CL150 / B~IO

Input/output modules for CL150, B~IO
Module Description

Edition 102

BOSCH
Automation

CL150 / B~IO

Input/output modules for CL150, B~IO
Module Description

1070 072 259-102 (02.03) GB

Discretionary charge 12.– €

Table of contents

1 Safety Instructions

Read this manual before you put the input and output modules of the module family B~IO into operation. Keep the manual in a location that is accessible to all users at all times.

1.1 Intended use

This manual contains information concerning use in accordance with the intended purpose. The products described are used as:

- decentralized input and output modules via bus connections for PROFIBUS-DP, InterBus-S, CANopen and DeviceNet
- centralized input and output modules of the CL150 PLC family

The products described hereunder

- were developed, manufactured, tested and documented in accordance with the relevant safety standards. In standard operation, and provided that the specifications and safety instructions relating to the project phase, installation and correct operation of the product are followed, there should arise no risk of danger to personnel or property.
- are certified to be in full compliance with the requirements of
  - the EMC Directives (89/336/EEC, 93/68/EEC and 93/44/EEC)
  - the Low-Voltage Directive (73/23/EEC)
  - the harmonized standards EN 50081-2 and EN 50082-2
- are designed for operation in an industrial environment (Class A emissions). The following restrictions apply:
  - No direct connection to the public low-voltage power supply is permitted.
  - Connection to the medium and/or high-voltage system must be provided via transformer.

  The following applies for application within a personal residence, in business areas, on retail premises or in a small-industry setting:
  - Installation in a control cabinet or housing with high shield attenuation.
  - Cables that exit the screened area must be provided with filtering or screening measures.
  - The user will be required to obtain a single operating license issued by the appropriate national authority or approval body. In Germany, this is the Federal Institute for Posts and Telecommunications, and/or its local branch offices.

☞ **This is a Class A device. In a residential area, this device may cause radio interference. In such case, the user may be required to introduce suitable countermeasures, and to bear the cost of the same.**

Proper transport, handling and storage, placement and installation of the product are indispensable prerequisites for its subsequent flawless service and safe operation.

1.2 Qualified personnel

This instruction manual is designed for specially trained personnel. The relevant requirements are based on the job specifications as outlined by the ZVEI and VDMA professional associations in Germany. Please refer to the following German-Language publication:
Weiterbildung in der Automatisierungstechnik
Publishers: ZVEI and VDMA Maschinenbau Verlag
Postfach 71 08 64
60498 Frankfurt/Germany

This manual is aimed at construction engineers who equip the machines and units with PLC s well as at skilled electrical technicians who install and put the machines into operation. They require special knowledge of PLC, the PROFIBUS-DP, the InterBus-S, the CANopen-Bus and the DeviceNet-Bus.

Interventions in the hardware and software of our products not described in this instruction manual may only be performed by our skilled personnel.

Unqualified interventions in the hardware or software or non-compliance with the warnings listed in this instruction manual or indicated on the product may result in serious personal injury or damage to property.

Installation and maintenance of the products described hereunder is the exclusive domain of trained electricians as per IEV 826-09-01 (modified) who are familiar with the contents of this manual.

Trained electricians are persons of whom the following is true:

- They are capable, due to their professional training, skills and expertise, and based upon their knowledge of and familiarity with applicable technical standards, of assessing the work to be carried out, and of recognizing possible dangers.
- They possess, subsequent to several years' experience in a comparable field of endeavour, a level of knowledge and skills that may be deemed commensurate with that attainable in the course of a formal professional education.

With regard to the foregoing, please read the information about our comprehensive training program. The professional staff at our training centre will be pleased to provide detailed information. You may contact the centre by telephone at (+49) 6062 78-258.

1.3 Safety markings on components

DANGER! High voltage!

CAUTION! Electrostatically sensitive components!

Disconnect mains power before opening!

Lug for connecting PE conductor only!

Functional earthing or low-noise earth only!

Screened conductor only!

1.4 Safety instructions in this manual

DANGEROUS ELECTRICAL VOLTAGE
This symbol warns of the presence of a **dangerous electrical voltage**. Insufficient of lacking compliance with this warning can result in **personal injury.**

DANGER
This symbol is used wherever insufficient or lacking observance of this instruction can result in **personal injury.**

CAUTION
This symbol is used wherever insufficient or lacking observance of instructions can result in **damage to equipment or data files.**

☞ This symbol is used to alert the user to an item of special interest.

★ This asterisk symbol indicates that the manual is describing an activity which the user will be required to perform.

1.5 Safety instructions for the described product

DANGER
Fatal injury hazard through ineffective Emergency-OFF devices!
Emergency-OFF safety devices must remain effective and accessible during all operating modes of the system. The release of functional locks imposed by Emergency-OFF devices must never be allowed to cause an uncontrolled system restart! Before restoring power to the system, test the Emergency-OFF sequence!

DANGER
Danger to persons and equipment!
Test every new program before operating the system!

DANGER
Retrofits or modifications may interfere with the safety of the products described hereunder!
The consequences may be severe personal injury or damage to equipment or the environment. Therefore, any system retrofitting or modification utilizing equipment components from other manufacturers will require express approval by Bosch.

DANGEROUS ELECTRICAL VOLTAGE
Unless described otherwise, maintenance procedures must always be carried out only while the system is isolated from the power supply. During this process, the system must be blocked to prevent an unauthorized or inadvertent restart.

If measuring or testing procedures must be carried out on the active system, these must be carried out by trained electricians.

CAUTION
Only Bosch-approved spare parts may be used!

CAUTION
Danger to the module!
All ESD protection measures must be observed when using the module! Prevent electrostatic discharges!

Observe the following protective measures for electrostatically endangered modules (EEM)!

- The Employees responsible for storage, transport and handling must be trained in ESD protection.
- EEMs must be stored and transported in the protective packaging specified.
- Out of principle, EEMs may be handled only at special ESD work stations equipped for this particular purpose.
- Employees, work surfaces and all devices and tools that could come into contact with EEMs must be on the same potential (e.g. earthed).
- An approved earthing wrist strap must be worn. It must be connected to the work surface via a cable with integrated 1 MΩ resistor.
- EEMs may under no circumstances come into contact with objects susceptible to accumulating an electrostatic charge. Most items made of plastic belong to this category.
- When installing EEMs in or removing them from an electronic device, the power supply of the device must be switched OFF.

1.6 Documentation, software release and trademarks

Documentation

This manual provides information on the installation and operation of the input and output modules of the module family B~IO.
It does not include generally applicable processes for project engineering and installation of the bus systems PROFIBUS-DP, InterBus-S, CANopen and DeviceNet.

Overview of available manuals:

Overview of the documentation	Order numbers			
	German	English	Italian	Spanish
CL150, CL151, CL150A, CL151A Control manual/Operations list	1070 072 438	1070 072 188	1070 072 243	1070 072 344
Input / output modules for CL150, B~IO	1070 072 199	1070 072 259	1070 072 248	–

Trademarks

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PROFIBUS® is a registered trademark of the PROFIBUS Nutzerorganisation e.V. (user organization).

INTERBUS-S® is a registered trade mark of Phoenix Contact.

DeviceNet® is a registered trade mark (TM) of ODVA (Open DeviceNet Vendor Association, Inc.).

Notes:

2 System overview

2.1 Area of application

The bus-independent input and output modules of the module family B~IO can be used together with the decentralized bus connections of the B~IO family or with the miniaturized control CL 150.

Bus connection B~IO

The bus connection is via a bus system with a higher-order control. The following bus connections can be used:

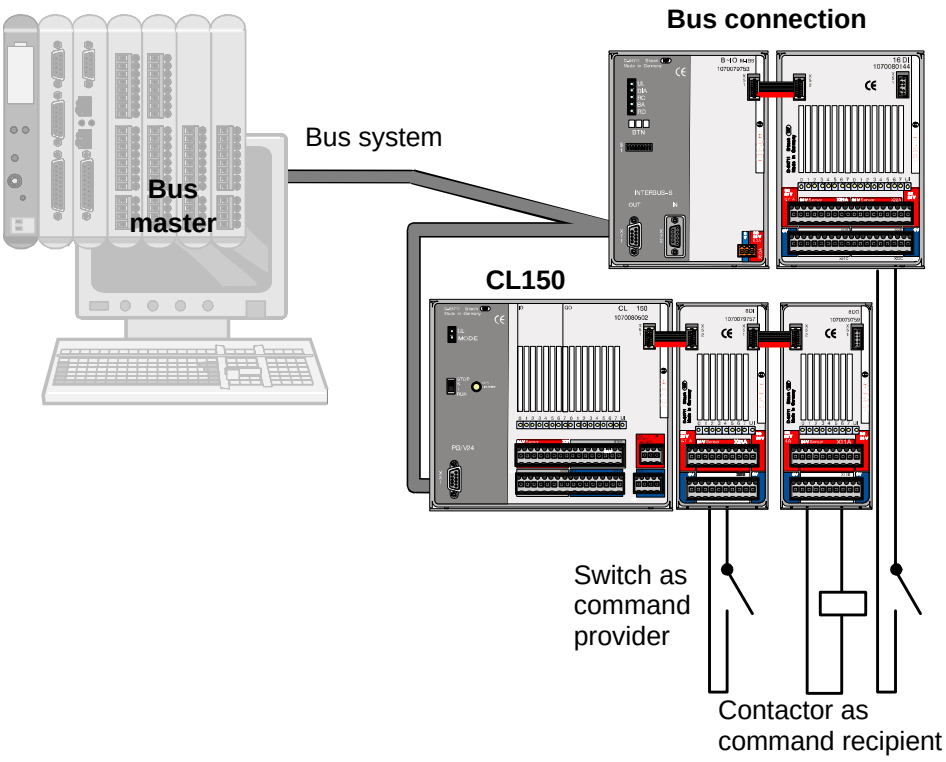
- PROFIBUS-DP, B~IO M-DP Order no. 1070 079 751
- InterBus-S, B~IO M-IBS Order no. 1070 079 753
- CANopen, B~IO M-CAN Order no. 1070 079 755
- DeviceNet, B~IO M-DEV Order no. 1070 079 950

Control CL150

If the miniaturized control CL150 is used, another higher-order control is not required.

☞ **Information on the bus connection B~IO and on the control CL150 can be found in the appropriate manuals, see page 1–7.**

Sample layout



2.2 Input/output modules

Digital inputs and outputs

Module	Order no.	Description
8DI	1070 079 757	Module with 8 inputs, 24 V DC
16DI	1070 080 144	Module with 16 inputs, 24 V DC
16DI-3	1070 081 862	Module with 16 inputs, 24 V DC, 3-wire connection
8DO	1070 079 759	Module with 8 outputs, 0.5 A
8DO/2A	1070 080 151	Module with 8 outputs, 2 A
16DO	1070 081 858	Module with 16 outputs, 0.5 A
8DI/DO	1070 080 709	Module with 8 connections that can be used bit by bit as digital inputs, 24 V DC or as 0.5 A semiconductor outputs
8DO R	1070 080 680	Module with 8 potential-free relay contacts, 2 A

Analog inputs and outputs

Module	Order no.	Description
4AI_UI	1070 080 524	Module with 4 analog inputs, 4 voltage or 2 current measurement ranges
4AI_UIT	1070 080 526	Module with 4 analog inputs, 3 voltage or 2 current measurement ranges, or 6 resistance thermometer types, or 7 thermal element types
4AO_U	1070 080 530	Module with 4 voltage outputs, –10 V to +10 V or 0 to 10 V
4AO_I	1070 080 528	Module with 4 current outputs, 0 to 20 mA or 4 to 20 mA

2.3 Gateway

Module	Order no.	Description
I/O gateway	1070 083 150	Gateway for linking 2 field bus systems, 8 or 20 byte data width

2.4 General technical data

Technical data	
corresponds to the general electrical engineering standards	• EN 61 131-2 • EN 50 178 • DIN VDE 0110 • EN 60 204-1 (corresponds to VDE 0113) • EMC Directive 93/68/EEC and revised legislation
Insulation testing voltage	• 350 V AC • 500 V DC • 500 V impulse 1.2/50 ms
Mechanical stress • Vibration, sinusoidal oscillations in all 3 axles EN 61 131-2 • Shock, impacts in all 3 axles EN 61 131-2	 • 10 to 57 Hz, 0.0375 mm amplitude constant, 0.075 mm amplitude occasional • 57 to 150 Hz, 0.5 g constant, 1 g occasional • 11 ms semi-sinusoidal 15 g
Degree of contamination complying with EN 61 131-2 and VDE 0470-1	2, Installation areas, at least IP 54, dust-free air
Type of protection complying with DIN VDE 0470-1	IP 20
Protection class complying with EN 50 178	1
Humidity class complying with EN 61 131-2	RH-2; 5 to 95 %, condensation not permitted
Operating temperature range	5 to 55 °C, average temperature over 24 hours maximum 50 °C
Air pressure complying with EN 61 131-2	Operation up to 2000 m above sea level
Transport resilience complying with EN 61 131-2	Drop height with packaging 1.0 m
Interference emission • Hard radiation • Radio interference suppression, housing complying with EN 50 081-2	 none Class A complying with EN 55 011 • Frequency 30 to 230 MHz Limit value 40 dB (mV/m) in 10 m • Frequency 230 to 1000 MHz Limit value 47 dB (mV/m) in 10 m
Interference immunity • High-frequency electromagnetic fields complying with EN 61 131-2, EN 50 082-2 and EN 61 000-4-3, Criterion A • Electrostatic discharge on accessible housing parts complying with EN 50 082-2, EN 61 131-2 and EN 61 000-4-2	 Test field strength 10 V/m; Frequency band 27 to 1000 MHz AM, 80 % with 1 kHz; Throughput speed 0.0015 dec./s • ESD resistance 4 for humidity class RH-2 • Testing voltage: air discharge 15 kV contact discharge 4 kV
Conducted interference • 24 V power supply complying with EN 61 131-2 and EN 50 082-2 • Digital inputs/outputs complying with EN 61131- and EN 50082-2	 • HF interaction unsymmetrical 10 V, 150 kHz to 80 MHz, 80 % AM, 1 kHz complying with EN 61000-4-6 • Rapid burst impulses, direct interaction 2 kV complying with EN 61000-4-4, Criterion A damped sinus 1 MHz, symmetrical 1 kV complying with EN 61000-4-12

The above data applies to all of the components described in this manual. It is supplemented by specific data of the assemblies.

Notes:

3 Installation

3.1 Installation positions and distances

The modules are placed directly on a 35 x 7.5 mm or 35 x 15 mm support rail complying with EN 50 022 in the switch cabinet. The support rails must be earthed, see page 13–5.

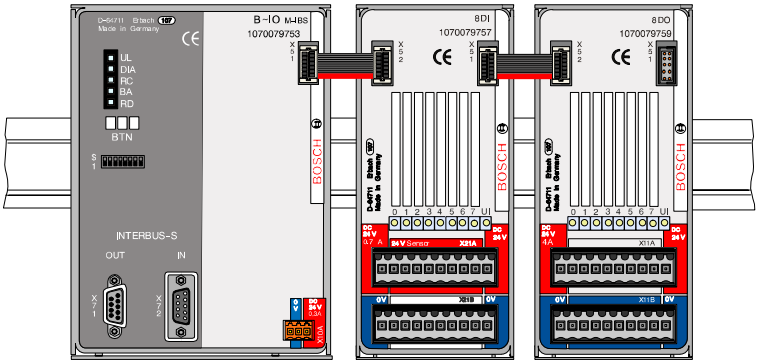
The modules are engaged to the right-hand side of a bus connection or a CL150 on the support rail and connected by means of the module connector plugs.

Permitted installation positions:

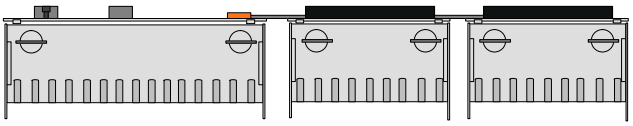
- horizontal
- lying
- vertical, above bus connection or CL150

Horizontal installation position (normal position)

I/O modules to the right-hand side of the CL150 or bus connection.

