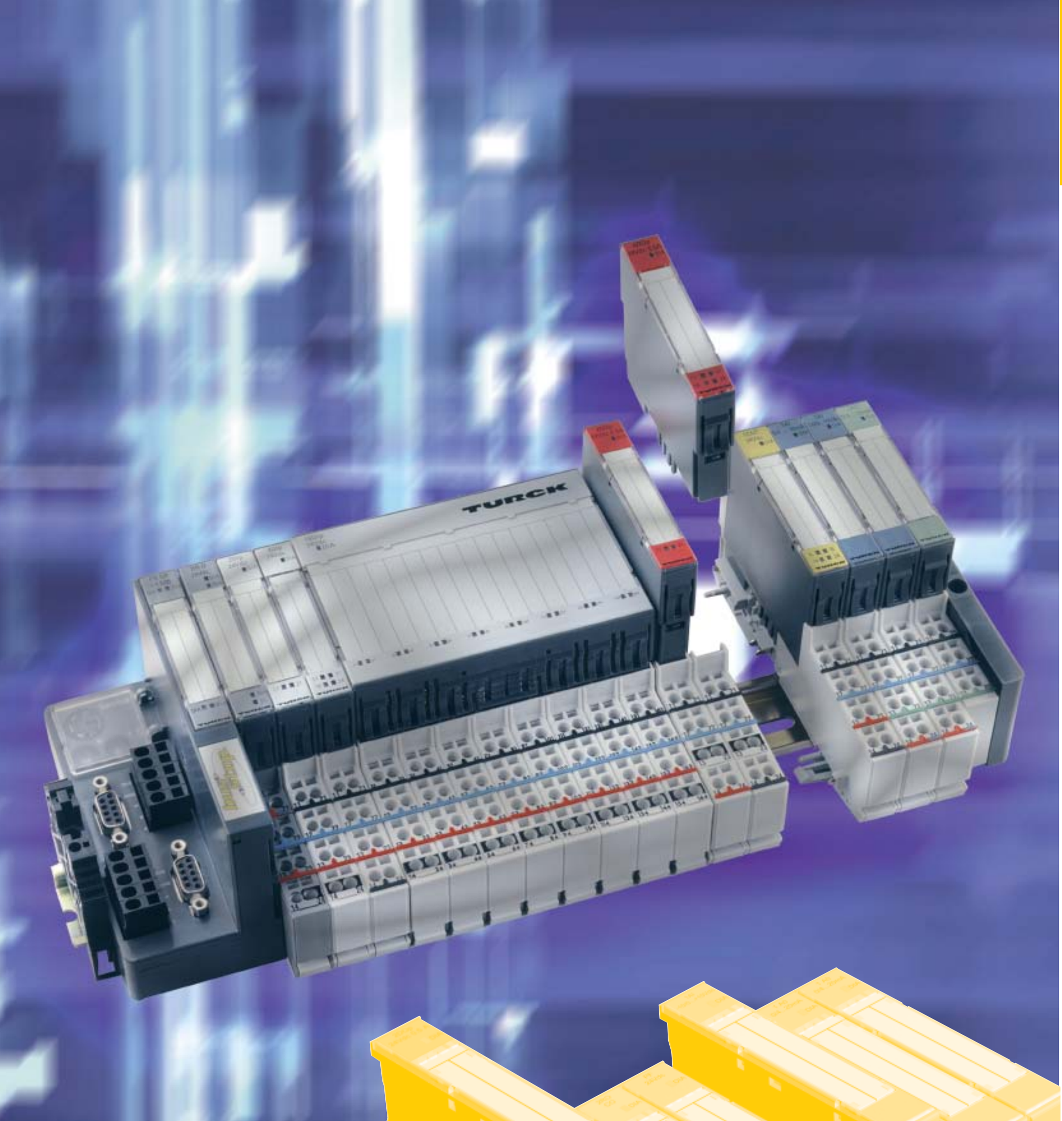
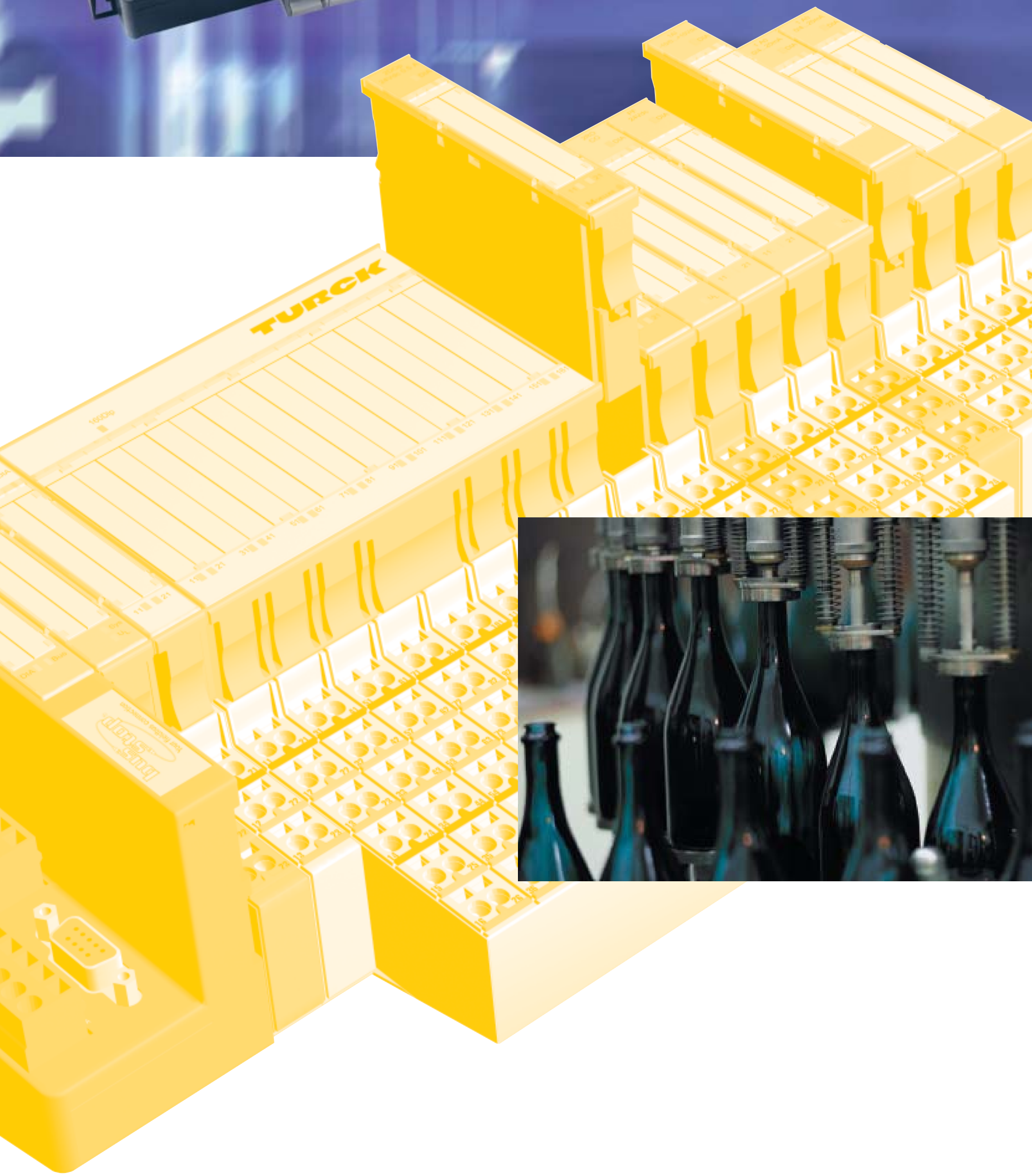
TURCK

Industrial
Automation

BL20 – I/O-MODULES

HARDWARE AND ENGINEERING





Edition 12/2011

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighboring units that are live.
- Follow the engineering instructions of the device concerned.
- Only suitably qualified personnel in accordance with EN 50 110-1/-2 (VDE 0 105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalization. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60 364-4-41 (VDE 0 100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60 204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE).
- All work relating to transport, installation, commissioning and maintenance must only be carried out by qualified personnel. (IEC 60 364 and HD 384 and national work safety regulations).
- All shrouds and doors must be kept closed during operation.

Industrial Automation

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1.1 Documentation concept

This manual contains all information about the bus-independent I/O-modules for the modular TURCK IP20 I/O system BL20.

The following chapters contain a short BL20 system description, exact descriptions of the I/O-modules' functionality and their technical data as well as all general information concerning the whole system as for example mounting/dismounting, labeling etc.

Furthermore, this manual contains a short description of the project planning and diagnostics software for TURCK I/O-systems, the software I/O-ASSISTANT.

The bus-specific BL20-gateways, the connection to the different automation devices, the maximum system extension as well as all other bus specific information are described in separate manuals (www.turck.de).

1.2 Description of symbols used

Danger

This sign can be found next to all notes that indicate a source of hazards. This can refer to danger to personnel or damage to the system (hardware and software) and to the facility.

This sign means for the operator: work with extreme caution.

Attention

This sign can be found next to all notes that indicate a potential hazard.

This can refer to possible danger to personnel and damages to the system (hardware and software) and to the facility.

Note

This sign can be found next to all general notes that supply important information about one or more operating steps. These specific notes are intended to make operation easier and avoid unnecessary work due to incorrect operation.

1.3 General information.

Attention
Please read this section carefully. Safety aspects cannot be left to chance when dealing with electrical equipment.

1.3.1 Prescribed use

Danger
The devices described in this manual must be used only in applications prescribed in this manual or in the respective technical descriptions, and only with certified components and devices from third party manufacturers.

Appropriate transport, storage, deployment and mounting as well as careful operating and thorough maintenance guarantee the trouble-free and safe operation of these devices.

1.3.2 Notes concerning planning /installation of this product

Danger
All respective safety measures and accident protection guidelines must be considered carefully and without exception.

1.4 List of revisions

In comparison to the previous manual edition, the following changes/ revisions have been made:

Table 1-1: List of revisions

Chapter	Subject/ Description	new	changed
Chap. 13	BL20-Approvals for Zone 2/ Division 2, → separate manual D301255		X

Note
The publication of this manual renders all previous editions invalid.

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2.1 The basic concept

BL20 is a modular I/O system for use in industrial automation. It connects the sensors and actuators in the field with the higher-level master.

BL20 offers modules for practically all applications:

- Digital input and output modules
- Analog input and output modules
- Technology modules (counters, RS232 interface...)

A complete BL20 station counts as one station on the bus and therefore occupies one fieldbus address in any given fieldbus structure. A BL20 station consists of a gateway, power distribution modules and I/O modules.

The connection to the relevant fieldbus is made via the bus-specific gateway, which is responsible for the communication between the BL20 station and the other fieldbus stations.

The communication within the BL20 station between the gateway and the individual BL20 modules is regulated via an internal module bus.

Note

The gateway is the only fieldbus-dependent module on a BL20 station. All other BL20 modules are not dependent on the fieldbus used.

Flexibility

All BL20 stations can be planned to accommodate the exact number of channels to suit your needs, because the modules are available in block and slice design.

A BL20 station can contain modules in any combination, which means it is possible to adapt the system to practically all applications in automated industry.

Compactness

The slim design of the BL20 modules (gateway 50.4 mm / 1.98 inch, slice 12.6 mm / 0.49 inch and block 100.8 mm / 3.97 inch) and their low overall height favor the installation of this system in confined spaces.

Easy to handle

All BL20 modules, with the exception of the gateway, consist of a base module and an electronics module.

The gateway and the base modules are snapped onto a mounting rail. The electronics modules are plugged onto the appropriate base modules.

The base modules are designed as terminal blocks. The wiring is secured by tension clamp or screw connection. The electronics modules can be plugged or pulled when the station is being commissioned or for maintenance purposes, without having to disconnect the field wiring from the base modules.

2.2 BL20 components

For a detailed explanation of the individual BL20 components, please refer to chapter 2 and chapter 4. The "Appendix" to this manual contains (amongst others) a list of all BL20 components and the assignment of electronics modules to base modules.

2.2.1 Gateways

The gateway connects the fieldbus to the I/O modules. It is responsible for handling the entire process data and generates diagnostic information for the higher-level master and the software tool I/Oassistant.

Gateways with integrated power supply

The BL20 gateways BL20-GWBR-xxx offer an integrated power supply unit for feeding the gateway and the connected I/O modules.

It is not necessary to supply each individual module with a separate voltage.

Figure 2-1: Gateway BL20-GWBR-PBDP

Gateways without power supply

> **Note**
> The gateways without integrated power supply unit need an additional power supply module (bus refreshing module) which feeds the gateway an the connected I/O modules.

2.2.2 Power distribution modules

The power supply for gateways and I/O modules is fed to the power distribution modules; therefore, it is not necessary to supply each individual module with a separate voltage.

Figure 2-2: Power distribution module

2.2.3 Electronics modules

Electronics modules contain the functions of the BL20 modules (power distribution modules, digital and analog input/output modules, and technology modules).

Electronics modules are plugged onto the base modules and are not directly connected to the wiring. The assignment table in the Section "Ordering Information" of the "Appendix" shows the possible combinations of electronics and base modules. They can be plugged or pulled when the station is being commissioned or for maintenance purposes, without having to disconnect the field wiring from the base modules.

Figure 2-3: Electronics module in slice design

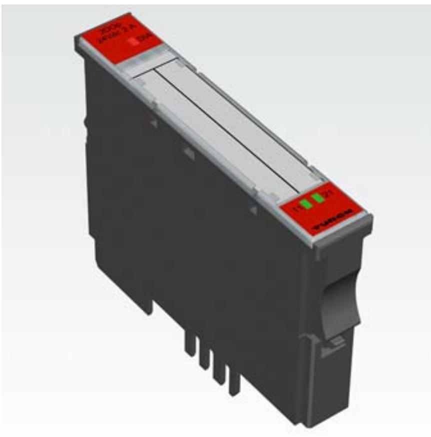
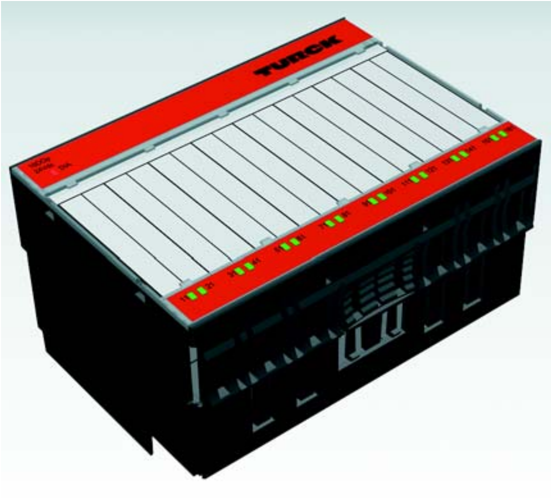


Figure 2-4: Electronics module in block design



2.2.4 Base modules

The field wiring is connected to the base modules. These are constructed as terminals in block and slice designs and are available in the following variations with either tension clamp or screw connections: 2-/3-wire (2-channel), 4-wire (2-channel) and 4x 2-/3-wire (4-channel).

The assignment table in the Section "Ordering Information" of the "Appendix" shows the possible combinations of electronics and base modules.

Figure 2-5: Base module with tension clamp connection

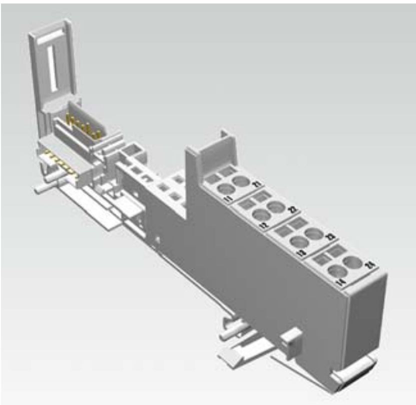


Figure 2-6: Base module with screw connection

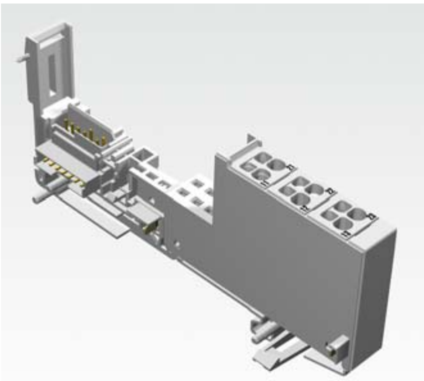
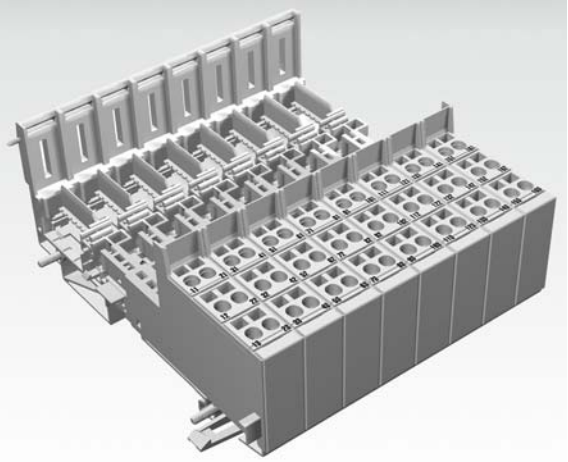


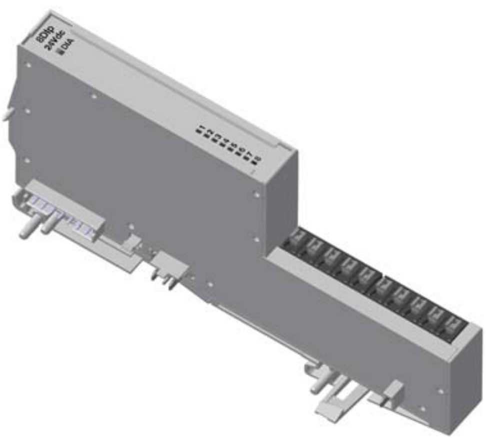
Figure 2-7: Base module in block design



2.2.5 BL20 ECO

With the BL20 ECO modules the electronics and connection technology is integrated into a single housing. Thus, the selection of a base module is unnecessary. Within a station the ECO modules can be combined with the modules with separate electronics/connection technology, provided that the base modules feature tension spring connections.

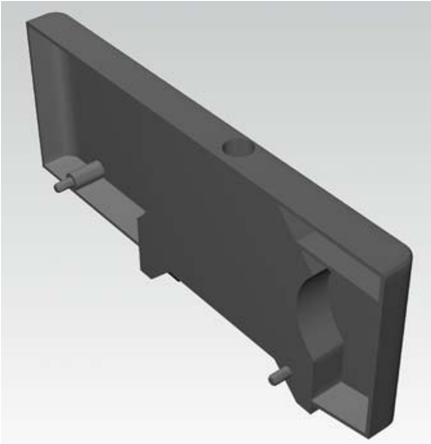
Figure 2-8: BL20 ECO



2.2.6 End plate

An end plate on the right-hand side physically completes the BL20 station. An end bracket mounted into the end plate ensures that the BL20 station remains secure on the mounting rail even when subjected to vibration.

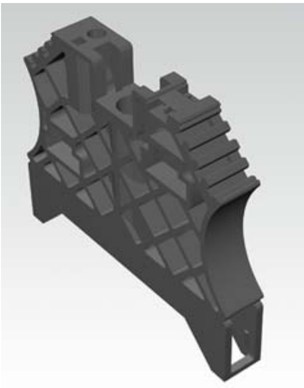
Figure 2-9: end Plate



2.2.7 End bracket

A second end bracket to the left of the gateway is necessary, as well as the one mounted into the end plate to secure the station.

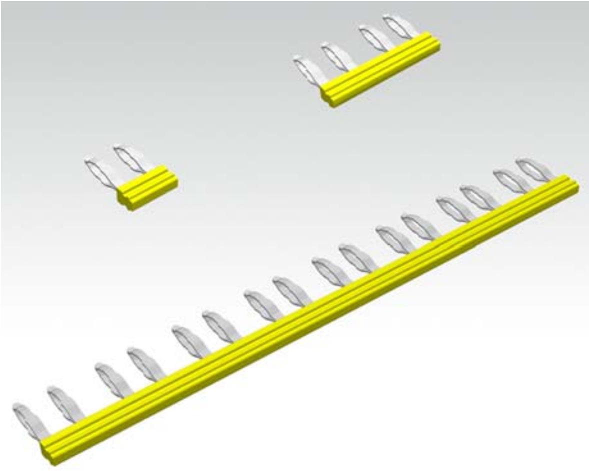
Figure 2-10: End bracket



2.2.8 Jumpers

Jumpers (QVRs) are used to bridge a connection level of a 4-wire base module. They can be used to connect potentials in relay modules (bridging the relay roots); thus considerably reducing the amount of wiring.

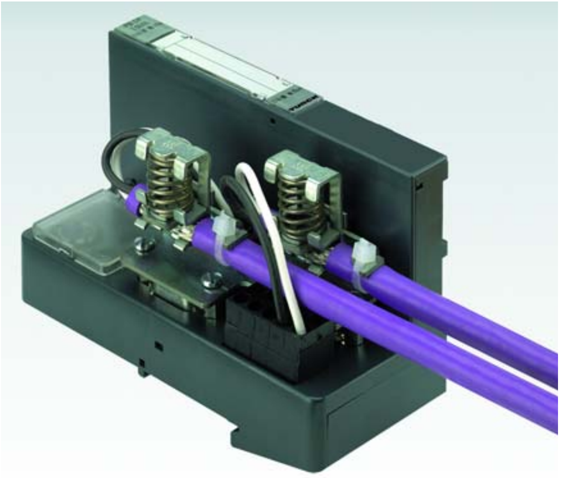
Figure 2-11: Jumpers



2.2.9 Shield connection (gateway)

If the gateway is wired directly to the fieldbus, it is possible to shield the connection using an attachment on the gateway.

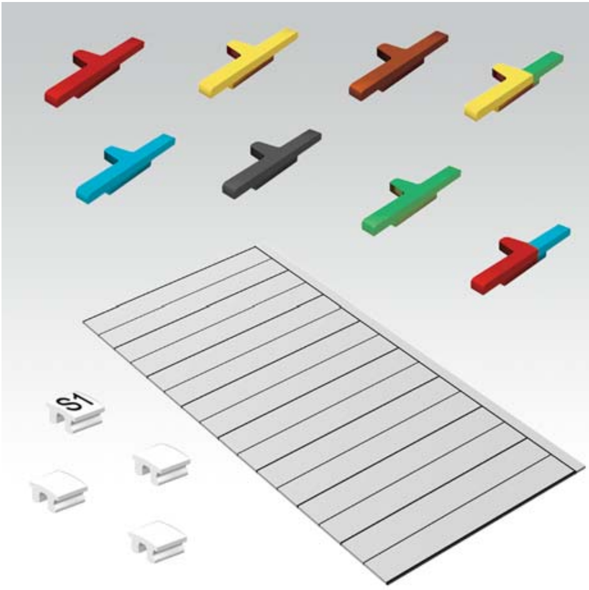
Figure 2-12: Shield connection (gateway)



2.2.10 Marking material

- Labels: for labeling BL20 electronics modules.
- Markers: for colored identification of connection levels of BL20 base modules.
- Dekafix connector markers: for numbering the mounting slots on BL20 base modules.

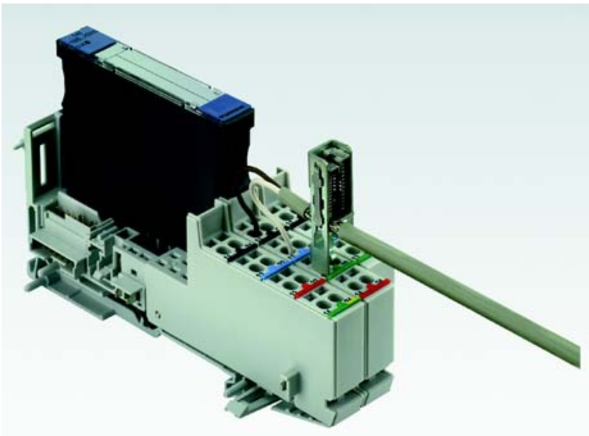
Figure 2-13: Marking material



2.2.11 Shield connection, 2-pole for analog modules

The 2-pole shield connection can be used to connect signal-cable shielding to the base modules of analog input and output modules. A special tension-clamp operating tool (BL20-ZBW5-2) is required to mount the shield connection onto the base module.

Figure 2-14: Shield connection



3 General technical Data of BL20 modules

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3.1 Introduction

This chapter describes the general technical data valid for all BL20 modules.

The following chapters contain all information about the BL20 power supply and I/O modules.

Note

The parameter and diagnosis information of the individual modules correspond to those determined in the bus configuration files (GSD- or EDS- files) which are described in the bus specific manuals for the BL20 gateways with PROFIBUS-DP (Turck Documentation-No.: English D300458), with DeviceNet (Turck Documentation-No.: English D300460).

Please refer to these manuals for the fieldbus-specific description of the diagnostic and parameter data of the individual BL20 modules.

Note

The gateway's technical data and the gateway's diagnostic options are also described in the bus-specific manuals for the BL20 gateways with PROFIBUS-DP (Turck Documentation-No.: English D300458), with DeviceNet (Turck Documentation-No.: English D300460).

An overview of all electronic modules and the appropriate base modules can be found in the „Appendix“.

3.2 Abbreviations

3.2.1 Module abbreviations

The module designations are explained in the following table:

Table 3-1: Module abbreviations

Abbr.	Designation	Example
ABPL	End plate for right-sided termination of a BL20 station	BL20-**ABPL**
AI	Analog input module	BL20-1**AI**-xxx
AO	Analog output module	BL20-1**AO**-xxx
B	Designation for base module in block design	BL20-**B**3S-SBB
B	Bridge connector: bridged connections on the same connection level in a base module, for applying potentials	BL20-S3T-S**BB**
B	Added to designation of base modules for those Bus Refreshing modules used within a BL20 station but do not supply the gateway with power.	BL20-P4T-SBBC-**B**
BR	Bus Refreshing module	BL20-**BR**-24VDC-D
C	Designation of a connection level with cross-connection to a C-rail and can, among other things, be used as a PE (only possible with certain base modules).	BL20-S4T-SBB**C**
CJ	Base module for BL20-2AI-THERMO-PI with integrated PT1000 for cold junction compensation	BL20-S4T-SBBS-**CJ**
CNT	Counter	BL20-1**CNT**-24VDC
CO	Change over	BL20-2DO-R-**CO**
D	Diagnostics	BL20-BR-24VDC-**D**
DI	Digital input module	BL20-2**DI**-24VDC-P
DO	Digital output module	BL20-2**DO**-24VDC-2A-P
GW	Gateway	BL20-**GW**-PBDP-1.5MB
KLBU	Terminal clip, shielded connection for analog input modules	BL20-**KLBU**/T
KO	Coding element for coding electronics and base module	BL20-**KO**/2
MB	Transmission rate MBit/s	BL20-GW-PBDP-1.5**MB**
N	Negative switching (sourcing)	BL20-2DI-24VDC-**N**

Table 3-1: Module abbreviations

Abbr.	Designation	Example
NC	Normally closed	BL20-2DO-R-**NC**
NI	For connecting resistance thermometers with sensors Ni100 and NI1000 in 2- or 3-wire measurement type	BL20-2AI-PT/**NI**-2/3
NO	Normally open	BL20-2DO-R-**NO**
P	Positive switching	BL20-2DI-24VDC-**P**
P	Designation of the base module for Power Feeding and Bus Refreshing modules	BL20-**P**3T-SBB
PBDP	BL20 gateway for PROFIBUS-DP	BL20-GW-**PBDP**-1.5MB
PF	Power Feeding modules	BL20-**PF**-24VDC-D
PT	Analog input module for connecting resistance thermometers with sensors PT100, PT200, PT500 and PT1000 in 2- or 3-wire measurement type	BL20-2AI-**PT**/NI-2/3
QV	Jumper for relay modules	BL20-**QV**/1
R	Relay module	BL20-2DO-**R**-NC
S	Designation for base module in slice design	BL20-**S**3T-SBB
S	Designation for base modules with screw connection	BL20-S3**S**-SBB
S	Designation for gateway with screw connection	BL20-GW-PBDB-1.5MB-**S**
S	Single connector: non-bridged connections on the same connection level in a base module, used for connecting the signal	BL20-S3T-**S**BB
T	Designation for base modules with tension clamp connection	BL20-S3**T**-SBB
x	Partly for "S" or "T" in the designations of base modules with screw or tension clamp connection	BL20-S3**x**-SBB

The following abbreviations are used in the technical data and wiring diagrams:

Table 3-2: technical abbreviations

Abbr.	Designation
GND	Ground
I_A	Active level current (with negative switching electronics modules)
I_L	Electrical operating supply (field supply)
I_H	High-level current
I_I	Inactive level current (with negative switching electronics modules)
I_L	Low-level current
I_{MB}	Current via the module bus
L-	Neutral conductor
L+	Positive conductor
PE	Protective earth conductor
R_{LI}	Load impedance, inductive
R_{LK}	Load impedance, resistive
R_{LL}	Lamp load
R_{LO}	Resistive load
S	Signal cable
Sh	Shielding
U_A	Active level voltage (with negative switching electronics modules)
U_H	High-level voltage
U_I	Inactive level voltage (with negative switching electronics modules)
U_h	Auxiliary voltage for analog sensor
U_L	Field supply with LEDs
U_L	Low-level voltage
U_{PF}	Voltage that is presently being supplied via the power distribution module
U_{sys}	System supply

3.3 Station dimensions

3.3.1 Dimensions for electronics modules

Dimensions in mm / inch (w x l x h)	
Slice design	12.6 x 74.1 x 55.4 / 0.49 x 2.92 x 2.18
Block design	100.8 x 74.1 x 55.4 / 3.97 x 2.92 x 2.18

3.3.2 Dimensions for base modules

Dimensions in mm / inch (w x l x h)	
Slice design	
2-/3-wire connection technology	12.6 x 117.6 x 49.9 / 0.49 x 4.63 x 1.96
4-wire connection technology	12.6 x 128.9 x 49.9 / 0.49 x 5.07 x 1.96
4 x 2-/3-wire connection technology	12.6 x 154.5 x 49.9 / 0.49 x 6.08 x 1.96
Block design	
2-/3-wire connection technology	100.8 x 117.6 x 49.9 /3.97 x 4.63 x 1.96
4-wire connection technology	100.8 x 128.9 x 49.9 /3.97 x 5.07 x 1.96
4 x 2-/3-wire connection technology	100.8 x 154.5 x 49.9 /3.97 x 6.08 x 1.96

3.3.3 Dimension drawings

Figure 3-1: Complete BL20 module (with tension clamp connection)

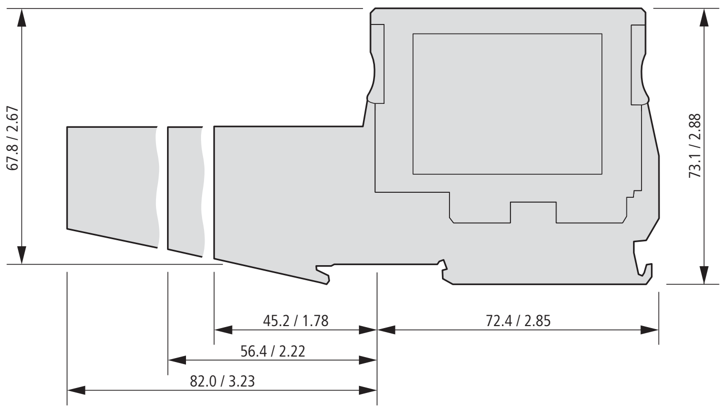


Figure 3-2: Rear view of complete BL20 module in slice design

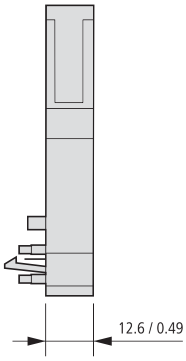


Figure 3-3: Rear view of complete BL20 module in slice design

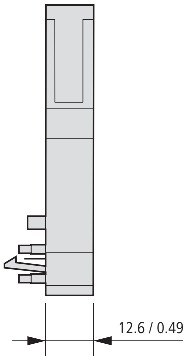


Figure 3-4: BL20 module in block design (top view)

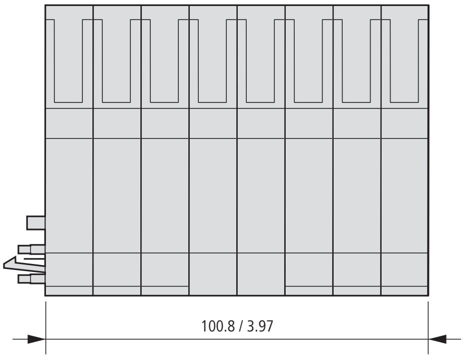


Figure 3-5: Electronics module

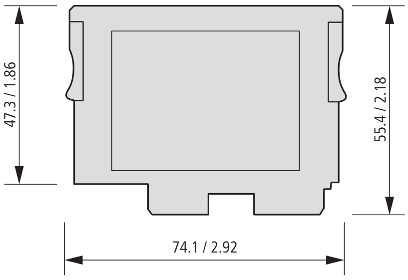


Figure 3-6: Rear view of electronics module in slice design

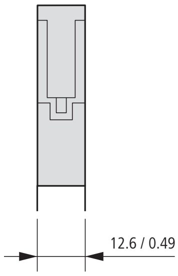


Figure 3-7: Rear view of electronics module in block design

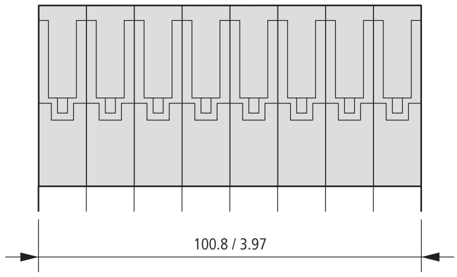


Figure 3-8: Base module with tension clamp connection

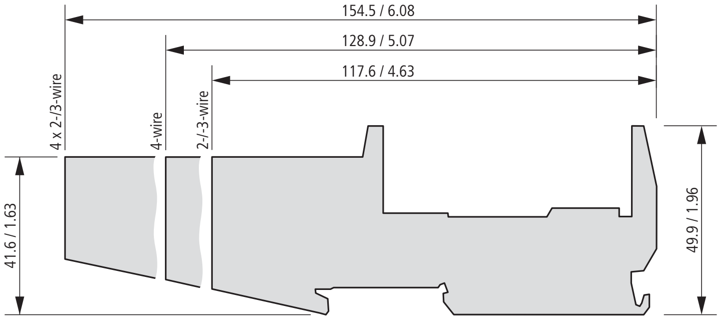


Figure 3-9: Base module with screw connection

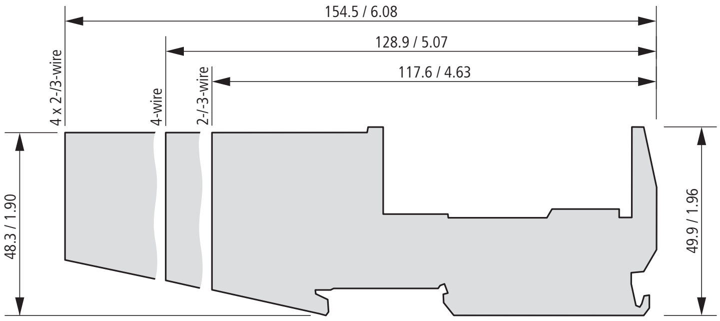


Figure 3-10: Base module in slice design (top view)

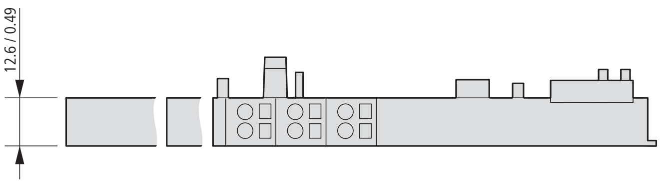


Figure 3-11:
Top view of base module in block design

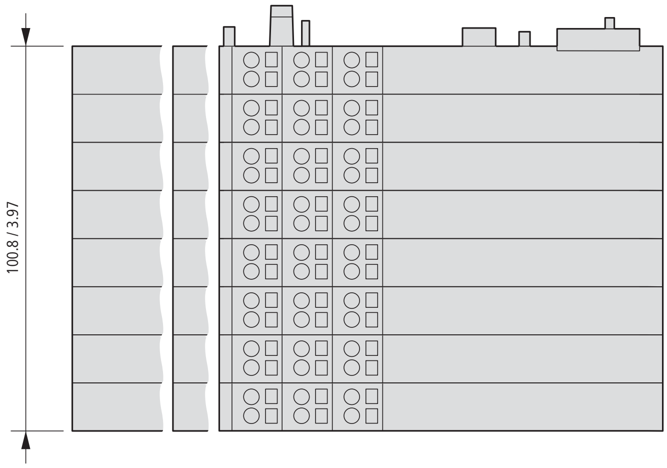
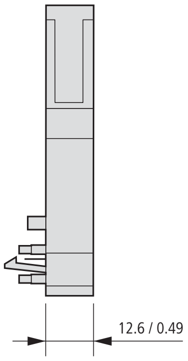


Figure 3-12:
Rear view of complete BL20 module in slice design



3.3.4 Dimensions of the BL20-ECO modules

Figure 3-13:
Side view
BL20-E-8D×

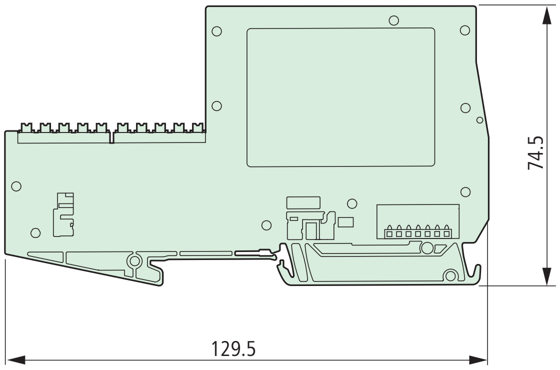


Figure 3-14:
Side view
BL20-E-16D×

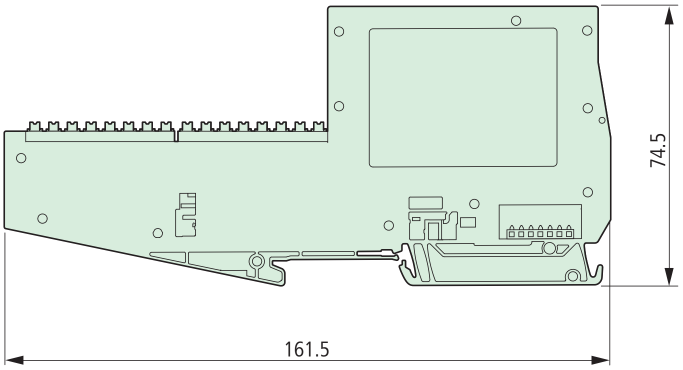
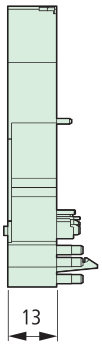


Figure 3-15:
Rear view
BL20-E-...
complete module



3.4 General technical data of a BL20 station

Note
The auxiliary power supply must comply with the stipulations of SELV (Safety Extra Low Voltage) according to IEC 60364-4-41.

Table 3-3: General technical data relating to a station

Supply voltage/ auxiliary voltage	
Nominal value (provision for other modules)	24 V DC
Permissible range	according to EN 61 131-2 (18 to 30 V DC)
Residual ripple	according to EN 61 131-2
Potential isolation	Yes, via optocoupler
Ambient conditions	
Ambient temperature	
– $t_{Ambient}$	0 to + 55 °C / 32 to 131 °F
– t_{Store}	-25 to + 85 °C / -13 to 185 °F
Relative humidity	according to IEC 61 131-2/ EN 50 178
Climatic tests	according to IEC 61131-2
Noxious gas	– SO2: 10 ppm (rel. humidity < 75 %, non-condensing) – H2S: 1.0 ppm (rel. humidity < 75 %, non-condensing)
Resistance to vibration according to IEC 61131-2	
10 to 57 Hz, Constant amplitude 0.075 mm / 0.003 inch, 1g	Yes
57 to 150 Hz, Constant acceleration 1 g	Yes
Mode of vibration	Frequency sweeps with a change in speed of 1 Octave/min
Period of oscillation	20 frequency sweeps per axis of coordinate
Shock resistant according to IEC 68-2-27	18 shocks, sinusoidal half-wave 15 g peak value/ 11 ms, in each case in +/- direction per space coordinate
Resistance to repetitive shock according to IEC 68-2-29	1 000 shocks, half-sinus 25 g peak value/6 ms, in each case in +/- direction per space coordinate
Topple and fall according to IEC 68-2-31 and free fall according to IEC 68-2-32	
Height of fall (Weight < 10 kg)	1.0 m / 39.37 inch
Height of fall (Weight 10 to 40 kg)	0.5 m / 19.69 inch
Test runs	7

Device with packaging, electrically tested printed-circuit board	
Electromagnetic compatibility (EMC) according to EN 50 082-2 (Industry)	
Static electricity according to EN 61 000-4-2	
– Discharge through air (direct)	8 kV
– Relay discharge (indirect)	4 kV
Electromagnetic HF fields according to EN 61 000-4-3 and ENV 50 204	10 V/m
Conducted interferences induced by HF fields according to EN 61 000-4-6	10 V
Fast transients (Burst) according to EN 61 000-4-4	
Emitted interference according to EN 50 081-2 (Industry)	according to EN 55 011 Class A, Group 1

Reliability	
Operational life MTBF	min. 120000 h
Electronic modules pull/ plug cycles	20
Tests according to EN 61 131-2	
Cold	DIN IEC 68-2-1, temperature -25 °C / -13 °F, duration 96 h; not in use
Dry heat	DIN IEC 68-2-2, Temperature +85 °C / 185 °F, duration 96 h; device not in use
Damp heat, cyclic	DIN IEC 68-2-30, temperature +55 °C / 131 °F, duration 2 cycles every 12 h; device in use
Temperature change	DIN IEC 68-2-14, temperature 0 to +55 °C / 32 to 131 °F, duration 2 cycles, temperature change per minute; device in use
Pollution severity according to IEC 664 (EN 61 131-2)	2
Protection class according to IEC 529	IP20

Danger
This device can cause radio disturbances in residential areas and in small industrial areas (residential, business and trading). In this case, the operator can be required to take appropriate measures to suppress the disturbance at his own cost.

3.4.1 Approvals

Table 3-4: Approvals

Approvals
CE
CSA
UL

3.4.2 Technical data of base modules

Table 3-5: technical data for base modules

	BL20	BL20 Economy
Protection class	IP 20	IP 20
Insulation stripping length	8 mm / 0.32 inch	8 mm / 0.32 inch
Max. wire range	0.5 to 2.5 mm^2 / 0.0008 to 0.0039 inch^2 / 20 to 12 AWG	0,14 to 1,5 mm^2/ 0.0056 to 0.06 inch^2 / 26 to 16 AWG
Crimpable wire		
"e" solid core H 07V-U	0.5 to 2.5 mm^2 / 0.0008 to 0.0039 inch^2 / 20 to 12 AWG	0,25 to 1,5 mm^2 / 0.01 to 0.06 inch$^{2/}$ 22 to 16 AWG
"f" flexible core H 07V-K	0.5 to 1.5 mm^2 / 0.0008 to 0.0023 inch^2 / 20 to 16 AWG	0,25 to 1,5 mm^2 / 0.01 to 0.06 inch$^{2/}$22 to 16 AWG
"f" with ferrules according to DIN 46228/1 (ferrules crimped gas-tight)	0.5 to 1.5 mm^2 / 0.0008 to 0.0023 inch^2 / 20 to 16 AWG	0,25 to 1,5 mm^2 / 0.01 to 0.06 inch$^{2/}$22 to 16 AWG
Plug gauge according to IEC 947-1/1988	A1	A1
max. torque for screw connection technology	0,4 to 0,6 Nm	-
Measurement data according to VDE 0611 Part 1/8.92/ IEC 947-7-1/1989		
Rated voltage	250 V	250 V
Rated current	17.5 A	17,5 A
Rated surge	4 kV	4 kV
Rated cross section	1,5 mm^2	1,5 mm^2
Pollution severity	2	2
TOP connection technology	Tension clamp or screw connection	

4 Power distribution modules

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4.1 Power Feeding modules

Power Feeding modules distribute the required 24 V DC or 120/230 V AC field voltage to the I/O modules. They are necessary when groups of modules with different potentials are planned within a BL20 station, or if the rated supply voltage cannot be guaranteed. Power Feeding modules are potentially isolated from the adjoining power supply module and modules to the left side.

Danger
Power Feeding modules cannot be used to distribute 5 V DC to BL20 gateways.

By using Power Feeding modules, it is not necessary to distribute power separately to each BL20 I/O module.

Power Feeding modules are available in slice design. They are mounted on to base modules with tension clamp or screw connections. The dusty grey color of the base modules for Power Feeding modules clearly distinguishes them from the base modules designed for BL20 I/O modules.

LED status indicators

Error signals and diagnostic statuses are indicated via LEDs on the module. The corresponding diagnostic information is transmitted to the gateway via diagnostic bits.

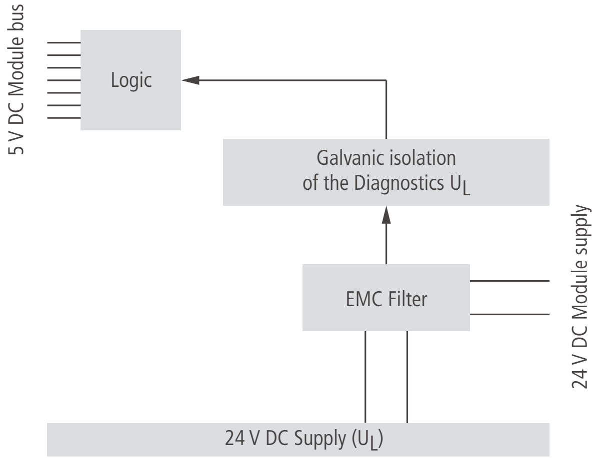
4.1.1 Module overview

- BL20-PF-24VDC-D
- BL20-PF-120/230VAC-D

4.1.2 Power Feeding module, 24 V DC, with diagnostics

Figure 4-1: BL20-PF-24VDC-D

Figure 4-2: Block diagram



Technical data

Table 4-1: Technical data

Designation	BL20-PF-24VDC-D
Nominal voltage	24 V DC
Permissible range	18 to 30 V DC
Field supply U_L	24 V DC
Permissible range of U_L	18 to 30 V DC
Nominal current from module bus I_{MB}	$\leq$ 28 mA
Ripple	< 5%
Residual ripple	according to EN 61 131-2
Maximum operating current I_{EI}	10 A
Voltage anomalies	according to EN 61 000-4-11/ EN 61 131-2

Diagnostic and status messages

The diagnostic functions monitor the supply voltages (system and field supply) supplied by the user for undervoltage. The diagnostic functions indicate errors via the "DIA" LED and transmit the corresponding diagnostic information to the gateway..

Table 4-2: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	Check the wiring from the module bus to the field power supply and to the system's power supply. Check the voltages of the field power supply and to the system power supply.
	Red	Module bus communication failure	Check if more than two ad-joining electronics modules have been pulled. Check the wiring from the module bus to the system power supply.
	Off	No error messages or diagnostics	–
U_L	Green	Field power supply via external power supply unit OK	–
	Off	Field power supply via external power supply unit faulty	Check the wiring to the field power supply. Check the external power supply unit.

This module has the following diagnostic data:

- "Undervoltage field supply"
  Monitoring of the external power supply to the field

Module parameters

None

Base modules

Figure 4-3: Base module BL20-P3T-SBB

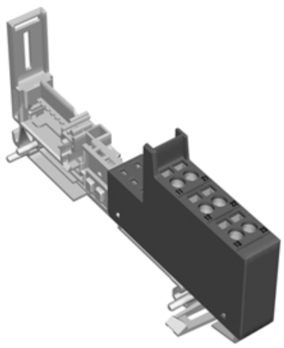
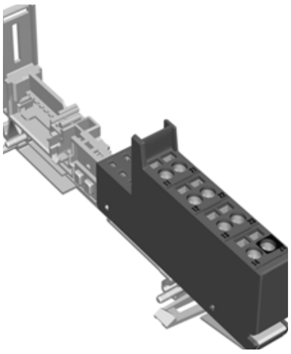


Figure 4-4:
Base module
BL20-P4T-SBBC



- with tension clamp connection
  BL20-P3T-SBB
  BL20-P4T-SBBC
- with screw connection
  BL20-P3S-SBB
  BL20-P4S-SBBC

Wiring diagrams

Figure 4-5:
Wiring diagram

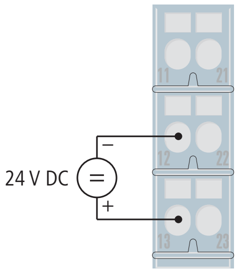
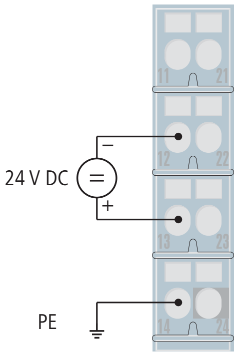


Figure 4-6:
Wiring diagram



4.1.3 Power Feeding module, 120/230 V AC, with diagnostics

Figure 4-7: electronics module

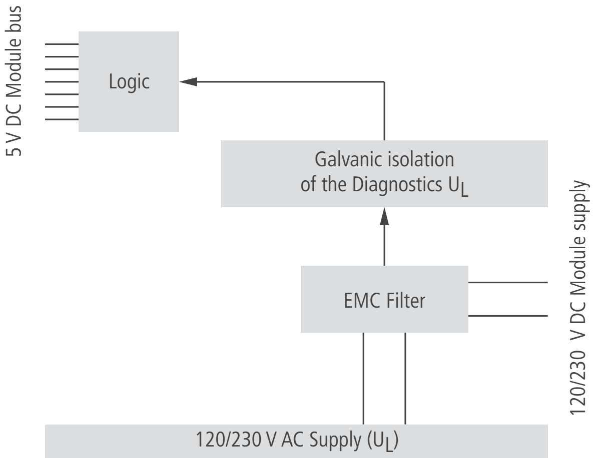


Figure 4-8: Block diagram

Technical data

Table 4-3: Technical data

Designation	BL20-PF-120/230VAC-D
Nominal voltage	120/230 V AC
– Permissible range	according to EN 61 131-2
Field supply U_L	120/230 V AC
Permissible range of U_L	according to EN 61 131-2
Nominal current from module bus I_{MB}	$\leq$ 25 mA
Ripple	< 5%
Residual ripple	according to EN 61 131-2
Maximum operating current I_{EI}	10 A
Voltage anomalies	according to EN 61 000-4-11/ EN 61 131-2

Diagnostic and status messages

The diagnostic functions monitor the supply voltages (system and field supply) supplied by the user for undervoltage. The diagnostic functions indicate errors via the "DIA" LED and transmit the corresponding diagnostic information to the gateway..

Table 4-4: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red, flashing, 0.5 Hz **and** LED U_L "Off"	voltage at the terminal < 84 V AC ± 5 V AC	Check the wiring to the field power supply. Check the external power supply unit and external mains unit.
	Red	Module bus communication failure	Check if more than two ad-joining electronics modules have been pulled. Check the wiring from the module bus to the system power supply.
	Off	No error messages or diagnostics	–
U_L	Green	Field power supply via external power supply unit OK	–
	Off	Field power supply via external power supply unit missing	Check the wiring to the field power supply. Check the external power supply unit.

This module has the following diagnostic data:

- "Undervoltage field supply"
  Monitoring the external power supply to the field

Module parameters

None

Base modules

Figure 4-9: Base module BL20-P3T-SBB

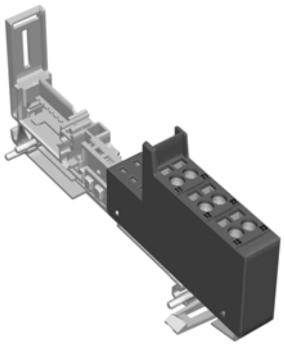
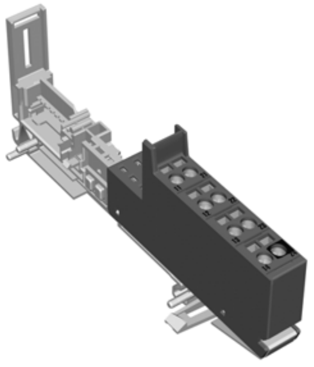


Figure 4-10: Base module BL20-P4T-SBBC



- with tension clamp connection
  BL20-P3T-SBB
  BL20-P4T-SBBC
- with screw connection
  BL20-P3S-SBB
  BL20-P4S-SBBC

Wiring diagrams

Figure 4-11: Wiring diagram

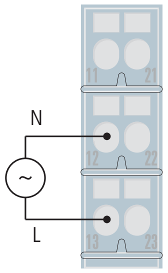
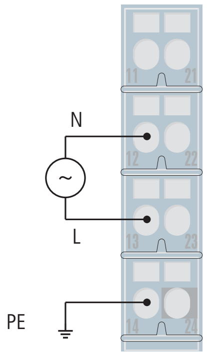


Figure 4-12: Wiring diagram



4.2 Bus Refreshing modules

Bus Refreshing modules are used to distribute 5 V DC to the internal BL20 module bus, as well as to distribute a nominal voltage of 24 V DC (permissible range according to EN 61 131-2) to the various BL20 modules, when building up BL20 stations with gateways **without** integrated power supply.

The adjoining power supply module and modules to the left are potentially isolated.

Attention
When using BL20 gateways with an integrated power supply unit (BL20-GWBR-xxxx), no additional Bus Refreshing module is needed to distribute 5 V DC to the internal BL20 module bus, as well as the nominal voltage of 24 V DC.

Attention
When using Bus Refreshing modules, this must be mounted immediately to the right of the gateway. This and a special base module guarantee the 5 V DC supply to the gateway.

Bus Refreshing modules eliminate the necessity to separately distribute the system or field voltage to each BL20 I/O module. Depending on the planned application, it is possible to build tailor-made groups of modules with different potentials by selecting appropriate Bus Refreshing modules. Bus Refreshing modules are available in slice design. They are mounted on to base modules with tension clamp or screw connections. The dusty grey color of the base modules for Bus Refreshing modules clearly distinguishes them from the base modules designed for BL20 I/O modules.

LED status indicators

Error signals and diagnostic statuses are indicated via LEDs on the module. The corresponding diagnostic information is transmitted to the gateway via diagnostic bits.

4.2.1 Module overview

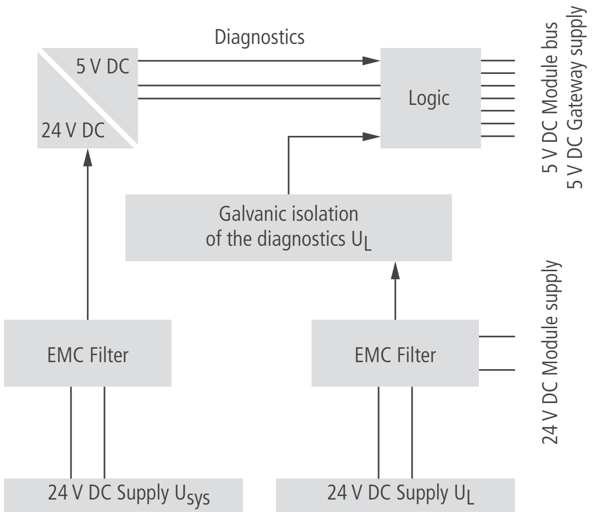
- BL20-BR-24VDC-D

Note
The structure of the individual supplies is described in detail in chapter 7.

4.2.2 Bus Refreshing module with diagnostics

Figure 4-13: BL20-BR-24VDC-D

Figure 4-14: Block diagram



Technical data

Table 4-5: Technical data

Designation	BL20-BR-24VDC-D
Nominal voltage	24 V DC
System supply U_{sys}	24 V DC / 5 V DC
Permissible range for U_{sys} = 24 V DC	18 to 30 V DC
Permissible range for U_{sys} = 5 V DC	4.7 to 5.3 V DC
Field supply U_L	24 V DC
Permissible range for U_L	18 to 30 V DC
Ripple	< 5%
Residual ripple	according to EN 61 131-2
Maximum operating current I_{EI}	10 A
Maximum system current supply I_{MB}	1.5 A

Diagnostic and status messages

The diagnostic functions monitor the supply voltages (system and field supply) supplied by the user for undervoltage. They indicate errors via "DIA" LED and transmit corresponding diagnostic information to the gateway.

Table 4-6: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Faulty power supply to the field U_L or system U_{sys}	Check the wiring from the module bus to the field power supply and to the system's power supply. Check the voltages of the field power supply and to the system power supply.
	Red	Module bus communication failure	Check if more than two ad-joining electronics modules have been pulled. Check the wiring from the module bus to the system power supply.
	Off	No error messages or diagnostics	–
V_{cc}	Green	5 V_{cc} voltage supply to the module bus is OK	–
	Off	5 V_{cc} voltage supply to the module bus is faulty	When LED "Sys" is off, then check the wiring and voltage of the system power supply.
Sys	Green	System power supply via external power supply unit OK	–
	Off	System power supply via external power supply unit faulty	Check the wiring to the system power supply. Check the external power supply unit.
U_L	Green	Field power supply via external power supply unit OK	–
	Off	Field power supply via external power supply unit faulty	Check the wiring to the field power supply. Check the external power supply unit.

This module has the following diagnostic data:

- "Module bus undervoltage warning"
  Monitoring of the external power supply to the system
  Usys = 24 V DC.
- "Undervoltage field supply"
  Monitoring of the external power supply to the field

Module parameters

None

Base modules

Figure 4-15: Base module BL20-P3T-SBB with gateway power supply

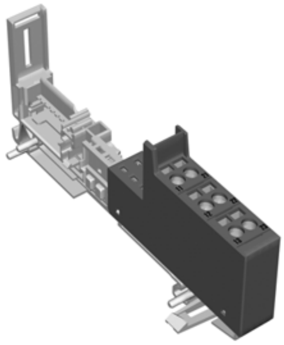
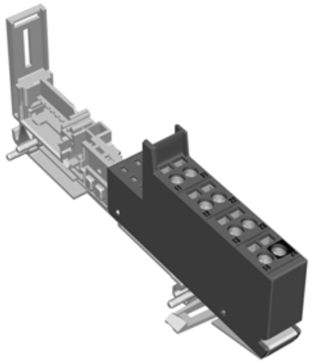


Figure 4-16: Base module BL20-P4T-SBBC-B without gateway power supply



Base modules **with** power supply to the gateway:

- with tension clamp connection
  BL20-P3T-SBB
  BL20-P4T-SBBC
- with screw connection
  BL20-P3S-SBB
  BL20-P4S-SBBC

Base modules **without** power supply to the gateway:

- with tension clamp connection
  BL20-P3T-SBB-B
  BL20-P4T-SBBC-B
- with screw connection:
  BL20-P3S-SBB-B
  BL20-P4S-SBBC-B

Attention
Only the modules BL20-P3x-SBB or BL20-P4x-SBBC
(= first module to the right of the gateway) can be used to distribute power to the gateways.

The base modules with or without power distribution to the gateways can be differentiated as follows:

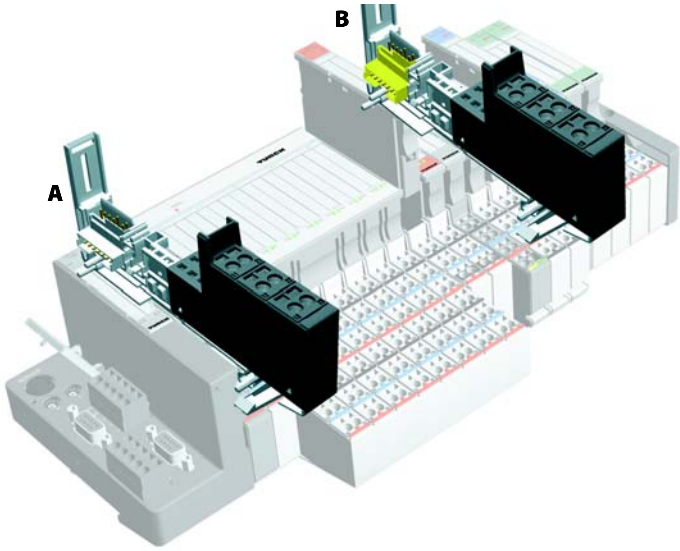


Figure 4-17: Assigning base modules

A *with power distribution to the gateway: light grey connection*
B *without power distribution to the gateway: yellow connection*

Wiring diagrams

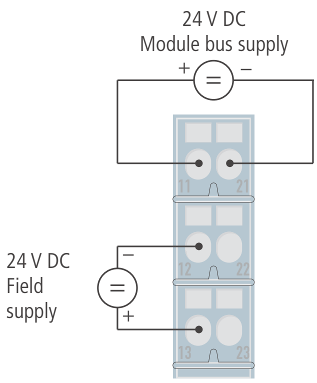
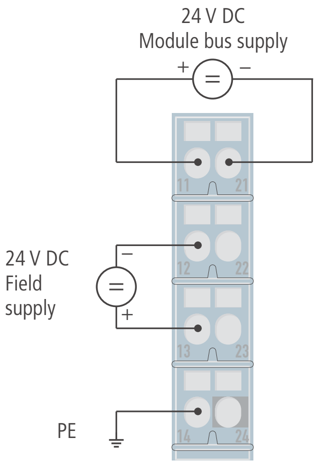


Figure 4-18: Wiring diagram

BL20-P3x-SBB with gateway supply
BL20-P3x-SBB-B without gateway supply

Figure 4-19: Wiring diagram



BL20-P4x-SBBC with gateway supply
BL20-P4x-SBBC-B without gateway supply

5 Digital input modules

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5.1 General

Digital input modules (DI) detect electrical high- and low-level values through the base module connections and transmit the corresponding digital value to the gateway via the module bus.

The module bus electronics of the digital input modules are galvanically isolated from the field level via an optocoupler. The module provides reverse polarity protection.

LED status indicators

Channel statuses are indicated by LEDs. Error signals from the I/O level are indicated by each module via the "DIA" LED.

A continuously lit up red "DIA" LED indicates the failure of the module bus communication at the digital input module.

5.1.1 Module overview

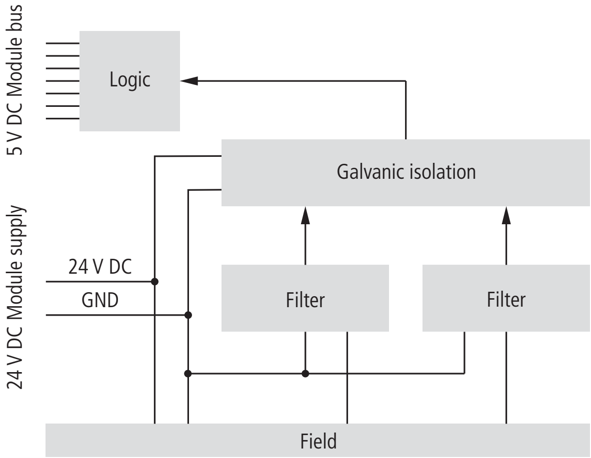
Table 5-1: Overview digital input modules

	Number of channels	Positive switching
BL20-2DI-24VDC-P	2	✓
BL20-2DI-24VDC-N	2	
BL20-2DI-120/230VAC	2	
BL20-4DI-24VDC-P	4	✓
BL20-4DI-24VDC-N	4	
BL20-E-8DI-24VDC-P	8	✓
BL20-16DI-24VDC-P	16	✓
BL20-32DI-24VDC-P	32	✓

5.2 Digital input module, 2DI, 24 V DC, positive switching (sinking)

Figure 5-1: BL20-2DI-24VDC-P

Figure 5-2: Block diagram



5.2.1 Technical data

Table 5-2: Technical data

Designation	BL20-2DI-24VDC-P
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	$\leq$ 20 mA
Nominal current from module bus I_{MB}	$\leq$ 28 mA
Power loss of the module, typical	approx. 0.7 W
Input voltage, nominal value at 24 V DC	
Low level U_L	- 30 V to +5 V
High level U_H	11 V to 30 V
Input current	
Low level I_L	0 mA to 1.5 mA
High level I_H	2 mA to 10 mA
Input delay	
t_{ON}	< 200 µs
t_{OFF}	< 200 µs
2-wire initiators (Bero®) can be connected with a permissible closed-circuit current of 1.5 mA	

5.2.2 Diagnostic and status messages

Table 5-3: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	

5.2.3 Module parameters

None

5.2.4 Base modules

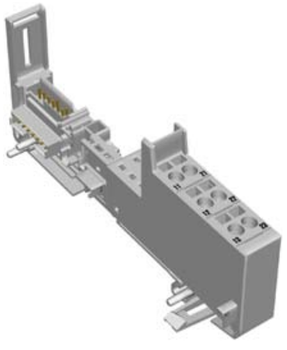


Figure 5-3: Base module BL20-S3T-SBB

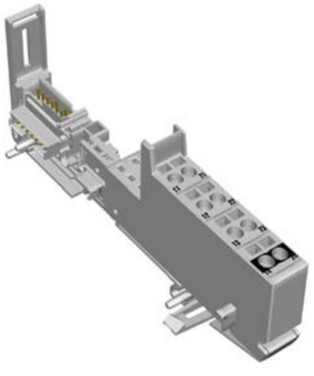


Figure 5-4: Base module BL20-S4T-SBBC

- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBC
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBC

5.2.5 Wiring diagrams

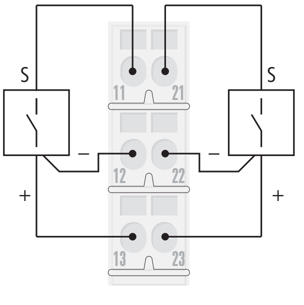
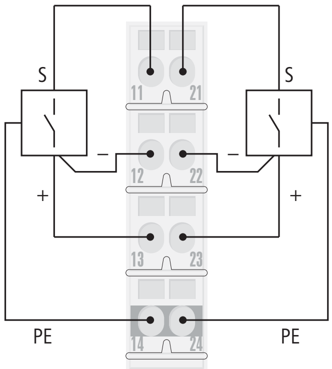


Figure 5-5: Wiring diagram BL20-S3x-SBB

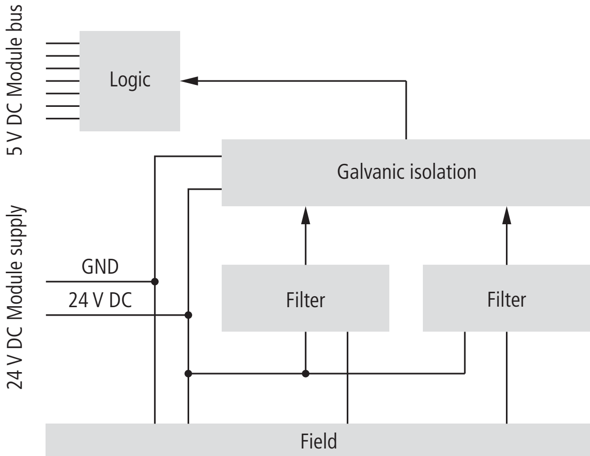
Figure 5-6: Wiring diagram BL20-S4x-SBBC



5.3 Digital input module, 2DI, 24 V DC, negative switching (sourcing)

Figure 5-7: BL20-2DI-24VDC-N

Figure 5-8: Block diagram



5.3.1 Technical data

Table 5-4: Technical data

Designation	BL20-2DI-24VDC-N
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 20 mA
Nominal current from module bus I_{MB}	≤ 28 mA
Power loss of the module, typical	approx. 0.7 W
Input voltage, nominal value at 24 V DC	
Active level U_A	0 V to +5 V
Inactive level U_I	> (U_{PF} - 11 V)
Input current	
Active level I_A	1.3 mA to 6 mA
Inactive level I_I	0 mA to 1.2 mA
Input delay	
t_{ON}	< 200 µs
t_{OFF}	< 200 µs
2-wire initiators (Bero®) can be connected with a permissible closed-circuit current of 1.5 mA	

5.3.2 Diagnostic and status messages

Table 5-5: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	

5.3.3 Module parameters

None

5.3.4 Base modules

Figure 5-9: Base module BL20-S3T-SBB

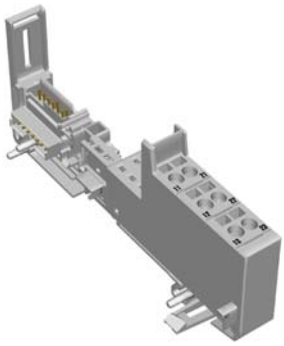
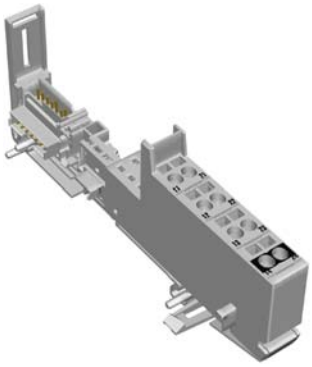


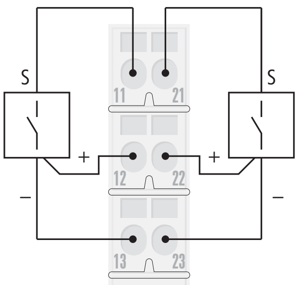
Figure 5-10: Base module BL20-S4T-SBBC



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBC
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBC

5.3.5 Wiring diagrams

Figure 5-11: Wiring diagram BL20-S3x-SBB



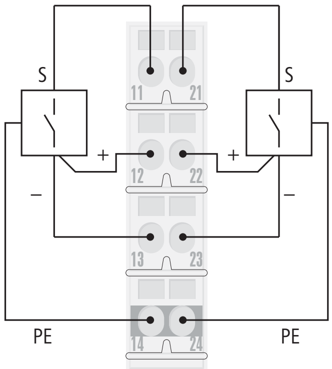


Figure 5-12:
Wiring diagram
BL20-S4x-SBBC

5.4 Digital input module, 2DI, 120/230 V AC

Figure 5-13: BL20-2DI-120/230VAC

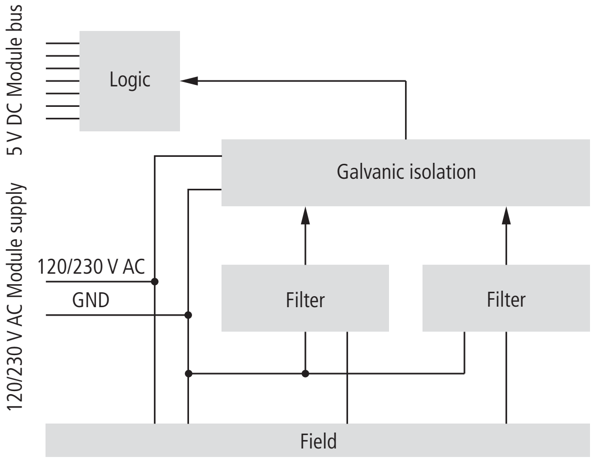


Figure 5-14: Block diagram

5.4.1 Technical data

Table 5-6: Technical data

Designation	BL20-2DI-120/230VAC
Number of channels	2
Nominal voltage from supply terminal U_L	120/230 V AC
Nominal current from supply terminal I_L	≤ 20 mA
Nominal current from module bus I_{MB}	≤ 28 mA
Power loss of the module, typical	< 1 W
Input voltage, nominal value at 120/230 V AC	
Low level U_L	0 V AC to 20 V AC
High level U_H	79 V AC to 265 V AC
Frequency range	47.5 Hz to 63 Hz
Input current	
Low level I_L	0 mA to 1 mA
High level I_H	3 mA to 10 mA
Input delay	
t_{ON}	< 20 ms
t_{OFF}	< 20 ms
Maximum permissible wire capacity	141 nF at 79 V AC/50 Hz 23 nF at 265 V AC/50 Hz

5.4.2 Diagnostic and status messages

Table 5-7: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	

5.4.3 Module parameters

None

5.4.4 Base modules

Figure 5-15: Base module BL20-S3T-SBB

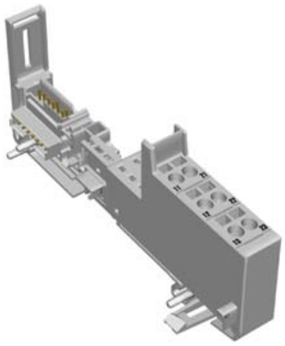
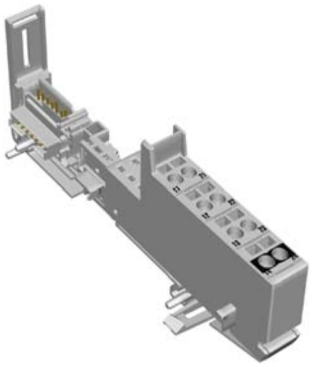


Figure 5-16: Base module BL20-S4T-SBBC



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBC
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBC

5.4.5 Wiring diagrams

Figure 5-17: Wiring diagram BL20-S3x-SBB

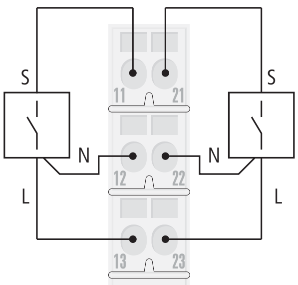
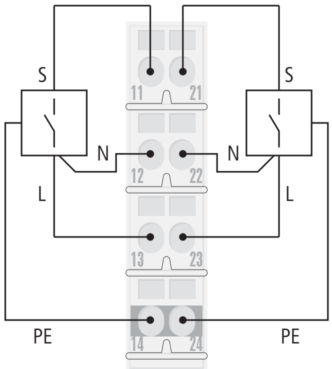


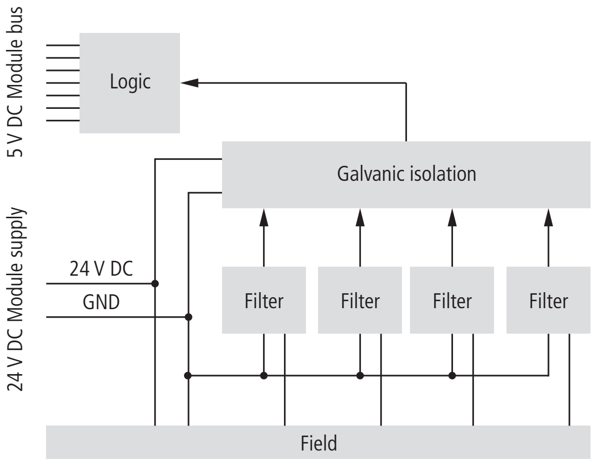
Figure 5-18: Wiring diagram BL20-S4x-SBBC



