMC/safety/shielding

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

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

ATTENTION

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

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

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

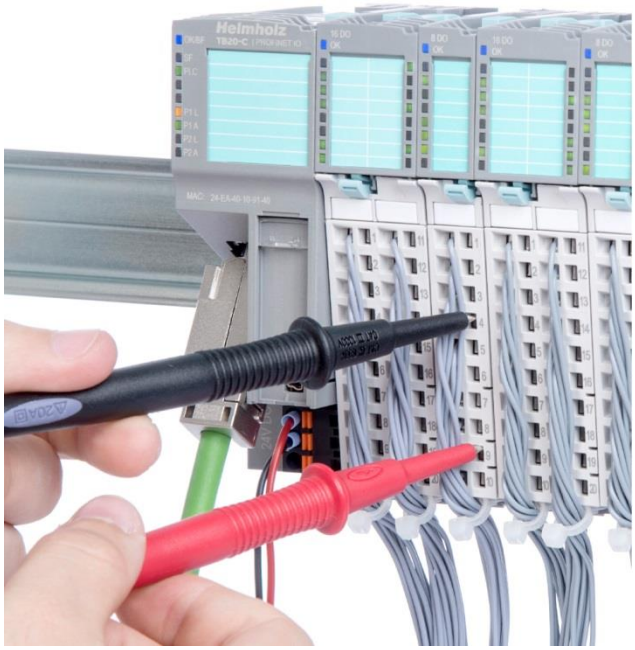
- All metal parts of the cabinet are to be connected with each other over a large area with good conductivity (no paint on paint). Where necessary, use contact washers or serrated washers.
- The cabinet door must be connected to the ground straps (top, middle, bottom) over as short a distance as possible.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

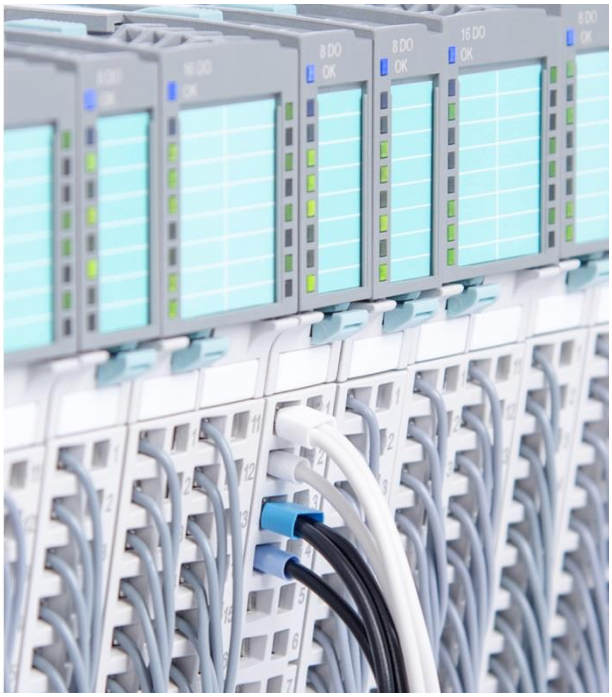
4.2 Front connectors

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

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

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





4.3 Wiring the coupler

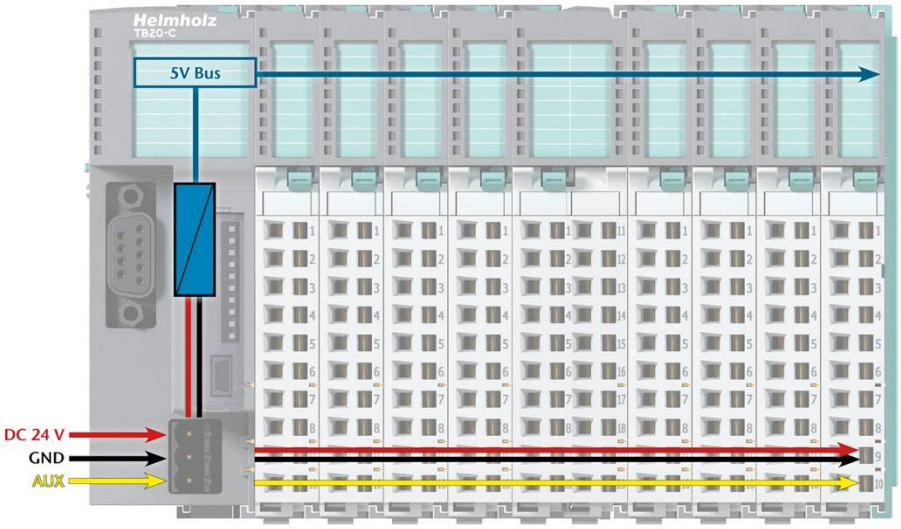
A power supply unit is integrated into the bus coupler. The power supply unit is responsible for powering the peripheral modules connected to the coupler.

The power supply itself draws its power from the three-pin terminal on the front (24 V DC, GND, AUX).

The 24 V connector is used to power two buses:

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

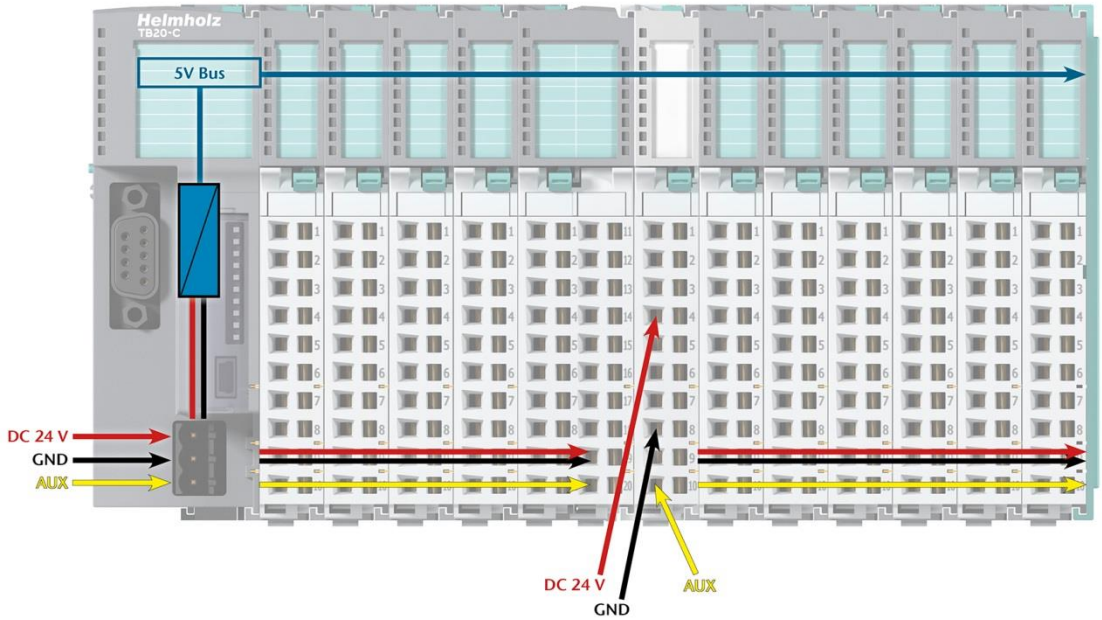
The AUX pin can be used to connect and use an additional voltage potential. Every peripheral module has an AUX terminal on its front connector (the bottommost terminal, i.e., terminals 10 and 20).



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

4.4 Using power and isolation modules

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

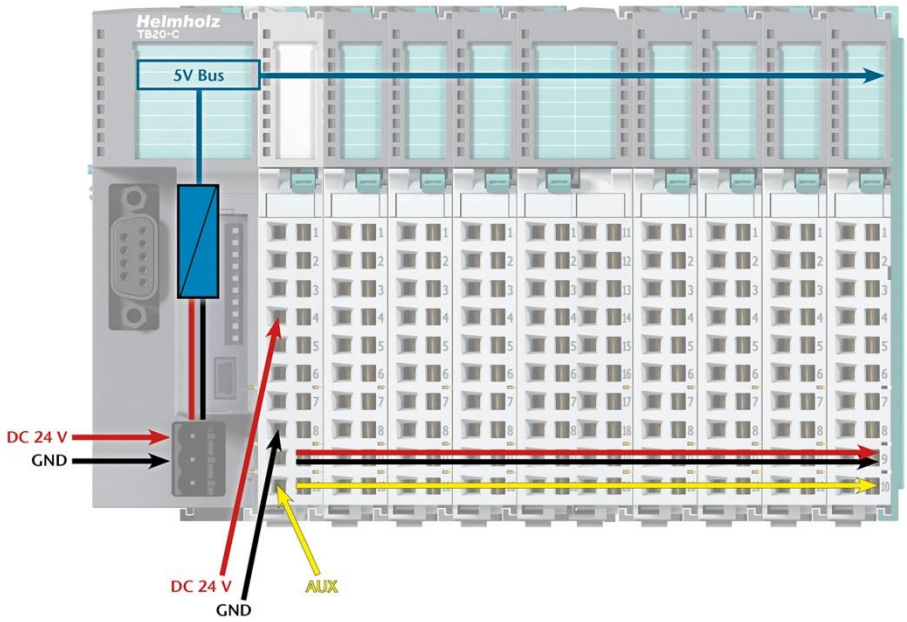


The order no. for the power and isolation module for 24 V signals is 600-710-0AA01.

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

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

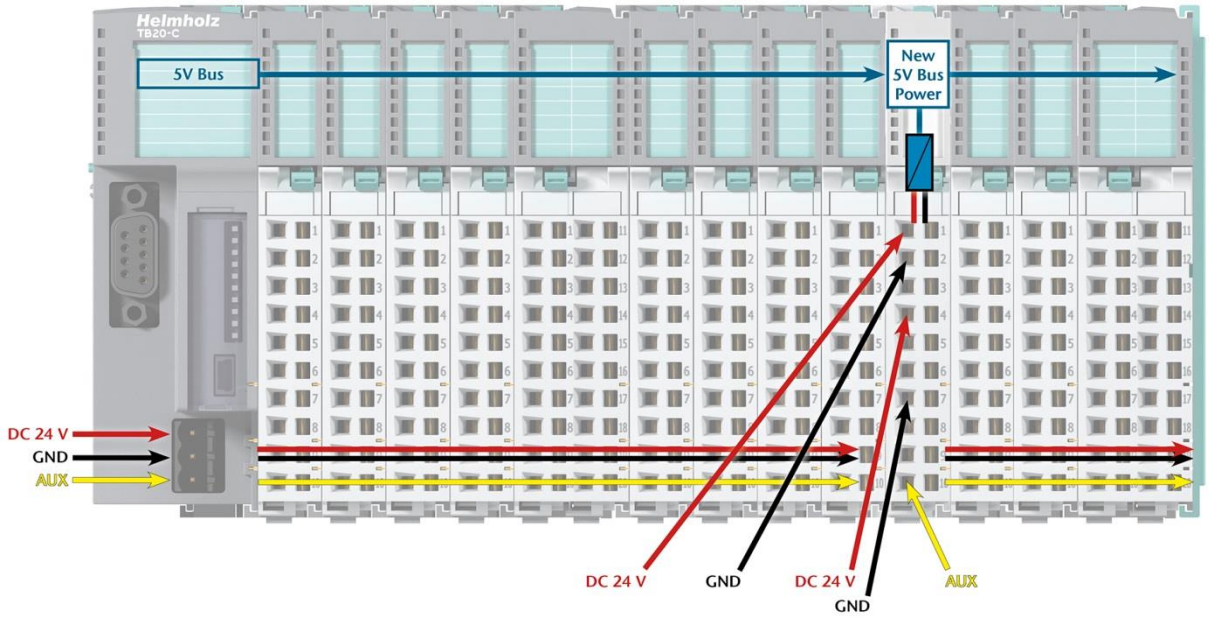
If the power supply for the coupler needs to be separate from the power supply for the I/O modules, a power and isolation module can be used right after the coupler.



4.6 Using power modules

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

24 V DC, GND, and AUX are fed into the terminals, whereas the supply of the sequenced modules runs via the bus system of the base modules.



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

4.7 Function of the OK-LED

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

Solid blue light	The module is running (RUN)
Slowly flashing blue light	The module is stopped (STOP); substitute values (if any) are being applied.
Quickly flashing blue light	The module is idle (IDLE); it has not been configured.
Solid red light	The module has a diagnostic error.
Flashing red	The module has a configuring error.

The red "**SF**" LEDs are only present on modules with configurable parameters or diagnostic capabilities.

4.8 Electronic nameplate

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

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

4.9 Fusing

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

5 TB20, strain gauge weighing module

5.1 Purpose

The weighing module serves the purpose of measuring and processing signals from weight, torque, or force sensors. The weighing module enables the direct connection of a load cell in the strain gauge full bridge circuit (voltage-fed bridge circuit).

The feed voltage of the bridge is generated from the back wall bus of the TB20 and amounts to 5 V with a maximum 70 mA load. The voltage output is protected with an internal, reversible fuse against overload and short circuit. Load cells with a minimum of 72 Ω can be connected. The external bridge feed of the load cell is possible.

The bridge voltage can be measured on the load cell with 6-wire connection. The measured value is incorporated into the calculation of the measurement value. Controlled by the application, wire break detection can also take place by feeding test current into the measurement channel.

The input channels have a resolution of 24 bits. Measurement values are issued configurable in mV/V or in kg.

With adjustable sample rates, interference voltages and mechanical fluctuations in the measurement can be suppressed. Disruptions from a series of measurement values can be smoothed out using a moving mathematical average. A zero point comparison of the load cell can be carried out with the offset, or measurement with a definite value can be commenced with. Linearity deviations of the measuring instruments can be linearized with up to 5 sampling points.

The measurement inputs have overvoltage protection relating to the 24 V potential and possess electrical isolation with 500 V dielectric strength.

5.2 Measurement values

The measuring ranges are calibrated to the specified precision upon delivery. The weighing module cannot be gauged.

5.2.1 Measurement value for conversion rate

The conversion rate can be configured to suppress interference frequencies. Separate operating modes of 50 or 60 Hz are not required.

Conversion rates for 50 Hz interference frequencies: 6.25/s; 12.5/s; 25/s; 50/s

Conversion rates for 60 Hz interference frequencies: 7.5/s; 15/s; 30/s; 60/s

5.2.2 Averaging

A moving arithmetical average with the number n: 1 ... 255 can be formed. After the start of the load cell module or the reconfiguring of the parameter, a correctly averaged measurement value is first available at the TB20 bus when the configured number of measurement values has been configured.

No averaging takes place for the number 1.