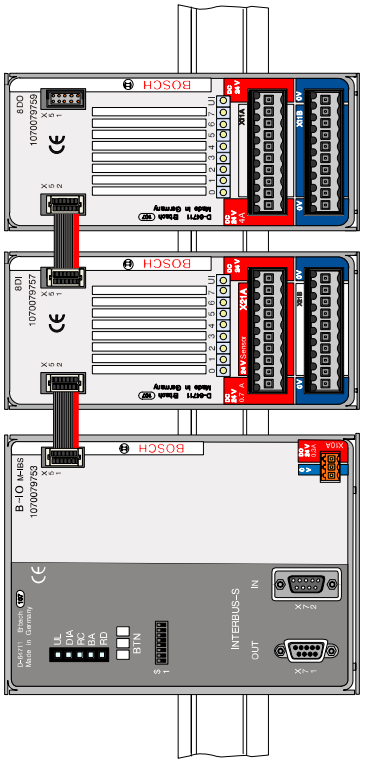


Lying installation position



☞ **Derating, see page 5–9.**

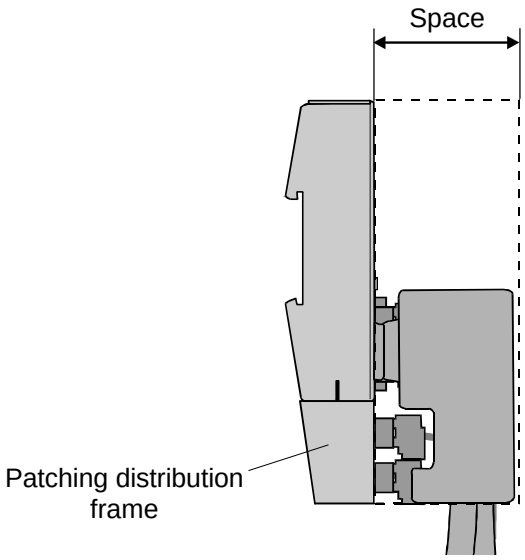
Vertical installation position



Minimum spacing

For easier installation and deinstallation, a space of 2 cm should be allowed above and below the modules. The free space at the front of the module is determined by the dimensions of the connector plugs used and the cable exits. Circulation of the surrounding air must be ensured.

Ensure that the ambient temperature is as low as possible, as high temperatures lead to more rapid ageing of components.

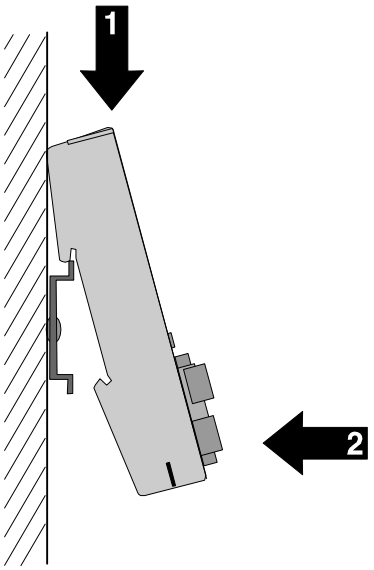


Fitting module

★ Insert module upwards in the rail.

★ Press module lightly downwards and engage.

★ Use module connector plug (ribbon cable) to attach connector X52 to connector X51 of the neighboring module on the left.



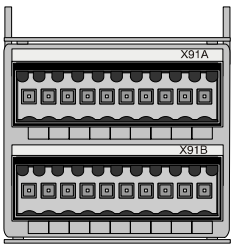
Labeling fields

Labeling fields are available for identification of the bus participant address and the inputs/outputs. These can be written in with a permanent marker.

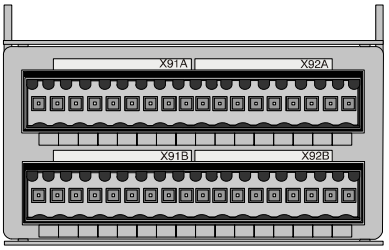
For labeling with an inkjet or laser printer, self-adhesive labels are available as DIN A4 sheets (see 'Accessories' in the relevant chapters of the modules).

Patching distribution frame

An optional patching distribution frame that might be required is inserted at the bottom of the module until it engages. This extends the module in a downward direction by 4 cm. Additional earthing is not required.



RV 2 x 10 M



RV 2 x 18 M

Maintenance

The modules are maintenance-free. If the housing needs to be cleaned, cleaning agents containing solvents or abrasives must not be used.

3.2 Combination of modules

Connection

The I/O modules are connected using module connector plugs (ribbon cable) to the neighboring modules and the bus connection or the CL150:

- Connector X52 to connector X51 of the neighboring module on the left
- Connector X51 to connector X52 the neighboring module on the right.
- If there is no neighboring module on the right, connector X51 remains open.

Arrangement

The sequence in which the I/O modules are connected to the CL150 or a bus connection is unimportant, with a few exceptions.

The allocation of the PLC addresses to the inputs and outputs of the I/O modules is regulated in different ways for the various bus systems.

☞ **For detailed information on the arrangement and addressing, refer to the documentation of the CL150 or the bus connection.**

Number of modules

A maximum of 16 modules can be connected to a CL150 or a bus connection. If more than 16 modules are connected, a fault is displayed.

☞ **The number of input/output bytes is restricted. For more detailed information, refer to the documentation of the CL150 or the bus connection.**

Sum current

Each CL150 or bus connection provides a maximum current of 500 mA for the logic supply of the I/O modules. This level of current must not be exceeded.

$I_{V, ges} = I_{V, module\ 1} + I_{V, module\ 2} + ... I_{V, module\ n} \leq 500$ mA

Module	Current consumption from internal bus
8DI	I_V = maximum 10 mA
16DI	I_V = maximum 20 mA
16DI-3	I_V = maximum 20 mA
8DO	I_V = maximum 15 mA
8DO/2A	I_V = maximum 10 mA
16DO	I_V = maximum 30 mA
8DO R	I_V = maximum 10 mA
8DI/DO	I_V = maximum 20 mA
4AI_UI	$I_V \leq 50$ mA
4AI_UIT	$I_V \leq 50$ mA
4AO_U	$I_V \leq 30$ mA
4AO_I	$I_V \leq 30$ mA
Gateway	I_V = maximum 10 mA

3.3 Arrangement of wiring

The wiring of the I/O modules is to be run from the distributor terminals in the switch cabinet for each module individually to the corresponding terminals. Two-wire sensors and actuators are connected directly at the relevant module. Three-wire or four-wire sensors and actuators are wired across the optional patching distribution frame.

☞ **The connected lines must be run with strain relief, e.g. through a cable duct.**

Parallel laying of data lines and power cables

A close parallel installation of data lines or input/output lines and interfering cables such as motor cables or leads to contactors with poor interference suppression must be avoided.
The smaller the spacing between the parallel installed cables, the greater the interacting interference (see 'Electromagnetic compatibility', section 13.4).

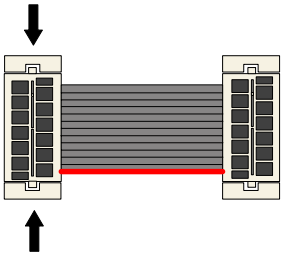
In cable ducts and switch cabinets, cables and data lines must be arranged at the greatest possible distance to one another, spacing of at least 10 cm and preferably in separate, shielded chambers.

Data lines to be crossed by power lines at an angle of 90°.

3.4 Deinstallation

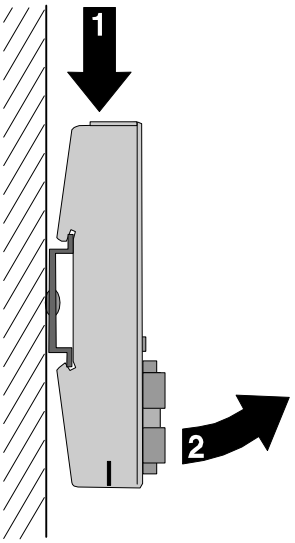
☞ **For deinstallation, ensure that the connectors are labeled. In this way, you ensure that the connector positions cannot be confused on reinstallation.**

★ Remove the module connector plugs to the left-hand and right-hand neighboring modules. To do so, unlock the connectors by pressing the engaging lugs and draw off carefully.



★ Lightly press the module downwards – against the spring force – and disengage from the bottom.

★ Disengage the module from the rail from above.

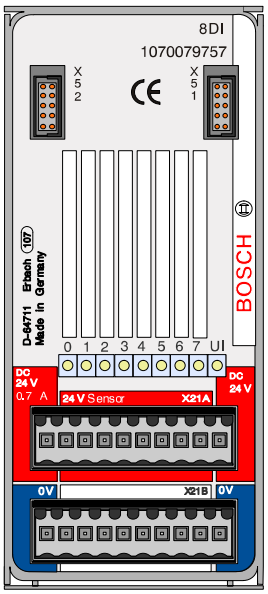


4 Digital inputs 8DI, 16DI and 16DI-3

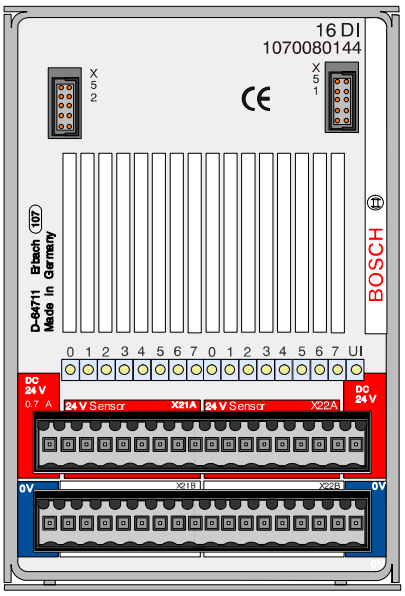
The input modules send the switching signals of the sensors via the module connector plugs to the CL150 or via a bus connection to the higher-order control.

4.1 Structure

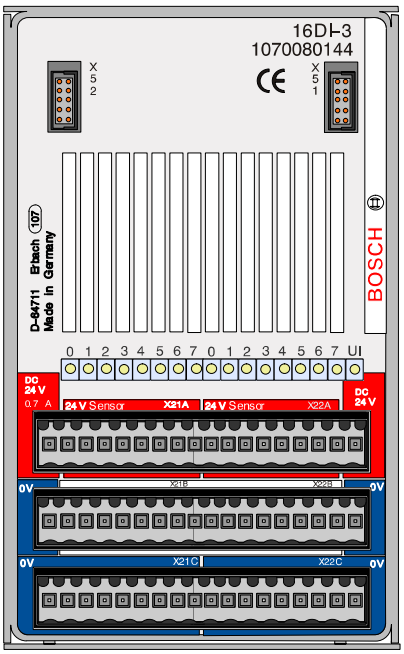
There are 8 or 16 inputs available for sensors (switch, photosensors, induction sensors, etc.).



8DI



16DI



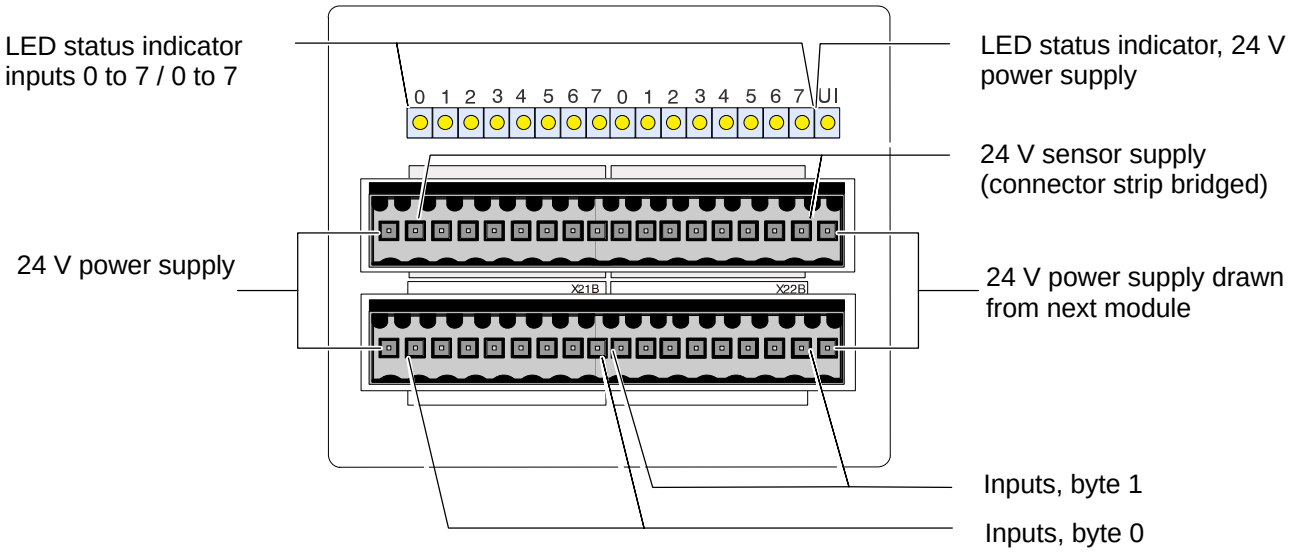
16DI-3

The modules contain the following elements:

- Connections for module connector plugs
- Labeling fields
- LED status indicators 0 to 7
- LED status indicator UI
- Connections to 24 V power supply of the module and the connected sensors
- Module 16DI-3 with additional connector strip GND for connection of 3-wire sensors

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

4.2 Connections and displays



4.2.1 Connections

Power supply

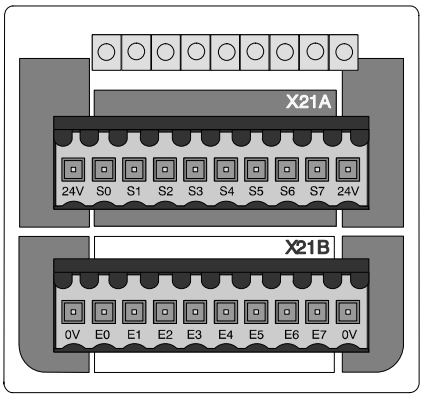
- The module requires a 24 V power supply. It can be looped on from module to module using the terminals at the ends of the connector strip (24 V and 0 V).
- The 24 V potentials for supply of the sensors are interconnected in the module.
- The sensor supply is monitored for short-circuits or overload (total current > 0.6 A). In the event of a fault, the supply is cut for all sensors until the fault is remedied.