5.5 Digital input module, 4DI, 24 V DC, positive switching (sinking)

Figure 5-19: BL20-4DI-24VDC-P

Figure 5-20: Block diagram



5.5.1 Technical data

Table 5-8: Technical data

Designation	BL20-4DI-24VDC-P
Number of channels	4
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	$\leq$ 40 mA
Nominal current from module bus I_{MB}	$\leq$ 29 mA
Power loss of the module, typical	approx. 1 W
Input voltage, nominal value at 24 V DC	
Low level U_L	- 30 V to +5 V
High level U_H	15 V to 30 V
Input current	
Low level I_L	0 mA to 1.5 mA
High level I_H	2 mA to 10 mA
Input delay	
t_{ON}	< 200 µs
t_{OFF}	< 200 µs

5.5.2 Diagnostic and status messages

Table 5-9: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"-	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	
14	Green	Status of channel 3 = "1"	
	Off	Status of channel 3 = "0"	
24	Green	Status of channel 4 = "1"	
	Off	Status of channel 4 = "0"	

5.5.3 Module parameters

None

5.5.4 Base modules

Figure 5-21: Base module BL20-S4T-SBBS

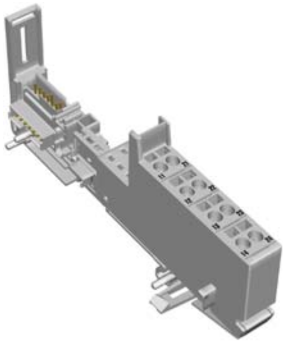
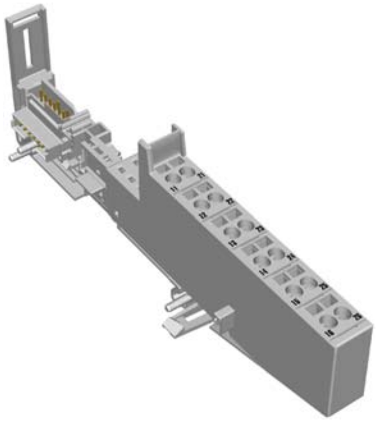


Figure 5-22: Base module BL20-S6T-SBBSBB



- with tension clamp connection
  BL20-S4T-SBBS
  BL20-S6T-SBBSBB
- with screw connection
  BL20-S4S-SBBS
  BL20-S6S-SBBSBB

5.5.5 Wiring diagrams

Figure 5-23: Wiring diagram BL20-S4x-SBBS

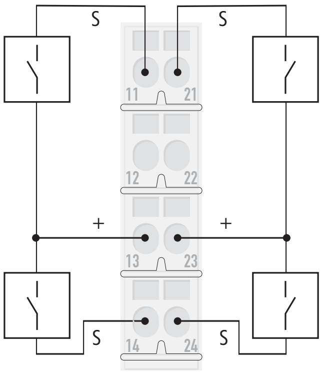
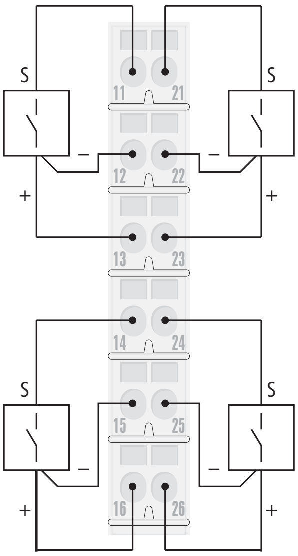


Figure 5-24: Wiring diagram BL20-S6x-SBBSBB



5.6 Digital input module, 4DI, 24 V DC, negative switching (sourcing)

Figure 5-25: BL20-4DI-24VDC-N

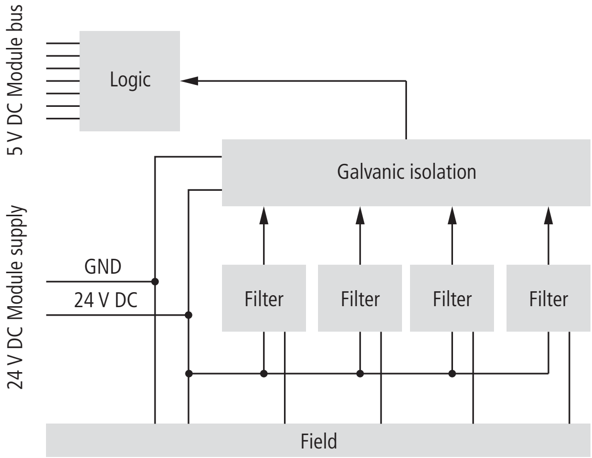


Figure 5-26: Block diagram

5.6.1 Technical data

Table 5-10: Technical data

Designation	BL20-4DI-24VDC-N
Number of channels	4
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 40 mA
Nominal current from module bus I_{MB}	≤ 28 mA
Power loss of the module, typical	< 1 W
Input voltage, nominal value at 24 V DC	
Active level U_A	0 V to +5 V
Inactive level U_I	> (U_{PF} - 11 V)
Input current	
Active level I_A	1.3 mA to 6 mA
Inactive level I_I	0 mA to 1.2 mA
Input delay	
t_{ON}	< 200 µs
t_{OFF}	< 200 µs

5.6.2 Diagnostic and status messages

Table 5-11: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"-	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	
14	Green	Status of channel 3 = "1"	
	Off	Status of channel 3 = "0"	
24	Green	Status of channel 4 = "1"	
	Off	Status of channel 4 = "0"	

5.6.3 Module parameters

None

5.6.4 Base modules

Figure 5-27: Base module BL20-S4T-SBBS

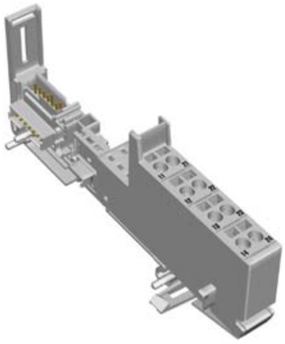
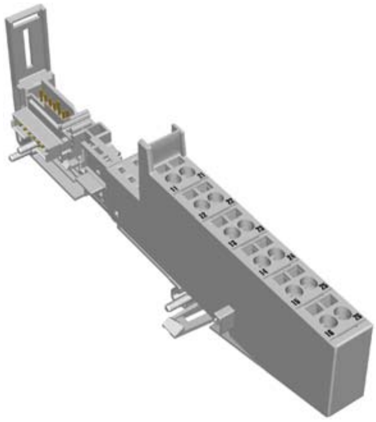


Figure 5-28: Base module BL20-S6T-SBBSBB



- with tension clamp connection
  BL20-S4T-SBBS
  BL20-S6T-SBBSBB
- with screw connection
  BL20-S4S-SBBS
  BL20-S6S-SBBSBB

5.6.5 Wiring diagrams

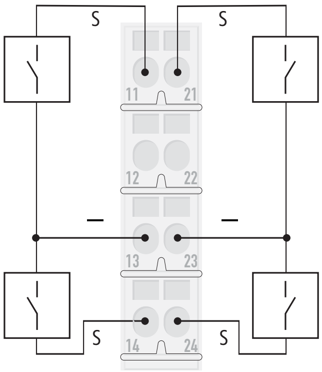


Figure 5-29: Wiring diagram BL20-S4x-SBBS

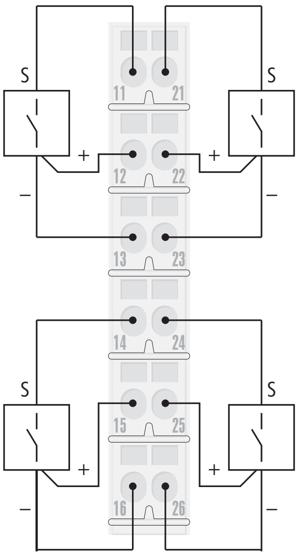
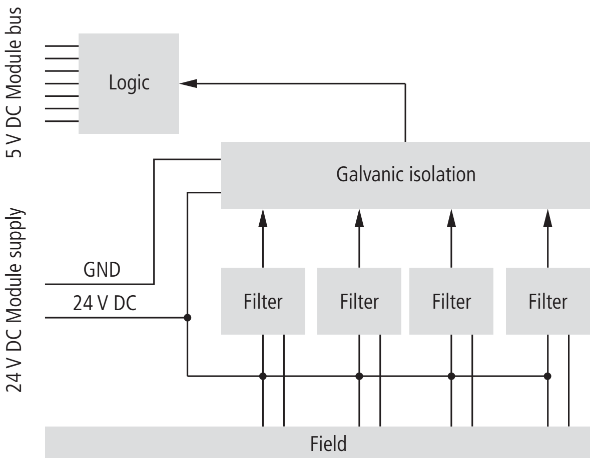


Figure 5-30: Wiring diagram BL20-S6x-SBBSBB

5.7 Digital input module, 4DI, NAMUR

Figure 5-31:
BL20-4DI-NAMUR

Figure 5-32:
Block diagram



5.7.1 Technical data

Table 5-12: Technical data

Designation	BL20-4DI-NAMUR
Number of channels	4
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 30 mA
Nominal current from module bus I_{MB}	≤ 40 mA
IN_{NAMUR} (input)	
sitch-on threshold	≥ 1,74 mA
sitch-off threshold	≤ 1,45 mA
IN_{WB}	
sitch-on threshold	≤ 0,08 mA
sitch-off threshold	≥ 0,12 mA
IN_{SC}	
sitch-on threshold	≥ 6,2 mA
sitch-off threshold	≤ 5,9 mA
Isolation voltage	
U_{TMB} (module bus/ filed)	2500 VDC
U_{FE} (field supply/ FE)	1000 VDC

5.7.2 Diagnostic and status messages

Table 5-13: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11 to 24	Green	Status of channel x= "1"	
	Red	Short circuit **or** open circuit	
	Off	Status of channel x= "0"	

This module has the following diagnostic data:

- "Overcurr./short circuit sensor x"
- "Open circuit sensor x"

5.7.3 Module parameters

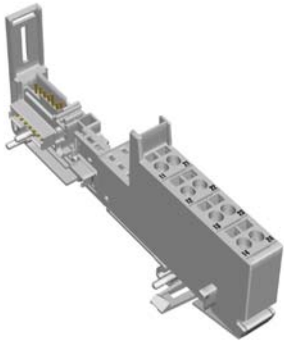
Table 5-14: Module parameters

A *Standard parameter value*

Parameter name	**Value**
Digital input x	normal **A**
	inverted
Input filter x	deactivate **A**
	activate
Short-circuit monitoring x	deactivate **A**
	activate
Short circuit diagnosis x	deactivate **A**
	activate
Open circuit monitoring x	deactivate **A**
	activate
Open circuit diagnosis x	deactivate **A**
	activate
Input on diagnostic x	output substitute value **A**
	hold current value
Substitute value on diag x	off **A**
	on

5.7.4 Base modules

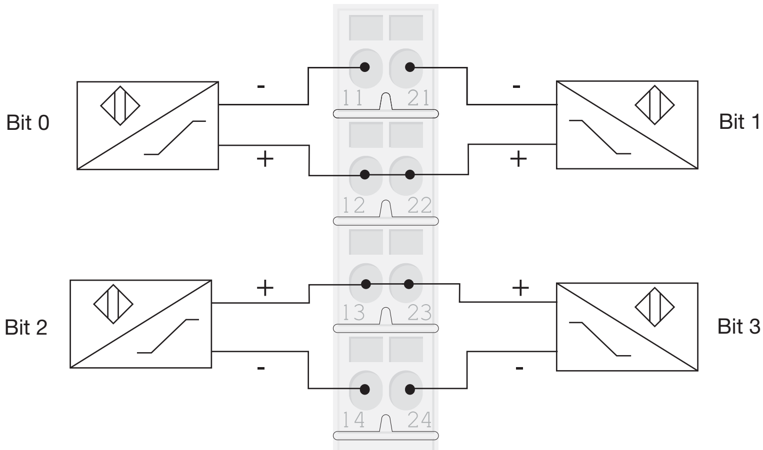
Figure 5-33: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S4T-SBBS
- with screw connection
  BL20-S4S-SBBS

5.7.5 Wiring diagrams

Figure 5-34: Wiring diagram BL20-S4x-SBBS



5.8 Digital input module, BL20 Economy, 8DI, 24 V DC, positive switching (sinking)

Figure 5-35:
BL20-E-8DI-24VDC-P

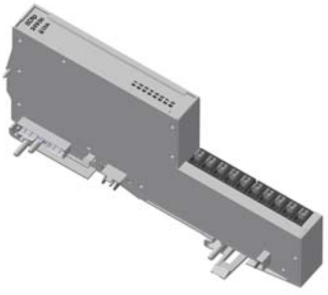
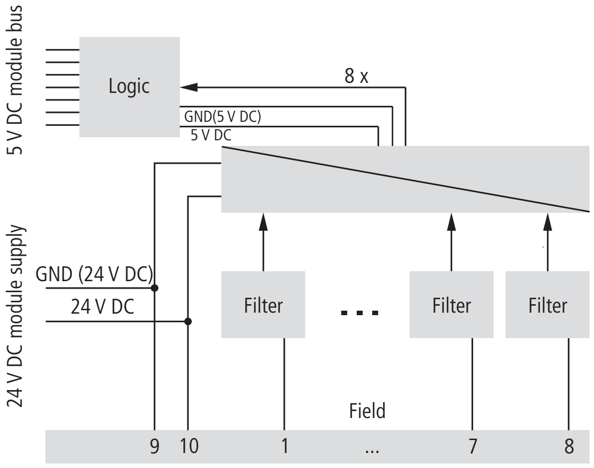


Figure 5-36:
Block diagram



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5.8.1 Technical data

Table 5-15: Technical data

A *The total current which is needed for every module is the sum of all partial currents.*

Designation	BL20-E-8DI-24VDC-P
Number of channels	8
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	1,5 mA **A**
Nominal current from module bus I_{MB}	< 30 mA
Input voltage, nominal value at 24 V DC	
Low level U_L	- 30 V to +5 V
High level U_H	11 V to 30 V
Input current	
Low level I_L	-1 mA to 1.5 mA
High level I_H	2 mA to 5 mA
Input delay	
t_{ON}	< 100 µs
t_{OFF}	< 200 µs
Isolation voltage	
Module bus/ Channels	500 V_{eff}

5.8.2 Diagnostic and status messages

Table 5-16: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
1	Green	Status of channel 1 = "1"-	
	Off	Status of channel 1 = "0"	
...	...	...	
8	Green	Status of channel 8 = "1"	
	Off	Status of channel 8 = "0"	

5.8.3 Wiring diagrams

Figure 5-37: Wiring diagram

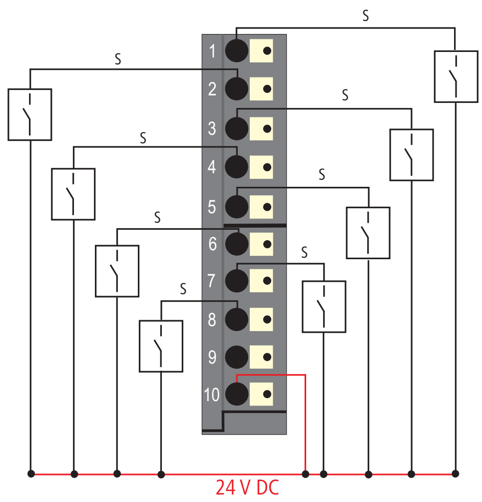
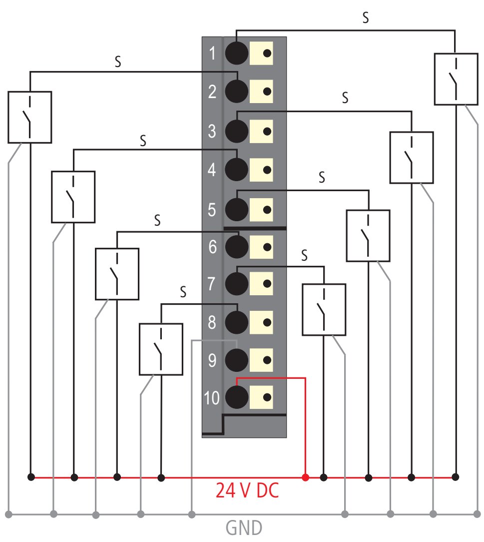


Figure 5-38: Wiring diagram with sensor supply



5.9 Digital input module, 16DI, 24 V DC, positive switching (sinking)

Figure 5-39: BL20-16DI-24VDC-P

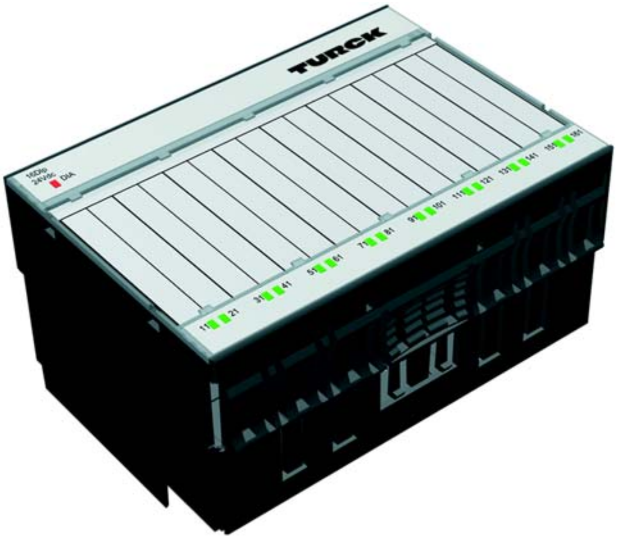
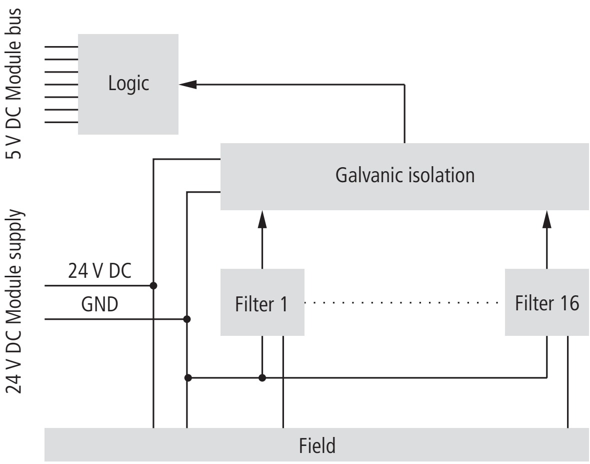


Figure 5-40: Block diagram



5.9.1 Technical data

Table 5-17: Technical data

Designation	BL20-16DI-24VDC-P
Number of channels	16
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 40 mA
Nominal current from module bus I_{MB}	< 45 mA
Power loss of the module, typical	< 2.5 W
Input voltage, nominal value at 24 V DC	
Low level U_L	- 30 V to +5 V
High level U_H	15 V to 30 V
Input current	
Low level I_L	0 mA to 1.5 mA
High level I_H	2 mA to 10 mA
Input delay	
t_{ON}	< 200 µs
t_{OFF}	< 200 µs

5.9.2 Diagnostic and status messages

Table 5-18: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"-	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	
. . .			
161	Green	Status of channel 16 = "1"	
	Off	Status of channel 16 = "0"	

5.9.3 Module parameters

None

5.9.4 Base modules

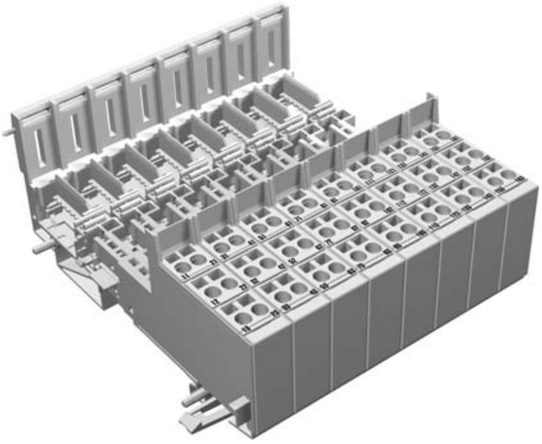


Figure 5-41:
Base module
BL20-B3T-SBB

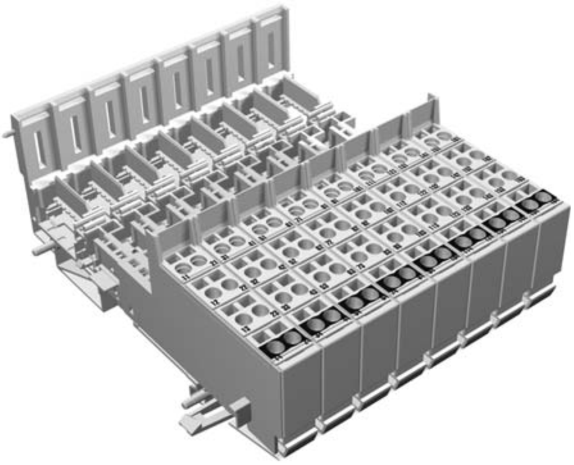


Figure 5-42:
Base module
BL20-B4T-SBBC

- with tension clamp connection
  BL20-B3T-SBB
  BL20-B4T-SBBC
- with screw connection
  BL20-B3S-SBB
  BL20-B4S-SBBC

5.9.5 Wiring diagrams

Figure 5-43: Wiring diagram BL20-B3x-SBB

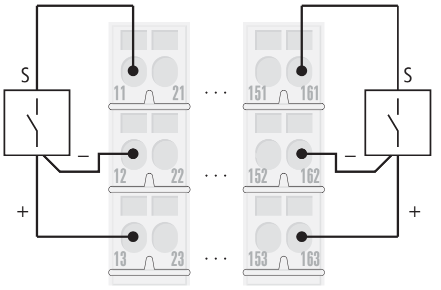
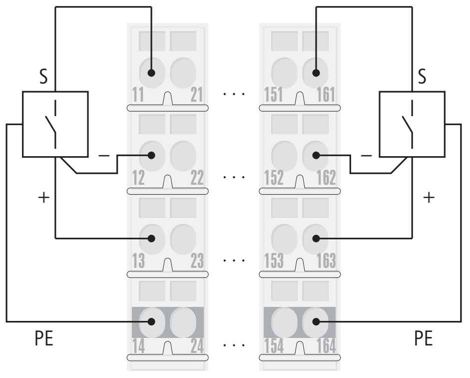


Figure 5-44: Wiring diagram BL20-B4x-SBBC



5.10 Digital input module, BL20 Economy, 16DI, 24 V DC, positive switching (sinking)

Figure 5-45:
BL20-E-16DI-24VDC-P

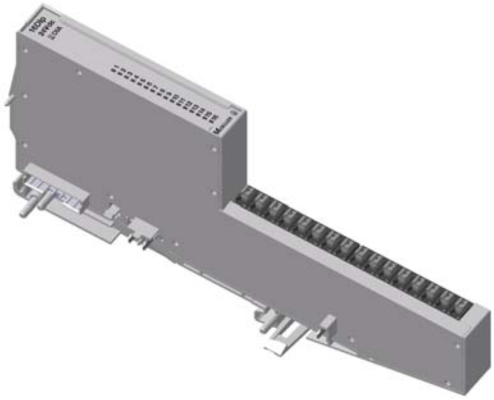
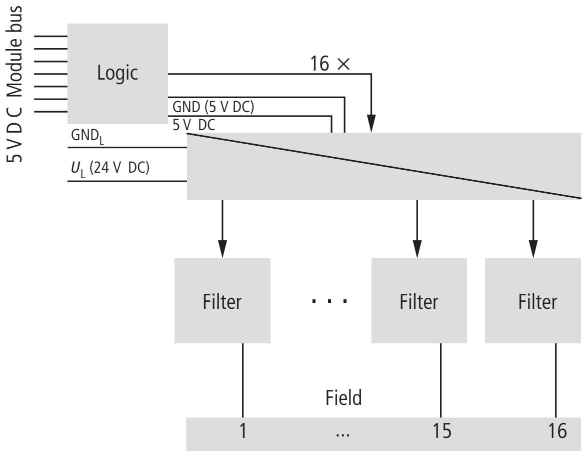


Figure 5-46:
Block diagram



5.10.1 Technical data

Table 5-19: Technical data

A *The total current which is needed for every module is the sum of all partial currents.*

Designation	BL20-E-16DI-24VDC-P
Number of channels	16
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	3 mA **A**
Nominal current from module bus I_{MB}	< 25 mA
Input voltage, nominal value at 24 V DC	
Low level U_L	- 30 V to +5 V
High level U_H	11 V to 30 V
Input current	
Low level I_L	-1 mA to 1.5 mA
High level I_H	2 mA to 5 mA
Input delay	
t_{ON}	< 150 µs
t_{OFF}	< 300 µs
Isolation voltage	
Module bus/ Channels	500 V_{eff}

5.10.2 Diagnostic and status messages

Table 5-20: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
1	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
...	...	...	
16	Green	Status of channel 16 = "1"	
	Off	Status of channel 16 = "0"	

5.10.3 Wiring diagrams

Figure 5-47: Wiring diagram

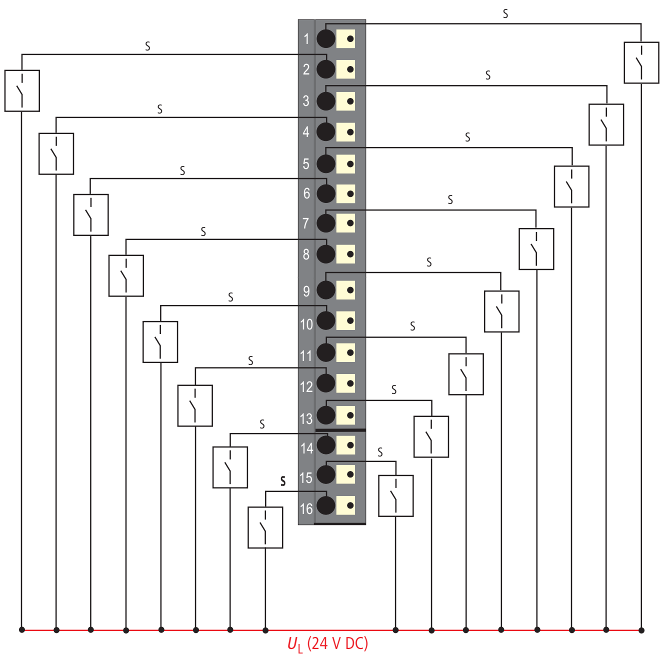
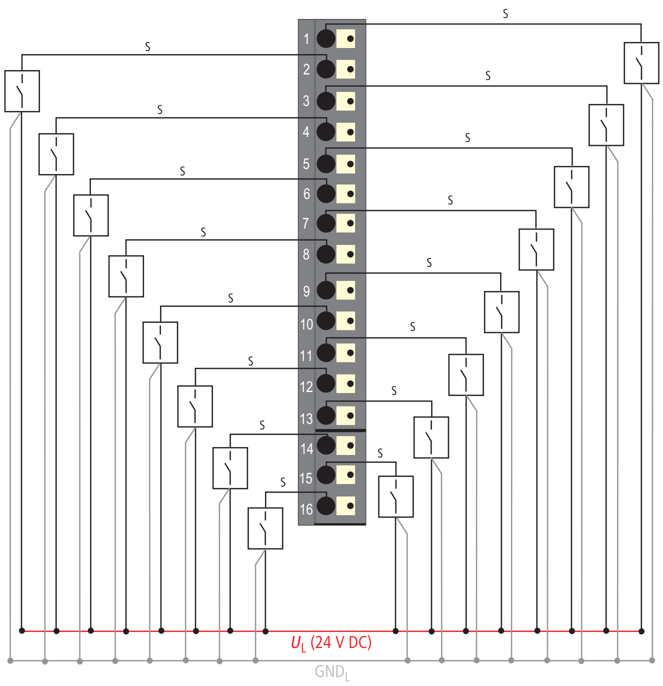


Figure 5-48: Wiring diagram with sensor supply



5.11 Digital input module, 32DI, 24 V DC, positive switching (sinking)

Figure 5-49: BL20-32DI-24VDC-P

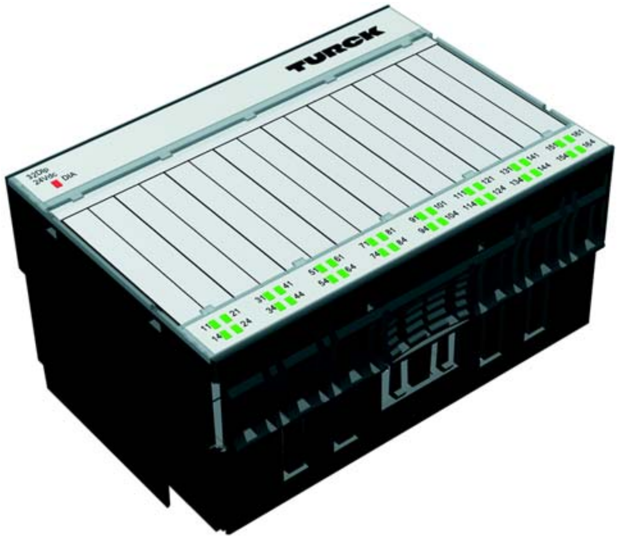
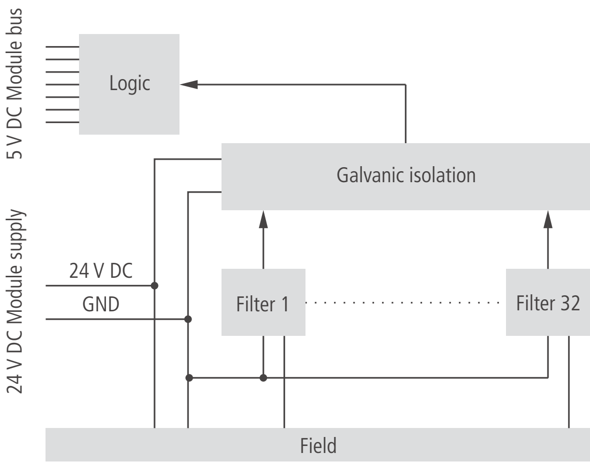


Figure 5-50: Block diagram



5.11.1 Technical data

Table 5-21: Technical data

Designation	BL20-32DI-24VDC-P
Number of channels	32
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 30 mA
Nominal current from module bus I_{MB}	< 45 mA
Power loss of the module, typical	< 4,2 W
Input voltage, nominal value at 24 V DC	
Low level U_L	- 30 V to +5 V
High level U_H	15 V to 30 V
Input current	
Low level I_L	< 1.5 mA
High level I_H	2 mA to 10 mA
Input delay	
t_{ON}	< 200 µs
t_{OFF}	< 200 µs

5.11.2 Diagnostic and status messages

Table 5-22: LED indicators

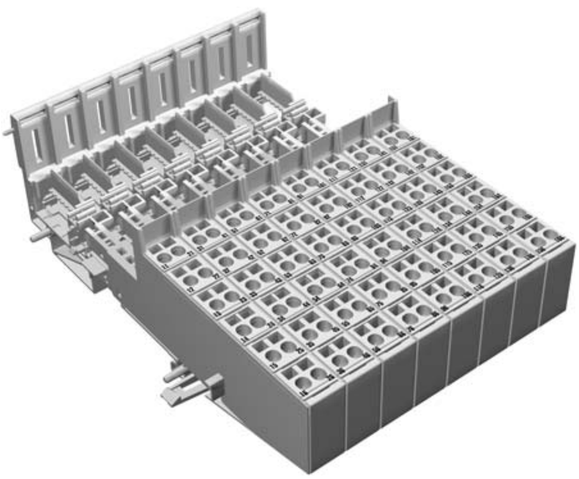
LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
...			
161	Green	Status of channel 16 = "1"	
	Off	Status of channel 16 = "0"	
...			
14	Green	Status of channel 17 = "1"	
	Off	Status of channel 17= "0"	
164	Green	Status of channel 32 = "1"	
	Off	Status of channel 32= "0"	

5.11.3 Module parameters

None

5.11.4 Base modules

Figure 5-51: Base module BL20-B6T-SBBSBB

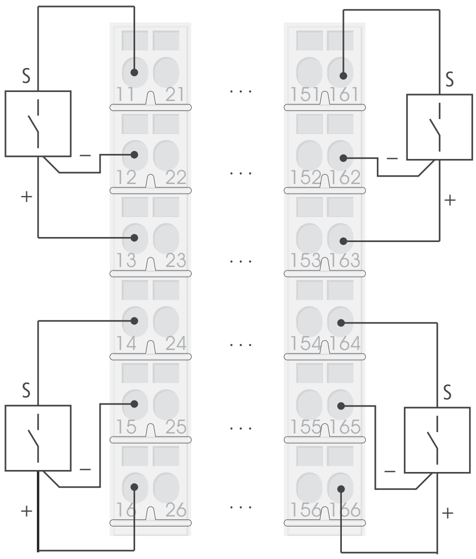


- with tension clamp connection BL20-B6T-SBBSBB

- with screw connection
  BL20-B6S-SBBSBB

5.11.5 Wiring diagrams

Figure 5-52:
Wiring diagram BL20-B6x-SBBSBB



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6.1 General

Analog input modules (AI) detect standard electrical signals at the connections of the base modules, digitalize them and transmit the corresponding measurement values to the gateway via the internal module bus.

The module bus electronics of the analog input modules are galvanically isolated from the field level via an optocoupler. The module provides reverse polarity protection.

Supported signal ranges

- 0 to 20 mA
- 4 to 20 mA
- 0 to 10 V DC
- -10 to +10 V DC
- HART®

Connectable sensors

- Platinum sensors (Pt100, Pt200, Pt500, Pt1000)
- Nickel sensors (Ni100, Ni1000,Ni100, Ni1000 (DIN 43 760), Ni1000TK5000)
- Thermoelements (types: B, E, J, K, N, R, S, T)
- Restistances (0 ... 250 Ω, 0 ... 400 Ω, 0 ... 800 Ω, 0 ... 2000 Ω, 0 ... 4000 Ω)

LED status indicators

Error signals from the I/O level are indicated by each module via the "DIA" LED. The corresponding diagnostic information is transmitted to the gateway via diagnostic bits.

If the "DIA" LED lights up continuously red, it signals the failure of the module bus communication at the digital input module.

6.1.1 Shielding

When using shielded signal cables, the connection between the shield and the base module is made via a two-pole shield connection, which is available as an accessory.

6.1.2 Analog value representation

The analog values can either be represented with16 bit or 12 bit. The two's-complement representation allow the representation of positive as well as negative values.

Note

For newer analog modules (e.g. BL20-E-8AI-U/I-4PT/NI or BL20-2AIH-I) with extended value representation functions, the tables for the measurement values can be found within the respective module descriptions.

Note

A detailed description of the 16 bit/12-bit-representation for the analog values can be found in the Appendix of this manual.

6.1.3 Module overview

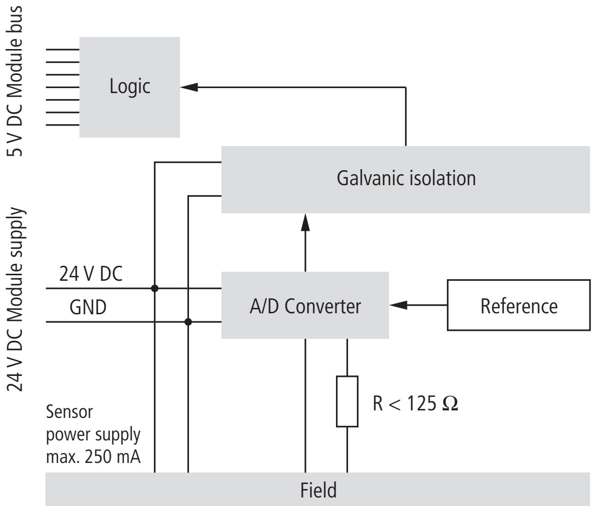
Table 6-1: Overview analog input modules

	Number of channels
BL20-1AI-I(0/4...20MA)	1
BL20-2AI-I(0/4...20MA)	2
BL20-1AI-U(-10/0...+10VDC)	1
BL20-2AI-U(-10/0...+10VDC)	2
BL20-2AI-Pt/NI-2/3	2
BL20-2AI-THERMO-PI	2
BL20-4AI-UI	4
BL20-E-8AI-U/I-4PT/NI	8/4
BL20-2AI-H-I	2

6.2 Analog input module, 1AI, 0/4...20 mA

Figure 6-1: BL20-1AI-I (0/4...20MA)

Figure 6-2: Block diagram



6.2.1 Technical data

Table 6-2: Technical data

Designation	BL20-1AI-I(0/4...20MA)
Number of channels	1
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 50 mA
Nominal current from module bus I_{MB}	≤ 41 mA
Power loss of the module, typical	<1 W
Input current	0/4 to 20 mA
Max. input current	50 mA
Input resistance (burden)	< 125 Ω
Cutoff frequency f_G	200 Hz
Basic error at 23 °C / 73.4 °F	< 0.2 %
Repeat accuracy	0.09 %
Temperature coefficient	≤ 300 ppm/°C from end value
Resolution of the A/D converter	14 bit signed integer
Measuring principle	gradual approximation
Measurement value representation	16 bit signed integer / 12 bit full range left-justified
Sensor supply	bridged with L+ and L- from the power supply; not short-circuit proof

6.2.2 Diagnostic and status messages

Table 6-3: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data:

- "Measurement value range error"
  Indicates an over- or undercurrent of 1 % of the set current range; whereby, undercurrents can only be recognized with those modules that have a set current range of 4 to 20 mA.
  Overcurrent:I_{max} (I > 20.2 mA);
  Undercurrent:I_{min} (I < 3.8 mA)
- "Open circuit"
  Indicates an open circuit in the signal line for the operating mode
  4 to 20 mA (I < 3 mA)

6.2.3 Module parameters

Table 6-4: Module parameters

A *Standard parameter value*

Parameter name	Value
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Current mode	0..20mA **A**
	4..20mA
Diagnostic	release **A**
	block

6.2.4 Base modules

Figure 6-3: Base module BL20-S3T-SBB

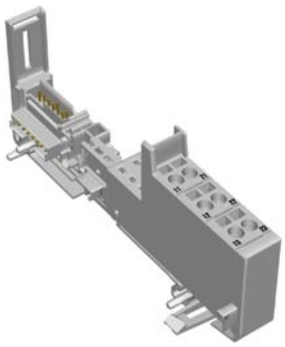
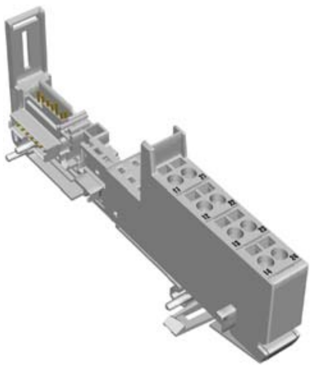


Figure 6-4: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBS
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBS

6.2.5 Wiring diagrams

Figure 6-5: 2-wire sensor with sensor supply via base module BL20-S4x-SBBS

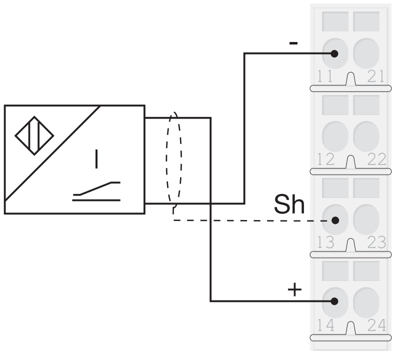


Figure 6-6: 3-wire sensor with sensor supply via base module BL20-S4x-SBBS

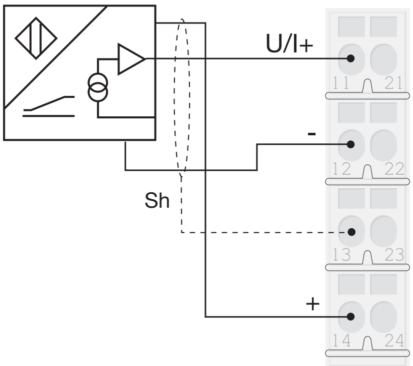


Figure 6-7: 4-wire sensor with sensor supply via base module BL20-S4x-SBBS

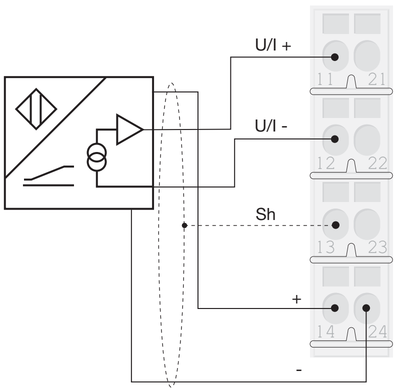
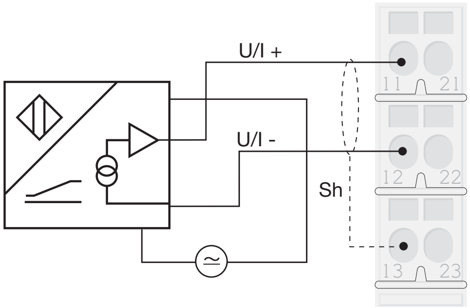


Figure 6-8: 4-wire sensor with external sensor supply, base module BL20-S3x-SBB



6.2.6 Measurement value representation

16 bit value representation

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  0000$_{hex}$ to 7FFF$_{hex}$ (decimal: 0 to 32767)

- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ **(decimal: 0 to 32767)**

12 bit value representation (left-justified)

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$(decimal: 0 to 4095)

- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

Note
A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.3 Analog input module, 2AI, 0/4...20 mA

Figure 6-9: BL20-2AI-I (0/4...20MA)

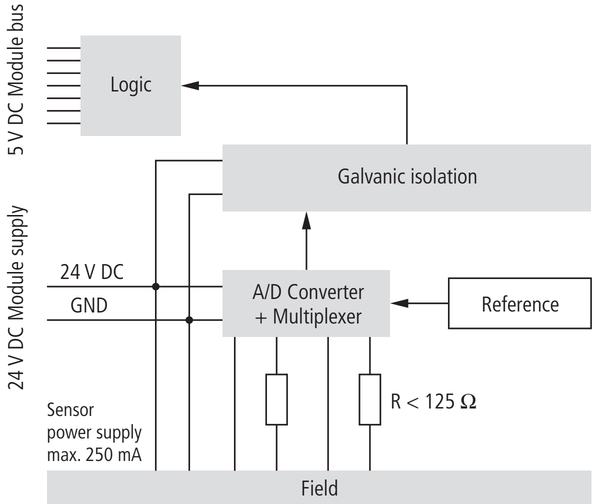


Figure 6-10: Block diagram

6.3.1 Technical data

Table 6-5: Technical data

Designation	BL20-2AI-I(0/4...20MA)
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 12 mA
Nominal current from module bus I_{MB}	≤ 35 mA
Power loss of the module, typical	< 1 W
Input current	0/4 to 20 mA
Max. input current	50 mA
Input resistance (burden)	< 125 Ω
Cutoff frequency f_G	≥ 50 Hz
Basic error at 23 °C / 73.4 °F	< 0.2 %
Repeat accuracy	0.05 %
Temperature coefficient	≤ 300 ppm/°C from end value
Resolution of the A/D converter	16 bit
Measuring principle	Delta Sigma
Measurement value representation	16 bit signed integer / 12 bit full range left-justified
Sensor supply	≤ 250 mA; brigded with L+ and L- from the power supply; not short-circuit proof

6.3.2 Diagnostic and status messages

Table 6-6: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data:

- "Measurement value range error"
  Indicates an over- or undercurrent of 1 % of the set current range; whereby, undercurrents can only be recognized with those modules that have a set current range of 4 to 20 mA.
  Overcurrent:I_{max} (I > 20.2 mA);
  Undercurrent:I_{min} (I < 3.8 mA)
- "Open circuit"
  Indicates an open circuit in the signal line for the operating mode 4 to 20 mA (I < 3 mA)

Note
If the measurement value representation is parameterized as "12bit (left-justified)" the diagnostic data will be transferred with the process data bits 0 to 3 of the respective channel.

6.3.3 Module parameters (per channel)

Table 6-7: Module parameters

A*Standard parameter value*

Parameter name	Value
Channel	activate **A**
	deactivate
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Current mode	0..20mA **A**
	4..20mA
Diagnostic	release **A**
	block

6.3.4 Base modules

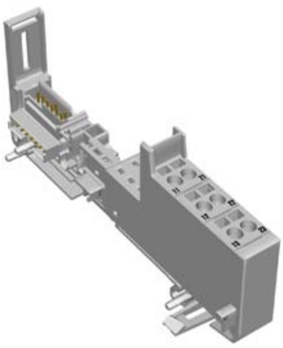
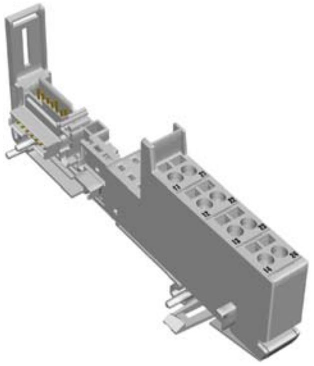


Figure 6-11: Base module BL20-S3T-SBB

Figure 6-12: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBS
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBS

6.3.5 Wiring diagrams

Figure 6-13: 2-wire sensors with sensor supply via base module BL20-S4x-SBBS

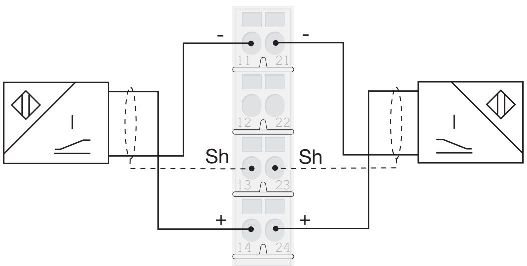


Figure 6-14: 3-wire sensor with sensor supply via base module BL20-S4x-SBBS

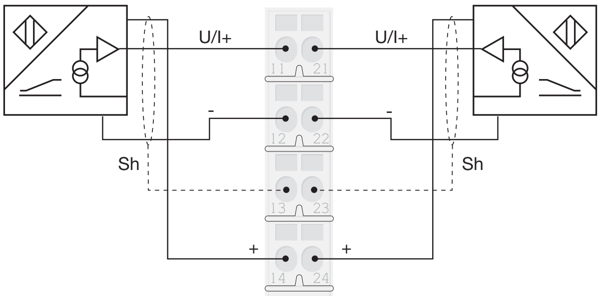
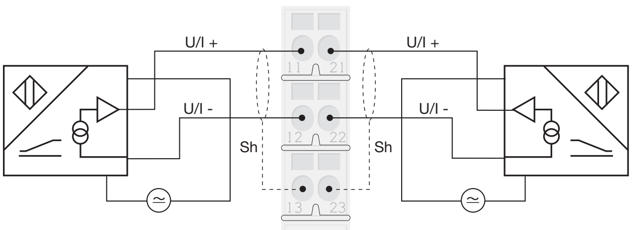


Figure 6-15: 4-wire sensor with external sensor supply, base module BL20-S3x-SBB



6.3.6 Measurement value representation

16 bit value representation

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

12 bit value representation (left-justified)

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  $000(0)_{hex}$ to $FFF(0)_{hex}$ (decimal: 0 to 4095)

- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  $000(0)_{hex}$ to $FFF(0)_{hex}$ (decimal: 0 to 4095)

Note
A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.4 Analog input module, 1AI, -10/0...+10 V DC

Figure 6-16: BL20-1AI-U (-10/0...+10VDC)

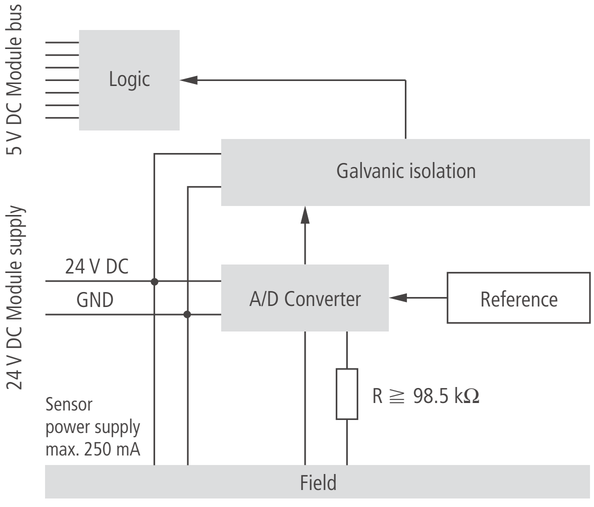


Figure 6-17: Block diagram

6.4.1 Technical data

Table 6-8: Technical data

Designation	BL20-1AI-U(-10/0...+10V DC)
Number of channels	1
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 50 mA
Nominal current from module bus I_{MB}	≤ 41 mA
Power loss of the module, typical	< 1 W
Input voltage	-10/0 to +10 V
Maximum input voltage	35 V continuous
Input resistance (burden)	≥ 98.5 kΩ
Cutoff frequency f_G	200 Hz
Basic error at 23 °C / 73.4 °F	< 0.2 %
Repeat accuracy	0.05 %
Temperature coefficient	≤ 300 ppm/°C from end value
Resolution of the A/D converter	gradual approximation
Measuring principle	Delta Sigma
Measurement value representation	16 bit signed integer /12 bit signed integer left-justified/ 12 bit full range left-justified
Sensor supply	bridged with L+ and L- from the power supply; not short-circuit proof

6.4.2 Diagnostic and status messages

Table 6-9: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data:

- "Measurement value range error"
  Indicates an over- or undervoltage of 1% of the set voltage range.
  Overvoltage:
  U_{max} (U > 10.1 V);
  Undervoltage:
  U_{min} (U < -10.1 V) at -10 to +10 V
  U_{min} (U < -0.1 V) at 0 to 10 V

6.4.3 Module parameters

Table 6-10: Module parameters

A*Standard parameter value*

Parameter name	Value
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Voltage mode	-10..+10V
	0..10V **A**
Diagnostic	release **A**
	block

6.4.4 Base modules

Figure 6-18: Base module BL20-S3T-SBB

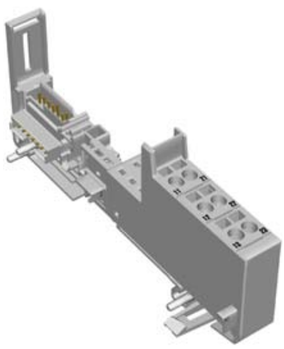
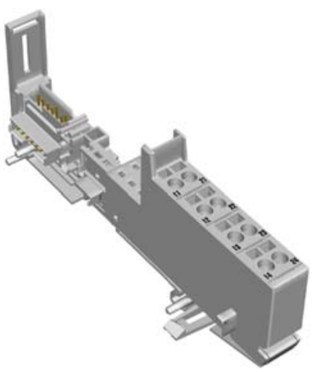


Figure 6-19: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBS
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBS

6.4.5 Wiring diagrams

Figure 6-20: 2-wire sensor with sensor supply via base module BL20-S4x-SBBS

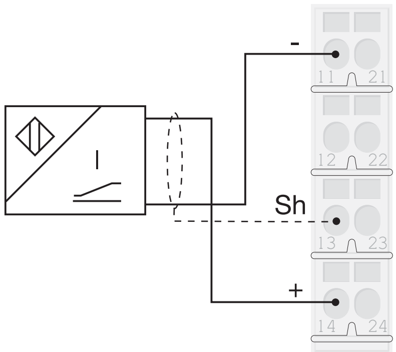


Figure 6-21: 3-wire sensor with sensor supply via base module BL20-S4x-SBBS

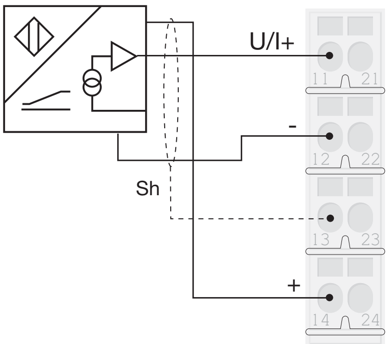


Figure 6-22: 4-wire sensor with sensor supply via base module BL20-S4x-SBBS

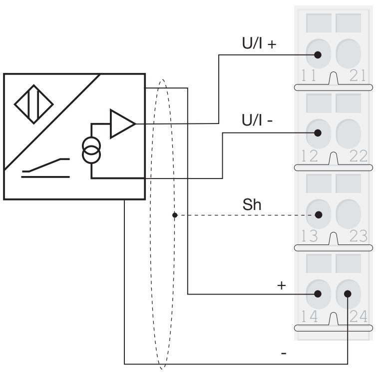
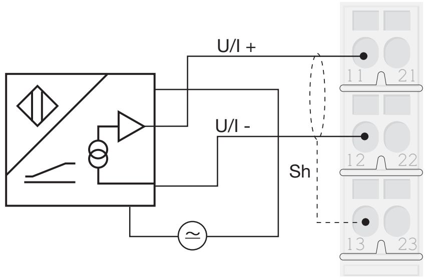


Figure 6-23: 4-wire sensor with external sensor supply BL20-S3x-SBB



6.4.6 Measurement value representation

16-bit-representation:

- Voltage values from 0 to 10 V DC

  The value range
  0 V DC to 10 V DC
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

- Voltage values from -10 to 10 V DC

  The value range
  -10 V to -3.052 10^{-4} **V**
  is displayed as follows:
  8000$_{hex}$ **to FFFF**$_{hex}$ (decimal:-32768 to -1)

  The value range
  0 V to 10 V
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

12-bit-representation (left-justified)

- Voltage values from 0 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Voltage values from -10 to 10 V DC

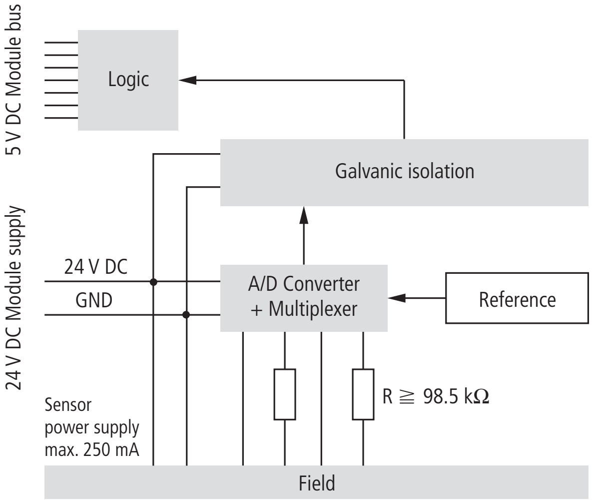
  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)$_{hex}$ **to 7FF(0)**$_{hex}$ (decimal: 0 to 2047)

Note
A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.5 Analog input module, 2AI, -10/0...+10 V DC

Figure 6-24: BL20-2AI-U (-10/0...+10VDC)

Figure 6-25: Block diagram



6.5.1 Technical data

Table 6-11: Technical data

Designation	BL20-2AI-U(-10/0...+10V DC)
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I^L	≤ 12 mA
Nominal current from module bus I_{MB}	≤ 35 mA
Power loss of the module, typical	< 1 W
Input voltage	-10/0 to +10 V
Maximum input voltage	35 V continuous
Input resistance (burden)	≥ 98.5 kΩ
Cutoff frequency f_G	≥ 50 Hz
Basic error at 23 °C / 73.4 °F	< 0.2 %
Repeat accuracy	0.05 %
Temperature coefficient	≤ 150 ppm/°C from end value
Resolution of the A/D converter	16 bit
Measuring principle	Delta Sigma
Measurement value representation	16 bit signed integer / 12 bit full range left-justified
Sensor supply	≤ 250 mA; bridged with L+ and L- from the power supply; not short-circuit proof

6.5.2 Diagnostic and status messages

Table 6-12: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data:

- "Measurement value range error"
  Indicates an over- or undervoltage of 1% of the set voltage range.
  Overvoltage:
  U_{max} (U > 10.1 V);
  Undervoltage:
  U_{min} (U < -10.1 V) at -10 to +10 V
  U_{min} (U < -0.1 V) at 0 to 10 V

Note
If the measurement value representation is parameterized as "12bit (left-justified)" the diagnostic data will be transferred with the process data bits 0 to 3 of the respective channel.

6.5.3 Module parameters (per channel)

Table 6-13: Module parameters

A*Standard parameter value*

Parameter name	Value
Channel	activate **A**
	deactivate
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Voltage mode	-10..+10V
	0..10V **A**
Diagnostic	release **A**
	block

6.5.4 Base modules

Figure 6-26: Base module BL20-S3T-SBB

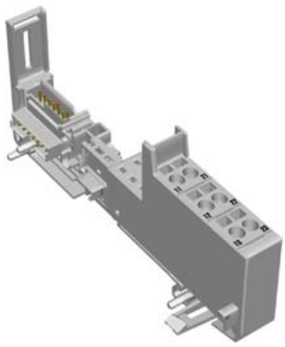
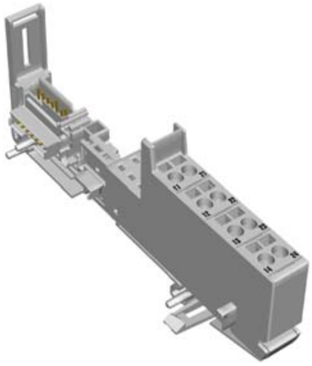


Figure 6-27: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBS
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBS

6.5.5 Wiring diagrams

Figure 6-28: 2-wire sensors with sensor supply via base module BL20-S4x-SBBS

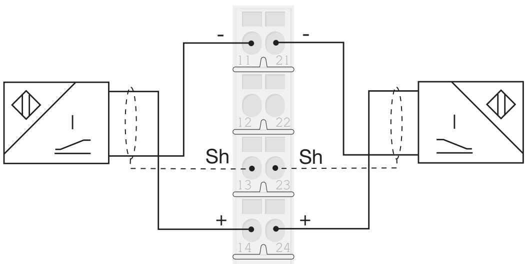


Figure 6-29: 3-wire sensor with sensor supply via base module BL20-S4x-SBBS

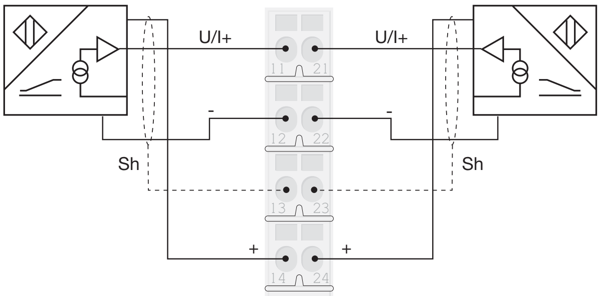
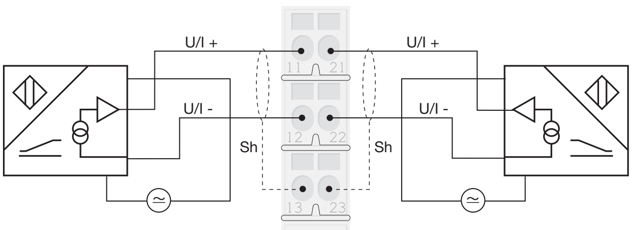


Figure 6-30: 4-wire sensor with external sensor supply, base module BL20-S3x-SBB



6.5.6 Measurement value representation

16-bit-representation:

- Voltage values from 0 to 10 V DC

  The value range
  0 V DC to 10 V DC
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

- Voltage values from -10 to 10 V DC

  The value range
  -10 V to -3.052 10^{-4} V
  is displayed as follows:
  8000$_{hex}$ **to FFFF**$_{hex}$ (decimal:-32768 to -1)

  The value range
  0 V to 10 V
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

12-bit-representation (left-justified)

- Voltage values from 0 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Voltage values from -10 to 10 V DC

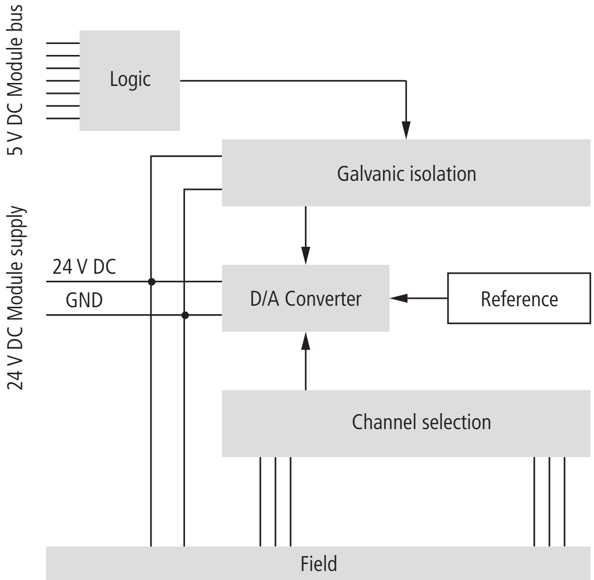
  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)$_{hex}$ **to 7FF(0)**$_{hex}$ (decimal: 0 to 2047)

Note
A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.6 Analog input module, 2AI, Pt-/Ni-sensors

Figure 6-31: BL20-2AI-PT/NI-2/3

Figure 6-32: Block diagram



6.6.1 Technical data

Table 6-14: Technical data

Designation	BL20-2AI-PT/NI-2/3
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 30 mA
Nominal current from module bus I_{MB}	≤ 45 mA
Power loss of the module, typical	< 1 W
Measurement current	< 1 mA
Destruction limit	> 30 V DC
Platinum sensors	according to DIN IEC 751
Nickel sensors	according to DIN 43 760
Offset error	≤ 0.1%
Linearity	< 0.1 %
Basic error at 23 °C / 73.4 °F	< 0.2 % from end value
Repeat accuracy	0.05 %
Temperature coefficient	≤ 300 ppm/°C from end value
Cycle time	≤ 130 ms per channel
Measuring principle	Delta Sigma
Connectable sensors	
Platinum sensors	Pt100, Pt200, Pt500, Pt1000
Nickel sensors	Ni100, Ni1000

6.6.2 Diagnostic and status messages

Table 6-15: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data:

- "Measurement value range error"
  Underflow diagnostic in the temperature measurement range only →
  Threshold: 1 % of positive measurement range end value
- "Open circuit"
- "Short-circuit"
  (only with temperature measurements) →
  Threshold: 5 Ω (loop resistance)

Note
3-wire measurements with Pt100 sensors cannot differentiate between a short-circuit and an open circuit at temperatures below -177 °C. In this case, the diagnostic "short-circuit" is generated.

6.6.3 Module parameters (per channel)

Table 6-16: Module parameters

A *Standard parameter value*

Parameter name	Value
Mains suppression	50Hz **A**
	60Hz
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Diagnostic	release **A**
	block
Channel	activate **A**
	deactivate
Element	PT100, -200..850°C **A** PT100, -200..150°C NI100, -60..250°C NI100, -60..150°C PT200, -200..850°C PT200, -200..150°C PT500, -200..850°C PT500, -200..150°C PT1000, -200..850°C PT1000, -200..150°C NI1000, -60..250°C NI1000, -60..150°C Resistance, 0..100Ω Resistance, 0..200Ω Resistance, 0..400Ω Resistance, 0..1000Ω
Measurement mode	2-wire **A**
	3-wire

6.6.4 Base modules

Figure 6-33: Base module BL20-S3T-SBB (only 2-wire measurement possible)

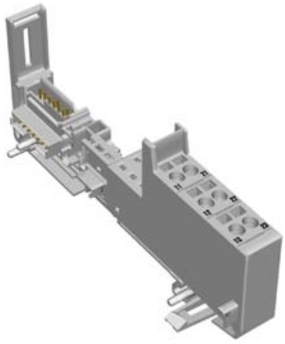
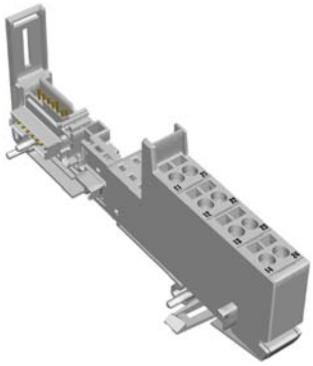


Figure 6-34: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S3T-SBB
  BL20-S4T-SBBS
- with screw connection
  BL20-S3S-SBB
  BL20-S4S-SBBS

6.6.5 Wiring diagrams

Figure 6-35: Wiring diagram BL20-S3x-SBB

2-wire measurement:

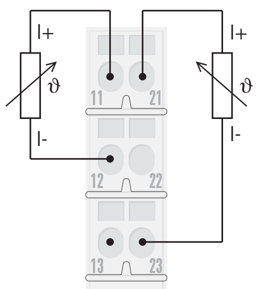
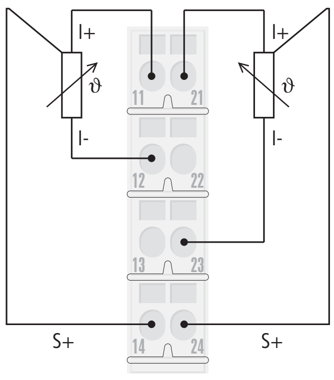


Figure 6-36: Wiring diagram BL20-S4x-SBBS

3-wire measurement:



6.6.6 Measurement value representation

16-bit-representation

- For the parameterization
  "PT100, -200...850°C"
  "NI100, -60...250°C"
  "PT200, -200...850°C"
  "PT500, -200...850°C"
  "PT1000, -200...850°C"
  "NI1000, -60...250°C"

  The value range
  -200 °C to -0.1°C
  is displayed as follows:
  F830$_{hex}$ **to FFFF**$_{hex}$ (decimal: -2000 to -1)

  The value range
  0 °C to 850°C
  is displayed as follows:
  0000$_{hex}$ **to 2134**$_{hex}$ (decimal: 0 to 8500)

- For the parameterization
  "PT100, -200...150°C"
  "NI100, -60...150°C"
  "PT200, -200...150°C"
  "PT500, -200...150°C"
  "PT1000, -200...150°C"
  "NI1000, -60...150°C"

  The value range
  -200 °C to -0.01°C
  is displayed as follows:
  B1E0$_{hex}$ **to FFFF**$_{hex}$ (decimal: -20000 to -1)

  The value range
  0 °C to 150°C
  is displayed as follows:
  0000$_{hex}$ **to 3A98**$_{hex}$ (decimal: 0 to 15000)

- For representation of resistance values only positive numbers (hexadecimal/binary) are used. The positive values can easily be converted into decimal ones.

  The value range
  0 to 100 Ω; 0 to 200 Ω; 0 to 200 Ω; 0 to 1000 Ω
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

12-bit-representation (left-justified)

- For the parameterization:
  "PT100, -200...850°C"
  "NI100, -60...250°C"
  "PT200, -200...850°C"
  "PT500, -200...850°C"
  "PT1000, -200...850°C"
  "NI1000, -60...250°C

  The value range
  -200 °C to -0.5°C
  is displayed as follows:
  E70(0)$_{hex}$ **to FF(0)F**$_{hex}$ (decimal: -400 to -1)

  The value range
  0 °C to 850°C
  is displayed as follows:
  00(0)0$_{hex}$ **to 6A4(0)**$_{hex}$ (decimal: 0 to 1700)
- For the parameterization:
  "PT100, -200...150°C"
  "NI100, -60...150°C"
  "PT200, -200...150°C"
  "PT500, -200...150°C"
  "PT1000, -200...150°C"
  "NI1000, -60...150°C"

  The value range
  -200 °C to -0.1°C
  is displayed as follows:
  830(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: -2000 to -1)

  The value range
  0 °C to 150°C
  is displayed as follows:
  000(0)$_{hex}$ **to 5DC(0)**$_{hex}$ (decimal: 0 to 1500)

  The value range
  0 Ω to 100 Ω;
  0 Ω to 200 Ω;
  0 Ω to 400 Ω;
  0 Ω to 1000 Ω;
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$(decimal: 0 to 4095)

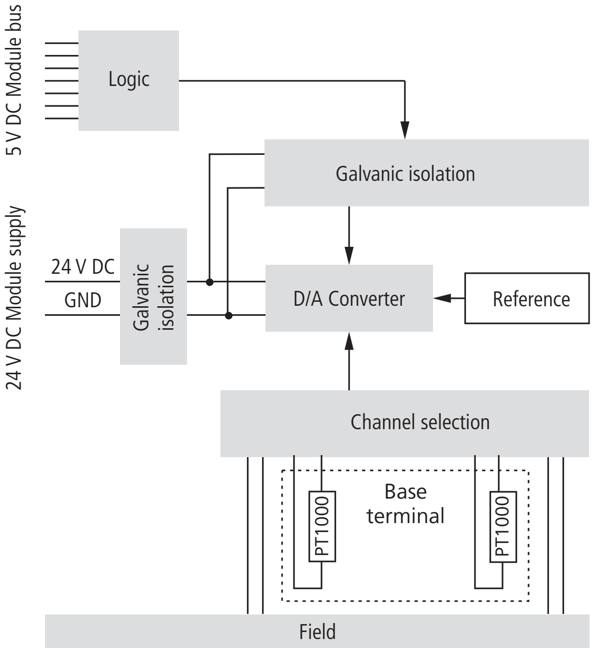
Note

A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.7 Analog input module, 2AI, thermocouple

Figure 6-37: BL20-2AI-THERMO-PI

Figure 6-38: Block diagram



6.7.1 Technical data

Table 6-17: Technical data

Designation	BL20-2AI-THERMO-PI
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 30 mA
Nominal current from module bus I_{MB}	≤ 45 mA
Power loss of the module, typical	< 1 W
Destruction limit	≥ 10 V DC (continuous)
Sensors	according to DIN IEC 584, class 1. 2. 3
Temperature ranges	
Type B	100 to 1820.0 °C
Type E	-270 to 1000.0 °C
Type J	-210 to 1200.0 °C
Type K	-270 to 1370.0 °C
Type N	-270 to 1300.0 °C
Type R	-50 to 1760.0 °C
Type S	-50 to 1540.0 °C
Type T	-270 to 400.0 °C
Voltage measurements (resolution)	
± 50 mV	< 2 µV
± 100 mV	< 4 µV
± 500 mV	< 20 µV
± 1 V	< 50 µV
Measurement value representation	16 bit signed integer / 12 bit full range left-justified
Basic error at 23 °C / 73.4 °F	Please refer to Table 37 below
Crosstalk suppression	≥ 80 dB
Repeat accuracy	Please refer to Table 37 below
Temperature coefficient	≤ 300 ppm/°C from end value
Cycle time	– Voltage measurement: 70 ms/channel – Temperature measurement: 130 ms/channel

Basic errors and repeat accuracies

Thermocouple	Temp. range/ °C	Basic error at 23°C / % of positive end value	Repeat accuracy/ % of positive end value	Error due to cold junction compensation/ % of positive end value **A**
Type B	100...1820	0.2	0.05	0.15
Type E	-270...1000	0.2	0.05	0.17
Type J	-210...1200	0.2	0.05	0.11
Type K	-270...1370	0.2	0.05	0.16
Type N	-270...1300	0.2	0.05	0.20
Type R	-50...1760	0.2	0.05	0.12
Type S	-50...1540	0.2	0.05	0.13
Type T	-200...400	0.6 0.2	0.1 0.075	– 0.50
Voltage measurement	all measurement ranges	0.2	0.05	–

A Wider deviations of the cold junction compensation are to be expected by negative measurement temperatures.

6.7.2 Diagnostic and status messages

Table 6-18: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data **per channel**:

- "Measurement value range error"
  → Threshold: 1 % of positive measurement range end value
- "Open circuit" (only with temperature measurements)
- "No Pt1000-sensor found":
  - the Pt1000-sensor for the respective channel in the base module is defective
  → the Pt1000-sensor of the other channel is taken as cold
  junction.
  The diagnostic message "No Pt1000-sensor found" at **both** module channels indicates the usage of a wrong base module.
  → A cold junction temperature of 23°C is presumed.

Note
The diagnostic "Underflow" is generated by the sensor types K, N and T when the temperature falls below -271.6 °C.