5.2.3 Permanent measurement operation mode

The measurement values are read in cyclically. The cycle time results from the configured conversion rate and the configured average filter. 6.25 ... 60 measurements are possible with a maximum number of 255 values for the averaging. The shortest measurement is 1/60 s without averaging. The longest measurement is 40.8 s with 255 values for averaging.

$$\text{Cycle time [s]} = \frac{\text{n average filter}}{\text{Sample rate [1/s]}}$$

5.2.4 Issuing of average

The average can be issued as a voltage value or as a weight:

- mV/V
- kg (configuring on the basis of load cell data required)

In order to issue the weight, the weighing module must be configured on the basis of the load cell data and be compared on the weighing instrument. The best precision of the scale is achieved through adjustment with gaging weights; see chapters 5.2.6 and 5.2.7.

To measure forces or torques, special force or torque sensors that work with the strain gauge full bridge circuit an be connected to the weighing module. The measurement values must be issued in mV/V. Configuration takes place on the basis of data of the force sensor in the corresponding unit of measurement. In the case of the issuing of the measurement value in mV/V, no offset and no linearization sampling points is possible. The issuing of the measurement value in the TB20 ToolBox is only possible in [kg].

5.2.5 Configuration of the weighing module

In order to be able to calculate the weight value from the voltage measurement value, the characteristic of the measurement system must be defined. The characteristic is defined by the points 0 and rated load. The zero point is defined by the unladen scale with its own weight. The endpoint of the characteristic, meaning the maximum quiescent point, is defined from the characteristic value of the load cell and the rated load of the load cell.

The weighing module is configured with the characteristic value of the connected load cell. The exact characteristic value of a load cell is indicated by the manufacturer of the load cells. If the characteristic value of the load cell is unknown, the value "1.000" can be used for 1 mV/V load cells and the value "2.000" for 2 mV/V load cells, etc.

Determination of the characteristic value of the weighing module with the help of the TB20 ToolBox:

- Issuing of measurement value in mV/V
- Load the load cell with a gaging weight with a rated load
- Enter the measurement value as a characteristic value of the load cell
- The weight used is to be entered as a rated load

The analog measurement value measured on the load cells is converted into a 24 bit digital value for internal processing. The weight value is calculated from the measurement value together with the characteristic value and the rated load of the load cell. All other functions of the weighing module use this weight value.

If the characteristic progression of the weighing instrument isn't linear, the characteristic can be linearized through sampling points, see 5.2.7.

5.2.6 Offset of the load cell

If the measurement value with an unladen load cell deviated from zero, or if the weighing is to commence with a fixed value, the characteristic of the load cell can be relocated with the parameter offset. The offset value relocates the entire characteristic.

NOTE

The offset adjustment must always take place with an unladen weighing instrument.

The offset value is a configuration parameter. The offset value must be transferred as a configuration value from the user program to the weighing module or be set with the help of the TB20 ToolBox. The offset value is permanently stored in the weighing module. The offset value can be changed by overwriting.

The offset value raises or lowers the entire characteristic including the set sampling points.

The offset value must be provided in kg with 2 decimal points. A negative offset value raises the characteristic.

If the weight of the weighing mechanics and/or the weighing vessel are to be incorporated into the offset, this weight is to be configured as an offset value instead of as 0 with an unladen load cell.

Example: Taring is to take place on a weighing vessel.

1. Weigh the vessel with the measurement value issue [kg], note the measurement value
2. Unload the scale.
3. Set the weight of the vessel positively as an offset value.

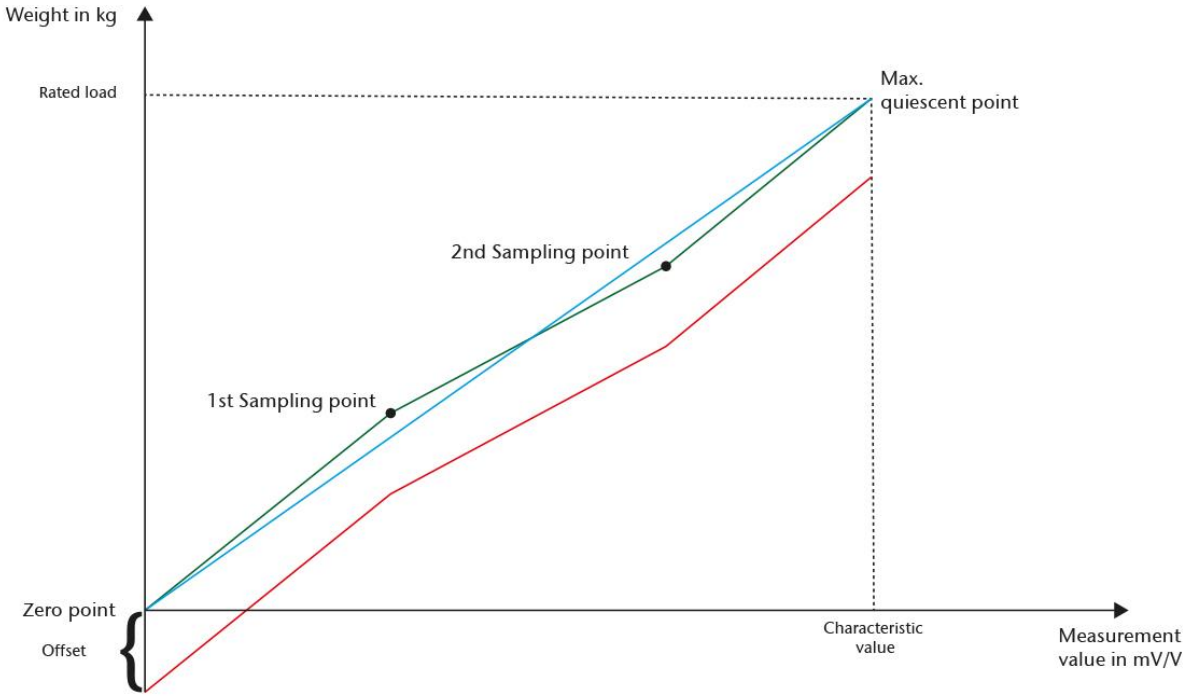
NOTE

The load on the load cell for which an offset value is to be set must be less than the rated load of the load cell. An offset value greater than the rated load value results in incorrect measurement values. Exceeding of this value is not monitored.

5.2.7 Linearization through sampling points

In the course of the configuration it can be indicated whether linearization with up to 5 sampling points should be carried out by the user. The characteristic of the load cell is linearized.

When setting a sampling point, the load cell is loaded with a defined weight. By way of a control command, the module is informed for which weight and for which sampling point a conversion factor should be created. The linearization values of the five sampling points are customer parameters. The sampling point values must be transferred from the user program to the weighing module or be set with the help of the TB20 ToolBox. The sampling point values are permanently stored in the weighing module. The sampling point values can be changed by overwriting. Should one or more sampling points not be used, deactivation must take place via the parameter "Number of sampling points", see chapter 8.



Linearization through sampling points

- Blue line - defined by zero point and max. quiescent point
- Green line - linearized with sampling points
- Red line - linearized with sampling points and relocated by offset.

The sampling points always refer to the zero point and not to the offset. The sampling point values must be provided in kg with 2 decimal points.

No linearization takes place if the sampling points are deactivated. The zero point parameter and the parameter "Characteristic value of the load cell" apply in connection with "Rated load of the load cell."

Linearization can take place with up to five decimal points, whereby the values of the sampling points must be ascending in a strictly monotonic manner. All sampling points can be created, but not all sampling points need be used. Usage takes place in an ascending sequence: first sampling point 1, sampling point 5 last. The amounts of the sampling points must be smaller than the rated load of the load cell. See graph: Linearization through sampling points.

The number of sampling points to be used is determined through the parameter "Number of sampling points used."

NOTE

If, the offset value is changed following the definition of the sampling points, the sampling points are lowered or raised by the offset value.

5.2.8 Wire break test of the measuring lines

A wire break test of the AI+ Sense line can be carried out with a control command. The wire break test briefly interrupts the continuous measurement.

The wire break test is completed when the "Control command has been executed" IB 5 Bit 7 has been set. When a wire break is determined, the error bit "Line break (=1)" IB 5 Bit 2 is set in the response data.

The error bit "Line break (=1)" IB 5 Bit 2 is displayed in the TB20 ToolBox in online operation. Following evaluation, the user is to reset the error bit "Line break (=1)" IB 5 Bit 2 via the "Acknowledgment for control command has been executed" OB 5 Bit 7. In the process, the error bit "Line break (=1)" IB 5 Bit 2 is also reset, see chapter 9.1.

5.2.9 Monitoring of the feed voltage

A minimum and a maximum threshold can be configured for the monitoring of the feed voltage. By way of a 2nd measurement channel, the bridge feed voltage is determined cyclically with active monitoring and checked for the broaching of limit values. The measurement of the feed voltage briefly interrupts the continuous measurement. The voltage range from 3.7 V – 6.5 V can be monitored. The monitoring limits can be configured within this range.

NOTE

The monitoring of the bridge feed voltage must always be simultaneously deactivated for min. and max. (both limit values 0) or activated (both limit values within the valid range).

No monitoring limit can be configured in the voltage range from 0 V to 3.7 V.

5.2.10 Setting, saving and displaying values

When offset and sampling points are loaded into the weighing module, these values are stored in non-volatile memory in the weighing module:

- The successful loading of the values is checked while loading.
- A change to the configuration with regard to the running time is possible.
- Using the control commands for issuing, the saved/used values for offset and sampling points can be read.

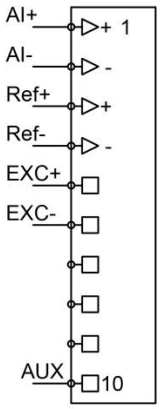
In the case of a module change, these values for offset and sampling points must be reconfigured.

5.3 Works parameters

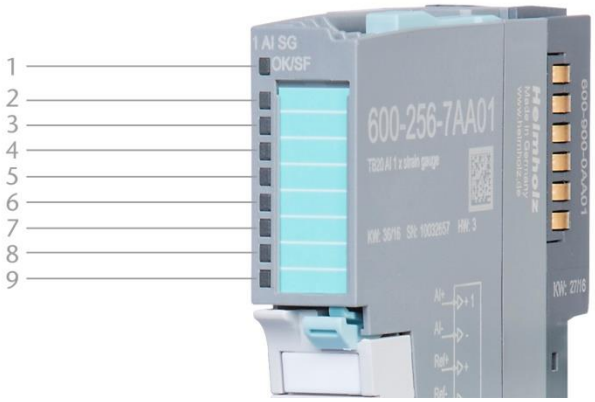
The default values for the module parameters are part of the firmware and can't be changed. When no parameters are transferred to the module, the module uses default values for all parameters. The default values are documented in chapter 8.

5.4 Pin assignment

Terminal	Assignment	Function
1	AI+	+Signal
2	AI-	-Signal
3	REF+	+ Sensor line
4	REF-	- Sensor line
5	EXC+	+ Feed line
6	EXC-	- Feed line
7	-	Reserved
8	-	Reserved
9	-	Reserved
10	AUX	AUX



5.5 LEDs of the weighing module



LED	Name	Display	Description
1	OK/SF LED	Solid blue light	The module is running (RUN)
		Slowly flashing blue light	The module is stopped (STOP)
		Quickly flashing blue light	The module is idle (IDLE); module's parameters have not been configured yet
		Flashing red	The module is indicating a parameter assignment error
2		Solid green light	Measurement running
3		Solid red light	Bridge supply voltage outside of valid limits (HW limit or configuration)
4		Solid red light	Line break
5		Red On	Error while reading/saving a sampling point/offset
6-9	Reserved		

For diagnostics reports see chapter 9.

NOTE

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

6 Commissioning

6.1 Initial commissioning of the TB20 strain gauge weighing module

The initial commissioning of the TB20 strain gauge weighing module can take place without the master control system with the help of the TB20 ToolBox and the bus coupler. During the commissioning, the characteristic of the weighing module must first be defined (see chapter 5.2.5).

Procedure for commissioning:

- Define the maximum quiescent point by setting the characteristic value of the load cell and the rated load of the load cell in the parameter data (see chapter 6.2).
- Following configuration, the zero point of the characteristic must be defined by setting the offset of unladen load cells. For the initial commissioning, it makes sense to set the offset to 0. (see chapters 5.2.6 and 9.2, and 9.3)

Optional:

- linearize the characteristic through configuration of the sampling points
- Change offset, e.g. for a measurement vessel. The offset may only be set for an unladen scale! There is no unladen weight function. In order to tare a measurement vessel, the weight of the vessel must be written in the load value of the offset.

Sampling points and offset can be set as desired and at any time, and are always saved remanent in the weighing module, even if this means that the monotony of the characteristic is violated and the value becomes invalid.

6.2 Parameters and configuration

The TB20 strain gauge weighing module differentiates between parameter values and configuration values.

Parameter values:

- Measuring range
- Conversion rate
- Values for averaging
- Number of sampling points
- Characteristic value of the load cell
- Rated load of the load cell
- Min. bridge feed voltage
- Max. bridge feed voltage

Configuration of the weighing module takes place via the user program of the bus master or the TB20 ToolBox. The parameter values are loaded to the weighing module at the start of the system.

Parameter values are stored in the user program in the PLC or in the bus coupler. See chapter 8 for a precise description of the parameters.