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 4–8):

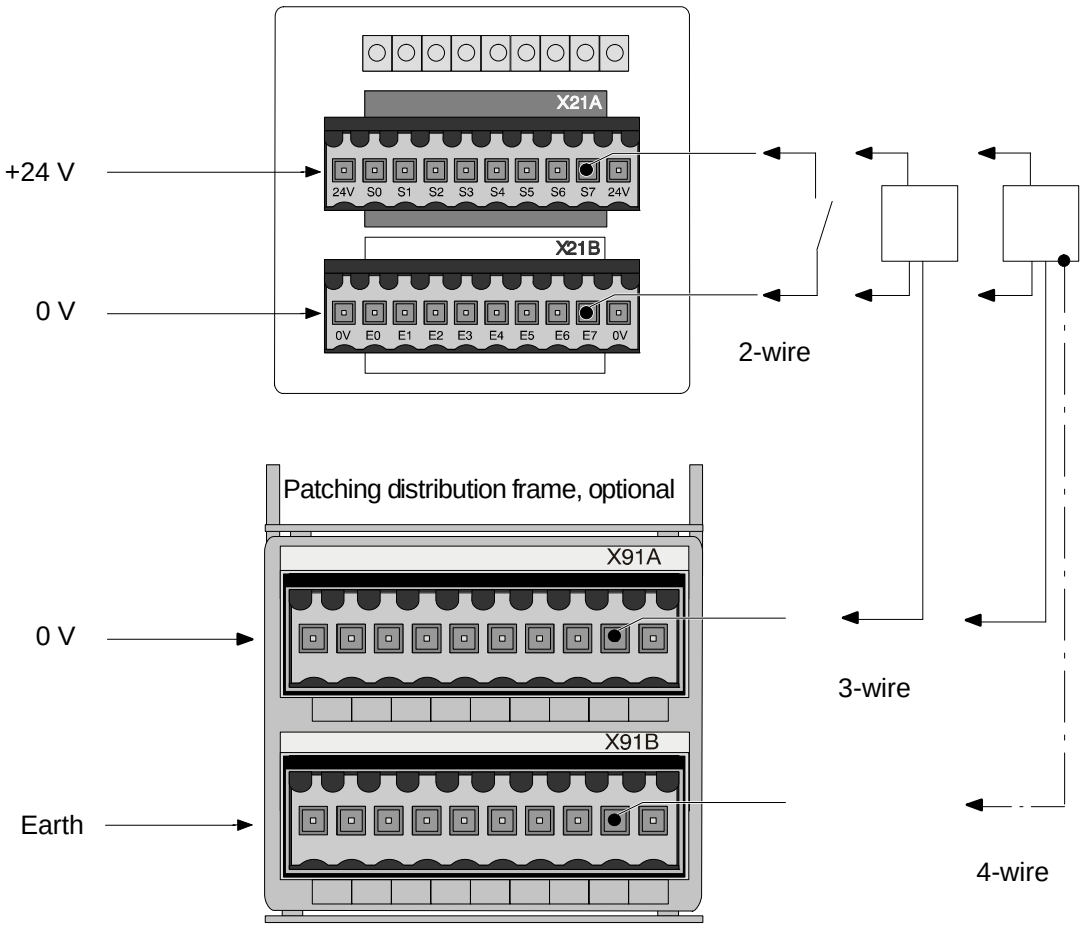
- Screw terminals
- Spring terminals

Connection allocation 8DI

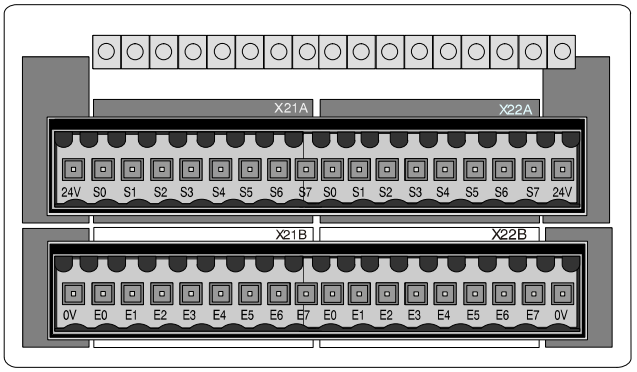


Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
S0 to S7	24 V power supply of sensors 0 to 7 (bridged)
E0 to E7	Inputs 0 to 7

Connection example 8DI

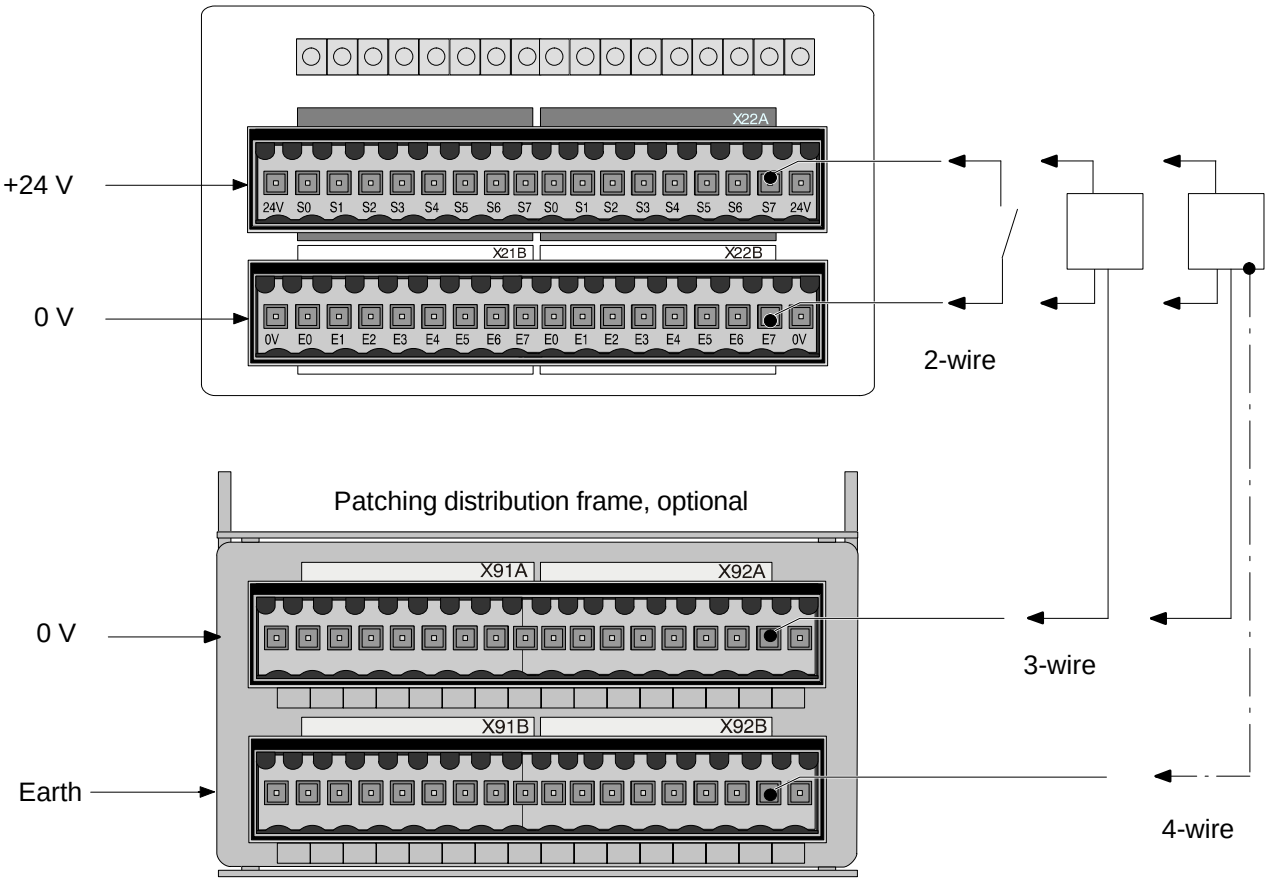


Connection allocation 16DI

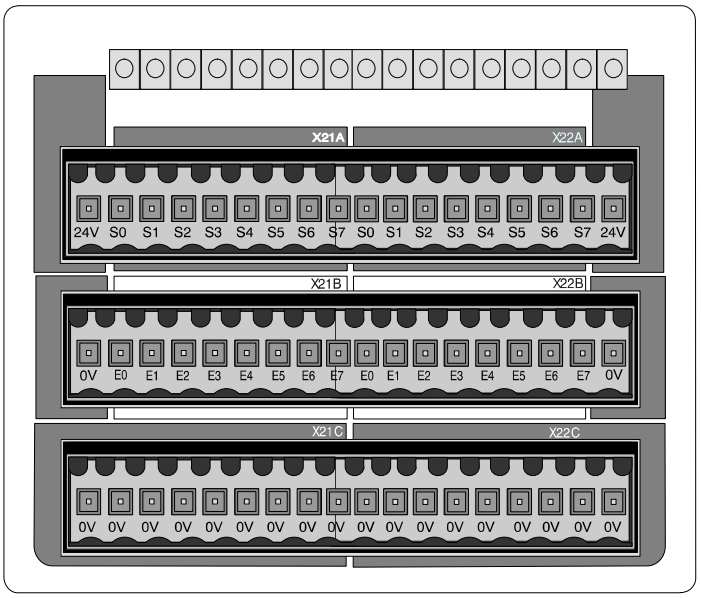


Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
S0 to S7 per byte	24 V power supply of sensors 0 to 15
E0 to E7 per byte	Inputs 0 to 15

Connection example 16DI

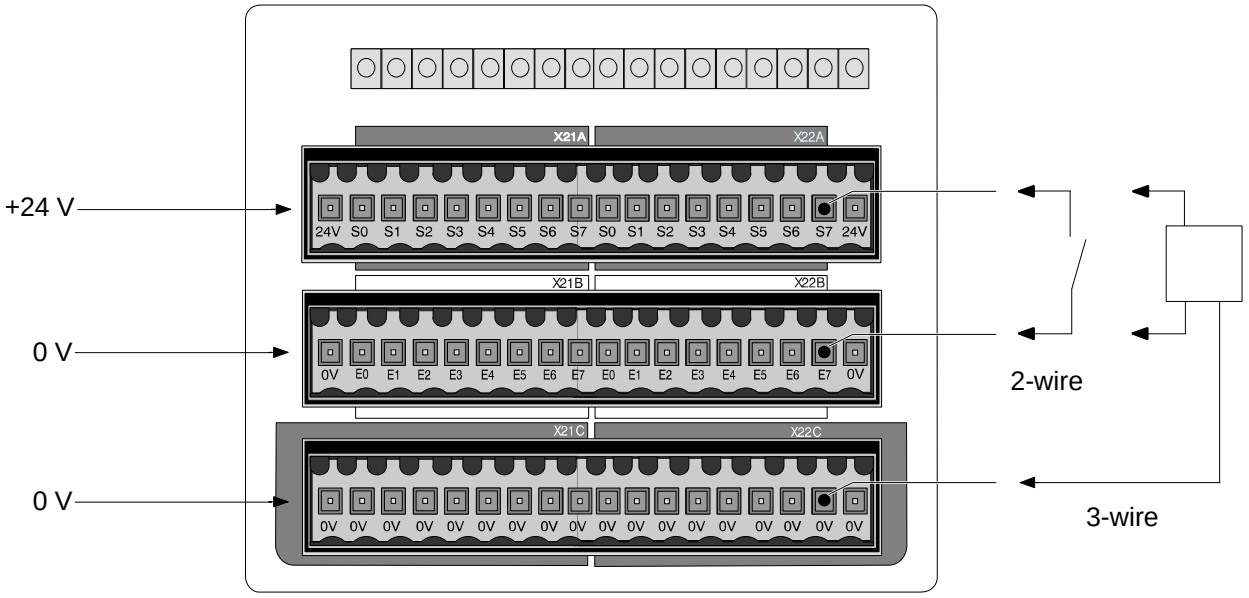


Connection allocation 16DI-3



Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
S0 to S7 per byte	24 V power supply of sensors 0 to 15
E0 to E7 per byte	Inputs 0 to 15
0 V	Power supply, 0 V potential

Connection example 16DI-3

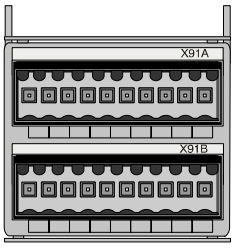


4.2.2 Patching distribution frame

Patching distribution frames can be used to extend modules 8DI and 16DI to 3-pole or 4-pole connection. Each patching distribution frame provides 2 additional connector strips, bridged in each case.

☞ **No patching distribution frame can be fitted to module 16DI-3!**

Connection allocation RV 2 x 10 M



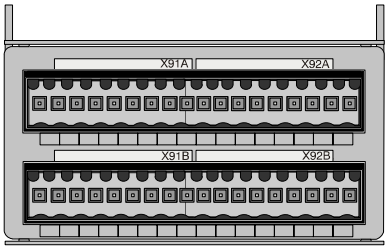
RV 2 x 10 M

Connector strip X91A, internally bridged

Connector strip X91B, internally bridged

Terminal	Allocation example
X91A	Power supply, 0 V potential
X91B	Potential earth

Connection allocation RV 2 x 18 M



RV 2 x 18 M

Connector strips X91A and X92A, internally bridged

Connector strips X91B and X92B, internally bridged

Terminal	Allocation example
X91A, X92A	Power supply, 0 V potential
X91B, X92B	Potential earth

4.2.3 Displays and fault messages

Name	LED	Meaning
0 to 7	green	State of the input: 1, active
	off	State of the input: 0, not active
16DI-3 (all versions) and 8DI, 16DI up to version 104		
UI	green	24 V power supply is OK
	off	• 24 V power supply is not present • Short-circuit in supply of sensors • Overload in supply of sensors
8DI, 16DI as of version 104		
UI	green	24 V power supply is OK
	red	Overload in supply of sensors
	off	24 V power supply is not present/polarity inverted

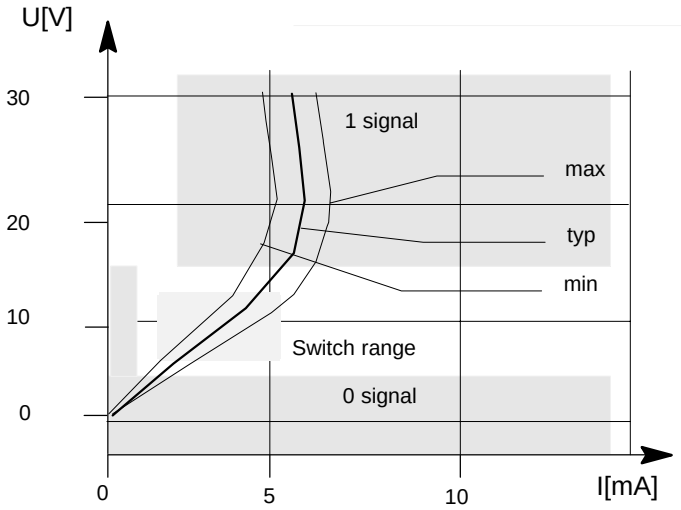
4.3 Technical data, accessories, order numbers

Technical data	8DI	16DI	16DI-3
Order no.	1070 079 757	1070 080 144	1070 081 862
Inputs complying with EN 61 131-2	8 digital inputs, type 1	16 digital inputs, type 1	
Current consumption off ● 24 V power supply (without sensor supply) ● internal bus	 typ. 40 mA max. 10 mA	 typ. 80 mA max. 20 mA	
Input voltage ● Rated voltage ● 0 signal ● 1 signal	 24 V –3 to 5 V 11 to 30 V		
Input current ● 0 signal ● 1 signal	 ≤ 2.5 mA 3 to 6 mA		
Supply of sensors ● Output voltage ● Output nominal current (total) ● Short-circuit / overcurrent protection	 typ. $U_{ext.}$ –1 V 0.6 A ≥ 1.2 A		
Delay time ● 0 → 1 ● 1 → 0	 4 ms 4 ms		
Status indicator	via LEDs, measured on load side		
Contact load capacity	max. 8 A per contact / T_U = 55 °C		
Cable length, unshielded	max. 100 m		
Connector grid	3.5 mm		
2-wire proximity switch ● Quiescent current ● Voltage drop	 ≤ 2.6 mA ≤ 6 V		
Dimensions in mm (L x W x D)	48 x 105 x 38	76 x 105 x 38	76 x 121 x 38
Weight	approx. 150 g	approx. 210 g	approx. 240 g

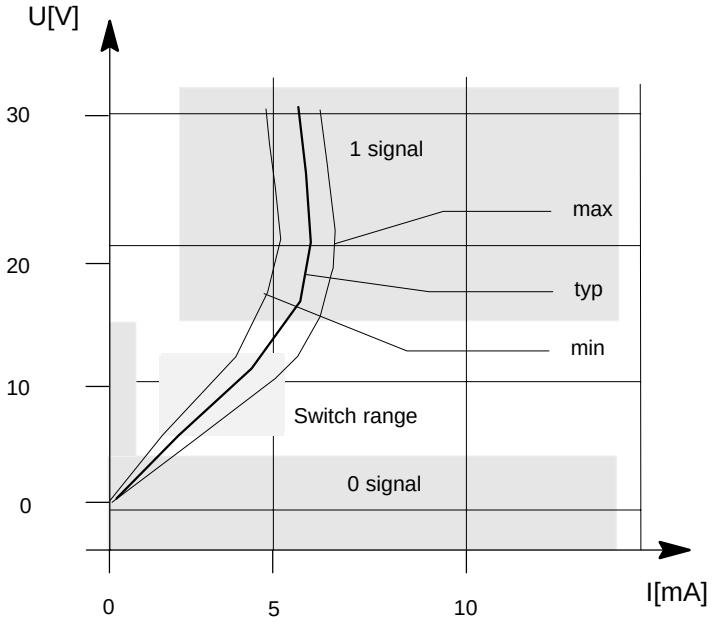
Accessories	8DI	16DI	16DI-3
Module connector plugs	1070 079 782	1070 079 782	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	1070 080 309		
Socket terminal strip sets ● Screw terminals ● Spring terminals	 1070 080 340 1070 080 347	 1070 080 341 1070 080 348	 1070 080 341 1070 080 348
Patching distribution frame	1070 080 159	1070 080 161	
Socket terminal strip sets for patching distribution frame ● Screw terminals ● Spring terminals	 1070 080 340 1070 080 347	 1070 080 341 1070 080 348	 – –
Pulling aid for socket terminal strips, 8-pole	1070 919 513		

4.4 Input characteristic curve

8DI



16DI and 16DI-3



Notes:

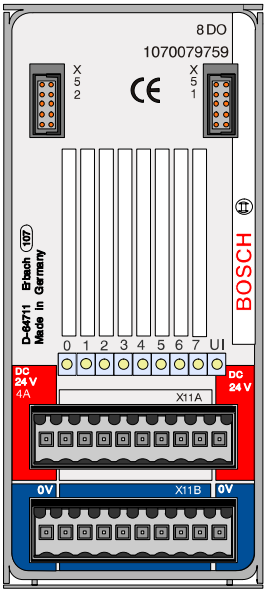
5 Digital outputs 8DO, 8DO/2A and 16DO

The output modules route the control commands to the connected actuators, for example valves, lamps or contactors.