6.7.3 Module parameters (per channel)

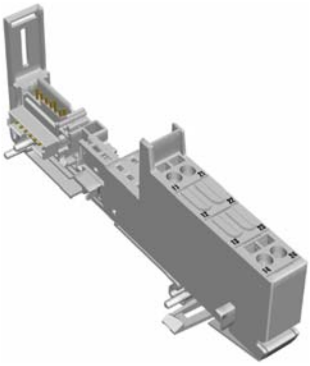
Table 6-19: Module parameters

A *Standard parameter value*

Parameter name	Value
Mains suppression	50Hz **A**
	60Hz
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Diagnostic	release **A**
	block
Channel	activate **A**
	deactivate
Element	type K, -270..1370°C **A** type B, +100..1820°C type E, -270..1000°C type J, -210..1200°C type N, -270..1300°C type R, -50..1760°C type S, -50..1540°C type T, -270..400°C +/-50mV +/-100mV +/-500mV +/-1000mV

6.7.4 Base modules

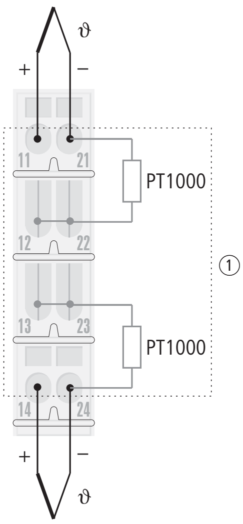
Figure 6-39: Base module BL20-S4T-SBBS-CJ



- with tension clamp connection BL20-S4T-SBBS-CJ
- with screw connection BL20-S4S-SBBS-CJ

6.7.5 Wiring diagrams

Figure 6-40: Wiring diagram BL20-S4x-SBBS-CJ



① Cold junction compensation in the base module

6.7.6 Measurement value representation

16-bit-representation

- For the parameterization
  "Type K, -270...1370°C"
  "Type B, +100...1820°C"
  "Type E, -270...1000°C"
  "Type J, -210...1200°C"
  "Type N, -270...1300°C"
  "Type R, -50...1760°C"
  "Type S, -50...1540°C"
  "Type T, -270...400°C"

  The value range
  -270 °C to -0.1°C
  is displayed as follows:
  F574$_{hex}$ **to FFFF**$_{hex}$(decimal: -2700 to -1)

  The value range
  0 °C to 1820°C
  is displayed as follows:
  0000$_{hex}$ **to 4718**$_{hex}$ (decimal: 0 to 18200)

  The value range
  -50 mV to -0.002 mV;
  -100 mV to -0.003 mV;
  -500 mV to -0.015 mV;
  -1000 mV to -0.031 mV
  is displayed as follows:
  8000$_{hex}$ **to FFFF**$_{hex}$ (decimal: -32768 to -1)

  The value range
  0 mV to 50 mV;
  0 mV to 100 mV;
  0 mV to 500 mV;
  0 mV to 1000 mV;
  is displayed as follows:
  0000$_{hex}$ **to7FFF**$_{hex}$(decimal: 0 to 32767)

12-bit-representation (left-justified)

- For the parameterization
  "Type K, -270...1370'C"
  "Type B, +100...1820'C"
  "Type E, -270...1000'C"
  "Type J, -210...1200'C"
  "Type N, -270...1300'C"
  "Type R, -50...1760'C"
  "Type S, -50...1540'C"
  "Type T, -270...400'C"

  The value range
  -270 °C to 1820°C
  is displayed as follows:
  EF2(0)$_{hex}$ **to 71C(0)**$_{hex}$ (decimal: -270 to 1820)

The value range
-50 mV to -0.024mV;
-100 mV to -0.049mV;
-500 mV to -0.244mV;
-1000 mV to -0.489mV;
is displayed as follows:
800(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: -2048 to -1)

The value range
0 mV to 50 mV;
0 mV to 100 mV;
0 mV to 500 mV;
0 mV to 1000 mV;
is displayed as follows:
0008(0)$_{hex}$ **to 7FF(0)**$_{hex}$ (decimal: 0 to 2047)

Note
A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.8 Analog input module, 4AI, voltage/ current

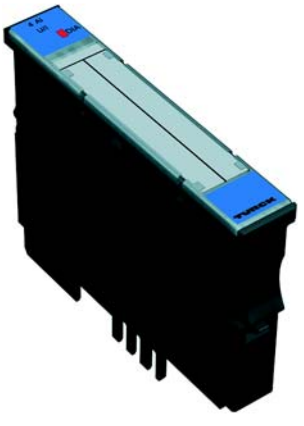


Figure 6-41: BL20-4AI-U/I

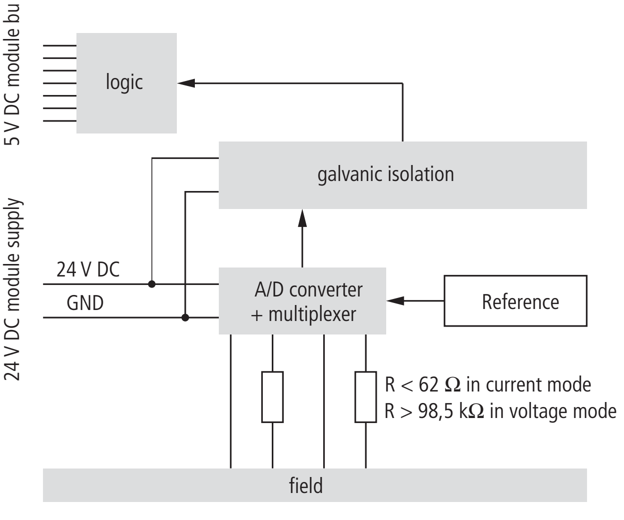


Figure 6-42: Block diagram

6.8.1 Technical data

Table 6-20: Technical data

Designation	BL20-4AI-U/I
Number of channels	4
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 20 mA
Nominal current from module bus I_{MB}	≤ 50 mA
Power loss of the module, typical	< 1 W
Input signal (current mode)	
Input resistance (burden)	< 62 Ω
Input current (range which can be evaluated by the A/D-converter)	0 to 20 mA 4 to 20 mA

Input current (maximum - an "measurement value range error" is shown if the current is ≤ 20.2 mA)	50 mA
Cutoff frequency f_G	20 Hz
Input signal (voltage mode)	
Input resistance (burden)	> 98.5 kΩ
Input voltage (range which can be evaluated by the A/D-converter)	-10 to 10 V DC 0 to 10 V DC
Input voltage (maximum - an "measurement value range error" is shown if the deviation from the valuable measurement range is 1%)	35 V DC
Cutoff frequency f_G	20 Hz
Accuracy of input signal	
Basic error at 23 °C	< 0.3 %
Temperature coefficient	≤ 300 ppm/°C from end value
Representation of the converted input signal	
Resolution of A/D converter	16 Bit
Measuring principle	Delta Sigma
Measurement value representation	– 16 Bit: two's complement or – 12 Bit left justified: two's complement (even negative values possible) Dual number without coding (only positive values possible)

6.8.2 Diagnostic and status messages

Table 6-21: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

This module has the following diagnostic data:

- "Measurement value range error"
  Indicates an over- or undercurrent of 1 % of the set current range; whereby, undercurrents can only be recognized with those modules that have a set current range of 4 to 20 mA.
  Overcurrent:I_{max} (I > 20.2 mA);
  Undercurrent:I_{min} (I < 3.8 mA)

  Indicates an over- or undervoltage of 1% of the set voltage range.
  Overvoltage:
  U_{max} (U > 10.1 V);
  Undervoltage:
  U_{min} (U < -10.1 V) at -10 to +10 V
  U_{min} (U < -0.1 V) at 0 to 10 V
- "Open circuit"
  Indicates an open circuit in the signal line for the operating mode

  4 to 20 mA (I < 3 mA)

Note
If the measurement value representation is "12 Bit left justified", the diagnostic data are transferred in the process data (bit 0 to 3) of respective channel.

6.8.3 Module parameters (per channel)

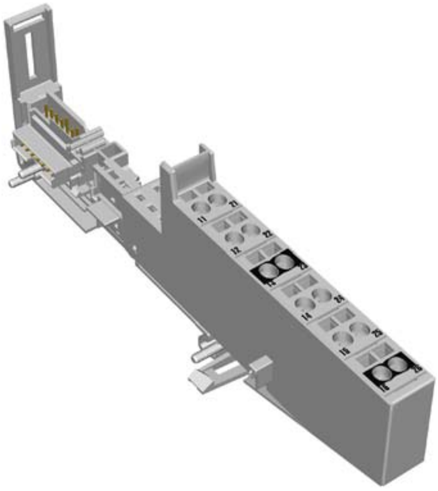
Table 6-22: Module parameters

A*Standard parameter value*

Parameter name	**Value**
Operation mode	voltage **A**
	current
Channel	activate **A**
	deactivate
Value representation	Integer (15bit + sign) **A**
	12bit (left-justified)
Current mode	0..20mA **A**
	4..20mA
Diagnostic	release **A**
	block

6.8.4 Base modules

Figure 6-43: Base module BL20-S6T-SBCSBC



- with tension clamp connection BL20-S6T-SBCSBC
- with screw connection BL20-S6S-SBCSBC

6.8.5 Wiring diagrams

Figure 6-44: 2-wire sensors with sensor supply via U_L or BR/PF-module, base module BL20-S6x-SBCSBC

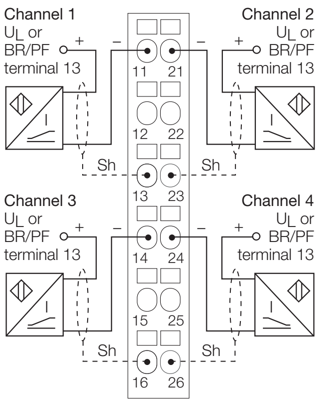


Figure 6-45: 3-wire sensors with sensor supply via U_L or BR/PF-module, base module BL20-S6x-SBCSBC

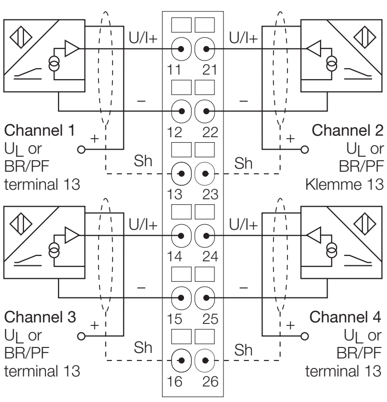
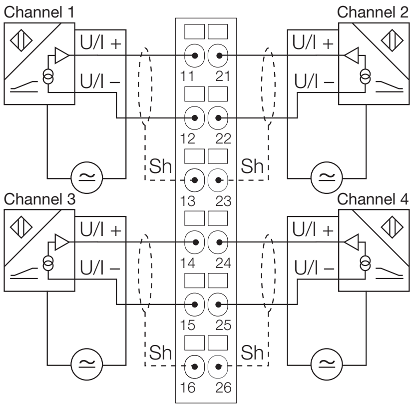


Figure 6-46: 4-wire sensor with external sensor supply, base module BL20-S6x-SBCSBC



6.8.6 Measurement value representation

16 bit value representation

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

- Voltage values from 0 to 10 V DC

  The value range
  0 V DC to 10 V DC
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

- Voltage values from -10 to 10 V DC

  The value range
  -10 V to -3.052 10^{-4} V
  is displayed as follows:
  8000_{hex} to $FFFF_{hex}$ (decimal:-32768 to -1)

  The value range
  0 V to 10 V
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

12 bit value representation (left-justified)

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Voltage values from 0 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)hex to FFF(0)hex (decimal: 0 to 4095)

  Voltage values from -10 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)hex to 7FF(0)hex (decimal: 0 to 2047)

Note
A detailed description of the measurement value representation for the analog input modules in 16 or 12 bit can be found in the Appendix, page 14-2.

6.9 Analog input module, 8AI voltage/current and 4 Pt/Ni

The analog input module is used to connect 8 analog signals. Each channel can be parameterized in different current or respectively voltage ranges. Additionally, 2 analog channels at a time can be combined to a Pt-/Ni- or R-input with 2- or 3-wire technology (see picture Connection options, page 6-51).

The module thus provides a maximum number of 8 measurement inputs for voltage or current or 4 channels for 2- or 3-wire Pt-/Ni- or resistance-measurement. The function-setting is done via channel-oriented parameters.

The module provides galvanic isolation between the field and the module bus connection.

The supply for the signals has to be connected externally. A shield connection to the base module is not possible.

Figure 6-47: BL20-E-8AI-U/I-4PT/NI

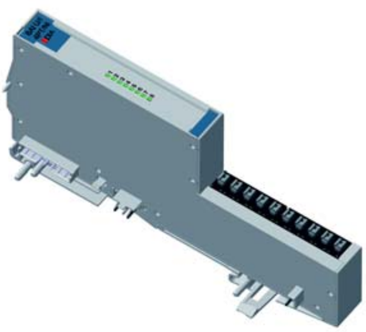
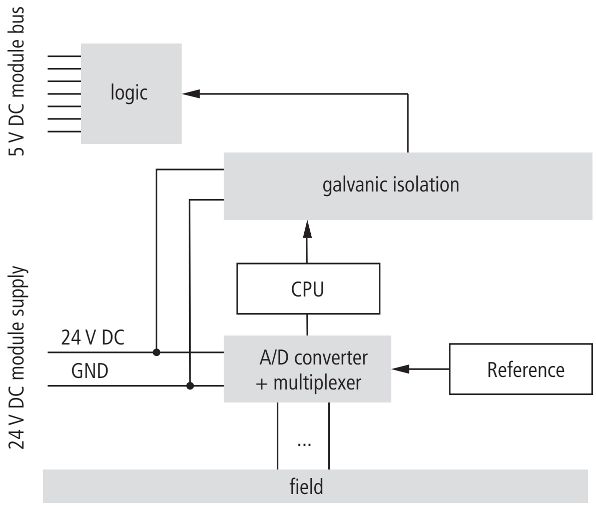


Figure 6-48: Block diagram



6.9.1 Technical data

Table 6-23: Technical data

Designation	BL20-E-8AI-U/I-4PT/NI
Number of channels	8 (U/I) /4 (Pt/Ni/R)
Nominal voltage from supply terminal U_L	24 V DC (18 VDC to 30 VDC)
Nominal current from supply terminal I_L	typ. 35 mA (without measurement signal)
Nominal current from module bus I_{MB}	< 30 mA
Power loss of the module, typical	< 1.5 W
Special technical data	
Parameterizable measured variable	voltage, current, Pt, Ni, R
– Voltage measurement	-10...10 VDC/ 0...10 VDC
Max. input voltage U_{max}	± 20 VDC
Input resistance (burden) R_L	> 200 kΩ
Cutoff frequency f^G	1.5 Hz
Basic error (nominal range at 23 °C)	0.2 %
Temperature coefficient	200 ppm/ °C
– Current measurement	0...20 mA/ 4...20 mA
Max. input current I_{max}	40 mA
Max. input voltage U_{max}	< 17 VDC
Input resistance (burden) R_L	< 52 Ω
Cutoff frequency f_G	1.5 Hz
Basic error (nominal range at 23 °C)	0.2 %
Temperature coefficient	200 ppm/°C from end value
– Pt-sensor (EN60 751)	Pt100, Pt200, Pt500, Pt1000
Measurement current I_{meas}	< 0.5 mA (integral)
Destruction limit U_{max}	> 30 V DC
Cutoff frequency f_G	1.5 Hz
Basic error (nominal range at 23 °C)	0.2 % (Pt200, Pt500, Pt1000), 0.35 % (Pt100)
Temperature coefficient	200 ppm/ °C
– Ni-sensor	Ni100, Ni1000 (DIN 43 760), Ni1000TK5000
Measurement current I_{meas}	< 0.5 mA (integral)
Destruction limit U_{max}	> 30 V DC
Cutoff frequency f_G	1.5 Hz

Basic error (nominal range at 23 °C)	0.2 % (Ni1000,. Ni1000TK5000), 0.35% (Ni100)
Temperature coefficient	200 ppm/ °C
– R (resistance measurement)	0 ... 250 Ω, 0 ... 400 Ω, 0 ... 800 Ω, 0 ... 2000 Ω, 0 ... 4000 Ω
Destruction limit U_{max}	> 30 V DC
Cutoff frequency f_G	1.5 Hz
Basic error (nominal range at 23 °C)	0.2 %
Temperature coefficient	200 ppm/ °C

6.9.2 Diagnostic and status messages

Table 6-24: LED-displays

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure or field voltage U_L not connected	Check if more than two adjoining electronics modules have been pulled. Check the the field voltage U_L
	Off	No error messages or diagnostics	–
1 -8	Green	channel input active	
	Green flashing, 4 Hz	channel is in overrange	
	Green flashing, 0.5 Hz	channel is in underrange	
	Off	channel inactive	

The module has the following diagnostic messages available per channel:

- Measurement value range error "Out of Range"

OoR

Indicates an exceed or undercut of the value ranges.

- – Limit values according to parameterization, page 6-52 ff.

The permissible measurement value limits are exceeded, it is thus possible that no valid measurement value can be detected.

- "Wire Break"

WB

Display of a wire break in the signal line for the operation mode.

- – in temperature measurement
- – in resistance measurement
- – in current measurement 4 to 20 mA

→ limits see page 6-52 ff.

- "Short circuit"

SC

- – in temperature measurement:
  threshold: 5 Ω (loop resistance)

- "Over-/Underflow"

OUFL

The measured value exceeds the measurement range and the module can not detect these values.

- – limits according to parameterization, page 6-52 ff.

Note

3-wire measurements with Pt100 sensors cannot differentiate between a short-circuit and an open circuit at temperatures below -177 °C. In this case, the diagnostic "short-circuit" is generated.

- "Hardware error"

HW Error

- – Shows common errors of the module hardware. The return value analog value in case of an error is "0"

> **Note**
> In the current measurement ranges , the module switches automatically to the voltage measurement after 300 ms if I > 40.0 mA. For the 300 ms, a current of max. 500 mA is accepted. After this, a periodical switching to current measurement is done. If the current falls again to the permissible range, the module switches permanently back to current measurement. During this procedure, the transmitted value is always the measurement range end value.
> Please observe the module’s maximum input voltage!

6.9.3 Module parameters (per channel)

The module provides 8 byte parameter data. One byte is assigned to each analog input channel.

> **Note**
> Please read page 6-52 ff. for detailed information about the parameter settings (Standard, Extended Range, PA (NE 43)).

Table 6-25: Module parameters

A *default-settings*
B *Pt-, Ni and resistance measurement, only the first of the used channel has to be parameterized (channel 1, 3, 5. 7). The parameterization of the second channel is ignored.*

Parameter	**Settings**
Operation mode Kx	– voltage -10 ... 10 V DC Standard **A** – voltage 0 ... 10 V DC Standard – voltage -10 ... 10 V DC PA (NE 43) – voltage 0 ... 10 V DC PA (NE 43) – voltage -10 ... 10 V DC Extended Range – voltage 0 ... 10 V DC Extended Range – current 0 ... 20 mA Standard – current 4 ... 20 mA Standard – current 0 ... 20 mA PA (NE 43) – current 4 ... 20 mA PA (NE 43) – current 0 ... 20 mA Extended Range – current 4 ... 20 mA Extended Range – Pt100 -200 °C ... 850 °C, 2 wire **B** – Pt100 -200 °C ... 150 °C, 2 wire – Pt200 -200 °C ... 850 °C, 2 wire – Pt200 -200 °C ... 150 °C, 2 wire – Pt500 -200 °C ... 850 °C, 2 wire – Pt500 -200 °C ... 150 °C, 2 wire – Pt1000 -200 °C ... 850 °C, 2 wire – Pt1000 -200 °C ... 150 °C, 2 wire – Pt100 -200 °C ... 850 °C, 3 wire – Pt100 -200 °C ... 150 °C, 3 wire – Pt200 -200 °C ... 850 °C, 3 wire – Pt200 -200 °C ... 150 °C, 3 wire – Pt500 -200 °C ... 850 °C, 3 wire – Pt500 -200 °C ... 150 °C, 3 wire – Pt1000 -200 °C ... 850 °C, 3 wire – Pt1000 -200 °C ... 150 °C, 3 wire

Table 6-25: Module parameters

Parameter	Settings
Operation mode Kx	– Ni100, -60 °C ... 250 °C, 2 wire – Ni100, -60 °C ... 150 °C, 2 wire – Ni1000, -60 °C ... 250 °C, 2 wire – Ni1000, -60 °C ... 150 °C, 2 wire – NI1000TK5000, -60 °C ... 250 °C, 2 wire – Ni100, -60 °C ... 250 °C, 3 wire – Ni100, -60 °C ... 150 °C, 3 wire – Ni1000, -60 °C ... 250 °C, 3 wire – Ni1000,-60 °C ... 150 °C, 3 wire – Ni1000TK5000, -60 °C ... 250 °C, 3 wire – resistance, 0 ... 250 Ω – resistance, 0 ... 400 Ω – resistance, 0 ... 800 Ω – resistance, 0 ... 2000 Ω – resistance, 0 ... 4000 Ω – deactivated
Value representation	– Integer (15 bit + sign) **A** – 12 bit (left-justified)
Diagnostics	– release **A** – block

6.9.4 Wiring diagrams

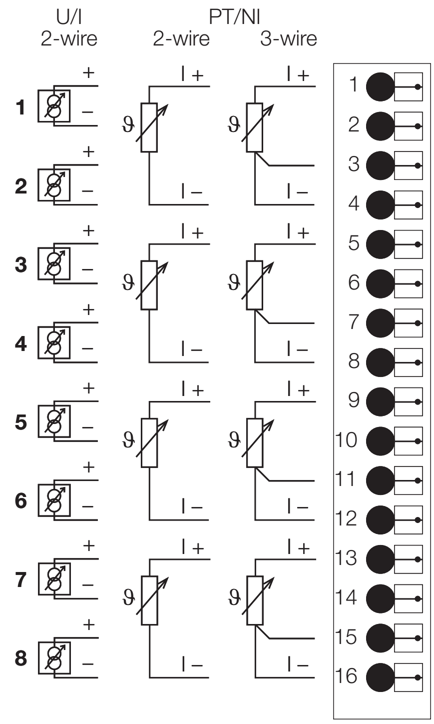


Figure 6-49: Connection options

> **Note**
> Open inputs or unused channels should not be parameterized in the operation mode PT/NI or R because this parameterization can cause marginal measurement errors in adjacent channels.

Process input data

For input-parameterization as Pt-/Ni-or R, the measurement value can be found in the channel with the lower number of the used channels (K1, K3, K5, K7).

channel	B7	B6	B5	B4	B3	B2	B1	B0	B7	B6	B5	B4	B3	B2	B1	B0
	MSB															LSB
1	Byte 1								Byte 0							
2	Byte 3								Byte 2							
3	Byte 5								Byte 4							
4	Byte 7								Byte 6							
5	Byte 9								Byte 8							
6	Byte 11								Byte 10							
7	Byte 13								Byte 12							
8	Byte 15								Byte 14							

6.9.5 Standard value representation for voltage/ current

16-bit-representation

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 3.052 × 10^{-4}) V				
> 10.1000 V		if ↑DIA **OoR** ON	32767	7FFF
≤ 10.0500 V		if ↓ DIA **OoR** OFF	32767	7FFF
10.0000 V	nominal range		32767	7FFF
9.9997 V			32766	7FFE
...			...	...
5.0002 V			16384	4000
...			...	...
0.000305 V			1	0001
0.000000 V			0	0000
-0.000305 V			-1	FFFF
...			...	...
-5.0000 V			-16384	C000
...			...	...
-9.9997 V			-32767	8001
≤ - 10.0000 V			-32768	8000
≥ -10.0500 V		if ↑DIA **OoR** OFF	-32768	8000
< -10.1000 V		if ↓ DIA **OoR** ON	-32768	8000

0...10 V	unipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 3.052 × 10^{-4}) V				
> 10.1000 V		if ↑DIA **OoR** ON	32767	7FFF
≤ 10.0500 V		if ↓ DIA **OoR** OFF	32767	7FFF
10.0000 V	nominal range		32767	7FFF
9.9997 V			32766	7FFE
...			...	...
5.0002 V			16384	4000
...			...	...
0.000305 V			1	0001
≤ 0.000000 V			0	0000
≥ -0.0500 V		if ↑DIA **OoR** OFF	0	0000
< -0.1000 V		if ↓ DIA **OoR** ON	0	0000

0...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value × 6.104 × 10^{-4}) mA				
> 20.2000 mA		if ↑DIA **OoR** ON	32767	7FFF
≤ 20.1000 mA		if ↓ DIA **OoR** OFF	32767	7FFF
20.0000 mA	nominal range		32767	7FFF
19.9994 mA			32766	7FFE
...			...	...
10.0003 mA			16384	4000
...			...	...
0.0006104 mA			1	0001
≤ 0.0000 mA			0	0000
≥ -0.1 mA		if ↑DIA **OoR** OFF	0	0000
< -0.2 mA		if ↓ DIA **OoR** ON	0	0000

4...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = ((dec. value × 4.883 × 10^{-4}) + 4) mA				
> 20.2000 mA		if ↑DIA **OoR** ON	32767	7FFF
≤ 20.1000 mA		if ↓ DIA **OoR** OFF	32767	7FFF
20.0000 mA			32767	7FFF
19.9995 mA			32766	7FFE
...			...	...
12.00024 mA	nominal range		16384	4000
...			...	...
4.0004883 mA			1	0001
≤ 4.0000 mA			0	0000
≥ 3.7000 mA		if ↑DIA **OoR** OFF	0	0000
< 3.6000 mA		if ↓ DIA **OoR** ON	0	0000
≥ 3.0000 mA		if ↑DIA **WB** OFF	0	0000
< 2.9000 mA		if ↓ DIA **WB** ON	0	0000

12-bit-representation (left-justified)

Note
In the values representation "12-bit-representation (left-justified)", the diagnostic data are transmitted with bits 0 to 3 of the channel's process data.

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value / 16 × 4.885 × 10^{-3}) V				
> 10.1000 V		if ↑DIA **OoR** ON	2047 × 16	7FF×
≤ 10.0500 V		if ↓ DIA **OoR** OFF	2047 × 16	7FF×
10.0000 V			2047 × 16	7FF×
9.9951 V			2046 × 16	7FE×
...			...	...
5.00244 V			1024 × 16	400×
...			...	...
0.00488 V			1 × 16	001×
0.000000 V	nominal range		0	000×
-0.000488 V			-1 × 16	FFF×
...			...	...
-5.0000 V			-1024 × 16	C00×
...			...	...
-9.99511 V			-2047 × 16	801×
≤ - 10.0000 V			-2048 × 16	800×
≥ -10.0500 V		if ↑DIA **OoR** OFF	-2048 × 16	800×
< -10.1000 V		if ↓ DIA **OoR** ON	-2048 × 16	800×

0...10 V	unipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value / 16 × 2.442 × 10^{-3}) V				
> 10.1000 V		if ↑DIA **OoR** ON	4095 × 16	FFF×
≤ 10.0500 V		if ↓ DIA **OoR** OFF	4095 × 16	FFF×
10.0000 V			4095 × 16	FFF×
9.9976 V			4094 × 16	FFE×
...			...	...
5.0012 V	nominal range		2048 × 16	800×
...			...	...
0.00244 V			1 × 16	001×
≤ 0.0000 V			0	000×
≥ -0.0500 V	underflow	if ↑DIA **OoR** OFF	0	000×
< -0.1000 V		if ↓ DIA **OoR** ON	0	000×

0...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value / 16 × 4.884 × 10^{-3}) mA				
> 20.2000 mA		if ↑DIA **OoR** ON	4095 × 16	FFF×
≤ 20.1000 mA		if ↓ DIA **OoR** OFF	4095 × 16	FFF×

0...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value / 16 × 4.884 × 10^{-3}) mA				
≥ 20.0000 mA	nominal range		4095 × 16	FFF×
19.9951 mA			4094 × 16	FFE×
...			...	...
10.0024 mA			2048 × 16	800×
...			...	...
0.00488 mA			1 × 16	001×
≤ 0.0000 mA			0	000×
≥ -0.1 mA		if ↑DIA **OoR** OFF	0	000×
< -0.2 mA		if ↓ DIA **OoR** ON	0	000×

4...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = ((dec. value / 16 × 3.907 × 10^{-3}) + 4) mA				
> 20.2000 mA		if ↑DIA **OoR** ON	4095 × 16	FFF×
≤ 20.1000 mA		if ↓ DIA **OoR** OFF	4095 × 16	FFF×
≥ 20.0000 mA	nominal range		4095 × 16	FFF×
19.9961 mA			4094 × 16	FFE×
...			...	...
12.0020 mA			2048 × 16	800×
...			...	...
4.0039 mA			1 × 16	001×
≤ 4.0000 mA			0	000×
≥ 3.7000 mA		if ↑DIA **OoR** OFF	0	000×
< 3.6000 mA		if ↓ DIA **OoR** ON	0	000×
≥ 3.0000 mA		if ↑DIA **WB** OFF		
< 2.9000 mA		if ↓ DIA **WB** ON		

6.9.6 Extended Range - value representation for voltage/current

16-bit-representation

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 3.617 × 10^{-4}) V				
≥ 11.851490 V	overflow		32767	7FFF
≥ 11.7593 V		if ↑DIA **OoR** ON	32512	7F00
11.7589 V	out of range		32511	7EFF
≤ 11.603010 V		if ↓ DIA **OoR** OFF	32080	7D50
10.000305 V			27649	6C01

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 3.617 × 10^{-4}) V				
10.000000 V	nominal range		27648	6C00
...			...	...
5.0000 V			13824	3600
...			...	...
0.0003617 V			1	0001
0.000000 V			0	0000
-0.0003617 V			-1	FFFF
...			...	...
-5.000000 V			-13824	CA00
...			...	...
-10.000000V			-27648	9400
-10.000362 V	out of range		-27649	93FF
≥ -11.60301 V		if ↑DIA **OoR** OFF	-32080	82B0
-11.758897 V			-32511	8100
-11.759259 V	underflow	if ↓ DIA **OoR** ON	-32512	80FF
≤ -11.851851 V			-32768	8000

0...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 3.617 × 10^{-4}) V				
≥ 11.851 V	overflow		32767	7FFF
≥ 11.7593 V		if ↑DIA **OoR** ON	32512	7F00
11.7589 V	out of range		32511	7EFF
≤ 11.603010 V		if ↓ DIA **OoR** OFF	32080	7D50
10.000305 V			27649	6C01
10.000000 V	nominal range		27648	6C00
...			...	...
5.0000 V			13824	3600
...			...	...
0.000361 V			1	0001
0.000000 V			0	0000
≥ -0.050 V	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.100 V		if ↓ DIA **OUFL** ON	0	0000

0...20 mA	bipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value × 7.234 × 10^{-4}) mA				
≥ 23.70298 mA	overflow		32767	7FFF
≥ 23.51852 mA		if ↑DIA **OoR** ON	32512	7F00
23.517795 mA	out of range		32511	7EFF
≤ 23.2060 mA		if ↓ DIA **OoR** OFF	32080	7D50
20.000723 mA			27649	6C01
20.000000 mA	nominal range		27648	6C00
...			...	...
10.0000 mA			13824	3600
...			...	...
0.0007234 mA			1	0001
0.000000 mA			0	0000
≥ -0.1 mA	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.2 mA		if ↓ DIA **OUFL** ON	0	0000

4...20 mA	bipolar	diagnostic message	dec.	hex.
current value I_M = ((dec. value × 5.787 × 10^{-4}) + 4) mA				
≥ 22.96238 mA	overflow		32767	7FFF
≥ 22.81481 mA		if ↑DIA **OoR** ON	32512	7F00
22.814236 mA	out of range		32511	7EFF
≤ 22.56482 mA		if ↓ DIA **OoR** OFF	32080	7D50
20.0006 mA			27649	6C01
20.000000 mA	nominal range		27648	6C00
...			...	...
12.0000 mA			13824	3600
...			...	...
4.005787 mA			1	0001
4.0000 mA			0	0000
3.9994 mA	out of range		-1	FFFF
≥ 1.5567 mA		if ↑DIA **OoR** OFF	-4222	EEBA
1.185185 mA			-4864	ED00
≤ 1.184606 mA	underflow	□if ↓ DIA **OoR** ON	-4865	ECFF
≤ 0.0000 mA			-6912	E500

12-bit-representation

The representation of the 12 bit values corresponds to that of the 16 bit values. Only bits 0 to 3 are set to "0". Diagnostic data are not mapped to the process data.

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value / 16 × 5.787 × 10^{-3}) V				
≥ 11.8460 V	overflow		2047 × 16	7FF0
≥ 11.7592 V		if ↑DIA **OoR** ON	2032 × 16	7F00
11.7535 V	out of range		2031 × 16	7EF0
≤ 11.6030 V		if ↓ DIA **OoR** OFF	2005 × 16	7D50
10.0058 V			1729 × 16	6C10
10.000000 V	nominal range		1728 × 16	6C00
...			...	...
5.0000 V			864 × 16	3600
...			...	...
0.000578 V			1 × 16	0010
0.000000 V			0	0000
-0.000578 V			-1 × 16	FFF0
...			...	...
-5.000000 V			-864 × 16	CA00
...			...	...
-10.000000V			-1728 × 16	9400
-10.0058 V	out of range		-1729 × 16	93F0
≥ -11.6030 V		if ↑DIA **OoR** OFF	-2005 × 16	82B0
-11.7592 V			-2032 × 16	8100
-11.7650 V	underflow	if ↓ DIA **OoR** ON	-2033 × 16	80F0
≤ -11.8518 V			-2048 × 16	8000

0...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value / 16 × 5.787 × 10^{-3}) V				
≥ 11.8460 V	overflow		2047 × 16	7FF0
≥ 11.7592 V		if ↑DIA **OoR** ON	2032 × 16	7F00
11.7535 V	out of range		2031 × 16	7EF0
≤ 11.6030 V		if ↓ DIA **OoR** OFF	2005 × 16	7D50
10.0058 V			1729 × 16	6C10
10.000000 V	nominal range		1728 × 16	6C00
...			...	...
5.0000 V			864 × 16	3600
...			...	...
0.000578 V			1 × 16	0010
0.00000 V			0	0000
< 0.00000 V	underflow		0	0000
≥ -0.050 V		if ↑DIA **OUFL** OFF	0	0000
< -0.100 V		if ↓ DIA **OUFL** ON	0	0000

0...20 mA	bipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value / 16 × 0.01157) mA				
≥ 23.6921 mA	overflow		2047 × 16	7FF0
≥ 23.51852 mA		if ↑DIA **OoR** ON	2032 × 16	7F00
23.5069 mA	out of range		2031 × 16	7EF0
≤ 23.2060 mA		if ↓ DIA **OoR** OFF	2005 × 16	7D50
20.0116 mA			1729 × 16	6C10
20.000000 mA	nominal range		1728 × 16	6C00
...			...	...
10.0000 mA			864 × 16	3600
...			...	...
0.01157 mA			1 × 16	0010
≤ 0.0000 mA			0	0000
≥ -0.1 mA	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.2 mA		if ↓ DIA **OUFL** ON	0	0000

4...20 mA	bipolar	diagnostic message	dec.	hex.
current value I_M = ((dec. value / 16 × 9.259 × 10^{-3}) + 4) mA				
≥ 22.9537 mA	overflow		2047 × 16	7FF0
≥ 22.8148 mA		if ↑DIA **OoR** ON	2032 × 16	7F00
22.8056 mA	out of range		2031 × 16	7EF0
≤ 22.5648 mA		if ↓ DIA **OoR** OFF	2005 × 16	7D50
20.0093 mA			1729 × 16	6C10
20.000000 mA	nominal range		1728 × 16	6C00
...			...	...
12.0000 mA			864 × 16	3600
...			...	...
4.00925 mA			1 × 16	0010
4,0000 mA			0	0000
3.9907 mA	out of range		-1 × 16	FFF0
≥ 1.2963 mA		if ↑DIA **OoR** OFF	-292 × 16	EDC0
1.1851 mA			-304 × 16	ED00
≤ 1.1759 mA	underflow	if ↓ DIA **OoR** ON	-305 × 16	ECF0
≤ 0.000 mA			-432 × 16	E500

6.9.7 Value representation for process automation (NE43) for voltage/current

16-bit-representation

The hexadecimal value transmitted by the module has to be interpreted as decimal value, which corresponds, if multiplied with a defined factor, to the analog value.

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 0.001) V				
≥ 11.000 V		if ↑DIA **OUFL** ON	11000	2AF8
≤ 10.999 V	overflow	if ↓ DIA **OUFL** OFF	10999	2AF7
10.501 V		if ↑DIA **OoR** ON	10501	2905
≥ 10.500 V			10500	2904
≤ 10.250 V	out of range	if ↓ DIA **OoR** OFF	10250	280A
10.001 V			10001	2711
10.000 V			10000	2710
...			...	...
5.000 V			5000	1388
...			...	...
0.001 V			1	0001
0.0000 V	nominal range		0	0000
-0.001 V			-1	FFFF
...			...	...
-5.0000 V			-5000	EC78
...			...	...
-10.000 V			-10000	D8F0
- 10.001 V			-10001	D8EF
-10.250 V	out of range	if ↑DIA **OoR** OFF	-10250	D7F6
-10.500 V		if ↓ DIA **OoR** ON	-10500	D6FC
-10.501 V			-10501	D6FB
-10.999 V	underflow	if ↑DIA **OUFL** OFF	-10999	D509
≤ -11.000 V		if ↓ DIA **OUFL** ON	-11000	D508

0...10 V	unipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 0.001) V				
≥ 11.000 V		if ↑DIA **OUFL** ON	11000	2AF8
≤ 10.999 V	overflow	if ↓ DIA **OUFL** OFF	10999	2AF7
10.501 V		if ↑DIA **OoR** ON	10501	2905
≥ 10.500 V			10500	2904
≤ 10.250 V	out of range	if ↓ DIA **OoR** OFF	10250	280A
10.001 V			10001	2711
10.000 V			10000	2710
...			...	...
5.000 V	nominal range		5000	1388
...			...	...
0.001 V			1	0001
0.000 V			0	0000
≥ - 0.05 V	underflow	if ↑ DIA **OUFL** OFF	0	0000
< -0.10 V		if ↓ DIA **OUFL** ON	0	0000

0...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value × 0.001) mA				
≥ 22.000 mA	overflow	if ↑DIA **OUFL** ON	22000	55F0
≤ 21.999 mA		if ↓ DIA **OUFL** OFF	21999	55EF
21.001 mA		if ↑DIA **OoR** ON	21001	5209
≥ 21.000 mA	out of range		21000	5208
≤ 20.500 mA		if ↓ DIA **OoR** OFF	20500	5014
20.001 mA			20001	4E21
20.000m A	nominal range		20000	4E20
...			...	...
10.000 mA			10000	2712
...			...	...
0.001 mA			1	0001
0.0000 mA			0	0000
≥ -0.1 mA	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.2 mA		if ↓ DIA **OUFL** ON	0	0000

4...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value × 0.001) mA				
≥ 22.000 mA	overflow	if ↑DIA **OUFL** ON	22000	55F0
≤ 21.999 mA		if ↓ DIA **OUFL** OFF	21999	55EF
21.001 mA		if ↑DIA **OoR** ON	21001	5209
≥ 21.000 mA	out of range		21000	5208
≤ 20.500 mA		if ↓ DIA **OoR** OFF	20500	5014
20.001 mA			20001	4E21
20.000m A	nominal range		20000	4E20
...			...	...
12.000 mA			12000	2EE0
...			...	...
4.001 mA			4001	0FA1
4.000 mA			4000	0FA0
3.999 mA	out of range		3999	0F9F
≥ 3.800 mA		if ↑DIA **OoR** OFF	3800	0ED8
3.600 mA		if ↓ DIA **OoR** ON	3600	0E10
3.599 mA	underflow		3599	0E0F
≥ 2.001 mA		if ↑DIA **WB** OFF	2001	07D1
≤ 2.000 mA		if ↓ DIA **WB** ON	2000	07D0
0.000 mA			0000	0000

12-bit-representation (left-justified)

The "12-bit-representation (left-justified)" in process automation corresponds to the 16-bit-representation in which the lower 4 bits of the analog value are overwritten with diagnostic data.

-10...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 0.001) V				
≥ 11.008 V	overflow	if ↑DIA **OUFL** ON	11008	2B00
≤ 10.992 V		if ↓ DIA **OUFL** OFF	10992	2AF0
10.512 V		if ↑DIA **OoR** ON	10512	2910
≥ 10.496 V	out of range		10496	2900
≤ 10.256 V		if ↓ DIA **OoR** OFF	10256	2810
10.016 V			10016	2720
10.000 V	nominal range		10000	2710
...				
4.992 V			4992	1380
...			...	...
0.016 V			16	0010
0.0000 V			0	0000
-0.016 V			-16	FFF0
...			...	...
-4.992 V			-4992	EC80
...			...	...
-10.000 V			-10000	D8F0
- 10.016 V	out of range		-10016	D8E0
-10.256 V		if ↑DIA **OoR** OFF	-10256	D7F0
-10.496 V			-10496	D700
-10.512 V	underflow	if ↓ DIA **OoR** ON	-10512	D6F0
-10.992 V		if ↑DIA **OUFL** OFF	-10992	D510
≤ -11.008 V		if ↓ DIA **OUFL** ON	-11008	D500

0...10 V	bipolar	diagnostic message	dec.	hex.
voltage value U_M = (dec. value × 0.001) V				
≥ 11.008 V	overflow	if ↑DIA **OUFL** ON	11008	2B00
≤ 10.992 V		if ↓ DIA **OUFL** OFF	10992	2AF0
10.512 V		if ↑DIA **OoR** ON	10512	2910
≥ 10.496 V	out of range		10496	2900
≤ 10.256 V		if ↓ DIA **OoR** OFF	10256	2810
10.016 V			10016	2720
10.000 V	nominal range		10000	2710
...				
4.992 V			4992	1380
...			...	...
0.016 V			16	0010
≤ 0.0000 V			0	0000
≥ -0.05 V	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.1 V		if ↓ DIA **OUFL** ON	0	0000

0...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value / 16 × 0.001) mA				
≥ 22.000 mA	overflow	if ↑DIA **OUFL** ON	22000	55F0
≤ 21.984 mA		if ↓ DIA **OUFL** OFF	21984	55E0
21.024 mA			21024	5220
≥ 21.008 mA	out of range	if ↑DIA **OoR** ON	21008	5210
≤ 20.496 mA		if ↓ DIA **OoR** OFF	20496	5010
20.016 mA			20016	4E30
20.000m A	nominal range		20000	4E20
...			...	...
10.000 mA			10000	2710
...			...	...
0.016 mA			16	0010
0.0000 mA			0	0000
≥ -0.1 mA	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.2 mA		if ↓ DIA **OUFL** ON	0	0000

4...20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value / 16 × 0.001) V				
≥ 22.000 mA	overflow	if ↑DIA **OUFL** ON	22000	55F0
≤ 21.984 mA		if ↓ DIA **OUFL** OFF	21984	55E0
21.024 mA			21024	5220
≥ 21.008 mA	out of range	if ↑DIA **OoR** ON	21008	5210
≤ 20.496 mA		if ↓ DIA **OoR** OFF	20496	5010
20.016 mA			20016	4E30
20.000m A	nominal range		20000	4E20
...			...	...
12.000 mA			12000	2EE0
...			...	...
4.016 mA			4016	0FB0
4.000 mA			4000	0FA0
3.984 mA	out of range		3984	0F90
≥ 3.792 mA		if ↑ DIA **OoR** OFF	3792	0ED0
< 3.600 mA		if ↓ DIA **OoR** ON	3600	0E10
3.584 mA	underflow		3584	0E00
≥ 2.016 mA		if ↑DIA **WB** OFF	2016	07E0
< 2.000 mA		if ↓ DIA **WB** ON	2000	07D0
0.000 mA			0000	0000

6.9.8 Standard value representation for Pt-/ Ni- and resistance measurement

Wire break and short circuit diagnostic in Pt-/Ni-measurement

- Wire break (WB) if resistance = end value of measurement range
- Short circuit (SC) resistance = loop resistance < 5 Ω

16-bit-representation

	Measurement range, Pt -200...850 °C		transmitted value	
	Pt100, Pt200, Pt500, Pt1000		dec.	hex.
	temperature T_M = (dec. value × 0.1) °C			
101.0 %	≥ 858.5 °C	if ↑DIA **OoR** ON	8500	2134
100.5 %	≤ 854.2 °C	if ↓ DIA **OoR** OFF	8500	2134
> 100.0 %	850.0 °C	nominal range	8500	2134
...	...		...	...
	0.1 °C		1	0001
0.0 %	0 °C		0	0000
	-0.1 °C		-1	FFFF
...				
-100 %	-200.0 °C		-2000	F830
-100.5 %	≥ -201.0 °C	if ↑DIA **OoR** OFF	-2000	F830
-101.0 %	≤ -202.0 °C	if ↓ DIA **OoR** ON	-2000	F830

	Measurement range, Pt -200...150 °C		transmitted value	
	Pt100, Pt200, Pt500, Pt1000		dec.	hex.
	temperature T_M = (dec. value × 0.01) °C			
101.0 %	≥ 151.50 °C	if ↑DIA **OoR** ON	15000	3A98
100.5 %	≤ 150.80 °C	if ↓ DIA **OoR** OFF	15000	3A98
> 100.0 %	150.00 °C	nominal range	15000	3A98
...	...		...	...
	0.01 °C		1	0001
0.0 %	0 °C		0	0000
	-0.01 °C		-1	FFFF
...				
-100 %	-200.0 °C		-20000	F830
-100.5 %	≥ -201.0 °C	if ↑DIA **OoR** OFF	-20000	F830
-101.0 %	≤ -202.0 °C	if ↓ DIA **OoR** ON	-20000	F830

	Measurement range, Ni -60...250 °C		transmitted value	
	Ni100, Ni1000, Ni100TK5000		dec.	hex.
	temperature T_M = (dec. value × 0.1) °C			
101.0 %	≥ 252.50 °C	if ↑DIA **OoR** ON	2500	09C4
100.5 %	≤ 251.20 °C	if ↓ DIA **OoR** OFF	2500	09C4
> 100.0 %	250.00 °C	nominal range	2500	09C4
...	...		...	...
	0.1 °C		1	0001
0.0 %	0 °C		0	0000
	-0.1 °C		-1	FFFF
...				
-100 %	-60.00 °C		-600	FDA8
-100.5 %	≥ -60.30 °C	if ↑DIA **OoR** OFF	-600	FDA8
-101.0 %	≤ -60.60 °C	if ↓ DIA **OoR** ON	-600	FDA8

	Measurement range, Ni -60...150 °C		transmitted value	
	Ni100, Ni1000		dec.	hex.
	temperature T_M = (dec. value × 0.01) °C			
101.0 %	≥ 151.50 °C	if ↑DIA **OoR** ON	15000	3A98
100.5 %	≤ 150.70 °C	if ↓ DIA **OoR** OFF	15000	3A98
> 100.0 %	150.0 °C	nominal range	15000	3A98
...	...		...	...
	0.01 °C		1	0001
0.0 %	0 °C		0	0000
	-0.01 °C		-1	FFFF
...				
-100 %	-60.00 °C		-6000	E890
-100.5 %	≥ -60.30 °C	if ↑DIA **OoR** OFF	-6000	E890
-101.0 %	≤ -60.6 0°C	if ↓ DIA **OoR** ON	-6000	E890

	Measurement range, R		transmitted value	
	0...250 Ω		dec.	hex.
	resistance R_M = (dec. value × 0.00762963) Ω			
101.0 %	≥ 252.5 Ω	if ↑DIA **OoR** ON	32767	7FFF
100.5 %	≤ 251.75 Ω	if ↓ DIA **OoR** OFF	32767	7FFF
> 100.0 %	> 250.0 Ω	nominal range	32767	7FFF
100.0 %	250.0 Ω		32767	7FFF
99.997 %	249.992 Ω		32766	7FFE
...	...		...	...
50.002 %	125.0038 Ω		16384	4000
49.998 %	124.9962 Ω		16383	3FFF
...	...		...	...
0.003 %	0.00763 Ω		1	0001
0 %	≤ 0.0000 Ω		0	0000

	Measurement range, R		transmitted value	
	0...400 Ω		dec.	hex.
	resistance R_M = (dec. value × 0.012207) Ω			
101.0 %	≥ 404.0 Ω	if ↑DIA **OoR** ON	32767	7FFF
100.5 %	≤ 402.0 Ω	if ↓ DIA **OoR** OFF	32767	7FFF
100.0 %	400.0 Ω	nominal range	32767	7FFF
99.997 %	399.988 Ω		32766	7FFE
...	...		...	...
50.002 %	200.0061 Ω		16384	4000
49.998 %	199.9939 Ω		16843	3FFF
...	...		...	...
0.003 %	0.01221 Ω		1	0001
0 %	≤ 0.0000 Ω		0	0000

	Measurement range, R		transmitted value	
	0...800 Ω		dec.	hex.
	resistance R_M = (dec. value × 0.0244148) Ω			
101.0 %	≥ 808.0 Ω	if ↑DIA **OoR** ON	32767	7FFF
100.5 %	≤ 804.0 Ω	if ↓ DIA **OoR** OFF	32767	7FFF
100.0 %	800.0 Ω	nominal range	32767	7FFF
99.997 %	799.976 Ω		32766	7FFE
...	...		...	...
50.002 %	400.012 Ω		16384	4000
49.998 %	399.988 Ω		16383	3FFF
...	...		...	...
0.003 %	0.02441 Ω		1	0001
0 %	≤ 0.0000 Ω		0	0000

	Measurement range, R		transmitted value	
	0...2000 Ω		dec.	hex.
	resistance R_M = (dec. value × 0.061037) Ω			
101.0 %	≥ 2020.0 Ω	if ↑DIA **OoR** ON	32767	7FFF
100.5 %	≤ 2010.0 Ω	if ↓ DIA **OoR** OFF	32767	7FFF
100.0 %	2000.0 Ω	nominal range	32767	7FFF
99.997 %	1999.94 Ω		32766	7FFE
...	...		...	...
50.002 %	1000.03 Ω		16384	4000
49.998 %	999.969 Ω		16383	3FFF
...	...		...	...
0.003 %	0.06104 Ω		1	0001
0 %	≤ 0.0000 Ω		0	0000

	Measurement range, R		transmitted value	
	0...4000 Ω		dec.	hex.
	resistance R_M = (dec. value × 0.12207) Ω			
101.0 %	≥ 4040.0 Ω	if ↑DIA **OoR** ON	32767	7FFF
100.5 %	≤ 4020.0 Ω	if ↓ DIA **OoR** OFF	32767	7FFF
100.0 %	4000.0 Ω	nominal range	32767	7FFF
99.997 %	3999.88 Ω		32766	7FFE
...	...		...	...
50.002 %	2000.06 Ω		16384	4000
49.998 %	1999.94 Ω		16383	3FFF
...	...		...	...
0.003 %	0.12207 Ω		1	0001
0 %	≤ 0.0000 Ω		0	0000

12-bit-representation (left-justified)

	Measurement range, Pt -200...850 °C		transmitted value	
	Pt100, Pt200, Pt500, Pt1000		dec.	hex.
	temperature T_M = (dec. value / 16 × 0.5) °C			
101.0 %	≥ 858.5 °C	if ↑DIA **OoR** ON	1700 × 16	6A4x
100.5 %	≤ 854.2 °C	if ↓ DIA **OoR** OFF	1700 × 16	6A4x
> 100.0 %	850.0 °C	nominal range	1700 × 16	6A4x
...	...		...	...
	0.5 °C		1 × 16	001x
0.0 %	0 °C		0	000x
	-0.5 °C		-1 × 16	FFFx
...				
-100 %	-200.0 °C		-400 × 16	E70x
-100.5 %	≥ -201.0 °C	if ↑DIA **OoR** OFF	-400 × 16	E70x
-101.0 %	≤ -202.0 °C	if ↓ DIA **OoR** ON	-400 × 16	E70x

	Measurement range, Pt -200...150 °C		transmitted value	
	Pt100, Pt200, Pt500, Pt1000		dec.	hex.
	temperature T_M = (dec. value / 16 × 0.1) °C			
101.0 %	≥ 151.50 °C	if ↑DIA **OoR** ON	1500 × 16	5DCx
100.5 %	≤ 150.80 °C	if ↓ DIA **OoR** OFF	1500 × 16	5DCx
> 100.0 %	150.00 °C	nominal range	1500 × 16	5DCx
...	...		...	...
	0.1 °C		1	001x
0.0 %	0 °C		0	000x
	-0.1 °C		-1	FFFx
...				
-100 %	-200.0 °C		-2000 × 16	830x
-100.5 %	≥ -201.0 °C	if ↑DIA **OoR** OFF	-2000 × 16	830x
-101.0 %	≤ -202.0 °C	if ↓ DIA **OoR** ON	-2000 × 16	830x

	Measurement range, Ni -60...250 °C		transmitted value	
	Ni100, Ni1000, Ni100TK5000		dec.	hex.
	temperature T_M = (dec. value / 16 × 0.5) °C			
101.0 %	≥ 252.50 °C	if ↑DIA **OoR** ON	500 × 16	1F4x
100.5 %	≤ 251.20 °C	if ↓ DIA **OoR** OFF	500 × 16	1F4x
> 100.0 %	250.00 °C	nominal range	500 × 16	1F4x
...	...		...	...
	0.5 °C		1 × 16	001x
0.0 %	0 °C		0	000x
	- 0.5 °C		-1 × 16	FFFx
...				
-100 %	-60.00 °C		-120 × 16	F88x
-100.5 %	≥ -60.30 °C	if ↑DIA **OoR** OFF	-120 × 16	F88x
-101.0 %	≤ -60.60 °C	if ↓ DIA **OoR** ON	-120 × 16	F88x

	Measurement range, Ni -60...150 °C		transmitted value	
	Ni100, Ni1000		dec.	hex.
	temperature T_M = (dec. value /16 × 0.1) °C			
101.0 %	≥ 151.50 °C	if ↑DIA **OoR** ON	1500 ×16	5DCx
100.5 %	≤ 150.70 °C	if ↓ DIA **OoR** OFF	1500 ×16	5DCx
> 100.0 %	150.0 °C	nominal range	1500 ×16	5DCx
...	...		...	...
	0.1 °C		1 × 16	001x
0.0 %	0 °C		0	000x
	-0.1 °C		-1 × 16	FFFx
...				
-100 %	-60.00 °C		-600 × 16	DA8x
-100.5 %	≥ -60.30 °C	if ↑DIA **OoR** OFF	-600 × 16	DA8x
-101.0 %	≤ -60.6 0°C	if ↓ DIA **OoR** ON	-600 × 16	DA8x

	Measurement range, R		transmitted value	
	0...250 Ω		dec.	hex.
	resistance R_M = (dec. value / 16 × 0.06105) Ω			
101.0 %	≥ 252.5 Ω	if ↑DIA **OoR** ON	4095 × 16	FFFx
100.5 %	≤ 251.75 Ω	if ↓ DIA **OoR** OFF	4095 × 16	FFFx
100.0 %	250.0 Ω	nominal range	4095 × 16	FFFx
99.976 %	249.939 Ω		4094 × 16	FFEx
...	...		...	...
50.012 %	125.030 Ω		2048 × 16	800x
49.988 %	124.969 Ω		2047 × 16	7FFx
...	...		...	...
0.024 %	0.06105 Ω		1 × 16	001x
0 %	≤ 0.0000 Ω		0 × 16	000x

	Measurement range, R		transmitted value	
	0...400 Ω		dec.	hex.
	resistance R_M = (dec. value / 16 × 0.09768) Ω			
101.0 %	≥ 404.0 Ω	if ↑DIA **OoR** ON	4095 × 16	FFF×
100.5 %	≤ 402.0 Ω	if ↓ DIA **OoR** OFF	4095 × 16	FFF×
100.0 %	400.0 Ω	nominal range	4095 × 16	FFF×
99.976 %	399.902 Ω		4094 × 16	FFE×
...	...		...	...
50.012 %	200.0488 Ω		2048 × 16	800x
49.988 %	199.9512 Ω		2047 × 16	7FF×
...	...		...	...
0.024 %	0.09768 Ω		1 × 16	001x
0 %	≤ 0.0000 Ω		0 × 16	000x

	Measurement range, R		transmitted value	
	0...800 Ω		dec.	hex.
	resistance R_M = (dec. value / 16 × 0.19536) Ω			
101.0 %	≥ 808.0 Ω	if ↑DIA **OoR** ON	4095 × 16	FFF×
100.5 %	≤ 804.0 Ω	if ↓ DIA **OoR** OFF	4095 × 16	FFF×
100.0 %	800.0 Ω	nominal range	4095 × 16	FFF×
99.976 %	799.805 Ω		4094 × 16	FFE×
...	...		...	...
50.012 %	400.098 Ω		2048 × 16	800x
49.988 %	399.902 Ω		2047 × 16	7FF×
...	...		...	...
0.024 %	0.19536 Ω		1 × 16	001x
0 %	≤ 0.0000 Ω		0 × 16	000x

	Measurement range, R		transmitted value	
	0...2000 Ω		dec.	hex.
	resistance R_M = (dec. value/ 16 × 0.4884) Ω			
101.0 %	≥ 2020.0 Ω	if ↑DIA **OoR** ON	4095 × 16	FFF×
100.5 %	≤ 2010.0 Ω	if ↓ DIA **OoR** OFF	4095 × 16	FFF×
100.0 %	2000.0 Ω	nominal range	4095 × 16	FFF×
99.976 %	1999.51 Ω		4094 × 16	FFE×
...	...		...	...
50.012 %	1000.24 Ω		2048 × 16	800x
49.988 %	999.756 Ω		2047 × 16	7FF×
...	...		...	...
0.024 %	0.4884 Ω		1 × 16	001x
0 %	≤ 0.0000 Ω		0 × 16	000x

	Measured value, R		transmitted value	
	0...4000 Ω		dec.	hex.
	resistance R_M = (dec. value / 16 × 0.9768) Ω			
101.0 %	≥ 4040.00 Ω	if ↑DIA **OoR** ON	4095 × 16	FFF×
100.5 %	≤ 4020.00 Ω	if ↓ DIA **OoR** OFF	4095 × 16	FFF×
100.0 %	4000.00 Ω	nominal range	4095 × 16	FFF×
99.976 %	3999.02 Ω		4094 × 16	FFE×
...	...		...	...
50.012 %	2000.49 Ω		2048 × 16	800x
49.988 %	1999.51 Ω		2047 × 16	7FF×
...	...		...	...
0.024 %	0.9768 Ω		1 × 16	001x
0 %	≤ 0.0000 Ω		0 × 16	000x

6.10 Analog input module, 2AI current, HART®

This analog input module provides 2 HART®-inputs for current measurement.

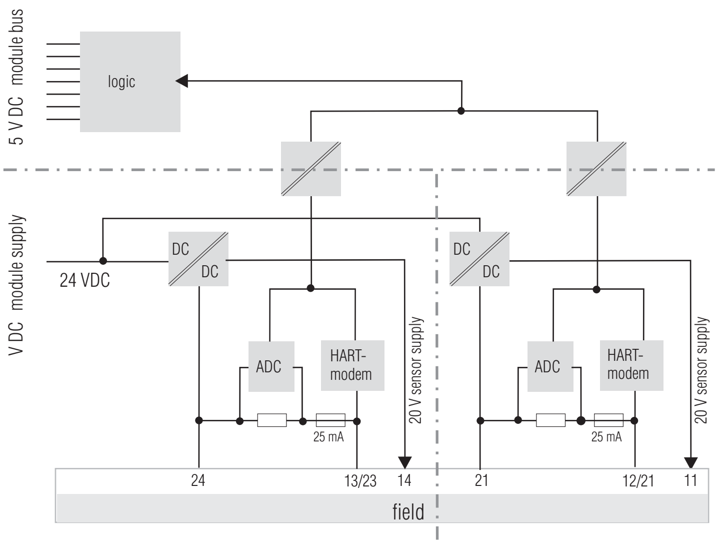
The two channels of the module are galvanically isolated. Additionally, the modules provides galvanic isolation between field level and module bus connection.

Note

For PROFIBUS:
The BL20-2AOH-I can only be used with the BL20-DPV1-gateways (BL20-GW-DPV1, BL20-E-GW-DP)!

Figure 6-50: BL20-2AIH-I

Figure 6-51: Block diagram



6.10.1 Technical data

Table 6-26: Technical data

Designation	BL20-2AIH-I
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC (18 V DC to 30 V DC)
Nominal current from supply terminal I_L	typ. 35 mA (without measured signal)
Nominal current from module bus I_{MB}	< 30 mA
Power loss of the module, typical	< 1 W
Max. input current I_{max}	24 mA
Max output voltage	20 V
Input resistance (burden) R_L	250 Ω
Cutoff frequency f_G	1.5 Hz
Basic error (nominal range at 23 °C)	0.1 %
Repeat accuracy	0.1 %
Temperature coefficient	< 200 ppm / °C from end value
Resolution	16 bit
Linearity	0.2 %
Galvanic isolation	electronic/ field level, channel/channel
Isolation voltage	500 V
Measurement value representation	16 Bit signed integer, NE 43 (PA), extended range

6.10.2 Diagnostic and status messages

Table 6-27: LED-displays

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure or field voltage U_L not connected	Check if more than two adjoining electronics modules have been pulled. Check the field voltage U_L
	Off	No error messages or diagnostics	–

Table 6-27: LED-displays

LED	Display	Meaning	Remedy
11/21	Red flashing, 0.5 Hz	Wire break/ short circuit (if parameterized as diagnostic)	
	Red	Invalid value	see diagnostics **Invalid value**
	Red, 4 Hz both LEDs alternating	Hardware-error	Please change the module.
	Off	Channel ok	
1H/ 2H	Green	HART®-communication ok	The HART®-status is only shown in active HART®-communication. The status-display is either realized acyclically or via polling operation (depending on the parameterization). With acyclical monitoring the information (LED) is turned off after 1.5 seconds. Further communication retriggers the LED.
	Red flashing, 0.5 Hz	HART® communication error: – no communication <u>or</u> – high number of CRC-errors	
	Red	HART®-status-flag (if HART®-status polling has been parameterized, see parameter Operation mode Kx)	
	Off	No HART®-communication	

Note

The LEDs 11 and 1H are assigned to channel 1 and the LEDs 21 and 2H to channel 2 of the module.

The module provides the following diagnostic messages per channel:

Byte	B7	B6	B5	B4	B3	B2	B1	B0
	Channel 1							
0	hardware error	invalid param.	HART® comm. error	HART® status error	underflow	short circuit	wire break	overflow
1	X							
	Channel 2							
2	hardware error	invalid param.	HART® comm. error	HART® status error	underflow	short circuit	wire break	overflow
3	X							

X = reserved

→ Limit values according to the parameterization, page 6-79.

- Wire break

WB

Shows a wire break in the signal line.

- Short-circuit

SC

Shows a short-circuit in the signal line

- Overflow

OFL

The measured value exceeds the upper measurement range and the module can not process the value.

- Underflow

UFL

The measured value is lower than the lower measurement range and the module can not process the value.

- **HART® status-error**

The connected HART®-device set a bit in the HART® status-information ("status - polling").

- **HART® communication error**

The channel does not allow communication with the HART®-device.

- **Invalid value**

Possible sources:

  – Setting of a reserved parameter bit

Module behavior:

  – Input value = 0 mA
  – The return value of the HART®-variable in the process data is 0×0000 0000.

- "Hardware failure"

HW Error

– Shows common errors of the module hardware. The return analog value in case of an error is "0".

Note
If an error message from the sensor occurs, the HART®-status is set to "1".

6.10.3 Module parameters (per channel)

The module has 8 bytes of parameters available (2 per channel and 1 per HART®-variable).

Table 6-28: Module parameters

A *default-settings*

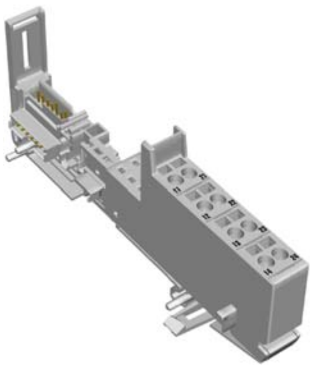
Parameter	Einstellungen
Channel Kx	0 = activate **A** 1 = deactivate
Short-circuit diagnostics Kx	0 = block 1 = release **A**
Wire Break diagnostics Kx	0 = block 1 = release **A**
HART®-diagnostic Kx	0 = release **A** 1 = block
Operation mode Kx	0 = 0… 20 mA (HART®-status polling *not* possible) 1 = 4…20 mA (HART®-status polling *not* possible) 2 = 4…20 mA HART® active **A** Cyclic polling of the HART®-Status is activated.
Value representation Kx	0 = Integer (15 bit + sign) **A** 1 = NE 43 2 = Extended mode
Mapped channel Vx	Defines the channel from which the HART®-variable is read. 0 = channel 1 1 = channel 2
Mapped variable Vx	Defines which HART®-variable of the connected sensor is mapped into the module's process data 0 = PV (primary variable) 1 = SV (2nd variable) 2 = TV (3rd variable) 3 = QV (4th variable)

Byte		B7	B6	B5	B4	B3	B2	B1	B0
	DP	Channel 1							
0	**7**	HART®-diag.	X	X	operation mode		wire break diag.	short-circuit diag.	channel
1	**6**	X						value representation	
		Channel 2							
2	**5**	HART®-diag.	X	X	operation mode		wire break diag.	short-circuit diag.	channel
3	**4**	X						value representation	
		HART®-variable A							
4	**3**	mapped variable		X					mapped channel
		HART®-variable B							
5	**2**	mapped variable		X					mapped channel
		HART®-variable C							
6	**1**	mapped variable		X					mapped channel
		HART®-variable D							
7	**0**	mapped variable		X					mapped channel

X = reserved

6.10.4 Base modules

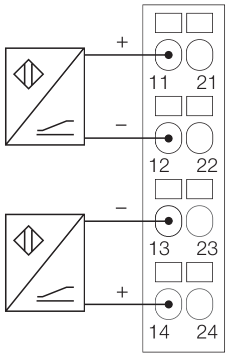
Figure 6-52: Base module BL20-S4T-SBBS



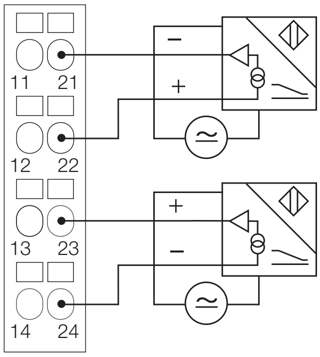
6.10.5 Wiring diagrams

Figure 6-53: Connection possibilities with the base module BL20-S4x-SBBS

2 wire-connection for passive HART®-sensors:



4-wire-connection for active HART®-sensors:



6.10.6 Process input data

Channel	Byte	B7	B6	B5	B4	B3	B2	B1	B0
1	0	Input value for channel 1							
	1								
2	2	Input value for channel 2							
	3								
Variable									
A	4	Parameterizable HART®-variable A without unit **A**							
	5								
	6								
	7								
B	8	Parameterizable HART®-variable AB without unit **A**							
	9								
	10								
	11								
C	12	Parameterizable HART®-variable C without unit **A**							
	13								
	14								
	15								
D	16	Parameterizable HART®-variable D without unit **A**							
	17								
	18								
	19								

A Representation of HART®-variables without unit according to ANSI/IEEE 754-1985 "Standard for Binary Floating-Point Arithmetic for microprocessor systems".

6.10.7 Standard value representation, 16 Bit Integer

0 ... 20 mA	**unipolar**	**diagnostic message**	**dec.**	**hex.**
current value I_M = (dec. value × 6.104 × 10^{-4}) mA				
approx. 22 mA	short-circuit	if ↑DIA **SC** ON	32767	7FFF
> 20.2000 mA	overflow		32767	7FFF
≤ 20.1000 mA		if ↑DIA **OFL** ON	32767	7FFF
20.0000 mA	nominal range		32767	7FFF
19.9994 mA			32766	7FFE
...			...	...
10.0003 mA			16384	4000
...			...	...
0.0006103 mA			1	0001
≤ 0.0000 mA			0	0000

4 ... 20 mA	unipolar	diagnostic message	dec.	hex.
current value I_M = ((dec. value × 4.883 × 10^{-4}) + 4) mA				
approx. 22 mA	short-circuit	if ↑DIA **SC** ON	32767	7FFF
> 20.2000 mA	overflow		32767	7FFF
≤ 20.1000 mA		if ↑DIA **OFL** ON	32767	7FFF
20.0000 mA	nominal range		32767	7FFF
19.9995 mA			32766	7FFE
...			...	...
12.00024 mA			16384	4000
...			...	...
4.0004883 mA			1	0001
≤ 4.0000 mA			0	0000
≥ 3.7000 mA	underflow	if ↓ DIA **UFL** ON	0	0000
< 3.6000 mA			0	0000
≥ 3.0000 mA	wire break	if ↓ DIA **WB** ON	0	0000
< 2.9000 mA			0	0000

6.10.8 Extended Range - value representation, 16-bit-representation

0...20 mA	bipolar	diagnostic message	dec.	hex.
current value I_M = (dec. value × 7.234 × 10^{-4}) mA				
≥ 23.70298 mA	overflow		32767	7FFF
≥ 23.51852 mA		if ↑DIA **OoR** ON	32512	7F00
23.517795 mA	out of range		32511	7EFF
≤ 23.2060 mA		if ↓ DIA **OoR** OFF	32080	7D50
20.000723 mA			27649	6C01
20.000000 mA	nominal range		27648	6C00
...			...	...
10.0000 mA			13824	3600
...			...	...
0.0007234 mA			1	0001
0.000000 mA			0	0000
≥ -0.1 mA	underflow	if ↑DIA **OUFL** OFF	0	0000
< -0.2 mA		if ↓ DIA **OUFL** ON	0	0000

4...20 mA	bipolar	diagnostic message	dec.	hex.
current value I_M = ((dec. value × 5.787 × 10^{-4}) + 4) mA				
≥ 22.96238 mA	overflow		32767	7FFF
≥ 22.81481 mA		if ↑DIA **OoR** ON	32512	7F00
22.814236 mA	out of range		32511	7EFF
≤ 22.56482 mA		if ↓ DIA **OoR** OFF	32080	7D50
20.0006 mA			27649	6C01
20.000000 mA	nominal range		27648	6C00
...			...	...
12.0000 mA			13824	3600
...			...	...
4.005787 mA			1	0001
4.0000 mA			0	0000
3.9994 mA	out of range		-1	FFFF
≥ 1.5567 mA		if ↑DIA **OoR** OFF	-4222	EEBA
1.185185 mA			-4864	ED00
≤ 1.184606 mA	underflow	if ↓ DIA **OoR** ON	-4865	ECFF
≤ 0.0000 mA			-6912	E500

6.10.9 Value representation process automation (NE 43), 16 bit representation

The hexadecimal value transmitted by the module has to be interpreted as decimal value, which corresponds, if multiplied with a defined factor, to the analog value.

0 ... 20 mA	unipolar	diagnostic message	dec.	hex.
curernt value I_M = (dec. value × 0.001) mA				
approx. 22 mA	short-circuit	if ↑DIA **SC** ON	22000	55F0
≥ 21.008 mA	overflow		21008	5210
≤ 20.496 mA		if ↑DIA **OFL** ON	20496	5010
20.016mA	nominal range		20016	4E30
20.000m A			20000	4E20
...			...	...
10.000 mA			10000	2710
...			...	...
0.016 mA			16	0010
0.0000 mA			0	0000

4 ... 20 mA	unipolar	diagnostic message	dec.	hex.
curernt value I_M = (dec. value × 0.001) mA				
approx. 22 mA	short-circuit	if ↑DIA **SC** ON	22000	55F0
≥ 21.008 mA	overflow		21008	5210
≤ 20.496 mA		if ↑DIA **OFL** ON	20496	5010
20.016mA	nominal range		20016	4E30
20.000m A			20000	4E20
...			...	...
12.000 mA			12000	2EE0
...			...	...
4.016 mA			4016	0FB0
4.000 mA			4000	0FA0
≥ 3.792 mA	underflow	if ↓ DIA **UFL** ON	3800	0ED0
< 3.600 mA			3600	0E10
≥ 2.496 mA	wire break	if ↓ DIA **WB** ON	2496	09C0
< 2.000 mA			2000	07D0

7 Digital output modules

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7.1 General

Digital output modules (DO) receive output values from the gateway via the internal module bus. The modules convert these values and transmit the corresponding high or low level signals for each channel to the field level via the base modules.

The outputs are rated according to EN 61 131-2 Type 2.

The module bus electronics of the digital output modules are galvanically isolated from the field level via an optocoupler.

LED status indicators

Channel statuses are indicated by LEDs. Error signals from the I/O level are indicated by each module via the "DIA" LED. The corresponding diagnostic information is transmitted to the gateway via diagnostic bits.

If the "DIA" LED lights up continuously red, it signals the failure of the module bus communication of the digital output module.

Attention
An external suppressor should be planned for inductive loads.