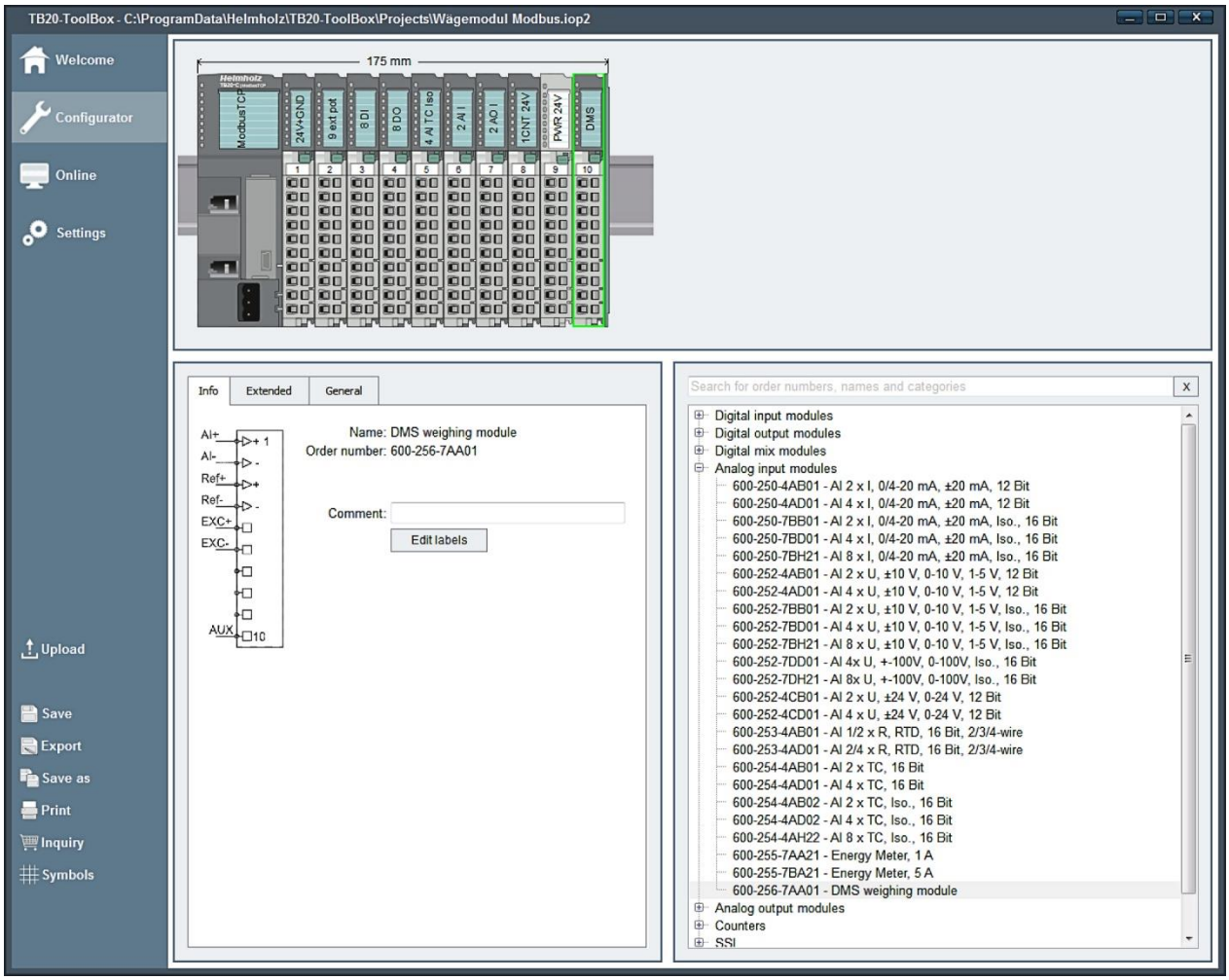
Configuration values:

- Offset
- Sampling point 1 ... 5

The configuration parameters are transferred from the user program to the weighing module or are set with the help of the TB20 ToolBox. The configuration parameters are permanently stored in the weighing module.

See chapters 9.2 and 9.3

6.3 Configuration with the TB20 ToolBox



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

The weighing module is configured via the user program of the bus master (PLC) when using the following couplers:

- PROFIBUS-DP
- PROFINET IO

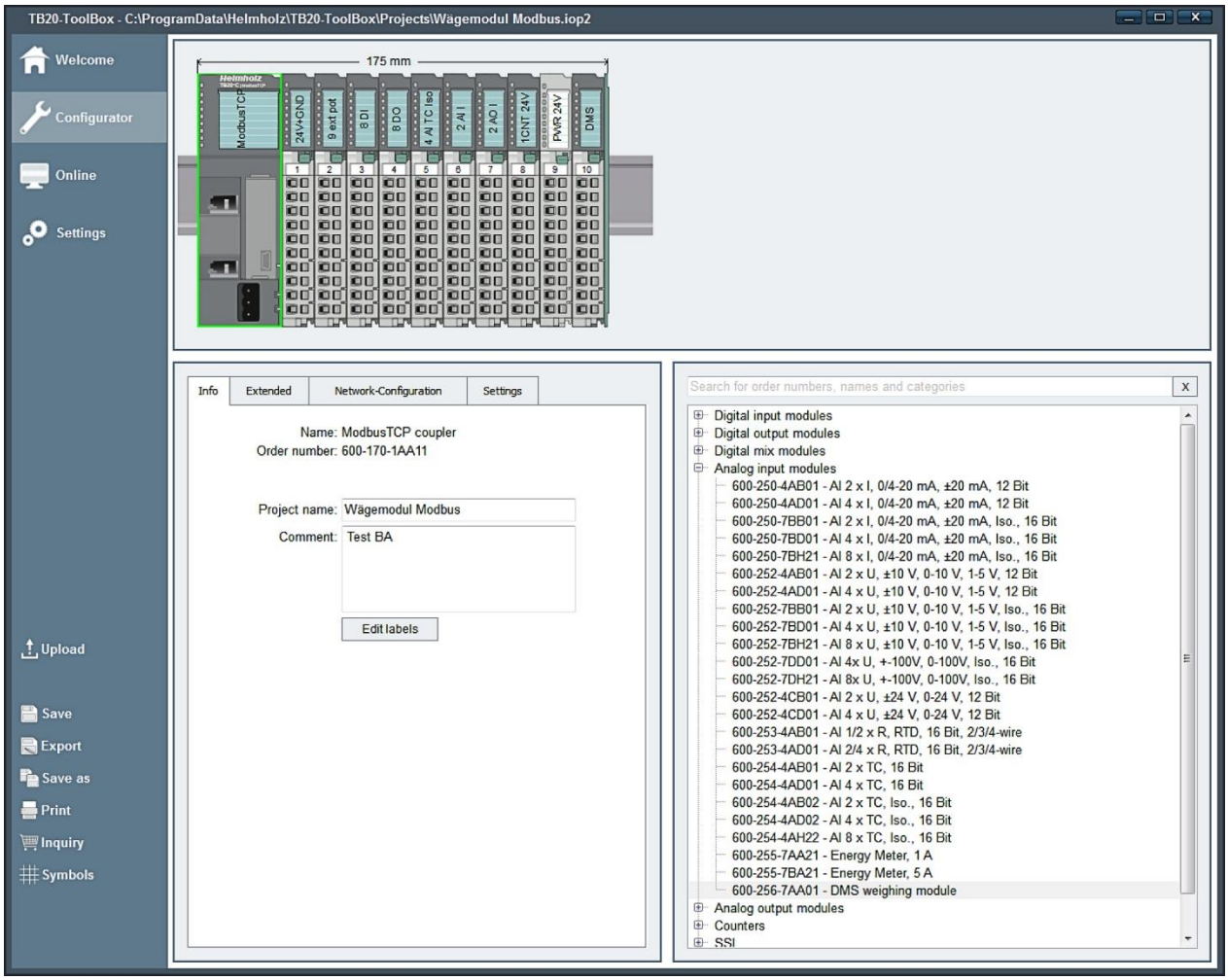
See chapter Fehler! Verweisquelle konnte nicht gefunden werden..

The weighing module is configured using the TB20 ToolBox when using the following couplers:

- CANopen
- Ethernet/IP
- ModbusTCP
- EtherCAT
- DeviceNet

6.3.1 Install TB20 ToolBox

Download the TB20 ToolBox from the Helmholz homepage www.helmholz.de. The TB20 ToolBox runs on Windows* 7, 8, 8.1, and 10.



A cable with USB 2.0 A plug to USB Mini B plug is required for communication with a TB20 bus coupler.

The Helmholz USB driver must be installed once on the computer under Windows* 7, 8, 8.1. Windows* 10 requires no additional USB driver.

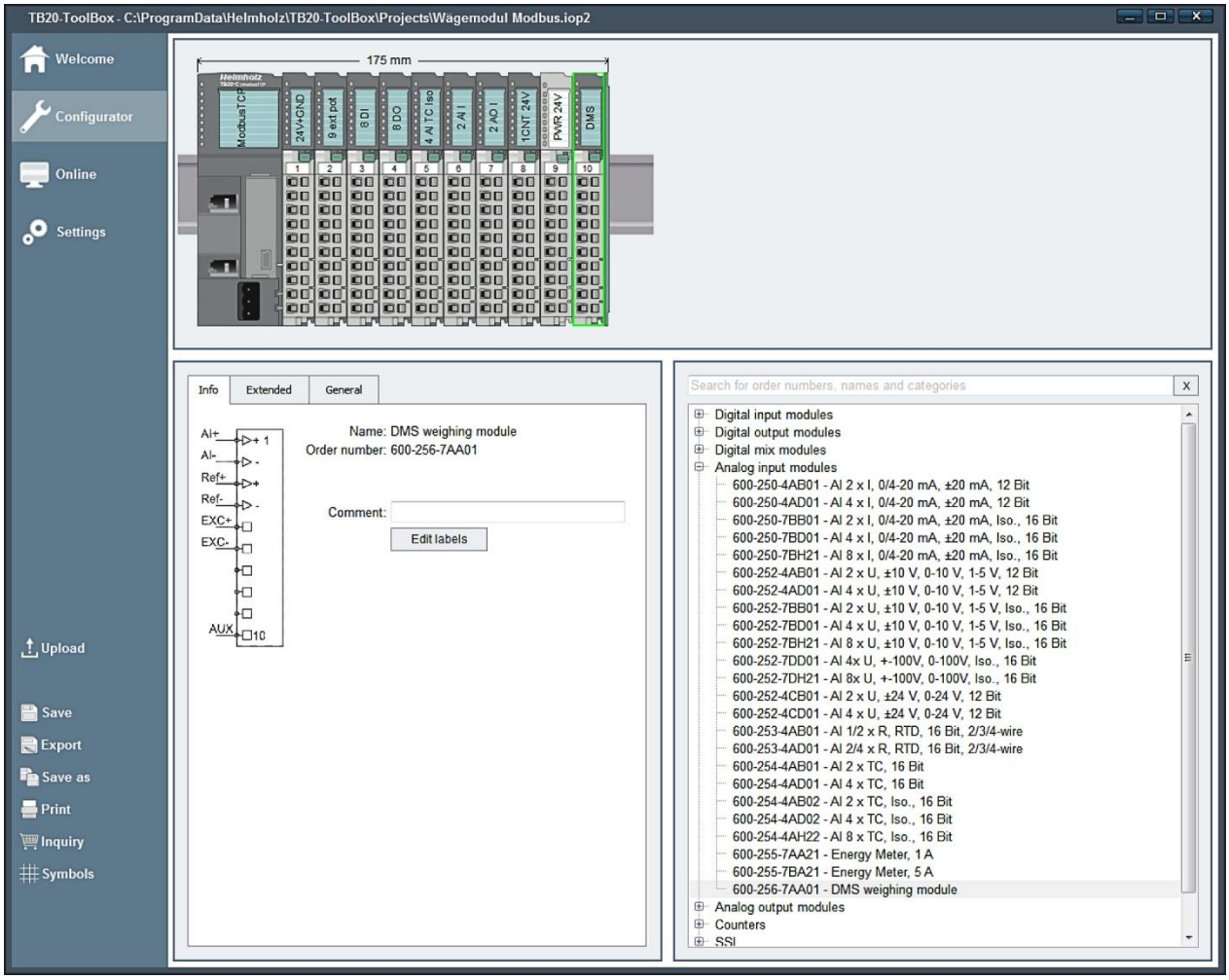
The Helmholz USB driver is contained in the installation file as of TB20 ToolBox version 1.38. It is also possible to download the USB driver from the Support page.

Start TB20 ToolBox

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

6.3.2 Configuration of the weighing module in a project

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



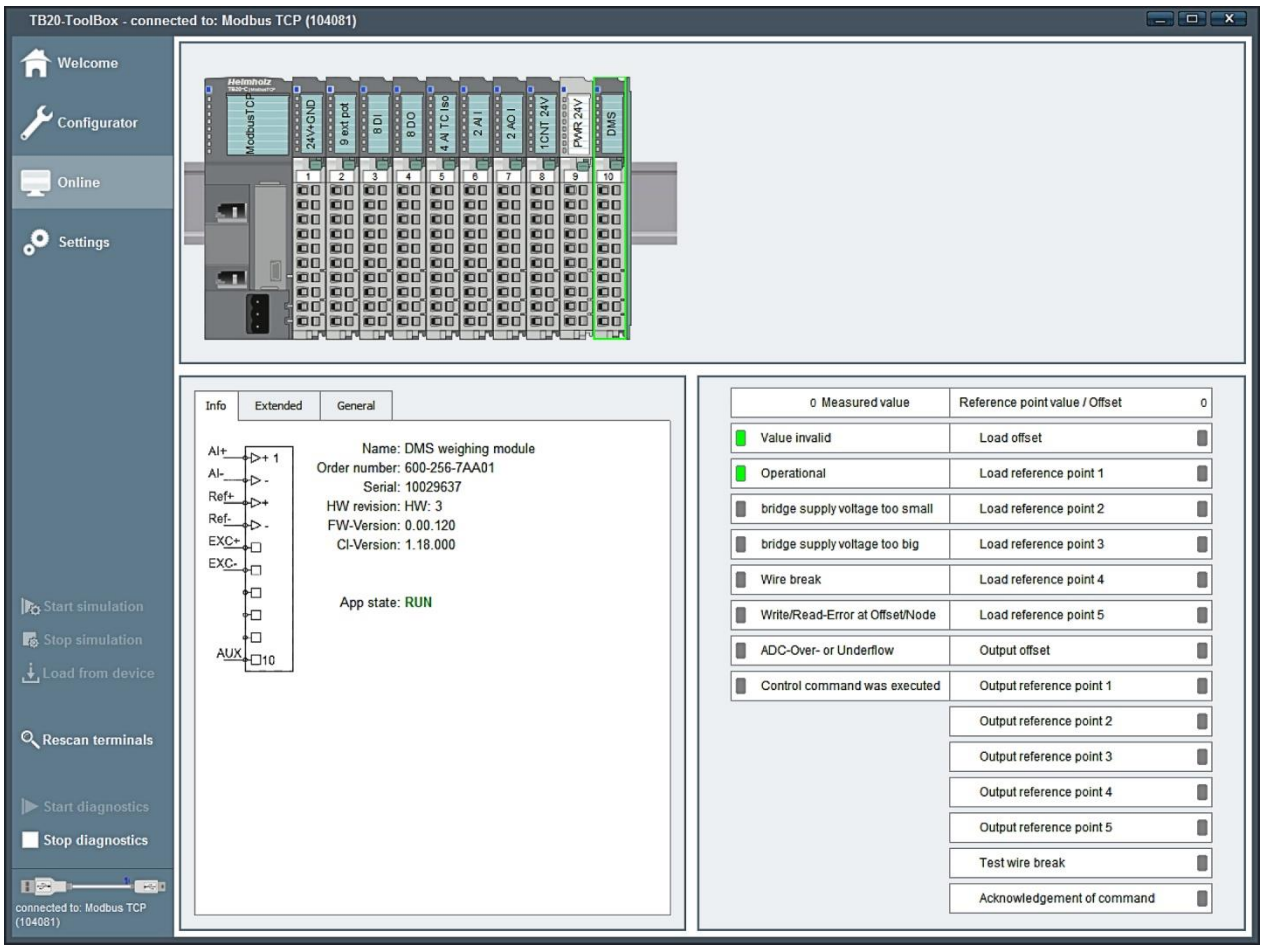
The weighing module is found under "Analog input modules." Paste the weighing module with a double click or with drag & drop.