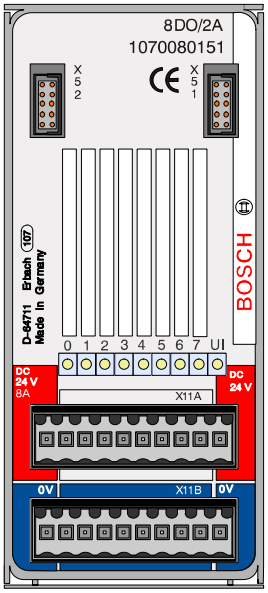
5.1 Structure

There are 8 or 16 outputs available for actuators. These 24 V outputs are non-storing; in the event of a power supply failure, the output signal is reset without a fault message. On restarting, the outputs are switched again by the signal of the control automatically.

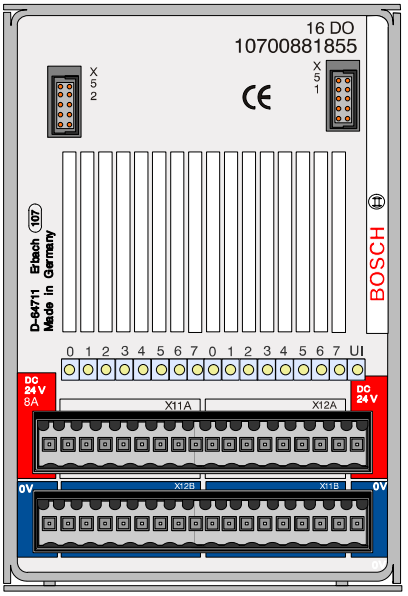
☞ **The module 8DO/2A is used if the maximum current of 0.5 A that can be supplied by an 8DO module output is not sufficient, that is, in the case of typical loads in the range from 12 to 48 Ω, corresponding to a current of 0.5 to maximum 2.0 A.**



8DO



8DO/2A



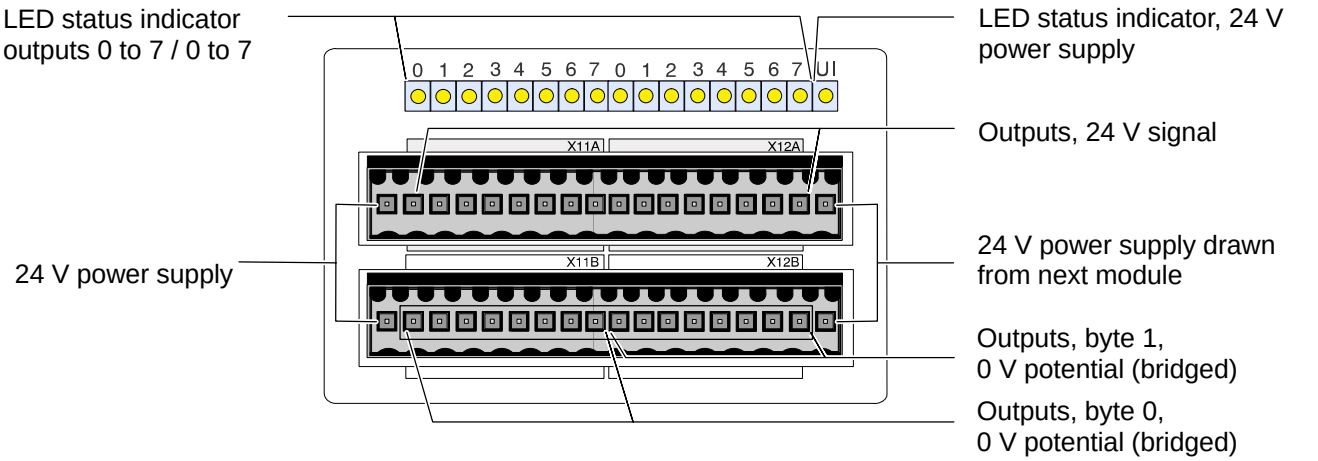
16DO

The modules contain the following elements:

- Connections for module connector plugs
- Labeling fields
- LED status indicators 0 to 7
- LED status indicator UI
- Connections to 24 V power supply of the module and the outputs

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

5.2 Connections and displays



5.2.1 Connections

Power supply

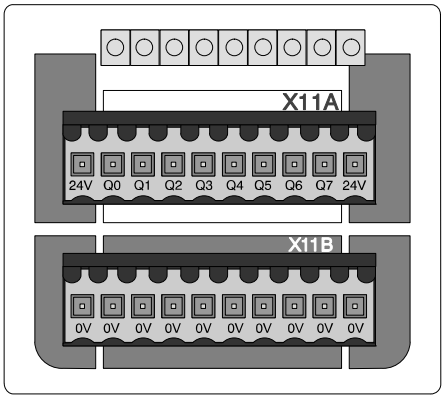
- The module requires a 24 V power supply. It can be looped on from module to module using the terminals at the ends of the connector strip (24 V and 0 V).
- The 0 V potentials for 2-pole connection of the loads are interconnected in the module.

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 5–8):

- Screw terminals
- Spring terminals

Connection allocation 8DO



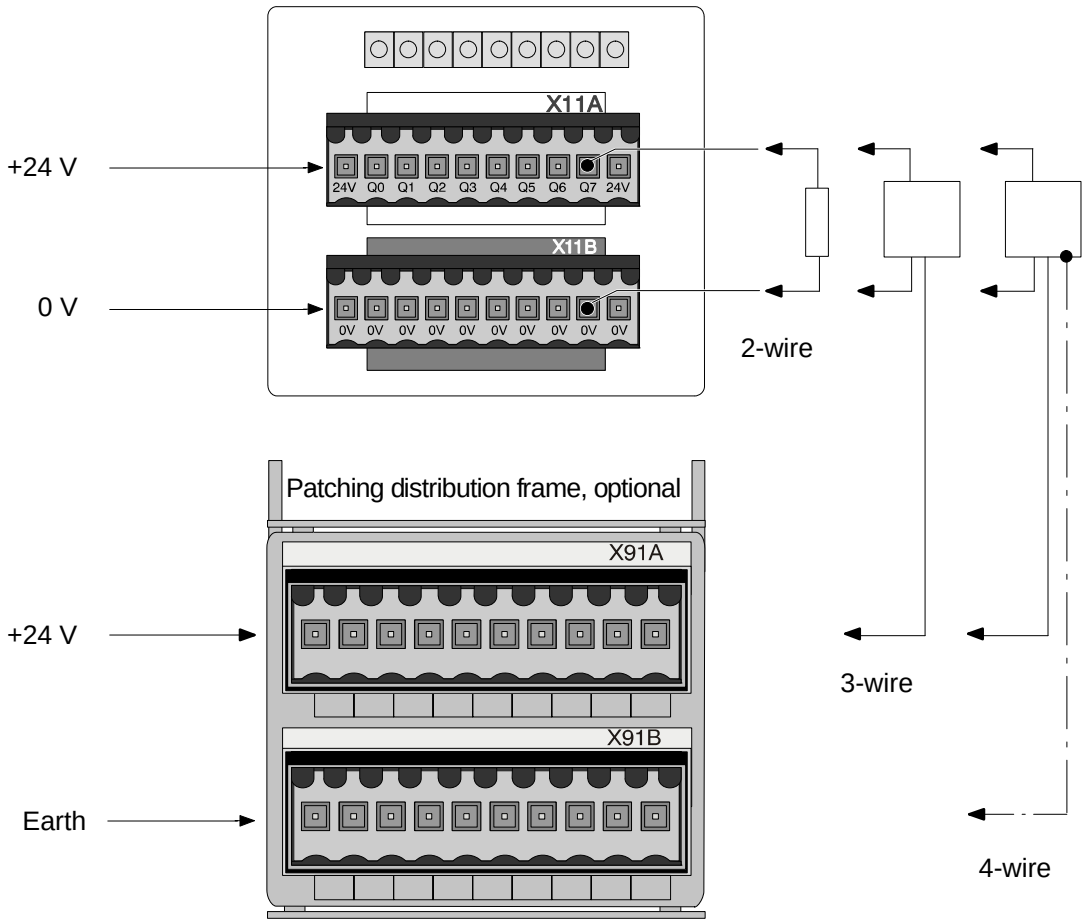
Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential (bridged)
Q0 to Q7	Outputs 0 to 7, output current 0.5 A

To multiply the output current of 0.5 A, the outputs Q0, Q1, Q2 and Q3 or the outputs Q4, Q5, Q6 and Q7 can be switched in parallel.

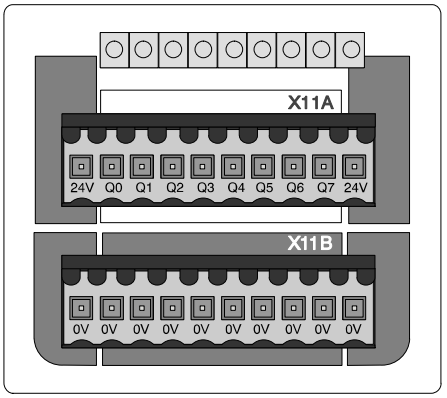
If a maximum of 4 outputs are switched in parallel, the output current is 2 A.

☞ **Bridged outputs must also be activated in the PLC program in parallel.**

Connection example 8DO



Connection allocation 8DO/2A



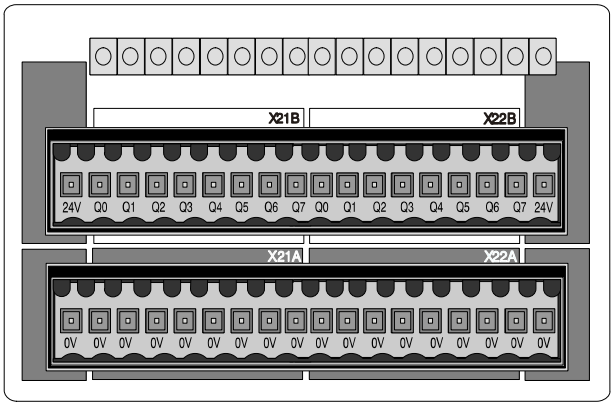
Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential (bridged)
Q0 to Q7	Outputs 0 to 7, output current 2.0 A

To double the output current of 2.0 A, the outputs Q0 + Q1, Q2 + Q3 or Q4 + Q5, Q6 + Q7 can be switched in parallel.

☞ **Bridged outputs must also be activated in the PLC program in parallel.**

CAUTION
Current load per connector pin maximum 8 A.
For the 24 V power supply, the critical limit is reached if all outputs have a simultaneity factor of over 50 % (> 4 x 2 A = 8 A).
Distribute the power supply to the 2 pins for 24 V and the 2 pins for 0 V. A loop-through of the power supply is then no longer possible.

Connection allocation 16DO



Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential (bridged)
Q0 to Q7 per byte	Outputs 0 to 15, output current 0.5 A

To multiply the output current of 0.5 A, the outputs Q0, Q1, Q2 and Q3 or the outputs Q4, Q5, Q6 and Q7 can be switched in parallel.

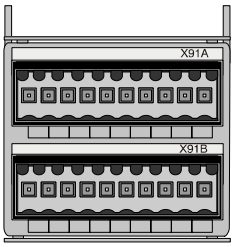
If a maximum of 4 outputs are switched in parallel, the output current is 2 A.

☞ **Bridged outputs must also be activated in the PLC program in parallel.**

5.2.2 Patching distribution frame

Patching distribution frames can be used to extend modules 8DO, 8DO/2A and 16DO to 3-pole or 4-connection. Each patching distribution frame provides 2 additional connector strips, bridged in each case.