7.1.1 Module overview

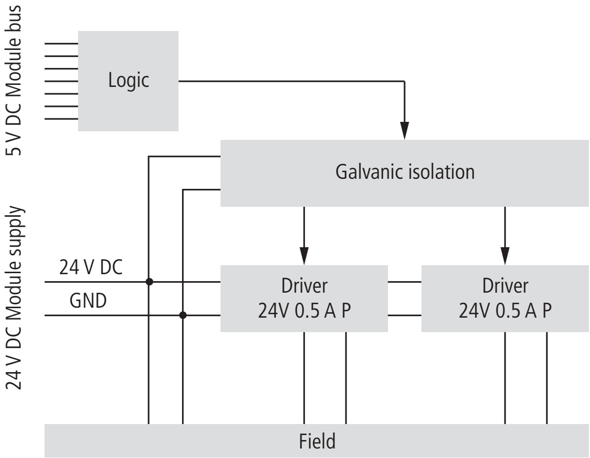
Table 7-1: Overview digital output modules

	Number of channels	Positive switching
BL20-2DO-24VDC-0.5A-P	2	✓
BL20-2DO-24VDC-0.5A-N	2	
BL20-2DO-24VDC-2A-P	2	✓
BL20-4DO-24VDC-0.5A-P	4	✓
BL20-E-8DO-24VDC-0.5A-P	8	✓
BL20-16DO-24VDC-0.5A-P	16	✓
BL20-2DO-120/230VAC-0.5A	2	
	Output current, max.	**Galvanically isolated**
BL20-2DO-24VDC-0.5A-P	0.5 A	✓
BL20-2DO-24VDC-0.5A-N	0.5 A	✓
BL20-2DO-24VDC-2A-P	2 A	✓
BL20-4DO-24VDC-0.5A-P	0.5 A	✓
BL20-E-8DO-24VDC-0.5A-P	0.5 A	✓
BL20-16DO-24VDC-0.5A-P	0.5 A	✓
BL20-2DO-120/230VAC-0.5A	0.5 A	✓

7.2 Digital output module, 2DO, 0.5 A, positive switching (sourcing)

Figure 7-1: BL20-2DO-24VDC-0.5A-P

Figure 7-2: Block diagram



7.2.1 Technical data

Table 7-2: Technical data

Designation	BL20-2DO-24VDC-0.5A-P
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	20 mA (when load current = 0)
Nominal current from module bus I_{MB}	$\leq$ 32 mA
Power loss of the module, typical	< 1 W
Output voltage (loaded)	
High level U_H	min. L+ (-1 V)
Output current	
High level I_H (nominal)	0.5 A
High level I_H (permissible range)	< 0.6 A
Delay at signal change and resistive load	
From low to high level	< 100 µs
From high to low level	< 100 µs
Load impedance range	48 Ω to 1 kΩ
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	min. 48 Ω
Load impedance, inductive R_{LI}	max. 1.2 H
Lamp load R_{LL}	max. 3 W
Switching frequency	
Resistive load	5 kHz (R_{LO} < 1 kΩ)
Lamp load	10 Hz
Short-circuit proof	according to EN 61 131
Overload proof	according to EN 61 131

7.2.2 Diagnostic and status messages

Table 7-3:
LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-
	Off	Status of channel 2 = "0"	-

The module has the following diagnostic data available per channel:

- "Overcurrent" (short-circuit)

7.2.3 Module parameters

None

7.2.4 Base modules

Figure 7-3:
Base module
BL20-S3T-SBC

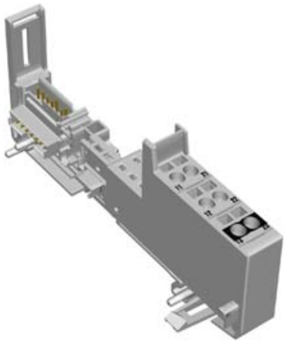
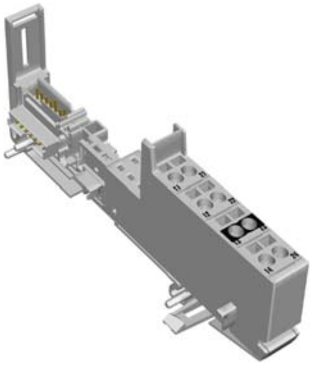


Figure 7-4:
Base module
BL20-S4T-SBCS



- with tension clamp connection
  BL20-S3T-SBC
  BL20-S4T-SBCS
- with screw connection
  BL20-S3S-SBC
  BL20-S4S-SBCS

7.2.5 Wiring diagrams

Figure 7-5:
Wiring diagram
BL20-S3x-SBC

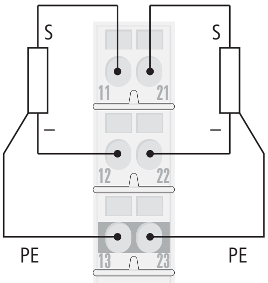
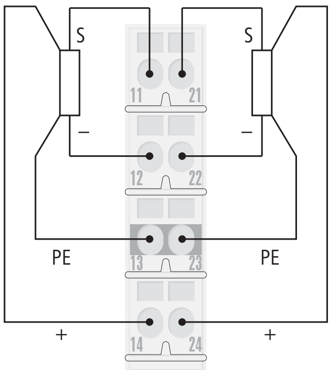


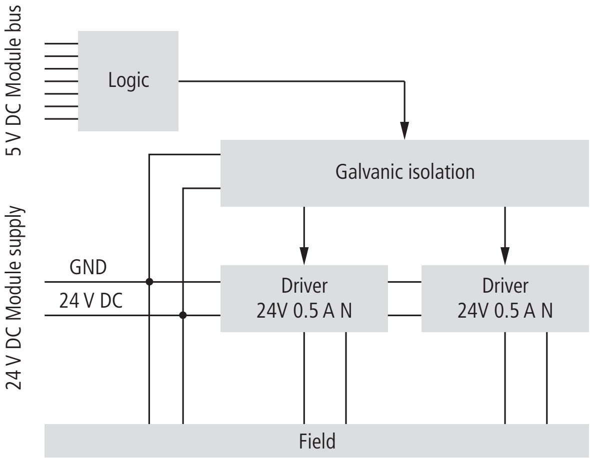
Figure 7-6:
Wiring diagram
BL20-S4x-SBCS



7.3 Digital output module, 2DO, 0.5 A, negative switching (sinking)

Figure 7-7:
BL20-2DO-24VDC-0.5A-N

Figure 7-8:
Block diagram



7.3.1 Technical data

Table 7-4: Technical data

Designation	BL20-2DO-24VDC-0.5A-N
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	20 mA (when load current = 0)
Nominal current from module bus I_{MB}	≤ 32 mA
Power loss of the module, typical	< 1 W
Output voltage (loaded)	
Active level U_A	max. GND +1 V
Output current	
Active level I_A (nominal)	0.5 A
Active level I_A (permissible range)	< 0.6 A
Delay at signal change and resistive load (R_{LO} < 1 kΩ)	
From inactive to active level	< 100 µs
From active to inactive level	< 100 µs
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	min. 48 Ω
Load impedance, inductive R_{LI}	max. 1.2 H
Lamp load R_{LL}	max. 12 W
Switching frequency	
Resistive load	100 Hz (R_{LO} < 1 kΩ)
Inductive load resistance	2 Hz
Lamp load	10 Hz
Short-circuit proof	according to EN 61 131-2 automatic restart after disconnecting the load and eliminating the reason for the short-circuit

7.3.2 Diagnostic and status messages

Table 7-5: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-
	Off	Status of channel 2 = "0"	-

The module has the following diagnostic data available per channel:

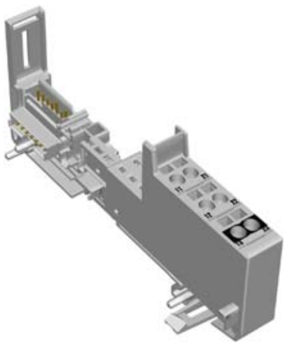
- "Overcurrent" (short-circuit)

7.3.3 Module parameters

None

7.3.4 Base modules

Figure 7-9: Base module BL20-S3T-SBC



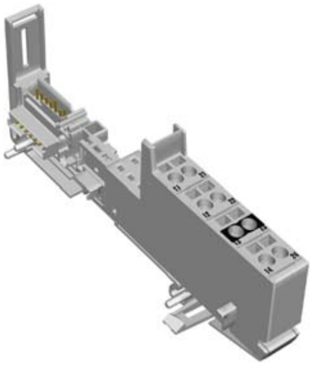


Figure 7-10: Base module BL20-S4T-SBCS

- with tension clamp connection
  BL20-S3T-SBC
  BL20-S4T-SBCS
- with screw connection
  BL20-S3S-SBC
  BL20-S4S-SBCS

7.3.5 Wiring diagrams

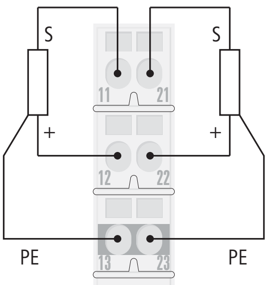


Figure 7-11: Wiring diagram BL20-S3x-SBC

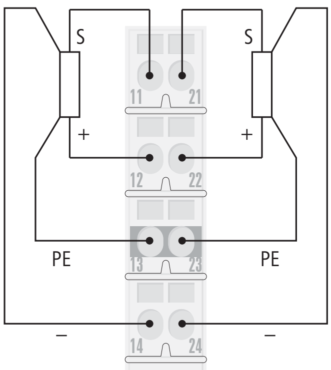
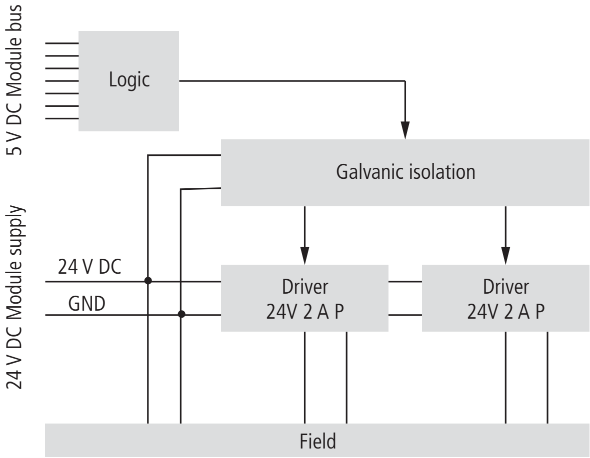


Figure 7-12: Wiring diagram BL20-S4x-SBCS

7.4 Digital output module, 2DO, 2 A, positive switching (sourcing)

Figure 7-13:
BL20-2DO-24VDC-2A-P

Figure 7-14:
Block diagram



7.4.1 Technical data

Table 7-6: Technical data

Designation	BL20-2DO-24VDC-2A-P
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	50 mA (when load current = 0)
Nominal current from module bus I_{MB}	$\leq$ 33 mA
Power loss of the module, typical	< 1 W
Output voltage (loaded)	
Active level U_A	min. L+ (-1 V)
Output current	
High level I_H (nominal)	2 A
High level I_H (permissible range)	< 2.4 A
High level (inductive load)	max. 1 A at 1.2 H
Delay at signal change and resistive load	
From low to high level	< 100 µs
From high to low level	< 100 µs
Load impedance range	12 Ω to 1 kΩ
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	min. 12 Ω
Load impedance, inductive R_{LI}	max. 1.2 H
Lamp load R_{LL}	max. 6 W
Switching frequency	
Resistive load	5 kHz (R_{LO} < 1 kΩ)
Lamp load	10 Hz
Short-circuit proof	according to EN 61 131-2
Overload proof	according to EN 61 131-2

7.4.2 Diagnostic and status messages

Table 7-7: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-
	Off	Status of channel 2 = "0"	-

The module has the following diagnostic data available per channel:

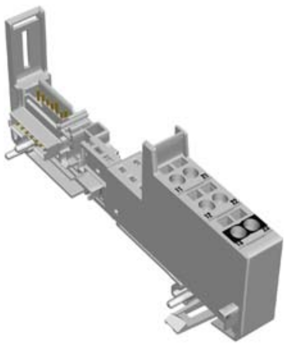
- "Overcurrent" (short-circuit)

7.4.3 Module parameters

None

7.4.4 Base modules

Figure 7-15: Base module BL20-S3T-SBC



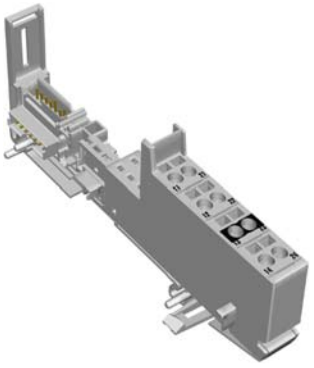


Figure 7-16:
Base module
BL20-S4T-SBCS

- with tension clamp connection
  BL20-S3T-SBC
  BL20-S4T-SBCS
- with screw connection
  BL20-S3S-SBC
  BL20-S4S-SBCS

7.4.5 Wiring diagrams

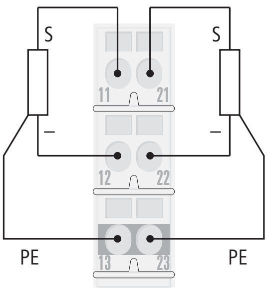


Figure 7-17:
Wiring diagram
BL20-S3x-SBC

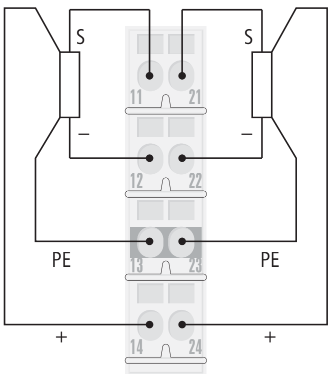
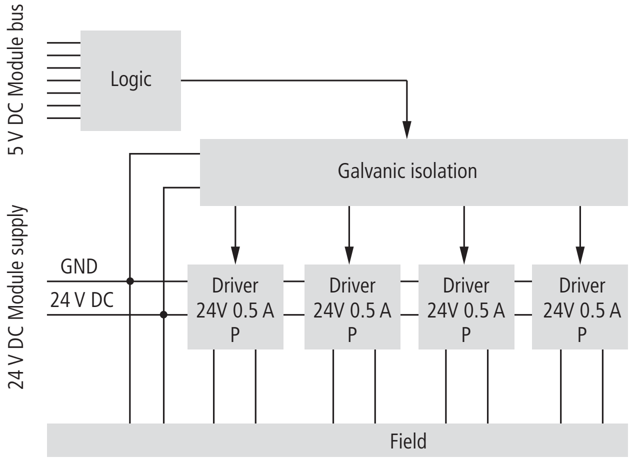


Figure 7-18:
Wiring diagram
BL20-S4x-SBCS

7.5 Digital output module, 4DO, 0.5 A, positive switching (sourcing)

Figure 7-19: BL20-4DO-24VDC-0.5A-P

Figure 7-20: Block diagram



7.5.1 Technical data

Table 7-8: Technical data

Designation	BL20-4DO-24VDC-0.5A-P
Number of channels	4
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 25 mA (when load current = 0)
Nominal current from module bus I_{MB}	$\leq$ 30 mA
Power loss of the module, typical	< 1 W
Output voltage (loaded)	min. L+ (-1 V)
Output current	
High level I_H (nominal)	0.5 A
High level I_H (Short-time overload)	< 1.0 A for max. 5 minutes
Delay at signal change and resistive load (R_{LO} < 1 kΩ)	
From low to high level	< 250 µs
From high to low level	< 250 µs
Load impedance range	48 Ω to 1 kΩ
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	min. 48 Ω
Load impedance, inductive R_{LI}	max. 1.2 H
Lamp load R_{LL}	max. 6 W
Switching frequency	
Resistive load	1 kHz (R_{LO} < 1 kΩ)
Inductive load resistance	2 Hz
Lamp load	10 Hz
Short-circuit proof	according to EN 61 131-2

Note

The parallel switching of outputs is possible with the synchronous switching of the channels. In this case, the maximum output current can be increased up to 2 A, depending on the number of the parallel switched outputs.

7.5.2 Diagnostic and status messages

Table 7-9: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-
	Off	Status of channel 2 = "0"	-
14	Green	Status of channel 3 = "1"	-
	Off	Status of channel 3 = "0"	-
24	Green	Status of channel 4 = "1"	-
	Off	Status of channel 4 = "0"	-

The module has the following diagnostic data available per channel:

- "Overcurr./short-circ.(1 ch. min)"

Note
If overcurrent is diagnosed the overloaded channel has to be switched off.

7.5.3 Module parameters

None

7.5.4 Base modules

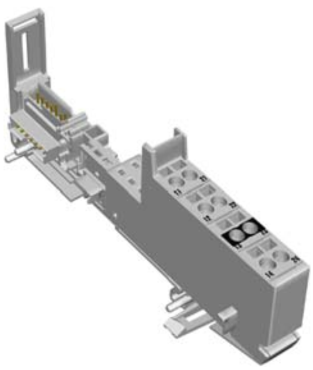
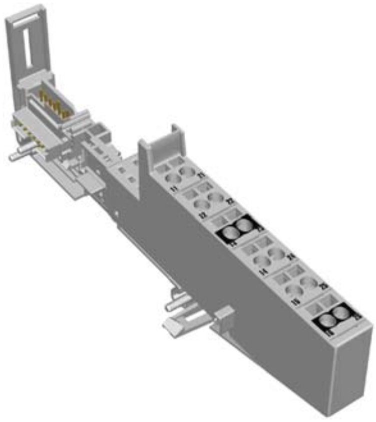


Figure 7-21: Base module BL20-S4T-SBCS

Figure 7-22:
BL20-S6T-SBCSBC



- with tension clamp connection
  BL20-S4T-SBCS
  BL20-S6T-SBCSBC
- with screw connection
  BL20-S4S-SBCS
  BL20-S6S-SBCSBC

7.5.5 Wiring diagrams

Figure 7-23:
Wiring diagram
BL20-S4x-SBCS

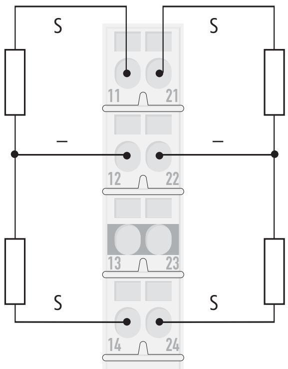
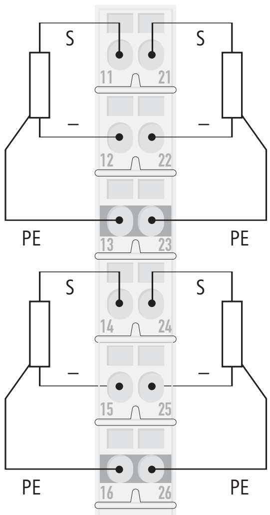


Figure 7-24:
Wiring diagram BL20-S6x-SBCSBC



7.6 Digital output module, BL20 Economy, 8DO, 0,5 A, positive switching (sourcing)

Figure 7-25: BL20-E-8DO-24VDC-0.5A-P

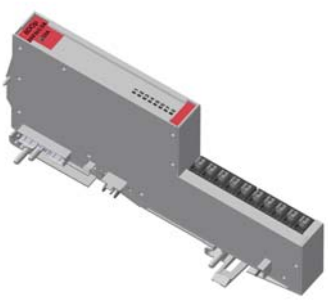
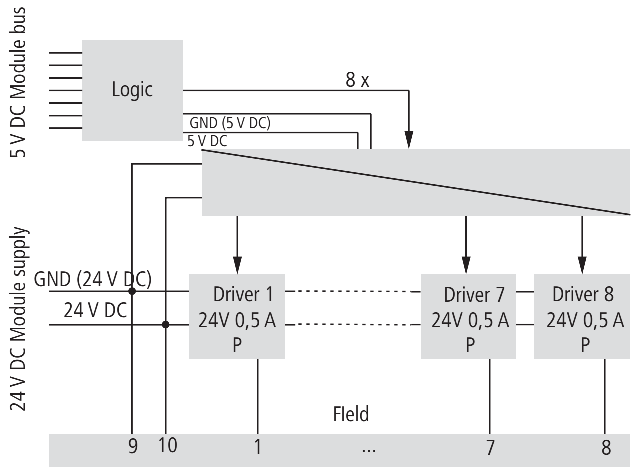


Figure 7-26: Block diagram



7.6.1 Technical data

Table 7-10: Technical data

A *The total current needed for every module is the sum of all partial currents.*

Designation	BL20-E-8DO-24VDC-0.5A-P
Number of channels	8
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 10 mA **A**
Nominal current from module bus I_{MB}	< 30 mA
Output voltage (loaded)	
High level U_H	min. L+ (-1 V)
Output current	
High level I_H (nominal)	0.5 A
High level I_H (for max. 5 minutes)	1 A
Delay at signal change and resistive load (R_{LO} < 1 kΩ)	
From low to high level	300 µs
From high to low level	300 µs
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	≥ 48 Ω
Load impedance, inductive R_{LI}	Category DC 13 according to EN 60 947-5-1
Lamp load R_{LL}	< 6 W
Switching frequency	
ohmic load	< 100 Hz
inductive load	DC13 according to IEC60947-5-1
lamp load	< 10 Hz
Overload proof	according to EN 61 131
short circuit proof	acc. to EN 61 131-2
Reset after eliminating a short circuit	automatic

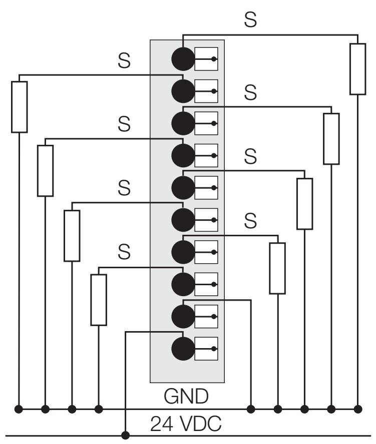
7.6.2 Diagnostic and status messages

Table 7-11: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
1	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
...			
8	Green	Status of channel 8 = "1"	-
	Off	Status of channel 8 = "0"	-

7.6.3 Wiring diagrams

Figure 7-27: Wiring diagram



7.7 Digital output module, 16DO, 0,5 A, positive switching (sourcing)

Figure 7-28: BL20-16DO-24VDC-0.5A-P

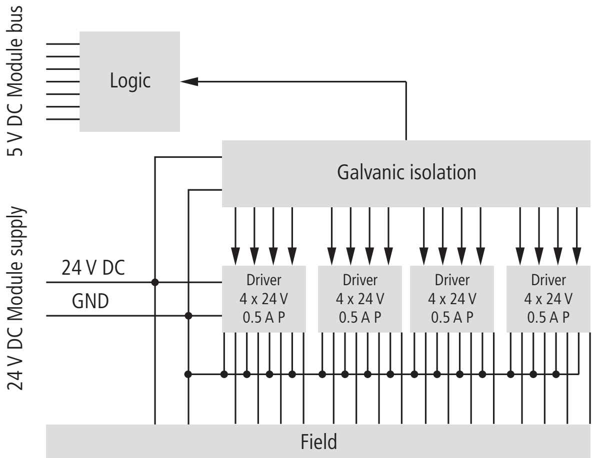


Figure 7-29: Block diagram

7.7.1 Technical data

Table 7-12: Technical data

Designation	BL20-16DO-24VDC-0.5A-P
Number of channels	16
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 30 mA
Nominal current from module bus I_{MB}	< 120 mA
Power loss of the module, typical	< 4 W
Output voltage (loaded)	
High level U_H	min. L+ (-1 V)
Output current	
High level I_H (nominal)	0.5 A
High level I_H (permissible range)	< 0.6 A
Delay at signal change and resistive load (R_{LO} < 1 kΩ)	
From low to high level	typ. 100 µs
From high to low level	typ. 100 µs
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	≥ 48 Ω
Load impedance, inductive R_{LI}	Category DC 13 according to EN 60 947-5-1
Lamp load R_{LL}	max. 3 W
Switching frequency	
Resistive load	100 Hz (R_{LO} < 1 kΩ)
Short-circuit proof	according to EN 61 131-2
Overload proof	according to EN 61 131

7.7.2 Diagnostic and status messages

Table 7-13: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-
	Off	Status of channel 2 = "0"	-
...			
161	Green	Status of channel 16 = "1"	-
	Off	Status of channel 16 = "0"	-

The module has the following diagnostic data available (group short-circuit recognition):

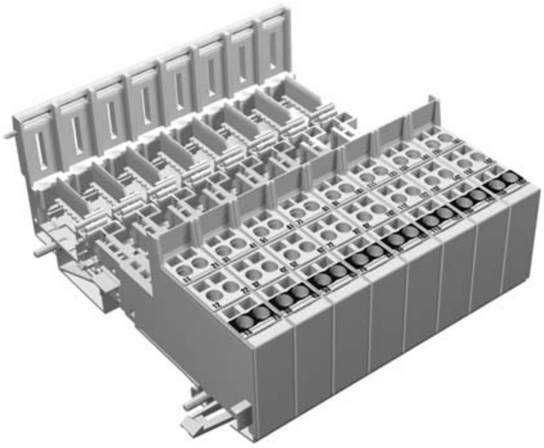
- "Overcurrent" (short-circuit) channel 1-4
- "Overcurrent" (short-circuit) channel 5-8
- "Overcurrent" (short-circuit) channel 9-12
- "Overcurrent" (short-circuit) channel 13-16

7.7.3 Module parameters

None

7.7.4 Base modules

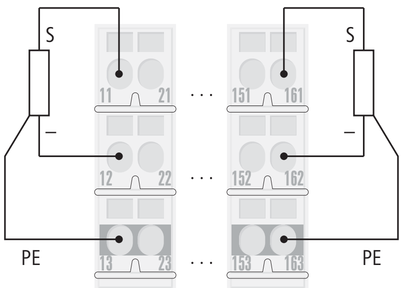
Figure 7-30: Base module BL20-B3T-SBCS



- with tension clamp connection
  BL20-B3T-SBC
- with screw connection
  BL20-B3S-SBC

7.7.5 Wiring diagrams

Figure 7-31: Wiring diagram BL20-B3x-SBC



7.8 Digital output module, BL20 Economy, 16DO, 0,5 A, positive switching (sourcing)

Figure 7-32: BL20-E-16DO-24VDC-0.5A-P

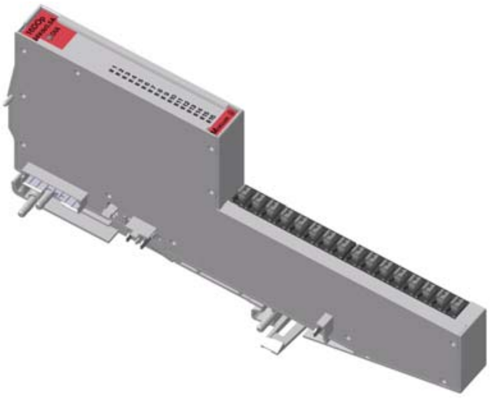
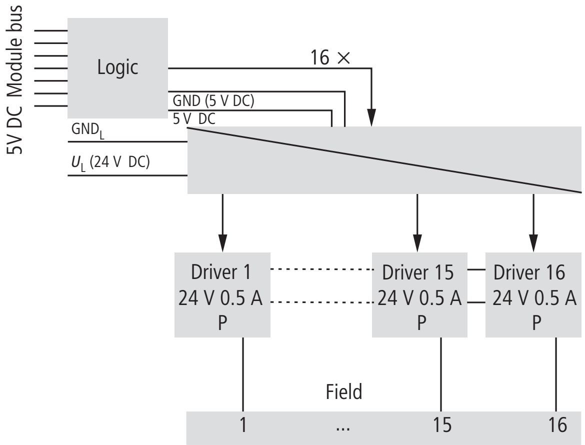


Figure 7-33: Block diagram



7.8.1 Technical data

Table 7-14: Technical data

A *The total current needed for every module is the sum of all partial currents.*

Designation	BL20-E-16DO-24VDC-0.5A-P
Number of channels	8
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 3 mA **A**
Nominal current from module bus I_{MB}	< 25 mA
Output voltage (loaded)	
High level U_H	min. L+ (-1 V)
Output current	
High level I_H (nominal)	0.5 A
High level I_H (for max. 5 minutes)	1 A
Delay at signal change and resistive load (R_{LO} < 1 kΩ)	
From low to high level	300 µs
From high to low level	300 µs
Total current for all outputs	max. 4 A
Synchronization factor	50 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	≥ 48 Ω
Load impedance, inductive R_{LI}	Category DC 13 according to EN 60 947-5-1
Lamp load R_{LL}	< 6 W
Switching frequency	
ohmic load	< 100 Hz
inductive load	DC13 according to IEC60947-5-1
lamp load	< 10 Hz
Overload proof	according to EN 61 131
short circuit proof	acc. to EN 61 131-2
Reset after eliminating a short circuit	automatic

7.8.2 Diagnostic and status messages

Table 7-15: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
1	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
...			
16	Green	Status of channel 16 = "1"	-
	Off	Status of channel 16 = "0"	-

7.8.3 Wiring diagrams

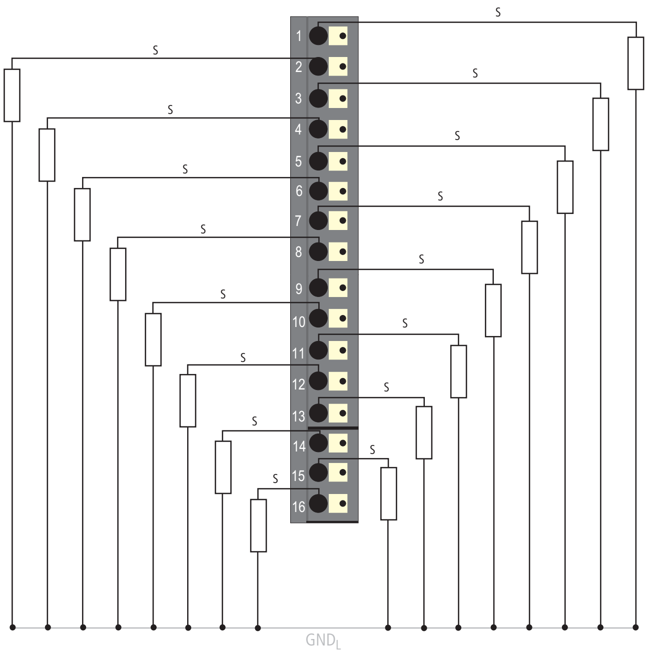


Figure 7-34: Wiring diagram

7.9 Digital output module, 32DO, 0,5 A, positive switching (sourcing)

Figure 7-35: BL20-32DO-24VDC-0.5A-P

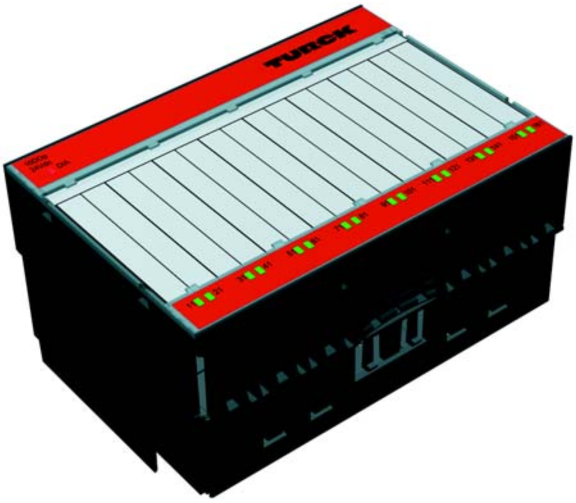
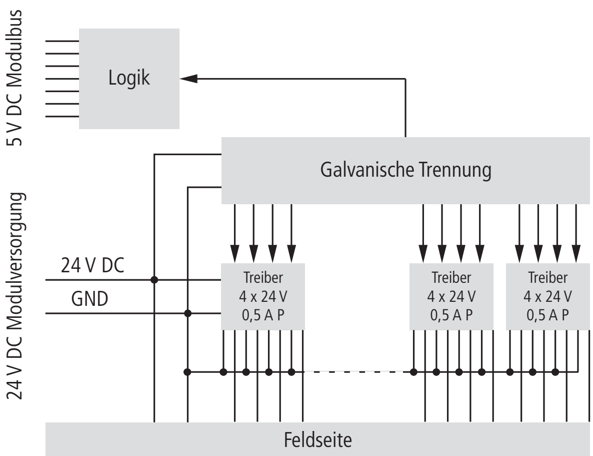


Figure 7-36: Block diagram



7.9.1 Technical data

Table 7-16: Technical data

Designation	BL20-32DO-24VDC-0.5A-P
Number of channels	32
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 50 mA
Nominal current from module bus I_{MB}	30 mA
Power loss of the module, typical	< 4 W
Output voltage (loaded)	
High level U_H	min. L+ (-1 V)
Output current (for supply of acutators/ output is switched on) **B**	
High level I_H (nominal)	0.5 A
High level I_H (permissible range)	< 1A
permissible total current aver all outputs **A**	10 A
Delay at signal change and resistive load	
From low to high level	typ. 300 µs
From high to low level	typ. 300 µs
Synchronization factor	100 %
Resistive, inductive and lamp loads can be connected	
Load impedance, resistive R_{LO}	≥ 48 Ω
Load impedance, inductive R_{LI}	< 1,2 H
Lamp load R_{LL}	< 6 W
Switching frequency	
Ohmic load	< 100 Hz
Short-circuit proof	according to EN 61 131-2
Reset after eliminating the short-circuit	automatic

A A maximum of 10 A can be transmitted via the base modules. The supply modules BL20-BR-24VDC-D and BL20-PF-24VDC-D supply a maximum of 10 A. The number of outputs that can be switched simultaneously, may therefore be smaller than 32.

B In order to increase the maximum output current to 1 A, two outputs can be switched simultaneously. Even in this case, the outputs are short circuit proof according to EN 61131-2.

7.9.2 Diagnostic and status messages

Table 7-17: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Red, flashing	Short-circuit at at least one of the 32 channels. A diagnostic message is generated.	Eliminate the cause for the short-circuit.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-
	Off	Status of channel 2 = "0"	-
...			
164	Green	Status of channel 32 = "1"	-
	Off	Status of channel 32 = "0"	-

The module has the following diagnostic data available (group short-circuit recognition):

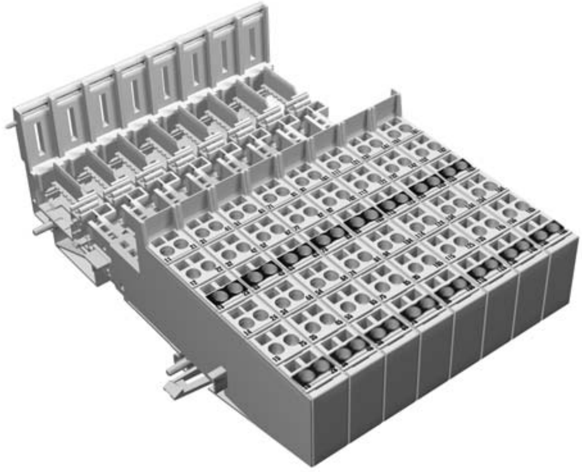
- "Overcurrent" (short-circuit) channel 1-4
- "Overcurrent" (short-circuit) channel 5-8
- "Overcurrent" (short-circuit) channel 9-12
- "Overcurrent" (short-circuit) channel 13-16
- "Overcurrent" (short-circuit) channel 17-20
- "Overcurrent" (short-circuit) channel 21-24
- "Overcurrent" (short-circuit) channel 25-28
- "Overcurrent" (short-circuit) channel 29-32

7.9.3 Module parameters

None

7.9.4 Base modules

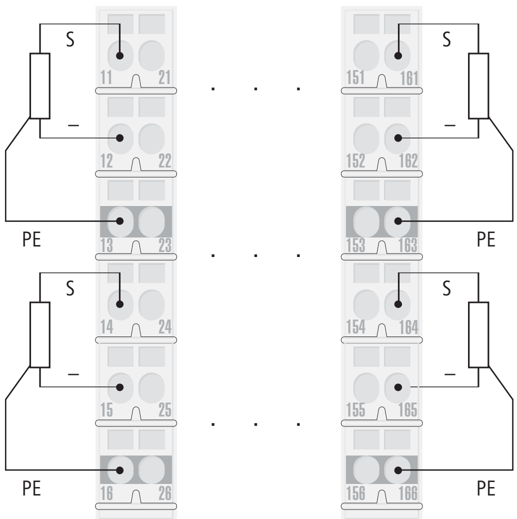
Figure 7-37: Base module BL20-B6T-SBCSBC



- with tension clamp connection BL20-B6T-SBCSBC
- with screw connection BL20-B6S-SBCSBC

7.9.5 Wiring diagrams

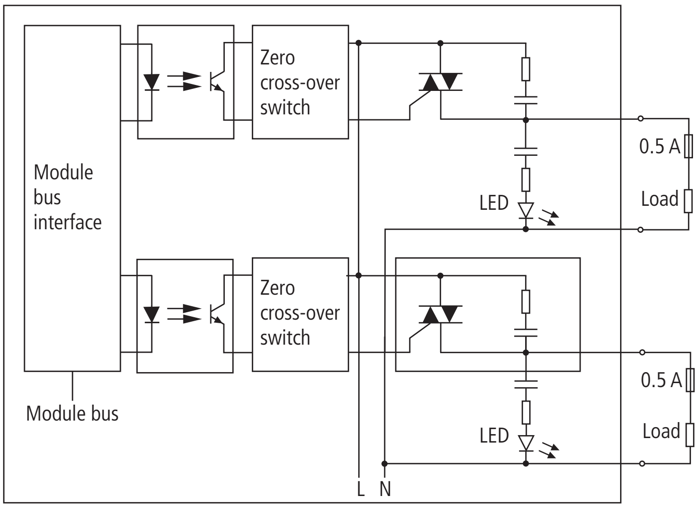
Figure 7-38: Wiring diagram BL20-B3x-SBCSBC



7.10 Digital output module, 2DO, 0.5A, 120/230 VAC

Figure 7-39: BL20-2DO-120/230VAC-0.5A

Figure 7-40: Block diagram



7.10.1 Technical data

Table 7-18: Technical data

Designation	BL20-2DO-120/230VAC-0.5A
Number of channels	2
Channel design	Voltage zero switching Triac
Nominal voltage from supply terminal U_L	120 to 230 V AC
Nominal current from supply terminal I_L	< 20 mA (at load current = 0 mA)
Nominal current from module bus I_{MB}	< 35 mA
Voltage drop at High level U_V	< 2 V
Max. leakage current at High level I_{Leak}	1.5 mA
Max. leakage current at Low level (residual current)	1.5 mA
Frequency range f_N	45 to 65 Hz
Power loss of the module	< 1 W
Surge current I_S	8 A (one period at 60 Hz)
Back-up fuse	≤ 500 mA very quick acting
Insulation voltage between the channels and the bus	2500 V
Turn-on time t_{ON}	T/2 + 1 ms
Turn-off time t_{OFF}	T/2 + 1 ms
Derating	
at 40°C	1 A (per channel 0.5 A)
at 50°C	0.75 A (per channel 0.375 A)
at 55°C	0.5 A (per channel 0.25 A)
Output current	
High level I_H (nominal)	0.5 A
High level I_H (permissible range)	< 0.6 A

Attention
A voltage may be present on the output in a switched-off state due to leakage currents → Figure 7-43:

The switching element is a non short-circuit protected Triac with integral suppressor, which switches off and on the load during a voltage zero.

Danger
Switch off the outputs before you insert or remove the module!

7.10.2 Diagnostic and status messages

Table 7-19: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	-
	Off	Status of channel 1 = "0"	-
21	Green	Status of channel 2 = "1"	-

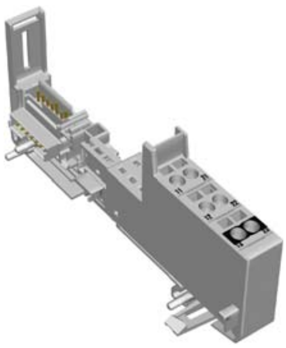
Note
The indication elements are supplied by the field voltage (and not by the module bus voltage). They only indicate switch status correctly when this voltage is fully present on the Power Feeding module. → Figure 7-43:.

7.10.3 Module parameters

None

7.10.4 Base modules

Figure 7-41: Base module BL20-S3T-SBC



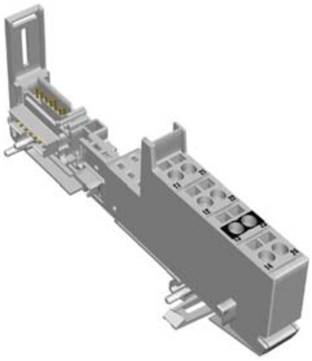


Figure 7-42: Base module BL20-S4T-SBCS

- with tension clamp connection
  BL20-S3T-SBC
  BL20-S4T-SBCS
- with screw connection
  BL20-S3S-SBC
  BL20-S4S-SBCS

7.10.5 Wiring diagrams

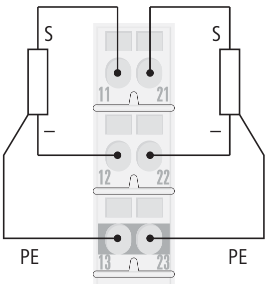
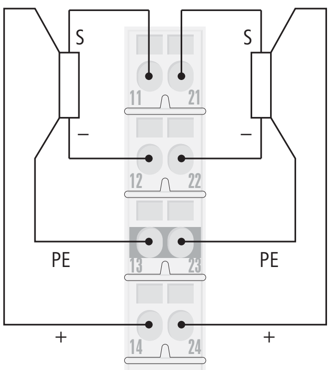


Figure 7-43: Wiring diagram BL20-S3x-SBC



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8.1 General

Analog output modules (AO) receive output values from the gateway via the internal module bus. The modules convert these values and transmit the corresponding signals for each channel to the field level via the base modules.

The module bus electronics of the analog input modules are galvanically isolated from the field level via an optocoupler, and provide reverse polarity protection.

The modules are short-circuit proof.

Supported signal ranges

- 0 to 20 mA,
- 4 to 20 mA,
- 0 to 10 V DC,
- -10 to +10 V DC

8.1.1 Resolution of analog value representations

In the bipolar mode the digitalized analog values are represented as a two's complement. The 16 bit or the 12-bit-representation (left justified) can be chosen by setting the respective module parameter.

Note
A detailed description of the 16 bit/12-bit-representation for the analog values can be found in the Appendix, page 14-15.

LED status indicators

Error signals from the I/O level are indicated by each module via the "DIA" LED. The corresponding diagnostic information is transmitted to the gateway via diagnostic bits.

If the "DIA" LED lights up continuously red, it signals the failure of the module bus communication at the analog output module.

8.1.2 Shielding

When using shielded signal cables, the connection between the shield and the base module is made via a two-pole shield connection, which is available as an accessory.

8.1.3 Module overview

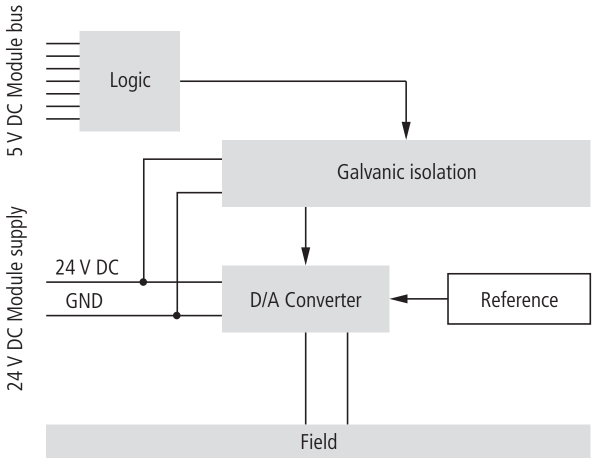
Table 8-1: Overview analog output modules

	Number of channels	Short-circuit proof
BL20-1AO-I(0/4...20MA)	1	✓
BL20-2AO-I(0/4...20MA)	2	✓
BL20-2AO-U(-10/0...+10VDC)	2	✓
BL20-E-4AO-U/I	4	✓

8.2 Analog output module, 1AO, 0/4...20 mA

Figure 8-1: BL20-1AO-I (0/4...20MA)

Figure 8-2: Block diagram



8.2.1 Technical data

Table 8-2: Technical data

Designation	BL20-1AO-I(0/4...20MA)
Number of channels	1
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	≤ 50 mA
Nominal current from module bus I_{MB}	≤ 39 mA
Power loss of the module, typical	<1 W
Output current	0/4 to 20 mA
Burden resistance	
Resistive load R_{LO}	< 550 Ω
Inductive load R_{LI}	< 1 mH
Transmission frequency	< 200 Hz
Basic error at 23 °C / 73.4 °F	0.2 %
Temperature coefficient	≤ 300 ppm/°C from end value

Settling time (maximum)	
Resistive load	0.1 ms
Inductive load	0.5 ms
Capacitive load	0.5 ms
Measurement value representation	16 Bit signed integer / 12 Bit full range left-justified

Note
Negative values are automatically displayed as 0 mA or 4 mA, depending on the configured measurement range.

8.2.2 Diagnostic and status messages

Table 8-3: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

8.2.3 Module parameters

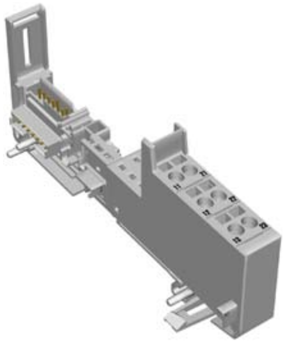
Table 8-4: Module parameters

A*Standard parameter value*

Parameter name	Value
Value representation	Integer (15Bit + sign) **A**
	12Bit (left-justified)
Current mode	0..20mA **A**
	4..20mA
Substitute value A1	The substitute value will be transmitted if the respective parameters of the gateway have been set to "output substitute value".

8.2.4 Base modules

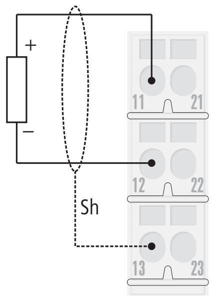
Figure 8-3: Base module BL20-S3T-SBB



- with tension clamp connection
  BL20-S3T-SBB
- with screw connection
  BL20-S3S-SBB

8.2.5 Wiring diagrams

Figure 8-4: Wiring diagram BL20-S3x-SBB



8.2.6 Measurement value representation

16-bit-representation:

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)
- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

12-bit-representation (left-justified)

- Current values from 0 to 20 mA

The value range
0 mA to 20 mA
is displayed as follows:
000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Current values from 4 to 20 mA

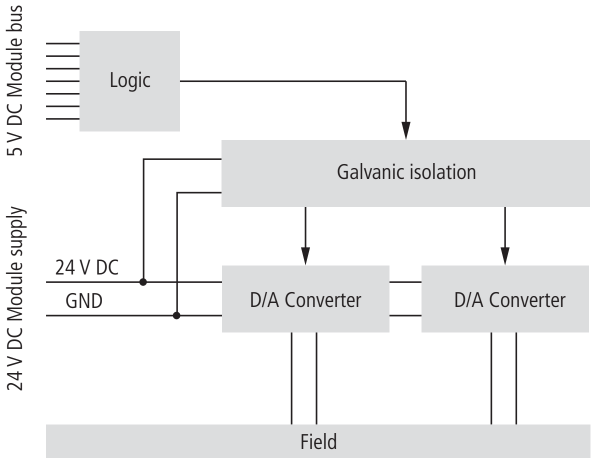
The value range
4 mA to 20 mA
is displayed as follows:
000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

Note
A detailed description of the 16 bit/12-bit-representation for the analog values can be found in the Appendix, page 14-15.

8.3 Analog output module, 2AO, 0/4...20 mA

Figure 8-5: BL20-2AO-I (0/4...20MA)

Figure 8-6: Block diagram



8.3.1 Technical data

Table 8-5: Technical data

Designation	BL20-2AO-I(0/4...20MA)
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 50 mA
Nominal current from module bus I_{MB}	< 40 mA
Power loss of the module, typical	<1 W
Output current	0/4 to 20 mA
Burden resistance	
Resistive load R_{LO}	< 450 Ω
Inductive load R_{LI}	< 1 mH
Transmission frequency	< 200 Hz
Basic error at 23 °C / 73.4 °F	0.2 %
Temperature coefficient	≤ 150 ppm/°C from end value

Settling time (maximum)	2 ms (at 450 Ω)
Measurement value representation	16 Bit Signed Integer / 12 Bit Full Range left-justified

Note
Negative values are automatically displayed as 0 mA or 4 mA, depending on the configured measurement range.

8.3.2 Diagnostic and status messages

Table 8-6: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

8.3.3 Module parameters (per channel)

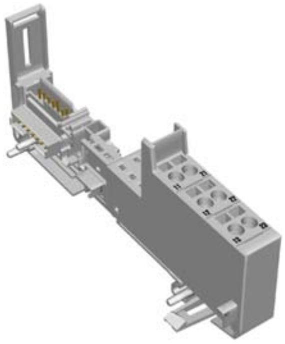
Table 8-7: Module parameters

A *Standard parameter value*

Parameter name	Value
Channel Kx	activate **A**
	deactivate
Value representation	Integer (15Bit + sign) **A**
	12Bit (left-justified)
Current mode	0..20mA **A**
	4..20mA
Substitute value Ax	The substitute value will be transmitted if the respective parameters of the gateway have been set to "output substitute value".

8.3.4 Base modules

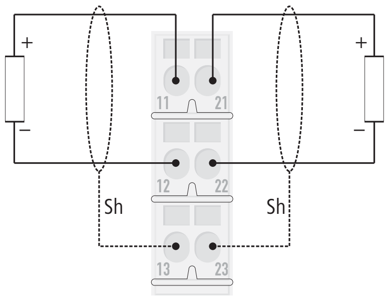
Figure 8-7: Base module BL20-S3T-SBB



- with tension clamp connection BL20-S3T-SBB
- with screw connection BL20-S3S-SBB

8.3.5 Wiring diagrams

Figure 8-8: Wiring diagram BL20-S3x-SBB



8.3.6 Measurement value representation

16-bit-representation:

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)
- Current values from 4 to 20 mA

  The value range
  4 mA to 20 mA
  is displayed as follows:
  0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

12-bit-representation (left-justified)

- Current values from 0 to 20 mA

  The value range
  0 mA to 20 mA
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Current values from 4 to 20 mA

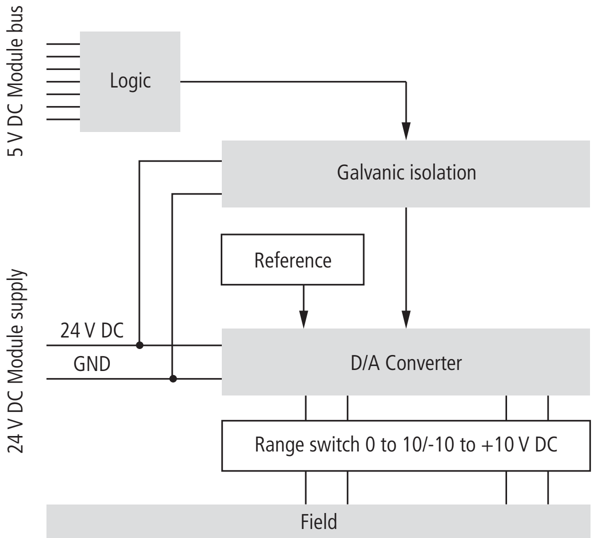
  The value range
  4 mA to 20 mA
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

Note
A detailed description of the 16 bit/12-bit-representation for the analog values can be found in the Appendix, page 14-15.

8.4 Analog output module, 2AO, -10/0...+10 V DC

Figure 8-9:
BL20-2AO-U
(-10/0...+10VDC)

Figure 8-10:
Block diagram



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8.4.1 Technical data

Table 8-8: Technical data

Designation	BL20-2AO-U(-10/0...+10VDC)
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 50 mA
Nominal current from module bus I_{MB}	< 43 mA
Power loss of the module, typical	<1 W
Output current	-10/0 to +10 V
Burden resistance	
Resistive load R_{LO}	> 1 kΩ
Capacitive load R_{LI}	> 1 µF
Short-circuit current	≤ 40 mA
Transmission frequency	< 100 Hz
Basic error at 23 °C / 73.4 °F	< 0.2 %
Temperature coefficient	≤ 300 ppm/°C from end value
Settling time (maximum)	
Resistive load	0.1 ms
Inductive load	0.5 ms
Capacitive load	0.5 ms
Interference voltage suppression	
Common-mode	> 90 dB
Normal mode	> 70 dB
Interference between the channels	> - 50 dB
Measurement value representation	16 Bit Signed Integer / 12 Bit Full Range left-justified

Note
Negative values are automatically displayed as 0 V in a configured measurement range of 0 to 10 V.

8.4.2 Diagnostic and status messages

Table 8-9: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–

8.4.3 Module parameters (per channel)

Table 8-10: Module parameters

A *Standard parameter value*

Parameter name	Value
Value representation	Integer (15Bit + sign) **A**
	12Bit (left-justified)
Voltage mode	0..10V **A**
	-10..+10V
Substitute value Ax	The substitute value will be transmitted if the respective parameters of the gateway have been set to "output substitute value".

8.4.4 Base modules

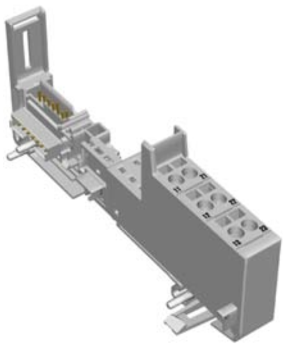
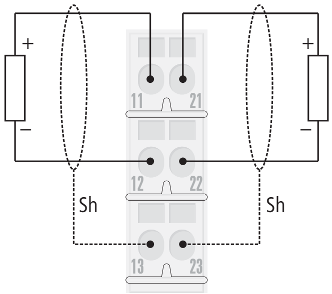


Figure 8-11: Base module BL20-S3T-SBB

- with tension clamp connection BL20-S3T-SBB
- with screw connection BL20-S3S-SBB

8.4.5 Wiring diagrams

Figure 8-12: Wiring diagram BL20-S3x-SBB



8.4.6 Measurement value representation

16-bit-representation

- Voltage values from 0 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

- Voltage values from -10 to 10 V DC

  The value range
  -10 V to -3.052 10^{-4} V
  is displayed as follows:
  8000$_{hex}$ **to FFFF**$_{hex}$ (decimal:-32768 to -1)

12-bit-representation (left-justified)

- Voltage values from 0 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: 0 to 4095)

- Voltage values from -10 to 10 V DC

  The value range
  0 V to 10 V
  is displayed as follows:
  000(0)$_{hex}$ **to 7FF(0)**$_{hex}$ (decimal: 0 to 2047)

  The value range
  -10 V to -0.0049 V
  is displayed as follows:
  800(0)$_{hex}$ **to FFF(0)**$_{hex}$ (decimal: -2048 to -1)

Note
A detailed description of the 16 bit/12-bit-representation for the analog values can be found in the Appendix, page 14-15.

8.5 Analog output module, 4AO, voltage/ current, Economy

This 4-channel analog output module provides 4 analog outputs for voltage or current.

The function-setting is carried out via channel-oriented parameters.

The module provides electrical isolation between the field and the module bus connection.

Figure 8-13: BL20-E-4AO-U/I

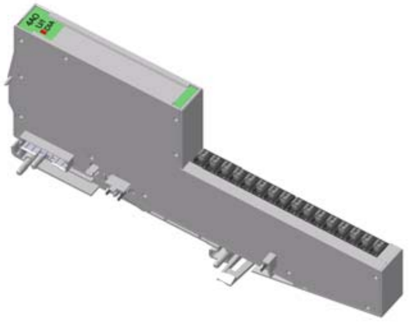
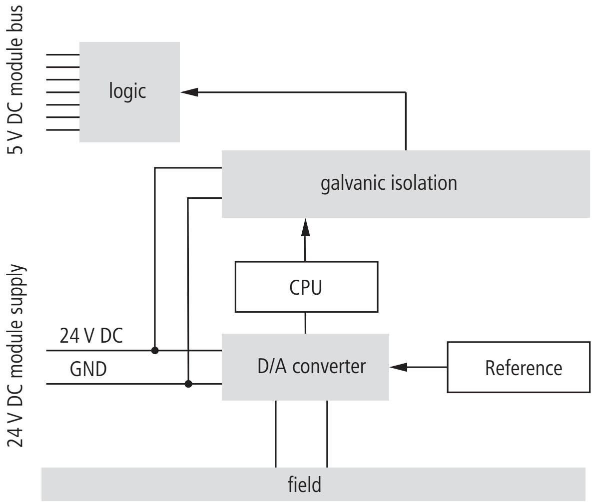


Figure 8-14: Block diagram



8.5.1 Technical data

Table 8-11: Technical data

Designation	BL20-E-4AO-U/I
Number of channels	4 (U/I)
Nominal voltage from supply terminal U_L	24 V DC (18 to 30 V DC)
Nominal current from supply terminal I_L	
without signal output	< 40 mA
with signal output	< 150 mA
Nominal current from module bus I_{MB}	< 40 mA
Power loss of the module, typical	< 3 W
Parameterizable measured variables	voltage, current
– Output value, *voltage*	-10...10 V DC/ 0...10 V DC
Burden resistance	
– Ohmic load	> 1 kΩ
– Capacitive load	< 1 µF
– Transmission frequency	< 20 Hz
Setting time (maximum)	
– Ohmic load	< 1 ms
– Capacitive load	< 2 ms
Short circuit current	< 40 mA
Basic error at 23 °C	0.2 % (nominal value)
Temperature coefficient	200 ppm/ °C
– Output value, current	0...20 mA /4...20 mA
Burden resistance	
– Ohmic load	< 450 Ω
– Inductive load	< 1 mH
– Transmission frequency	< 20 Hz
Setting time (maximum)	
– Ohmic load	< 1 ms
– Inductive	< 2 ms
Basic error at 23 °C	0.2 % (nominal value)
Temperature coefficient	200 ppm/ °C

8.5.2 Diagnostic and status messages

Table 8-12: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure or field voltage U_L not connected	Check if more than two adjoining electronics modules have been pulled. Check the field voltage U_L
	Off	No error messages or diagnostics	–

The module has the following diagnostic messages available per channel:

- "Measurement value range error "Out of Range"

OoR

Indicates an exceed or undercut of the value ranges.

– Limit values according to parameterization, page 8-21 ff.

The permissible output value limits are exceeded.

- "Over-/Underflow"

OUFL

The output value exceeds the output range and the module can not transmit this value.

– limits according to parameterization, page 8-21 ff.

- "Hardware error"

HW Error

– Shows common errors of the module hardware. The output value of the analog value is "0".

8.5.3 Module parameters (per channel)

The module provides 12 byte parameter data. Three bytes are assigned to each analog output channel.

Note

Please read page 8-24 ff. for detailed information about the parameter settings (Standard, Extended Range, PA (NE 43)).

Table 8-13: Module parameters

A *default-settings*
B *values according to paramete-rization, see* page 8-20

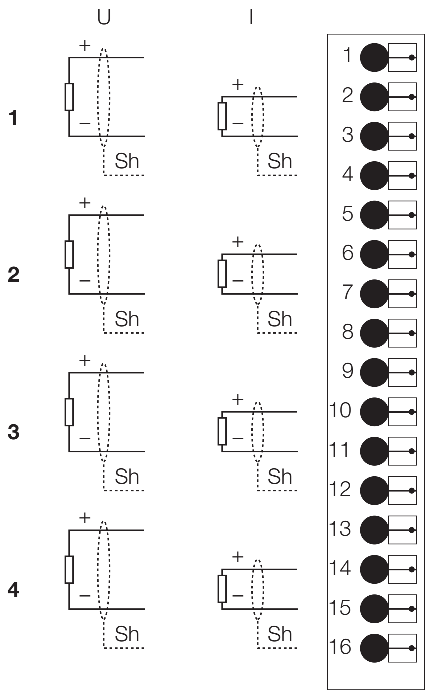
Parameter	Settings
Operation mode Kx	– voltage -10...10 V DC Standard **A** – voltage 0...10 V DC Standard – voltage -10...10 V DC PA (NE 43) – voltage 0...10 V DC PA (NE 43) – voltage -10...10 V DC Extended Range – voltage 0...10 V DC Extended Range – current 0...20 mA Standard – current 4...20 mA Standard – current 0...20 mA PA (NE 43) – current 4...20 mA PA (NE 43) – current 0...20 mA Extended Range – current 4...20 mA Extended Range – deactivated
Value representation Kx	– Integer (15 bit + sign) **A** – 12 bit (left-justified)
Diagnostics Kx	– release **A** – block
Behavior module bus error Ax	– output substitute value **A** – hold current value
Substitute value Ax	Substitute value = "0" **A** 1. The substitute value defined here will be sent in consequence of certain events parameterized in the gateway. or 2. In case of a module bus error: The substitute value defined here will be sent if the parameter "Behavior module bus error Ax" is set to "output substitute value".

Table 8-14: Min./ max. values

Value representation/ resolution	Rage	Min. value	Max. value
Standard/ 16 bit/ 12 bit	-10 ... 10 VDC	-10 VDC	10 VDC
	0 ... 10 VDC	0 VDC	10 VDC
	0 ... 20 mA	0 mA	20 mA
	4 ... 20 mA	4 mA	20 mA
Extended Range/ 16 bit/ 12 bit	-10 ... 10 VDC	-11.76 VDC	11.76 VDC
	0 ... 10 VDC	0 VDC	11.76 VDC
	0 ... 20 mA	0 mA	23.52 mA
	4 ... 20 mA	0 mA	22.81 mA
PA (NE43) 16 bit/ 12 bit	-10 ... 10 VDC	-10.5 VDC	10.5 VDC
	0 ... 10 VDC	0 VDC	10.5 VDC
	0 ... 20 mA	0 mA	21 mA
	4 ... 20 mA	3.6 mA	21 mA

8.5.4 Wiring diagrams

Figure 8-15: Wiring options



Note
Each channel can be parameterized separately for voltage or current output. Output terminals which are not in use, have to be left unconnected.

8.5.5 Standard value representation

16-bit-representation

	dec.	hex.	bipolar	-10...10 V
dec. value= 3276.7 [1/V] × voltage value [V]				
100.00 %	32767	7FFF	nominal range	10.0000 V
99.99695 %	32766	7FFE		9.9997 V
	...	...		...
50.00153 %	16384	4000		5.0002 V
	...	...		...
0.00305 %	1	0001		0.000305 V
0.00000 %	0	0000		0.000000 V
-0.00305 %	-1	FFFF		-0.000305 V
	...	...		...
-50.00000 %	-16384	C000		-5.0000 V
	...	...		...
-99.99695 %	-32767	8001		-9.9997 V
-100.00 %	-32768	8000		- 10.0000 V

	dec.	hex.	unipolar	0...10 V
dec. value= 3276.7 [1/V] × voltage value [V]				
100.00 %	32767	7FFF	nominal range	10.0000 V
99.99695 %	32766	7FFE		9.9997 V
	...	...		...
50.00153 %	16384	4000		5.0002 V
	...	...		...
0.00305 %	1	0001		0.000305 V
0.00000 %	0	0000		0.000000 V
-0.00305 %	-1	FFFF	DIA **OoR** ON at FFFF to 8000	0.000000 V
	...	...		...
-50.00000 %	-16384	C000		0.000000 V
	...	...		...
-99.99695 %	-32767	8001		0.000000 V
-100.00 %	-32768	8000		0.000000 V

	dec.	hex.	unipolar	0...20 mA
dec. value= 1638.35 [1/mA] × current value [mA]				
100.00 %	32767	7FFF	nominal range	20.0000 mA
99.99695 %	32766	7FFE		19.9994 mA
	...	...		...
50.00153 %	16384	4000		10.0003 mA
	...	...		...
0.00305 %	1	0001		0.0006103 mA
0.00000 %	0	0000		0.000000 mA
-0.00305 %	-1	FFFF	DIA **OoR** ON at FFFF to 8000	0.000000 mA
	...	...		...
-50.00000 %	-16384	C000		0.000000 mA
	...	...		...
-99.99695 %	-32767	8001		0.000000 mA
-100.00 %	-32768	8000		0.000000 mA

	dec.	hex.	unipolar	4...20 mA
dec. value= 2047.94 [1/mA] × (current value [mA] - 4 mA)				
100.00 %	32767	7FFF	nominal range	20.0000 mA
99.99695 %	32766	7FFE		19.9995 mA
	...	...		...
50.00153 %	16384	4000		12.00024 mA
	...	...		...
0.00305 %	1	0001		4.0004883 mA
0.00000 %	0	0000		4.000000 mA
-0.00305 %	-1	FFFF	DIA **OoR** ON at FFFF to 8000	4.000000 mA
	...	...		...
-50.00000 %	-16384	C000		4.000000 mA
	...	...		...
-99.99695 %	-32767	8001		4.000000 mA
-100.00 %	-32768	8000		4.000000 mA

12-bit-representation (left-justified)

	dec.	hex.	bipolar	-10...10 V
dec. value= 204.7 [1/V] × voltage value [V] × 16				
100.00 %	2047 × 16	7FF×	nominal range	10.0000 V
99.951 %	2046 × 16	7FEx		9.9951 V
	...	...		...
0.04885 %	1 × 16	001x		0.004885 V
0.00000 %	0	000x		0.000000 V
-0.04883 %	-1 × 16	FFF×		-0.004883 V
	...	...		...
-99.95 %	-2047 × 16	801x		-9.9951 V
-100.00 %	-2048 × 16	800x		- 10.0000 V

	dec.	hex.	unipolar	0...10 V
dec. value= 409.5 [1/V] × voltage value [V] × 16				
100.00 %	4095 × 16	FFF×	nominal range	10.0000 V
99.9756 %	4094 × 16	FFEx		9.9976 V
	...	...		...
50.0122%	2048 × 16	800x		5.0012 V
	...	...		...
0.0244 %	1 × 16	001x		0.002442 V
0.00000 %	0	000x		0.000000 V

	dec.	hex.	unipolar	0...20 mA
dec. value= 204.75 [1/mA] × current value [mA] × 16				
100.00 %	4095 × 16	FFF×	nominal range	20.0000 mA
99.9756 %	4094 × 16	FFEx		19.995117 mA
	...	...		...
50.0122 %	2048 × 16	800x		10.0024 mA
	...	...		...
0.0244 %	1 × 16	001x		0.004883 mA
0.00000 %	0	000x		0.000000 mA

	dec.	hex.	unipolar	4...20 mA
dec. value= (255.9 [1/mA] × (current value [mA] - 4 mA)) × 16				
100.00 %	4095 × 16	FFF×	nominal range	20.0000 mA
99.9756 %	4094 × 16	FFEx		19.99609 mA
	...	...		...
50.0122 %	2048 × 16	800x		12.0020 mA
	...	...		...
0.0244 %	1 × 16	001x		4.00391 mA
0.00000 %	0	000x		4.000000 mA

8.5.6 Extended Range - value representation for voltage/current

16-bit-representation

	dec.	hex.	bipolar	-10...10 V
dec. value= 2764.8 [1/V] × voltage value [V]				
118.515 %	32767	7FFF	DIA **OoR** ON at 7F00 to 7FFF	11.851 V
118.461 %	32752	7FF0		11.846 V
117.593 %	32512	7F00		11.753 V
117.589 %	32511	7EFF	out of range	11.789 V
117.535 %	32496	7EF0		11.75 V
100.058 %	27664	6C10		10.0058 V
≥100.004 %	27649	6C01		10.0004 V
100.000 %	27648	6C00	nominal range	10 V
0.05787 %	16	0010		5.787 mV
0.003617 %	1	0001		361.7 µV
0.000 %	0	0000		0 V
-0.00362 %	-1	FFFF		-361.7 µV
-0.05787 %	-16	FFF0		- 5.787 mV V
-25.000 %	-6912	E500		-2.5 V
-100.000 %	-27648	9400		-10 V
≤ -100.004 %	-27649	93FF	out of range	-10.0004 V
-100.058 %	-27664	93F0		-10.0058 V
-117.593 %	-32512	8100		-11.7593 V
-117.596 %	-32513	80FF	DIA **OoR** ON at 80FF to 8000	11.7596 V
-118.461 %	-32752	80F0		-11.846 V
-118.519 %	-32768	800		-11.852 V

	dec.	hex.	unipolar	0...10 V
dec. value= 2764.8 [1/V] × voltage value [V]				
118.515 %	32767	7FFF	DIA **OoR** ON at 7F00 to 7FFF	11.851 V
118.461 %	32752	7FF0		11.846 V
117.593 %	32512	7F00		11.793 V
117.589 %	32511	7EFF	out of range	11.789 V
117.535 %	32496	7EF0		11.75 V
100.058 %	27664	6C10		10.0058 V
≥100.004 %	27649	6C01		10.0004 V
100.000 %	27648	6C00	nominal range	10 V
0.05787 %	16	0010		5.787 mV
0.003617 %	1	0001		361.7 µV
0.000 %	0	0000		0.00 V
-0.00362 %	-1	FFFF	DIA **OUFL** ON at FFFF to 8000	0.00 V
-0.05787 %	-16	FFF0		0.00 V
-25.000 %	-6912	E500		0.00 V
-100.000 %	-27648	9400		0.00 V
≤-100.004 %	-27649	93FF		0.00 V
-100.058 %	-27664	93F0		0.00 V
-117.593 %	-32512	8100		0.00 V
-117.596 %	-32513	80FF		0.00 V
-118.461 %	-32752	80F0		0.00 V
-118.519 %	-32768	8000		0.00 V

	dec.	hex.	unipolar	0...20 mA
dec. value= 1382.4 [1/mA] × current value [mA]				
118.515 %	32767	7FFF	DIA **OoR** ON at 7F00 to 7FFF	23.7030 mA
118.461 %	32752	7FF0		23.692 mA
117.593 %	32512	7F00		23.518 mA
117.589 %	32511	7EFF	out of range	23.517 mA
117.535 %	32496	7EF0		23.507 mA
100.058 %	27664	6C10		20.0116 mA
≥100.004 %	27649	6C01		20.0007 mA
100.000 %	27648	6C00	nominal range	20 mA
0.05787 %	16	0010		11.574 µA
0.003617 %	1	0001		0.7234 µA
0.000 %	0	0000		0.0000 mA
-0.00362 %	-1	FFFF	DIA **OUFL** ON at FFFF to 8000	0.0000 mA
-0.05787 %	-16	FFF0		0.0000 mA
-25.000 %	-6912	E500		0.0000 mA
-100.000 %	-27648	9400		0.0000 mA
≤ -100.004 %	-27649	93FF		0.0000 mA
-100.058 %	-27664	93F0		0.0000 mA
-117.593 %	-32512	8100		0.0000 mA
	-32513	80FF		0.0000 mA
-118.461 %	-32752	80F0		0.0000 mA
-118.519 %	-32768	8000		0.0000 mA

	dec.	hex.	unipolar	4...20 mA
dec. value= 1382.4 [1/mA] × current value [mA]				
118.515 %	32767	7FFF	DIA **OoR** ON at 7F00 to 7FFF	22.9624 mA
118.461 %	32752	7FF0		22.9537 mA
117.593 %	32512	7F00		22.8148 mA
117.589 %	32511	7EFF	out of range	22.8142 mA
117.535 %	32496	7EF0		22.8056 mA
100.058 %	27664	6C10		20.0093 mA
≥100.004 %	27649	6C01		20.0006 mA
100.000 %	27648	6C00	nominal range	20.0000 mA
0.05787 %	16	0010		4.009259 mA
0.003617 %	1	0001		4.000578 mA
0.000 %	0	0000		4.0000 mA
-0.00362 %	-1	FFFF	out of range	3.99942 mA
-0.05787 %	-16	FFF0		3.99075 mA
-25.000 %	-6912	E500		0.0000 mA
-100.000 %	-27648	9400	DIA **OUFL** ON at E4FF to 8000	0.0000 mA
≤-100.004 %	-27649	93FF		0.0000 mA
-100.058 %	-27664	93F0		0.0000 mA
-117.593 %	-32512	8100		0.0000 mA
-117.596 %	-32513	80FF		0.0000 mA
-118.461 %	-32752	80F0		0.0000 mA
-118.519 %	-32768	8000		0.0000 mA

12-bit-representation (left-justified)

The representation of the 12 bit values is similar to that of the 16 bit values. Only the bits Bit 0-3 are set to "0".

8.5.7 Value representation for process automation (NE 43)

The hexadecimal value, transmitted from the module has to be interpreted as decimal value which, multiplied by a certain factor, corresponds to the analog measurement value.

Example:

Process value	
– dec.	15020
– hex.	3AAC
Output current	15.02 mA

16-bit-representation

	dec.	hex.	bipolar	-10...10 V
dec. value= 1000 [1/V] × voltage value [V]				
327.67 %	32767	7FFF	DIA **OUFL** ON at 2AF9 to 7FFF	11.000 V
110. 01 %	11001	2AF9		11.000 V
110.00 %	11000	2AF8	DIA **OoR** ON at 2905 to 7FFF	11.000 V
105.01 %	10501	2905		10.501 V
105.00 %	10500	2904	out of range	10.500 V
100.01 %	10001	2711		10.001 V
100.000 %	10000	2710	nominal range	10.000 V
40.00 %	4000	0FA0		4.000 V
0.01 %	1	0001		0.001 V
0.000 %	0	0000		0 V
-0.01 %	-1	FFFF		-0.001 V
-40.00 %	-4000	F060		-4.000 V
-100.00 %	-10000	D8F0		-10.000 V
≤ -100.01 %	-10001	D8EF	out of range	-10.001 V
-105.00 %	-10500	D6FC		-10.500 V
-105.01 %	-10501	D6FB	DIA **OoR** ON at D6FB to 8000	-10.501 V
-110.00 %	-1100	D508		-11.000 V
-110.01 %	-11001	D507	DIA **OUFL** ON at D507 to 8000	-11.00 0 V
-327.68 %	-32768	8000		-11.000 V

	dec.	hex.	bipolar	0...10 V
dec. value= 1000 [1/V] × voltage value [V]				
655.35 %	65535	FFFF	DIA **OUFL** ON at 2AF9 to FFFF	11.000 V
> 110. 01 %	> 11001	2AF9		11.000 V
110.00 %	11000	2AF8	DIA **OoR** ON at 2905 to FFFF	11.000 V
105.01 %	10501	2905		10.501 V
105.00 %	10500	2904	out of range	10.500 V
100.01 %	10001	2711		10.001 V
100.000 %	10000	2710	nominal range	10.000 V
40.00 %	4000	0FA0		4.000 V
20.00 %	2000	07D0		2.000 V
0.01 %	1	0001		0.001 V
0.000 %	0	0000		0 V

	dec.	hex.	unipolar	0...20 mA
dec. value= 1000 [1/mA] × current value [mA]				
327.675 %	65535	FFFF	DIA **OUFL** ON at 55F1 to FFFF	22.000 mA
> 110. 005 %	≥ 22001	55F1	DIA **OUFL** ON at 55F1 to FFFF	22.000 mA
110.00 %	22000	55F0	DIA **OoR** ON at 5209 to FFFF	22.000 mA
> 105.005 %	21001	5209	DIA **OoR** ON at 5209 to FFFF	21.001 mA
105.000 %	21000	5208	out of range	21.000 mA
100.006 %	20001	4E21	out of range	20.001 mA
100.000 %	20000	4E20	nominal range	20.000 mA
40.00 %	8000	1F40	nominal range	8.000 mA
20.00 %	4000	0FA0	nominal range	4.000 mA
0.01 %	2	0002	nominal range	0.002 mA
0.005 %	1	0001	nominal range	0.001 mA
0.000 %	0	0000	nominal range	0.000 mA

	dec.	hex.	unipolar	4...20 mA
dec. value= 1000 [1/mA] × current value [mA]				
384.594 %	65535	FFFF	DIA **OUFL** ON at 55F1 to FFFF	22.000 mA
> 112.506 %	22001	55F1	DIA **OUFL** ON at 55F1 to FFFF	22.001 mA
112.500 %	22000	55F0	DIA **OoR** ON at 5209 to 7FFF	22.000 mA
106.256%	21001	5209	DIA **OoR** ON at 5209 to 7FFF	21.001 mA
106.250 %	21000	5208	out of range	21.000 mA
100.005 %	20001	4E21	out of range	20.001 mA
100.000 %	20000	4E20	nominal range	20.000 mA
25.000 %	8000	1F40	nominal range	8.000 mA
0.000 %	4000	0FA0	nominal range	4.000 mA
≤ -0.006 %	3999	0F9F	out of range	3.999 mA
-1.250 %	3800	0ED8	out of range	3.800 mA
-2.500 %	3600	0E10	out of range	3.600 mA
-2.506 %	3599	0E0F	DIA **OoR** ON at 0E0F to 0000	3.599 mA
-12.500 %	2000	07D0	DIA **OoR** ON at 0E0F to 0000	2.000 mA
-12.506 %	1999	07CF	DIA **OoR** ON at 0E0F to 0000	1.999 mA
-24.994 %	1	0001	DIA **OoR** ON at 0E0F to 0000	0.001 mA
-25.000 %	0	0000	DIA **OoR** ON at 0E0F to 0000	0.000 mA

12-bit-representation (left-justified)

The representation of the 12 bit values is similar to that of the 16 bit values. Only the bits Bit 0-3 are set to "0".

8.6 Analog output module, 2AO current, HART®

This analog input module provides 2 current HART®-outputs.

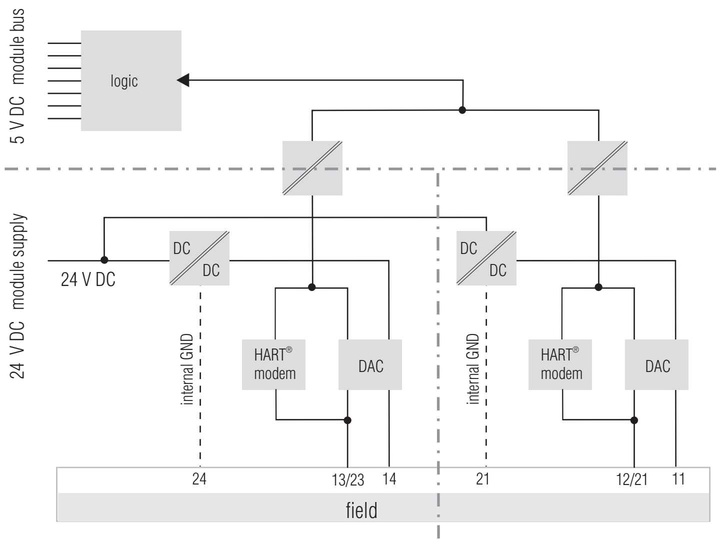
The two channels of the module are galvanically isolated. Additionally, the modules provides galvanic isolation between field level and module bus connection.

Note

For PROFIBUS:
The BL20-2AOH-I can only be used with the BL20-DPV1-gateways (BL20-GW-DPV1, BL20-E-GW-DP)!

Figure 8-16:
BL20-2AOH-I

Figure 8-17:
Block diagram



8.6.1 Technical data

Table 8-15: Technical data

Designation	BL20-2AOH-I
Number of channels	2
Nominal voltage from supply terminal U_L	24 V DC (18 to 30 V DC)
Nominal current from supply terminal I_L	
no signal output	< 20 mA
with signal output	< 80 mA
Nominal current from module bus I_{MB}	< 30 mA
Power loss of the module, typical	< 1 W
Output current	0/4 to 20 mA
Burden resistance	
ohmic load R_{LO}	< 600 Ω
inductive load R_{LI}	< 1 mH
Transmission frequency	< 200 Hz
Repeat accuracy	0.1 %
Basic error at 23 °C	0.2 %
Temperature coefficient	≤ 200 ppm/°C from end value
Setting time (maximum)	
ohmic load	0.1 ms
inductive load	0.5 ms
Measurement value representation	16 Bit signed integer, NE 43(PA), extended range

8.6.2 Diagnostic and status messages

Table 8-16: LED-displays

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Diagnostics pending	-
	Red	Module bus communication failure or field voltage U_L not connected	Check if more than two adjoining electronics modules have been pulled. Check the field voltage U_L
	Off	No error messages or diagnostics	–
11/21	Red flashing, 0.5 Hz	Wire break (if parameterized as diagnosis)	
	Red	Invalid value	see diagnostics **Invalid Value**
	Red, 4 Hz both LEDs alternating	Hardware-error	Please change the module.
	Off	Channel ok	
1H/ 2H	Green	HART®-communication ok	The HART®-status is only shown in active HART®-communication. The status-display is either realized acyclically or via polling operation (depending on the parameterization). With acyclical monitoring the information (LED.) is turned off after 1.5 seconds. Further communication retriggers the LED.
	Red flashing, 0.5 Hz	HART®-communication error: – no communication or – high number of CRC-errors	
	Red	HART®-status-flag (if HART®-status polling has been parameterized, see parameter Operation mode Kx)	
	Off	No HART®-communication	

Note

The LEDs 11 and 1H are assigned to channel 1 and the LEDs 21 and 2H to channel 2 of the module.