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

When using PROFIBUS or PROFINET, configuration is carried out via the GSD or GSDML in the programming surface of the PLC or of the master configurator.

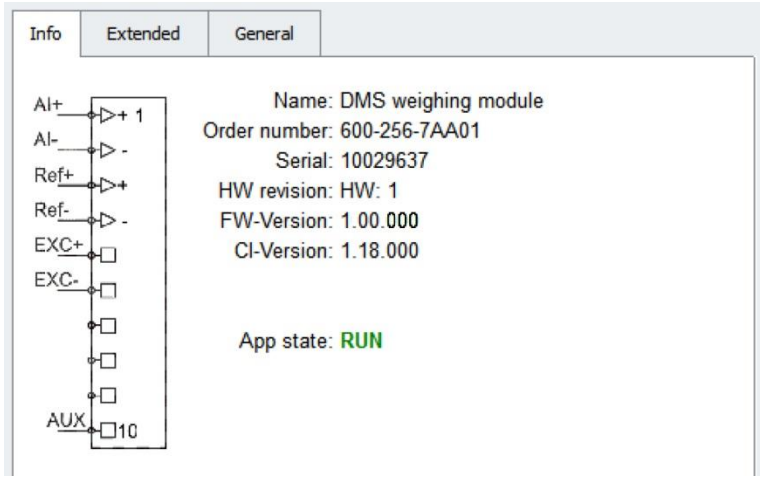
When using CANopen, Ethernet/IP, ModbusTCP, EtherCAT, or DeviceNet, configuration takes place in the "Configurator" menu under "General." For configuration of the planned hardware, an upload of the TB20 ToolBox project takes place on the coupler.

6.3.3 Display of the weighing module



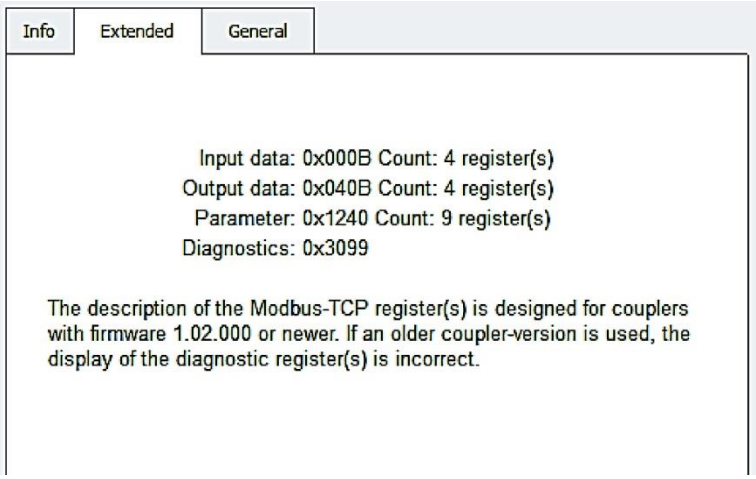
Online operation of the TB20 ToolBox enables observation of a configured TB20 in running operation.

The diagnostics start after the coupler is clicked. The currently active parameter values of the weighing module are displayed when the weighing module is clicked.



- **Name** Catalog name of the module according to hardware catalog
- **Order number** according to Helmholz catalog
- **Serial number** of the installed module

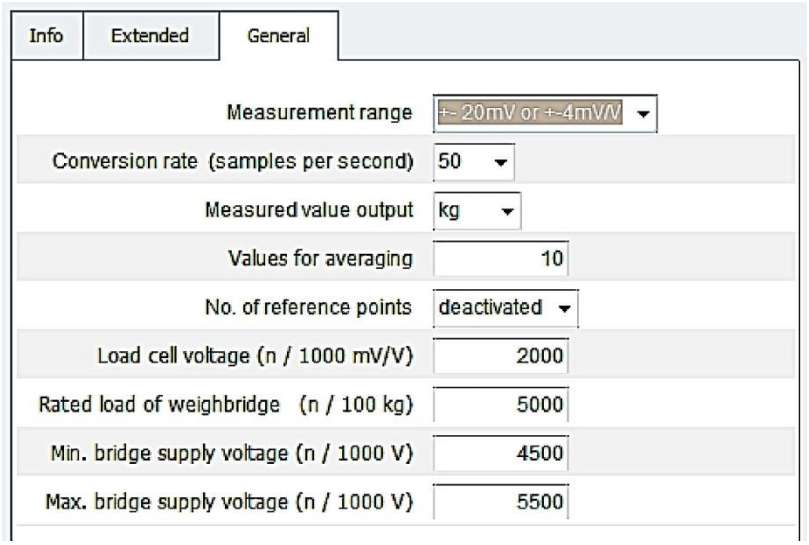
- **HW revision** of the installed module
- **FW version** of the installed module
- **CI version** of the installed module
- **App status** Operating status of the weighing module



Other displays depending upon the bus coupler used. In the figure above, with the example of the ModbusTCP coupler:

- Input data length, tab
- Output data length, tab
- Parameter length
- Diagnoses

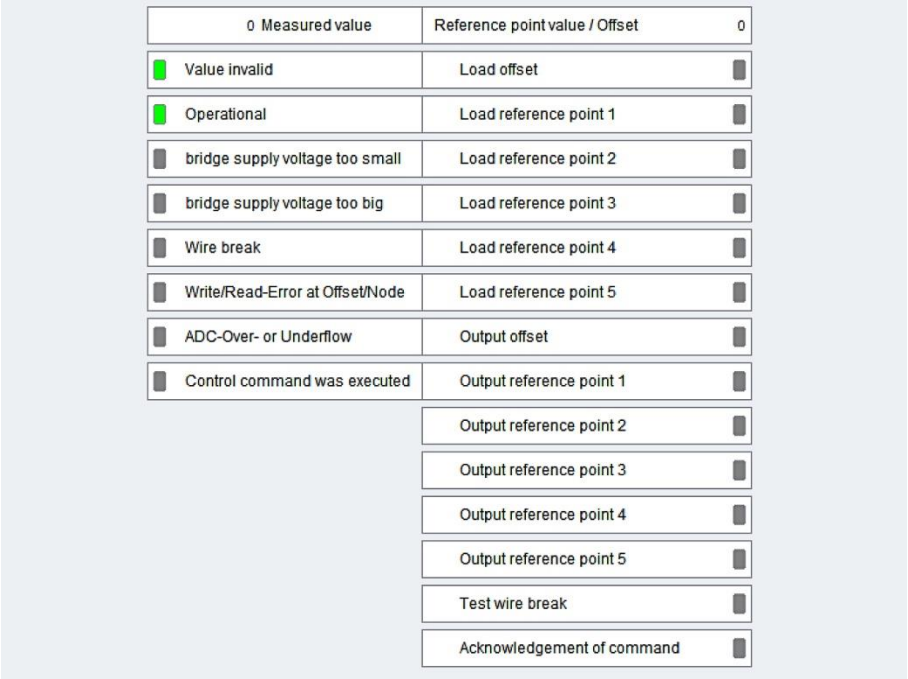
Show "General" tab / parameters:



The configuration of the planned hardware takes place through an upload of the TB20 ToolBox project to the coupler or through configuration with GSD or GSDML.

Measuring range	+-20 mV or +-4 mV/V +-10 mV or +-2 mV/V
	The resolution of the D/A converter is doubled in the measuring range 2 mV/V. The measuring range can be exceeded until the IB5 Bit 5 "ADC overflow or underflow (=1)" reports the overflow of the ADC. At the same time, the IB4 Bit 0 "Value valid. (=1)" is set to 0.
	The rated load of the connected load cell is to be considered. Measurement errors can occur when the rated load is exceeded.
Conversion rate (samples per second)	6.25; 7.5; 12.5; 15; 25; 30; 50; 60
Issuing of measurement value	mV/V; kg
Values for averaging	1, 2 ... 255 The time for the averaging can be calculated by multiplying the number of averages and the conversion rate.
Number of sampling points	deactivated;, 1 ... 5
Characteristic value of the load cell	0.001 to 4.000 [mV/V] (entry without period)
Rated load of the load cell	0.01 to 100000.00 [kg] (entry without period)
Minimum bridge feed voltage	0 = no monitoring 3.700 to 6.500 [V] (entry without period) Lower monitoring limit on the sensor line Terminals 3 and 4.
Maximum bridge feed voltage	0 = no monitoring 3.700 to 6.500 [V] (entry without period) Upper monitoring limit on the sensor line Terminals 3 and 4.

Right window: Display of live statuses (IO data):



Measurement value: Current measurement value in mV/V or kg, or issuing of the configured offset in kg or of the configured sampling points in kg.

Value valid: for causes for an invalid measurement value see chapter 0.
In the case of moving averaging, the "Value valid" display is delayed. For the averaging, the measurement cycle must be run through once until a valid measurement value is displayed.

Bridge feed voltage is too small: the voltage prevailing at the terminals REF+/REF- is smaller than the configured min. voltage limit. No reporting when the voltage monitoring is deactivated.

Bridge feed voltage is too large: the voltage prevailing at the terminals REF+/REF- is greater than the configured max. voltage limit. No reporting when the voltage monitoring is deactivated.

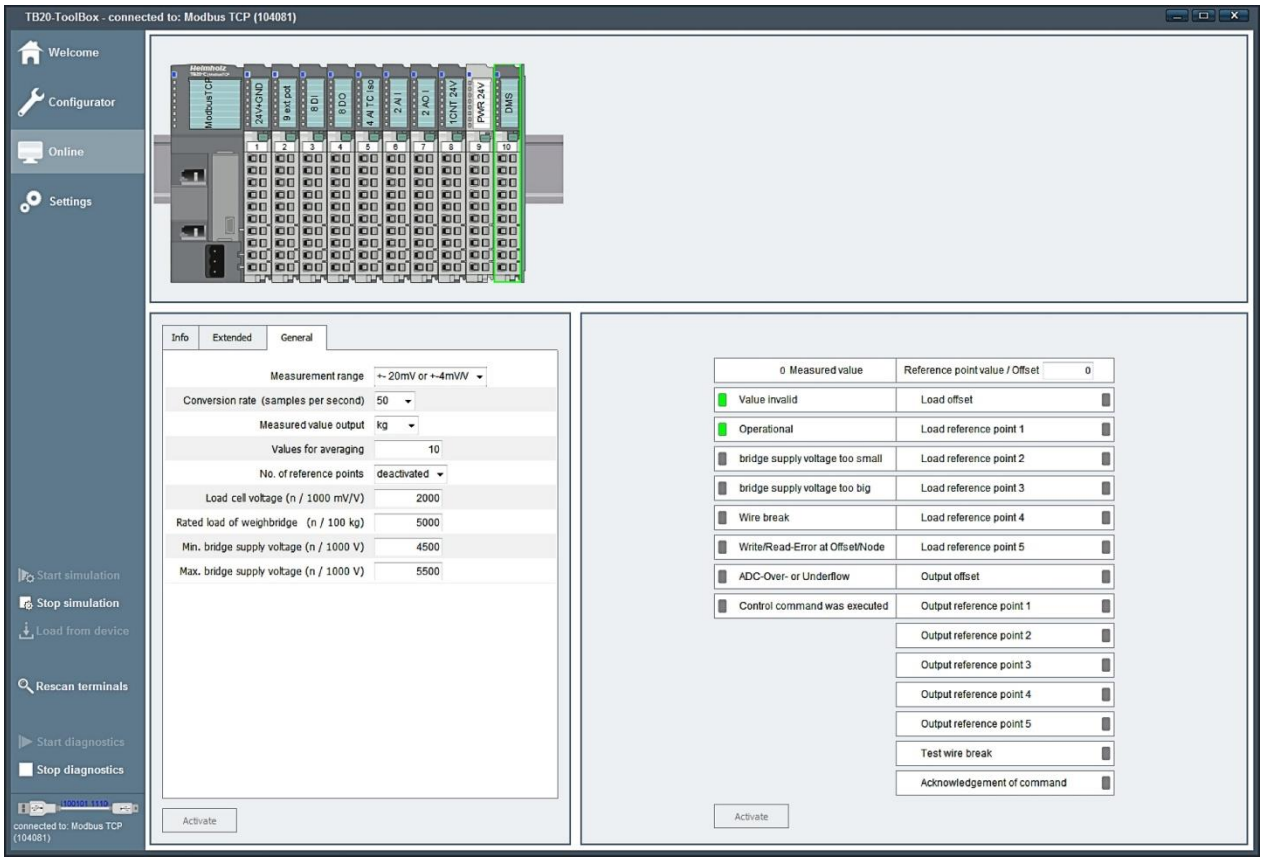
Line break: display when a line break of the AI+ sense line is determined. The measurement of the measuring lines to the load cell must be initiated by the bus master or in the simulation.

Writing/reading error for offset/sampling point: The configuration values for offset/sampling point are only transmitted once via the bus during the configuration or when reading out. The message appears when an error has occurred in the EEPROM while writing an offset or sampling point.

ADC overflow: the measurement inputs neighboring on the AI+/AI- or REF+/REF- result in the overflow/underflow of the analog-digital converter of the measurement channel.

Control command executed: shows that a control command has been carried out. The bit must then be reset by the "Acknowledgment bit for system command was executed" OB5 Bit 7.

6.3.4 Configuration and reading out of the measurement values without a connection to the bus master



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

The TB20 ToolBox must be connected with the coupler via USB and be online when starting the simulation.

If no appropriate project is saved in the TB20 ToolBox, the currently connected configuration can be read out and saved as a project:

Load from device

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

Going online again

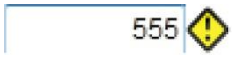
Start simulation

ATTENTION Interruption of communication with the control system!

The simulation operation interrupts the bus communication. The coupler logs out from the bus during simulation operation.