Connection allocation RV 2 x 10 M



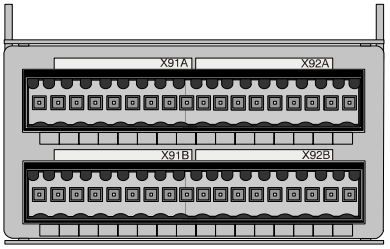
RV 2 x 10 M

Connector strip X91A, internally bridged

Connector strip X91B, internally bridged

Terminal	Allocation example
X91A	Power supply, 0 V potential
X91B	Potential earth

Connection allocation RV 2 x 18 M



RV 2 x 18 M

Connector strips X91A and X92A, internally bridged

Connector strips X91B and X92B, internally bridged

Terminal	Allocation example
X91A, X92A	Power supply, 0 V potential
X91B, X92B	Potential earth

5.2.3 Displays and fault messages

Name	LED	Meaning
UI	green	24 V power supply is OK
	off	24 V power supply is not present
	red	Overload at one or more outputs
0 to 7	green	State of the output: 1, active
	off	State of the output: 0, not active

5.3 Technical data, accessories, Order numbers

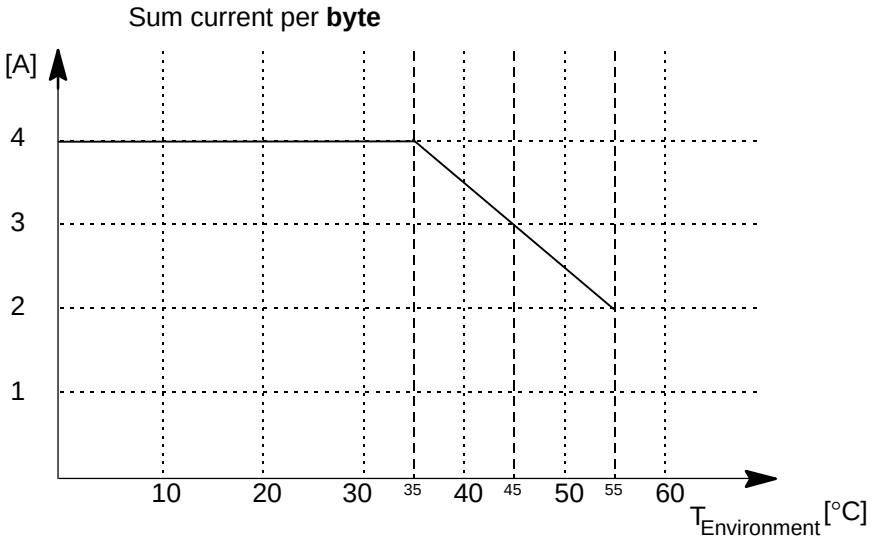
Technical data	8DO	8DO/2A	16DO
Order no.	1070 079 759	1070 080 151	1070 081 858
Power supply EN 61 131-2	24 V; 19.2 to 30 V		
Current consumption off • 24 V power supply (outputs activated, without load) • internal bus	typ. 30 mA max. 15 mA	typ. 55 mA max. 10 mA	typ. 80 mA max. 30 mA
Outputs complying with EN 61 131-2	8 semiconductor outputs, non-storing, protected, supplying current		16 semiconductor outputs, non-storing, protected, supplying current
Output voltage	Rating 24 V, voltage drop at 1 signal ≤ 1.5 V ... ≤ 0.5 V		
Output current (Derating, see page 5–9) • Rating • Maximum value • 1 signal • 0 signal, leakage current	 0.5 A 0.6 A 2 mA to 0.6 A ≤ 0.5 mA	 2.0 A 2.0 A 2 mA to 2.0 A ≤ 0.5 mA	 0.5 A 0.6 A 2 mA to 0.6 A ≤ 0.5 mA
Overload protection • Minimum current level that leads to shutdown • Automatic restart on removal of overload after	0.6 A, typ. 1.2 A approx. 10 ms	2.0 A, typ. 3.6 A approx. 10 ms	0.6 A, typ. 1.2 A approx. 10 ms
Parallel switching of outputs	yes, max. 4	2 outputs each	yes, max. 4
Switching frequency • ohmic load • inductive load	 100 Hz 1 Hz		
Status indicator	via LEDs, measured on load side		
Output delay times	< 500 µs		
Cable length, unshielded	max. 100m		
Simultaneity factor	see Derating curve		
Inductive shutdown voltage	on $U_{ext.}$ - 50 V, nominal operation to typ. –26 V		
Contact load capacity	max. 8 A per contact at T_U = 55 °C		
Contactor size at 1 Hz	SG1; 6.2 W	SG8; 30 W, NG6 Bosch hydraulic valve	SG1; 6.2 W
Lamp load at 8 Hz	5 W	15 W	5 W
Connector grid	3.5 mm		
Dimensions in mm (L x W x D)	48 x 105 x 38		75.6 x 105 x 38
Weight	approx. 150 g		approx. 210 g

Accessories	8DO	8DO/2A	16DO
Module connector plugs	1070 079 782		1070 079 782
Labels • 10 DIN A4 sheets, each with 20 labels	1070 080 309		
Socket terminal strip sets • Screw terminals • Spring terminals	 1070 080 340 1070 080 347		 1070 080 341 1070 080 348
Patching distribution frame	1070 080 159		1070 080 161
Socket terminal strip sets for patching distribution frame • Screw terminals • Spring terminals	 1070 080 340 1070 080 347		 1070 080 341 1070 080 353
Pulling aids for socket terminal strips, 8-pole	1070 919 513		

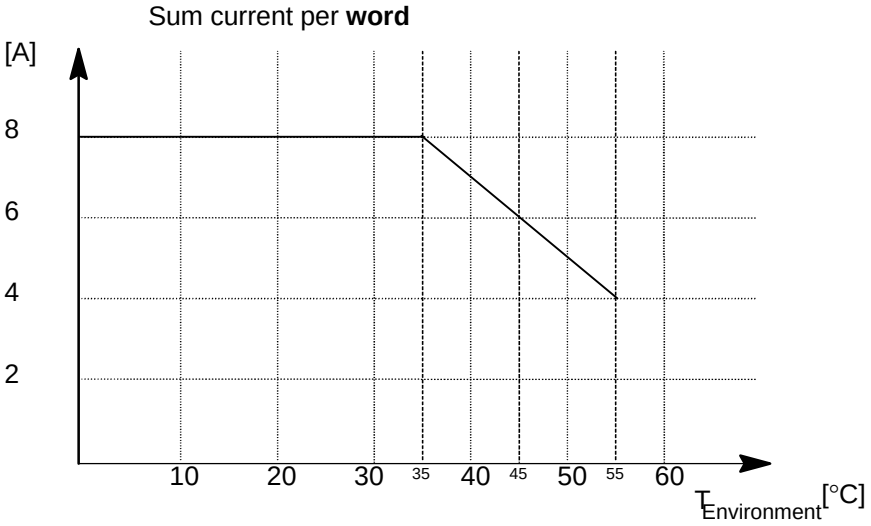
5.4 Derating

The derating specifies how strongly the power output is reduced at increased temperature.

Derating 8DO

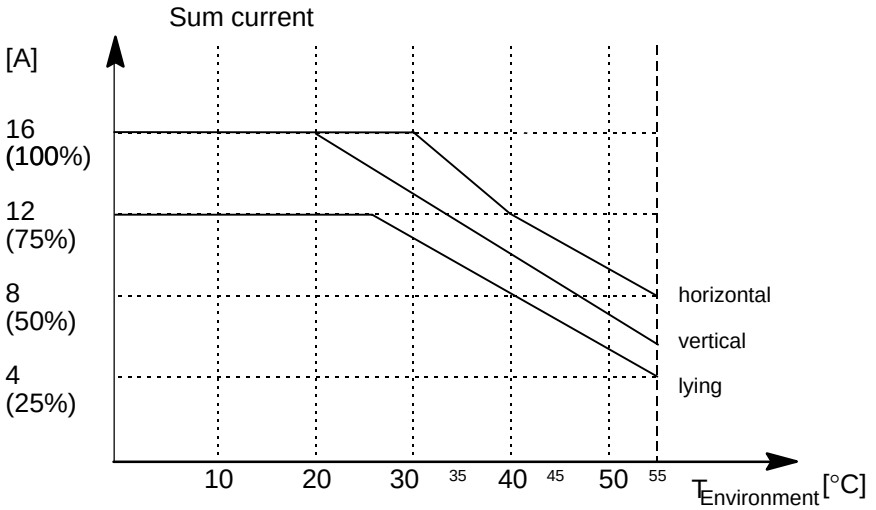


Derating 16DO

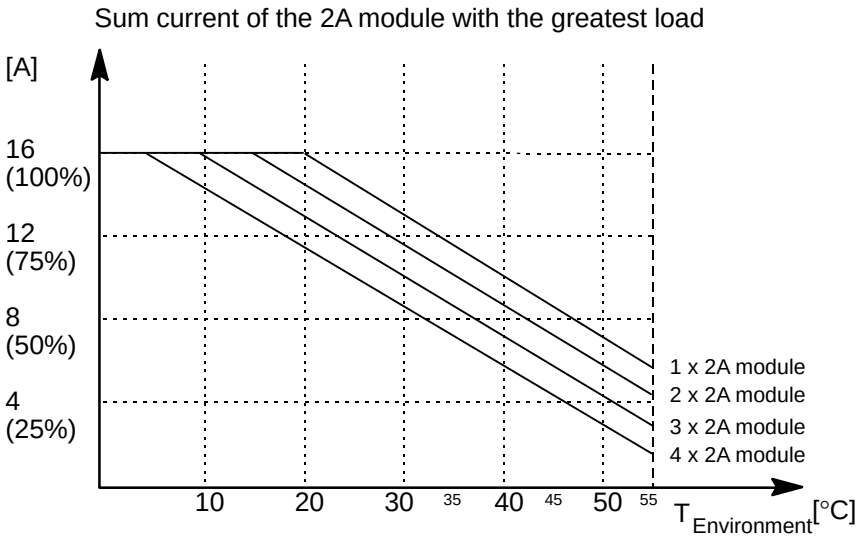


Derating 8DO/2A

The derating is additionally dependent on the installation position (permitted installation positions, see page 3–1).



In the case of vertical operation with more than one 8DO/2A module, the derating of the module with the greatest load increases further in accordance with the following curve:



Sample calculation

The following I/O modules are to be operated in vertical installation position:

1. 8DI,
2. 8DO (0.5 A),
3. 8DO2A, maximum current 8 A,
4. 8DO2A, maximum current 5 A,
5. 8DI,
6. 8DI,
7. 8DO2A, maximum current 4 A,

☞ **The specified maximum currents are calculated from known loads to be connected and the simultaneity ratios.**

What maximum ambient temperature is permitted for this system?

– for 8DI, 8DO (0.5 A), 50° are permitted in the vertical installation position,
– the module with the greatest load is 8DO2A, maximum current 8 A,
– a total of three 2A modules are in the system,

⇒ from derating curve, 2A module with the greatest load :
8 A at 3 x 2A module,

⇒ Ambient temperature: 37˚ permitted.

☞ **If for example, there were only 2 8DO2A modules in the system, 42° would be permitted.**

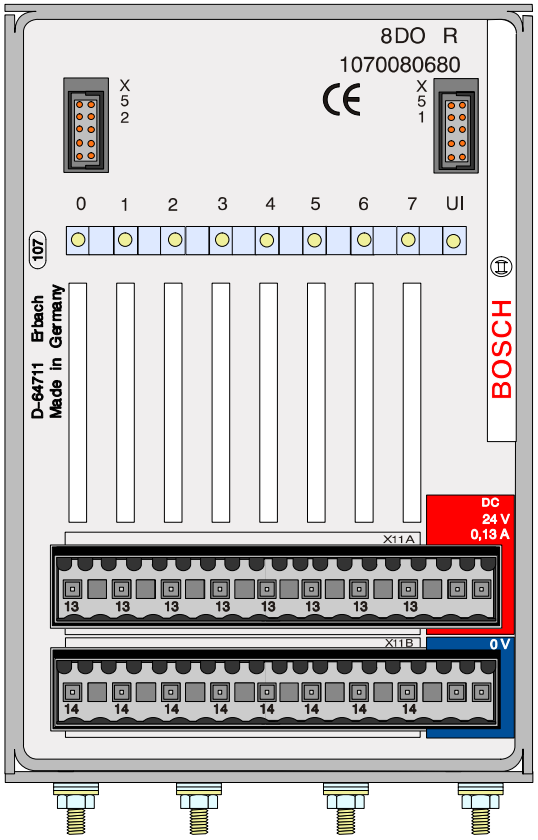
Notes:

6 Digital output 8DO R

The output module 8DO R with relay outputs routes the commands of the control to the connected actuators, such as valves, lamps or contactors. It is used for switching tasks at mains voltage and in the 24 V industrial mains up to 2 A.

6.1 Structure

The relay output module has 8 potential-free relay contacts (close contacts) for a rated current of 2 A. It meets the requirements of safe isolation complying with EN 50 178 for overvoltage class II. Within a 4-part plug-in terminal, voltages of overvoltage class III can be switched if the voltages are separated by an unused terminal. The modules begin to output data directly after 'Power on'.



Connections for module connector plugs

LED status indicators 0 to 7
LED status indicator UI

Labeling fields

Connector strips for:
- 24 V power supply
- Relay outputs

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

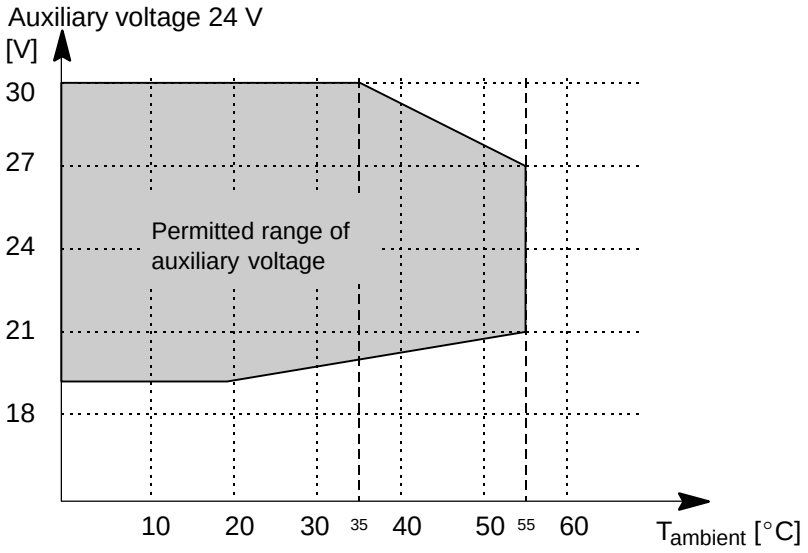
6.2 Connections and displays

6.2.1 Connections

Power supply

- The digital part is supplied via the module connector plug.
- The relay coils are supplied via an external 24 V auxiliary voltage.

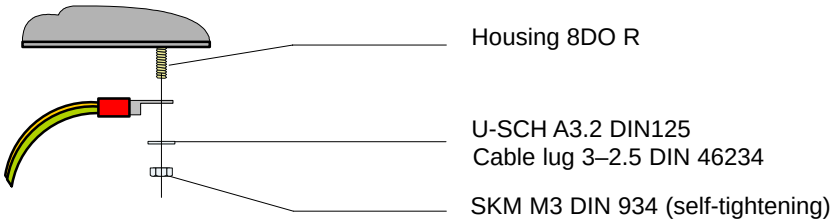
Depending on the ambient temperature, the following auxiliary voltage range is permitted.



DANGEROUS ELECTRICAL VOLTAGE
The 24 V auxiliary voltage must always meet the requirements of 'Safe isolation'.

Protective earth connection

The relay output module provides a total of 4 M3 screw bolts for connecting the protective earth.



Short-circuit protection

CAUTION
Module defect due to overloaded relay contact.
Secure the connected load current circuits against short-circuit using suitable measures.

Connection of inductive loads

Inductive loads, such as solenoid valves or contactors, which are to be switched via the relay contact, **must** be fitted with cancel connection directly at the load. The relay module 8DO R is equipped with a varistor protective connection. However, its primary purpose is to protect the switch contact against burn-up and excessively rapid wear.

If no additional interference suppression measures are implemented at the inductive load, thermal conditions require that the relative switching frequency of large contactors (contactor size 8) is kept below 0.1 Hz.

It must also be taken into account that interference occurring when an inductive load is switched can lead, via the cables, to disruptions in other parts of the system. The recommendations described in the installation guidelines, chapter 13, apply.

All commercially available interference suppression filters can be used as cancel filters.