The module provides the following diagnostic messages per channel:

Byte	B7	B6	B5	B4	B3	B2	B1	B0
	Channel 1							
0	hardw. error	invalid param.	HART® comm. error	HART® status error	value below lower limit	invalid value	wire break	value above upper limit
1	X							
	Channel 2							
2	hardw. error	invalid param.	HART® comm. error	HART® status error	value below lower limit	invalid value	wire break	value above upper limit
3	X							

X = reserved

- **Value above upper limit**

Display of a measurement range exceeding.
→ limit values according to parameterization, from page 8-38.

The allowed output range limits are exceeded.

- **WB**

Display of a wire break in the signal line.

- **Invalid Value**

The output value exceeds the values which the module is able to interpret.

- **Value below lower limit**

Display of a measurement value underflow.
→ limit values according to parameterization, from page 8-38.

The allowed output range limits are exceeded.

- **HART® status-error**

A connected HART®-device set a bit in the HART® status-information ("status - polling").

- **HART®communication error**

The channel does not allow communication with the HART®-device.

- **Invalid Parameter**

Possible sources:

– Setting of a reserved parameter bit
– The substitute value which is set is not within the measurement value range.
E.g. the substitute value is set to 0×8000 and the signal representation is parameterized as standard value representation page 8-38.
→ An interpretation of the value is not possible

Module behavior:

– Output value/substitute value = 0 mA
– The return value of the HART®-variable in the process data is 0×0000 0000.

- "Hardware failure"

HW Error

– Shows common errors of the module hardware. The return value analog value in case of an error is "0"

Note

If an error message from the sensor occurs, the HART®-status is set to "1".

8.6.3 Module parameters (per channel)

The module has 8 bytes of parameters available (2 per channel and 1 per HART®-variable)

Table 8-17: Module parameters

***A**default-settings*

Parameter	Settings
Channel Kx	0 = activate **A** 1 = deactivate
Diagnostics Kx	0 = block 1 = release **A**
HART®-diagnostic Kx	0 = release **A** 1 = block
Operation mode Kx	0 = 0… 20 mA (HART®-status polling *not* possible) 1 = 4…20 mA (HART®-status polling *not* possible) 2 = 4…20 mA HART® active **A** Cyclic polling of the HART®-status is activated.
Value representation Kx	0 = Integer (15 bit + sign) **A** 1 = NE 43 2 = Extended mode
Behavior module bus error Ax	– output substitute value **A** – hold current value
Substitute value Ax	Substitute value = "0" **A** 1. The substitute value defined here is sent in case of events which have been parameterized in the gateway or 2. In case of a module bus failure: the substitute value is only sent if parameter "Behavior module bus error Ax" (see above) is set to "setting output substitute value".

Table 8-17: Module parameters

Parameter	Settings
Mapped channel Vx	Defines the channel from which the HART®-variable is read. 0 = channel 1 1 = channel 2
Mapped variable Vx	Defines which HART®-variable of the connected sensor is mapped into the module's process data 0 = PV (primary variable) 1 = SV (2nd variable) 2 = TV (3rd variable) 3 = QV (4th variable)

Byte		B7	B6	B5	B4	B3	B2	B1	B0
	DP	Channel 1							
0	11	HART®-diag.	X	X	operation mode		X	diag.	channel
1	10	Behavior module bus error		X				value representation	
2	9	substitute value Ax							
3	8								
		Channel 2							
4	7	HART®-diag.	X	X	operation mode		X	diag.	channel
5	6	Behavior module bus error		X				value representation	
6	5	HART®-diag.	X	X	operation mode		X	diag.	channel
7	4	Behavior module bus error		X				value representation	
		HART®-variable A							
5	3	mapped variable		X					mapped channel
		HART®-variable B							
9	2	mapped variable		X					mapped channel
		HART®-variable C							
10	1	mapped variable		X					mapped channel
		HART®-variable D							
11	0	mapped variable		X					mapped channel

X = reserved

8.6.4 Base module

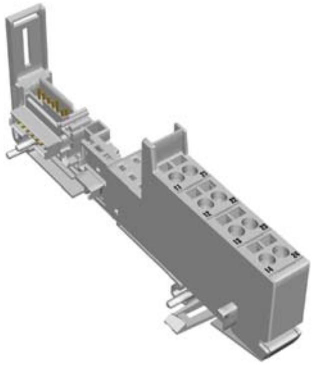


Figure 8-18: Base module BL20-S4T-SBBS

8.6.5 Wiring diagram

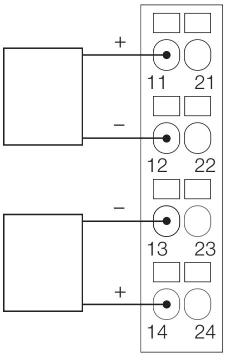


Figure 8-19: Connection options with base module BL20-S4x-SBBS

8.6.6 Process input data

Byte	B7	B6	B5	B4	B3	B2	B1	B0
0	Parameterizable HART®-variable A without unit **A**							
1								
2								
3								
4	Parameterizable HART®-variable B without unit **A**							
5								
6								
7								
8	Parameterizable HART®-variable C without unit **A**							
9								
10								
11								
12	Parameterizable HART®-variable D without unit **A**							
13								
14								
15								

A Representation of HART®-variables without unit according to ANSI/IEEE 754-1985 "Standard for Binary Floating-Point Arithmetic for microprocessor systems".

8.6.7 Process output data

Byte	B7	B6	B5	B4	B3	B2	B1	B0
0	output value for channel 1							
1								
2	output value for channel 2							
3								

8.6.8 Standard value representation, 16-bit-representation)

	dec.	hex.	unipolar	0 ... 20 mA
	dec. value = 1638.35 [1/mA] × current value [mA]			
100.00 %	32767	7FFF	nominal range	20.0000 mA
99.99695 %	32766	7FFE		19.9994 mA
	...	...		...
50.00153 %	16384	4000		10.0003 mA
	...	...		...
0.00305 %	1	0001		0.0006103 mA
0.00000 %	0	0000		0.000000 mA
-0.00305 %	-1	FFFF	DIA **Invalid Value** ON at FFFF to 8000	0.000000 mA
	...	...		...
-50.00000 %	-16384	C000		0.000000 mA
	...	...		...
-99.99695 %	-32767	8001		0.000000 mA
-100.00 %	-32768	8000		0.000000 mA

	dec.	hex.	unipolar	4 ... 20 mA
dec. value = 2047.94 × (current value [mA]- 4 mA)				
100.00 %	32767	7FFF	nominal range	20.0000 mA
99.99695 %	32766	7FFE		19.9995 mA
	...	...		...
50.00153 %	16384	4000		12.00024 mA
	...	...		...
0.00305 %	1	0001		4.0004883 mA
0.00000 %	0	0000		4.000000 mA
-0.00305 %	-1	FFFF	DIA **Invalid Value** ON at FFFF to 8000	4.000000 mA
	...	...		...
-50.00000 %	-16384	C000		4.000000 mA
	...	...		..
-99.99695 %	-32767	8001		4.000000 mA
-100.00 %	-32768	8000		4.000000 mA

8.6.9 Extended Range - value representation, 16-bit-representation

	dec.	hex.	unipolar	0 ... 20 mA
dec. value = 1382.4 [1/mA] × current value [mA]				
118.515 %	32767	7FFF	DIA **Value above upper limit** ON at 7F00 to 7FFF	23.703 mA
118.461 %	32752	7FF0		23.692 mA
117.593 %	32512	7F00		23.5185 mA
117.589 %	32511	7EFF	out of range	23.5178 mA
117.535 %	32496	7EF0		23.507 mA
100.058 %	27664	6C10		20.0116 mA
≥ 100.004 %	27649	6C01		20.0007 mA
100.000 %	27648	6C00	nominal range	20 mA
0.05787 %	16	0010		11.574 µA
0.003617 %	1	0001		0.7234 µA
0.000 %	0	0000		0.0000 mA
-0.00362 %	-1	FFFF	DIA **Invalid Value** ON at FFFF to 8000	0.0000 mA
-0.05787 %	-16	FFF0		0.0000 mA
-25.000 %	-6912	E500		0.0000 mA
-100.000 %	-27648	9400		0.0000 mA
≤ -100.004 %	-27649	93FF		0.0000 mA
-100.058 %	-27664	93F0		0.0000 mA
-117.593 %	-32512	8100		0.0000 mA
-117.596 %	-32513	80FF		0.0000 mA
-118.461 %	-32752	80F0		0.0000 mA
-118.519 %	-32768	8000		0.0000 mA

	dec.	hex.	unipolar	4 ... 20 mA
dec. value = 1728 [1/mA] × (current value [mA] - 4 mA)				
118.515 %	32767	7FFF	DIA **Value above upper limit** ON at 7F00 to 7FFF	22.962 mA
118.461 %	32752	7FF0		22.954 mA
117.593 %	32512	7F00		22.8148 mA
117.589 %	32511	7EFF	out of range	22.8142 mA
117.535 %	32496	7EF0		22.8056 mA
100.058%	27664	6C10		20.0093 mA
≥ 100.004 %	27649	6C01		20.0006 mA
100.000 %	27648	6C00	nominal range	20 mA
0.05787 %	16	0010		4.009259 mA
0.003617 %	1	0001		4.000578 mA
0.000 %	0	0000		4.0000 mA
-0.00362 %	-1	FFFF	out of range	3.99942 mA
-0.05787 %	-16	FFF0		3.99075 mA
-25.000 %	-6912	E500		0.0000 mA
-25.004 %	-6913	E4FF	DIA **Invalid Value** ON at E4FF to 8000	0.0000 mA
-100.000 %	-27648	9400		0.0000 mA
≤ -100.004 %	-27649	93FF		0.0000 mA
-100.058 %	-27664	93F0		0.0000 mA
-117.593 %	-32512	8100		0.0000 mA
-117.596 %	-32513	80FF		0.0000 mA
-118.461 %	-32752	80F0		0.0000 mA
-118.519 %	-32768	8000		0.0000 mA

8.6.10 Value representation process automation (NE 43), 16-bit-representation

The hexadecimal value, transmitted from the module has to be interpreted as decimal value which, multiplied by a certain factor, corresponds to the analog measurement value.

Example:

Process value	
– dec.	15020
– hex.	3AAC
Output current	15.02 mA

	dec.	**hex.**	**unipolar**	**0 ... 20 mA**
dec. Value = 1000 [1/mA] × current value [mA]				
327.675 %	65535	FFFF	DIA **Invalid Value** ON at 55F1 to FFFF	22.000 mA
110. 05 %	22001	55F1		22.000 mA
110.000 %	22000	55F0	DIA **Value above upper limit** ON at 5209 to 7FFF	22.000 mA
105.005 %	21001	5209		21.001 mA
105.00 %	21000	5208	out of range	21.000 mA
100.005 %	20001	4E21		20.001 mA
100.000 %	20000	4E20	nominal range	20.000 mA
40.00 %	8000	1F40		8.000 mA
20.00 %	4000	0FA0		4.000 mA
0.01 %	2	0002		0.002 mA
0.005 %	1	0001		0.001 mA
0.000 %	0	0000		0.000 mA

	dec.	hex.	unipolar	4 ... 20 mA
dec. value = 1000 [1/mA] × current value [mA]				
384.594 %	65535	FFFF	DIA **Invalid Value** ON at 55F1 to FFFF	22.000 mA
112. 506 %	22001	55F1		22.001 mA
112.500 %	22000	55F0	DIA **Value above upper limit** ON at 5209 to FFFF	22.000 mA
106.256 %	21001	5209		21.001 mA
106.250 %	21000	5208	out of range	21.000 mA
100.006 %	20001	4E21		20.001 mA
100.000 %	20000	4E20	nominal range	20.000 mA
25.000 %	8000	1F40		8.000 mA
0.000 %	4000	0FA0		4.000 mA
≤ -0.006 %	≤ 3999	0F9F	out of range	3.999 mA
-1.250 %	3800	0ED8		3.800 mA
-2.500 %	3600	0E10		3.600 mA
-2.506 %	3599	0E0F	DIA **Value below lower limit** ON at 0E0F to 0000	3.599 mA
-12.506 %	2000	07D0		2.000 mA
-12.505 %	< 1999	07CF		1.999 mA
-24.994 %	1	0001		0.001 mA
-25.000 %	0	0000		0.000 mA

9 Relay modules

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9.1 General

BL20 relay modules (R) receive output values from the gateway via the internal module bus. The modules convert these values and transmit the corresponding circuit state for each channel to the field level via the base modules.

Relay modules are suitable for solenoid valves, DC contactors and signal lamps in the nominal-load voltage range 24 V DC / V AC to 230 V AC.

Relay modules have a reverse polarity protection and are potentially isolated from the power supply.

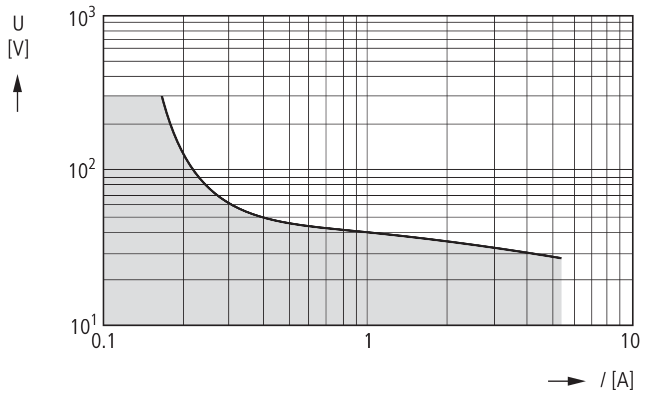
LED status indicators

Error signals from the I/O level are indicated by each module via the "DIA" LED. The corresponding diagnostic information is transmitted to the gateway. If the "DIA" LED lights up continuously red, it signals the failure of the module bus communication of the relay modules.

9.1.1 Load limit curve with resistive load

At 1 000 switching cycles, no sustained arcs with a burning life > 10 ms may occur.

Figure 9-1: Definition of load limit curve



Note

If possible, modules with standard module description should not be used with relay modules. Mistakenly exchanged relay modules (changeover, normally closed, normally open) can cause a short-circuit which could destroy the module.

Attention

An external suppressor should be planned for inductive loads

9.1.2 Module overview

Table 9-1: Overview relay modules

BL20-2DO-R-NC	normally closed contacts
BL20-2DO-R-NO	normally open contacts
BL20-2DO-R-CO	change over contacts

9.2 Relay module, 2 normally-closed contacts

Figure 9-2: BL20-2DO-R-NC

Figure 9-3: Block diagram with base module BL20-S4x-SBBS

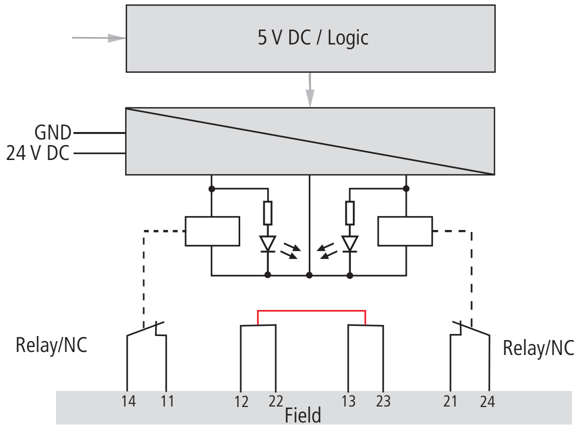
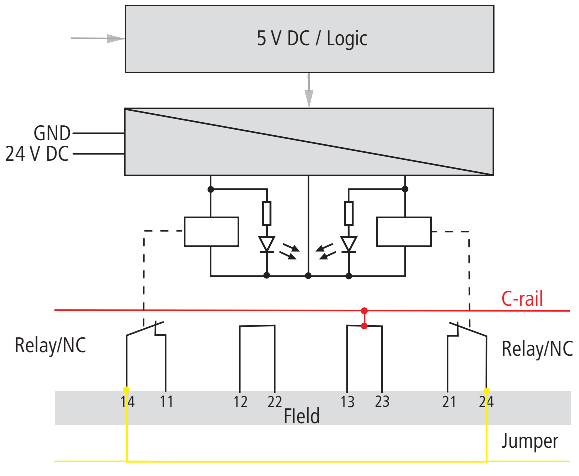


Figure 9-4: Block diagram with base module BL20-S4x-SBCS



9.2.1 Technical data

Table 9-2: Technical data

Designation	BL20-2DO-R-NC
Number of channels	2, normally-closed contact
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 20 mA
Nominal current from module bus I_{MB}	≤ 28mA
Power loss of the module, typical	< 1 W
Resistive, inductive and lamp loads can be connected	
Application category as per AC15 / DC13	
Switching voltage (to supply the actuators)	
Nominal load voltage	230 V AC/30 V DC
Switching current (to supply the actuators)	10 mA at ≥ 12 V DC
Current for DC (purely resistive)	Load limit curve: → page 9-2
Nominal current (DC13) 24 V DC	1 A
Nominal current (AC15) 250 V AC	3 A
Minimum load current (≥ 12 V DC)	100 mA
Synchronization factor	100 %
Current and number of switching operations (operational life): (AC15) 250 V AC	1 x 10^5 at 2 A
	2 x 10^5 at 1 A
	4 x 10^5 at 0.5 A
Current and number of switching operations (operationallife): (DC13) 24 V DC	2 x 10^5 at 1 A
	> 5 x 10^5 at 0.5 A
Switching frequency	
Resistive load	< 0.1 Hz
Inductive load	< 0.1 Hz
Lamp load	< 0.1 Hz
Isolation voltage	
relay output to relay output	no
relay output to module bus	1.5 kV_{eff}
relay output to field voltage cable	1.5 kV_{eff}
module bus to field voltage cable	500 V_{eff}

9.2.2 Diagnostic and status messages

Table 9-3: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	

9.2.3 Module parameters

none

9.2.4 Base modules

Figure 9-5: Base module BL20-S4T-SBBS

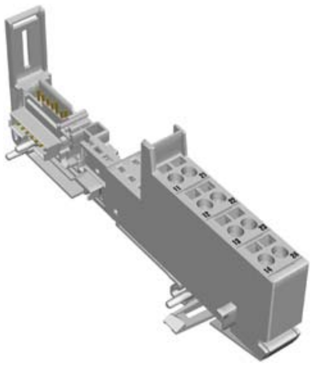
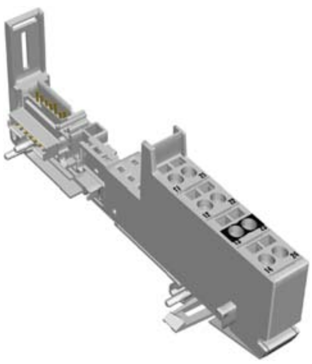


Figure 9-6: Base module BL20-S4T-SBCS



- with tension clamp connection
  BL20-S4T-SBBS
  BL20-S4T-SBCS

- with screw connection
  BL20-S4S-SBBS
  BL20-S4S-SBCS

9.2.5 Wiring diagrams

1. The potential free contacts 11 and 14 or 21 and 24 can be used directly.
2. In addition to that, the following wiring diagrams show different possibilities for a common power supply of the connected loads.

Figure 9-7: Wiring diagram BL20-S4x-SBBS

With externally connected supply and cross-connected root:

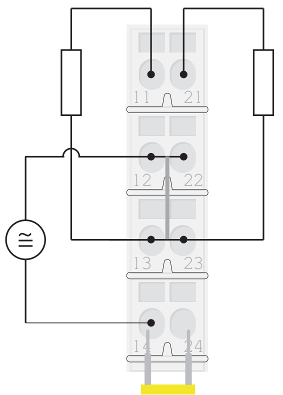
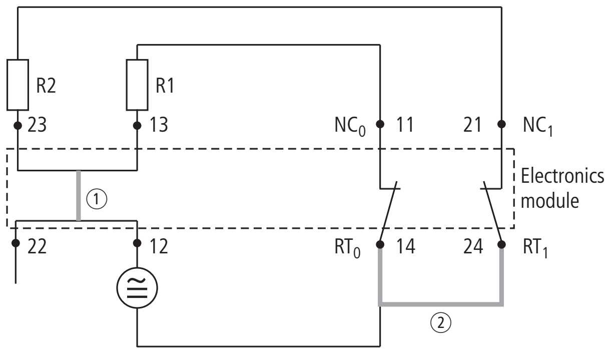


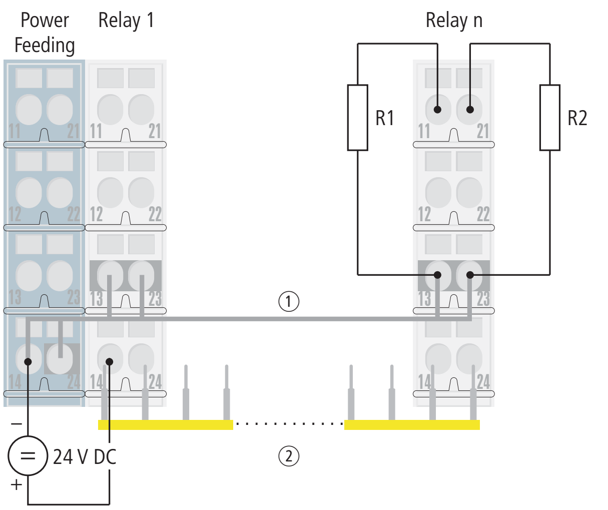
Figure 9-8: Module circuit diagram BL20-S4x-SBBS



① Bridged in the electronics
② Cross-connection via jumper in the base module

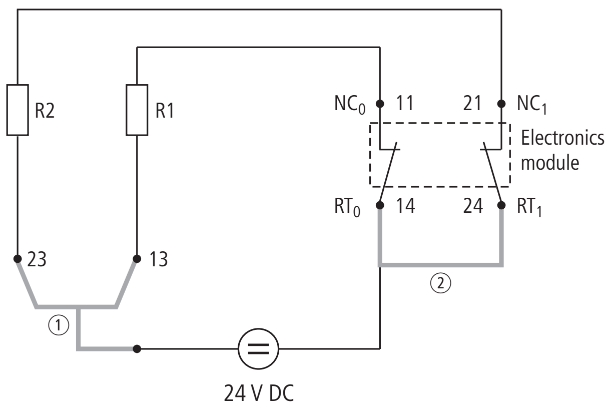
Figure 9-9: Wiring diagram BL20-S4x-SBCS

With supply via C-rail and cross-connected root:



① Supply via C-rail
② max. 8 relay modules

Figure 9-10: Module circuit diagram BL20-S4x-SBCS



① C-rail
②Cross-connection via jumper in the base module

Danger
It is permitted to load the C-rail with a maximum of 24 V. Not 230 V!

Note
Contact designations used for base modules are not designations of relay contacts according to DIN.

9.3 Relay module, 2 normally-open contacts

Figure 9-11: BL20-2DO-R-NO

Figure 9-12: Block diagram with base module BL20-S4x-SBBS

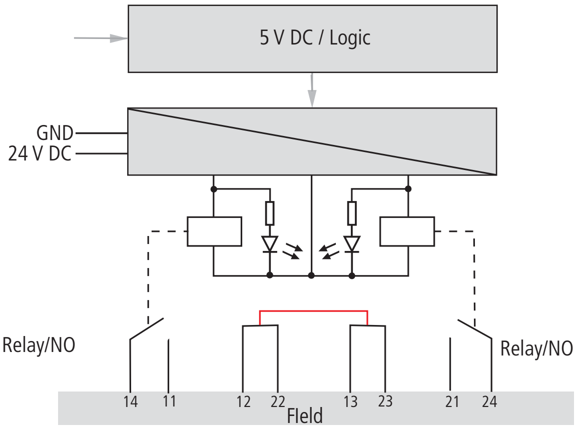
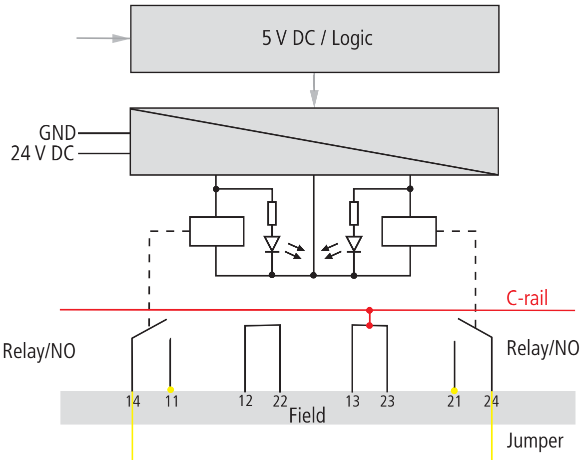


Figure 9-13: Block diagram with base module BL20-S4x-SBCS



9.3.1 Technical data

Table 9-4: Technical data

Designation	BL20-2DO-R-NO
Number of channels	2, normally-open contact
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 20 mA
Nominal current from module bus I_{MB}	≤ 28mA
Power loss of the module, typical	< 1 W
Resistive, inductive and lamp loads can be connected	
Application category as per AC15 / DC13	
Switching voltage (to supply the actuators)	
Nominal load voltage	230 V AC/30 V DC
Switching current (to supply the actuators)	10 mA at ≥ 12 V DC
Current for DC (purely resistive)	Load limit curve: → page 9-2
Nominal current (DC13) 24 V DC	1 A
Nominal current (AC15) 250 V AC	3 A
Minimum load current (≥ 12 V DC)	100 mA
Synchronization factor	100 %
Current and number of switching operations (operational life): (AC15) 250 V AC	1 x 10^5 at 2 A
	2 x 10^5 at 1 A
	4 x 10^5 at 0.5 A
Current and number of switching operations (operationallife): (DC13) 24 V DC	2 x 10^5 at 1 A
	> 5 x 10^5 at 0.5 A
Switching frequency	
Resistive load	< 0.1 Hz
Inductive load	< 0.1 Hz
Lamp load	< 0.1 Hz
Isolation voltage	
relay output to relay output	no
relay output to module bus	1.5 kV_{eff}
relay output to field voltage cable	1.5 kV_{eff}
module bus to field voltage cable	500 V_{eff}

9.3.2 Diagnostic and status messages

Table 9-5: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	

9.3.3 Module parameters

none

9.3.4 Base modules

Figure 9-14: Base module BL20-S4T-SBBS

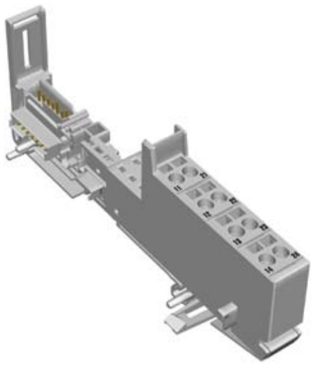
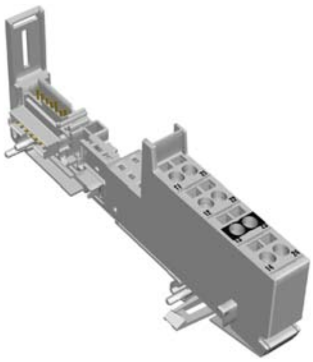


Figure 9-15: Base module BL20-S4T-SBCS



- with tension clamp connection
  BL20-S4T-SBBS
  BL20-S4T-SBCS

- with screw connection
  BL20-S4S-SBBS
  BL20-S4S-SBCS

Wiring diagrams

1. The potential free contacts 11 and 14 or 21 and 24 can be used directly.
2. In addition to that, the following wiring diagrams show different possibilities for a common power supply of the connected loads.

Figure 9-16: Wiring diagram BL20-S4x-SBBS

With externally connected supply and cross-connected root:

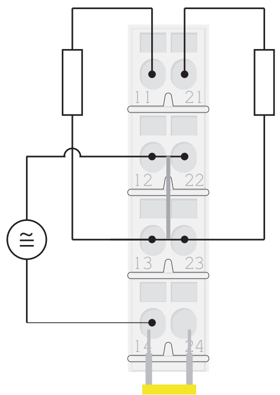
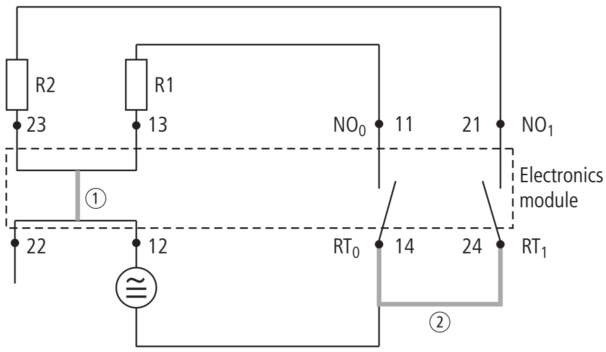


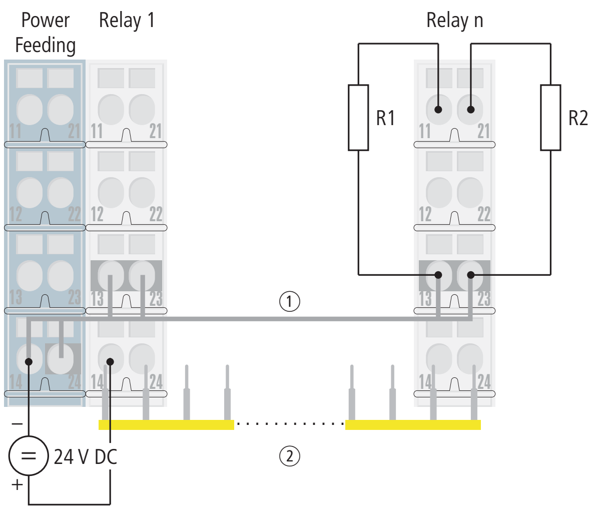
Figure 9-17: Module circuit diagram BL20-S4x-SBBS



① Bridged in the electronics
② Cross-connection via jumper in the base module

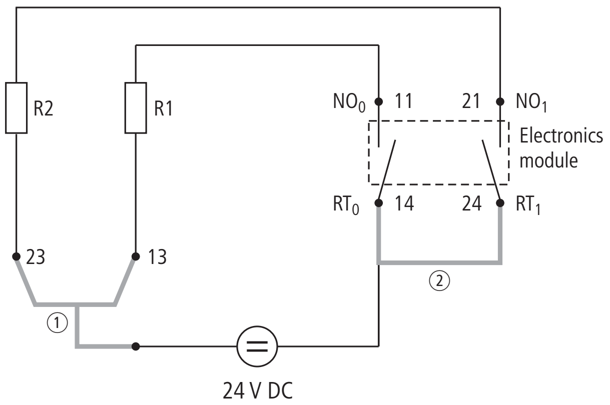
Figure 9-18: Wiring diagram BL20-S4x-SBCS

With supply via C-rail and cross-connected root:



① Supply via C-rail
② max. 8 relay modules

Figure 9-19: Module circuit diagram BL20-S4x-SBCS



① C-rail
② Cross-connection via jumper in the base module

Danger
It is permitted to load the C-rail with a maximum of 24 V. Not 230 V!

Note
Contact designations used for base modules are not designations of relay contacts according to DIN.

9.4 Relay module, 2 changeover contacts

Figure 9-20: BL20-2DO-R-CO

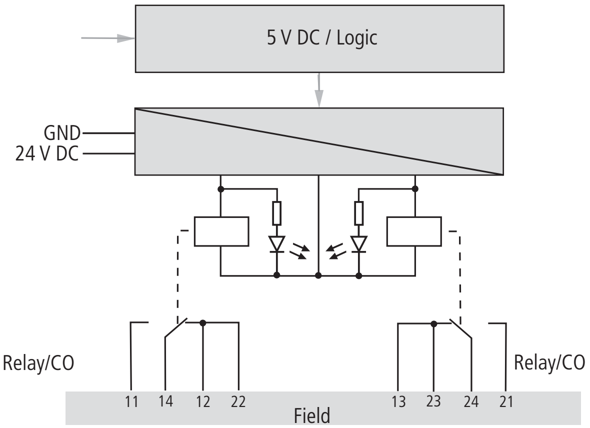


Figure 9-21: Block diagram with base module BL20-S4×-SBBS

9.4.1 Technical data

Table 9-6: Technical data

Designation	BL20-2DO-R-CO
Number of channels	2, changeover
Nominal voltage from supply terminal U_L	24 V DC
Nominal current from supply terminal I_L	< 20 mA
Nominal current from module bus I_{MB}	≤ 28mA
Power loss of the module, typical	< 1 W
Resistive, inductive and lamp loads can be connected	
Application category as per AC15 / DC13	
Switching voltage (to supply the actuators)	
Nominal load voltage	230 V AC/30 V DC
Switching current (to supply the actuators)	10 mA at ≥ 12 V DC
Current for DC (purely resistive)	Load limit curve: → page 9-2
Nominal current (DC13) 24 V DC	1 A

Nominal current (AC15) 250 V AC	3 A
Minimum load current (≥ 12 V DC)	100 mA
Synchronization factor	100 %
Current and number of switching operations (operational life): (AC15) 250 V AC	1 x 10^5 at 2 A
	2 x 10^5 at 1 A
	4 x 10^5 at 0.5 A
Current and number of switching operations (operationallife): (DC13) 24 V DC	2 x 10^5 at 1 A
	> 5 x 10^5 at 0.5 A
Switching frequency	
Resistive load	< 0.1 Hz
Inductive load	< 0.1 Hz
Lamp load	< 0.1 Hz
Isolation voltage	
relay output to relay output	no
relay output to module bus	1.5 kV_{eff}
relay output to field voltage cable	1.5 kV_{eff}
module bus to field voltage cable	500 V_{eff}

9.4.2 Diagnostic and status messages

Table 9-7: LED indicators

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
11	Green	Status of channel 1 = "1"	
	Off	Status of channel 1 = "0"	
21	Green	Status of channel 2 = "1"	
	Off	Status of channel 2 = "0"	

9.4.3 Module parameters

none

9.4.4 Base modules

Figure 9-22: Base module BL20-S4T-SBBS

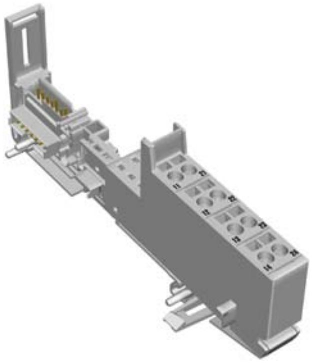
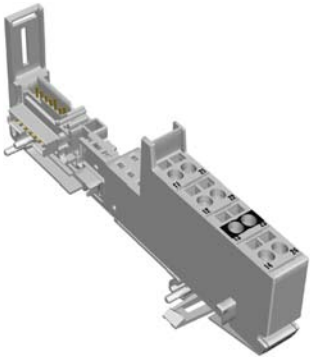


Figure 9-23: Base module BL20-S4T-SBCS



- with tension clamp connection
  BL20-S4T-SBBS
- with screw connection
  BL20-S4S-SBBS

9.4.5 Wiring diagrams

1 The potential free contacts 11/12 and 14 or 21/23 and 24 can be used directly.

2 In addition to that, the following wiring diagram shows the possibility for a common power supply of the connected loads.

Figure 9-24: Wiring diagram BL20-S4x-SBBS

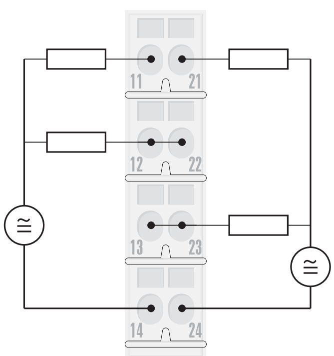
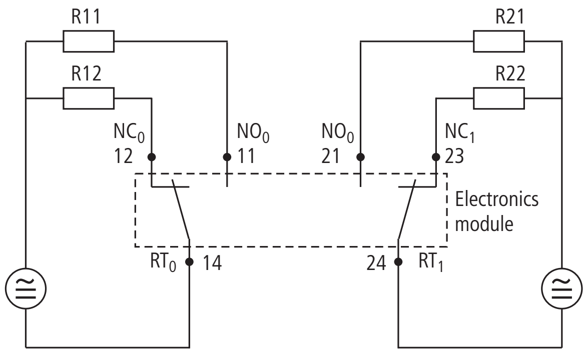


Figure 9-25: Module circuit diagram BL20-S4x-SBBS



Note

Contact designations used for base modules are not designations of relay contacts according to DIN.

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10.1 Module BL20-1CNT-24VDC

The BL20 counter module offers the connection of a pulse generator for measuring 24 V DC signals (11 to 30 V DC), up to a frequency of 200 kHz.

Moreover, the module provides the sensor with 24 V DC.

The electronics module supports the following operating modes:

Counter modes:

- Continuous count
- Single-action count
- Periodical count

Measurement modes:

- Frequency measurement
- Revolutions measurement
- Period duration measurement

Each of the operating modes have individual parameters assigned to them. The relevant parameter lists are specified in more detail in the descriptions of the integration in the fieldbus systems.

The counter module is provided with a digital output that is used for direct control of the process or for indicating comparison results.

The digital input of the counter module is used for initiating the hardware release signal, the synchronization or latch and retrigger function.

The BL20 counter module can process signals generated from the following sensors:

- 24 V DC pulse generator with direction signal
- 24 V DC pulse generator without direction signal
- 24 V DC pulse generator with two 90° offset channels (rotary sensor)

10.1.1 Selecting counter or measurement mode

Profibus-DP:

The GSD file provides 2 module codes the BL20-1CNT-24VDC modules. For count mode select modules with code C For measurement mode select modules with code M.

DeviceNet:

The attribute no. 113 must be written first and determines the operating mode.The write operation to attribute no. 113 resets all other attributes to the default values!

CANopen:

Object 5800hex controls the operating mode parameters of the BL20 counter module. Its uses include the setting of count mode or measurement mode.

10.1.2 Counter modes

The count modes are used for supporting different counter applications such as the counting of bulk goods.

The following modes can be selected:

- Continuous counting, such as for positioning with 24 V DC incremental sensors
- Single-action counting, such as for counting units up to a maximum limit
- Periodical count, such as in applications with recurring count operations

Maximum count range

- The upper count limit is +2147483647 (2^{31}-1)
- The lower count limit is -2147483648 (-2^{31})

10.1.3 Main count direction

The main count direction determines the behavior of the counter when the set count limit is reached. On reaching a count limit, the count value "jumps" to a defined value. Three different values are possible:

- Lower limit
- Upper limit
- Load value

The following table shows which of the three values the counter accepts according to the main count direction set and the operating mode:

Table 10-1: Main count direction

A *Values assumed after reaching the counter limits, depending on the operating mode and the main count direction.*

Operating mode			
	Main count direction	**Upper count limit**	**Lower count limit**
Continuous count			
	None	Jump to lower limit	Jump to upper limit
	Up counting	Jump to lower limit	Jump to upper limit
	Down counting	Jump to lower limit	Jump to upper limit
Single-action count			
	None	Jump to lower limit	Jump to upper limit
	Up counting	Jump to load value	Jump to upper limit
	Down counting	Jump to lower limit	Jump to load value
Periodical count			
	None	Jump to load value	Jump to load value
	Up counting	Jump to load value	Jump to upper limit
	Down counting	Jump to lower limit	Jump to load value

Reset states with main count direction set for none/up counting

- Load value: 0
- Count value: 0
- Reference value DO1: 0
- Reference value DO2: 0

Reset states with main count direction set for none/down counting

- Load value: upper limit
- Count value: upper limit
- Reference value 1: upper limit
- Reference value 2: upper limit

10.1.4 Limit values of count mode

Specific conditions must be fulfilled in order to ensure that internal and external events are processed correctly. The following sections describe the limit values for both types of events.

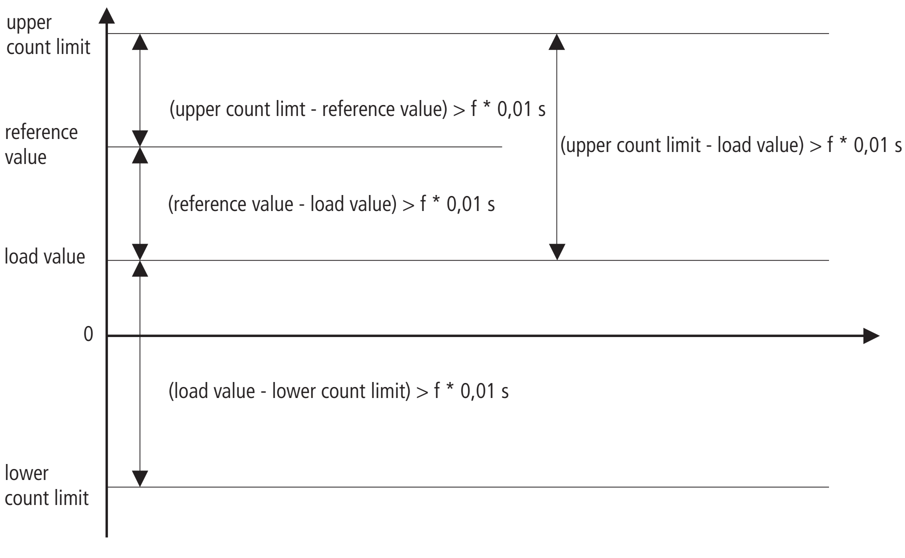
Minimum number of count pulses between internal events

A certain minimum number of count pulses must be ensured between the parameters when setting Upper count limit, Reference value and Lower limit value.

This ensures that internal operations are carried out before a new event occurs.

Illustration of the minimum number of count pulses between two events in relation to the counter frequency:

Table 10-2: Limit values of count mode



f = Counter frequency in Hz

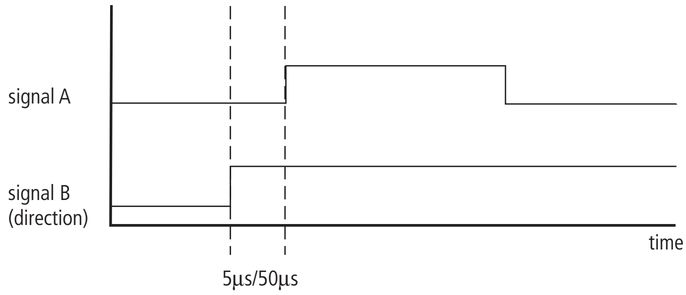
Table 10-3: Minimum number of count pulses

Counter frequency	Minimum number of count pulses between two events
200 kHz	2000 pulses
100 kHz	1000 pulses
50 kHz	500 pulses
10 kHz	100 pulses
1 kHz	10 pulses

Time between direction signal (B) and counter signal (A)

On pulse generators with a direction signal, it must be ensured that there is a gap of at least 5 µs/50 µs between the direction signal (B) and the counter signal (A), depending on the input filter configured.

Figure 10-1: Time gap between the direction signal and the counter signal



Continuous counting

Definition

In this mode the counter module counts after the release signal from the load value continuously between the upper and lower limit.

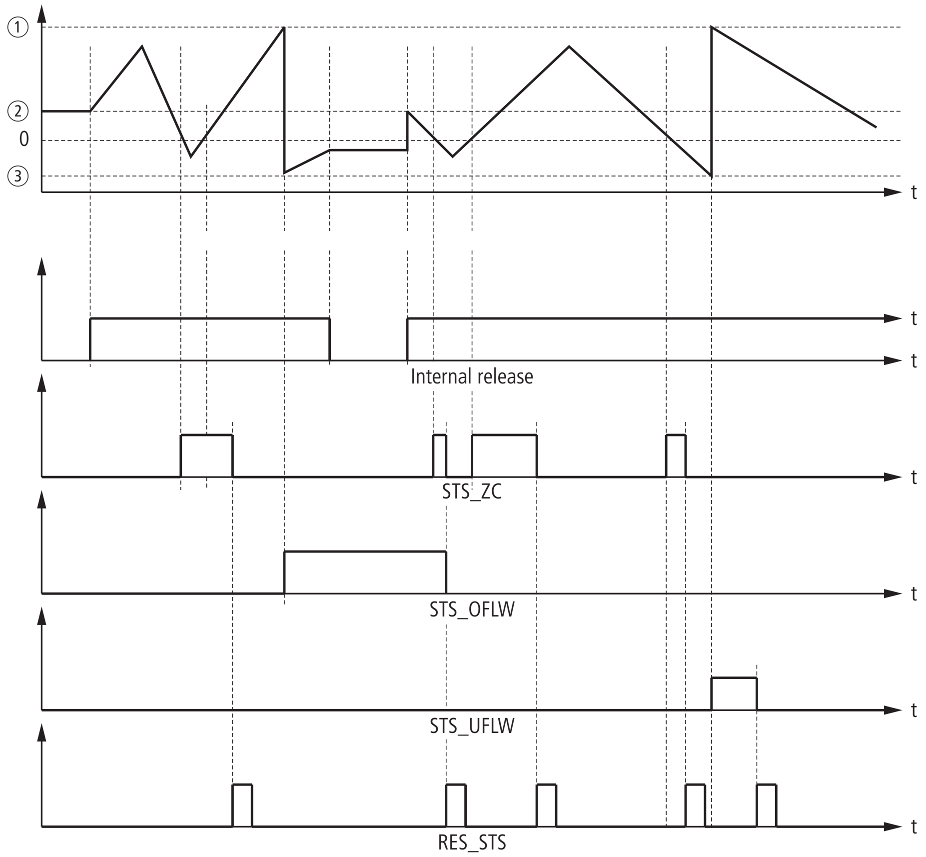
- If the counter counts up and reaches the upper count limit, it will jump to the lower count limit when another counter signal is received, and will continue to count without signal loss from this point.
- If the counter counts down and reaches the lower count limit, it will jump to the upper count limit when another counter signal is received, and will continue to count without signal loss from this point.
- In this mode the function does not depend on the main count direction.

These settings are illustrated in the following diagram:

- Operating mode: Continuous count

- Main count direction: none, up or down

Figure 10-2: Continuous counting with status bit



① Upper count limit

② Load value

③ Lower count limit

Single-action count

Definition

In this mode the counter module runs a single-action count after the release signal from the load value to the upper or lower limit value, depending on the main count direction set.

1 No main count direction

- If the counter counts up and reaches the upper count limit, it will jump to the lower count limit when another counter signal is received. The internal release signal is automatically reset.
- If the counter counts down and reaches the lower count limit, it will jump to the upper count limit when another counter signal is received. The internal release signal is automatically reset.

2 Main count direction up

- If the counter counts up and reaches the upper count limit, it will jump to the load value when another counter signal is received. The internal release signal is automatically reset.
- If the counter counts down and reaches the lower count limit, it will jump to the upper count limit when another counter signal is received. The internal release signal is automatically reset.

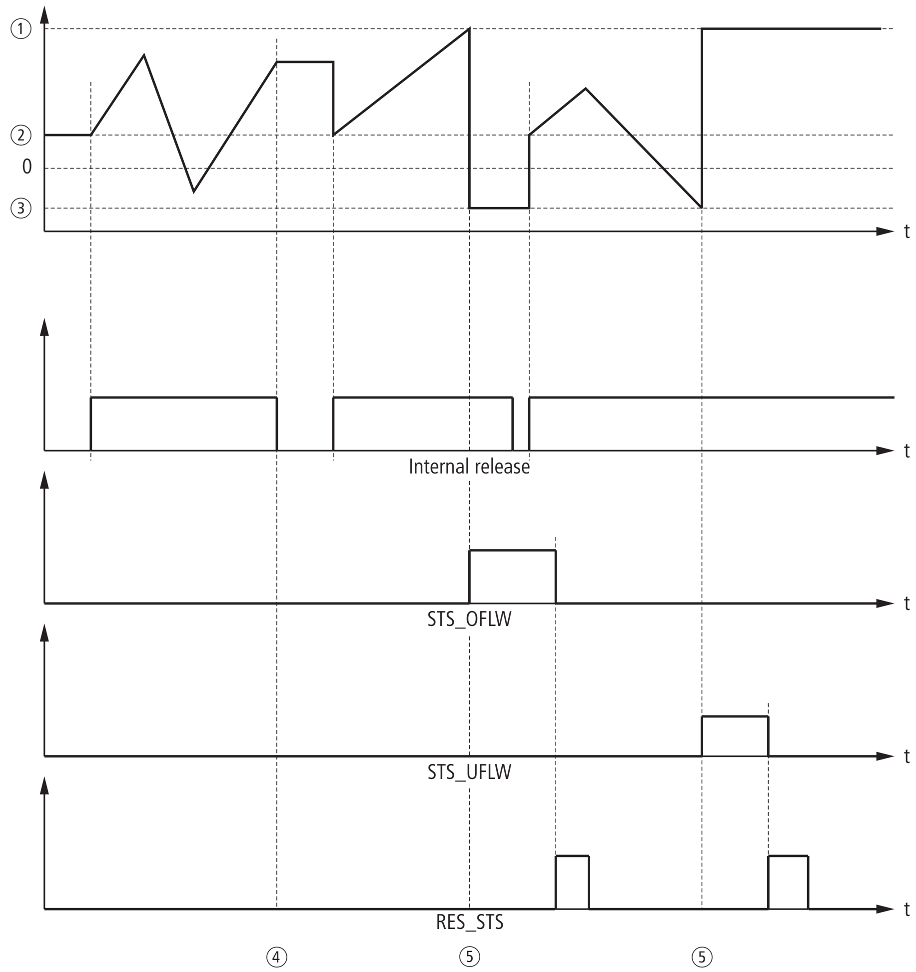
3 Main count direction down

- If the counter counts up and reaches the upper count limit, it will jump to the lower count limit when another counter signal is received. The internal release signal is automatically reset.
- If the counter counts down and reaches the lower count limit, it will jump to the load value when another counter signal is received. The internal release signal is automatically reset.

The internal release signal is automatically reset if the counter passes either the upper or lower limit values. A rising edge must be present in order for counting to be restarted. This occurs either by resetting and setting the hardware release signal (digital input if this is configured as HW gate), or by resetting and setting the software release (SW_GATE bit in the control interface/process output).

The following three diagrams show the counter's behavior in "single-action count" mode with the three main count directions: none, up, down.

Figure 10-3: Single-action count without main count direction



① Upper count limit

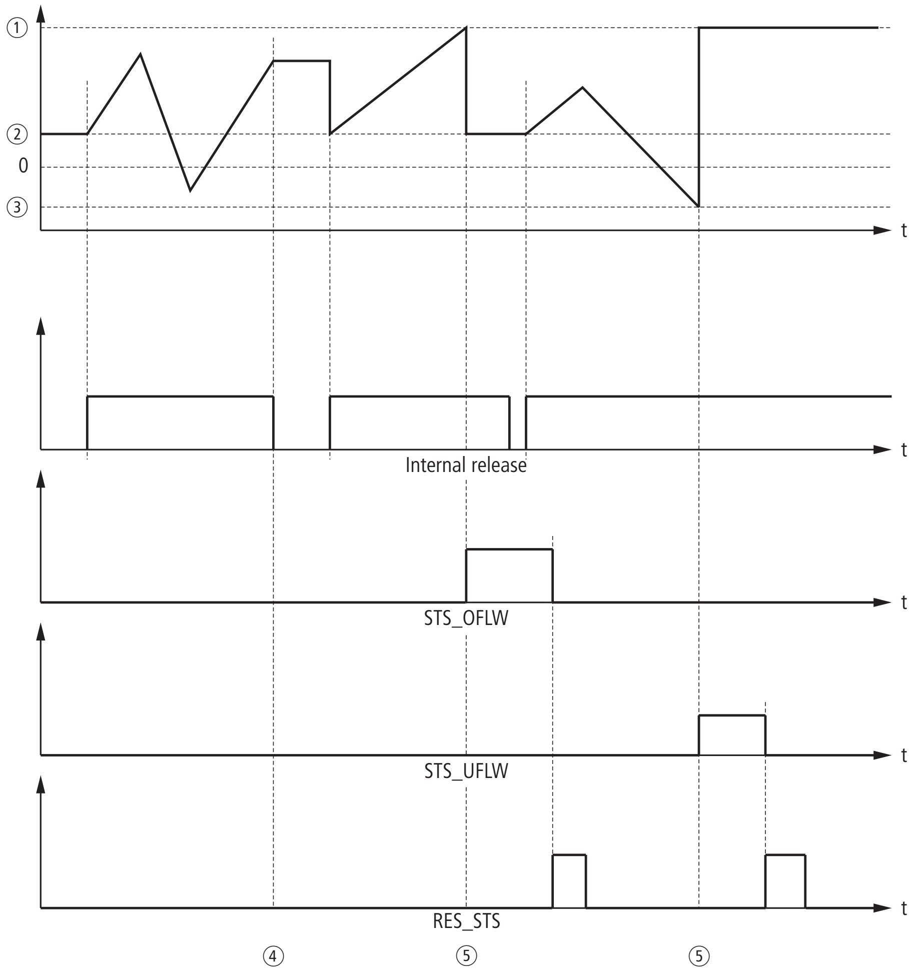
② Load value

③ Lower count limit

④ Release stop, internal release

⑤ Release stop, automatic

Figure 10-4: Single-action counting with main count direction up



① Upper count limit

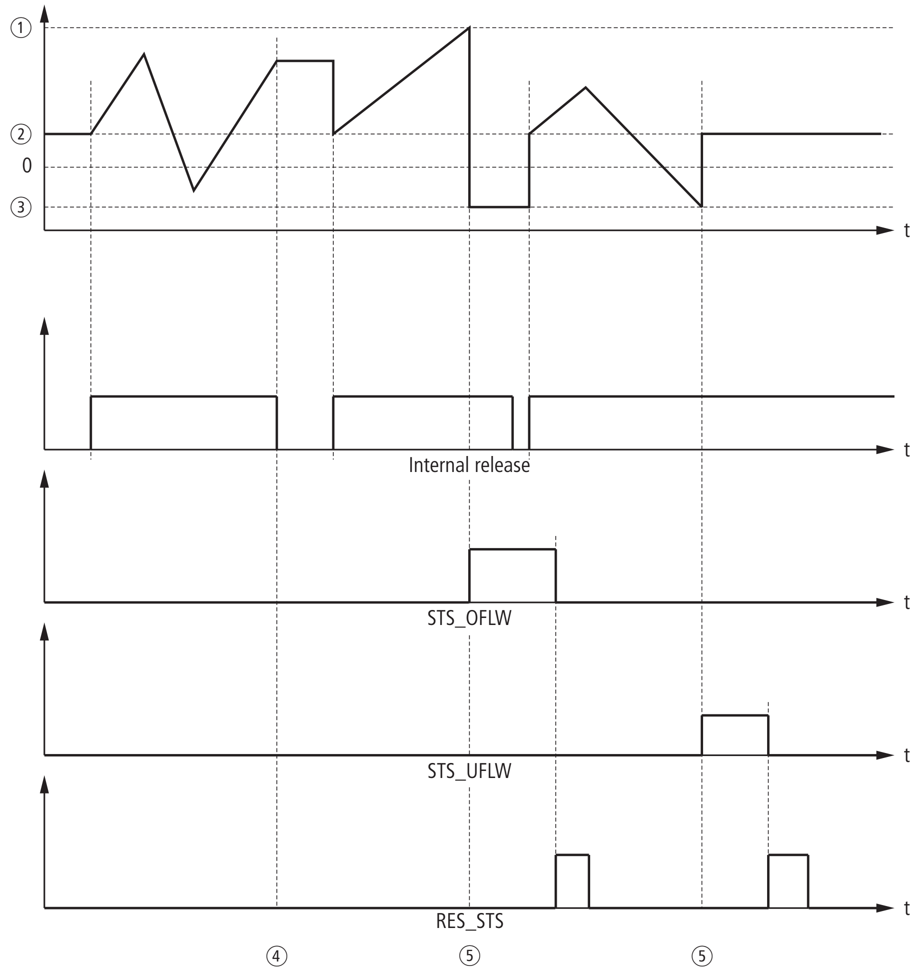
② Load value

③ Lower count limit

④ Release stop, internal release

⑤ Release stop, automatic

Figure 10-5: Single-action counting with main count direction down



① Upper count limit

② Load value

③ Lower count limit

④ Release stop, internal release

⑤ Release stop, automatic

Periodical count

Definition

In this operating mode the electronic module counts periodically after the release signal is set within the defined counter range and in the defined main count direction:

1 No main count direction

- If the counter counts up and reaches the upper or lower count limit, it will jump to the load value when another counter signal is received, and will continue to count from there without losing a signal.

2 Main count direction up

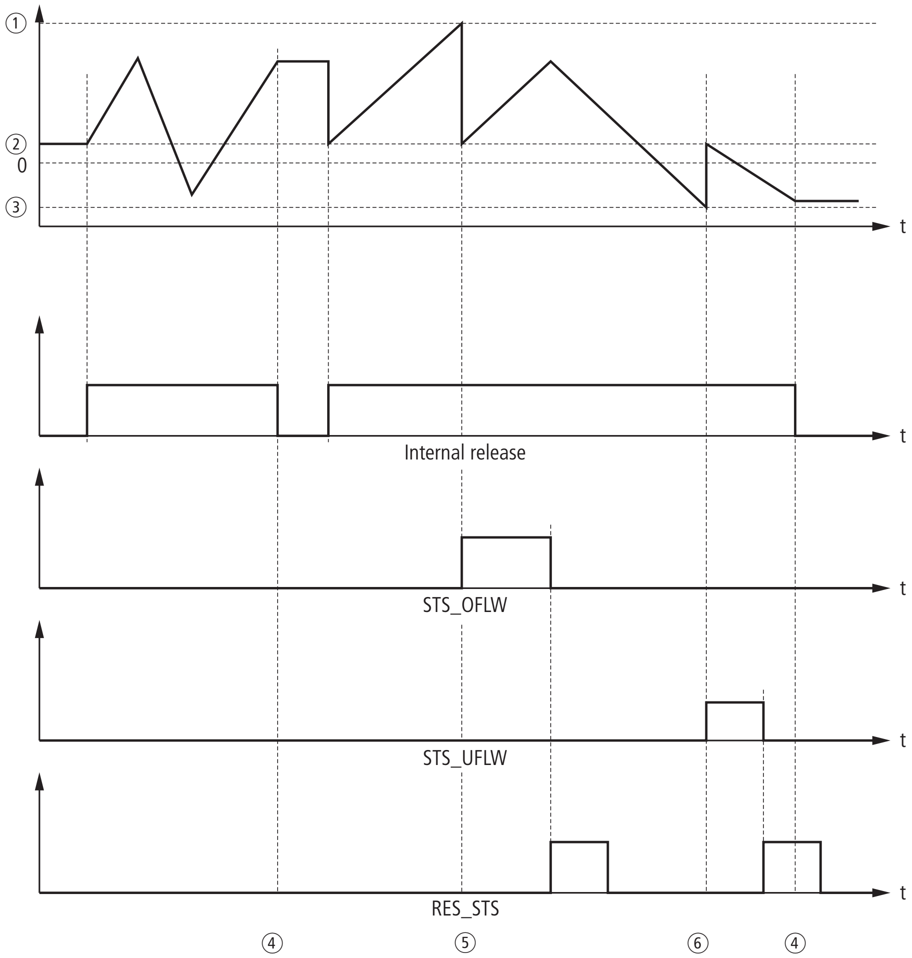
- If the counter counts up and reaches the upper count limit, it will jump to the load value when another counter signal is received, and will continue to count from there without losing a signal.
- If the counter counts down and reaches the lower count limit, it will jump to the upper count limit when another counter signal is received, and will continue to count from there.

3 Main count direction down

- If the counter counts up and reaches the upper count limit, it will jump to the lower count limit when another counter signal is received, and will continue to count from there.
- If the counter counts down and reaches the lower count limit, it will jump to the lower count limit when another counter signal is received, and will continue to count from there.

The following three diagrams show the counter's behavior in "periodical count" mode with the three main count directions: none, up, down.

Figure 10-6: Periodical count without main count direction



① Upper count limit

② Load value

③ Lower count limit

④ Release stop, internal release

⑤ Overflow

⑥ Underflow

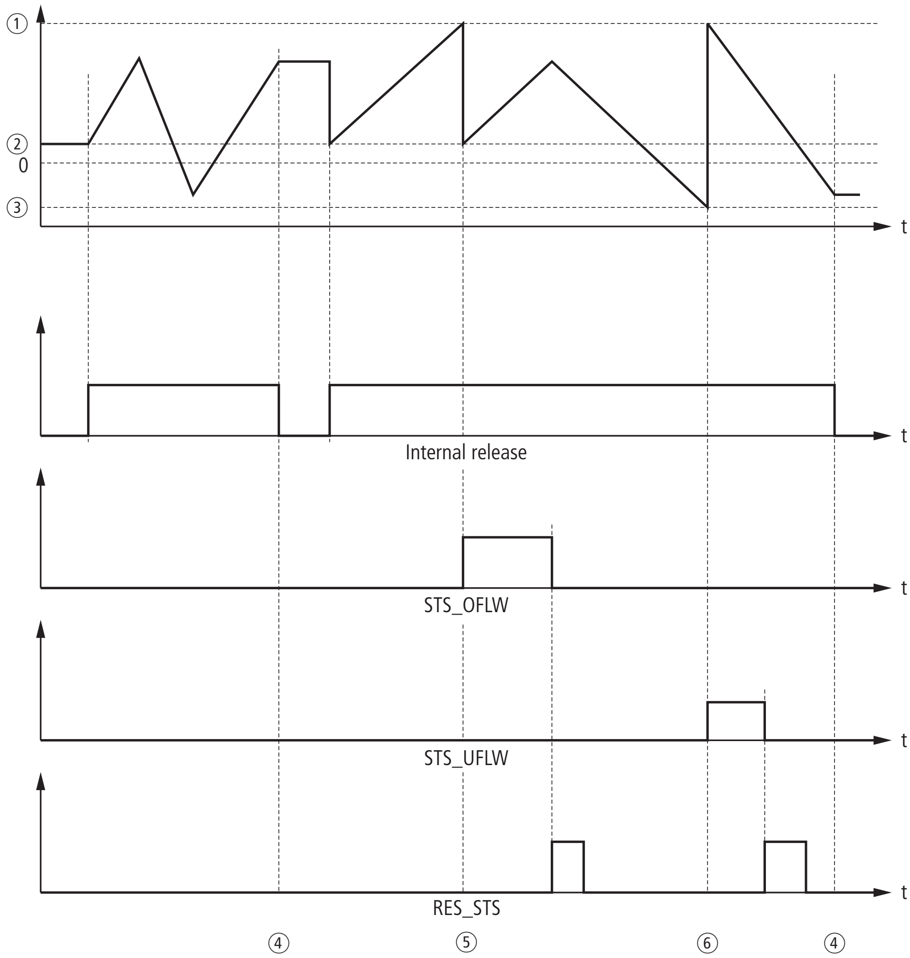


Figure 10-7: Periodical count with main count direction up

① Upper count limit

② Load value

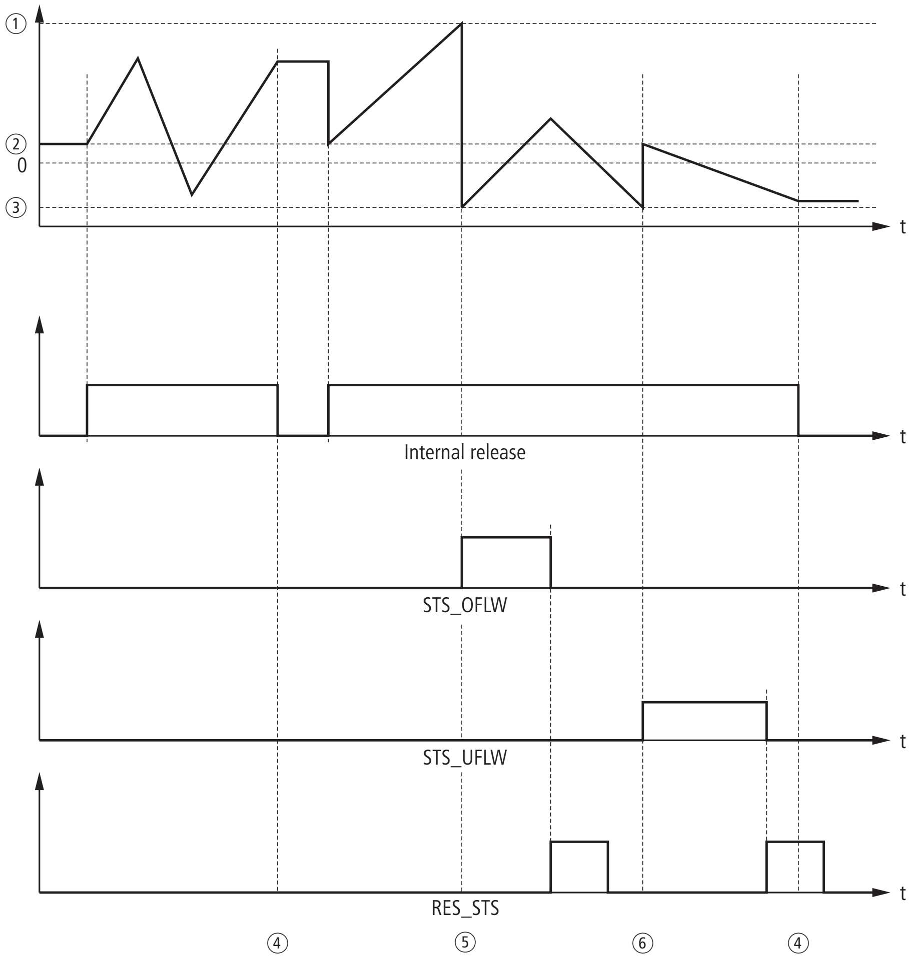
③ Lower count limit

④ Release stop, manual

⑤ Overflow

⑥ Underflow

Figure 10-8: Periodical count with main count direction down



① Upper count limit

② Load value

③ Lower count limit

④ Release stop, manual

⑤ Overflow

⑥ Underflow

10.1.5 Measurement mode

Measuring procedure

The measuring operation is started by setting the internal software release signal, or by setting the hardware and software release signal if the digital input is configured as a hardware release.

Measuring is carried out within a definable integration time that can be adjusted via the control interface/process output. The measured value is then updated.

After the integration time has elapsed, STS_MVAL indicates that an actual measured value is present. This bit must be reset via the RES_STS status bit in the control interface.

Frequency measurement

Definition

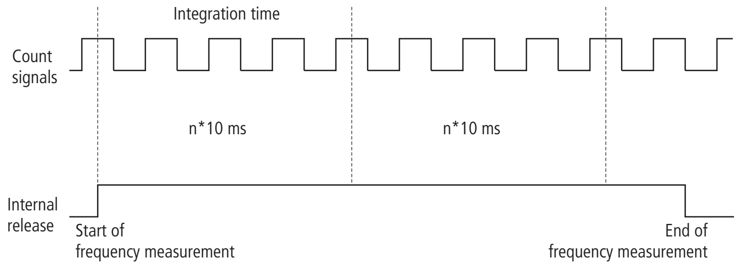
In this operating mode the module counts the pulses received within a specified integration time.

The integration time can be set by a parameter or via the control interface/process output during operation. It can be set in 10 ms increments to between 10 ms and 10 s.

The value of the frequency determined is made available as a 10^{-3} Hz value. You can read the measured frequency value in the check-back interface/process input.

The displayed value cannot be updated until the integration time has elapsed.

Figure 10-9: Frequency measurement with release function



Limit value monitoring

The limit values can be configured and defined at a later time via the control interface/process output. The following limit value ranges are possible:

Range defined by parameters
→ The value range is restricted by the 3 byte parameter length

- Lower limit n_u is 0 to 16 777 214 × 10^{-3} Hz
- Upper limit n_o is 1 to 16 777 215 × 10^{-3} Hz

The upper limit must be greater than the lower limit. The diagnostics messages Upper limit wrong and Lower limit wrong indicate parameter definitions that are outside of the permissible value range. The diagnostics messages are cleared when valid parameters are entered.

Range defined via the control interface/process output

(LOAD_UPLIMIT/LOAD_LOLIMIT)

- Lower limit n_u is 0 to 199 999 999 × 10^{-3} Hz
- Upper limit n_o is 1 to 200 000 000 × 10^{-3} Hz

The upper limit must be greater than the lower limit. An error is indicated by the ERR_LOAD status bit via the check-back interface/process input. The status bit is cleared when a valid value is entered.

Table 10-4: Possible measuring ranges

Integration time	f_{min}	f_{max}
10 s	0.1 Hz	200000 Hz
1 s	1 Hz	200000 Hz
0.1 s	10 Hz	200000 Hz
0.01 s	100 Hz	200000 Hz

Revolutions measurement

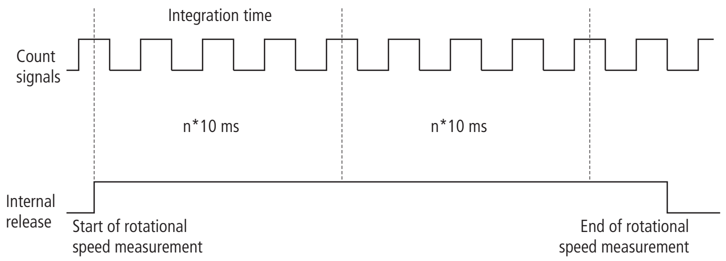
Definition

In this operating mode, the counter module counts the pulses received from a rotary sensor within a predefined integration time. The number of "sensor pulses per revolution" must be defined beforehand by parameters in the system. The number of "sensor pulses per revolution" and the pulses counted determine the speed of the connected motor.

The integration time is defined by measuring parameters. It can be set in 10 ms increments to between 10 ms and 10 s.

The speed is indicated in units of 1×10^{-3} rpm.

Figure 10-10: Revolutions measurement with release function



Limit value monitoring

The limit values can be configured and defined at a later time via the control interface/process output. The following limit value ranges are possible:

Range defined by parameters

→ The value range is restricted by the 3 byte parameter length

- Lower limit n_u is 0 to 16 777 214 × 10^{-3} rpm
- Upper limit n_o is 1 to 16 777 215 × 10^{-3} rpm

The upper limit must be greater than the lower limit. The diagnostics messages Upper limit wrong and Lower limit wrong indicate parameter definitions that are outside of the permissible value range. The diagnostics messages are cleared when valid parameters are entered.

Range defined via the control interface/process output

(LOAD_UPLIMIT/LOAD_LOLIMIT)

- Lower limit n_u is 0 to 24 999 999 × 10^{-3} rpm
- Upper limit n_o is 1 to 25 000 000 × 10^{-3} rpm

The upper limit must be greater than the lower limit. An error is indicated by the ERR_LOAD status bit via the check-back interface/process input. The status bit is cleared when a valid value is entered.

Table 10-5: Possible measuring ranges with 60 pulses per sensor revolution

Integration time	n_{min}	n_{max}
10 s	1 rpm	200000 rpm
1 s	1 rpm	200000 rpm
0.1 s	10 rpm	200000 rpm
0.01 s	100 rpm	200000 rpm

Table 10-6: Possible measuring ranges with 60 000 pulses per sensor revolution

Integration time	n_{min}	n_{max}
10 s	1 rpm	200 rpm
1 s	1 rpm	200 rpm
0.1 s	1 rpm	200 rpm
0.01 s	1 rpm	200 rpm

Period duration measurement

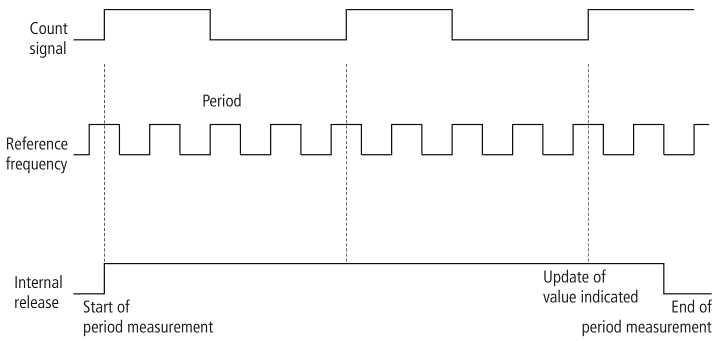
Definition

In this operating mode the counter module measures the precise time between two rising edges of the counter signal in ms by counting the pulses of an exact internal quartz crystal reference frequency (1 MHz). An averaging operation can be carried out over 1 to 1 000 periods. It is defined by the integration time parameter or by the LOAD_INTTIME status bit in the control interface/process output.

The displayed measured value cannot be updated until the set number of periods have elapsed.

The measured value is displayed in units of ms in the check-back interface/process input.

Figure 10-11: Period duration measurement with release function; no. of periods = 2



Limit value monitoring

The limit values can be defined and altered at a later time via the control interface/process output. The following limit value ranges are possible:

Range defined by parameters

→ The value range is restricted by the 3 byte parameter length

- Lower limit n_u 0 to 16 777 214 ms
- Upper limit n_o 1 to 16 777 215 ms

The upper limit must be greater than the lower limit. The diagnostics messages Upper limit wrong and Lower limit wrong indicate parameter definitions that are outside of the permissible value range. The diagnostics message is cleared when a valid value is entered.

Range defined via the control interface/process output

(LOAD_PREPARE/LOAD_VAL)

- Lower limit n_u 0 to 99 999 999 ms
- Upper limit n_o 1 to 100 000 000 m

The upper limit must be greater than the lower limit. An error is indicated by the ERR_LOAD status bit via the check-back interface/process input. The status bit is cleared when a valid value is entered.

Table 10-7: Possible measuring ranges

Measuring cycle via number of periods	t_{min}/ update after	t_{max}/ update after
1000	10 ms/10 ms	10000 ms/10 s
100	10 ms/1 ms	100000 ms/10 s
10	100 ms/1 ms	1000000 ms/10 s
1	1000 ms/1 ms	10000000 ms/10 s

With the measuring cycles selected here the display is updated after a maximum of 10 s.

10.1.6 Functions and explanations

Software gate and hardware gate

A release signal is required in order to start counting/measuring.
The counter module controls the starting and stopping of the counting/measuring operation by means of so-called "gates". A software gate and a hardware gate are provided for implementing this control both via the software (process output/control interface) and via a physical output:

- The software gate initiates the release via the SW_GATE control bit.
  The release is activated by the rising edge from 0 → 1 of the SW_GATE control bit.
  If Function DI = HW Gate is set at the same time, it should be ensured that a High signal is present at the digital input. With DI digital input = normal this is 24 V DC.
  A stop is initiated by resetting the SW_GATE control bit from 1 → 0. If Function DI = HW Gate is set, the counting/measuring operation can be stopped either by the software gate or the hardware gate.