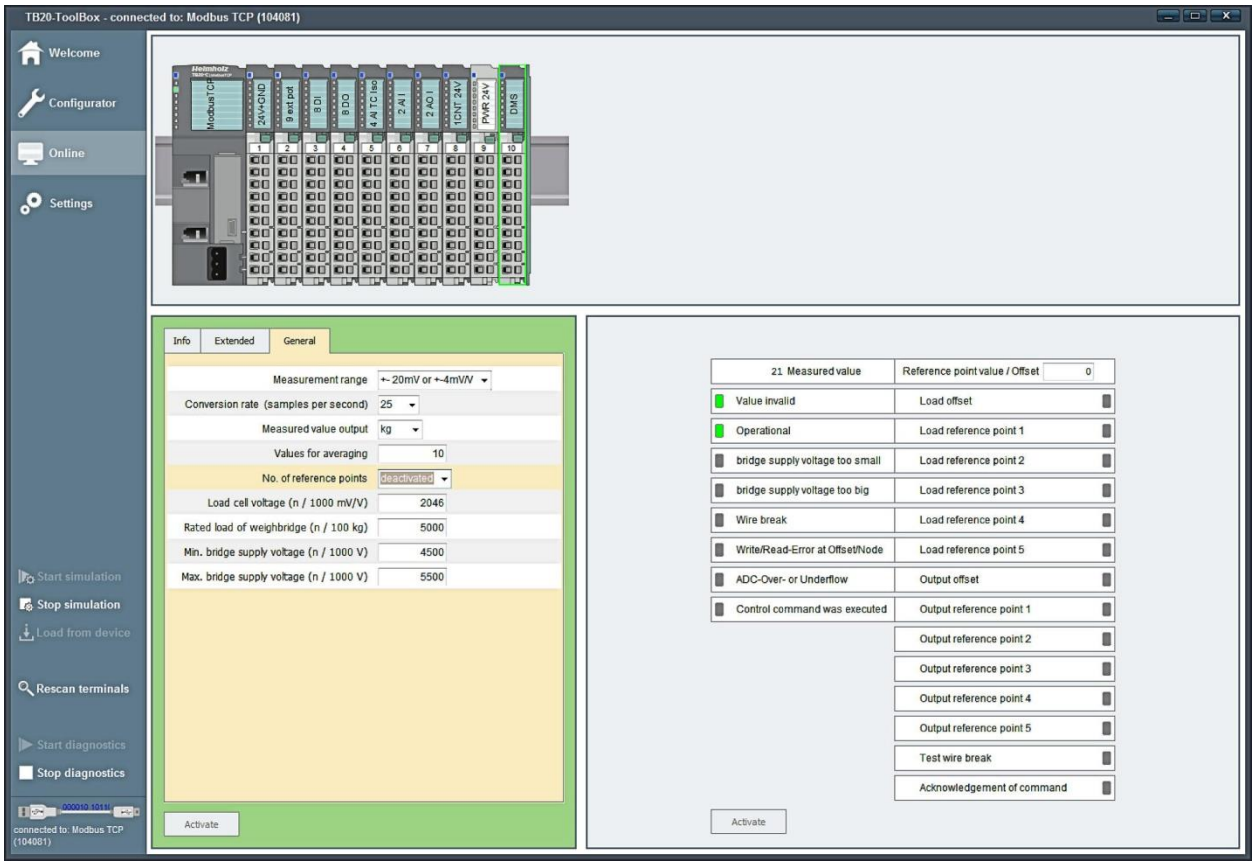
Mark the coupler by clicking it and start the simulation.

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



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

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



NOTE

All parameter settings are reversed following the end of simulation operation!

6.4 Use the weighing module with PLCs

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

6.5 Use the weighing module with STEP7 or TIA

The weighing module can be incorporated into the project and configured with a GSD file (PROFIBUS) or GSDML file (PROFINET). The GSD and GSDML files can be downloaded in the download area under www.helmholz.de.

The weighing module can be configured and read out with the S7 program.

The data exchange with the weighing module is described in chapter 9; for configuration see chapter 8.

7 Measurement wiring

7.1 Specific safety instructions

ATTENTION Equipment damage due to incorrect wiring!

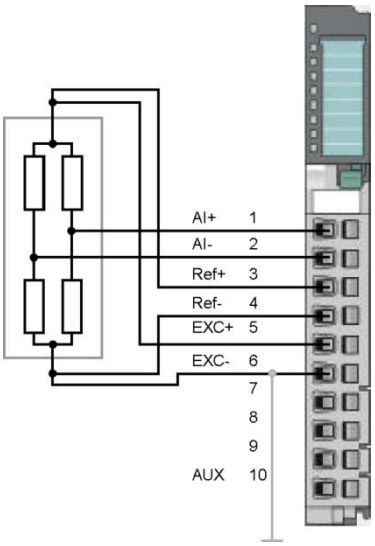
Measurements must be carried out in full bridge circuit. No voltage may be attached directly to the signal inputs. Use load cells in your measurement wiring that are appropriate for the input voltage range of the weighing module.

7.2 Measurement wiring

Load cell with 6-conductor connection

The supply voltage is measured directly at the load cell via dead measuring lines. The voltage supply is provided through the weighing module. Voltage fluctuations at the load cell are detected

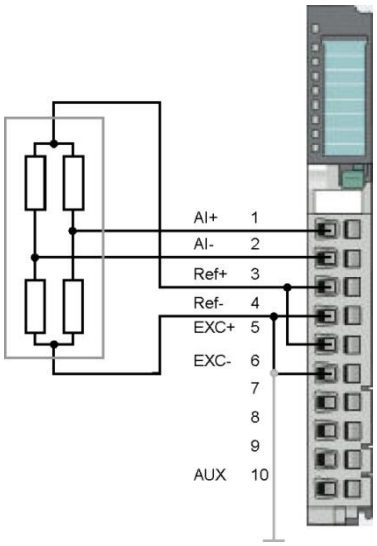
The 6-conductor connection should be used for line lengths of >5 m for high precision requirements and for large temperature fluctuations during the measurement.



Load cell with 4-conductor connection

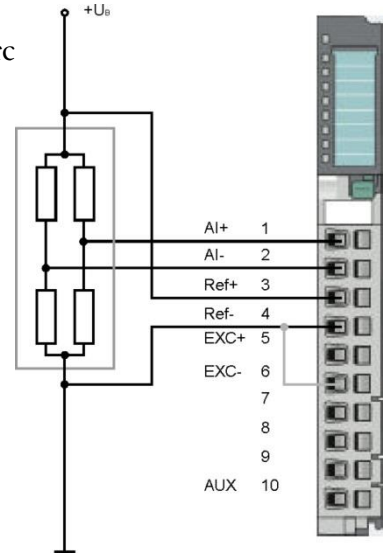
The supply voltage for the load cell is measured by the weighing module via the supply line. With long lines, the voltage drop on the supply lines can falsify the measurement.

The 4-conductor connection should only be used for line lengths of <5 m.



Load cell with 4-conductor connection and external feed

The supply voltage for the load cell comes from an external voltage sourc dead.

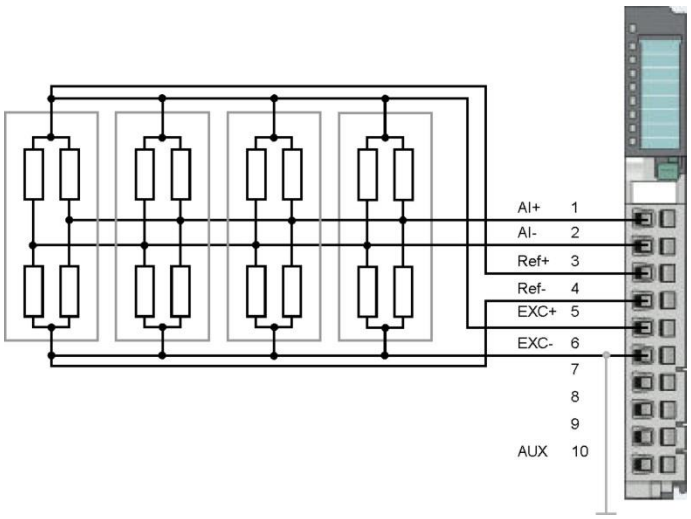


NOTE

The measurement connection of the bridge feed voltage is not necessary for the operation of the weighing module.

Parallel connection of load cells with 6-conductor connection

If several load cells are necessary for a measurement, the load cells can be connected parallel. The supply voltage is measured directly at the most distant load cell via dead measuring lines. The voltage supply is provided through the weighing module. Voltage fluctuations at the load cell are detected

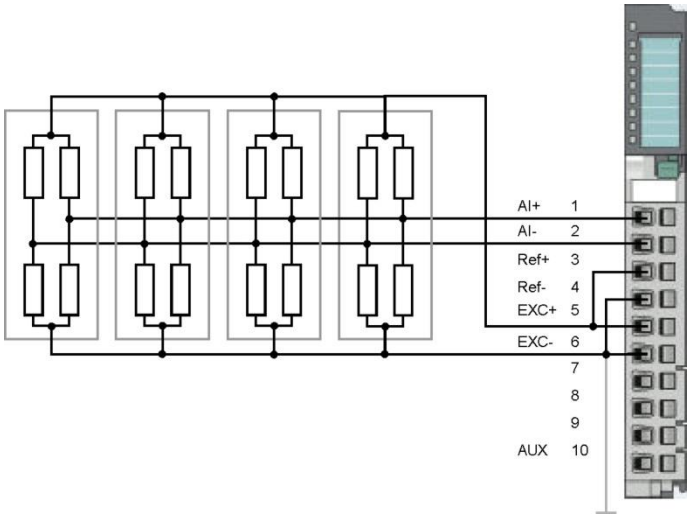


Parallel connection of load cells with 4-conductor connection

If several load cells are necessary for a measurement, the load cells can be connected parallel.

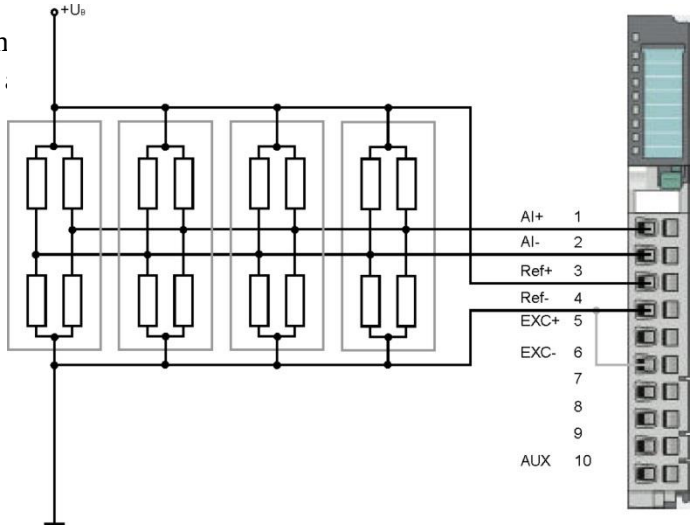
The supply voltage for the load cell is measured by the weighing module via the supply line. With long lines, the voltage drop on the supply lines can falsify the measurement.

The 4-conductor connection should only be used for line lengths of <5 m.



Parallel connection of load cells with 4-conductor connection and external feed

If several load cells are necessary for a measurem
The supply voltage for the load cell comes from
The measuring lines are dead.



NOTE

The measurement connection of the bridge feed voltage is necessary for the operation of the weighing module.

7.3 Measuring method

The measurements take place with a Wheatstone bridge in full bridge circuit with 4 or 6-conductor connection. The bridge voltage resulting from the detuning of the Wheatstone bridge is measured. The weighing module provides a voltage of 5 V from the back wall bus of the TB20 system as feed voltage. The bridge connection can be fed externally.

The feed voltage is monitored via sensor lines. In the case of a 6-conductor connection, the sensor lines are connected at the terminal of the load cell feed voltage. In the case of a 4-conductor connection, the sensor lines at the weighing module are connected at the output of the feed voltage.

A wire break detection is possible for 6-conductor connection.

The recording rate can be configured in steps between 6.25 Hz and 60 Hz. The measurement value can be issued in mV/V or kg. The issued measurement value can be averaged over a max. of 255 measurement values. Faults of the load cell can be compensated via a characteristic linearization with a max. of 5 sampling points and the measurement range of the weighing module can be adapted to the weight to be weighed.

Bridge feed output and measurement inputs are protected against 24 V. The weighing module is electrically isolated from the backplane bus.

8 Parameters of the weighing module

The configuration takes place for the measuring of bridge voltages of a load cell and issuing in mV/V or standardized in kg. The weighing module is configured over a data range of 15 bytes.

The default settings are underlined.

Parameters	Address	Description	Value range
Operating mode 1	Byte 0	Operating mode in which the load cell module works.	1: Measuring Mode
Measuring range	Byte 1: Bit 0	Measurement range in which the AD converter works.	0: ±20 mV or ±4 mV/V 1: ±10 mV or ±2 mV/V
Conversion rate	Byte 1: Bit 1-3	The conversion rates can be configured in samples per second (SPS).	0: 6.25 1: 7.5 2: 12.5 3: 15 4: 25 5: 30 6: 50 7: 60
Issuing of measurement value	Byte 1: Bit 4	Representation of the measurement value	0: kg 1: mV/V
Number of values for the averaging	Byte 2	The measurement values can be steadied through a moving average filter with a differing number of averages.	1: no filtering (n=1) n = 2 ... 255
Number of sampling points to be used	Byte 3: Bit 0-2	Number of sampling points (to be used ascending and without gaps!)	0: Sampling points are not used n = 1...5
Characteristic value	Byte 4– Byte 5	Characteristic value of the connected load cell in mV/V with 3 decimal places (e.g. 2.345 are transferred as 2345)	1 to 4000
Rated load	Byte 6 – Byte 9	Rated load of the connected load cell in kg with 2 decimal places (10000, for example, is transferred as 100.00 kg)	1 to 10000000
Minimum bridge feed voltage	Byte 10 – Byte 11	Feed voltage with 3 decimal places. Transferred are, for example, 3756 as 3.756 V. When min. and max. values are zero, the monitoring of the bridge feed voltage is deactivated.	0 or 3700 to 6500 Minimum voltage must be less than the maximum bridge feed voltage
Maximum bridge feed voltage	Byte 12 – Byte 13	Feed voltage with 3 decimal places. Transferred are, for example, 5123 as 5.123 V. When min. and max. values are zero, the monitoring of the bridge feed voltage is deactivated.	0 or 3700 to 6500 Minimum voltage must be greater than the minimum bridge feed voltage.
Reserved	Byte 14		0

9 Operation of the weighing module

9.1 Data transfer between the PLC and the weighing module

For the operation of the weighing module behind a TB20 bus coupler, a command must be carried out once when starting up in order that the module is ready for operation (e.g. load offset + acknowledgment). The master writes data into the outputs and reads data from the inputs of the bus coupler.

9.1.1 Setup of the control commands

Outputs: 7 bytes

	7	6	5	4	3	2	1	0
OB 0 - 3	Sampling point value / offset (for example, 10000 transferred as 100.00 kg)							
OB 4	Reserved	Reserved	Load sampling point 5	Load sampling point 4	Load sampling point 3	Load sampling point 2	Load sampling point 1	Load offset
OB 5	Acknowledgment for "Control command has been carried out"	Carry out wire break test	Output sampling point 5	Output sampling point 4	Output sampling point 3	Output sampling point 2	Output sampling point 1	Output offset
OB 6	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

9.1.2 Setup of the response data

Inputs: 8 bytes

	7	6	5	4	3	2	1	0
IB 0 - 3	Return value Measurement value of the load cell or saved value (offset/sampling point) (Transferred are, for example, 10000 as 100.00 kg or 2345 as 2,345 mV/V depending upon the issuing unit)							
IB 4	1 = Ready for operation	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Value valid. (=1)
IB 5	Control command was carried out (= 1)	Reserved	ADC overflow or underflow (=1)	Fault when reading or saving a sampling point/offset (=1)	Reserved	Line break (=1)	Bridge feed voltage is too large (= 1)	Bridge feed voltage is too small (=1)
IB 6	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
IB 7	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

9.1.3 Diagnostic messages

NOTE

The reading out of the messages takes place together with the data and must be initiated by the program of the master control system, see chapter 9.1.