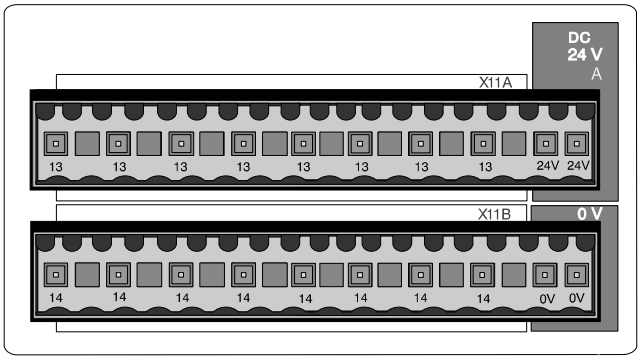
Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 6–7):

- Screw terminals
- Spring terminals

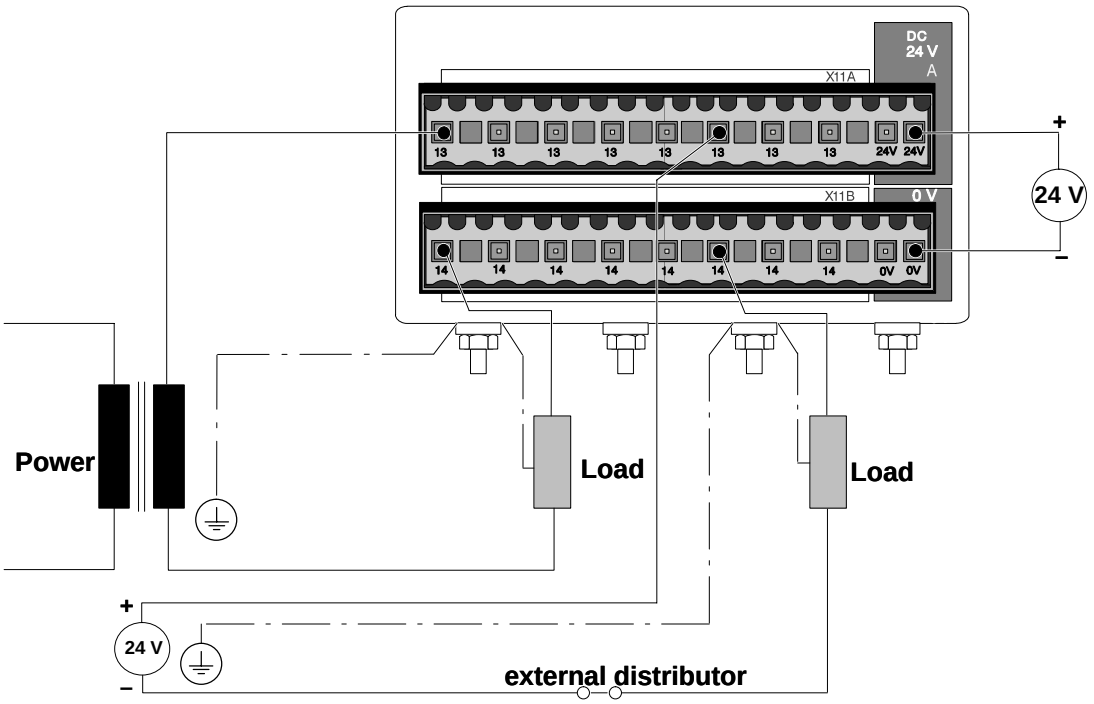
CAUTION
Dangerous voltage at exposed relay contacts.
Ensure the module is free of voltage before removing a socket terminal strip.

Connection allocation 8DO R



Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
13/0 to 7	Relay connection 13, 0 to 7
14/0 to 7	Relay connection 14, 0 to 7

Connection example



☞ **In compliance with EN60204, insulated, one-wire cables should be color-coded as follows:**

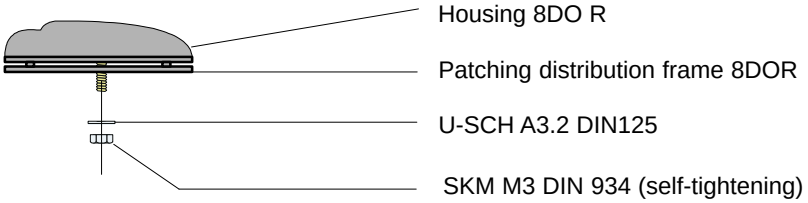
Main power circuit for AC and DC:	**black**
Control power circuits for AC:	**red**
Control power circuits for DC:	**blue**
Protective earth:	**green/yellow**

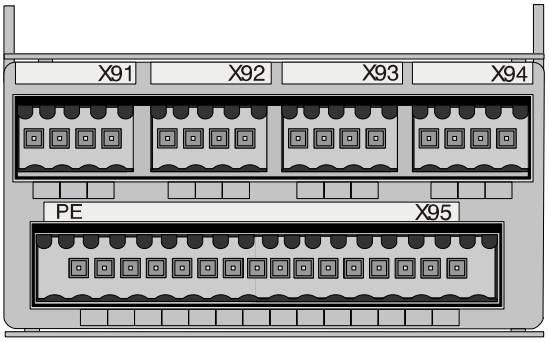
6.2.2 Patching distribution frame

To facilitate connection of the relay output module, the patching distribution frame RV 8DOR can be used. This has 16 protective earth connections as well as 4 groups of return wire connections, each bridged to and isolated from one another (overvoltage category II).

The protective earth connections are secured by screws and can only be removed using a tool:

- Connector strip X95 and the socket terminal strip are connected mechanically by 2 screws
- the patching distribution frame is plugged onto the module from below and also screwed on by means of at least two nuts.

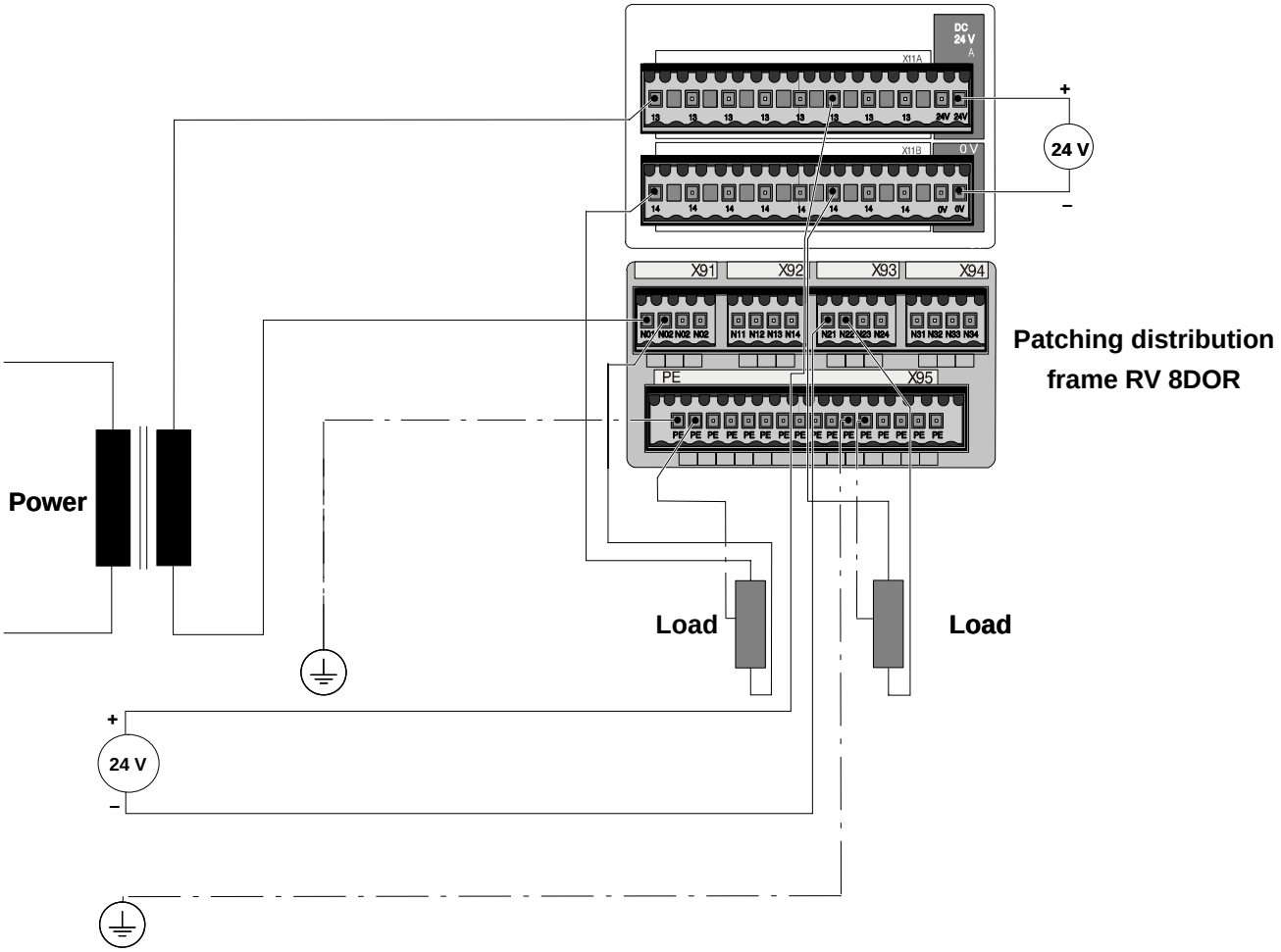




RV 8DOR

Terminal	Allocation example
X91, N01 to N04	Distributor return wire 0
X92, N11 to N14	Distributor return wire 1
X93, N21 to N24	Distributor return wire 2
X94, N31 to N34	Distributor return wire 3
PE	Protective earth connection

Connection example 8DO R with patching distribution frame



6.2.3 Displays and fault messages

Name	LED	Meaning
UI	green	24 V power supply is OK
	off	24 V power supply is not present
0 to 7	green	State of the output: 1, active
	off	State of the output: 0, not active

6.3 Technical data, accessories, Order numbers

Technical data	8DO R
Order no.	1070 080 680
Power supply EN 61 131-2	24 V; 19.2 to 30 V
Current consumption off: ● 24 V power supply ● internal bus	 < 130 mA (relay activated, without load) max. 10 mA
Outputs complying with EN 61 131-2	8 relay outputs (make contacts)
Output voltage	Rating 250 V AC / 30 V DC
Output current	Rating 2 A
Overload protection	no
Parallel switching of outputs	no
Switching frequency	max. 6 Hz
Status indicator	via LEDs
Output delay times	< 6 ms
Cable length, unshielded	max. 100 m
Simultaneity factor	100 %
Contact load capacity	max. 8 A per contact at T_U = 55 °C
Connector grid	3.5 / 7 mm
Potential isolation	500 V between 24 V auxiliary voltage and system
Dimensions in mm (LxWxD)	83 x 105 x 38
Weight	280 g

Accessories	Order no.
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	 1070 080 309
Socket terminal strip sets ● Screw terminals ● Spring terminals	 1070 081 311 1070 081 312
Patching distribution frame	1070 080 895
Socket terminal strip sets for patching distribution frame ● Screw terminals ● Spring terminals	 1070 081 315 1070 081 314
Pulling aids for socket terminal strips, 8-pole	1070 919 513

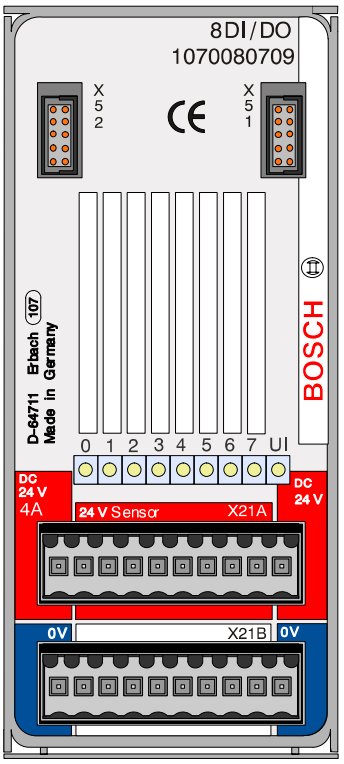
Notes:

7 Digital Input/output module 8DI/DO

The main area of application for the combined module 8DI/DO is to supplement systems in which the deployment of individual 8DI and 8DO modules would be uneconomical. The module contains 8 complete inputs or outputs.

7.1 Structure

The combined module provides 8 semiconductor outputs or alternatively 8 digital inputs. The desired combination of the inputs and outputs can be used bit by bit and can be flexibly adapted to requirements, e.g. 3 inputs and 5 outputs in any allocation.
The module begins to read in and/or output data directly after 'Power on'.



Connections for module connector plugs

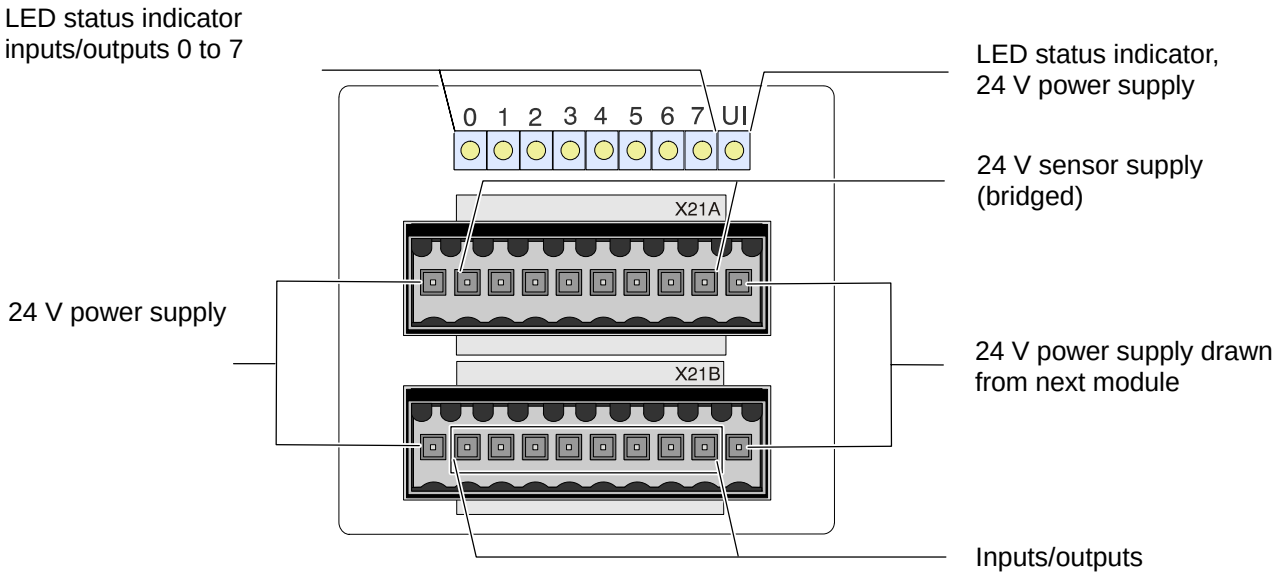
Labeling fields

LED status indicator 0 to 7
LED status indicator UI

Connector strips for:
- 24 V power supply
- Input or output signals

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

7.2 Connections and displays



7.2.1 Connections

Power supply

- The module requires a 24 V power supply. It can be looped on from module to module using the terminals at the ends of the connector strip (24 V and 0 V).
- The 24 V potentials for supply of the sensors are interconnected in the module.
- The sensor supply is monitored for short-circuits or overload (total current > 0.6 A). In the event of a fault, the supply is cut for all sensors until the fault is remedied.

Inputs and outputs

The module contains 8 connections which can be set optionally as inputs or outputs. In the PLC, one input byte and one output byte are set.

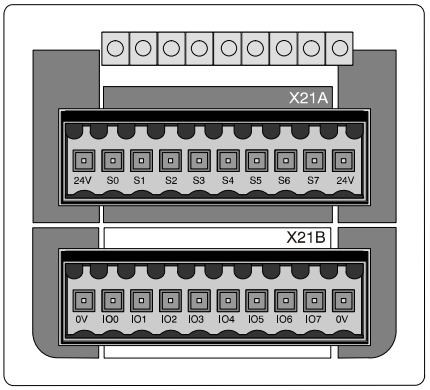
If used as an input, the corresponding output bit must not be activated by the PLC, i. e. the state 0 must be specified.
If used as an output, no sensor may be connected.

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 7–6):

- Screw terminals
- Spring terminals

Connection allocation 8DI/DO



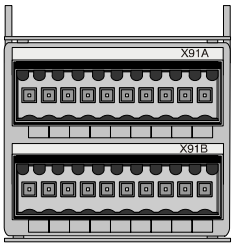
Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
IO0 to 7	Inputs/outputs 0 to 7
S0 to 7	Sensor supply 0 to 7

In order to multiply the output current, the outputs can be switched in parallel within a half byte.

7.2.2 Patching distribution frame

Patching distribution frames can be used to extend the module 8DI/DO to 3-pole or 4-pole connection. Each patching distribution frame provides 2 additional connector strips, bridged in each case.