  A Hardware gate initiates a release via a 24 V DC signal at the digital input. This function is configured with Function DI = HW gate. The release is then only possible if the SW_GATE bit =1 at the same time.
  This bit is set when there is a rising edge from 0 → 1 at the input and reset with a falling edge from 1 → 0.
  The edge change can be reversed by inverting the digital input.
  Digital input DI = inverted

Note

If the counting operation is aborted, counting begins from the load value on restart. If the counting operation is interrupted, however, the counter continues on restart from the actual counter value.
→ see "gate function"

Synchronization

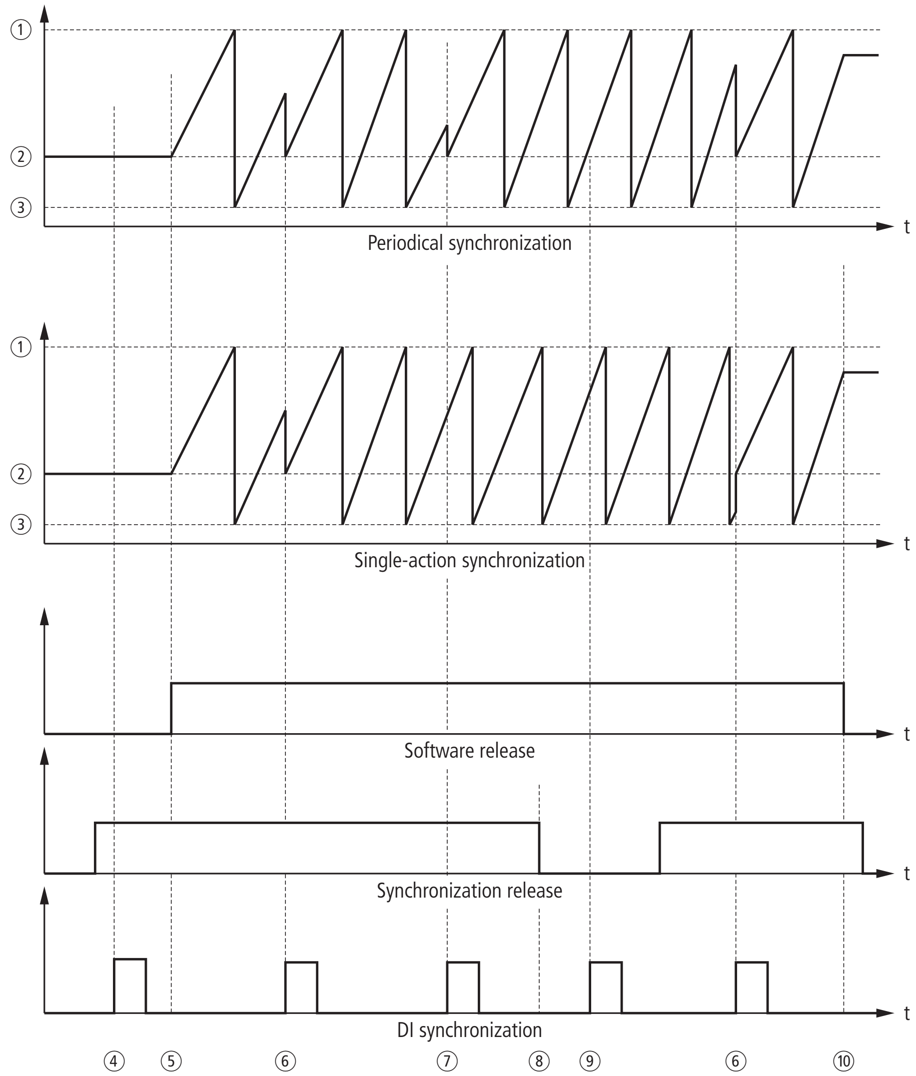
Synchronization must be configured before operating the counter module (Function DI = Synchronization when edge positive). The rising edge of a reference signal at the input is used to set the counter to the load value.

- A single-action or periodical synchronization can be selected. This is possible under the following conditions:
- The counting operation must be started with the software release.
- The Release Synchronization (CRTL_SYN) control bit must be set.
- With single-action synchronization the first 0 → 1 edge at the digital input sets the counter to the load value after the release bit is set.
- With periodical synchronization the first and every subsequent 0 → 1 edge at the digital input sets the counter to the load value after the release bit is set.
- After synchronization is successfully completed the STS_SYN status bit is set. It can only reset by the RES_STS control bit.
- The STS_DI check-back bit indicates the status of the reference signal at the digital input.

When single-action synchronization is set, a subsequent synchronization operation can be initiated by resetting and setting the Release synchronization (CRTL_SYN) control bit. This is executed on the next 0 → 1 edge at the digital input.

The signal of a bounce-free switch or the zero reference mark of a rotary sensor can be used as a reference signal.

Figure 10-12: Synchronization with continuous counting



① Upper count limit

② Load value

③ Lower count limit

④ Synchronization without release

⑤ Release set

⑥ 1st synchronization

⑦ 2nd synchronization

⑧ Stop synchronization

⑨ No synchronization

⑩ Release reset

Latch retrigger function

This function enables the event-driven evaluation of the counter status.

The actual internal counter status of the electronic module is retained when there is an edge at the digital input. The check-back interface/process input data supplies the "frozen" value. The internal counter status is retriggered, i.e. the load value is loaded and counting is resumed from the load value.

In order to execute this function the counting mode must be released with the software gate.

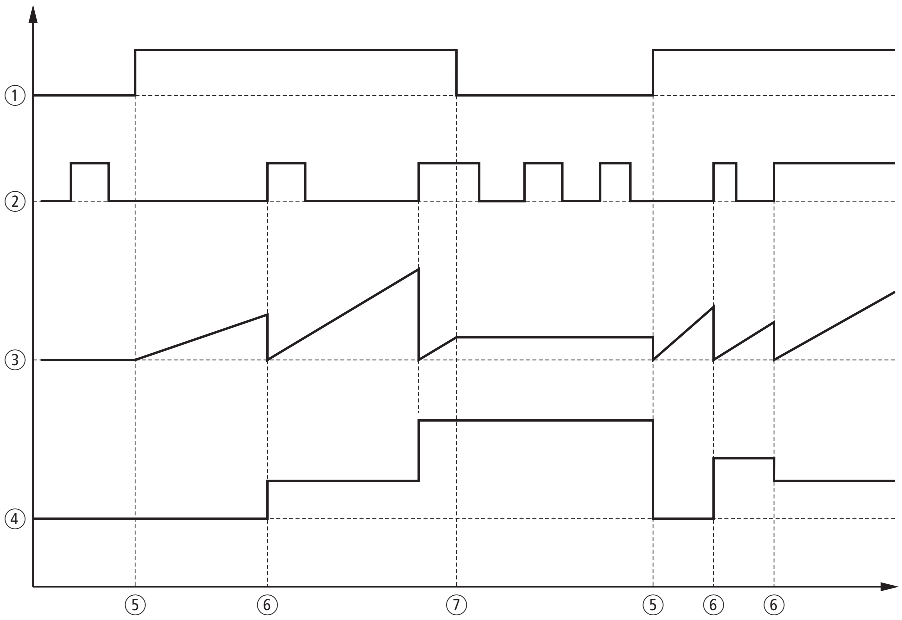
Bit STS_DI (Status DI) indicates the status of the Latch and Retrigger signal. The edge signal cannot be inverted.

The load value with which the operating mode starts is displayed before the first edge after the software release is set.

A direct loading of the counter does not change the counter status indicated.

Note
Ensure that input DI is not inverted otherwise this will generate an error/diagnostics message.

Figure 10-13: Latch retrigger function with the counter operation abort configured



① Software release
② Digital input
③ Internal counter status
④ Displayed counter status
⑤ Start, manual
⑥ Latch
⑦ Stop

Behavior of the DI digital input

The digital input can be run with different sensors (positive switch or push-pull).

The input signal can be inverted (exception: in Latch and retrigger function).

The STS_DI status bit indicates the status of the digital input.

The following digital input functions are available for selection in count mode:

- Digital input
- Hardware release (HW gate)
- Latch retrigger function when edge positive
- Synchronization when edge positive

The following digital input functions are available for selection in measurement mode:

- Digital input
- Hardware release (HW gate)

Behavior of the digital outputs DO1/DO2

Count mode

The digital outputs can be activated depending on the counter status and reference values.

The module is provided with a "real" digital output and a "virtual" digital output that is only present as a status bit in the check-back interface/process input.

Two reference values can be stored on the counter module and assigned to the digital outputs separately.

The following functions can be selected:

- Output (no switching via comparator)
- Set if counter value ≥ reference value
- Set if counter value ≤ reference value
- Pulse if counter value = reference value

Comparison results for comparator 1 are assigned to the physical output DO1.

Comparison results for comparator 2 are assigned to the virtual output DO2.

Permissible value range for the two reference values

Lower count limit
to
upper count limit

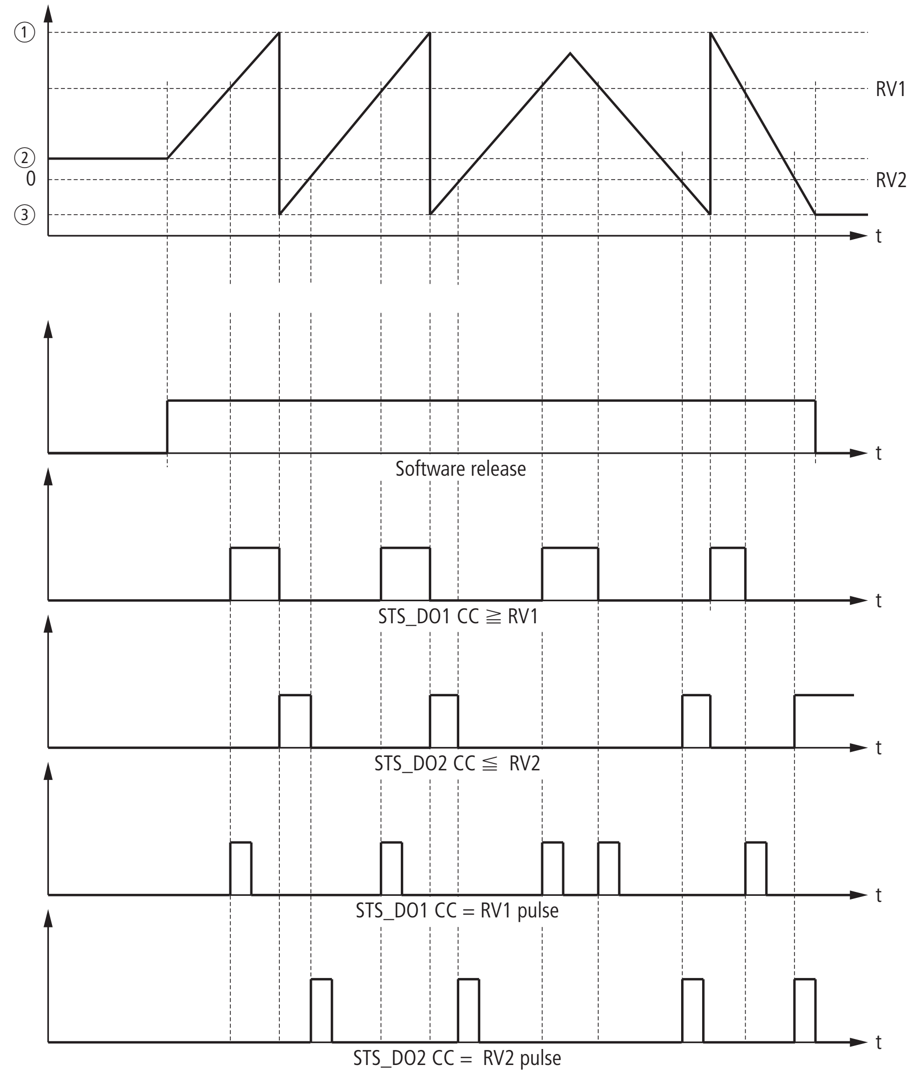


Figure 10-14: Continuous counting with release function

① Upper count limit

② Load value

③ Lower count limit

RV1 = reference value 1

RV2 = reference value 2

CC = counter content

The count limits configured represent the upper and lower count limits.

The behavior of the digital outputs depend on:

- Hysteresis
- Pulse duration

The behavior of the digital outputs can be configured before operation or by means of a control command during operation.

DO1/DO2 in Output mode

In Output mode, the outputs can be set and reset via the process output/control interface. This requires that the relevant output is released (CTRL_DO1, CTRL_DO2). Set/reset (SET_DO1, SET_DO2) can then be carried out irrespective of the counter status.

Measurement mode

An upper and lower measuring limit can be set on the counter module

In measurement mode only the physical output DO1 is active.

The following functions can be selected:

- Output (no switching when upper/lower measuring limit reached)
- Measured value outside of the set limits
- Measured value below the lower limit
- Measured value above the upper limit

Releasing the output

Control bit CTRL_DO1 is used to release the output.

Control bit SET_DO1 is used to activate or deactivate the released output.

The status of the output is stored in the check-back interface/process input and can be scanned with the status bit (STS_DO1).

Hysteresis for digital output DO1/DO2

In count mode, the hysteresis controls the switching of the outputs DO1/DO2 with comparisons.

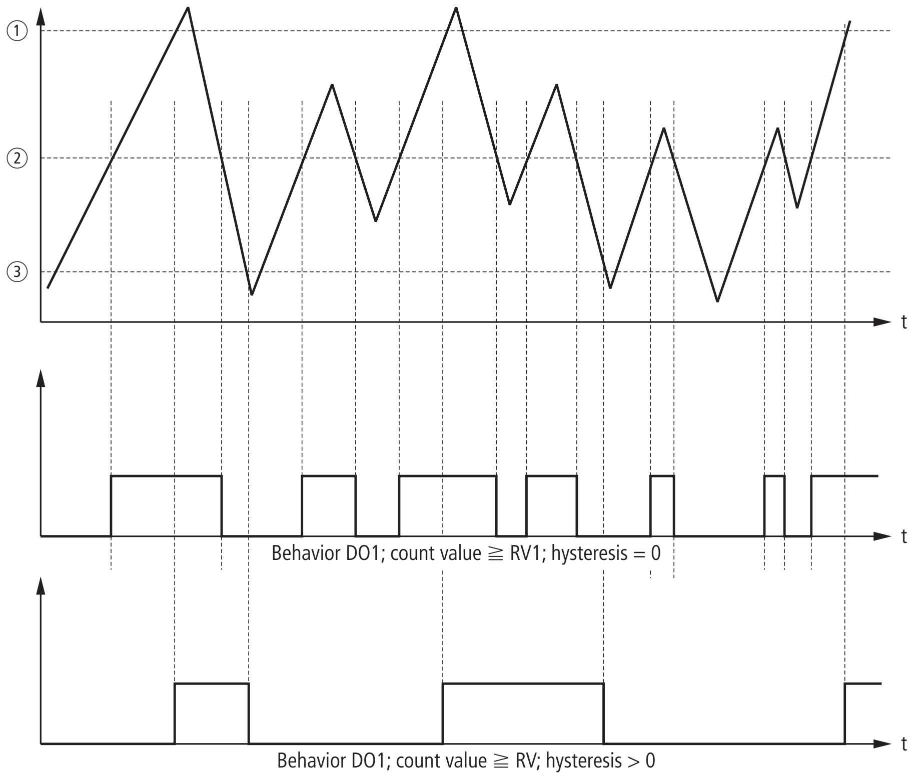
A sensor may stand still at a specified position and "oscillate" around this position. This condition will cause the counter status to fluctuate by a specified value. If the reference value RV1/RV2 is within this fluctuation range, this would mean that the DO1/DO2 output would switch on and off in time with the fluctuating signal.

A programmable hysteresis function can therefore be used in order to prevent switching resulting from small fluctuations. This hysteresis can be set between 0 and 255 (0 means Hysteresis switched off).

The hysteresis can also be changed using the LOAD_DO_PARAM control command.

If the output is set for Switching >= Reference value, the digital output will have the following behavior (example for DO1 - DO2 will respond accordingly):

Figure 10-15: Hysteresis with output set to Switch >= Reference value



① Reference value + hysteresis

② Reference value RV1

③ Reference value - hysteresis

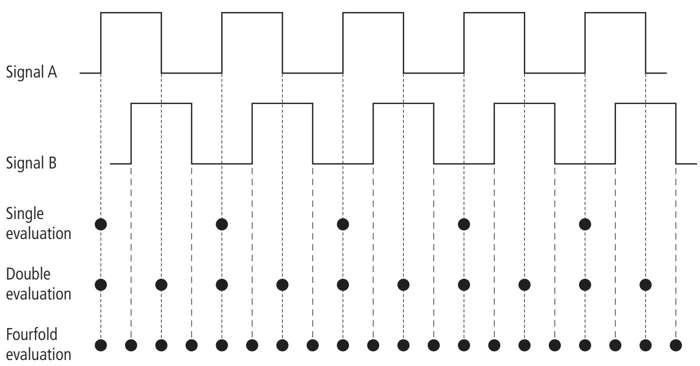
If the output is set for Switch on counter value = reference value, a pulse is generated at output DO1.

Signal evaluation options for rotary sensors

The evaluation options can be set in the BL20 counter module configuration. The following settings are possible:

- Single
- Double
- Fourfold

Figure 10-16: Evaluation options for count mode (measurement mode only allows single evaluation)



Scan points with different evaluations

The set configuration determines how the counter status is incremented or decremented according to the rising and falling edges of signals A and B. The following evaluations are possible:

- Single evaluation:
  Only the rising edge of signal A is evaluated.
- Double evaluation:
  Both the rising and falling edge of signal A are evaluated.
- Fourfold evaluation:
  Both the rising and falling edge of signal A and B are evaluated.

In count mode rotary sensors with single, double and fourfold evaluation can be selected.

In measurement mode only rotary sensors with single evaluation can be selected.

Pulse and direction

Count mode

Input A receives the counter signal and input B the direction signal.

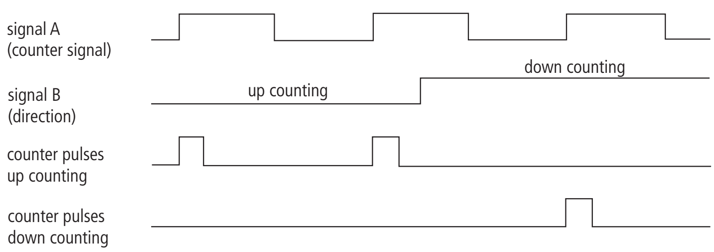
A signal at input A can either increment or decrement the counter status depending on the state of input B.

Measurement mode

In measurement mode input B receives a signal for the direction of rotation. The process entry/check-back interface returns the status (rotation direction via STS_DN and STS_UP.

Note
The signals at A and B can be inverted.

Figure 10-17: Changing the counter status on counter signal and direction signal



Load value direct/in preparation

The counter can be assigned with a load value. This value can either be set via the connected controller or via the I/O-Assistant software. The type of setting (direct/optional) is set via a bit in the controller:

1. The **direct** load causes the counter to accept the load value directly as the new counter value.
2. The load value can also be loaded **in preparation**. In this case, the load value is accepted as the new counter value in response to any of the following events:

- Lower or upper count limit is reached when no main count direction has been configured.
- Reaching the upper count limit with the main count direction set to up counting.
- Reaching the lower count limit with the main count direction set to down counting.

Pulse duration on reaching the reference value

The pulse duration starts from when the digital output is set and can be specified in order to adapt to the actuators used. It specifies how long the output is to be set. The pulse duration can be set in 2 ms increments to between 2 and 510 ms.

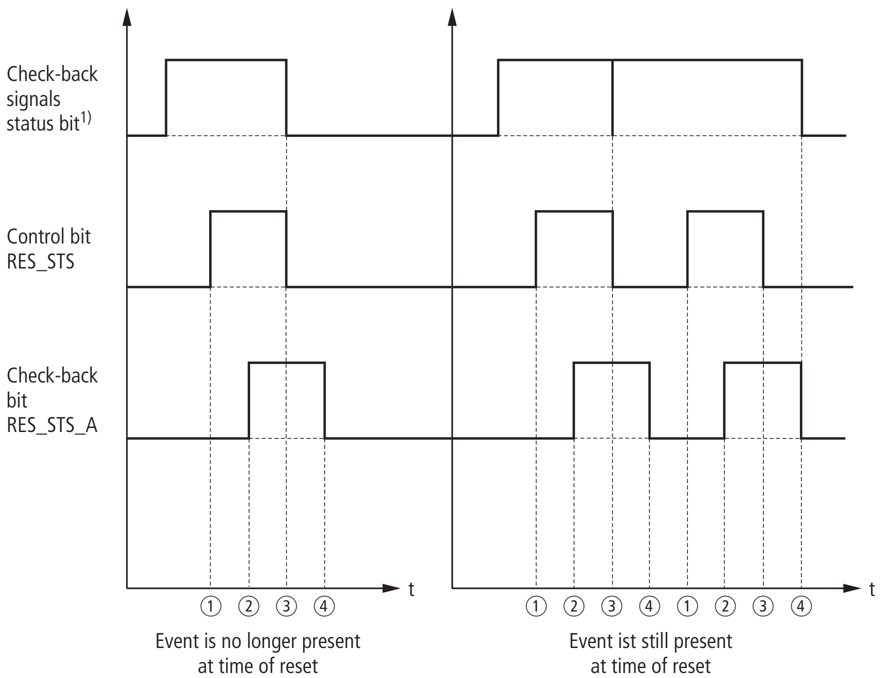
If the pulse duration = 0, the output is set for as long as the comparison condition is fulfilled.

Note
No pulse is generated if the counter value goes above the counter value, e.g. jumps from the upper limit to the lower limit when counting up.

10.1.7 Resetting the status bit

Status bits:
STS_ND, STS_UFLW, STS_OFLW, STS_CMP2, STS_CMP1, STS_SYN

Figure 10-18: Resetting the status bits



① Reset requested by the controller

② Reset by electronic module

③ Reset request revoked by controller

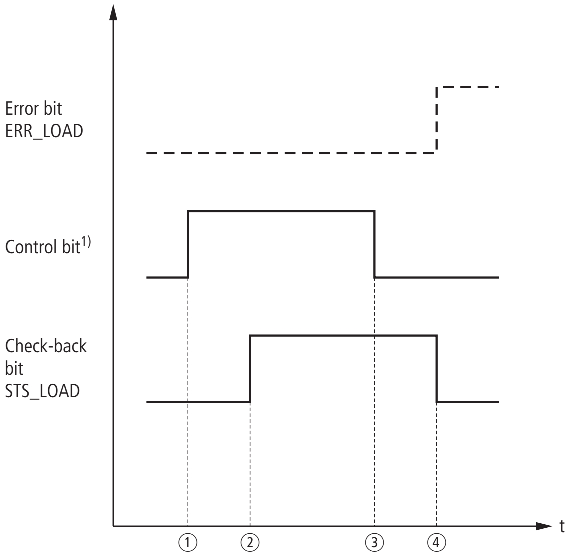
④ Reset executed in electronic module

⑤ Transfer of values/load function

10.1.8 Transfer of values/load function

Control bits: LOAD_VAL, LOAD_PREPARE, LOAD_CMP_VAL1, LOAD_CMP_VAL2, LOAD_DO_PARAM, LOAD_INTTIME, LOAD_UPLIMIT, LOAD_LOLIMIT

Figure 10-19: Transferring values with the load function



① controller requests value transfer/ value available

② reset understood by electronic module

③ request revoked by controller/ value still available

⑤ value accepted/ transfer complete

Note
Only one of the status bits1) mentioned should be set. Otherwise the ERR_LOAD error is indicated until all the stated control bits have been reset.

Count mode

The following values can be changed using the load function during operation:

- Counter status (LOAD_VAL)
- Load value (LOAD_PREPARE)
- Reference value1 (LOAD_CMP_VAL1)
- Reference value2 (LOAD_CMP_VAL2)
- Behavior of the digital outputs DO1/DO2 (LOAD_DO_PARAM)

Note
When changing the behavior of the digital output via the control interface/process output (value LOAD_DO_PARAM) the values for pulse duration and hysteresis are changed as well! These changes are stored in a volatile memory, i.e. when the module is reset (removed/fitted) they are overwritten by the values configured via the gateway.

Measurement mode

The following values can be changed using the load function during operation:

- Behavior of the digital output DO1 (LOAD_DO_PARAM)
- Lower limit (LOAD_UPLIMIT)
- Upper limit (LOAD_LOLIMIT)

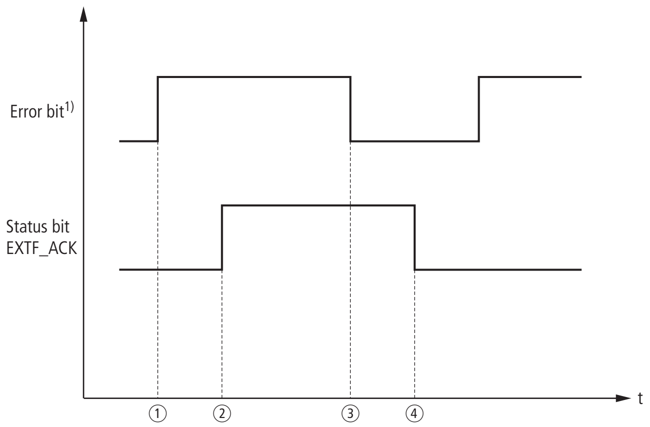
Error acknowledgement

The Error Digital output error (ERR_DO) and Short circuit sensor supply (ERR_24Vdc) status bits must be acknowledged. The errors are detected by the counter module and shown in the check-back interface/ process input. They can also initiate a diagnostics message with the appropriate parameter definition.

The following figure shows the chronological relationship between the occurrence of an error and its acknowledgement:

Error bit: ERR_DO or ERR_24Vdc

Figure 10-20: Error detection



① Error occurred/ module sets error bit and diagnostics message if necessary/ error detection continues

② Error bit acknowledged/ any diagnostics message present is cleared/ further error detection not possible.

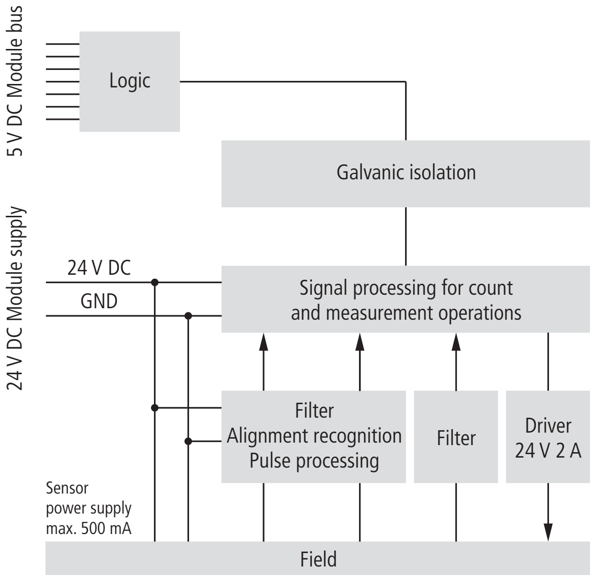
③ Error bit was reset/ further error detection not possible.

④ The status bit EXTF_ACK is reset/ further error detection possible.

10.1.9 Technical features

Figure 10-21: BL20-1CNT-24VDC

Figure 10-22: Block diagram



Technical data

Table 10-8: Technical data

Designation	BL20-1CNT-24VDC
Number of channels	1
Nominal voltage from supply terminal	24 V DC
Nominal current from supply terminal I_{EI}	< 50 mA (with load current = 0)
Nominal current from module bus I_{MB}	< 40 mA
Power loss of the module, typical	<1.3 W
Sensor supply	
Output voltage	L+ (-0.8 V)
Output current	≤ 0.5 A, short-circuit-proof
Counter signals and digital input	
Input voltage at rated current 24 V DC	
Low signal level U_L	-30 V DC to 5 V DC
High signal level U_H	11 V DC to 30 V DC
Input current	
Low signal level I_L	-8 to 1.5 mA
High signal level I_H	2 mA to 10 mA
Input delay	≤ 200 ms
Minimum pulse width (maximum counter frequency)	
Filter on	≥ 25 ms (20 kHz)
Filter off	≥ 2.5 ms (200 kHz)
Digital output	
Output voltage at rated current 24 V DC	
Low signal level U_L	≤ 3 V DC
High signal level U_H	≥ L+ (-1 V DC)
Output current	
High signal I_H (permissible range)	5 mA to 2 A
High signal I_H (rated value)	0.5 A (55 °C)
Switching frequency	
With resistive load	100 Hz
With inductive load	2 Hz
With lamp load	≤ 10 Hz

Lamp load R_{LL}	≤ 10 W
Output delay (resistive load)	100 µs
Short-circuit-proof	Yes
Response threshold	2.6 to 4 mA
Inductive reset	L+ -(50 to 60 V)
Measuring ranges	
Frequency measurement	0.1 to 200 kHz
Revolutions measurement	1 rpm to 25 000 rpm
Period duration measurement	5 ms to 120 s
Count modes	
Signal evaluation A, B	Pulse and direction Rotary sensor, single Rotary sensor, double Rotary sensor, fourfold
Count mode	Continuous count Single-action count Periodical count
Hysteresis	0 to 255
Pulse duration	0 to 255
Synchronization	Single Periodical
Count limits	
Upper count limit	0 to 7FFF FFFF
Lower count limit	8000 0000 to 0
Measurement modes	
Signal evaluation A, B	Pulse and direction Rotary sensor single

Diagnostic and status messages

Table 10-9: LED indicators

LED	Display	Meaning	Remedy
DIA	Red, flashing, 0.5 Hz	Parameter error	Parameter error
	Red	Module bus communication failure	Check if more than two adjoining electronics modules have been pulled. Check the power supply to the module bus.
	Off	No error messages or diagnostics	–
A	Green	Counter input active or measuring input active	-
	Off	Counter input not active or measuring input not active	-
B	Green	Counter input not active or direction input set for down	-
	Off	Counter input active or direction input set for up	-
14	Green	Status of digital input = 1	-
	Off	Status of digital input = 0	-
24	Red	Error on digital output	Check the wiring of the digital output.
	Green	Status of digital output = 1	-
	Off	Status of digital output = 0	-

Diagnostic message via software

Table 10-10: Diagnostic messages of the counter module per software

A *Bit 7 = 1 (measuring mode) is only displayed if one other diagnotic bit is set*

Counter mode	Measuring mode	Assignment (byte, bit)
Short-circuit/ wire break ERR_DO		0,0
Short-circuit sensor supply ERR-24 V DC		0,1
End of counter range wrong	Sensor pulse wrong	0,2
Start of counter range wrong	Integration time wrong	0,3
Invert-DI+latch-retrigger not permitted It is not permitted to invert the level of the digital input when using the latch-retrigger-function	Upper limit wrong	0,4
Main count direction wrong	Lower limit wrong	0,5
Operating mode wrong		0,6
Operating mode = 0	Operating mode = 1 **A**	0,7

Base modules

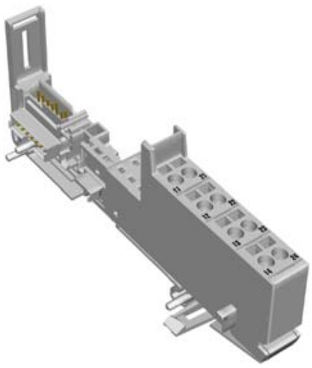


Figure 10-23: Base module BL20-S4T-SBBS

- with tension clamp connection BL20-S4T-SBBS
- with screw connection BL20-S4S-SBBS

Wiring diagrams

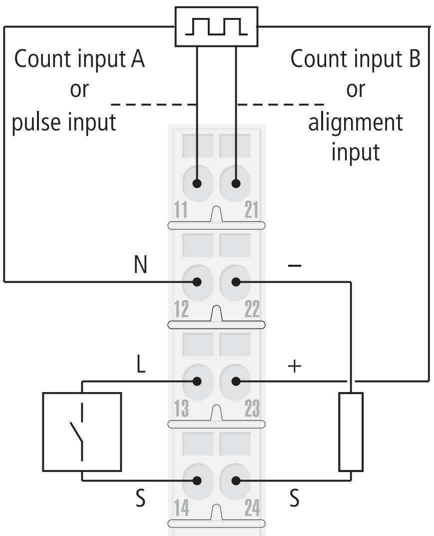


Figure 10-24: Wiring diagram BL20-S4x-SBBS

Table 10-11: Connection options for pulse generators

	Connection type	Count direction
Pulse generator without direction indicator	24 V DC count pulses at terminal 11	Up
Pulse generator with direction signal	24 V DC count pulses at terminal 11 and 24 V DC direction at terminal 21	Up, down
Pulse generator with 2 90° offset spur lines	Channel A at terminal 11 and channel B at terminal 21	Up, down

10.2 RS232 Interface BL20-1RS232

The module BL20-1RS232 transmits serial data through the BL20 system via a RS232 interface and enables the connection of different devices (printer/ scanner/ bar code reader), which as well provide a serial RS232 interface.

10.2.1 Data transfer method

The serial data transfer is flexible. An operational data transfer method can be set by the module's parameters.

The data transfer can be parameterized as follows:

- Data rate: 300 Bit/s to 115200 Bit/s.
- Data bits: 7 or 8 data bits in one data frame
- Parity: none, odd or even
- Stop bits: 1 or 2 Bit.

Note
The data flow control can be realized via a hardware handshake (RTS/CTS) or a software handshake (XON/XOFF).

10.2.2 Data exchange

For the data exchange with a field device, the module provides a 64-byte transmit-buffer and a 128-byte receive-buffer. This is a hardware-restriction. The data telegrams which have to be sent or received can be larger.

The data transfer from the PLC into the transmit-buffer of the module or from the receive-buffer of the module to the PLC is realized via a 8-byte transmission channel in the process input or process output data.
To ensure the error-free data transmission, 2 byte of each data package are used to display status-, control- and diagnosis information. The amount of user data is therefore reduced to 6 byte within a data package.

10.2.3 Process input data (PDin)

The incoming data are stored in the receive-buffer of the BL20-1RS232 module, segmented and transferred to the PLC via the module bus and the gateway.

The transmission is realized in a 8-byte format, structured as follows:

- 6 byte user data
- 1 byte diagnostic data
- 1 status byte, used to guarantee error free data-transmission.

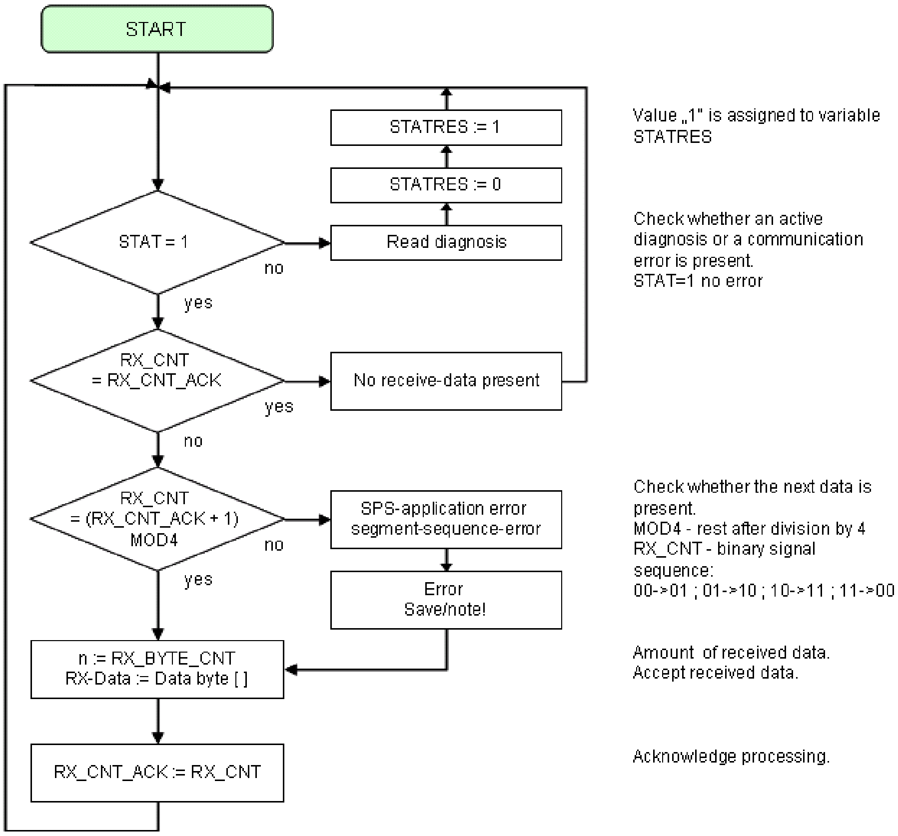
Meaning of the data bits

Table 10-12: Meaning of the data bits (process input)

Designation	Value	Meaning
BufOvfl; FrameErr; HndShErr; HwFailure; PrmErr	0 - 255	Diagnostic information (correspond to the diagnostic information in the diagnosis telegram). These diagnostics are always displayed and independent to the setting of the parameter "Diagnostics".
STAT	0-1	1: The communication with the data terminal equipment (DTE) is error free 0: The communication with the data terminal equipment (DTE) is disturbed. A diagnosis message is generated if the parameter "Diagnostics" is set to "0/ release". The diagnostic data show the cause of the communication disturbance. The user has to set back this bit in the process output data by using STATRES.
TX_CNT_ACK	0-3	The value TX_CNT_ACK is a copy of the value TX_CNT. TX_CNT has been transmitted together with the last data segment of the process output data. TX_CNT_ACK is an acknowledge for the successful transmission of the data segment with TX_CNT.
RX_CNT	0-3	This value is transferred together with every data segment. The RX_CNT values are sequential: 00->01->10->11->00... (decimal: 0->1->2->3->0...) Errors in this sequence show the loss of data segments.
RX_BYTE_CNT	0-7	Number of the valid bytes in this data segment.

10.2.4 Schematic diagram of the receive sequence

Figure 10-25: Schematic diagram of the receive sequence



10.2.5 Process output data (PDout)

The data received from the PLC are loaded into the transmit- buffer of the BL20-1RS232 module.

The fieldbus specific transmission for PROFIBUS-DP is realized in a 8-byte format which is structured as follows:

- 6 byte user data
- 1 byte containing signals to flush the transmit- and receive buffer.
- 1 control byte, used to guarantee error free data-transmission.

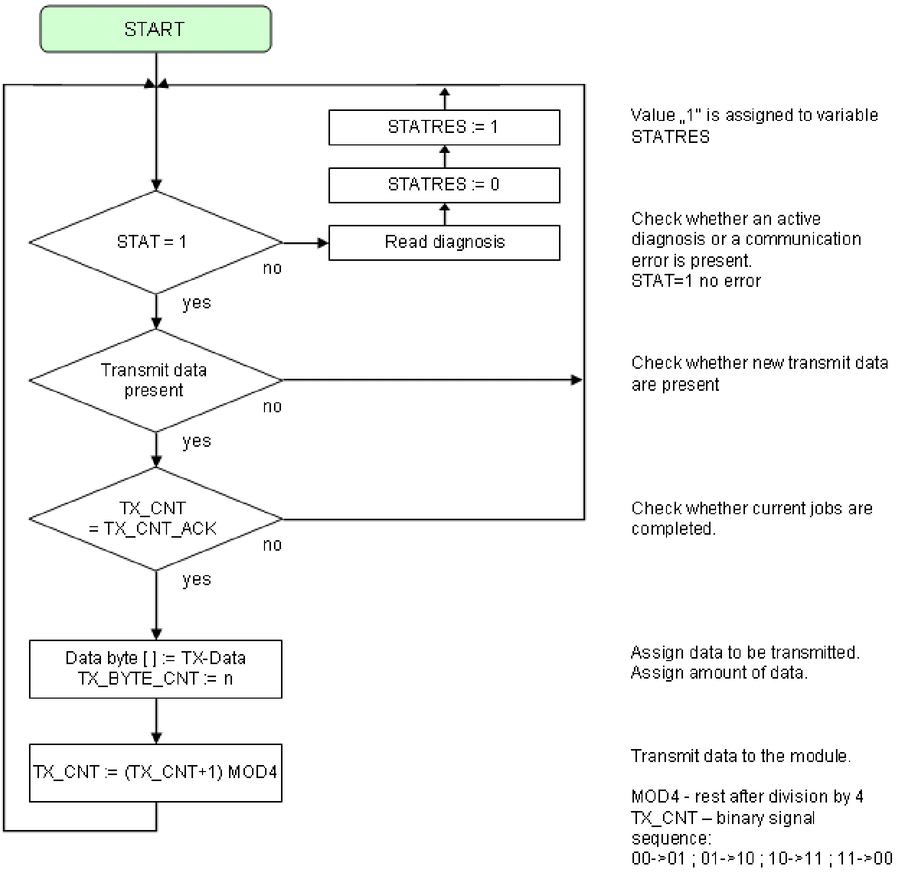
Meaning of the data bits

Table 10-13: Meaning of the data bits (process output)

Designation	Value	Meaning
RXBUF FLUSH	0 - 1	This bit is used to flush the receive-buffer. If STATRES = 1: The command RXBUF FLUSH = 1 is ignored. If STATRES = 0: RXBUF FLUSH = 1 causes the flushing of the receive-buffer.
TXBUF FLUSH	0-1	This bit is used to flush the transmit-buffer. If STATRES = 1: The command TXBUF FLUSH = 1 is ignored. If STATRES = 0: TXBUF FLUSH = 1 causes the flushing of the transmit-buffer.
STATRES	0-1	This bit is set to reset the STAT bit in the process input data. With the change from 1 to 0 the STAT bit is reset (from 0 to 1). If this bit is 0, all changes in TX_BYTE_CNT, TX_CNT and RX_CNT_ACK are ignored. Flushing the transmit-/ receive-buffer with RXBUF FLUSH/ TXBUF FLUSH is possible. If this bit is 1 or with the change from 0 to 1, the flushing of the transmit-/ receive-buffer with RXBUF FLUSH/ TXBUF FLUSH is not possible.
RX_CNT_ACK	0-3	The value RX_CNT_ACK is a copy of the value RX_CNT. TX_CNT has been transmitted together with the last data segment of the process input data. TX_CNT_ACK is an acknowledge for the successful transmission of the data segment with RX_CNT.
TX_CNT	0-3	This value is transferred together with every data segment. The TX_CNT values are sequential: 00->01->10->11->00... (decimal: 0->1->2->3->0...) Errors in this sequence show the loss of data segments.
TX_BYTE_CNT	0 - 7	Number of the valid user data in this data segment. In PROFIBUS-DP, the data segments contain a maximum number of 6 bytes of user data.

10.2.6 Schematic diagram of the transmit sequence

Figure 10-26: Schematic diagram of the transmit sequence



10.2.7 Technical data

Figure 10-27: BL20-1RS232

Figure 10-28: Block diagram

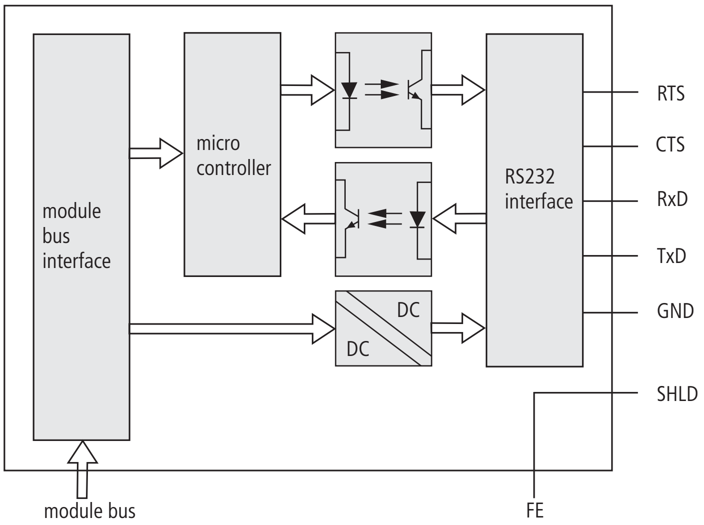


Table 10-14: Technical data

Designation	BL20-1RS232
Number of Channels	1
Voltage supply	via module bus
Voltage from module bus U_{MB}	5 VDC
voltage range	4.75 to 5.25 VDC
Field supply	24 DC
voltage range	18 to 30 VDC
Nominal current from supply terminal I_{EL}	0 mA
Nominal current from module bus I_{MB}	$\leq$ 140 mA
Memory	128 Byte receive, 64 Byte transmit
In/- Outputs	
transmission level active (U_{RS1})	-15 to -3 VDC
transmission level inactive (U_{RS0})	3 to 15 VDC
transmission channels	2 (1/1) TxD and RxD, full-duplex
transmission rate	300 to 115200 Baud (defined by parameters) Data, Parity, Stop (default: 9600 Baud, 7 Bit, impair, 2 stop-bits)
RS232 cable length	max. 15 m
Flow Control	Software-Handshake (Xon/ Xoff) Hardware-Handshake (RTS/ CTS)
Diagnostic data can be written into the process image (depending on the parameterization)	
Isolation voltage	
U_{TMB} (module bus /RS232)	max. 1000 VDC
U_{Field} (Field voltage/ RS232	max. 1000 VDC

10.2.8 Diagnostic and status messages

Diagnosis via LEDs

Table 10-15: Diagnosis via LEDs

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two ad-joining electronic modules have been pulled. This concerns modules located between this module and the gateway.
	Red flashing, 0.5 Hz	Diagnostics message present.	
	Off	No error messages or diagnostics	–
TxD	Green	Data currently transmitted.	-
	Off	No data currently transmitted.	-
RxD	Green	Data currently received	-
	Off	No data currently received	-

Diagnosis via software

The module has the following diagnostic data available.

Table 10-16: Diagnosis

Diagnostic message	
Buffer Overflow	Overflow of the receive-buffer (RX-buffer).
Frame error	The module has to be parameterized for adaptation to the data structure of the data terminal equipment (DTE). A frame error occurs in case of inconsequent parameterization (number of data bits, stop bits, method of parity,...).
Data flow control error	The DTE connected t the module does not react to XOFF or RTS handshake. The internal receive-buffer may overflow (buffer-overflow = 1).
Hardware failure	The module has to be replaced (e.g. error in EEPROM or UART)
Parameterization error	The parameter settings can not be supported.

10.2.9 Module Parameters

Table 10-17: Module parameters

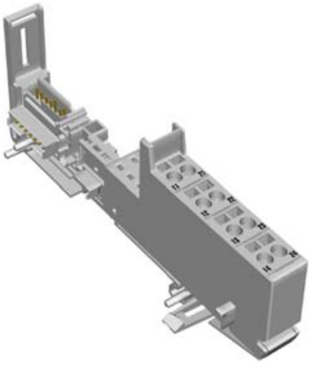
A *default-setting*

Parameter name	**Value**	
Diagnostic	release	Diagnosis activated/ diagnosis deactivated: This item only concerns the field bus specific diagnostic messages not the diagnosis mapped into the process input data of the module
	block **A**	
Disable ReducedCtrl	1	Constant setting: The diagnosis messages are set in Byte 6 of the process input data (independent of "diagnostic"). Byte 6 of the process output data contains two bits which may set to flush the transmit- or the receive-buffer. Byte 7 contains the status- or the control-byte. Bytes 0 to 5 contain the user data.
Data rate	300 Bit/s 600 Bit/s 1200 Bit/s 2400 Bit/s 4800 Bit/s 9600 Bit/s **A** 14400 Bit/s 19200 Bit/s 28800 Bit/s 38400 Bit/s 57600 Bit/s 115200 Bit/s	
	none **A**	The data flow control has been deactivated.
Data flow control	XON/XOFF	Software-Handshake (XON/XOFF) activated.
	RTS/CTS	Hardware-Handshake (RTS/CTS) activated.
Data bits	7 **A**	The number of data bits is 7.
	8	The number of data bits is 8.
Parity	none	-
	odd **A**	The number of the bits set (data bits and parity bit) is odd.
	even	The number of the bits set (data bits and parity bit) is even.
Stop bits	1	Number of stop bits is 1.
	2 **A**	Number of stop bits is 2.
XON character	0 – 255	XON-character (17 **A**) This character is used to start the data transfer of the data terminal device (DTE) when the software-handshake is activated

	XOFF character	0 – 255	XOFF-sign (19 **A**) This character is used to stop the data transfer of the data terminal device (DTE) when the software-handshake is activated

10.2.10 Base modules

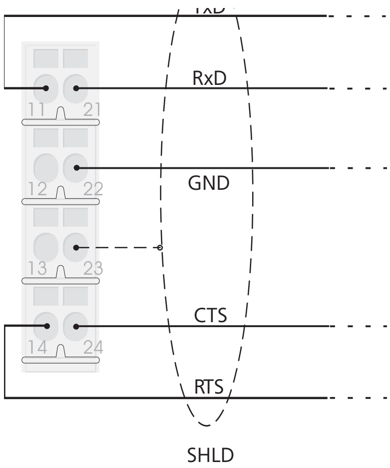
Figure 10-29: Base module BL20-S4T-SBBS



- with tension clamp connection BL20-S4T-SBBS
- with screw connection BL20-S4S-SBBS

10.2.11 Wiring diagrams

Figure 10-30: Wiring diagram BL20-S4x-SBBS



10.2.12 Pin assignment

Assignment of signals for a 9-pole submin D plug

Table 10-18: Pin assignment RS232

Pin No.	Signal designation	
1	DCD	Data Carrier Detect
2	RxD	Receive Data
3	TxD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

Note
The table rows highlighted in grey indicate signals that are also available at the terminals of the base module.

10.3 RS485/422 interface BL20-1RS485/422

The module BL20-1RS485/422 allows the transfer of serial data streams via the RS485/422 interface and therefore enables various devices to be connected, such as printers, scanners or bar code readers that use the RS485/422 interface for communication. The interface transfers the data received from the device to the PLC or transfers data to be sent from the PLC to the device.

10.3.1 Transmission procedure

The BL20-1RS485/422 module allows the flexible transfer of serial data. The RS422 connection mode supports two wire simplex or four wire full-duplex transmission. The RS485 connection supports two wire half-duplex transmission.

The parameters of the module can be configured by the user to set up a functional transmission procedure as required.

The following transfer parameters can be configured:

- Bit transmission rate: 300 bit/s to 115200 bit/s.
- Data bits: 7 or 8 user data bits in a data frame.
- Parity: none, even or odd.
- Stop bits: 1 or 2 bits.

The data flow control can be implemented in RS422 operation with a software handshake (XON/XOFF) routine.

10.3.2 Data exchange

The module provides a 64 byte transmit buffer and a 128 byte receive buffer for data exchange with the field device.This is a hardware-restriction. The data telegrams which have to be sent or received can be larger.

The data transfer from the PLC into the transmit-buffer of the module or from the receive-buffer of the module to the PLC is realized via a 8-byte transmission channel in the process input or process output data.
To ensure the error-free data transmission, 2 byte of each data package are used to display status-, control- and diagnosis information. The amount of user data is therefore reduced to 6 byte within a data package.

10.3.3 Process input data (PDin)

The incoming data are stored in the receive-buffer of the BL20-1RS485/422 module, segmented and transferred to the PLC via the module bus and the gateway.

The transmission is realized in a 8-byte format, structured as follows:

- 6 byte user data
- 1 byte diagnostic data
- 1 status byte, used to guarantee error free data-transmission.

Meaning of the data bits

Table 10-19: Meaning of the data bits (process input)

Designation	Value	Meaning
BufOvfl; FrameErr; HndShErr; HwFailure; PrmErr	0 - 255	Diagnostic information (correspond to the diagnostic information in the diagnosis telegram). These diagnostics are always displayed and independent to the setting of the parameter "Diagnostics".
STAT	0-1	1: The communication with the data terminal equipment (DTE) is error free 0: The communication with the data terminal equipment (DTE) is disturbed. A diagnosis message is generated if the parameter "Diagnostics" is set to "0/ release". The diagnostic data show the cause of the communication disturbance. The user has to set back this bit in the process output data by using STATRES.
TX_CNT_ACK	0-3	The value TX_CNT_ACK is a copy of the value TX_CNT. TX_CNT has been transmitted together with the last data segment of the process output data. TX_CNT_ACK is an acknowledge for the successful transmission of the data segment with TX_CNT.
RX_CNT	0-3	This value is transferred together with every data segment. The RX_CNT values are sequential: 00->01->10->11->00... (decimal: 0->1->2->3->0...) Errors in this sequence show the loss of data segments.
RX_BYTE_CNT	0-7	Number of the valid bytes in this data segment.

10.3.4 Schematic diagram of the receive sequence

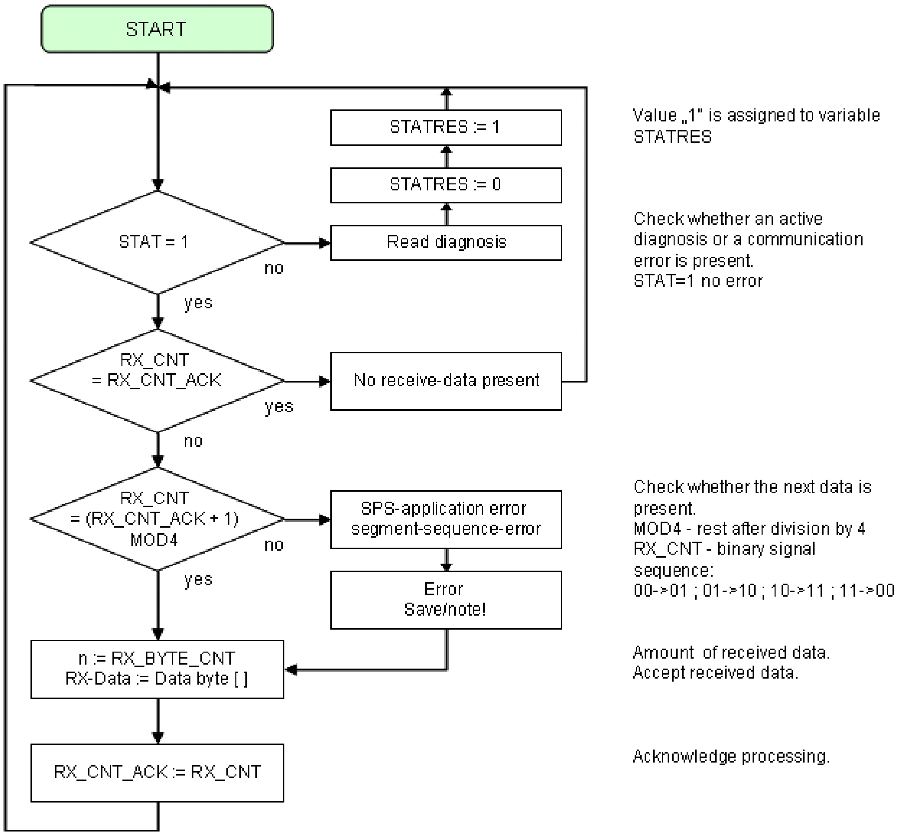


Figure 10-31: Schematic diagram of the receive sequence

10.3.5 Process output data (PDout)

The data received from the PLC are loaded into the transmit- buffer of the BL20-1RS485/422 module.

The fieldbus specific transmission for PROFIBUS-DP is realized in a 8-byte format which is structured as follows:

- 6 byte user data
- 1 byte containing signals to flush the transmit- and receive buffer.
- 1 control byte, used to guarantee error free data-transmission.

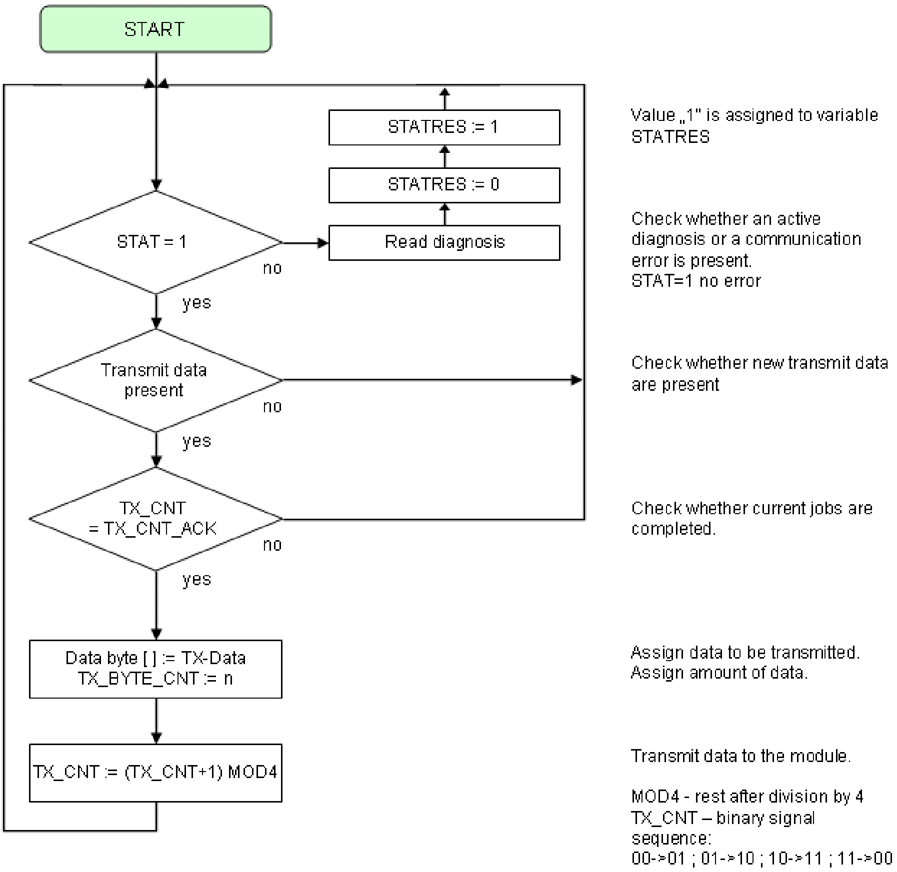
Meaning of the data bits

Table 10-20: Meaning of the data bits (process output)

Designation	Value	Meaning
RXBUF FLUSH	0 - 1	This bit is used to flush the receive-buffer. If STATRES = 1: The command RXBUF FLUSH = 1 is ignored. If STATRES = 0: RXBUF FLUSH = 1 causes the flushing of the receive-buffer.
TXBUF FLUSH	0-1	This bit is used to flush the transmit-buffer. If STATRES = 1: The command TXBUF FLUSH = 1 is ignored. If STATRES = 0: TXBUF FLUSH = 1 causes the flushing of the transmit-buffer.
STATRES	0-1	This bit is set to reset the STAT bit in the process input data. With the change from 1 to 0 the STAT bit is reset (from 0 to 1). If this bit is 0, all changes in TX_BYTE_CNT, TX_CNT and RX_CNT_ACK are ignored. Flushing the transmit-/ receive-buffer with RXBUF FLUSH/ TXBUF FLUSH is possible. If this bit is 1 or with the change from 0 to 1, the flushing of the transmit-/ receive-buffer with RXBUF FLUSH/ TXBUF FLUSH is not possible.
RX_CNT_ACK	0-3	The value RX_CNT_ACK is a copy of the value RX_CNT. TX_CNT has been transmitted together with the last data segment of the process input data. TX_CNT_ACK is an acknowledge for the successful transmission of the data segment with RX_CNT.
TX_CNT	0-3	This value is transferred together with every data segment. The TX_CNT values are sequential: 00->01->10->11->00... (decimal: 0->1->2->3->0...) Errors in this sequence show the loss of data segments.
TX_BYTE_CNT	0 - 7	Number of the valid user data in this data segment. In PROFIBUS-DP, the data segments contain a maximum number of 6 bytes of user data.

10.3.6 Schematic diagram of the transmit sequence

Figure 10-32: Schematic diagram of the transmit sequence



10.3.7 Technical data

Figure 10-33: BL20-1RS485/422

Abbildung 11: Block diagram (RS422)

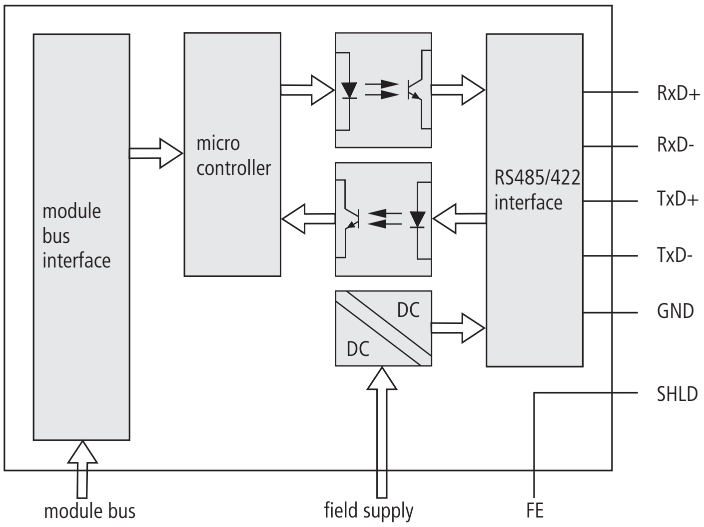


Abbildung 12: Block diagram (RS485)

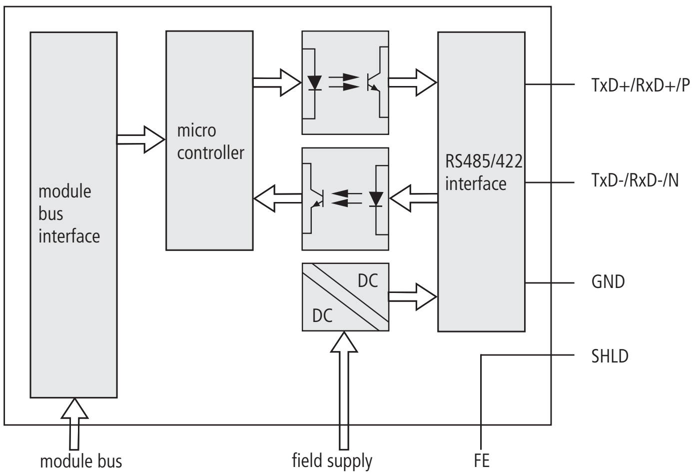


Tabelle 11: Technical data BL20-1RS485/422

Designation	BL20-1RS485/422
Number of RS485/422-interfaces	1
Nominal voltage via supply terminal	18 to VDC
Nominal current from supply terminal (field) I_{EL}	25 mA
Voltage from module bus	4,75 to 5,25 VDC
Nominal current consumption from 5 VDC (module bus) I_{MB}	60 mA
transmission channels	RxD, TxD
Data buffer	
Receive buffer	128 byte
Transmit buffer	64 byte
RS422 connection type	Two wire simplex or four wire full-duplex
RS485 connection type	Two wire half-duplex
Bit transmission rate	max. 115200 Bit/s (parameterizable)
RS485/422 cable length	max. 30 m
Cable impedance	120 Ω
Bus terminating resistors	120 Ω (external)
Isolation voltage	
U_{TMB} (module bus/ field voltage/ RS485)	500 V_{ms}
U_{Field} (field voltage/ RS485)	500 V_{ms}

10.3.8 Diagnostic and status messages

Diagnosis via LEDs

Table 10-1: Diagnosis via LEDs

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two ad-joining electronic modules have been pulled. This concerns modules located between this module and the gateway.
	Red flashing, 0,5 Hz	Diagnosis pending	-
	Off	No error messages or diagnostics	–
TxD	Green	Data currently transmitted	-
	Off	No data currently transmitted	-
RxD	Green	Data currently received	-
	Off	No data currently received	-

Diagnosis via software

The module has the following diagnostic data available.

Table 10-2: Diagnosis

Diagnostic message	
Buffer Overflow	Overflow of the receive-buffer (RX-buffer).
Frame error	The module has to be parameterized for adaptation to the data structure of the data terminal equipment (DTE). A frame error occurs in case of inconsequent parameterization (number of data bits, stop bits, method of parity,...).
Data flow control error	The DTE connected t the module does not react to XOFF or RTS handshake. The internal receive-buffer may overflow (buffer-overflow = 1).
Hardware failure	The module has to be replaced (e.g. error in EEPROM or UART)
Parameterization error	The parameter settings can not be supported.

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10.3.9 Module parameters

Table 10-3: Module parameters

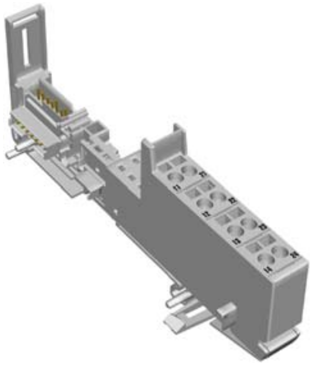
A*default-settings*

Parameter name	Value	
Diagnostic	release	Diagnosis activated/ diagnosis deactivated: This item only concerns the field bus specific diagnostic messages not the diagnosis mapped into the process input data of the module
	block **A**	
Disable ReducedCtrl	1	Constant setting: The diagnosis messages are set in Byte 6 of the process input data (independent of "diagnostic"). Byte 6 of the process output data contains two bits which may set to flush the transmit- or the receive-buffer. Byte 7 contains the status- or the control-byte. Bytes 0 to 5 contain the user data.
Data rate	300 Bit/s 600 Bit/s 1200 Bit/s 2400 Bit/s 4800 Bit/s 9600 Bit/s **A** 14400 Bit/s 19200 Bit/s 28800 Bit/s 38400 Bit/s 57600 Bit/s 115200 Bit/s	
software data flow control	None **A**	The data flow control is deactivated.
	XON/XOFF	Software handshake (XON/XOFF) activated. (this function is only available for RS422 operation.)
Data bits	7 **A**	The number of data bits is 7.
	8	The number of data bits is 8.
Parity	none	-
	odd **A**	The number of the bits set (data bits and parity bit) is odd.
	even	The number of the bits set (data bits and parity bit) is even.
stop bits	1	Number of stop bits is 1.
	2 **A**	Number of stop bits is 2.
XON character (RS422)	0 – 255 (17**A**)	XON character for RS422 operation. This character is used to start the data transfer of the data terminal device with the software handshake activated.

Tabelle 11:	XOFF character (RS422)	0 – 255 (19 **A**)	XOFF character for RS422 operation. This character is used to stop the data transfer of the data terminal device with the software handshake activated.

10.3.10 Base modules

Figure 10-1: Base module BL20-S4T-SBBS



- with tension clamp connection BL20-S4T-SBBS
- with screw connection BL20-S4S-SBBS

10.3.11 Wiring diagrams

Figure 10-2: Wiring diagram BL20-S4x-SBBS for module as RS422

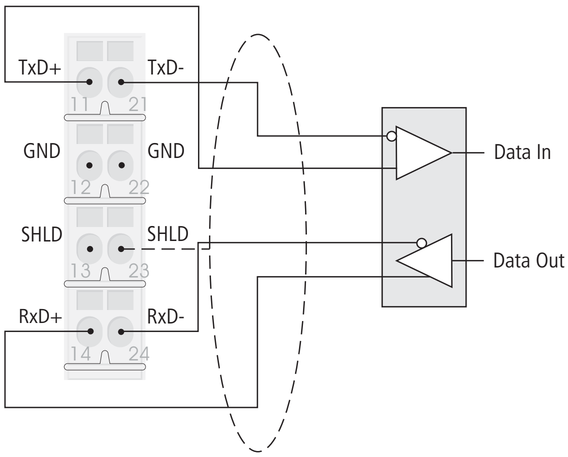
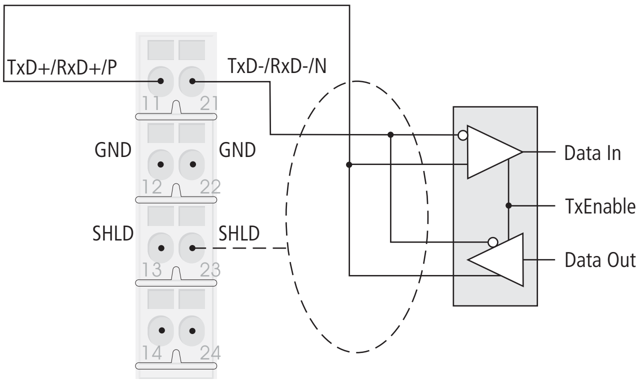


Figure 10-3: Wiring diagram BL20-S4x-SBBS for module as RS485



Signal types

Table 10-1: Pin assignment RS485/422

Signal designation	
RxD	Receive Data
TxD	Transmit Data
GND	Ground

10.4 SSI Interface BL20-1SSI

The BL20-1SSI module is used for connecting SSI encoders with a maximum word length of 32 bits and a maximum bit transmission rate of 1Mbit/s. It provides a 24 VDC (500 mA) power supply.

In order to read SSI encoder data, the module outputs a clock signal with which the encoder value can be read via the signal input. The clock signal and the signal input are based on the RS422 protocol.

10.4.1 Transmission procedure

The BL20-1SSI module enables the SSI data to be transferred according to the requirements of the application. The parameters of the module can be configured by the user to set up a functional transmission procedure as required.

- Gray code or binary code data transmission is possible.
- Bit transmission rates from 62.5 Kbit/s to 1 Mbit/s are possible.

The SSI encoder value can be represented in a data frame with between 1 to 32 bits. Bits can be deactivated at both the LSB and MSB side of the frame. At the MSB side this is done by a masking operation, which causes invalid bits to be set to 0. At the LSB side, the invalid bits are removed by shifting the entire data frame to the right. The missing bits on the MSB side are filled with zeros.

10.4.2 Data exchange

The process output data is transmitted from the PLC to the BL20-1SSI module, whilst the process input data is transferred from the module to the PLC.

The process output data is used for writing the registers and requesting data from them. It is possible to stop the communication with the SSI encoder and activate or deactivate comparison operations.

The process input data is used for reading the contents of the registers inside the modules. In this case, the SSI encoder value is part of the register. The writing of these registers can be controlled. The results of different comparison operations can be supplied, and the communication status with the SSI encoder can also be displayed. Status messages that were generated by the connected SSI encoder can be passed to the PLC as process input data.

The diagnostics messages are also embedded in the process input data.

The parameter and diagnostics interface allows acyclic data to be transferred in addition to this cyclic data. The parameters for the data transmission on the SSI module, such as bit transmission rate, telegram length etc. are set via the parameter interface. The diagnostics interface supplies the higher level system with error messages, such as parameter errors.

10.4.3 Internal registers - read and write operations

The SSI module is provided with a universal register interface that enables access to up to 64 registers. These are accessed via the process data.

For write access, it must be ensured beforehand that the register write interface is in the default status and that a write access operation is therefore not currently active. This is ensured if REG_WR = 0 in the process output data, and is confirmed in the process input data with REG_WR_AKN = 0. Write access is then possible. The following values must be transferred with the process output data for this:

- REG_WR_ADR = Register address,
- REG_WR_DATA = Value to be written (32 bit)
- REG_WR = 1 (write command)

The SSI module acknowledges the processing of the write command via the process input data by signalling REG_WR_AKN = 1. REG_WR_ACEPT = 1 in the process input data confirms whether the write operation to the register was successfully completed. If the register could not be written (no access authorization, out of value range,...), this is indicated by REG_WR_ACEPT = 0. The write operation must then be terminated by REG_WR = 0 in order to resume the default state.

The address specified at REG_RD_ADR of the process output data is used for read access. The read register content is entered in REG_RD_DATA (bytes 4-7) if the address at REG_RD_ADR was accepted in the process input data and if REG_RD_ABORT = 0 confirms that the register was read error-free. REG_RD_ABORT = 1 indicates that the register could not be read. REG_RD_ADR in the process input data then contains the address that could not be accessed successfully. The user data is then set to ZERO.

10.4.4 Register access and meaning

Table 10-2: Register access and meaning

Designation		Description	Default (HEX)
REG_SSI_POS		Actual binary SSI encoder value	
REG_MAGIC_NO	1	Magic number (0xaa55cc33)	
REG_HW_VER	2	Hardware version	
REG_SW_VER	3	Software version	
REG_SF	4	Special Function register	
REG	5	Reserve	
	...		
REG_WR_ADR	14	Pointer register OUT	
PREG_RD_ADR	15	Pointer register IN	
REG_DIAG1	16	Diagnostics data	
REG	17	Reserve	
	...		
REG_PARA1	20	Parameter data	0 x 19 01 00 00
REG	21	Reserve	
	...		
REG_GRAY_POS	32	32 Actual Gray-coded SSI encoder value.	
REG_SSI_FRAME	33	33 Complete frame read from SSI encoder.	
REG_CMP1	34	Comparison value 1	0 x 00 00 00 00
REG_CMP2	35	Comparison value 2	0 x 00 00 00 00

Table 10-2: Register access and meaning

Designation		Description	Default (HEX)
REG	36	Reserve	
	...		
REG_LOWER_LIMIT	484	Lower limit	0 x 00 00 00 00
REG_UPPER_LIMIT	49	Upper limit	0 x FF FF FF FF
REG_OFFSET	50	Offset value	0 x 00 00 00 00
REG_SSI_MASK	51	Selection of the SSI encoder diagnostics transferred to the diagnostics interfaces	0 x 00 00 00 00
	52 to 63	Reserve	

Tabelle 11: Designation of the interfaces

Designation		Interfaces				
		Process output	Storage in module	Process input	Param.	Diagn.
REG_ SSI_POS	0			RD		
REG_MAGIC_NO	1			RD		
REG_HW_VER	2			RD		
REG_SW_VER	3			RD		
REG_SF	4	WR	volatile	RD		
REG_WR_ADR	14			RD		
REG_RD_ADR	15			RD		
REG_DIAG1	16			RD		RD
REG_PARA1	20	WR	non violette	RD	WR	
REG_GRAY_POS	32			RD		
REG_SSI_FRAME	33			RD		
REG_CMP1	34	WR	volatile	RD		
REG_CMP2	35	WR	volatile	RD		
REG_LOWER_LIMIT	48	WR	non volatile	RD		
REG_UPPER_LIMIT	49	WR	non volatile	RD		
REG_OFFSET	50	WR	non volatile	RD		
REG_SSI_MASK	51	WR	non volatile	RD		

Note

The non volatile registers can be written maximum 100.000 times.

10.4.5 Comparison value 1, comparison value 2

The recorded encoder position can be compared with two loadable values. The character "x" below stands for "1" or "2". The register contents are loaded into the register REG_CMPx using in a write operation. The comparison functions are activated by setting bit EN_CMPx = 1 in the process output data. The results of the continuous comparison operations are displayed in the process input data via STS_CMPx, REL_CMPx and FLAG_CMPx. Bit REL_CMPx indicates as the actual status message the relation of the actual value (register content of REG_SSI_POS) to the comparison value (register content of REG_CMPx). Bit STS_CMPx is non-retentive and indicates whether the current actual value (REG_SSI_POS) and the comparison value (REG_CMPx) match. FLAG_CMPx is also used as a marker to indicate that the status (REG_SSI_POS = REG_CMPx) is present or lost. This bit must be reset by the application via the process output data using CLR_CMPx = 1. If the comparator is inactive (EN_CMPx = 0), the signals from STS_CMPx, REL_CMPx and FLAG_CMPx are always zero.

Table 10-1: Comparator enable

A
**The value Z0 of this flag is 1 as soon as the comparison values match. The value stays 1 until it is reset.*

Comparator EN_CMPx = 0		
Process input data		**Process output data**
	REL_CMPx = 0 STS_CMPx = 0 FLAG_CMPx = 0	
Comparator EN_CMPx = 1		
Process input data		**Process output data**
(REG_SSI_POS) < (REG_CMPx)		
	REL_CMPx = 1 STS_CMPx =0 FLAG_CMPx = Z0 **A**	Reset the Flag FLAG_CMPx with CLR_CMPx = 1
(REG_SSI_POS) > (REG_CMPx)		
	REL_CMPx = 1 STS_CMPx =0 FLAG_CMPx = Z0 **A**	Reset the Flag FLAG_CMPx with CLR_CMPx = 1
(REG_SSI_POS) = (REG_CMPx)		
	REL_CMPx = 1 STS_CMPx = 1 FLAG_CMPx = 1	Resetting the FLAG_CMPx not possible, as long as equality exists.