Messages that can be read out over response data are:

- Value valid: The "Value valid" bit is set to invalid as long as the following situation prevails:
  - The AD converter switches to overflow.
  - A calculation for determining the measurement value switches to overflow
  - One or several sampling points violate the monotony.
- Ready for operation
- Bridge feed voltage is too small
- Bridge feed voltage is too large
- Wire break
- Writing/reading error for offset/sampling point
- ADC overflow or underflow
- Control command executed

A configuration error is reported via the corresponding diagnostics.

9.2 Set and read out the offset/sampling point values with the PLC

Example of configuration of the offset/sampling point values

Prerequisite: A correctly configured TB20 load cell system in the cyclical data exchange with a PLC.

When carrying out the following functions, only the calling up of an individual function via the corresponding bit is allowed. When several functions are indicated simultaneously, the module carries out none of the functions. The return bit "Value valid" IB4 Bit 0 is not relevant for the following functions.

9.2.1 Load offset/sampling points

NOTE

The scale must be unladen to set the offset value! To set the sampling point values, the scale must be laden with the gaging weights with the value of the sampling point to be set.

- Write the offset/sampling point value into the output data of the master control system, and thus into the weighing module into the output bytes OB 0 – 3.
- Set the corresponding sampling point bit in the output data of the master control system and thus write it into the weighing module into the output byte OB 4 Bit 0 – 5.
- Offset or the indicated sampling point is accepted and saved in the weighing module. The correctness must be verified in the user program by reading back the saved value. If an error occurs at some point throughout the entire procedure, the "Error while saving sampling point/offset" bit IB 5 Bit 4 is set. This bit is to be acknowledged with OB5 Bit 7.
- The "Control command has been carried out" bit IB 5 Bit 7 is then set by the module (except in the error case above) and is to be reset by the user through the acknowledgment bit for "Control command was carried out" OB5 Bit7.
- The module is then once again in the operating mode *Measure*.

9.2.2 Read out offset/sampling points

- Set corresponding issue bit Offset – sampling point x OB 5 Bit 0 – 5.
- When the indicated sampling point is displayed in the "Return value" IB 0 – 3, the bit "Control command has been carried out" IB 5 Bit 7 is set by the module, except in the case of the following error.
- If an error occurs at some point throughout the entire procedure, the "Error while reading or saving sampling point/offset" bit IB 5 Bit 4 is set. This bit is to be acknowledged with OB5 Bit 7.
- Following acceptance of the value by the user, the bit "Control command has been carried out" IB 5 Bit 7 is to be reset through the "Acknowledgment bit" OB5 Bit 7.
- The module is then once again in the operating mode *Measure*.

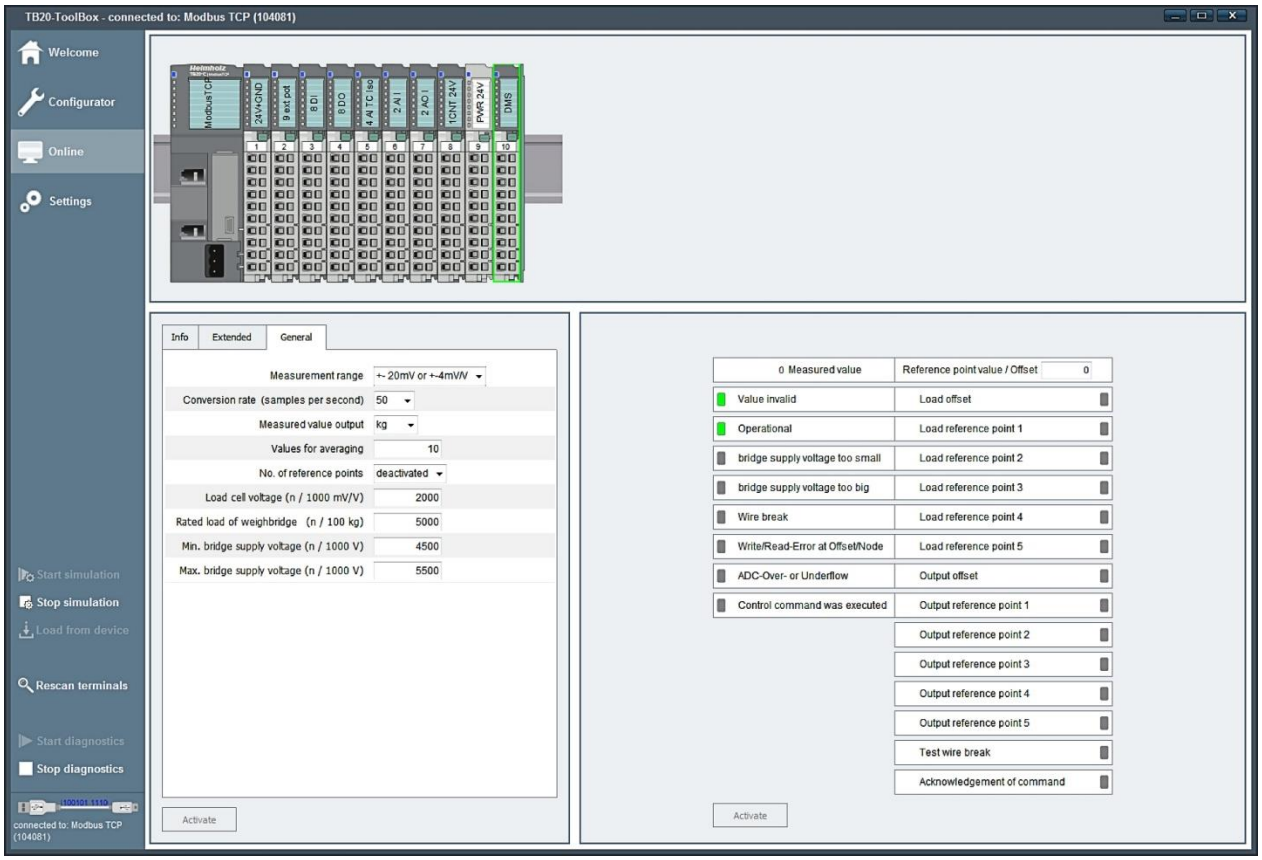
9.2.3 Carry out wire break test

The wire break monitoring must be initiated by the program of the master control system. The wire break monitoring doesn't take place cyclically and interrupts the continuous measurement procedure during testing. The wire break test only takes place on the AI+ Sense line.

- Set the bit "Carry out wire break test" AB 5 Bit 6.
- When the test has been carried out, the bit "Control command has been carried out" IB 5 Bit 7 is set by the module.
- In the bit "Line break" IB 5 Bit 2 of the response data, it can be determined whether a wire break has occurred or not.
- Following acceptance of the value by the user, the bit "Control command has been carried out" IB 5 Bit 7 is to be reset through the "Acknowledgment bit".
- The module is then once again in the operating mode *Measure*.

9.3 Read out and change offset/sampling point values with the TB20 ToolBox

With the help of the TB20 ToolBox, the measurement value of the load cell and the status displays of the weighing module can also be displayed in online operation without a connected master control system.
The configuration can be temporarily changed for test purposes in **simulation operation** with continuous measuring.

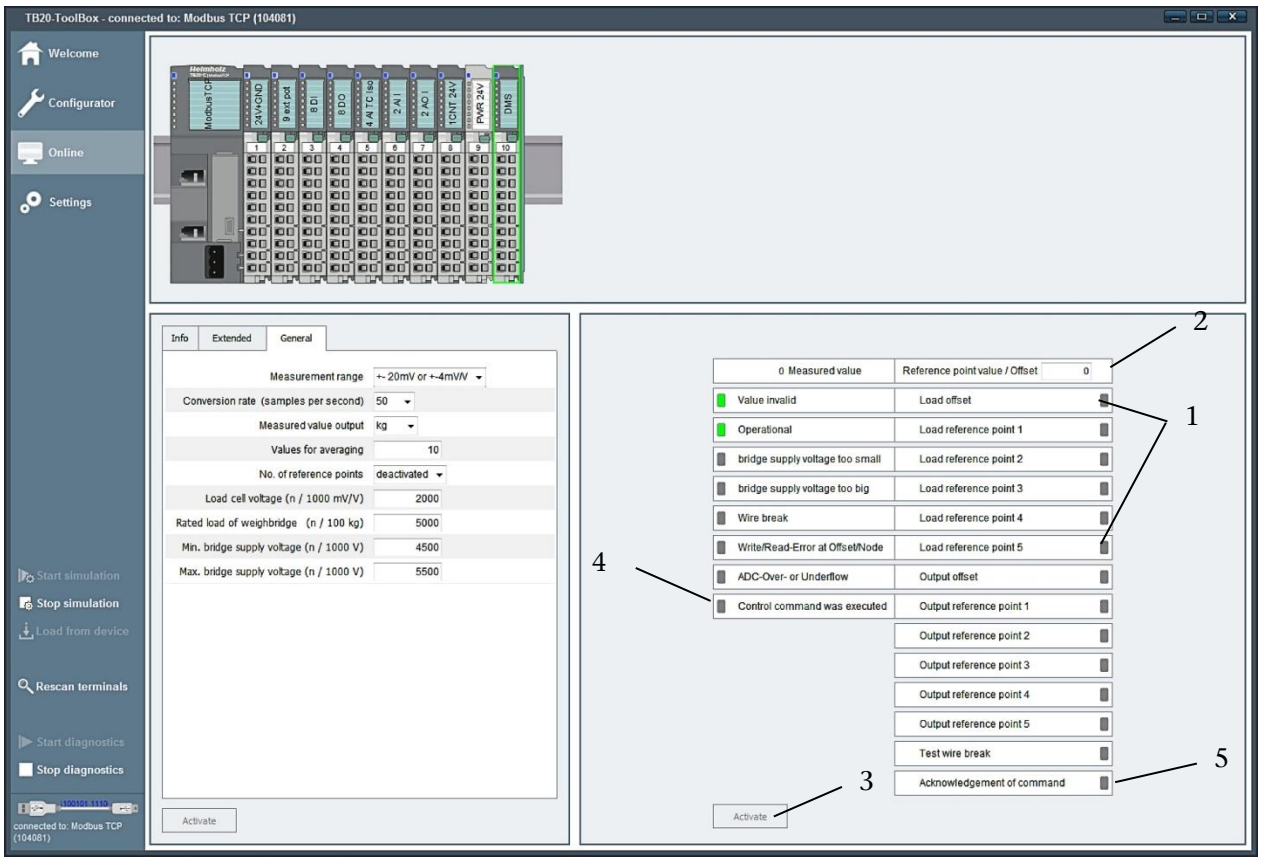


- Mark the module and call up the "General" window
- Edit the parameters to be changed in the left window.
  Changed lines and the window turn yellow.
- Activate click in the left window. The window briefly turns green following acceptance.
- When a prohibited value is entered, a warning appears and the window turns red. Activation is then no longer possible.

ATTENTION Malfunction of the control system!

The simulation operation interrupts the bus communication. The coupler logs out from the bus during simulation operation.

9.3.1 Setting offset/sampling point values



NOTE

The scale must be unladen to set the offset value! To set the sampling point values, the scale must be laden with the gaging weights with the value of the sampling point to be set.

NOTE

Only one load command may be carried out for offset/sampling points (1). No value is transferred when several load commands are carried out at the same time.

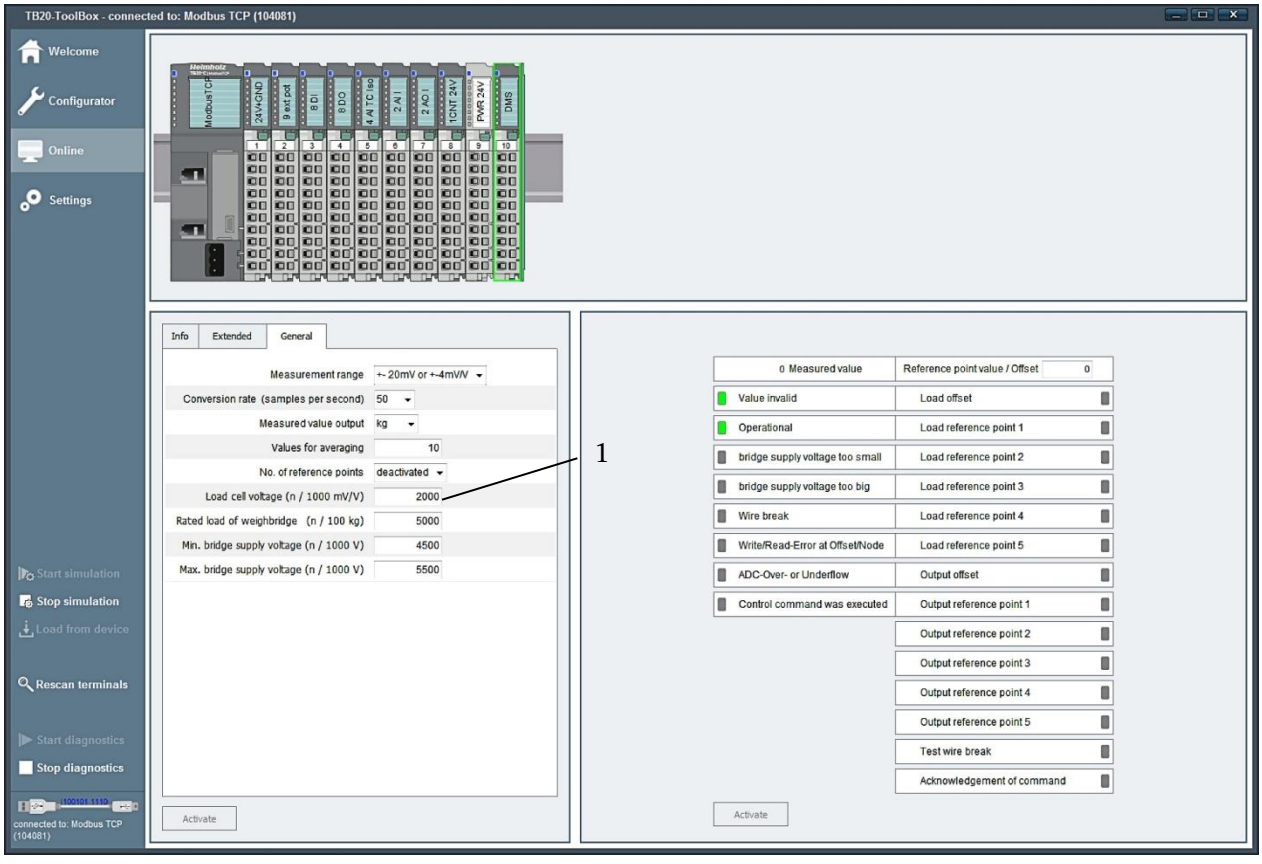
In the right window:

- Enter sampling point /offset value (2)
  (kg with 2 decimal places without comma)
- Activate the offset/sampling point value to be displayed; green display (1).
  The field turns yellow.
- Activate click in the right window (3). The window turns green following acceptance.