Connection allocation RV 2 x 10 M



RV 2 x 10 M

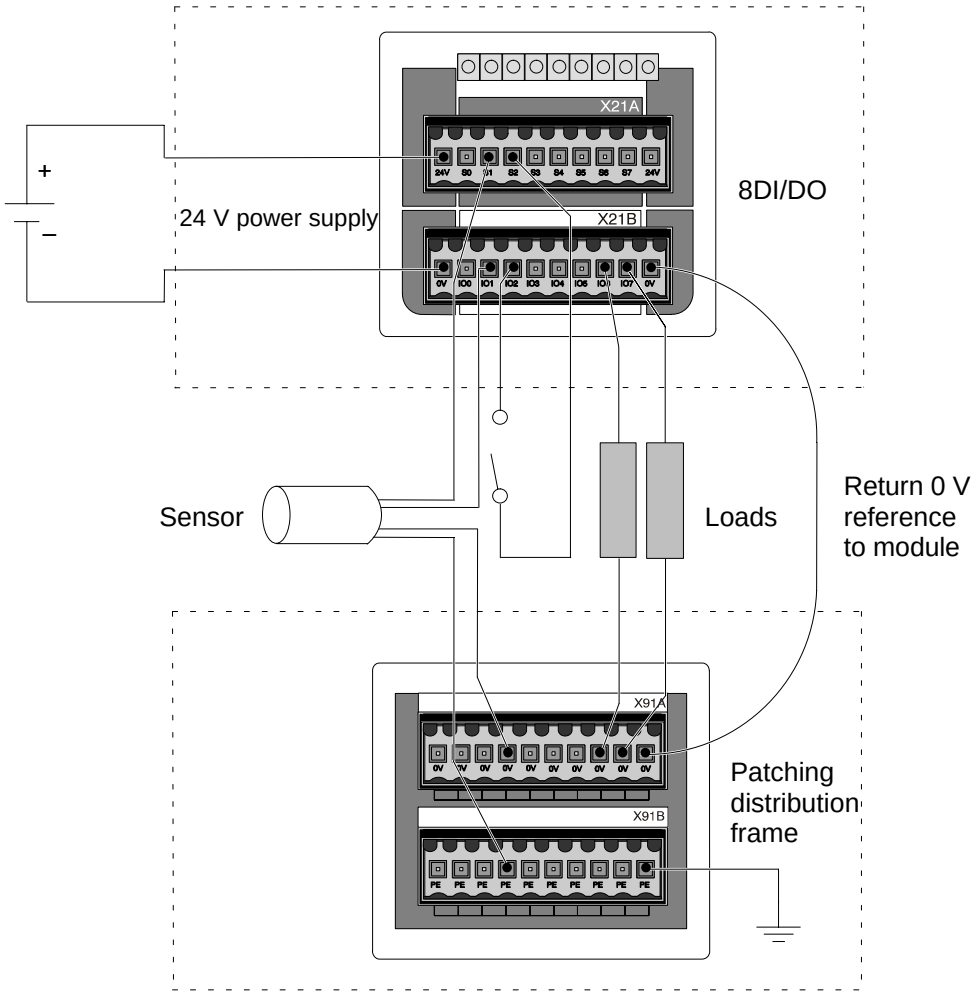
Connector strip X91A, internally bridged

Connector strip X91B, internally bridged

Terminal	Allocation example
X91A	Power supply, 0 V potential
X91B	Potential earth

Connection example

(clearly laid out connection, as for each sensor/each load terminals located one above the other can be used)



7.2.3 Displays and fault messages

Name	LED	Meaning
UI	green	24 V power supply is OK
	off	24 V power supply is not present
	red	• Overload at one or more outputs • Overload in supply of sensors
0 to 7	green	State of the input/output: 1, active
	off	State of the input/output: 0, not active

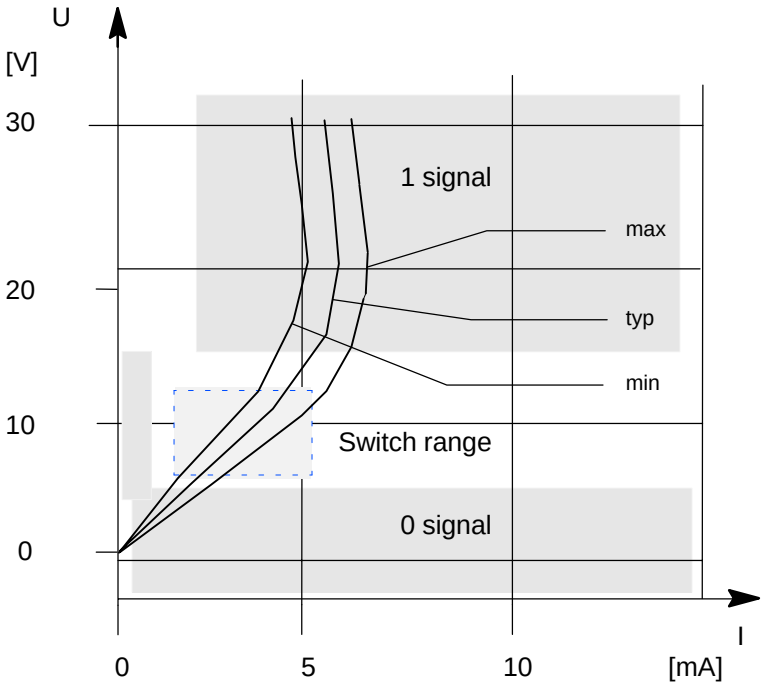
7.3 Technical data, accessories, Order numbers

Technical data	**8DI/DO**
Order no.	1070 080 709
Power supply complying with EN 61 131-2	24 V; 19.2 to 30 V
Current consumption off: ● 24 V power supply ● internal bus	 max. 20 mA (outputs activated, without load) max. 20 mA
Inputs complying with EN 61 131-2	8 digital inputs, type 1 (see Input characteristic curve, section 7.4)
Input voltage ● Rated voltage ● 0 signal ● 1 signal	 24 V -3 to 5 V 11 to 30 V
Input current ● 0 signal ● 1 signal	 ≤2.5 mA 3 to 6 mA
Supply of sensors ● Output voltage ● Output nominal current (total) ● Short-circuit/overcurrent protection	 typ. $U_{ext.}$ -1 V 0.5 A ≥1.2 A
Delay time ● 0 → 1 ● 1 → 0	 4 ms 4 ms
2-wire proximity switch ● Quiescent current ● Voltage drop	 ≤2.6 mA ≤6 V
Outputs complying with EN 61 131-2	8 semiconductor outputs, non-storing, protected, supplying current
Output voltage	Rating 24 V, voltage drop at 1 signal ≤1.5 V
Output current ● Rating ● Maximum value ● 1 signal ● 0 signal, leakage current	 0.5 A 0.6 A 2 mA to 0.6 A ≤0.5 mA
Overload protection ● Minimum current level that leads to shutdown ● Automatic restart after	 0.6 A, typ. 1.2 A approx. 10 ms
Parallel switching of outputs	yes, maximum 4

Technical data	8DI/DO
Simultaneity factor	see 'Derating curve', section 7.5
Switching frequency ● ohmic load ● inductive load	 100 Hz 1 Hz
Status indicator	via LEDs, measured on load side
Output delay times	< 500 µs
Cable length, unshielded	Maximum 100 m
Inductive shutdown voltage	on $U_{ext.}$ -50 V, thus nominal operation to typ. -26 V
Contact load capacity	maximum 8 A per contact at T_U = 55 °C
Contactor size at 1 Hz	SG1; 6.2 W
Lamp load at 8 Hz	5 W
Connector grid	3.5 mm
Dimensions in mm (LxWxD)	48 x 105 x 38
Weight	154 g

Accessories	Order no.
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	 1070 080 309
Socket terminal strip sets ● Screw terminals ● Spring terminals	 1070 080 340 1070 080 347
Patching distribution frame	1070 080 159
Socket terminal strip sets for patching distribution frame ● Screw terminals ● Spring terminals	 1070 080 340 1070 080 347
Pulling aid for socket terminal strips, 8-pole	1070 919 513

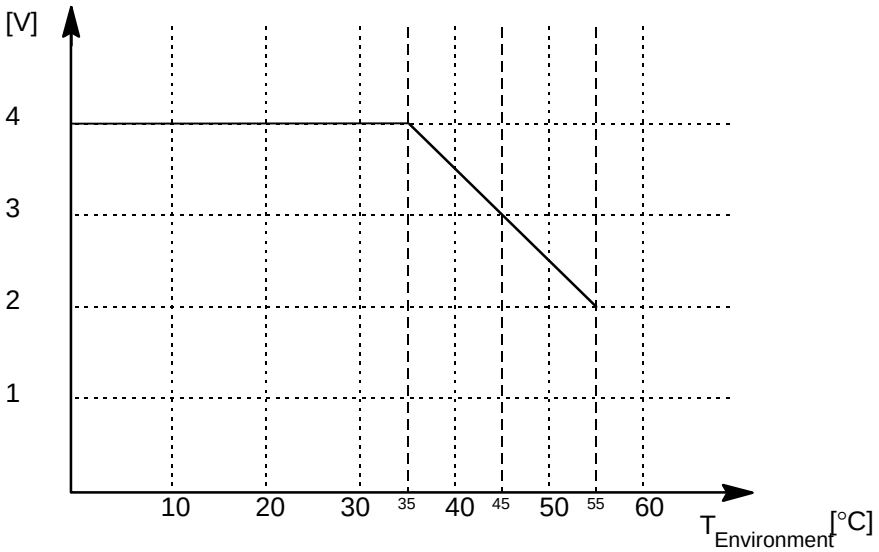
7.4 Input characteristic curve



7.5 Derating

The derating specifies how strongly the power output is reduced at increased temperature.

Sum current per **output byte**



8 Analog input module 4AI_UI

For the control of processes, there are often analog signals to be measured, supplied by encoders (sensors), e.g. for pressure, temperature or speed.

The analog input module 4AI_UI can measure

- analog voltages and
- analog currents

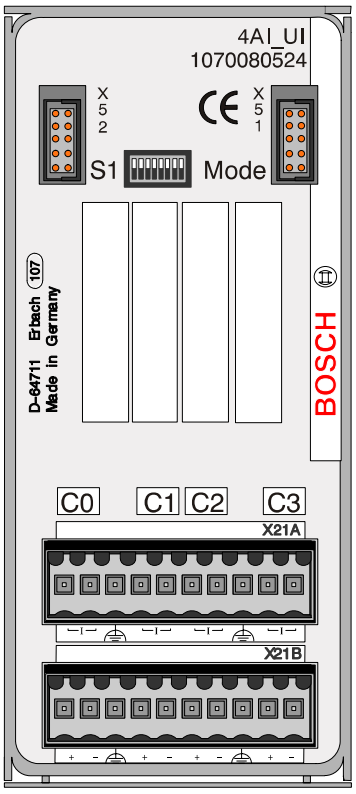
on 4 channels and route them as digital values to the PLC. Mean values can also be formed from the measured values; settings via DIP switch S1.

8.1 Structure

The analog input module sets 8 input bytes (2 bytes per channel). The input bytes can be assigned to any PLC addresses:

- in the CL150 via the I/O configuration of the WinPLC
- in a bus connection via the relevant bus configurator

The module is configured using DIP switches. No function module is required for operation.



Connections for module connector plugs

DIP switch S1

Labeling fields

Connector strips for:

- 24 V power supply
- analog measured value inputs

Features

- 4 analog inputs
- 12-bit resolution
- Measuring voltages and currents
- Measuring range can be selected (applies to all channels)
- Mean value formation via n measurements
- Sensor break detection in the 4 to 20 mA measuring range

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

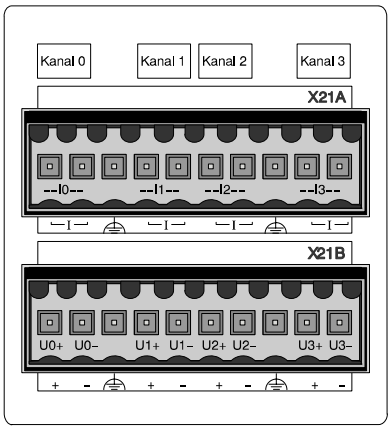
8.1.1 Connections

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 8–9):

- Screw terminals
- Spring terminals

Connection allocation 4AI_UI



Terminal	Allocation
Ux+	Analog inputs 0 to 3 / positive input
Ux–	Analog inputs 0 to 3 / negative input
--Ix--	Measuring shunt bridge for current measurement

The 4AI_UI module provides one terminal for shielded connection per channel, U+ and U–.

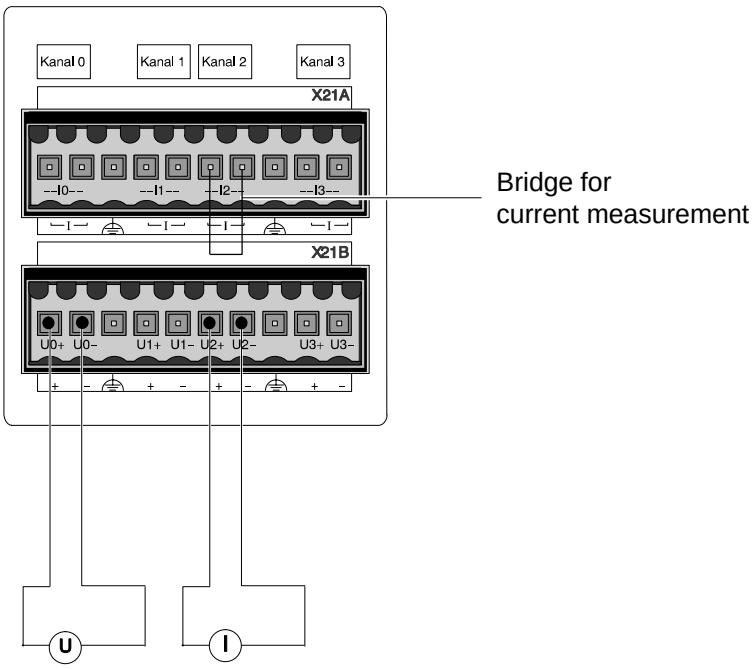
The input signals are related to 0 V; no differential inputs.

Connected sensors must lie at the same potential. Potential differences falsify the measured result.

Connection example

In the case of **voltage measurement**, the plus lead is connected at the Ux+ terminal and the minus lead at the Ux terminal.

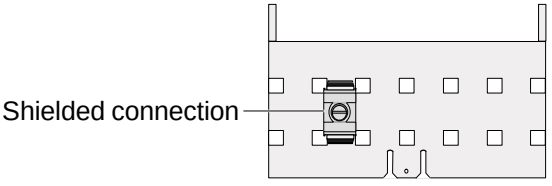
In the case of **current measurement**, connection is the same as for voltage measurement. In addition, a bridge must be inserted between the two terminals --Ix--, e.g. between terminals --I2--. This bridge enables the internal measurement shunt.



8.1.2 Patching distribution frame

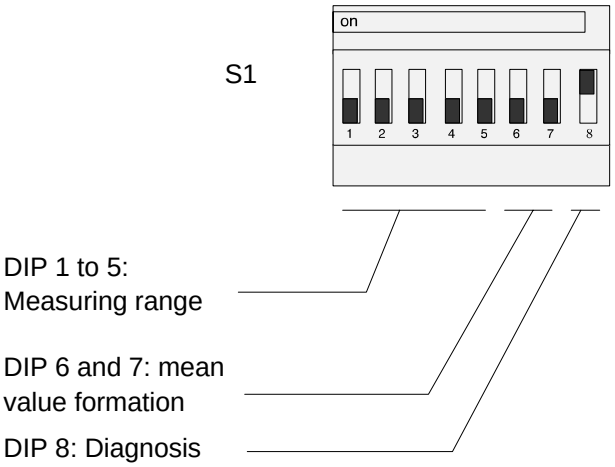
The modules can be extended to include a patching distribution frame. This provides a convenient shielded connection for each channel and ensures the strain relief of the connections.