10.4.6 Lower limit, upper limit

The recorded encoder position can be compared with up to two loadable limit values. The upper limit value must be entered in the REG_UPPER_LIMIT register and the lower limit value in REG_LOWER_LIMIT. Writing these registers with values that are different to the default values will activate the monitoring of the limits, and bits STS_OFLW and STS_UFLW will be enabled in the process input data. The diagnostics function will indicate the presence of values above or below the default values.

"Encoder value overflow" and "Encoder value underflow" signals will also indicate this via the acyclic diagnostics interface.

The limit values are set by default to the maximum and minimum value.

Table 10-2: Overflow of the encoder values

Register access	Process input data	Diagnostics
REG_UPPER_LIMIT at default-value FFFFFFFFh	STS_OFLW = 0	Value: 0
Register content of REG_UPPER_LIMIT less than FFFFFFFFh	(REG_SSI_POS) ≤ (REG_UPPER_LIMIT)	Value: 0
	STS_OFLW = 0	
	(REG_SSI_POS) > (REG_UPPER_LIMIT)	Value: 1 Text: Encoder value overflow
	STS_OFLW = 1	

Table 10-3: Underflow of the encoder values

Register access	Process input data	Diagnostics
REG_LOWER_LIMIT at default-value 00000000h	STS_UFLW = 0	Value: 0
Register content of REG_LOWER_LIMIT greater than 0	(REG_SSI_POS) ≥ (REG_LOWER_LIMIT)	Value: 0
	STS_UFLW = 0	
	(REG_SSI_POS) < (REG_LOWER_LIMIT)	Value: 1 Text: Encoder value underflow
	→ STS_UFLW = 1	

10.4.7 Offset function / load value

This function is activated by writing the REG_OFFSET register with a value <> 0. The content of the register is then subtracted from the SSI encoder value and stored in REG_SSI_POS. All limit values, such as lower limit, upper limit, comparison value 1, comparison value 2 then refer to the newly calculated value (REG_SSI_POS).

The calculation is thus:

(REG_SSI_POS) = SSI encoder - (REG_OFFSET)

This function can be deactivated by writing the REG_OFFSET with zero.

10.4.8 Status messages of the SSI encoder

Some SSI encoders not only transfer the position value in the data frame that they transfer to the module but also supply additional status messages. It is useful to include these status messages in the application in order to analyze the measured value.

Writing the REG_SSI_MASK register allows up to four individual bits to be taken from the data frame of the SSI encoder and transferred to the SSI_STSx bits of the process input data. It is also possible to output the "SSI encoder group diagnostics message" with an acyclic diagnostics operation when a status message is initiated.

Table 10-4: Masking with REG_SSI_MASK

Process input data	REG_SSI_MASK							
	Byte	Bit 7	Bit 6	B5	B4	B3	B2	B1
SSI_STS0	0	EN_D0_RMS0	EN_D0_DS	X	SSI_FRAME_BIT_SEL0			
SSI_STS1	1	EN_D1_RMS1	EN_D1_DS	X	SSI_FRAME_BIT_SEL1			
SSI_STS2	2	EN_D2_RMS2	EN_D2_DS	X	SSI_FRAME_BIT_SEL2			
SSI_STS3	3	EN_D3_RMS3	EN_D3_DS	X	SSI_FRAME_BIT_SEL3			

Table 10-5: Description of the diagnosis messages

A*default*

Designation	Value	Description
EN_Dx_RMSx	0 **A**	The transfer of the SSI status messages to the process input data is not activated
	1	The transfer of the SSI status messages to the process input data is activated
EN_ Dx_DS	0 **A**	The evaluation of the SSI status messages for bit 0 of the diagnostics is not activated
	1	The evaluation of the SSI status messages for bit 0 of the diagnostics is activated.
SSI_FRAME_BIT_SEL	0-31	Definition of the selected bits in the frame of the SSI encoder to be evaluated or copied. Default:0

The following applies to bit 0 (SSI group diagnostics) of the diagnostics interface and SSI_DIAG of the process input data:

(SSI_STS0 & EN_D0_DS) || (SSI_STS1 & EN_D1_DS) || (SSI_STS2 & EN_D2_DS) || (SSI_STS3 & EN_D3_DS)

10.4.9 Resetting the register bank

If register REG_SF is written with the signature:

"LD20" = 6C643230hex,
all default values of the retentive registers (incl. parameter registers) are reset.

If register REG_SF is written with the signature:

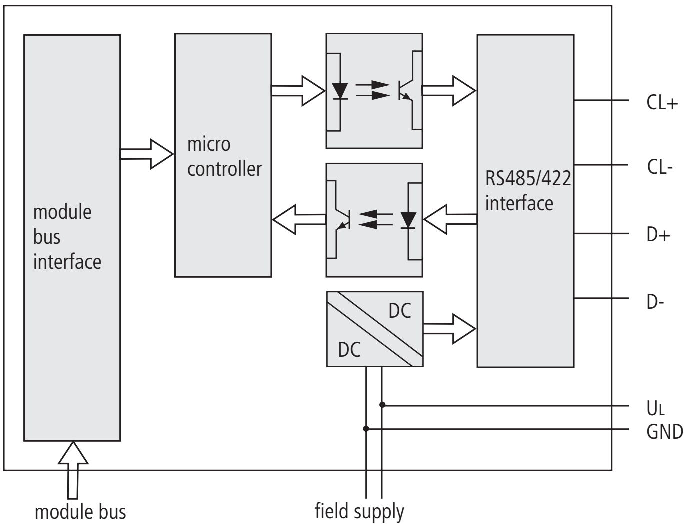
"LD48" = 6C643438hex
all default values of the retentive registers except the parameter registers are reset.

Note
Overwritten values are lost.

10.4.10 Technical data

Figure 10-4: BL20-1SSI

Figure 10-5: BL20-1SSI



The module is provided with two RS422 interfaces that form one SSI interface. One RS422 interface works as the clock generator for reading the data, which is then received on the other RS422 interface.

Table 10-6: Technical data BL20-1SSI

Designation	BL20-1SSI
Number of serial interfaces	1
Nominal voltage from supply terminal	24 VDC
Nominal current from supply voltage (field) I_{EL}	25 mA (without encoder current)
Nominal current consumption at 5 VDC (module bus) I_{MB}	50 mA
Power loss of the module	< 1 W
U_{TMB} (module bus/ field voltage)	500 V_{eff}
Encoder voltage	24 VDC (-15% / +20%)
Encoder current	500 mA (not short-circuit proof)
U_{RS1} (active)	> 500 mV
U_{RS0} (inactive)	0 to 200 mV
U_{GLRS} (common mode)	-7 to 12 mV
Clock output type	RS422
Signal input type	RS422
RS422 cable length	max. 30 m

10.4.11 Diagnostic and status messages

Diagnosis via LEDs

Tabelle 11: Diagnosis via LEDs

LED	Display	Meaning	Remedy
DIA	Red	Module bus communication failure	Check if more than two ad-joining electronic modules have been pulled. This concerns modules located between this module and the gateway.
	Off	No error messages or diagnostics	–
UP	Green	Direction of movement upwards	–
	Off	No upwards direction of movement	–
DN	Green	Direction of movement downwards	–
	Off	No downwards direction of movement	–

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Diagnosis via software

The module has the following diagnostic data available.

Table 10-1: Diagnosis

Diagnostic message	
SSI group diagnostics	Status messages of the SSI encoder present.
Wire-break	SSI encoder signal faulty (e.g. due to a cable break).
Encoder values overflow	SSI encoder value above upper limit. Overflow occurred.
Encoder values underflow	SSI encoder value below lower limit. Underflow occurred.
Parameter error	Operation of the module is not possible with the present parameter set.

10.4.12 Module parameters

Table 10-2: Module parameters

A *default-settings*

Parameter name	Value	Description
Encoder data cable test	Activate **A**	ZERO test of data cable.
	Deactivate	After the last valid bit, a ZERO test of the data cable is not carried out.
Number of invalid bits (LSB)	"0" to "15"	Number of invalid bits on the LSB side of the position value supplied by the SSI encoder. The meaningful word width of the position value transferred to the module bus master is as follows: SSI_FRAME_LEN - INVALID_BITS_MSB - INVALID_ BITS_LSB. The invalid bits on the LSB side are removed by shifting the position value to the right, starting with the LSB. (Default 0 Bit = 0x 0). INVALID_BITS_MSB + INVALID_BITS_LSB must always be less than SSI_FRAME_LEN.
Number of invalid bits (MSB)	"0" to "7"	Number of invalid bits on the MSB side of the position value supplied by the SSI encoder. The meaningful word width of the position value transferred to the module bus master is as follows: SSI_FRAME_LEN -INVALID_BITS_MSB - INVALID_BITS_LSB. The invalid bits on the MSB side are zeroed by masking the position value. INVALID_BITS_MSB + INVALID_BITS_LSB must always be less than SSI_FRAME_LEN. Default: 0 = 0hex

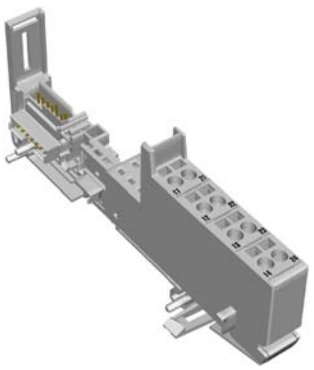
	Bit transmission rate	1000000 Bit/s 500000 Bit/s **A** 250000 Bit/s 125000 Bit/s 100000 Bit/s 83000 Bit/s 71000 Bit/s 62500 Bit/s	
	Number of data frame bits	1 to 32	Number of bits of the SSI data frame. SSI_FRAME_LEN must always be greater than INVALID_BITS. Default: 25 = 19hex
	Data format	Binary coded	SSI encoder sends data in binary code
		GRAY coded	SSI encoder sends data in Gray code

Number of data frame bits:

INVALID_BITS_MSB: Number of invalid bits (MSB)
INVALID_BITS_LSB: Number of invalid bits (LSB)
INVALID_BITS: INVALID_BITS_MSB + INVALID_BITS_LSB

10.4.13 Base modules

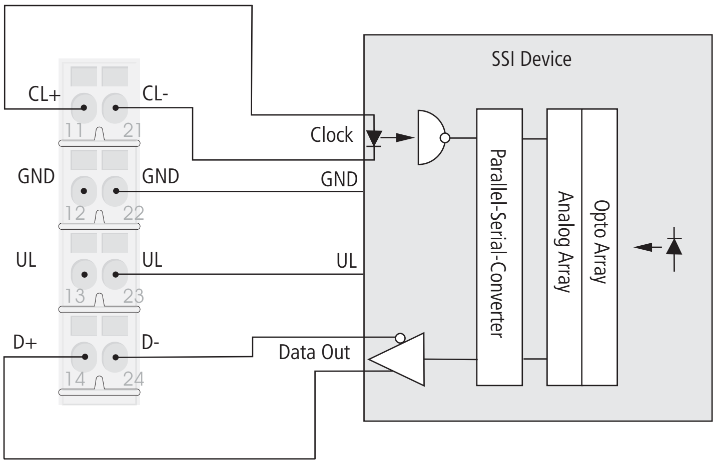
Figure 10-6: Base module BL20-S4T-SBBS



- with tension clamp connection
  BL20-S4T-SBBS
- with screw connection
  BL20-S4S-SBBS

10.4.14 Wiring diagrams

Figure 10-7: Wiring diagram BL20-S4x-SBBS



Signal types

Table 10-3: Pin assignment SSI

Signal designation	
CL	Clock
D	Data
GND	Ground

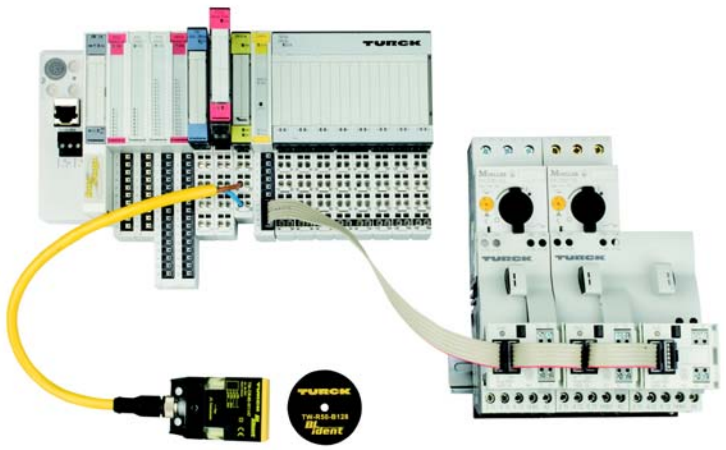
10.5 BL20-E-1SWIRE

10.5.1 Features

The BL20-E-1SWIRE makes it possible to operate an SWIRE bus with up to 16 SWIRE slaves. A 6-core cable is used here for power and data transfer.

A BL20-Station may contain a maximum number of 3 SWIRE-modules.

Abbildung 11: BL20-E-1SWIRE in a BL20-system



The voltage U_{AUX} for supplying the relays and the U_{SW} for supplying the electronic equipment must be connected separately on the BL20-E-1SWIRE.

Both power supplies must be fed from a single power supply unit although it is possible to disconnect U_{AUX} separately. The SWIRE slaves and the accessories must be purchased from TURCK.

The product BL20-E-1SWIRE connects the motor starters networked via SWIRE as local components to different standard fieldbus systems.

The maximum number of BL20-E-1SWIRE modules per BL20 station is restricted by:

- the number of process data, diagnostics, parameter and configuration bytes of the BL20-E-1SWIRE:
  – 8 bytes input data
  – 8 bytes output data
  – 24 bytes parameter data
  – 8 bytes diagnostics data
- and the fieldbus system used.

From version VN 01-04, BL20-E-1SWIRE can be run in conformance with the Moeller SmartWire standard. For this the "Moeller Conformance" function has been implemented. See page 10-89, Moeller SWIRE conformance criteria..

Figure 10-1: BL20-E-1SWIRE

10.5.2 Function parameterization

Scan physical structure and store in the BL20-E-1SWIRE

In order for the SWIRE bus to start operation, the physical structure must match the SWIRE configuration stored in the BL20-E-1SWIRE. On power up, the physical structure of the SWIRE bus is scanned and compared with the SWIRE configuration stored in the BL20-E-1SWIRE (configuration check of number of slaves, type and assigned address). If the physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE (SW LED flashing):

- the physical structure of the SWIRE bus must be stored in the BL20-E-1SWIRE
- or the physical structure must be corrected.

The parameter setting determines how the physical structure of the SWIRE bus is stored:

- manually (see below Section "Manual SWIRE configuration (default setting)")
- or automatically (see below Section "Automatic SWIRE configuration").

Note
Only the manual SWIRE configuration is possible if the "Moeller Conformance" function is active.
The BL20-E-1SWIRE is factory set with a stored configuration of "Zero" slaves.

Storing with manual and automatic SWIRE configuration:

- The slaves physically located on the SWIRE bus are scanned.
- Each slave is assigned an address which is stored in the corresponding slave.
- The configuration is stored in the BL20-E-1SWIRE.

Manual SWIRE configuration (default setting)

To store the physical structure of the SWIRE bus in the BL20-E-1SWIRE, the CFG button of the BL20-E-1SWIRE must be pressed manually (only functions if the SW LED is flashing).

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - Disable CFG = 0
- DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 1 = 0

Automatic SWIRE configuration

If the physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE on power up, the physical structure is stored automatically in the BL20-E-1SWIRE.

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - Disable CFG = 1
    and
  - MC = 0
  - DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 1 = 1 and
  - Bit 4 = 0

Activate and deactivate PLC configuration check

During the PLC configuration check, the configuration stored in the BL20-E-1SWIRE is compared with the SET configuration stored in the PLC. The complete device ID must match. If the two configurations match completely, the entire SWIRE bus is ready for data exchange (RDY LED lit). If the two configurations do not match, the system responds according to other parameter settings (see System behavior with negative configuration checks and slave failure, page 10-73).

PLC configuration check active (default setting)

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - Configuration = 0
- DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 2 = 0

PLC configuration check inactive

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - Configuration = 1
- DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 2 = 1

System behavior with positive configuration checks

1 The physical structure of the SWIRE bus is scanned on power up and compared with the configuration stored in the BL20-E-1SWIRE (SW LED flashing).
   - The SWIRE bus starts operation (SW LED lit) if the physical structure of the SWIRE bus matches the SWIRE configuration stored in the BL20-E-1SWIRE.

2 If the PLC configuration check is activated, the configuration stored in the BL20-E-1SWIRE is compared with the SET configuration stored in the PLC. The complete device ID must match.
   - If the two configurations match completely, the entire SWIRE bus is ready for data exchange (RDY LED lit)

3 The system then starts data exchange.

4 The physical structure of the SWIRE bus is monitored continuously during operation so that any changes on the bus or slave failures can be detected.

System behavior with negative configuration checks and slave failure

Attention

SWIRE bus energized
Any manipulation of the physical structure (e.g. exchange of the SWIRE slaves) may damage the device.
→ De-energize the SWIRE bus before carrying out any changes.

The system behavior when the result of a configuration check is negative, depends on the individual parameter settings:

Note

The following functions are deactivated if the "Moeller Conformance" function is active:
– Automatic SWIRE configuration
– Bus-oriented configuration check
– Slave-oriented configuration check

The following occurs if the physical structure of the SWIRE bus is found not to match the configuration stored in the BL20-E-1SWIRE on power up (SW LED flashing):

- If the "Moeller Conformance" function is deactivated, the physical structure is continuously compared with the configuration stored in the BL20-E-1SWIRE. The SWIRE bus starts operation as soon as the matching configurations are detected:
  - After the physical structure was stored in the BL20-E-1SWIRE:
    - Automatically (if the automatic SWIRE configuration is activated)
    - Or manually (if the automatic SWIRE configuration is deactivated), by pressing the CFG button (only functions if the SW LED is flashing).
  - After the physical structure has been rectified.
- The operation is aborted if the "Moeller Conformance" function is activated. The SWIRE bus only starts operation:
    - After the physical structure was stored in the BL20-E-1SWIRE and a match was determined:
    - Manually, by pressing the CFG button (only functions if the SW LED is flashing).
      After the configuration is stored, the physical structure is compared once more with the configuration stored in the BL20-E-1SWIRE.

 – If the physical structure of the SWIRE bus matches the configuration stored in the BL20-E-1SWIRE the next time that USW is switched on.

The following occurs if the PLC configuration check (PLC configuration check must be activated) finds that the configuration stored in the BL20-E-1SWIRE does not completely match the SET configuration stored in the PLC:

- If the configuration check is set to Bus-oriented or the "Moeller Conformance" function is activated, the operation is aborted for the entire SWIRE bus (RDY LED flashing).
- If the configuration check is set to Slave-oriented:
  - The SWIRE slaves that match are ready for data exchange.
  - The operation is aborted for the SWIRE slaves that do not match.

The system behaves as follows if a modification to the bus or a slave failure is detected:

- If the "Moeller Conformance" function is activated, the system retains data exchange with the functional SWIRE slaves.
- If the "Moeller Conformance" function is deactivated, SWIRE communication on the entire SWIRE bus is aborted. The physical structure is then compared cyclically with the configuration stored in the BL20-E-1SWIRE.
  - The SWIRE bus starts operation as soon as matching configurations are detected:
    - After the physical structure was stored in the BL20-E-1SWIRE:
      - Automatically (if the automatic SWIRE configuration is activated)
      - Or manually (if the automatic SWIRE configuration is deactivated), by pressing the CFG button (only functions if the SW LED is flashing).
    - After the physical structure has been rectified.
  - Depending on the parameter settings, the data exchange is then either started or the operation is aborted:
    - The data exchange is resumed immediately if the PLC configuration check is deactivated.
    - If the PLC configuration check is activated and the configuration check is set to Bus-oriented, data exchange is only restarted if the configuration stored in the BL20-E-1SWIRE matches the SET configuration stored in the PLC. The operation for the entire SWIRE bus is aborted if they do not match completely.
    - If the PLC configuration check is activated and the configuration check is set to Slave-oriented, the configuration stored in the BL20-E-1SWIRE is compared with the SET configuration stored in the PLC:
      - The SWIRE slaves that match resume data exchange.
      - The operation is aborted for the SWIRE slaves that do not match.

Bus-oriented configuration check (default setting)

Note
This function is automatically deactivated if the "Moeller Conformance" function is active.

If the physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE on power up (SW LED flashing), the physical structure is compared continuously with the configuration stored in the BL20-E-1SWIRE. The SWIRE bus starts operation as soon as the matching configurations are detected:

After the physical structure was stored in the BL20-E-1SWIRE:

- Automatically (if the automatic SWIRE configuration is activated)
- Or manually (if the automatic SWIRE configuration is deactivated), by pressing the CFG button (only functions if the SW LED is flashing).

- After the physical structure has been rectified.

If the PLC configuration check is activated, data exchange is only started if the configuration stored in the BL20-E-1SWIRE fully matches the SET configuration stored in the PLC. If the two configurations do not match completely (RDY LED flashing), the operation is aborted for the entire SWIRE bus (RDY LED flashing).

SWIRE communication is aborted for the entire SWIRE bus, if a bus modification or slave failure is detected during operation. The physical structure is then compared cyclically with the configuration stored in the BL20-E-1SWIRE.

- The SWIRE bus starts operation as soon as the matching configurations are detected:
  - After the physical structure was stored in the BL20-E-1SWIRE:
    - Automatically (if the automatic SWIRE configuration is activated)
    - Or manually (if the automatic SWIRE configuration is deactivated), by pressing the CFG button (only functions if the SW LED is flashing).
  - After the physical structure has been rectified.
- Depending on the parameter settings, the data exchange is then either started or the operation is aborted:
  - The data exchange is resumed immediately if the PLC configuration check is deactivated.
  - If the PLC configuration check is activated, data exchange is only restarted if the configuration stored in the BL20-E-1SWIRE fully matches the SET configuration stored in the PLC. The operation for the entire SWIRE bus is aborted if they do not match completely.

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - MNA = 0
    and
  - MC = 0 (MXpro: "Moeller compliant" = deactivate)
- DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 3 = 0 and
  - Bit 4 = 0

Slave-oriented configuration check

> **Note**
> This function is automatically deactivated if the "Moeller Conformance" function is active.

If the physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE on power up (SW LED flashing), the physical structure is compared continuously with the configuration stored in the BL20-E-1SWIRE. The SWIRE bus starts operation as soon as matching configurations have been detected:

- After the physical structure was stored in the BL20-E-1SWIRE:
  - Automatically (if the automatic SWIRE configuration is activated)
  - Or manually (if the automatic SWIRE configuration is deactivated), by pressing the CFG button (only functions if the SW LED is flashing).
- After the physical structure has been rectified.

If the PLC configuration check is activated, data exchange is started with all SWIRE slaves that match the SET configuration stored in the PLC. The SWIRE slaves that do not match the SET configuration stored in the PLC do not perform any data exchange.

SWIRE communication is aborted for the entire SWIRE bus, if a bus modification or slave failure is detected during operation. The physical structure is then compared cyclically with the configuration stored in the BL20-E-1SWIRE.

- The SWIRE bus starts operation as soon as the matching configurations are detected:
  - After the physical structure was stored in the BL20-E-1SWIRE:
    - Automatically (if the automatic SWIRE configuration is activated)
    - Or manually (if the automatic SWIRE configuration is deactivated), by pressing the CFG button (only functions if the SW LED is flashing).
  - After the physical structure has been rectified.
- Depending on the parameter settings, the data exchange is then either started or the operation is aborted:
  - The data exchange is resumed immediately if the PLC configuration check is deactivated.
  - If the PLC configuration check is activated, the configuration stored in the BL20-E-1SWIRE is compared with the SET configuration stored in the PLC.
    - The SWIRE slaves that match resume data exchange.
    - The operation is aborted for the SWIRE slaves that do not match.

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - MNA = 1
    and
  - MC = 0
- DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 3 = 1 and
  - Bit 4 = 0

10.5.3 MC (Moeller Conformance)

If the "Moeller Conformance" function is activated, the BL20-E-1SWIRE behaves according to the Moeller SWIRE conformance criteria. Moeller SWIRE conformance criteria, see Chapter 6. Moeller SWIRE conformance criteria, page 55.

If the physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE (SW LED flashing) when USW is switched on, the SWIRE bus only starts operation:

- After the physical structure was stored in the BL20-E-1SWIRE:
  - Manually, by pressing CFG button (only functions if the SW LED is flashing). After the configuration is stored, the physical structure is compared once more with the configuration stored in the BL20-E-1SWIRE.
- If the physical structure of the SWIRE bus matches the configuration stored in the BL20-E-1SWIRE the next time that USW is switched on.

If the PLC configuration check is activated, data exchange is only started if the configuration stored in the BL20-E-1SWIRE fully matches the SET configuration stored in the PLC. If the two configurations do not match completely (RDY LED flashing), the operation is aborted for the entire SWIRE bus (RDY LED flashing).

The system retains data exchange with the functional SWIRE slaves if a modification or slave failure is detected in the SWIRE bus during operation.

Parameter setting:

- PROFIBUS-DP and CANopen (Byte 1):
  - MC = 1 (
- DeviceNet (Attribute 121 (79hex) "PARAM_COMMON_OERATION_MODES"):
  - Bit 4 = 1

10.5.4 Other parameters

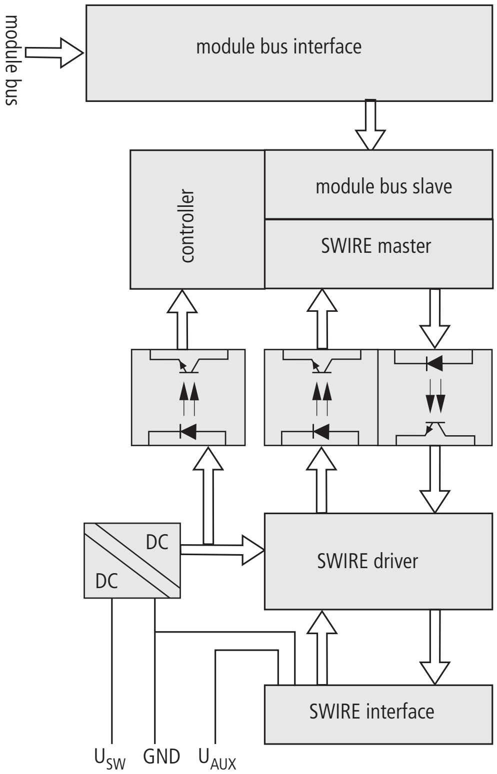
The parameters U_{AUXERR}, $TYPE_{ERR}$, $TYPE_{INFO}$, PKZ_{ERR}, PKZ_{INFO}, SD_{ERR} and SD_{INFO} enable events to be indicated to the PLC as an error message or not.

10.5.5 Diagnostics

Faulty system states are indicated by means of a number of different diagnostics messages. The error messages U_{AUXERR}, $TYPE_{ERR}$, $TYPE_{ERR}$Sx, PKZ_{ERR}, PKZ_{ERR}Sx, SD_{ERR} and SD_{ERR}Sx can be deactivated via the parameter setting.

10.5.6 Technical features

Figure 10-2: Block diagram



Technical data

Tabelle 11: technical data SWIRE

Designation	BL20-E-1SWIRE
Number of SWIRE buses	1
Number of slaves per bus	16
Power supply	
Field voltage (range)	24 V DC (18 to 30 V DC)
Field current (SWIRE buses at full load)	max 600 mA
Power supply of contactors (range)	24 V DC (18 to 30 V DC)
Power supply current of contactors	3 A
Rated current from module bus (module bus voltage)	60 mA (4,75 to 5,25 V DC)
Power supply of SWIRE slaves (short-circuit protected)	17 V DC
Power supply current of all SWIRE slaves (short-circuit protected)	max 500 mA
Insulation voltage between SWIRE and the module bus	500 V_{rsm}
Insulation voltage between power supply of contactors and the field voltage	500 V_{rsm}
Insulation voltage between SWIRE and power supply of contactors	none
Product standard	EN 61131-2
Protection type	IP 20

Approved SWIRE slaves

The following slaves on the SWIRE bus are currently approved for the BL20-E-1SWIRE:

ID	Device	Manufacturer
0x20	SWIRE-DIL	Moeller

Diagnosis via LEDs

Table 10-1: Diagnosis via LEDs

LED	Signal	Meaning
module diagnostics		
DIA	OFF	o.k.
	Red	Module bus communication faulty
	Red flashing	Module indicates a diagnostics message
configuration status		
Rdy	OFF	SWIRE bus not active
	Green	– The SWIRE bus is ready for data exchange. – If the PLC configuration check is activated: – The configuration stored in the BL20-E-1SWIRE matches the SET configuration stored in the PLC. – SW LED and RDY LED are lit: The SWIRE bus is in data exchange mode.
	Green flashing	– The PLC configuration check is carried out. – The configuration stored in the BL20-E-1SWIRE does not match the SET configuration stored in the PLC.
SWIRE bus status		
SW	OFF	SWIRE bus not active
	Green	– The physical structure of the SWIRE bus matches the configuration stored in the BL20-E-1SWIRE. – The SWIRE bus is in operation. – SW LED and RDY LED are lit: The SWIRE bus is in data exchange mode.
	Green flashing	– The physical structure of the SWIRE bus is compared with the configuration stored in the BL20-E-1SWIRE. – The physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE. – The SWIRE bus cannot be assigned a valid configuration. Possible causes: – SWIRE bus with zero slaves. – SWIRE slave faulty.

Table 10-1: Diagnosis via LEDs

LED	Signal	Meaning
indication of the SWIRE bus operating voltage		
U_{SW}	OFF	– The voltage U_{SW} is faulty. – The module bus voltage is not present.
	Green	The voltage U_{SW} is within the permissible range and the module bus voltage is present.
indication of the relay supply of the bus		
U_{AUX}	OFF	The voltage U_{AUX} is faulty.
	Green	The voltage U_{AUX} is in the permissible range.

Diagnosis via software

Table 10-2: Diagnostic messages via software

Designation	Value		Meaning
SW_{ERR}	SWIRE MASTER		
	If the physical structure of the SWIRE bus does not match the configuration stored in the BL20-E-1SWIRE, this bit indicates an error.		
	0	Data exchange	The physical structure of the SWIRE bus was accepted and the SWIRE bus is in operation.
	1	Offline	The physical structure was not accepted, the SWIRE bus does not start operation (SW LED flashing).
RDY_{ERR}	PLC Slave		
	This bit indicates an error if the configuration stored in the BL20-E-1SWIRE does not match the SET configuration stored in the PLC.		
	0	OK	No error present. The SWIRE bus is ready for data exchange.
	1	Offline	The configuration stored in the BL20-E-1SWIRE was not accepted. The data exchange is prevented (RDY LED flashing).
COM_{ERR}	Communication SWIRE		
	A communication error is present, as long as a slave can no longer be reached, its internal timeout has elapsed or communication is faulty. The master cannot carry out data exchange with at least one slave.		
	0	OK	No error present.
	1	faulty	An error is present

Table 10-2: Diagnostic messages via software

Designation	Value		Meaning
U_{SWERR}	Voltage U_{SW}		
	Voltage fault in U_{SW}, voltage U (17 VDC) for supplying the SWIRE slaves		
	0	OK	No error present.
	1	Undervoltage	An error is present
$GENE\text{-}RAL_{ERR}$	Error message		
	The creation of a function block shows that systems / function blocks for the general checking of a slave for any diagnostics messages present only check the first byte.		
	0	None	No diagnostics message present
	1	Present	One/several diagnostics messages present
SD_{ERR}	Communication SWIRE slave		
	If the parameter $SD_{ERR}A$ is set for group diagnostics, this bit indicates an error as soon as only one slave on the bus sets its SD_{ERR} error bit.		
	0	OK	No error is present or diagnostics function has been deactivated via the parameter setting.
	1	faulty	An error is present
PKZ_{ERR}	Overcurrent protective circuit-breaker		
	If the parameter $PKZ_{ERR}A$ is set for group diagnostics, this bit indicates an error as soon as only one PKZ of a slave has tripped.		
	0	OK	No PKZ has tripped or diagnostics function has been deactivated via the parameter setting.
	1	Tripping	At least one PKZ has tripped.
$TYPE_{ERR}$	Configuration		
	If the TYP_{ERR} parameter is set with group diagnostics in the parameter setting, this bit indicates an error as soon as a PLC configuration check detects differing slave numbers, types or position of an SWIRE slave.		
	0	OK	The PLC configuration check was positive (the configuration stored in the BL20-E-1SWIRE matches the SET configuration stored in the PLC) or the diagnostics function is deactivated via the parameter setting.
	1	faulty	A mismatch was determined in the PLC configuration check.

Table 10-2: Diagnostic messages via software

Designation	Value		Meaning
U_{AUXERR}	Voltage U_{AUX}		
	If the U_{AUXERR}A parameter is activated, U_{AUXERR} will generate an error message as soon as the power supply goes below the level at which the function of the relays is not guaranteed.		
	0	OK	Contactor supply voltage is o.k. (> 20 VDC) or diagnostics function has been deactivated via this parameter.
	1	Undervoltage	Contactor supply voltage is not o.k. (< 18 VDC).
$TYPE_{ERR}Sx$	Device configuration, slave x		
	Info field for the individual indication of a configuration error as error message. If the TYP_{INFO} parameter is set with individual diagnostics, the error is indicated in this bit field as soon as a PLC configuration check detects differing slave numbers, types or position of an SWIRE slave.		
	0	OK	No configuration error is present and the slave is in data exchange mode or diagnostics function has been deactivated via the parameter setting.
	1	Incorrect	No configuration error present and the slave is NOT in data exchange mode
$SD_{ERR}Sx$	Communication, slave x		
	Info field for the individual indication of the release of the slave diagnostics as error message. If the SD_{INFO}A is set for single diagnostics, this bit field indicates the error as soon as the slave diagnostic message of the slave Sx is triggered.		
	0	OK	No error is present or diagnostics function has been deactivated via the parameter setting.
	1	Offline	The slave has set its diagnostics bit or the slave was in data exchange with the SWIRE master but is not any longer.
$PKZ_{ERR}Sx$	Only SWIRE-DIL: Overcurrent protective circuit-breaker slave x		
	Info field for the individual indication of the tripping a motor-protective circuit-breaker (PKZ) as error message. If the PKZ_{INFO}A is set for single diagnostics, this bit field indicates the error as soon as the PKZ of the slave Sx has tripped.		
	0	OK	The PKZ of the slave has not tripped or diagnostics function has been deactivated via the parameter setting.
	1	Tripped	The PKZ of the slave has tripped.

Note

The error messages U_{AUXERR}, TYP_{ERR}, $TYP_{ERR}Sx$, PKZ_{ERR}, $PKZ_{ERR}Sx$, SD_{ERR} and $SD_{ERR}Sx$ can be deactivated via parameter settings.

10.5.7 Module parameters

The module has 25 bytes of parameters available:Wiring diagram and pin assignment

Table 10-3: Module parameters

A*Default setting*

Parameter name	Value	Meaning
Byte 1		
Disable Cfg	If the physical structure of the SWIRE bus does **not** match the configuration stored in the BL20-E-1SWIRE on power up (SW LED flashing), the physical structure of the SWIRE bus must be stored in the BL20-E-1SWIRE.	
	Inactive **A**	Manual SWIRE configuration: To store the physical structure of the SWIRE bus in the BL20-E-1SWIRE, the CFG button of the BL20-E-1SWIRE must be pressed manually (only functions if the SW LED is flashing).
	Active	Automatic SWIRE configuration: If the physical structure of the SWIRE bus does **not** match the configuration stored in the BL20-E-1SWIRE on power up, the physical structure is stored automatically in the BL20-E-1SWIRE.
Configuration	PLC configuration check	
	If the PLC configuration check is activated, the configuration stored in the BL20-E-1SWIRE is compared with the SET configuration stored in the PLC.	
	Active **A**	The configuration stored in BL20-E-1SWIRE is compared with the SET configuration stored in the PLC. Only SWIRE slaves in the SWIRE bus are accepted that have a device ID completely matching the SET configuration.
	Inactive	All slaves are mapped in 4Bit INPUT / 4Bit OUTPUT without checking the device ID.

Table 10-3: Module parameters

A*Default setting*

Parameter name	Value	Meaning
MNA active/ passive	Configuration check	
	Bus or slave-oriented configuration check (without function if MC = 1)	
	Bus based **A**	If the PLC configuration check is activated, data exchange is only started if the configuration stored in the BL20-E-1SWIRE fully matches the SET configuration stored in the PLC. Modifying the bus during operation causes the system to be aborted.
	Slave based	If the PLC configuration check is activated, data exchange is started with all SWIRE slaves that match the SET configuration stored in the PLC. The SWIRE slaves that do not match the SET configuration stored in the PLC do not perform any data exchange.
MC	Moeller conformance **(from version VN 01-04)**	
	Behavior of the BL20-E-1SWIRE in accordance with SWIRE Conformance criteria.	
	Inactive **A**	Default behavior
	Active	The BL20-E-1SWIRE master responds according to the Moeller SWIRE Conformance criteria.
SD_{INFO}	Slave error field	
	Activate slave diagnostics info field $SD_{ERR}Sx$. As soon as a slave on the bus sets its error bit, this is indicated individually as an error depending on the parameter setting.	
	Active **A**	Single diagnostics is activated
	Inactive	Single diagnostics is not activated
Byte 2		
SD_{ERR}	Group error - slave error	
	Activate slave diagnostics $SD_{ERR}Sx$. As soon as only one slave on the bus sets its error bit, this is indicated as a group error depending on the parameter setting.	
	Active **A**	Group diagnostics is activated
	Inactive	Group diagnostics is not activated

Table 10-3: Module parameters

A*Default setting*

Parameter name	Value	Meaning
PKZ_{INFO}	PKZ error field	
	Activate slave diagnostics info field PKZ_{ERR}Sx. As soon as a SWIRE-DIL slave on the bus clears its PKZ bit, this is indicated as an individual error depending on the parameter setting.	
	Active **A**	Single diagnostics is activated
	Inactive	Single diagnostics is not activated
PKZ_{ERR}	Group PKZ error field	
	Activate slave diagnostics PKZ_{ERR}Sx. As soon as only one SWIRE-DIL slave on the bus clears its PKZ bit, this is indicated as an error depending on the parameter setting.	
	Active **A**	Group diagnostics is activated
	Inactive	Group diagnostics is not activated
$TYPE_{INFO}$	Configuration error field	
	As soon as a slave on the bus does not match the set configuration and therefore cannot be started, this is indicated as an individual error depending on the parameter set.	
	Active **A**	Single diagnostics is activated
	Inactive	Single diagnostics is not activated.
$TYPE_{ERR}$	Group configuration error field	
	Activate slave diagnostics $TYPE_{ERR}$Sx. As soon as only one slave on the bus is incorrectly configured, this is indicated as an error depending on the parameter setting.	
	Active **A**	Group diagnostics is activated
	Inactive	Group diagnostics is not activated
U_{AUXERR}	Error message -U_{AUX}-	
	Activate system diagnostics U_{AUXERR}. U_{AUXERR} will generate an error message as soon as the power supply goes below a level at which the function of the relays is not guaranteed.	
	Active **A**	Error message U_{AUXERR} activated
	Inactive	Error message U_{AUXERR} not activated
Byte 3	reserved	

Table 10-3: Module parameters

A*Default setting*

Parameter name	Value	Meaning
Byte 4		
reserved (lifeguarding time up to version VN 01-03)	Up to version VN 01-03: Lifeguarding time of the SWIRE slaves.	
	Lifeguarding time of the SWIRE slaves	
	Setting of lifeguarding time, timeout time up to automatic reset of the slaves in the event of communication failure. (n ∞ 10ms) (Default 1s) 0xFF: Lifeguarding off	
Byte 5, 6		
$SC_{DIAG}Sx$	Input bit communication error, slave x	
	Slave diagnostics message from Byte 1 / Bit 7 is accepted in the feedback interface as Bit4	
	Active **A**	$SC_{DIAG}Sx$ is accepted
	Inactive	$SC_{DIAG}Sx$ is not accepted
Byte 7, 8	reserved	
Byte 9 to 24		
Device ID, slave x	TYPE setting for the SWIRE slave at position x on the SWIRE bus	
	0x20	SWIRE-DIL-MTB
	0xFF	Basic setting (no slave)

The following diagram is an example of the connected SWIRE power supply with a disconnection function (emergency-off) for the coil supply of the SWIRE relays.

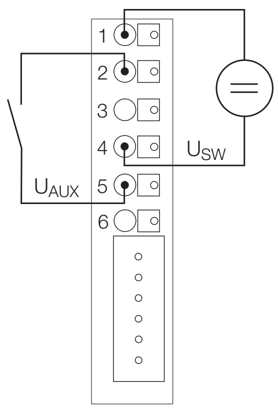


Figure 10-3: Connection of the operating voltage for the BL20-E-SWIRE with disconnectable coil power supply U_{AUX} of the SWIRE relays

The following diagram is a connection example for the SWIRE power supply. The coil supply voltage for the SWIRE relays is connected via PIN 2.

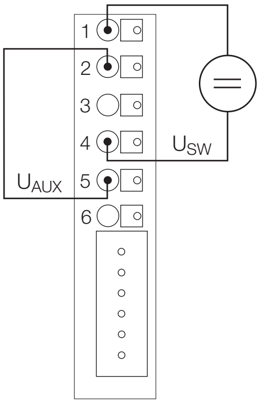


Figure 10-4: Connection of the operating voltage for the BL20-E-1SWIRE. The coil supply voltage U_{AUX} for the SWIRE relays is connected via PIN 2.

Table 10-4: Pin assignment

PIN	Assignment	Connection
1	U_{SW} operating voltage supply of the SWIRE bus	PIN 1 and PIN 2 are bridged internally!
2	U_{SW} operating voltage supply of the SWIRE bus	
3	GND frame potential	PIN 3 and PIN 4 are bridged internally!
4	GND frame potential	
5	U_{AUX} relay power supply	PIN 4 and PIN 6 are bridged internally!
6	U_{AUX} relay power supply	

10.6 Moeller SWIRE conformance criteria

The SWIRE system was developed by Moeller. The BL20-E-1SWIRE supports the SWIRE slaves SWIRE-DIL. For this particular requirements must be fulfilled to ensure compatible operation. The "Moeller Conformance" function is supported from version VN 01-04.

Note
The "Moeller Conformance" function is deactivated by default.

10.6.1 Special system behavior with the "Moeller Conformance" function

The following applies if the "Moeller Conformance" function is activated.

- The following functions are automatically deactivated:
  - Automatic SWIRE configuration
  - Bus-oriented configuration check
  - Slave-oriented configuration check
- To store the physical structure of the SWIRE bus in the BL20-E-1SWIRE, the CFG button of the BL20-E-1SWIRE must be pressed manually (only functions if the SW LED is flashing).
- The physical structure of the SWIRE bus is scanned once and compared with the SWIRE configuration stored in the BL20-E-1SWIRE once when U_{SW} is switched on, or after a new configuration is stored (by pressing the CFG button while the SW LED is flashing).
- If the physical structure of the SWIRE bus does **not** match the configuration stored in the BL20-E-1SWIRE (SW LED flashing) when U_{SW} is switched on, the SWIRE bus only starts operation:
  - After the physical structure was stored in the BL20-E-1SWIRE:
    - Manually, by pressing CFG button (only functions if the SW LED is flashing).
      After the configuration is stored, the physical structure is compared once more with the configuration stored in the BL20-E-1SWIRE.
  - If the physical structure of the SWIRE bus matches the configuration stored in the BL20-E-1SWIRE the next time that U_{SW} is switched on.
- If the "Moeller Conformance" function is activated, the physical structure of the SWIRE bus is continuously monitored during operation. However, data exchange continues with functioning slaves if slave failures occur. Not until the next power up is operation of the bus with faulty slaves discontinued.

System behavior with the configuration checks ("Moeller Conformance")

Parameter setting

- PROFIBUS-DP and CANopen (Byte 1):
  - MC = 1 (
- DeviceNet (Attribute 121 (79_{hex}) "PARAM_COMMON_OERATION_MODES"):
  - Bit 4 = 1

10.6.2 System behavior with the configuration checks

1 The physical structure of the SWIRE bus is scanned when U_{SW} is switched on (power up) and compared with the configuration stored in the BL20-E-1SWIRE.

- The SWIRE bus starts operation (SW LED lit) if the physical structure of the SWIRE bus matches the SWIRE configuration stored in the BL20-E-1SWIRE.
- The operation is aborted if the physical structure of the SWIRE bus does **not** match the configuration stored in the BL20-E-1SWIRE (SW LED flashing). The SWIRE bus only starts operation:
  - After the physical structure was stored in the BL20-E-1SWIRE and a match was determined:
    - Manually, by pressing CFG button (only functions if the SW LED is flashing).
      After the configuration is stored, the physical structure is compared once more with the configuration stored in the BL20-E-1SWIRE.
- If the physical structure of the SWIRE bus matches the configuration stored in the BL20-E-1SWIRE the next time that U_{SW} is switched on.

2 If the PLC configuration check is activated, the configuration stored in the BL20-E-1SWIRE is compared with the SET configuration stored in the PLC. The complete device ID must match.

- If the two configurations match completely, the entire SWIRE bus is ready for data exchange (RDY LED lit)
- If the two configurations do **not** match completely (RDY LED flashing), the operation is aborted for the entire SWIRE bus (RDY LED flashing).

3 The system then starts data exchange.

4 The physical structure of the SWIRE bus is monitored continuously during operation so that any changes on the bus or slave failures can be detected. The system retains data exchange with the functional slaves if a modification or slave failure is detected.

11 Mounting and wiring

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11.1 Mechanical mounting

11.1.1 General mounting rules

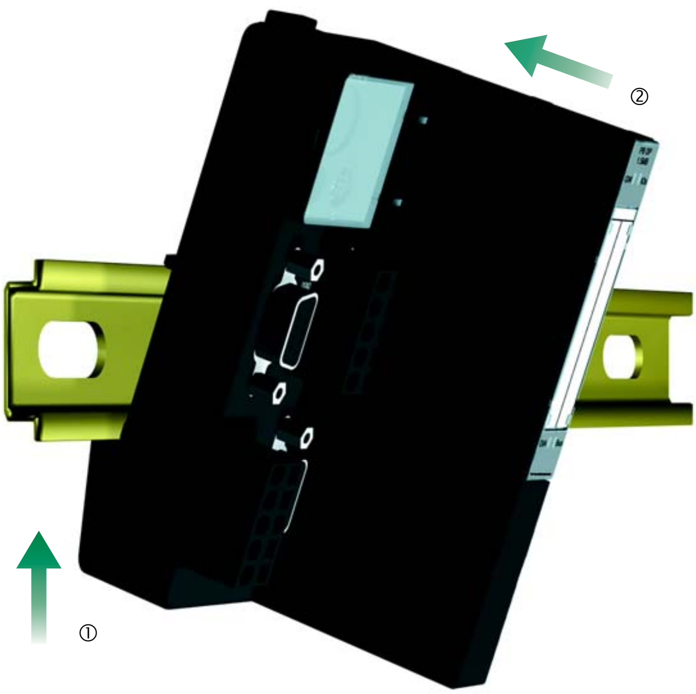
- Keep a small space to the left of the gateway free for the first end bracket.
- The gateway is the first electronics component on a BL20 station.
- If a gateway with integrated power supply unit is used, (BL20-GWBR-xxx), the I/O-modules are mounted subsequently in the order required directly following the gateway.
- When using a gateway without integrated power supply unit, the second component is a Bus Refreshing module, which provides the gateway with 5 V DC via the module bus. It must be ensured that the correct base module is used (see module chapters).
- Should it become necessary, a potential isolation can be achieved by mounting a Power Feeding module (power distribution) before mounting the next module.
- Power Feeding and Bus Refreshing modules can be mounted between the rest of the modules as required.
- An end plate is mounted at the end of each BL20 station.
- The complete BL20 system is secured to the mounting rail by means of two end brackets. The first is to the left of the gateway, the second is placed at the other end of the system and mounted together with the end plate.

Mounting rails

The mounting rails used for BL20 should be mounted onto a galvanized mounting plate with a minimum thickness of 2 mm / 0.08 inch. This allows a reference potential for protective earth (PE) and functional earth to be created. Please allow for a maximum distance of 150 mm / 5.91 inch between mounting holes, when mounting non pre-drilled mounting rails.

11.1.2 Mounting the gateway

Figure 11-1: Mounting the gateway



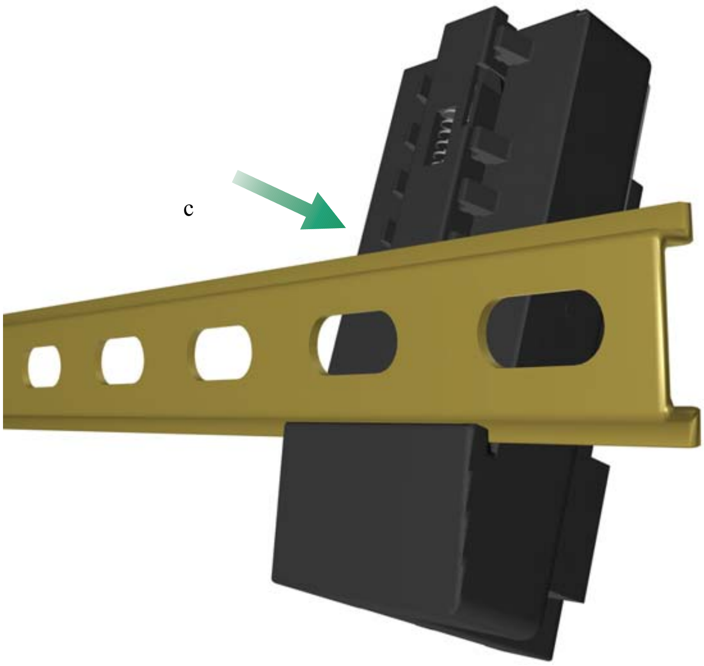
Please observe:

- The mounting rail must already be mounted.
- An end bracket must be mounted to the left of the gateway. The end bracket can be mounted before or after the station is mounted. If the gateway is mounted first, then a space must be kept free for the end bracket. Please read „Mounting end brackets and end plates“ in this chapter.
- The gateway is the first **electronics** component on a BL20 station.
- When fully mounted, the gateway's resistance to vibration is provided for by the locating hook located on the underside of the gateway. The locating hook is moved only when the gateway is mounted or dismounted.

Method:

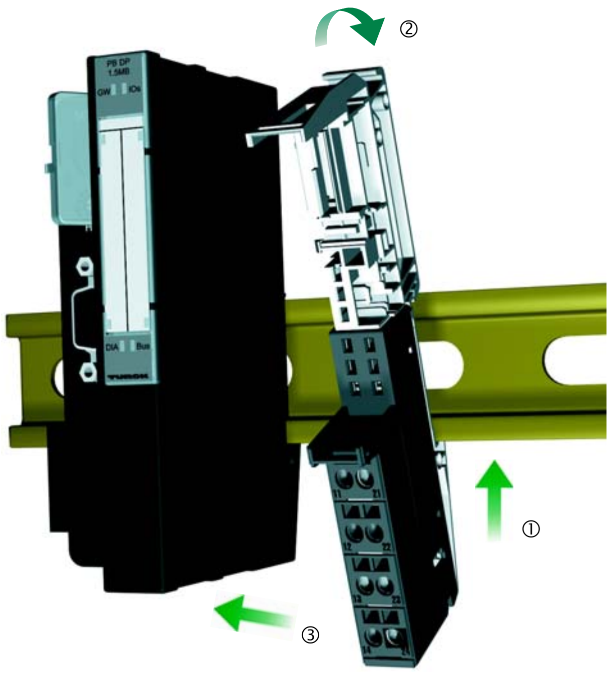
- Tilt the top of the gateway towards you, position the groove provided on the rear of the gateway onto the lower edge of the mounting rail ①.
- Tilt the top of the gateway away from you ② and towards the mounting rail.
- Press the gateway until it locks in with an audible click ③.

Figure 11-2: Locating hook on the gateway



11.1.3 Mounting the base module (block or slice design)

Figure 11-3: Mounting the base module for the Bus Refreshing module



Please observe:

- The gateway must already be mounted.
- The base modules are mounted to the right of the gateway onto the mounting rail.
- The first base module following a gateway must be suitable for a Bus Refreshing module which supplies the gateway with power.
- It is recommended that the base modules should be mounted and wired **before the electronics modules are mounted**.
- Suitable measures should be taken to protect the contacts of the module bus and electronics modules from becoming dirty.

Note

Mixed usage of base modules with screw connections and tension clamp connections is only possible once a new power distribution module has been added. Thereby, all the following base modules must have the same connection technology as the power distribution module (tension clamp or screw connection).

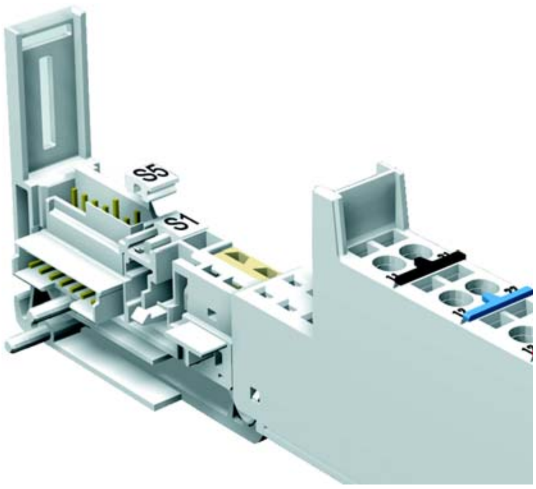
Method:

- Tilt the top of the base module towards you, position the groove provided on the rear of the base module onto the lower edge of the mounting rail ①.
- Tilt the top of the base module away from you and towards the mounting rail, and press until it locks in with an audible click ②.
- Slide the base module as far as possible to the left until the locating hooks lock in with an audible click into the gateway (should this be the first base module to be mounted) or into the next base module ③. This provides a stable connection and guarantees communication via the module bus.

11.1.4 Mounting slot identification and color markers

Mounting slot identification

Figure 11-4: Mounting slot identification using Dekafix



Please observe:

- Dekafix labels can be used to label mounting slots. There is room for a six-digit label on every base module. For example, the six-digit device short name, which you can define in the software tool I/O-ASSISTANT. Dekafix labels must be attached **before the electronics modules are mounted**.

Method:

- Press the Dekafix labels into the recesses provided in the base module (see Figure 11-4:).

Color markers

Figure 11-5: Color-coding of the connection levels

Please observe:

- The base modules can be fitted with colored connection markers for the purposes of individual identification of channels and to ease cable assignment. The colored connection markers are available as accessories.

Method

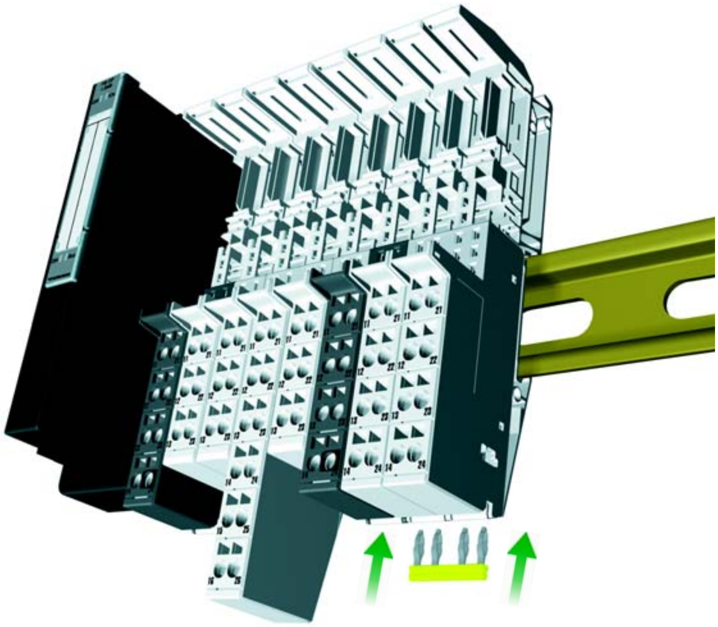
- Insert the colored connection markers, according to the module wiring (see wiring diagrams in the module chapters), into the slots provided immediately below each connection level on the base module. The table shows the meaning of the colors and connection types.

Table 11-1: Color-coding of base modules

Color of label	Connection type
Black	Signal cable
Red	V DC (+24V; +5V)
Blue	-; 0V; N
Red-blue	System supply
Yellow-green	PE
Green	Shield
Brown	Phase L1

11.1.5 Jumpers for relay modules

Figure 11-6: Plugging jumpers



Please observe:

- To multiply signals and/or save wiring, it can be useful to cross-connect a number of base modules for relays. To achieve this, jumpers (QVR) are available as accessories in various sizes.

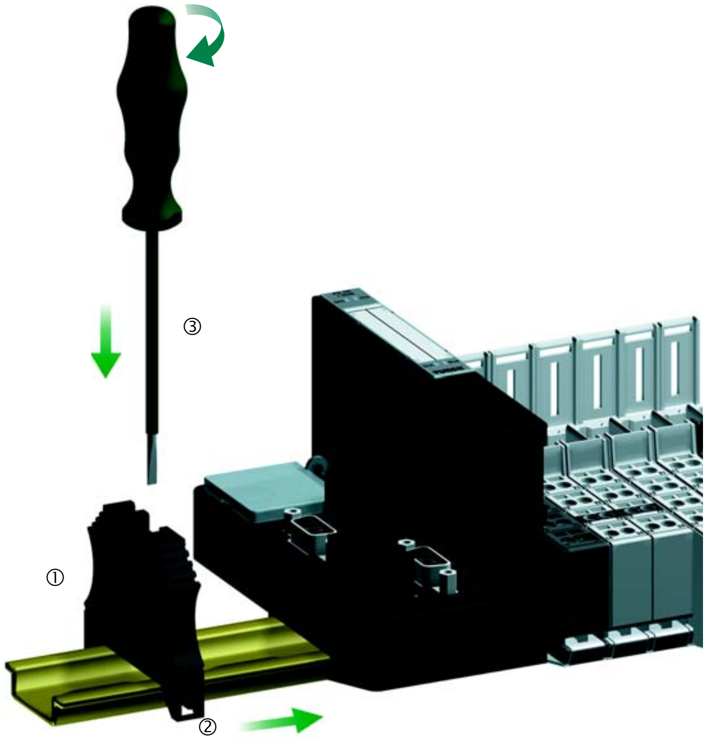
Method:

- Press the jumper as far as it will go into the slots provided on the front (facing down) of two adjoining base modules.

11.1.6 Mounting end brackets and end plates

End bracket

Figure 11-7: Mounting end brackets



Please observe:

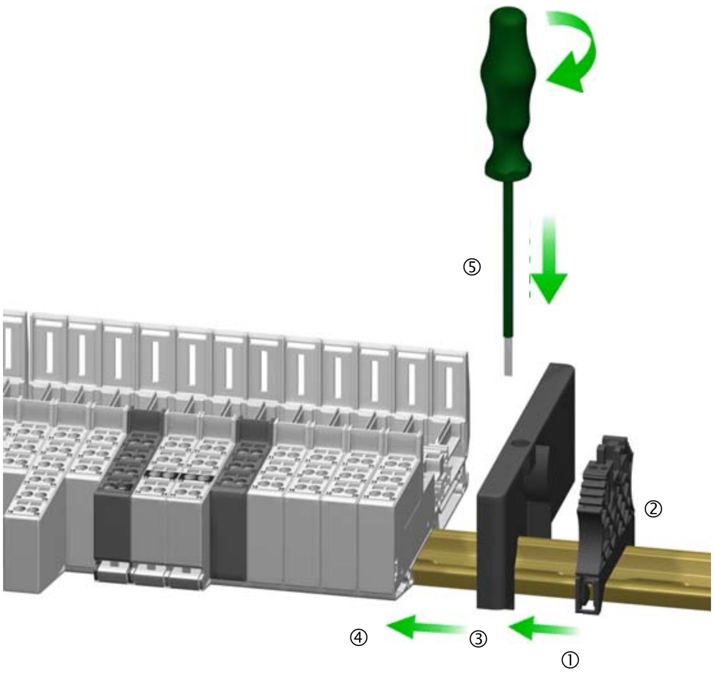
- BL20 stations must be fixed securely onto the mounting rail using two end brackets (BL20-WEW-35/2-SW). The first end bracket is mounted to the left of the gateway, the second is mounted together with the end plate at the end of the station.

Method:

- The first end bracket is mounted to the left of the gateway onto the mounting rail. Clip the end bracket onto the mounting rail until you hear an audible click ①. If necessary, loosen the screw beforehand.
- Slide the end bracket up to the gateway ② and tighten the screw ③.

End Plate

Figure 11-8: Mounting end bracket and end plate

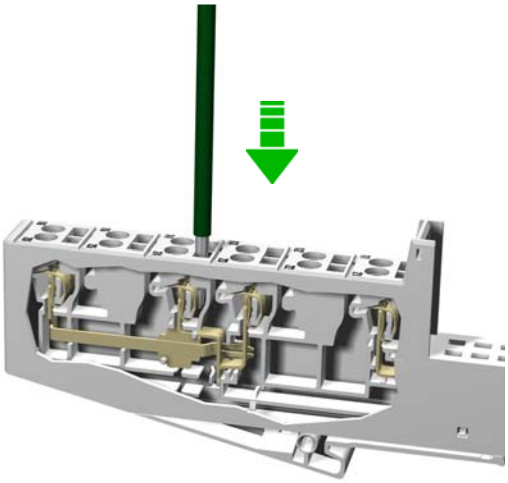


Method:

- Insert the end bracket into the recess provided in the end plate ①.
- The end bracket and end plate should be held so that the connectors on the end plate are facing the last module of the BL20 station.
- Press the end plate onto the mounting rail until you hear an audible click ② (if necessary, loosen the screw beforehand). Then slide the end bracket and end plate up to the last module of the BL20 station ③.
- Press the end plate with the end bracket firmly up to the last module of the BL20 station. The end plate's connectors must lock firmly into the locating holes provided in the module ④.
- To secure the end bracket, insert a screwdriver into the hole provided in the end plate and tighten the screw ⑤.

11.1.7 Wiring with tension clamp connections

Figure 11-9: Tension clamp connections

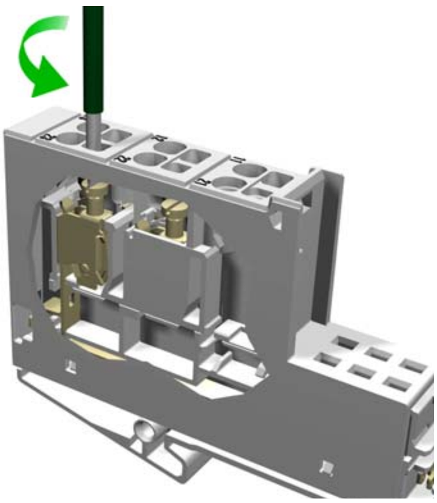


Method:

- Insert a screwdriver into the rectangular opening located immediately above the connection level of the base module. When you feel a slight resistance, push the screwdriver into the opening until it comes up against a stop. This opens a tension clamp on the inside of the connection level.
- Insert the wiring into the round opening located directly below the rectangular opening, until the wire comes up against a stop.
- Remove the screwdriver; the tension clamp closes and secures the wire.

11.1.8 Wiring of screw connection

Figure 11-10: Screw connection



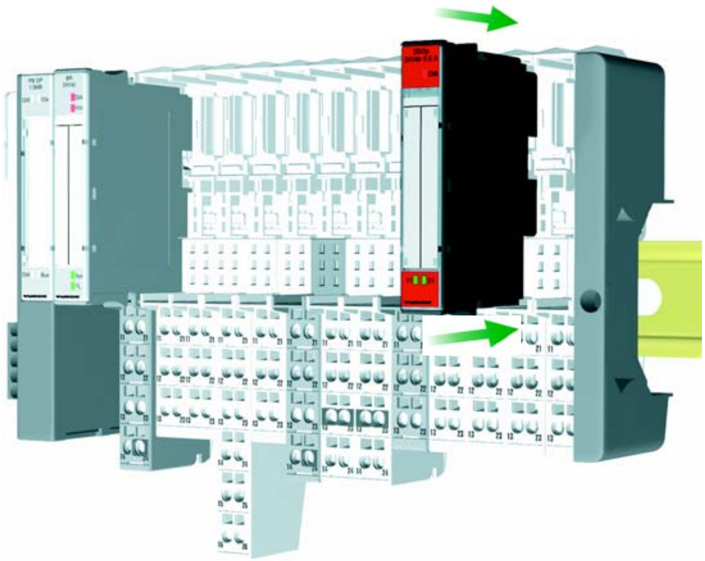
Method:

- Place the screwdriver in the rectangular opening of a connection level on the base module. Turn the screw ant-clockwise as far as possible, without fully removing it.
- Insert the wire in to the round opening, located directly below the rectangular opening, until it comes up against a stop.

- Turn the screw clockwise until the wire is fully secured, and cannot be pulled out.

11.1.9 Mounting the electronics modules

Figure 11-11: Plugging electronics modules



Please observe:

- The correct base module must have been previously mounted onto the mounting rail.
- Electronics modules are fitted onto the previously mounted and wired base modules.

Note

Before plugging the electronics modules, it is advisable to blow-clean the station with compressed air. This prevents dust and grains of dirt from contaminating the contacts, which can negatively influence the communication on the station.

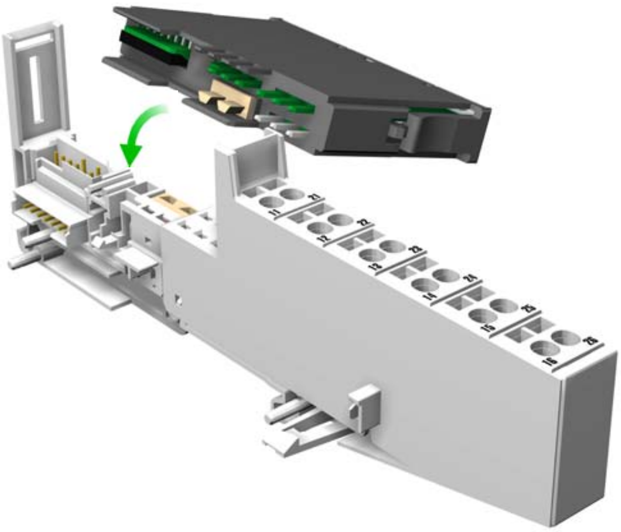
Method:

- Press the electronics module squarely onto the base module, until you hear it lock into place at the front and back.

11.1.10 Prevention of false mounting

A mechanical coding element prevents an electronics module from being mounted onto the wrong base module – for example, following a defect in an electronics module. The coding element consists of two pieces and is supplied with every electronics module.

Figure 11-12: Coding an electronics and base module



The complete coding element is mounted on the underside of each electronics module. When mounting the electronics module for the first time, the lower part of the coding element is automatically inserted into the recess provided in the base module.

Note

When plugging electronics modules for the first time, an initial resistance must be overcome. This is because the lower part of the coding element has to be pressed into the base module.

Should the electronics module be pulled, one half of the coding element remains in the base module, the other half remains in the electronics module. It is now possible to mount a new electronics module only when its coding matches that of the base module.

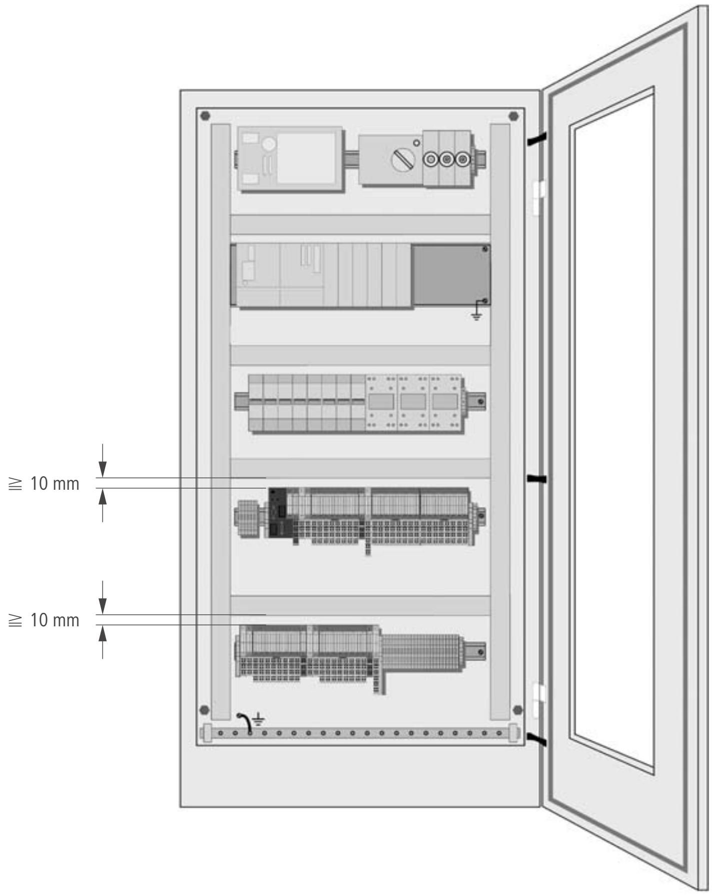
When replacing an electronics module (plugging a new electronics module), remove and dispose of the lower part of the coding element (that part destined for the base module). The original lower part of the coding element, which remains in the base module, cannot be removed.

Note

When all modules are mounted, the supply to the module bus should be applied to check if the station communication functions correctly (no false mounting, no empty slots, etc). The field voltage should be applied only when the correct functioning of the station has been established.

11.1.11 Switchgear cabinet layout

Figure 11-13: Switchgear cabinet layout



BL20 modules are suitable for installation and operation in confined spaces. The minimum distance to any passive components should be 10 mm / 0.39 inch. Should the adjoining component be an active element (for example load-current supply, transformers), then a minimum distance of 75 mm / 2.95 inch must be kept, to comply with EMC regulations and to prevent overheating. If necessary, provide for an appropriate air conditioning/cooling of the temperature. You should in every case, take into consideration the values for ambient temperature given in the module chapters.

11.2 Dismounting from the mounting rail

Please observe the following basic rules when dismounting:

11.2.1 Dismounting of a single component

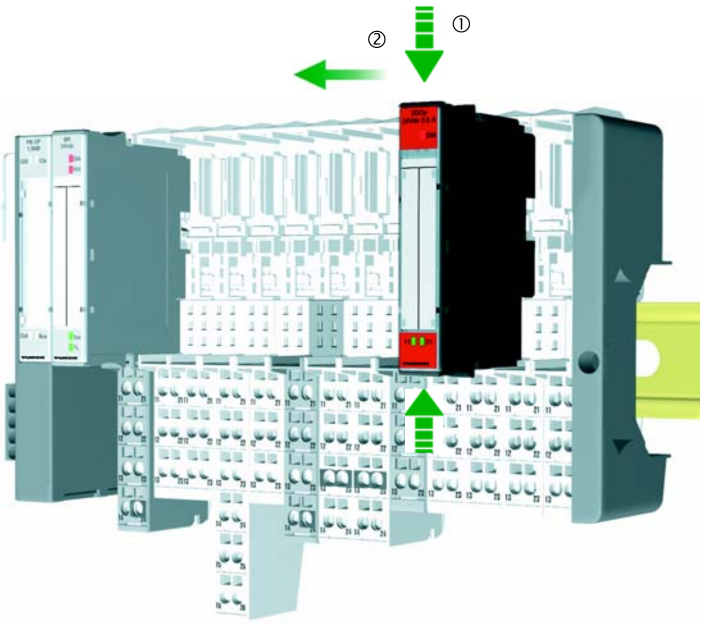
- **Base modules** and **gateways** can only be dismounted after the end plate has been disconnected from the last base module on the mounting rail. To do this, the end bracket mounted together with the end plate must be loosened.
- The **gateway** can only be dismounted from a station after all the base modules located on its right are separated and moved away to the right along the mounting rail. Furthermore, all connections from the gateway to the fieldbus must be disconnected. All wires must be disconnected and the fieldbus must be switched off.
- Individual base modules can only be removed from a station when all base modules located to its right have been moved away to the right along the mounting rail. A minimum distance of 30 mm / 1.18 inch is required between the base module to be replaced and the previously adjoining base modules.

Danger
Before dismounting a base module, the supply voltage to the relevant power distribution modules must be switched off. All wires must be disconnected.

- Dismounting an entire BL20 station in chronological order
- Switch off the power to the distribution modules (Bus Refreshing and Power Feeding)
- Pull the electronics modules
- Disconnect wiring
- Loosen/remove end bracket and end plate
- Dismount base modules
- Dismount gateway

11.2.2 Dismounting electronics modules

Figure 11-14: Dismounting electronics modules



Please observe:

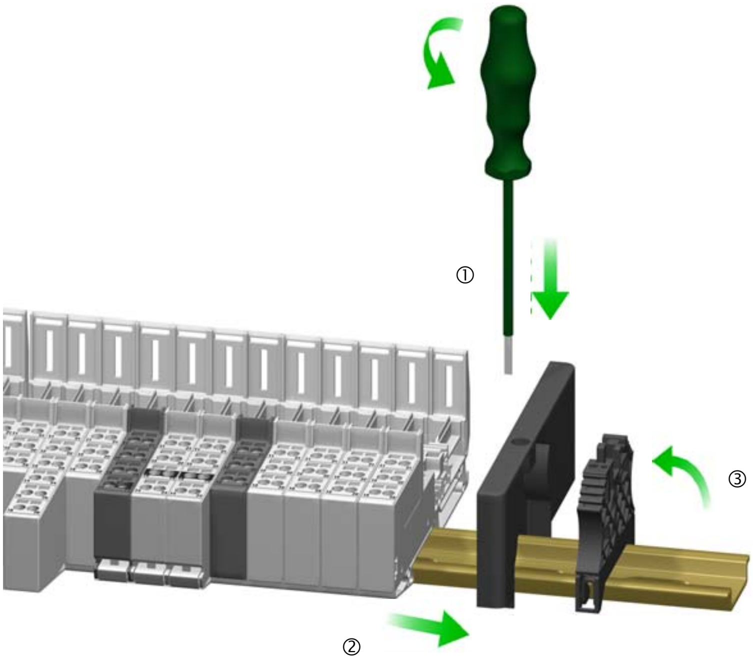
- Tools are not usually required to dismount electronics modules.

Method:

- Squeeze both locating hooks towards one another ①; these are located at either end of the electronics modules and pull the module away from the base module ②.

11.2.3 Dismounting end brackets and Eend plates

Figure 11-15: Dismounting the end plate



Method:

- Insert the screwdriver into the hole in the end plate and loosen the screw in the end bracket ①.
- Slide the end plate and end bracket to the right, away from the last base module. If necessary, use a screwdriver; however take care not to break the end plate connectors which are locked into the locating holes of the base module ②.
- Loosen the screw in the end bracket to remove the end bracket and end plate from the mounting rail ③.