- When "Control command has been carried out" appears, green display (4), deactivate "Load offset/sampling point value again" (1) and set the "Acknowledgment bit for control command" (5)
- Activate click in the right window (3)
  The "Control command has been carried out" bit (4) is reset
- Deactivate the "Acknowledgment bit for control command" again (5). The field turns yellow.
- Activate click in the right window (3).
- Continue with the next sampling point

9.3.2 Activation of the sampling point values

Define and set the number of sampling points in the left window. Values in the numerical sequence of ascending values must be assigned to the sampling points. Activation only takes place for the duration of the simulation. The configured number of sampling points apply again following the end of the simulation. Parameters can't be changed and saved permanently in the simulation.



- Click the number of sampling points to be used in the pull-down menu (1); the window turns yellow.
- Activate click in the left window.
- The window turns green following acceptance of the change
- Check whether "Value valid" and "Ready for operation" are displayed in the right window.

Not all configured sampling point values must be used. When activating fewer than 5 sampling point values, the lowest in the sequence is used.

9.3.3 Deleting offset/sampling point values

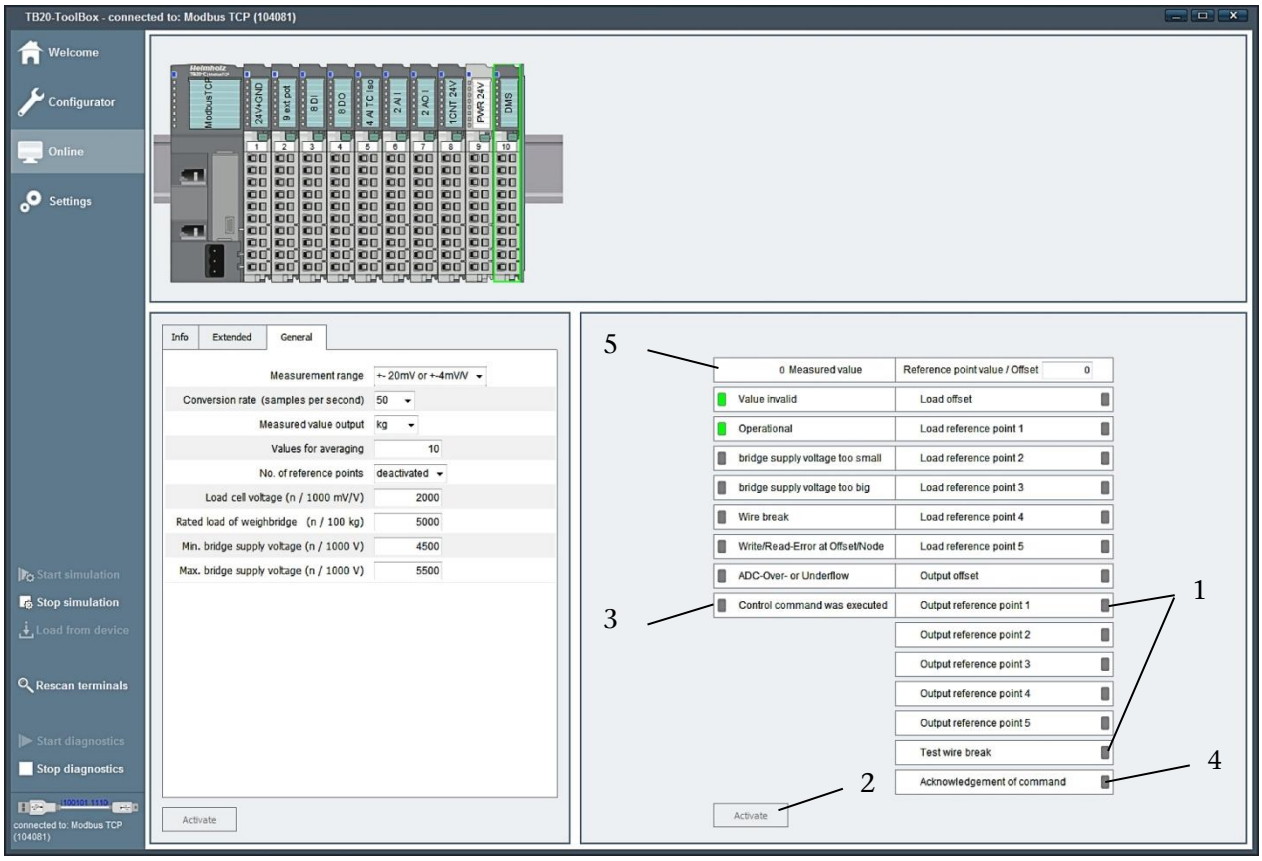
It is not possible to delete offset or sampling point values.

9.3.4 Saving offset/sampling point values

Offset and sampling point values are saved in non-volatile memory in the weighing module. The values stored in the weighing module are not overwritten by the upload of a project.

9.3.5 Reading out offset/sampling point values

Offset and sampling point values are saved in non-volatile memory in the weighing module. The offset and sampling point values can be read out with the help of the TB20 ToolBox.



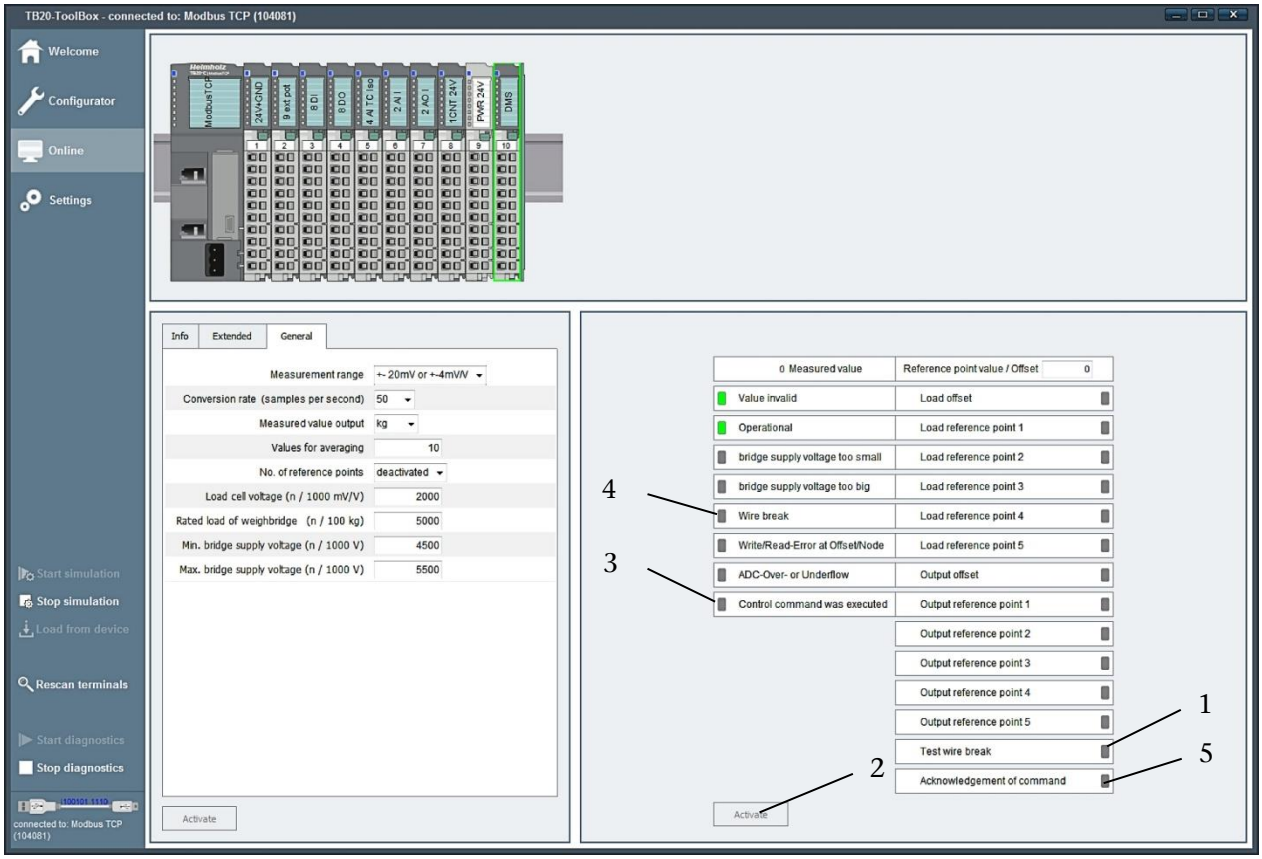
In the right window:

- Activate the offset/sampling point value to be displayed; green display (1).
  The field turns yellow.
- Activate click in the right window (2). The window turns green following acceptance.
- When "Control command has been carried out" appears, green display (3), the value to be read can be read off as a measurement value (5).
- Deactivate "Issue offset/sampling point value" again (1)
- Set "Acknowledgment bit for control command" (4)

- Activate click in the right window (2)
  The "Control command has been executed" bit (3) is reset and the measurement operation is continued. The measurement value is displayed again (5).
- Deactivate the "Acknowledgment bit for control command" again (4). The field turns yellow.
- Activate click in the right window (2).
- Continue with the next sampling point

9.3.6 Wire break test

A wire break test of the AI+ Sense line can be carried out with the TB20 Toolbox.



In the right window:

- Activate "Carry out wire break test", green display (1).
  The field turns yellow.
- Activate click in the right window (2). The window turns green following acceptance.
- When "Control command has been carried out" appears, green display (3), the wire break test can be evaluated (4).
- Deactivate "Carry out wire break test" again (1) and set the "Acknowledgment bit for control command" (5).
- Activate click in the right window (2)
  The "Control command has been carried out" bit (3) is reset

- Deactivate the "Acknowledgment bit for control command" again (4). The field turns yellow.
- 

click in the right window (2).

9.4 Important instructions for usage and configuration

NOTE

Limitation of the work range through offset.

An offset reduces the work range. The rated load of the load cell should be measured in such a way that the total of the offset load and the load to be weighed is less than the rated load of the load cell in order to avoid overloading the load cell.

NOTE

The values for the offset and the sampling points must be smaller than the rated load of the load cell.

The offset value and the value of the largest sampling point must be smaller than the rated load of the load cell. The total of the offset value and the value of the largest sampling point must be smaller than the rated load of the load cell.

An offset value greater than the rated load value of the load cell results in incorrect measurement values. The exceeding of the rated load by the offset value is not monitored. The measurement value does not become invalid.

The offset value can be composed of the own weight of the weighing mechanism and the weighing vessel used.

NOTE

The values for the sampling points must be ascending in a strictly monotonic manner.

Ascending in a strictly monotonic manner means that the following value is greater than the previous. Equal values are excluded with strict monotony.

NOTE

Following the changing of the parameters after an exchange of the load cells, the values for offset and the sampling points stored in the weighing module must be tested and reset where necessary.

The change to one of the following parameters makes a new comparison of the offset and the sampling points necessary:

- Characteristic value of the load cell
- Rated load of the load cell

NOTE

The monitoring of the bridge feed voltage must always be activated or deactivated for min. and max. simultaneously.

A respectively valid value must be entered for the min. and the max. bridge voltage or 0 must be entered for both values when no monitoring is to take place.

The voltage range from 0 V to 3.7 V cannot be monitored. The entry of voltage values 0 V < U < 3.7 V result in a configuration error.

NOTE

When the configuring of the weighing module doesn't take place through the master control system, the configuration is lost with a replacement of the bus coupler.

The configuration of the weighing module is saved for the following bus couplers:

- CANopen
- Ethernet/IP
- ModbusTCP
- EtherCat
- DeviceNet

When the bus coupler is exchanged, the weighing module is reset to the factory setting and must be loaded with a saved project with the help of the TB20 ToolBox or reconfigured. The values for offset and sampling points are saved in the module and are retained, but can become invalid in the event of a deviating reconfiguration.

NOTE

The wire break monitoring must be initiated by the program of the master control system; see chapter 9.1.

The wire break monitoring doesn't take place cyclically and interrupts the continuous measurement procedure during testing; see chapter 9.1.

10 Usage instructions for load cells

10.1 Principle of measuring with strain gauges

Mass, force, and torque cannot be directly measured as an electrical signal. The conversion of a force through a Piezo element is too imprecise. The state of the art is the measurement of the deformation of a defined mechanical element caused by the force to be measured. The strain of the element is measured with the help of a strain gauge. The strain measurement with the strain gauge presumes that the strain of the object to be examined or the measurement element is transferred without loss to the strain gauge. To this purpose the strain gauge and the measurement object must be directly connected. The strain causes a change to the electrical resistance in the strain gauge. Strain gauges can be directly applied to the object to be measured for special measuring tasks. Special load cells, force sensors, and torque sensors are available for industrial use and for use in consumer goods. The industrially produced strain gauge measuring elements are produced in accordance with precise technical specifications and guidelines and enable measurements that can be reproduced very precisely.

The resistance change takes place with the help of a Wheatstone bridge and special measurement amplifiers. Usual are strain gauges with 120 Ohm, 350 Ohm, 700 Ohm, or 1,000 Ohm resistance with a measurement voltage of 3 ... 12 V.

For additional specific data, see the data sheets of the manufacturer.

10.2 Measurement with Wheatstone bridge

The strains to be measured with the strain gauge for the force measurement are very small. The result is that the resistance changes are also very small and cannot be directly measured with an Ohmmeter. The Wheatstone bridge connection is used as a measurement connection, the voltage change of which is measured with a measurement amplifier in the event of detuning.

Measurement connection and measurement amplifiers, as well as the measurement connection are passive links (in the physical sense). They must be supplied with energy in order to receive a utilizable signal. The Wheatstone bridge connection consists of two voltage dividers connected parallel. Depending upon the number of strain gauges in the bridge connection, a differentiation is made between quarter, semi, and full bridge circuits.

The full bridge has the best properties. In comparison to the quarter bridge, 4 times the sensitivity is achieved when 2 strain gauges each are clinched or stretched. The full bridge is less sensitive to interference like temperature drift and creep. In order to achieve this high level of sensitivity, the 4 individual strain gauges are laid out on the carrier in such a way that 2 are stretched and 2 are clinched. The TB20 strain gauge module is suitable for the use of commercially available load cells, force sensors, and torque sensors, and for the connection of own strain gauge applications in the field of technical data.

10.3 Voltage supply/agitation of the strain gauge bridge

The Wheatstone bridge circuit is a passive measurement circuit and requires a voltage supply. The feed voltage must be constant. Due to the resistances of the load cells, a not negligible current flows. With higher feed voltage, the heating of the strain gauge results in measurement errors. A lower feed voltage means that the voltage drop through the wiring is not negligible.

Voltage fluctuations have a direct proportional effect on the bridge voltage. For the purposes of the detection of voltage fluctuations, the TB20 strain gauge module can monitor the feed voltage in configurable limits.

10.4 4/6-conductor connection

A voltage drop in the connection lines occurs as a result of the current requirement of the load cells that has an influence on the bridge voltage.

Example:

Feed voltage for TB20 strain gauge weighing module:	5 V
Load cell Ri	120 Ω
Resulting current IREF	25 mA
Line resistance with 50 m Cu 0.25 mm²	3.4 Ω
Voltage drop of the feed voltage UREF	0.87 V

With load cells connected parallel, the current increases correspondingly.

In the case of poor wiring in a 4-conductor circuit with an inadequate line cross section or long lines, this results in a voltage drop that it may still be possible to compensate for through calibration. In the event of major fluctuations in the ambient temperature, the line resistance changes and static compensation through calibration is no longer possible.

The TB20 strain gauge module in the 6-conductor connection offers the possibility of measuring the feed voltage directly at the load cell with a dead measuring line. The measured feed voltage is incorporated into the calculation of the measurement value. In this way, feed voltages deviating completely from the nominal voltage can be recorded and monitored for an external voltage feed of the load cell.

10.5 Rated load of the load cell

The rated load of the load cell is usually the maximum permitted load for operation. In addition to this, non-linearities can occur, or the load cell is permanently damaged when the spring material reaches the plastic area. To this purpose see the data sheets of the manufacturer.

10.6 Rated value k mV/V

The rated value of a load cell is the ratio of output voltage AI to feed voltage UREF with rated load. The rated value is also referred to as the rated characteristic or rated sensitivity.

Example:

Feed voltage for TB20 strain weighing gauge module:	5 V
Load cell rated value k	2 mV/V
Maximum output voltage at rated load	10 mV
Measurement range to be configured	+-10 mV or +-2 mV/V

With well-known manufacturers, each load cell is accompanied by a manufacturer protocol that indicates the characteristic measured for the individual load cells, e.g. 2.0135 mV/V. An imprint on the packaging is also common.

10.7 Temperature coefficient of the rated value k

The nominal rated value k applies at room temperature. The rated value k changes with the temperature in a very close linear proximity. The behavior of the rated value k depends upon the material of the strain gauge. The temperature coefficient of the rated value k is indicated by the manufacturers of the strain gauge or of the load cells.

10.8 Minimum gaging value v_{min}

The minimum gaging value v_{min}, is the smallest measurement that can be measured without exceeding the maximum permitted error of the load cell, see data sheets of the manufacturers.

10.9 Scale interval

The scale interval is the resolution of the load cell that lies within the valid error limits. The minimum scale interval of v_{min} is indicated in the respective unit of the load cell. A load cell with the rated load E_{max} = 1,000 kg and a minimum scale interval of v_{min} = 0.1 kg has 10,000 parts.

10.10 Precision class according to OIML R60

A classification of the load cells take place in applications subject to and not subject to gaging. For load cells planned for use in applications subject to classification, the international OIML R60 guideline applies. The classes prescribe a maximum and minimum value for scale intervals d. The TB20 strain gauge weighing module cannot be gauged. It is not necessary to indicate the precision class.

10.11 Precision class according to PTB

The European precision classes PTB defines the classes for micro scales, precision scales, commercial scales, and rough scales.

10.12 Minimum measurement range % of rated load

The minimum measurement range is the minimum measurement range/measurement range interval a gaging-capable load cell /scale must cover. The TB20 strain gauge weighing module cannot be gauged. It is not necessary to indicate the minimum measurement range.

10.13 Parallel connection of load cells

When a load can't be mechanically measured at only one measurement point, e.g. a silo on 4 supports, several strain gauge load cells must be used simultaneously. The load cells connected parallel mechanically can also be connected parallel electrically and connected to 1 TB20 strain gauge module.

The load cells used for the parallel connection must be coordinated with one another and approved by the manufacturer.

The current draw of the load cells connected parallel may not overload the TB20 strain gauge module.

10.14 Measurement errors

Measurement errors are mainly caused by the load cells and the connection technology. Commercially available load cells possess a high degree of precision. Measurement errors usually occur due to incorrect usage not in keeping with the specified conditions of use.

Measuring line

A voltage drop on the measuring line occurs with 4-conductor connection and/or with poor wiring. The line-related errors are avoided with a 6-conductor connection.

Due to the very low voltage level in the mV and µV ranges, all lines should be shielded.

Creep

When subjected to a constant load over a longer period of time, the spring materials of the load cells can deform further in the direction of the load. The measurement value changes slowly during the static measurement. The deformation is reversible. The same effect occurs when the load cells are relieved. The spring materials slowly return to their original condition. High quality, commercially available load cells mostly avoid creep errors through the layout of the geometry of the load cells and special adhesive materials.

Hysteresis

Even when the loading and unloading of the load cells progresses uniformly, the progression of the ascending characteristic of the measurement voltage AI is not congruent with the dropping characteristic. The deformation of the spring materials of the load cells, the deformation of the strain gauge, and the behavior of the glue cause differing behavior of the load cell under when loading and unloading. As a result of the hysteresis, the measurement values when loading and unloading can deviate from one another with the same load.

Temperature drift

When in operation, the load cells require a current in proportion with the voltage to be measured.

Example:

Load cell	Ri = 120 Ω
Feed voltage	UREF = 5 V
Resulting current	IREF = 25 mA
Power dissipation of the load cell	PV = 125 mW

The load cells must be able to conduct the power dissipation PV away in continuous operation without self-heating. Continuous heating of the strain gauge is represented as apparent strain and results in a not negligible measurement error. The feed voltage of the load cells may not be exceeded. Load cells that are specified for short-term operation cannot be used for continuous measurement.

Non-linearity

Non-linearity can be caused by mechanical influences of the weighing apparatus and occurs with semi-conductor strain gauges. Compensation may be possible with the help of the characteristic sampling points. Semiconductor strain gauges should only be operated in the linear characteristic range.

10.15 Weighing technology terms

Calibration

Calibration in weighing technology is the measurement process for the reliably reproducible determination and documentation of the deviation. A scale is checked with the help of a benchmark (e.g. measurement piece) for the precision of the measurement value (display value). It is necessary that the benchmark have a higher degree of precision than the weighing apparatus itself, e.g. gaging weight. No intervention in the measurement chain takes place.

Adjustment

Adjustment is necessary when setting up a weighing device anew or in the event of failure of a component of the measurement chain. An intervention in the measurement chain takes place.

1. The zero point of the weighing device is determined in the unladen condition (taring).

2. In the case of a presumed linear load characteristic, the end point of the load characteristic is adapted as a characteristic value (amplification factor of the load cell) for the display in the unit of the physical measurement variable corresponding with the applied comparison weight.

3. In the case of linearity deviations, the load characteristic is corrected by sampling points determined through gaging weights.

The precision of the gaging weights is decisive for the precision of an adjustment. Calibration must then be carried out again.

Gaging

Gaging corresponds to calibration. However, gaging is a juridical procedure that can only be carried out by bureaus of standards or other approved offices. No intervention of any kind into the measurement chain for the purpose of improving / adjusting the displayed value to the benchmark (gaging weight). Gaging is imperative for contractual commerce and is clearly regulated by laws.

11 Technical data

Order no.	**600-256-7AA01**
Module type	Strain gauge weighing module
Measuring ranges	4 mV / V 2 mV / V
Measurement error With reference to the measuring range end value	0.1% for conversion rates with 50 Hz suppression
Resolution	24 bits
Frequency mode	50 / 60 Hz
Conversion rate	6.25, 7.5, 12.5, 15, 25, 30, 50 [n/s]
Load cell terminal	6-conductor technology 4-conductor technology with 2 bridges
Average filter	Arithmetical average with nmax=255
Issuing of measurement value	mV/V or kg configurable
Characteristic linearization	Max. 5 sampling points
Access protection of the works parameters/data	no
Testing of line break	Feeding of test current into the measurement channel
Internal bridge feed	5 V 70 mA Ri: ca. 6.5 Ohm Internal, reversible fuse
Overvoltage protection	Bridge feed output and measurement inputs are protected against 24 V
Diagnostics	Error response via status bits
Power supply for modules	5 V DC, max. 130 mA Voltage supply via back wall bus, irrespective of voltage to be measured
Hot plug-capable	Yes
Isolation voltage	500 V
Power dissipation	Max. 0.7 W
Protection rating	IP 20
Relative humidity	95% without condensation
Installation position	Any
Permissible ambient temperature	0 °C to 60 °C
Transport and storage temperature	-20 °C to 80 °C
Dimensions (H x W x D)	110 mm x 14 mm x 73 mm
Weight	Approx. 70 g

11.1 Certifications

The following approvals have been issued for the weighing module:

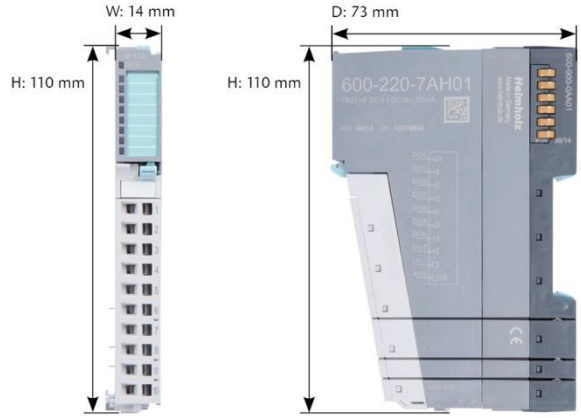
CE marking

11.2 Standards and guidelines

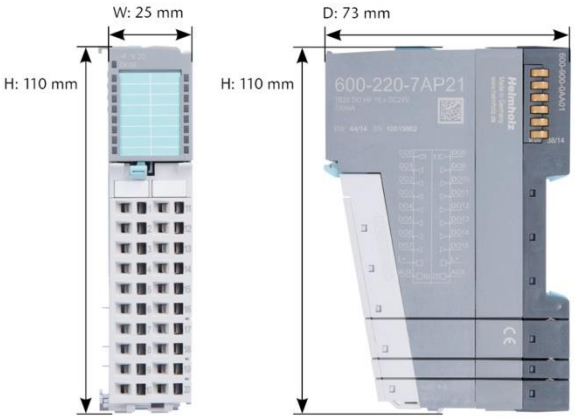
Interference immunity:	DIN EN 61000-6-2 “EMC Immunity”
Interference emission:	DIN EN 61000-6-4 “EMC Emission”
Vibration and shock resistance	DIN EN 60068-2-8:2008 "Vibration" DIN EN 60068-27:2010 "Shock"

12 TB20 System Dimensions

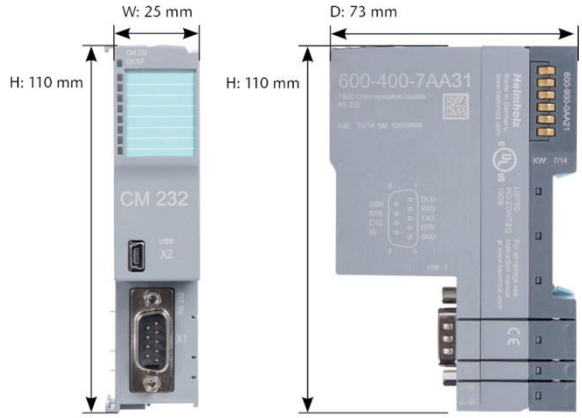
Module with standard width



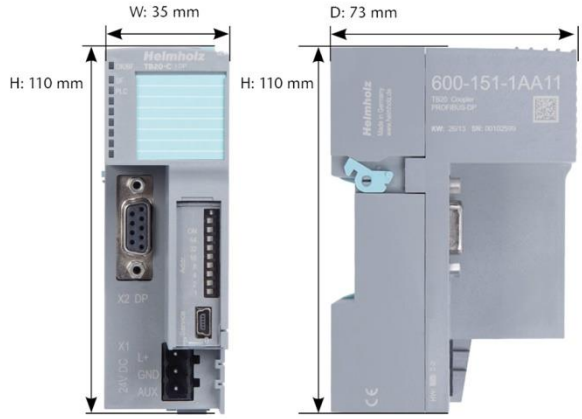
Module with double width

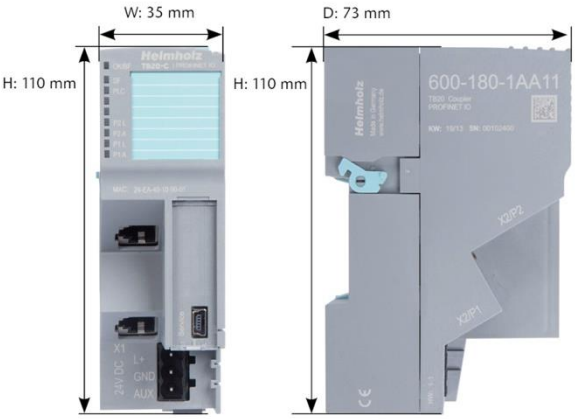


Communication Module



Bus Coupler





13 Spare parts

13.1 Base modules

13.1.1 14 mm width standard base module

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

13.1.2 25 mm width base module

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

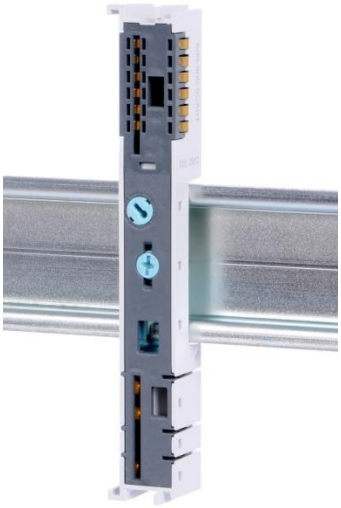
13.1.3 Power and isolation base module

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

13.1.4 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.



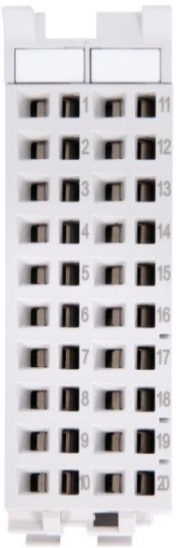
13.2 Front connectors

13.2.1 10-terminal front connector

The 10-terminal front connector is available in sets of five with order number 600-910-9AJ01.

13.2.2 20-terminal front connector

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



13.3 Electronic modules

Electronic modules can be ordered as spare parts with the order number of the original product. The entire product is always sent, including the base module and the front connector.

13.4 Final cover

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