11.2.4 Dismounting base modules

Danger

The supply voltage to the relevant power distribution modules must be switched off before dismounting a base module.

Please observe:

- Base modules can only be dismounted from the right.
- The end plate must already be dismounted.
- The electronics module must be pulled.

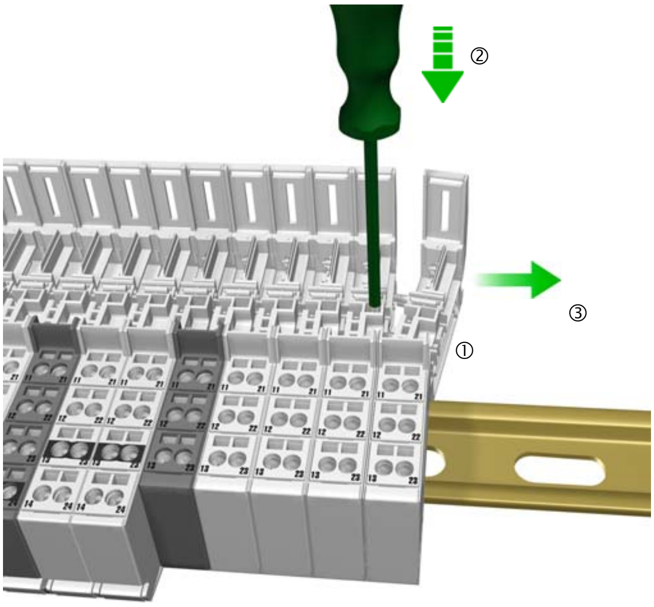
Method for dismounting base modules in slice design:

- Disconnect the wiring from the base module.

Attention

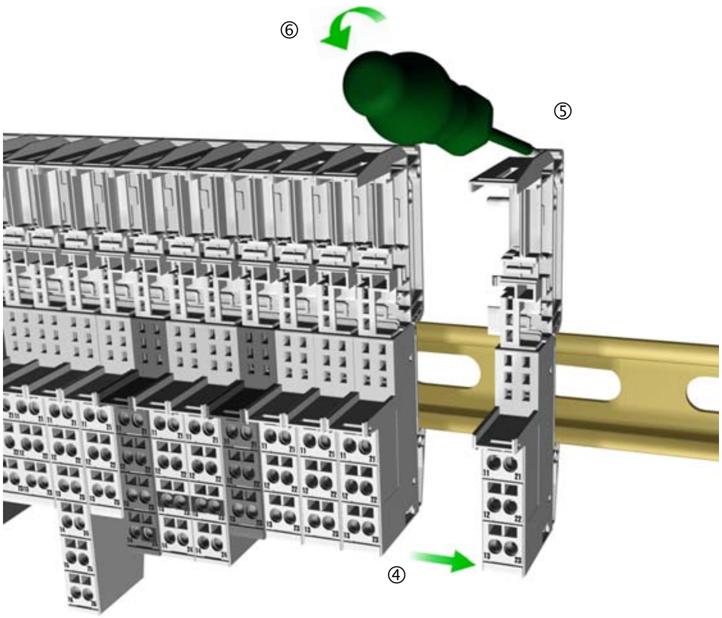
If you are dismounting a base module for a relay, then any mounted jumpers must be removed from the front of the module before commencing with dismounting.

Figure 11-16: Dismounting base modules in slice design



- Insert a screwdriver into the rectangular opening in the mounting slot of the base module ①.
- Press the screwdriver into the opening ②, thereby disengaging the connection between the base module to be dismounted and the adjoining module to its left. Pull the module away to the right until the rear locating hook disengages. Remove the screwdriver.
- Pull the modules apart at the rear by hand (the module to be dismounted and the adjoining module) ③. This "drawing apart" motion automatically disengages the locating hook which connects both modules at the front.

Figure 11-17: Removing a base module from the mounting rail

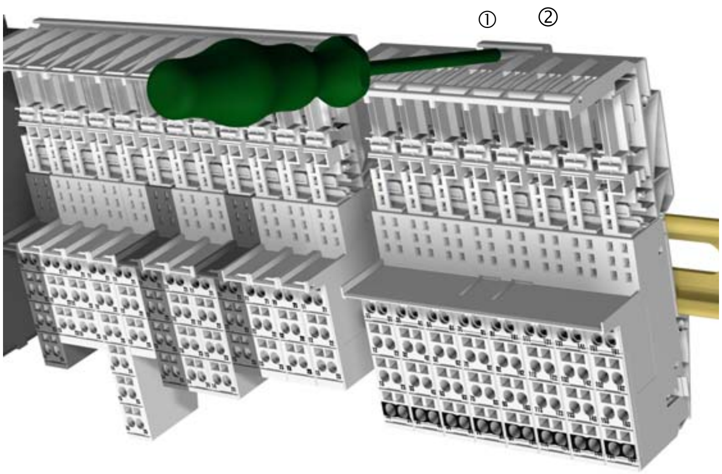


- When both locating hooks are disengaged, slide the base module to be dismounted to the right ④.
- Insert the screwdriver into the slot provided in the locking mechanism ⑤ and lever the base module up and towards you, thereby releasing it from the mounting rail ⑥.

Method for dismounting base modules in block design:

- Disconnect the wiring from the base module.
- Carry out the steps indicated in Figure 11-16:, Seite 11-17 and Figure 11-17:, Seite 11-18. The method is identical at this point for both slice and block base modules.

Figure 11-18: Removing a base module in block design from the mounting rail

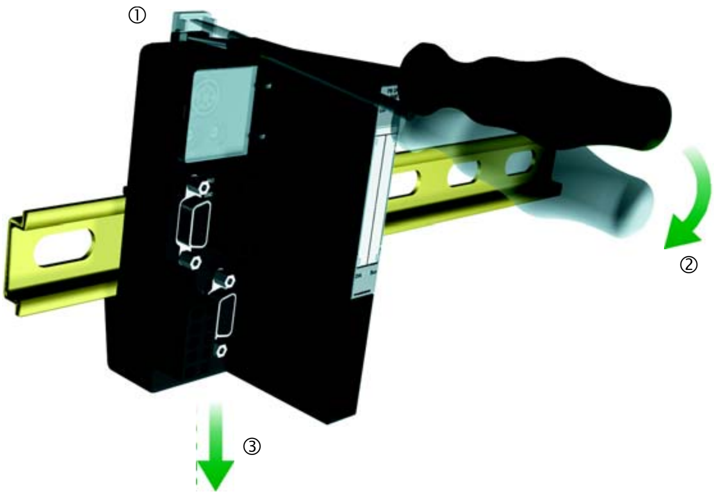


- There are two locking mechanisms in the middle of the block base module. These must be unlocked in two steps.
  Insert the screwdriver into the slot provided in the **left-hand** locking mechanism ① and lever the handle of the screwdriver downwards thereby moving the locking mechanism up until it disengages from the mounting rail.

Insert the screwdriver into the slot of the provided in the **right-hand** locking mechanism ② and lever the handle of the screwdriver downwards thereby moving the second mounting foot up until it disengages from the mounting rail. Remove the base module from the mounting rail.

11.2.5 Dismounting the gateway

Figure 11-19: Dismounting the gateway



Danger
The supply voltage to the Bus Refreshing module must be switched off before dismounting the gateway. The connection to the fieldbus must also be disconnected.

Please observe:

- All base modules on the mounting rail must be either moved away sufficiently to the right or dismounted.

Method:

- Disconnect the connection between the fieldbus and the gateway.
- Insert a screwdriver into the opening provided in the locking mechanism – on the top of the gateway – ①, then carefully pull the screwdriver downwards as far as it will go ②. The spring loaded locking mechanism is levered upwards and disengages.
- Tilt the top end of the gateway with the screwdriver towards you and away from the mounting rail ③.

11.3 Plugging and pulling electronics modules

BL20 enables the pulling and plugging of electronics modules without having to disconnect the field wiring. The BL20 station remains in operation if an electronics module is pulled. The voltage and current supplies as well as the protective earth connections are not interrupted.

Attention

If the field and system supplies remain connected when electronics modules are plugged or pulled, short interruptions to the module bus communications can occur in the BL20 station. This can lead to undefined statuses of individual inputs and outputs of different modules.

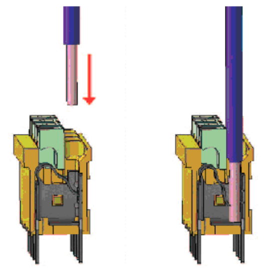
11.4 Handling the BL20 economy modules

The BL20 Economy modules use direct push-in contacts different from the BL20 base modules which use tension clamp contacts. The handling of these direct push-in contacts is described in the following:

11.4.1 Insertion of the conductor

The conductor is simply pushed into the corresponding contact.

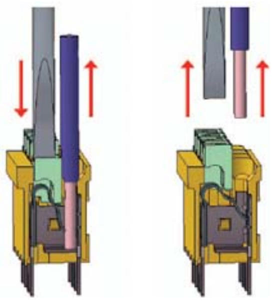
Figure 11-20: Insertion of the conductor



11.4.2 Removal of the conductor

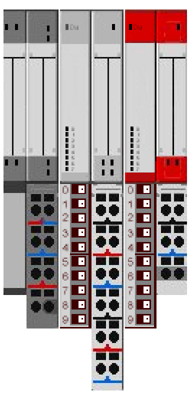
The conductor can be removed from the contact by pressing the release mechanism, e. g. with a screw driver.

Figure 11-21: Removal of the conductor



Note
The BL20 Economy modules can be easily combined with the base modules with tension clamp connection technology (BL20-B-…T-…). A connection is not possible on base modules using the screw connection technology (BL20-B-…S-…).

Abbildung 12: BL20 Economy modules combined with tension clamp modules



12 Module labeling

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12.1 General notes

All electrical and electronics components for BL20 stations are supplied with labels to guarantee clear identification. In addition, Turck offers marking and labeling materials which enable individual and application specific labeling of each component. Fundamentally, the differences are as follows.

12.1.1 Colors

Each electronics module can be recognized immediately by the colored lid imprint (top and bottom).

Table 12-1: Color identification of BL20 modules

Gateway (GW)	X	dusty grey
Power Feeding 24 V DC (PF)	X	dusty grey
Power Feeding 120/230 V AC (PF)	X	orange brown
Bus Refreshing (BR)	X	dusty grey
Digital input modules (DI)	X	light grey (white)
Analog input modules (AI)	X	pigeon blue
Digital output modules (DO)	X	strawberry red
Analog output modules (AO)	X	pale green
Relay modules (R)	X	pastel orange
Technology modules (CNT)	X	zinc yellow

12.1.2 Designations/catalog numbers

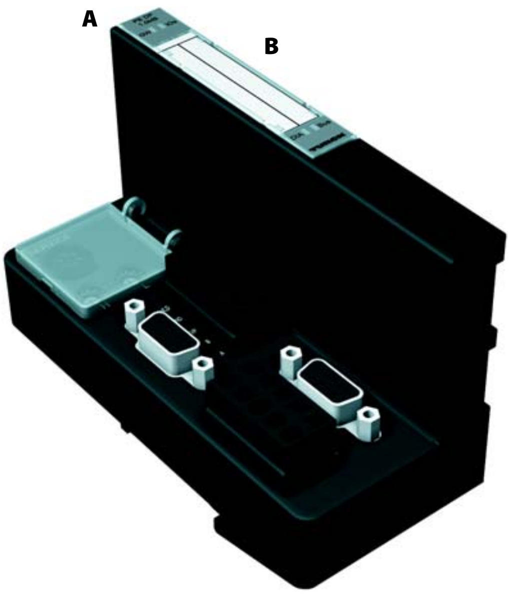
The designation is imprinted on the top of the electronics modules. Each module is clearly identified by a catalogue number. The catalogue number as well as further module-specific details can be found on a label attached to the side of the respective module.

12.2 Gateways

- BL20 gateway, 1.5 MBits/s.

Table 12-2: Gateway labeling

A *Designation*
B *Label for application-specific details*



12.3 Electronics modules

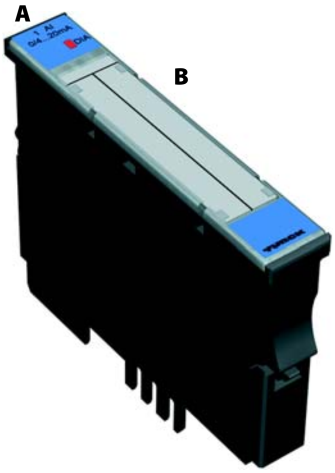


Figure 12-1: Electronics module labeling

A *Designation*
B *Label for application-specific details*

The module's wiring diagram is printed on the lid of every electronics module. Example:

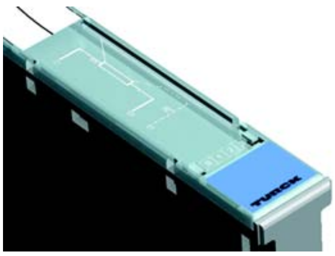
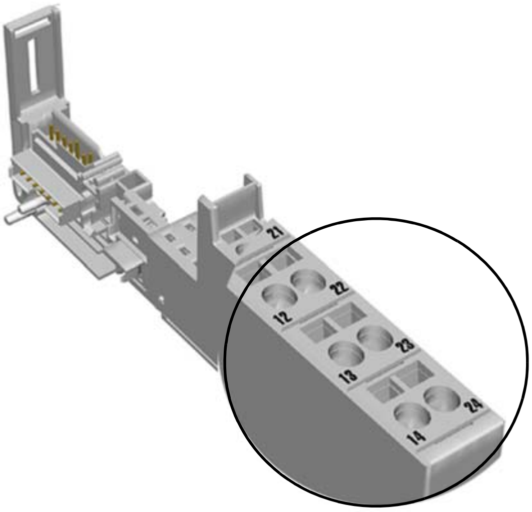


Figure 12-2: Wiring diagram

12.4 Base modules

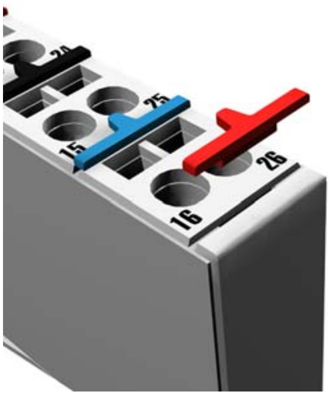
Base module connections are numbered consecutively channel by channel.

Figure 12-3: Channel numbering



The colored markers are used to label the different base module connection levels and can be used to denote specific applications. They are available as accessories in the following colors: blue, red, green, black, brown, red/blue and yellow/green.

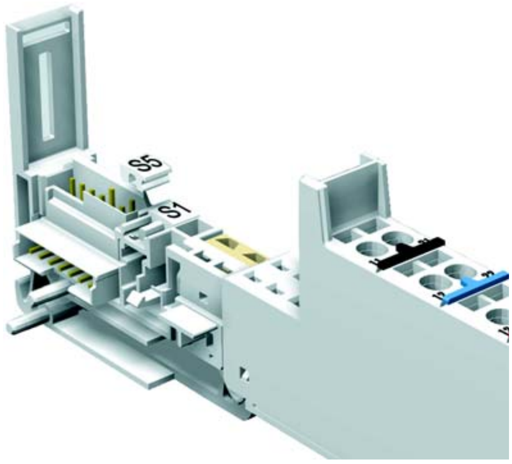
Figure 12-4: Color-coding of connection levels



Note
The individual colored markers assigned to the connection levels should be chosen in accordance with the electronics modules used.

Dekafix connection markers can be used to label the mounting slots for the electronics modules. Insert the connection into the mounting slots to the rear of the base module.

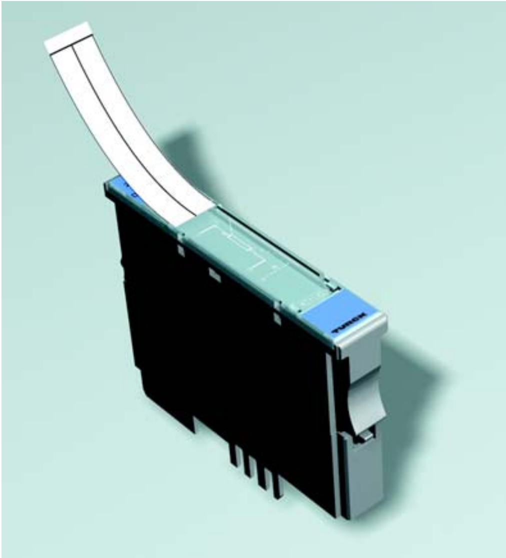
Figure 12-5: Mounting slot identification using Dekafix



12.5 Labels

Each electronics module is supplied with a label to enable application-specific identification. Labels are available as accessories (see Appendix).

Figure 12-6: Label



13 BL20-Approvals for Zone 2/ Division 2

Note

The Zone 2 - approval certificates for BL20 can be found in a separate manual for approvals D301255 on www.turck.de.

Turck Industrial Automation

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14.1 Analog value representation (analog input modules)

The analog values can either be represented with16 bit or 12 bit. The two's-complement representation allows the representation of positive as well as negative values.

16-bit-representation:

The 16-bit-representation is realized as a two's-complement. 2 byte of process data are completely occupied:

Figure 14-1: 16 bit representation

analog value	16 bit representation															
byte	byte 1								byte 0							
bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
meaning	+/-	measurement value														

12-bit-representation:

In the voltage measurement/ output and in the temperature measurement, the value is represented as a two's-complement. In the current measurement/ output and in the resistance measurement, the value is represented as a dual number. The 12 bit value is left-justified and occupies bit 15 to 4 of the process data:

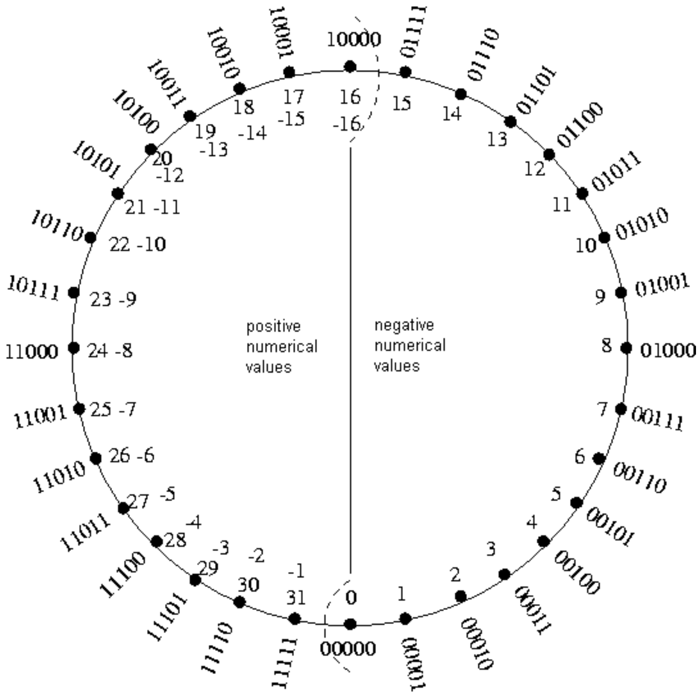
Figure 14-2: 12 bit representation

analog value	12 bit representation															
byte	byte 1								byte 0							
bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
meaning	measurement value (without sign)												diagnostic data			

The diagnosis information is integrated in the process input data and occupies 4 bit (right-justified).

The figure shows a 5-digit binary code in the outer circuit. The inner circuit shows the respective dual number, if the binary code is interpreted as binary number (positive numerical values) and as two's complement.

Figure 14-3: Binary code as binary number and two's complement



14.1.1 Equations for 16 bit representation

Current values from 0 to 20 mA

Before using the equation below, the hexadecimal or binary value has to be converted into a decimal value.

The value range

0 mA to 20 mA

is displayed as follows:

0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

The hexadecimal/binary value can easily be converted into a decimal value, because all numbers belong to the positive range of the two's complement (→ page 14-3).

The current value can now be calculated by means of the following equation:

$$\text{current value} = \frac{\text{decimal value}}{1638{,}35}\,\text{mA} = 6{,}1 \cdot 10^{-4}\,\text{mA} \cdot \text{decimal value}$$

Current values from 4 to 20 mA

Before using the equation below, the hexadecimal or binary value has to be converted into a decimal value.

The value range

4 mA to 20 mA

is displayed as follows:

0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

The hexadecimal/binary value can easily be converted into a decimal value, because all numbers belong to the positive range of the two's complement (→ page 13-4).

The current value can now be calculated by means of the following equation:

$$\text{current value} = 4{,}88 \cdot 10^{-4}\,\text{mA} \times \text{decimal value} + 4\text{mA}$$

Temperature- and resistance values (BL20-2AI-PT/NI-2/3)

Before using the equation below, the hexadecimal or binary value has to be converted into a decimal value.

The hexadecimal/binary values for the negative value range cannot easily be converted into decimal values, because the values are coded as two's complement (→ page 14-3).

All numerical values from 0000_{hex} to $7FFF_{hex}$ represent **positive** values when coded as two's complement. Values in this range can easily be converted into decimal values. This is also relevant for binary numbers in which the most significant bit (bit 16) is "0".

All numerical values from 8000_{hex} to $FFFF_{hex}$ represent **negative** values when coded as two's complement. This is also relevant for binary numbers in which the most significant bit (bit 16) is "1".

The conversion into a decimal number is shown in the following:

Example of the conversion of negative numerical values

The following parameterization is used in the example:

"PT100, -200...150°C"

The temperature is thus calculated with the factor 0.01 (see below).

The example explains the general procedure to convert a hexadecimal or binary number coded as two's complement to a decimal number.

The hexadecimal value should be "**B344**".

1 The binary value is:

B344 ↔ **1011.0011.0100.0100**

2 Invert the binary number:

1011.0011.0100.0100 → **0100.1100.1011.1011**

3 Add a "1"to the inverted binary number:

0100.1100.1011.1011
0000.0000.0000.0001
0100.1100.1011.1100

4 Convert the binary number into a decimal number:

0100110010111100 ↔ **19644**

5 The temperature value is calculated as follows:

$$\text{temperature value} = 0{,}01\,°\text{C} \times \text{decimal value} = 0{,}01\,°\text{C} \times (-19644) = -196{,}44\,°\text{C}$$

The temperature values can now be calculated according to the parameterization.

- For the parameterization
  "PT100, -200...850°C"
  "NI100, -60...250°C"
  "PT200, -200...850°C"
  "PT500, -200...850°C"
  "PT1000, -200...850°C"
  "NI1000, -60...250°C"

  use the equation:

  temperature value = **0,1 °C** × decimal value

The value range

-200 °C to -0,1°C

is displayed as follows:

F830$_{hex}$ **to FFFF**$_{hex}$ (decimal: -2000 to -1)

The value range

0 °C to 850°C

is displayed as follows:

0000$_{hex}$ **to 2134**$_{hex}$ (decimal: 0 to 8500)

- For the parameterization
  "PT100, -200...150°C"
  "NI100, -60...150°C"
  "PT200, -200...150°C"
  "PT500, -200...150°C"
  "PT1000, -200...150°C"
  "NI1000, -60...150°C"

  use the equation:

  temperature value= **0,01 °C** × decimal value

The value range

-200 °C to -0,01°C

is displayed as follows:

B1E0$_{hex}$ **to FFFF**$_{hex}$ (decimal: -20000 to -1)

The value range

0 °C to 150°C

is displayed as follows:

0000$_{hex}$ **to 3A98**$_{hex}$ (decimal: 0 to 15000)

For representation of resistance values only positive numbers (hexadecimal/binary) are used. The positive values can easily be converted into decimal ones.

The value range

0 to 100 Ω; 0 to 200 Ω; 0 to 200 Ω; 0 to 1000 Ω

is displayed as follows:

0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

The resistance values can now be calculated according to the parameterization.

The following equations are valid:

- "resistance, 0...100 Ohm":

  $$\text{resistance value} = 0{,}00305\ \Omega \cdot \text{decimal value}$$

- "resistance, 0...200 Ohm":

  $$\text{resistance value} = 0{,}00610\ \Omega \cdot \text{decimal value}$$

- "resistance, 0...400 Ohm":

  $$\text{resistance value} = 0{,}01221\ \Omega \cdot \text{decimal value}$$

- "resistance, 0...1000 Ohm":

  $$\text{resistance value} = 0{,}03052\ \Omega \cdot \text{decimal value}$$

Temperature- and voltage values (BL20-2AI-THERMO-PI)

Before using the equation below, the hexadecimal or binary value has to be converted into a decimal value.

The hexadecimal/binary values for the negative value range cannot easily be converted into decimal values, because the values are coded as two's complement (→ page 13-4).

All numerical values from 0000_{hex} to $7FFF_{hex}$ represent **positive** values when coded as two's complement. Values in this range can easily be converted into decimal values. This is also relevant for binary numbers in which the most significant bit (no. 16) is "0".

All values from 8000_{hex} to $FFFF_{hex}$ represent **negative** values when coded as two's complement. This is also relevant for binary numbers in which the most significant bit (no. 16) is "1".

Please see → Example of the conversion of negative numerical values, page 14-5.

The temperature and voltage values can now be calculated according to the parameterization.

- For the parameterization
  "Typ K, -270...1370°C"
  "Typ B, +100...1820°C"
  "Typ E, -270...1000°C"
  "Typ J, -210...1200°C"
  "Typ N, -270...1300°C"
  "Typ R, -50...1760°C"
  "Typ S, -50...1540°C"
  "Typ T, -270...400°C"

  use the equation.

  temperature value= **0,01 °C** × decimal value

The value range
-270 °C to -0,1°C
is displayed as follows:
$F574_{hex}$ to $FFFF_{hex}$ (decimal: -2700 to -1)

The value range
0 °C to 1820°C
is displayed as follows:
0000_{hex} to 4718_{hex} (decimal: 0 to 18200)

The value range
-50 mV to -0,002 mV;
-100 mV to -0,003 mV;
-500 mV to -0,015 mV;
-1000 mV to -0,031 mV
is displayed as follows:
8000_{hex} to $FFFF_{hex}$ (decimal: -32768 to -1)

The value range
0 mV to 50 mV;
0 mV to 100 mV;
0 mV to 500 mV;
0 mV to 1000 mV;

is displayed as follows:
0000$_{hex}$ **to7FFF**$_{hex}$ (decimal: 0 to 32767)

- For the parameterization "+/-50mV":

$$\text{voltage value} = 0{,}001526\ \text{mV} \times \text{decimal value}$$

- For the parameterization "+/-100mV":

$$\text{voltage value} = 0{,}003052\ \text{mV} \times \text{decimal value}$$

- For the parameterization "+/-500mV":

$$\text{voltage value} = 0{,}015259\ \text{mV} \times \text{decimal value}$$

- For the parameterization "+/-1000mV":

$$\text{voltage value} = 0{,}030519\ \text{mV} \times \text{decimal value}$$

Voltage values from 0 to 10 V DC

Before using the equation below, the hexadecimal or binary value has to be converted into a decimal value. The hexadecimal/binary value can easily be converted into a decimal value, because all numbers belong to the positive range of the two's complement
(→ page 13-4).

The value range

0 V DC to 10 V DC

is displayed as follows:

0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

The voltage values can now be calculated by means of the following equation:

$$\text{voltage value} = 3{,}05185 \times 10^{-4}\ \text{V} \times \text{decimal value}$$

Voltage values from -10 to 10 V DC

Before using the equation below, the hexadecimal or binary value has to be converted into a decimal value.

The hexadecimal/binary values for the negative value range cannot easily be converted into decimal values, because the values are coded as two's complement (→ page 13-4).

All numerical values from 0000$_{hex}$ to 7FFF$_{hex}$ represent **positive** values when coded as two's complement. Values in this range can easily be converted into **decimal** values. This is also relevant for binary numbers in which the most significant bit (no. 16) is "0".

All numerical values from 8000$_{hex}$ to FFFF$_{hex}$ represent **negative** values when coded as two's complement. This is also relevant for binary numbers in which the most significant bit (no. 16) is "1".

Please see → Example of the conversion of negative numerical values, page 14-5.

The value range

-10 V to -3,052 10^{-4} V

is displayed as follows:

8000$_{hex}$ **to FFFF**$_{hex}$ (decimal:-32768 to -1)

The value range

0 V to 10 V

is displayed as follows:

0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

$$\text{voltage value} = 3{,}052 \times 10^{-4}\,\text{V} \times \text{decimal value}$$

14.1.2 Equations for 12-bit-representation

Attention

The 12-bit-representation is "left-justified". The value is transmitted with 16 bit. The last 4 digits of the binary number or respectively the last digit position of the hexadecimal value are used as diagnostic bits!

Note

Before using the following equations, the hexadecimal or binary value always has to be converted into a decimal value.
The value is contained in the 3 more significant digit positions of the hexadecimal number or in the 12 more significant bits of the binary number.

Note

In the 12-bit-representation only the 3 more significant digit positions of the hexadecimal number or the 12 more significant bits of the binary number are used for the calculation of the decimal value.

Current values from 0 to 20 mA

The value range

0 mA to 20 mA

is displayed as follows:

000_{hex} to FFF_{hex} (decimal: 0 to 4095)

The current values can now be calculated by means of the following equation:

$$\text{current value} = 4{,}88 \times 10^{-3}\,\text{mA} \times \text{decimal value}$$

Current values from 4 to 20 mA

The value range

4 mA to 20 mA

is displayed as follows:

000_{hex} to FFF_{hex} (decimal: 0 to 4095)

The current values can now be calculated by means of the following equation:

$$\text{current value} = 3{,}91 \times 10^{-3}\,\text{mA} \times \text{decimal value} + 4\,\text{mA}$$

Temperature and resistance values (BL20-2AI-PT/NI-2/3)

The hexadecimal/binary values for the negative value range cannot easily be converted into decimal values, because the values are coded as two's complement (→ page 13-4).

All numerical values from 000_{hex} to $7FF_{hex}$ represent **positive** values when coded as two's complement. Values in this range can easily be converted into **decimal** values. This is also relevant for binary numbers in which the most significant bit (no. 16) is "0".

All numerical values from 800_{hex} to FFF_{hex} represent **negative** values when coded as two's complement. This is also relevant for binary numbers in which the most significant bit (no. 16) is "1".

Please see → Example of the conversion of negative numerical values, page 14-5.

The temperature values can now be calculated depending on the parameterization.

- For the parameterization:
  "PT100, -200...850°C"
  "NI100, -60...250°C"
  "PT200, -200...850°C"
  "PT500, -200...850°C"
  "PT1000, -200...850°C"
  "NI1000, -60...250°C

  use the following equation:

  $$\text{temperature value} = 0{,}5°C \times \text{decimal value}$$

The value range

-200 °C to -0,5°C

is displayed as follows:

$E70_{hex}$ to FFF_{hex} (decimal: -400 to -1)

The value range

0 °C to 850°C

is displayed as follows:

000_{hex} to $6A4_{hex}$ (decimal: 0 to 1700)

- For the parameterization:
  "PT100, -200...150°C"
  "NI100, -60...150°C"
  "PT200, -200...150°C"
  "PT500, -200...150°C"
  "PT1000, -200...150°C"
  "NI1000, -60...150°C"

  use the following equation:

  $$\text{temperature value} = 0{,}1°C \times \text{decimal value}$$

The value range

-200 °C to -0,1°C

is displayed as follows:

830_{hex} to FFF_{hex} (decimal: -2000 to -1)

The value range

0 °C to 150°C

is displayed as follows:

000$_{hex}$ **to 5DC**$_{hex}$ (decimal: 0 to 1500)

Note

In the 12-bit-representation only the 3 more significant digit positions of the hexadecimal number or the 12 more significant bits of the binary number are used for the calculation of the decimal value.

The temperature values can now be calculated depending on the parameterization.

The value range

0 Ω to 100 Ω;
0 Ω to 200 Ω;
0 Ω to 400 Ω;
0 Ω to 1000 Ω;

is displayed as follows:

000$_{hex}$ **to FFF**$_{hex}$ (decimal: 0 to 4095)

The following equations are valid:

- "resistance, 0...100 Ohm":

$$\text{resistance value} = 0{,}02442\ \Omega \cdot \text{decimal value}$$

- "resistance, 0...200 Ohm":

$$\text{resistance value} = 0{,}04884\ \Omega \cdot \text{decimal value}$$

- "resistance, 0...200 Ohm":

$$\text{resistance value} = 0{,}09768\ \Omega \cdot \text{decimal value}$$

- "resistance, 0...1000 Ohm":

$$\text{resistance value} = 0{,}24420\ \Omega \cdot \text{decimal value}$$

Temperature- and voltage values (BL20-2AI-THERMO-PI)

All numerical values from 000_{hex} to $7FF_{hex}$ represent **positive** values when coded as two's complement. Values in this range can easily be converted into **decimal** values. This is also relevant for binary numbers in which the most significant bit (no. 16) is "0".

All numerical values from 800_{hex} to FFF_{hex} represent **negative** values when coded as two's complement. This is also relevant for binary numbers in which the most significant bit (no. 16) is "1".

Please see → Example of the conversion of negative numerical values, page 14-5.

Note

In the 12-bit-representation only the 3 more significant digit positions of the hexadecimal number or the 12 more significant bits of the binary number are used for the calculation of the decimal value.

The temperature values can now be calculated depending on the parameterization.

- For the parameterization
  "Typ K, -270...1370'C"
  "Typ B, +100...1820'C"
  "Typ E, -270...1000'C"
  "Typ J, -210...1200'C"
  "Typ N, -270...1300'C"
  "Typ R, -50...1760'C"
  "Typ S, -50...1540'C"
  "Typ T, -270...400'C"

  use the following equation:

  $$\text{temperature value} = 1°\text{C} \times \text{decimal value}$$

The value range

-270 °C to 1820°C

is displayed as follows:

$EF2_{hex}$ to $71C_{hex}$ (decimal: -270 to 1820)

- For the parameterization "+/-50mV" :

  $$\text{voltage value} = 0{,}02443\ \text{mV} \times \text{decimal value}$$

- For the parameterization "+/-100mV":

  $$\text{voltage value} = 0{,}04885\ \text{mV} \times \text{decimal value}$$

- For the parameterization "+/-500mV":

  $$\text{voltage value} = 0{,}24426\ \text{mV} \times \text{decimal value}$$

- For the parameterization "+/-1000mV":

  $$\text{voltage value} = 0{,}48852\ \text{mV} \times \text{decimal value}$$

The value range

-50 mV to -0,024mV;

-100 mV to -0,049mV;

-500 mV to -0,244mV;

-1000 mV to -0,489mV;

is displayed as follows:

800_{hex} to FFF_{hex} (decimal: -2048 to -1)

The value range

0 mV to 50 mV;

0 mV to 100 mV;

0 mV to 500 mV;

0 mV to 1000 mV;

is displayed as follows:

000_{hex} to $7FF_{hex}$ (decimal: 0 to 2047)

Voltage values from 0 to 10 V DC

Note

In the 12-bit-representation only the 3 more significant digit positions of the hexadecimal number or the 12 more significant bits of the binary number are used for the calculation of the decimal value.

The voltage values can now be calculated by means of the following equation:

$$\text{voltage value} = 0{,}002442\ \text{V} \times \text{decimal value}$$

The value range

0 V to 10 V

is displayed as follows:

000_{hex} to FFF_{hex} (decimal: 0 to 4095)

Voltage values from -10 to 10 V DC

All numerical values from 000_{hex} to $7FF_{hex}$ represent **positive** values when coded as two's complement. Values in this range can easily be converted into **decimal** values. This is also relevant for binary numbers in which the most significant bit (no. 16) is "0".

All numerical values from 800_{hex} to FFF_{hex} represent **negative** values when coded as two's complement. This is also relevant for binary numbers in which the most significant bit (no. 16) is "1".

Note

In the 12-bit-representation only the 3 more significant digit positions of the hexadecimal number or the 12 more significant bits of the binary number are used for the calculation of the decimal value.

For **positive** voltage values (0 to 10 V DC) use:

$$\text{voltage value} = 0{,}004885\ \text{V} \times \text{decimal value}$$

The value range

0 V to 10 V

is displayed as follows:

000_{hex} to $7FF_{hex}$ (decimal: 0 to 2047)

For **negative** voltage values (-10 to 10 V DC) use:

$$\text{voltage value} = 0{,}004883\ \text{V} \times \text{decimal value}$$

The value range

-10 V to -0,0049 V

is displayed as follows:

800_{hex} to FFF_{hex} (decimal: -2048 to -1)

14.2 Analog value representation (analog output modules)

In the bipolar mode the digitalized analog values are represented as a two's complement. The 16 bit or the 12-bit-representation (left justified) can be chosen by setting the respective module parameter.

14.2.1 Equations for 16 bit representation

Current values from 0 to 20 mA

The decimal values can be converted into current values from 0 mA to 20 mA by means of the following equation:

$$\text{decimal value} = 1638{,}35\,\frac{1}{\text{mA}} \times \text{current value}$$

The value range

0 mA to 20 mA

is displayed as follows:

0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

The decimal values can easily be converted into a hexadecimal value, because all possible values belong to the positive value range of the two's complement (→ page 14-3).

Current values from 4 to 20 mA

The decimal values can be converted into current values from 4 mA to 20 mA by means of the following equation:

$$\text{decimal value} = 2047{,}9375\,\frac{1}{\text{mA}} \times \text{current value} - 8191{,}75$$

The value range

4 mA to 20 mA

is displayed as follows:

0000_{hex} to $7FFF_{hex}$ (decimal: 0 to 32767)

The decimal values can easily be converted into a hexadecimal value, because all possible values belong to the positive value range of the two's complement (→ page 14-3).

Voltage values from 0 to 10 V DC

The decimal values can be converted into voltage values from 0 to 10 V DC by means of the following equation:

$$\text{decimal value} = 3276{,}7\,\frac{1}{\text{V}} \times \text{voltage value}$$

The decimal values can easily be converted into a hexadecimal value, because all possible values belong to the positive value range of the two's complement (→ page 14-3).

Voltage values from -10 to 10 V DC

The decimal values can be converted into voltage values from -10 to 10 V DC by means of the following equation:

For **positive** voltage values (0 to 10 V DC) use:

$$\text{decimal value} = 3276{,}7\ \frac{1}{V} \times \text{voltage value}$$

The value range

0 V to 10 V

is displayed as follows:

0000$_{hex}$ **to 7FFF**$_{hex}$ (decimal: 0 to 32767)

For **negative** voltage values (-10 to 0 V DC) use:

$$\text{decimal value} = 3276{,}8\ \frac{1}{V} \times \text{voltage value}$$

The value range

-10 V to -3,052 10^{-4} V

is displayed as follows:

8000$_{hex}$ **to FFFF**$_{hex}$ (decimal:-32768 to -1)

Conversion of the decimal values into hexadecimal/ binary values

The decimal value can easily be converted into hexadecimal or binary values. The two's complement (→ page 14-3) for the 16 bit values corresponds to the dual numbers in the positive range.

The conversion of negative decimal values into hexadecimal values is more complicated, because the values have to be coded as a two's complement.

The following example explains the method of conversion:

The 4-digit hexadecimal number for the voltage value **-6V** is searched:

$$\text{decimal value} = 3276{,}8\ \frac{1}{V} \times (-6V) = -19660{,}8$$

Some calculators can be used to convert negative decimal values directly in a hexadecimal value coded as two's complement.

Without such a calculator, convert the value as follows:

1 Convert the amount of the negative decimal value to a binary number:

$$|-19660{,}8| = 19660{,}8 \Leftrightarrow 100.1100.1100.1100$$

2 Fill the 16 bit of the binary number with "0":

$100.1100.1100.1100 \Leftrightarrow 0100.1100.1100.1100$

3 Invert the 16-digit binary number:

$0100.1100.1100.1100 \Rightarrow 1011.0011.0011.0011$

4 Add "1" to this inverted number:

1011.0011.0011.0011
0000.0000.0000.0001
1011.0011.0011.0100

5 The number is now coded as a two's complement and can be converted into a hexadecimal number.

1011.0011.0011.0100 ⇒ B334

6 The result is:

-6 V ⇒ 19660,8 ⇒ B334

Equations for 12-bit-representation

Attention
The 12-bit-representation is "left-justified". The value is transmitted with 16 bit. The last 4 digits of the binary number or the last digit position of the hexadecimal value are always "0".

Current values from 0 to 20 mA

The decimal values can be converted into current values from 0 to 20 mA by means of the following equation:

$$\text{decimal value} = 204{,}75\,\frac{1}{\text{mA}} \times \text{current value}$$

The value range

0 mA to 20 mA

is displayed as follows:

000$_{hex}$ **to FFF**$_{hex}$ (decimal: 0 to 4095)

Note
As the numbers are represented left-justified, a "0" has to be added to the 3-digit hexadecimal value or the number has to move one digit to the left.

$XXX_{hex} \Rightarrow XXX0_{hex}$

The 12-digit binary number has to be filled with 4 digits of "0" or has to move 4 digits to the left:

XXXX.XXXX.XXXX ⇒ XXXX.XXXX.XXXX.0000

Current values from 4 to 20 mA

The decimal values can be converted into current values from 4 to 20 mA by means of the following equation:

$$\text{decimal value} = 255{,}9375\ \frac{1}{\text{mA}} \times \text{current value} - 1023{,}75$$

The value range

4 mA to 20 mA

is displayed as follows:

000_{hex} to FFF_{hex} (decimal: 0 to 4095)

Voltage values from 0 to 10 V DC

The decimal values can be converted into voltage values from 0 to 10 V DC by means of the following equation:

$$\text{decimal value} = 409{,}5\ \frac{1}{\text{V}} \div \text{voltage value}$$

The value range

0 V to 10 V

is displayed as follows:

000_{hex} to FFF_{hex} (decimal: 0 to 4095)

Voltage values from -10 to 10 V DC

The decimal values can be converted into voltage values from -10 to 10 V DC by means of the following equation:

For **positive** voltage values (0 to 10 V DC) use:

$$\text{decimal value} = 204{,}7\ \frac{1}{V} \times \text{voltage value}$$

The value range

0 V to 10 V

is displayed as follows:

000_{hex} to $7FF_{hex}$ (decimal: 0 to 2047)

For **negative** voltage values (-10 to 0 V DC) use:

$$\text{decimal value} = 204{,}8\ \frac{1}{V} \times \text{voltage value}$$

The value range

-10 V to -0,0049 V

is displayed as follows:

800_{hex} to FFF_{hex} (decimal: -2048 to -1)

Positive decimal values can easily be converted into hexadecimal values. The two's complement (→ page 14-3) corresponds to the 12 bit values in the positive range of the binary numbers.

Note

As the numbers are represented left-justified, a "0" has to be added to the 3-digit hexadecimal value or the number has to move one digit to the left (→ page 14-17).

Conversion of the negative decimal values into hexadecimal/ binary value

The conversion of negative decimal values into hexadecimal values is more complicated, because the values have to be coded as a two's complement.

The following example explains the method of conversion:

The 4-digit hexadecimal number for the voltage value **-6V** is searched:

$$\text{decimal value} = 204{,}8 \ \frac{1}{V} \times (-6V) = -1228{,}8$$

Some calculators can be used to convert negative decimal values directly in a hexadecimal value coded as two's complement.

Without such a calculator, convert the value as follows:

1 Convert the amount of the negative decimal value to a binary number:

$$|-1228{,}8| = 1228{,}8 \Leftrightarrow 100.1100.1\ 100$$

Fill the 12 bit of the binary number with "0":

100.1100.1100 ⇒ 0100.1100.1100

2 Invert the 12-digit binary number:

0100.1100.1100 ⇒ 1011.0011.0011

3 Add "1" to this inverted number:

1011.0011.0011
0000.0000.0001
1011.0011.0100

4 The number is now coded as a two's complement and can be converted into a hexadecimal number.

1011.0011.0100 ⇒ B34

5 As the number is represented as 16 bit left-justified, the hexadecimal value has to be completed with a "0" and the binary value with 4 "0".

B34 ⇒ B340
(1011.0011.0100 ⇒ 1011.0011.0100.0000)

6 The result is:

- 6 V ⇒ -1228,8 ⇒ B340

14.3 Identcodes of the BL20-modules

Each module modul is identified by the gateway with the help of a module-specific ident code.

Table 14-1: Module ident codes

Module	Ident code
Digital input modules	
BL20-2DI-24VDC-P	0×210020××
BL20-2DI-24VDC-N	0×220020××
BL20-2DI-120/230VAC	0×230020××
BL20-4DI-24VDC-P	0×410030××
BL20-4DI-24VDC-N	0×420030××
BL20-4DI-NAMUR	0×015640××
BL20-E-8DI-24VDC-P	0×610040××
BL20-16DI-24VDC-P	0×810050××
BL20-E-16DI-24VDC-P	0×820050××
BL20-32DI-24VDC-P	0×A10070××
Analog input modules	
BL20-1AI-I(0/4...20MA)	0×012350××
BL20-2AI-I(0/4...20MA)	0×225570××
BL20-1AI-U(-10/0...+10VDC)	0×011350××
BL20-2AI-U(-10/0...+10VDC)	0×235570××
BL20-2AI-PT/NI-2/3	0×215770××
BL20-2AI-THERMO-PI	0×215570××
BL20-4AI-U/I	0×417790××
BL20-E-8AI-U/I-PT/NI	0x6199B0××
BL20-2AIH-I	0x2179C0xx
Digital output modules	
BL20-2DO-24VDC-0,5A-P	0×212002××
BL20-2DO-24VDC-0,5A-N	0×222002××
BL20-2DO-24VDC-2A-P	0×232002××
BL20-2DO-120/230VAC-0.5A	0×250002××
BL20-4DO-24VDC-0,5A-P	0×013003××
BL20-E-8DO-24VDC-0.5A-P	0×610004××
BL20-16DO-24VDC-0,5A-P	0×413005××

Table 14-1: Module ident codes

Module	Ident code
BL20-E-16DO-24VDC-0.5A-P	0×820005××
BL20-32DO-24VDC-0,5A-P	0×614007××
Analog output modules	
BL20-1AO-I(0/4...20MA)	0×010605××
BL20-2AO-I(0/4...20MA)	0×220807××
BL20-2AO-U(-10/0...+10VDC)	0×210807××
BL20-E-4AO-U/I	0x417A09××
BL20-2AOH-I	0×217AB7××
Relay modules	
BL20-2DO-R-NC	0×230002××
BL20-2DO-R-NO	0×220002××
BL20-2DO-R-CO	0×210002××
Technology modules	
BL20-1CNT-24VDC	0×014B99××
BL20-1RS232	0×014799××
BL20-1RS485/422	0×024799××
BL20-1SSI	0×044799××
BL20-E-1SWIRE	0×169C99××
BL20-1RFID-x	0x242224xx
Power supply modules	
BL20-BR-24VDC-D	0×013000××
BL20-PF-24VDC-D	0×023000××
BL20-PF-120/230VAC-D	0×053000××

14.4 Nominal current consumption and power loss

14.4.1 Nominal current consumption of the BL20 modules from supply terminal I_L

Table 14-2: Nominal current consumption

Modules	Power supply	Nominal current consumption
Gateway		–
BL20-BR-24VDC-D	10 A	
BL20-PF-24VDC-D	10 A	
BL20-PF-120/230VAC-D	10 A	
BL20-2DI-24VDC-P		≤ 20 mA
BL20-2DI-24VDC-N		≤ 20 mA
BL20-2DI-120/230VAC		≤ 20 mA
BL20-4DI-24VDC-P		≤ 40 mA
BL20-4DI-24VDC-N		≤ 40 mA
BL20-4DI-NAMUR		≤ 30 mA
BL20-16DI-24VDC-P		≤ 40 mA
BL20-32DI-24VDC-P		≤ 30 mA
BL20-1AI-I(0/4..20MA)		≤ 50 mA
BL20-2AI-I(0/4..20MA)		≤ 12 mA
BL20-1AI-U(-10/0..+10VDC)		≤ 50 mA
BL20-2AI-U(-10/0..+10VDC)		≤ 12 mA
BL20-2AI-PT/NI-2/3		< 30 mA
BL20-2AI-THERMO-PI		< 30 mA
BL20-4AI-U/I		< 20 mA
BL20-E-8AI-U/I-4PT/NI		50 mA
BL20-2AIH-I		typ. 35 mA (without measuring signal)
BL20-2DO-24VDC-0.5A-P		20 mA (when load current = 0)
BL20-2DO-24VDC-0.5A-N		20 mA (when load current = 0)
BL20-2DO-24VDC-2A-P		< 50 mA (when load current = 0)
BL20-4DO-24VDC-0.5A-P		≤ 25 mA (when load current = 0)
BL20-16DO-24VDC-0.5A-P		< 30 mA
BL20-32DO-24VDC-0.5A-P		< 50 mA
BL20-2DO-120/230VAC-0.5A		< 20 mA (when load current = 0)

Table 14-2: Nominal current consumption

Modules	Power supply	Nominal current consumption
BL20-1AO-I(0/4..20MA)		≤ 50 mA
BL20-2AO-I(0/4..20MA)		≤ 50 mA
BL20-2AO-U(-10/0..+10VDC)		≤ 50 mA
BL20-E-4AO-U/I		< 50 mA
BL20-2AOH-I		< 20 mA (without signal output)
BL20-2DO-R-NC		< 20 mA
BL20-2DO-R-NO		< 20 mA
BL20-2DO-R-CO		< 20 mA
BL20-1CNT-24VDC		< 50 mA (when load current = 0)
BL20-1RS232		-
BL20-1RS485/422		< 25 mA
BL20-1SSI		< 25 mA
BL20-2RFID-A/-C		≤ 100 mA

14.4.2 Nominal current of the BL20 modules on the module bus I_{MB}

Table 14-3: Nominal current of the BL20 modules on the module bus

Modules	Power supply	Nominal current consumption
Gateway		≤ 430 mA
BL20-BR-24VDC-D	1 500 mA	
BL20-PF-24VDC-D		≤ 28 mA
BL20-PF-120/230VAC-D		≤ 25 mA
BL20-2DI-24VDC-P		≤ 28 mA
BL20-2DI-24VDC-N		≤ 28 mA
BL20-2DI-120/230VAC		≤ 28 mA
BL20-4DI-24VDC-P		≤ 29 mA
BL20-4DI-24VDC-N		≤ 28 mA
BL20-4DI-NAMUR		≤ 40 mA
BL20-16DI-24VDC-P		≤ 45 mA
BL20-32DI-24VDC-P		≤ 30 mA
BL20-1AI-I(0/4...20MA)		≤ 41 mA
BL20-2AI-I(0/4...20MA)		≤ 35 mA
BL20-1AI-U(-10/0...+10VDC)		≤ 41 mA
BL20-2AI-U(-10/0...+10VDC)		≤ 35 mA
BL20-2AI-PT/NI-2/3		≤ 45 mA
BL20-2AI-THERMO-PI		≤ 45 mA
BL20-4AI-U/I		≤ 50 mA
BL20-2AIH-I		< 30 mA
BL20-E-8AI-U/I-4PT/NI		< 50 mA
BL20-2DO-24VDC-0.5A-P		≤ 32 mA
BL20-2DO-24VDC-0.5A-N		≤ 32 mA
BL20-2DO-24VDC-2A-P		≤ 33 mA
BL20-4DO-24VDC-0.5A-P		≤ 30 mA
BL20-16DO-24VDC-0.5A-P		≤ 45 mA
BL20-326DO-24VDC-0.5A-P		≤ 30 mA
BL20-2DO-120/230VAC-0.5A		< 35 mA
BL20-1AO-I(0/4...20MA)		≤ 39 mA

Table 14-3: Nominal current of the BL20 modules on the module bus

Modules	Power supply	Nominal current consumption
BL20-2AO-I(0/4...20MA)		≤ 40 mA
BL20-2AO-U(-10/0...+10VDC)		≤ 43 mA
BL20-E-4AO-U/I		< 50 mA
BL20-2AOH-I		< 30 mA
BL20-2DO-R-NC		≤ 28 mA
BL20-2DO-R-NO		≤ 28 mA
BL20-2DO-R-CO		≤ 28 mA
BL20-1CNT-24VDC		≤ 40 mA
BL20-1RS232		≤ 140 mA
BL20-1RS485/422		≤ 60 mA
BL20-1SSI		≤ 50 mA
BL20-E-1SWIRE		≤ 60 mA
BL20-2RFID-A/-C		≤ 30 mA

14.4.3 Power loss of the BL20 modules

Table 14-4: Power loss

Modules	Power loss (typical)
Gateway	–
BL20-BR-24VDC-D	–
BL20-PF-24VDC-D	–
BL20-PF-120/230VAC-D	–
BL20-2DI-24VDC-P	0.7 W
BL20-2DI-24VDC-N	0.7 W
BL20-2DI-120/230VAC	< 1 W
BL20-4DI-24VDC-P	< 1 W
BL20-4DI-24VDC-N	< 1 W
BL20-16DI-24VDC-P	< 2.5 W
BL20-32DI-24VDC-P	< 4.2 W
BL20-1AI-I(0/4..20MA)	< 1 W
BL20-2AI-I(0/4..20MA)	< 1 W
BL20-1AI-U(-10/0..+10VDC)	< 1 W
BL20-2AI-U(-10/0..+10VDC)	< 1 W
BL20-2AI-PT/NI-2/3	< 1 W
BL20-2AI-THERMO-PI	1 W
BL20-4AI-U/I	< 1W
BL20-2AIH-I	< 1W
BL20-E-8AI-U/I-4PT/NI	< 1,5 W
BL20-2DO-24VDC-0.5A-P	1 W
BL20-2DO-24VDC-0.5A-N	1 W
BL20-2DO-24VDC-2A-P	1 W
BL20-4DO-24VDC-0.5A-P	< 1 W
BL20-16DO-24VDC-0.5A-P	< 4 W
BL20-32DO-24VDC-0.5A-P	< 4 W
BL20-2DO-120/230VAC-0.5A	< 1 W
BL20-1AO-I(0/4..20MA)	< 1 W
BL20-2AO-I(0/4..20MA)	< 1 W
BL20-2AO-U(-10/0..+10VDC)	< 1 W

Table 14-4: Power loss

Modules	Power loss (typical)
BL20-E-4AO-U/I	< 1,5 W
BL20-2AOH-I	< 1W
BL20-2DO-R-NC	1 W
BL20-2DO-R-NO	1 W
BL20-2DO-R-CO	1 W
BL20-1CNT-24VDC	1.3 W
BL20-1RS232	≤ 1 W
BL20-1RS485/422	≤ 1 W
BL20-1SSI	≤ 1 W
BL20-E-1SWIRE	≤ 1 W
BL20-2RFID-A/-C	≤ 1 W

14.5 Acronyms

Abbr.	Designation	Example
ABPL	End plate for right-sided termination of a BL20 station	BL20-**ABPL**
AI	Analog input module	BL20-2**AI**-I(0/4...20MA)
AO	Analog output module	BL20-1**AO**-I(0/4...20MA)
B	designation for base module in block design	BL20-**B**3S-SBB
B	Bridge connector: bridged connections on the same connection level in a base module, for applying potentials	BL20-S3T-S**BB**
B	Added to designation of base modules for those Bus Refreshing modules used within a BL20 station but do not supply the gateway with power.	BL20-P4T-SBBC-**B**
BR	Bus Refreshing module	BL20-**BR**-24VDC-D
C	Designation of a connection level with cross-connection to a C-rail and can, among other things, be used as a PE (only possible with certain base modules).	BL20-S4T-SBB**C**
CJ	Base module for BL20-2AI-THERMO-PI with integrated PT1000 for cold junction compensation	BL20-S4T-SBBS-**CJ**
CNT	Counter	BL20-1**CNT**-24VDC
CO	Change over	BL20-2DO-R-**CO**
D	Diagnostics	BL20-BR-24VDC-**D**
DI	Digital input module	BL20-2**DI**-24VDC-P
DO	Digital output module	BL20-2**DO**-24VDC-2A-P
GW	Gateway	BL20-**GW**-PBDP-1.5MB
KLBU	Terminal clip, shielded connection for analog input modules	BL20-**KLBU**/T
KO	Coding element for coding electronics and base module	BL20-**KO**/2
MB	Transmission rate MBit/s	BL20-GW-PBDP-1.5**MB**
N	Negative switching	BL20-2DI-24VDC-**N**
NC	Normally closed	BL20-2DO-R-**NC**
NI	Potential isolation of analog modules for thermocouples	BL20-2AI-PT/**NI**-2/3
NO	Normally open	BL20-2DO-R-**NO**

Abbr.	Designation	Example
P	Positive switching	BL20-2DI-24VDC-**P**
P	Designation of the base module for Power Feeding and Bus Refreshing modules	BL20-**P**3T-SBB
PBDP	BL20-Gateway for PROFIBUS-DP	BL20-GW-**PBDP**-1.5MB
PF	Power Feeding modules	BL20-**PF**-24VDC-D
PI	Analog input module for connecting thermocouples with cold junction compensation	BL20-2AI-THERMO-**PI**
PT	Analog input module for connecting resistance thermometers with sensors PT100, PT200, PT500 and PT1000 in 2- or 3-wire measurement type	BL20-2AI-**PT**/NI-2/3
QV	Jumper for relay modules	BL20-**QV**/1
R	Relay module	BL20-2DO-**R**-NC
S	Designation for base module in slice design	BL20-**S**3T-SBB
S	Designation for base modules with screw connection	BL20-S3**S**-SBB
S	Designation for gateway with screw connection	BL20-GW-PBDB-1.5MB-**S**
S	Single connector: non-bridged connections on the same connection level in a base module, used for connecting the signal	BL20-S3T-**S**BB
T	Designation for base modules with tension clamp connection	BL20-S3**T**-SBB
x	Partly for "S" or "T" in the designations of base modules with screw or tension clamp connection	BL20-S3**x**-SBB

14.5.1 Electronic and base modules

Electronics modules / Base modules	BL20-S3x-SBB	BL20-S3x-SBC	BL20-S4x-SBBC	BL20-S4x-SBBS	BL20-S4x-SBCS	BL20-S4x-SBBS-CJ	BL20-S6x-SBBSBB	BL20-S6x-SBCSBC	BL20-B3x-SBB	BL20-B3x-SBC	BL20-B4x-SBBC	BL20-B6x-SBBSBB	BL20-P3x-SBB	BL20-P3x-SBB-B	BL20-P4x-SBBC	BL20-P4x-SBBC-B
Digital input																
BL20-2DI-24VDC-P	X		X													
BL20-2DI-24VDC-N	X		X													
BL20-2DI-120/230VAC	X		X													
BL20-4DI-24VDC-P				X			X									
BL20-4DI-24VDC-N				X			X									
BL20-16DI-24VDC-P									X		X					
BL20-32DI-24VDC-P												X				
BL20-4DI-NAMUR				X												
Analog input																
BL20-1AI-I(0/4...20MA)	X			X												
BL20-2AI-I(0/4...20MA)	X			X												
BL20-1AI-U(-10/0...+10VDC)	X			X												
BL20-2AI-U(-10/0...+10VDC)	X			X												
BL20-2AI-PT/NI-2/3	X			X												
BL20-2AI-THERMO-PI						X										
BL20-4AI-U/I								X								
BL20-2AIH-I				X												
Digital output																
BL20-2DO-24VDC-2A-P		X			X											
BL20-2DO-24VDC-0.5A-P		X			X											
BL20-2DO-24VDC-0.5A-N		X			X											
BL20-4DO-24VDC-0.5A-P					X			X								
BL20-16DO-24VDC-0.5A-P										X						
BL20-32DO-24VDC-0.5A-P											X					
BL20-2DO-120/230VAC-0.5A		X			X											

Electronics modules / Base modules	BL20-S3x-SBB	BL20-S3x-SBC	BL20-S4x-SBBC	BL20-S4x-SBBS	BL20-S4x-SBCS	BL20-S4x-SBBS-CJ	BL20-S6x-SBBSBB	BL20-S6x-SBCSBC	BL20-B3x-SBB	BL20-B3x-SBC	BL20-B4x-SBBC	BL20-B6x-SBBSBB	BL20-P3x-SBB	BL20-P3x-SBB-B	BL20-P4x-SBBC	BL20-P4x-SBBC-B
Analog output																
BL20-1AO-I(0/4...20MA)	X															
BL20-2AO-I(0/4...20MA)	X															
BL20-2AO-U(-10/0...+10VDC)	X															
BL20-2AOH-I				X												
Relay modules																
BL20-2DO-R-NC				X	X											
BL20-2DO-R-NO				X	X											
BL20-2DO-R-CO				X												
Technology modules																
BL20-1CNT-24VDC				X												
BL20-1RS232				X												
BL20-1RS485/422				X												
BL20-1SSI				X												
Power distribution																
BL20-BR-24VDC-D													X 1)	X 2)	X 1)	X 2)
BL20-PF-24VDC-D													X		X	
BL20-PF-120/230VAC-D													X		X	

1) Base modules for gateway supply

2) Base modules for bus refreshing within the station

14.6 Conversion table decimal to hexadecimal

Decimal	Hexadecimal	Decimal	Hexadecimal	Decimal	Hexadecimal	Decimal	Hexadecimal	Decimal	Hexadecimal
001	01	026	1A	051	33	076	4C	101	65
002	02	027	1B	052	34	077	4D	102	66
003	03	028	1C	053	35	078	4E	103	67
004	04	029	1D	054	36	079	4F	104	68
005	05	030	1E	055	37	080	50	105	69
006	06	031	1F	056	38	081	51	106	6A
007	07	032	20	057	39	082	52	107	6B
008	08	033	21	058	3A	083	53	108	6C
009	09	034	22	059	3B	084	54	109	6D
010	0A	035	23	060	3C	085	55	110	6E
011	0B	036	24	061	3D	086	56	111	6F
012	0C	037	25	062	3E	087	57	112	70
013	0D	038	26	063	3F	088	58	113	71
014	0E	039	27	064	40	089	59	114	72
015	0F	040	28	065	41	090	5A	115	73
016	10	041	29	066	42	091	5B	116	74
017	11	042	2A	067	43	092	5C	117	75
018	12	043	2B	068	44	093	5D	118	76
019	13	044	2C	069	45	094	5E	119	77
020	14	045	2D	070	46	095	5F	120	78
021	15	046	2E	071	47	096	60	121	79
022	16	047	2F	072	48	097	61	122	7A
023	17	048	30	073	49	098	62	123	7B
024	18	049	31	074	4A	099	63	124	7C
025	19	050	32	075	4B	100	64	125	7D

14.7 Parameter gateway – assignment in hexadecimal format

14.7.1 Parameter 4

Parameter in hexadecimal format	Outputs module exchange				Outputs module exchange error				Outputs fieldbus error		
	Output 0[1)]	Output substitute value	Hold current value	Exchange process data	Output 0[1)]	Output substitute value	Hold current value	Exchange process data	Output 0[1)]	Output substitute value	Hold current value
00	X				X				X		
01		X			X				X		
02			X		X				X		
03				X	X				X		
04	X					X			X		
05		X				X			X		
06			X			X			X		
07				X		X			X		
08	X						X		X		
09		X					X		X		
0A			X				X		X		
0B				X			X		X		
0C	X							X	X		
0D		X						X	X		
0E			X					X	X		
0F				X				X	X		
10	X				X					X	
11		X			X					X	
12			X		X					X	
13				X	X					X	
14	X					X				X	
15		X				X				X	

Parameter in hexadecimal format	Outputs module exchange				Outputs module exchange error				Outputs fieldbus error		
	Output 0[1]	Output substitute value	Hold current value	Exchange process data	Output 0[1]	Output substitute value	Hold current value	Exchange process data	Output 0[1]	Output substitute value	Hold current value
16			X			X				X	
17				X		X				X	
18	X						X			X	
19		X					X			X	
1A			X				X			X	
1B				X			X			X	
1C	X							X		X	
1D		X						X		X	
1E			X					X		X	
1F				X				X		X	
20	X				X						X
21		X			X						X
22			X		X						X
23				X	X						X
24	X					X					X
25		X				X					X
26			X			X					X
27				X		X					X
28	X						X				X
29		X					X				X
2A			X				X				X
2B				X			X				X
2C	X							X			X
2D		X						X			X
2E			X					X			X
2F				X				X			X

1) ... These parameters are default settings.

14.7.2 Parameter 5

Parameter in hexadecimal format	Integer Data format		Diagnostics all Modules		Station Configuration		I/Oassistant Force Mode		Gateway Diagnostics	
	LSB first[1)]	MSB first	Activate[1)]	Deactivate[1)]	Do not allow changes[1)]	Allow changes	Release[1)]	Lock	Device related Diagnostics[1)]	Dev./identifier/channel-diagn.
00	X		X		X		X		X	
01		X	X		X		X		X	
02	X			X	X		X		X	
03		X		X	X		X		X	
04	X		X		X		X		X	
05		X	X		X		X		X	
06	X			X	X		X		X	
07		X		X	X		X		X	
08	X		X			X	X		X	
09		X	X			X	X		X	
0A	X			X		X	X		X	
0B		X		X		X	X		X	
0C	X		X			X	X		X	
0D		X	X			X	X		X	
0E	X			X		X	X		X	
0F		X		X		X	X		X	
10	X		X		X			X	X	
11		X	X		X			X	X	
12	X			X	X			X	X	
13		X		X	X			X	X	
14	X		X		X			X	X	
15		X	X		X			X	X	

Parameter in hexadecimal format	Integer Data format		Diagnostics all Modules		Station Configuration		I/Oassistant Force Mode		Gateway Diagnostics	
	LSB first[1)]	MSB first	Activate[1)]	Deactivate[1)]	Do not allow changes[1)]	Allow changes	Release[1)]	Lock	Device related Diagnostics[1)]	Dev./identifier/channel-diagn.
16	X			X	X			X	X	
17		X		X	X			X	X	
18	X		X			X		X	X	
19		X	X			X		X	X	
1A	X			X		X		X	X	
1B		X		X		X		X	X	
1C	X		X			X		X	X	
1D		X	X			X		X	X	
1E	X			X		X		X	X	
1F		X		X		X		X	X	
20	X		X		X		X			X
21		X	X		X		X			X
22	X			X	X		X			X
23		X		X	X		X			X
24	X		X		X		X			X
25		X	X		X		X			X
26	X			X	X		X			X
27		X		X	X		X			X

Parameter in hexadecimal format	Integer Data format		Diagnostics all Modules		Station Configuration		I/Oassistant Force Mode		Gateway Diagnostics	
	LSB first[1)]	MSB first	Activate[1)]	Deactivate[1)]	Do not allow changes[1)]	Allow changes	Release[1)]	Lock	Device related Diagnostics[1)]	Dev./identifier/channel-diagn.
28	X		X			X	X			X
29		X	X			X	X			X
2A	X			X		X	X			X
2B		X		X		X	X			X
2C	X		X			X	X			X
2D		X	X			X	X			X
2E	X			X		X	X			X
2F		X		X		X	X			X
30	X		X		X			X		X
31		X	X		X			X		X
32	X			X	X			X		X
33		X		X	X			X		X
34	X		X		X			X		X
35		X	X		X			X		X
36	X			X	X			X		X
37		X		X	X			X		X
38	X		X			X		X		X
39		X	X			X		X		X
3A	X			X		X		X		X
3B		X		X		X		X		X
3C	X		X			X		X		X
3D		X	X			X		X		X
3E	X			X		X^		X		X
3F		X		X		X		X		X

1) ... These parameters are default settings.

15 Glossary

A

Acknowledge

Acknowledgment of a signal received.

Active metal component

Conductor or conducting component that is electrically live during operation.

Address

Identification number of, e.g. a memory position, a system or a module within a network.

Addressing

Allocation or setting of an address, e. g. for a module in a network.

Analog

Infinitely variable value, e. g. voltage. The value of an analog signal can take on any value, within certain limits.

Automation device

A device connected to a technical process with inputs and outputs for control. Programmable logic controllers (PLC) are a special group of automation devices.

B

Baud

Baud is a measure for the transmission speed of data. 1 Baud corresponds to the transmission of one bit per second (Bit/s).

Baud rate

Unit of measurement for measuring data transmission speeds in Bit/s.

Bidirectional

Working in both directions.

Bus

Bus system for data exchange, e. g. between CPU, memory and I/O levels. A bus can consist of several parallel cables for data transmission, addressing, control and power supply.

Bus cycle time

Time required for a master to serve all slaves or stations in a bus system, i. e. reading inputs and writing outputs.

Bus line

Smallest unit connected to a bus, consisting of a PLC, a coupling element for modules on the bus and a module.

Bus system

All units which communicate with one another via a bus.

C

Capacitive coupling

Electrical capacitive couplings occur between cables with different potentials. Typical sources of interference are, for example, parallel-routed signal cables, contactors and electrostatic discharges.

Coding elements

Two-piece element for the unambiguous assignment of electronic and base modules.

Configuration

Systematic arrangement of the I/O modules of a station.

CPU

Central Processing Unit. Central unit for electronic data processing, the processing core of the PC.

D

Digital

A value (e. g. a voltage) which can adopt only certain statuses within a finite set, mostly defined as 0 and 1.

DIN

German acronym for German Industrial Standard.

E

EIA

Electronic Industries Association – association of electrical companies in the United States.

Electrical components

All objects that produce, convert, transmit, distribute or utilize electrical power (e. g. conductors, cable, machines, control devices).

EMC

Electromagnetic compatibility – the ability of an electrical part to operate in a specific environment without fault and without exerting a negative influence on its environment.

EN

German acronym for European Standard.

ESD

Electrostatic Discharge.

F

Field power supply

Voltage supply for devices in the field as well as the signal voltage.

Fieldbus

Data network on sensor/actuator level. A fieldbus connects the equipment on the field level. Characteristics of a fieldbus are a high transmission security and real-time behavior.

G

GND

Abbreviation of ground (potential "0").

Ground

Expression used in electrical engineering to describe an area whose electrical potential is equal to zero at any given point. In neutral grounding devices, the potential is not necessarily zero, and one speaks of the ground reference.

Ground connection

One or more components that have a good and direct contact to earth.

Ground reference

Potential of ground in a neutral grounding device. Unlike earth whose potential is always zero, it may have a potential other than zero.

GSD

Acronym for Electronic Device Data Sheet which contains standardized PROFIBUS DP station descriptions. They simplify the planning of the DP master and slaves. Default language is English.

H

Hexadecimal

System of representing numbers in base 16 with the digits 0 ... 9, and further with the letters A, B, C, D, E and F.

Hysteresis

A sensor can get caught up at a certain point, and then "waver" at this position. This condition results in the counter content fluctuating around a given value. Should a reference value be within this fluctuating range, then the relevant output would be turned on and off in rhythm with the fluctuating signal.

I

I/O

Input/output.

Impedance

Total effective resistance that a component or circuit has for an alternating current at a specific frequency.

Inactive metal components

Conductive components that cannot be touched and are electrically isolated from active metal components by insulation, but can adopt voltage in the event of a fault.

Inductive coupling

Magnetic inductive couplings occur between two cables through which an electrical current is flowing. The magnetic effect caused by the electrical currents induces an interference voltage. Typical sources of interference are for example, transformers, motors, parallel-routed network and HF signal cables.

Intelligent modules

Intelligent modules are modules with an internal memory, able to transmit certain commands (e. g. substitute values and others).

L

Laod value

Predefined value for the counter module with which the count process begins.

Lightning protection

All measures taken to protect a system from damage due to overvoltages caused by lightning strike.

Low impedance connection

Connection with a low AC impedance.

LSB

Least Significant Bit

M

Mass

All interconnected inactive components that do not take on a dangerous touch potential in the case of a fault.

Master

Station in a bus system that controls the communication between the other stations.

Master/slave mode

Mode of operation in which a station acting as a master controls the communication between other stations in a bus system.

Module bus

The module bus is the internal bus in a BL20 station. The BL20 modules communicate with the gateway via the module bus which is independent of the fieldbus.

MSB

Most Significant Bit

Multi-master mode

Operating mode in which all stations in a system communicate with equal rights via the bus.

N

Namur

German acronym for an association concerned with standardizing measurement and control engineering. Namur initiators are special versions of the two-wire initiators. Namur initiators are characterized by their high immunity to interference and operating reliability, due to their special construction (low internal resistance, few components and compact design).

O

Overhead

System administration time required by the system for each transmission cycle.

P

PLC

Programmable Logic Controller.

Potential compensation

The alignment of electrical levels of electrical components and external conductive components by means of an electrical connection.

Potential free

Galvanic isolation of the reference potentials in I/O modules of the control and load circuits.

Potential linked

Electrical connection of the reference potentials in I/O modules of the control and load circuits.

PROFIBUS-DP

PROFIBUS bus system with DP protocol. DP stands for decentralized periphery. PROFIBUS-DP is based on DIN 19245 Parts 1 + 3 and has been integrated into the European fieldbus standard EN 50170.
It ensures a fast cyclic data exchange between the central DP master and the decentralized periphery devices (slaves). Its universal use is realized by the multi master concept.

PROFIBUS-DP address

Each PROFIBUS-DP module is assigned an explicit PROFIBUS-DP address, with which it can be queried by the master.

PROFIBUS-DP master

The PROFIBUS-DP master is the central station on the bus and controls access of all stations to PROFIBUS.

PROFIBUS-DP slave

PROFIBUS-DP slaves are queried by the PROFIBUS-DP master and exchange data with the master on request.

Protective earth

Electrical conductor for protection against dangerous shock currents. Generally represented by PE (protective earth).

R

Radiation coupling

A radiation coupling appears when an electromagnetic wave hits a conductive structure. Voltages and currents are induced by the collision. Typical sources of interference are for example, sparking gaps (spark plugs, commutators from electric motors) and transmitters (e. g. radio), that are operated near to conducting structures.

Reaction time

The time required in a bus system between a reading operation being sent and the receipt of an answer. It is the time required by an input module to change a signal at its input until the signal is sent to the bus system.

Reference potential

Potential from which all voltages of connected circuits are viewed and/or measured.

Repeater

The phase and the amplitude of the electric data signals are regenerated during the transmission process by the repeater.
Further, it is possible to change the topology of the PROFIBUS network. It can be extended considerably by means of the repeater.

Root-connecting

Creating a new potential group using a power distribution module. This allows sensors and loads to be supplied individually.

RS 485

Serial interface in accordance with EIA standards, for fast data transmission via multiple transmitters.

S

Serial

Type of information transmission, by which data is transmitted bit by bit via a cable.

Setting parameters

Setting parameters of individual stations on the bus and their modules in the configuration software of the master.

Shield

Conductive screen of cables, enclosures and cabinets.

Shielding

Description of all measures and devices used to join installation components to the shield.

Short-circuit proof

Characteristic of electrical components. A short-circuit proof part withstands thermal and dynamic loads which can occur at its place of installation due to a short circuit.

Station

A functional unit or I/O components consisting of a number of elements.

SUB-D connector

9-pin connector for connecting the fieldbus to the I/O-stations.

T

Terminating resistance

Resistor on both ends of a bus cable used to prevent interfering signal reflections and which provides bus cable matching. Terminating resistors must always be the last component at the end of a bus segment.

To ground

Connection of a conductive component with the grounding connection via a grounding installation.

Topology

Geometrical structure of a network or the circuitry arrangement.

U

UART

Universal Asynchronous Receiver/Transmitter. UART is a logic circuit which is used to convert an asynchronous serial data sequence to a parallel bit sequence or vice versa.

Unidirectional

Working in one direction.

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