☞ **The patching distribution frames extend the modules in a downward direction by approx. 4 cm.**



8.2 Configuration with DIP switch S1

The measurement method with measuring range is set for all channels at DIP switch S1.



To enable modified settings, the module must be switch off and then on again.

S1.1 to S1.3 The measuring range is set at the DIP switches S1.1 to S1.3.

DIP 1.1	DIP 1.2	DIP 1.3	Measuring range
0	0	0	±10 V
1	0	0	0 to 10 V
0	1	0	±5 V
1	1	0	0 to 5 V
0	0	1	0 to 20 mA
1	0	1	4 to 20 mA, SB detection < 3.8 mA
0	1	1	4 to 20 mA, SB detection < 3.3 mA

SB = sensor break

☞ **Other switch settings are invalid.**

S1.4 The output format of the measured values is set at DIP switch S1.4.

DIP 1.4	Output format of measured values
0	Straight binary
1	Double complement

Representation of the measured values in the double complement is only possible in the case of bipolar measuring ranges (±10 V and ±5 V).

For unipolar measuring ranges, DIP 1.4 must always be set at 0.

S1.5 The position of the 12-bit measured value within the data word is set at DIP switch S1.5.

DIP 1.5	Representation of the measured values
0	aligned left
1	aligned right

The measured values converted into digital values (12-bit resolution) can be positioned optionally in a word aligned to the left or right.

In the case of right aligned representation in the double complement, the free bits 15 to 12 are filled with the value of the preceding sign bit (bit 11).

S1.6 and S1.7 The number of measurements used to form a mean value is set at DIP switches S1.6 and S1.7.

DIP 1.6	DIP 1.7	Number of measurements
0	0	no mean value formation
1	0	8
0	1	32
1	1	128

A mean value formation can filter out unwanted, high-frequency interference. The time for one measuring cycle increases linearly with the number of mean value formations.

S1.8 At the DIP switch S1.8, the setting is made as to whether the module sets a diagnosis messageat the CL150 or bus connection in the measuring range 4 to 20 mA in the event of a sensor break. (See measuring range 4 to 20 mA.)

DIP 1.8	Diagnosis message in the event of sensor break
0	no message
1	message to CL150 or bus connection

8.3 Measuring range and data formats

Validity of data after 'Power on'

The module begins to convert the analog values after 'Power on'. As some time passes before all channels have measured values, FFFF Hex is entered in the measured values until this time. This value indicates that the measured values are not yet valid.

8.3.1 Voltage measurement

Measuring range				Coding	
0 to 5 V	**±5 V**	**0 to 10 V**	**±10 V**	**Straight binary**	
				aligned right	**aligned left**
4.99878 V	+4.99756 V	9.99756 V	+9.99512 V	0FFF	FFF0
2.50122 V	0.00244 V	5.00244 V	0.00488 V	0801	8010
+2.5 V	0 V	+5 V	0 V	0800	8000
0.00122 V	–4.99756 V	0.00244 V	–9.99512 V	0001	0010
0 V	–5 V	0 V	–10 V	0000	0000
invalid	invalid	invalid	invalid	FFFF	FFFF

Measuring range		Coding	
±5 V	**±10 V**	**Double complement aligned right**	**Double complement aligned left**
+ 4.99756 V	+ 9.99512 V	07FF	7FF0
0.00244V	0.004884 V	0001	0010
0 V	0 V	0000	0000
–4.99756 V	–9.99512 V	F801	8010
–5 V	–10 V	F800	8000
invalid	invalid	FFFF	FFFF

In the case of right aligned representation in the double complement, the free bits 15 to 12 are filled with the value of the preceding sign bit (bit 11). This has the advantage that it can be recognized from the MSB (bit 15) whether a positive or negative number is involved.

8.3.2 Current measurement 0 to 20 mA

For a current measurement, the integrated measuring shunt for each channel must be activated by inserting an External bridge. (Bridge between the two contacts marked with --I--.)

In this measuring range, no sensor break detection is possible.

Measuring range	**Coding**	
0 to 20 mA	**Straight binary**	
	aligned right	**aligned left**
19.99512 mA	0FFF	FFF0
10.00488 mA	0801	8010
10 mA	0800	8000
0.00488 mA	0001	0010
0 mA	0000	0000
invalid	FFFF	FFFF

CAUTION
Ensure that no voltages above 5 V are present at inputs + and – of the module.
Higher voltages can destroy the module!

8.3.3 Current measurement 4 to 20 mA

For a current measurement, the integrated measuring shunt for each channel must be activated by inserting an External bridge. (Bridge between the two contacts marked with --I--.)

Measuring range	**Coding**	
4 to 20 mA	**Straight binary**	
	aligned right	**aligned left**
Sample measured values		
19.99603 mA	0FFF	FFF0
12.00397 mA	0801	8010
12 mA	0800	8000
4.00397 mA	0001	0010
≤ 4 mA	0000	0000
invalid	FFFF	FFFF
Sensor break	1000	0001

CAUTION
Ensure that no voltages above 5 V are present at inputs + and – of the module.
Higher voltages can destroy the module!

Sensor break

In the case of sensor break detection, 2 monitoring ranges are distinguished, switchable via S1:

- sensor break for currents < 3.8 mA or
- sensor break for currents < 3.3 mA

Sensor break is reported:

- in the measured value. With left aligned representation, the LSB = 1 is set (0001). With right aligned representation, the MSB = 1 is set (1000).
- by means of additional diagnosis message if S1.8 is set to ON

Unused channels

Unused channels always cause a sensor break message. In these channels, always set a bridge between the contacts —Ix—. This delivers a measured value around 0x0000.

8.4 Technical data, accessories, order numbers

Technical data	4AI_UI
Order no.	1070 080 524
Power supply	via internal bus, I ≤ 50 mA
Potential isolation	no
Inputs complying with EN 61 131-2	4 inputs single ended
Input voltage	• ±10 V • 0 to 10 V • ±5 V • 0 to 5 V
Input current	• 0 to 20 mA • 4 to 20 mA (200 Ω shunt integrated)
Resolution	12 bit incl. preceding sign
Representation	Straight binary or double complement aligned left
Configuration	via DIP switch
Measurement error	<1 % at $T_{ambient}$ = 5 to 55 °C
Matching	without
Diagnosis	Sensor break, with current measurement 4 to 20 mA
Conversion time	all channels within 500 µs ±10 V, without mean value formation
Dimensions in mm (L x W x D)	48 x 105 x 38
Weight	154 g

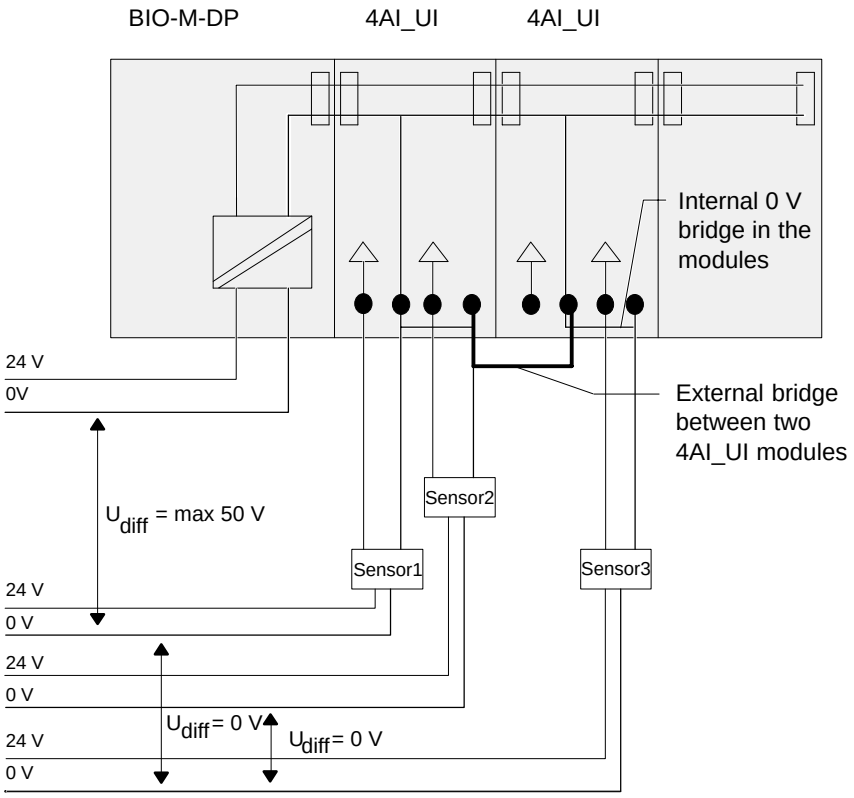
Accessories	Order no.
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	1070 080 309
Socket terminal strip sets	
• Screw terminals	1070 080 340
• Spring terminals	1070 080 347
Pulling aids for socket terminal strips, 8-pole	1070 919 513
Patching distribution frame for shielded connection	1070 081 247

8.5 Installation notes

Potential equalization

As the inputs of the module are not potential-isolated, the minus input of the module and the GND of all sensors must lie at the same potential.

CAUTION
If several 4AI_UI modules are deployed, the minus input of the individual modules must be bridged so that any existing potential difference is not equalized via the ribbon cable.
Otherwise, the ribbon cable could be destroyed!



Protection against overvoltage

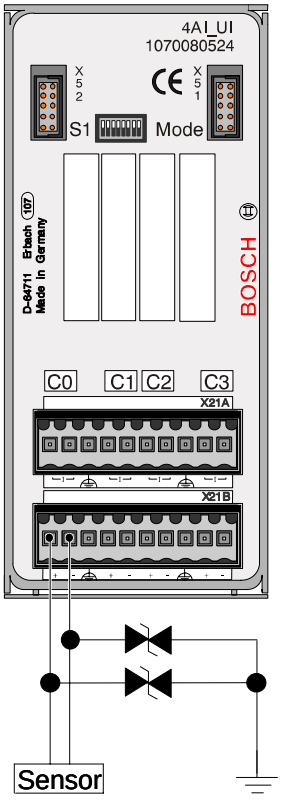
In relation to the maximum (permanent) input voltage of ±12 V specified in the technical data, the module withstands brief overvoltages of ±16.5 V at the ± inputs.

This voltage can be exceeded due to external interference, for example during thunderstorms, and destroy the module.

Protection against overvoltage is provided by:

- e.g. so-called 'lighting ductors' made by Dehn,
- 'bipolar transient diodes'. These should have a breakdown voltage of 14 V to 18 V

☞ **The diodes slightly falsify the measurement result due to corresponding offset currents.**



Selection of analog line

★ Use cables with braided shields.

Shielded cables twisted in pairs must be used for the analog lines. These reduce the influence of external interference and guarantee optimum transfer of the analog signals. If cables with foil shields are used, it should be borne in mind that the foil can be very easily damaged by pull or push stresses. This drastically reduces the shielding effect.

The cable length is limited to a maximum of 200 m.

To avoid interaction on the analog signals, the cables must not be installed parallel to high-energy lines (e.g. supply leads).

Shielded connection

Taking the EMC criteria into account, the cable shield must always be earthed at both ends of the cable to increase interference immunity.

If potential differences between the analog inputs and the sensors occur (e.g. due to cut power supply or earthing at various parts of the unit), high compensatory currents can occur at the shield placed on both sides. These can heavily distort the analog signal and even damage the lead.

★ In this case, lay additional low-impedance potential compensation cables (at least 16 mm^2 Cu), connected on a large surface area with the grounder/protective earth.

It is only in exceptional cases of low interference environments that a cable shield earthed on one side of the analog module can be accepted.

The cable shield is connected as short as possible on the analog module at the

- shield distributor
- or by means of a cable end sleeve at the connector X21B

★ Use cable end sleeves to connect the signal cables. In doing so, ensure that the terminal connections are absolutely clean and firmly tightened.

Measured value encoder

Non-insulated encoders are linked to the local earth potential. As the encoders are attached at different positions, potential differences between the individual earth points in relation to the control potential can occur. This can be avoided using potential compensation cables between the individual encoders.

☞ **Insulated measured value encoders may not be used, as the analog module has no differential inputs.**

9 Analog input module 4AI_UIT

For the control of processes, there are often analog signals to be measured, which are supplied by encoders (sensors), e.g. for pressure, temperature or speed.

The analog input module 4AI_UIT can measure

- analog voltages
- analog currents and
- temperatures via thermal elements or resistance thermometers

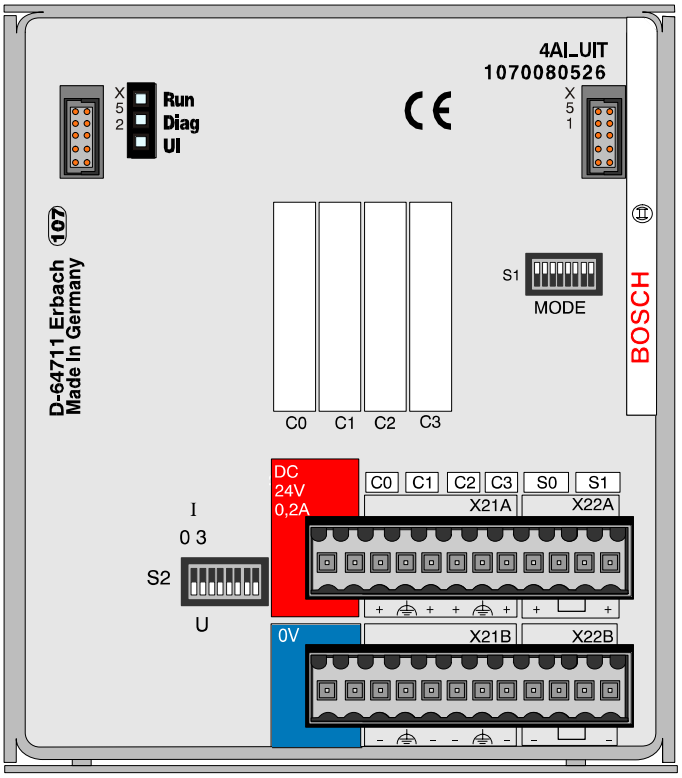
on 4 channels and route them as digital values to the PLC. Mean values can also be formed from the measured values; settings via DIP switch S1.

9.1 Structure

The analog input module sets 8 input bytes (2 bytes per channel). The input bytes can be assigned to any PLC addresses:

- in the CL150 via the I/O configuration of the WinPLC
- in a bus connection via the relevant bus configurator

The module is configured using DIP switches. No function module is required for operation.



Connections for module connector plugs

LED status indicators

DIP switch S1

Labeling fields

DIP switch S2

Connector strips for:

- 24 V power supply
- analog measured value inputs

Features

- 4 potential-isolated differential inputs
- 14-bit resolution
- Measuring range can be selected (applies to all channels)
- Mean value formation via n measrements
- Monitoring of compensation measurement exceeding range
- Measuring voltages and currents
- Measuring temperatures with thermal elements
- Characteristic curve correction, compensation, conversion to degrees
- Measuring temperatures with resistance thermometers
- 2 constant current sources, each with 2.5 mA

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

9.2 Connections and displays

9.2.1 Connections

Power supply

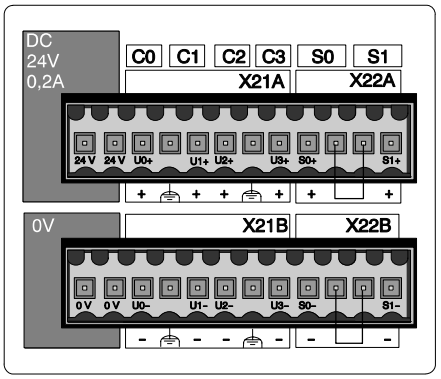
- The digital part is supplied via the module connector plug.
- The constant power sources are supplied via an external 24 V auxiliary voltage.

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 9–17):

- Screw terminals
- Spring terminals

Connection allocation 4AI_UIT



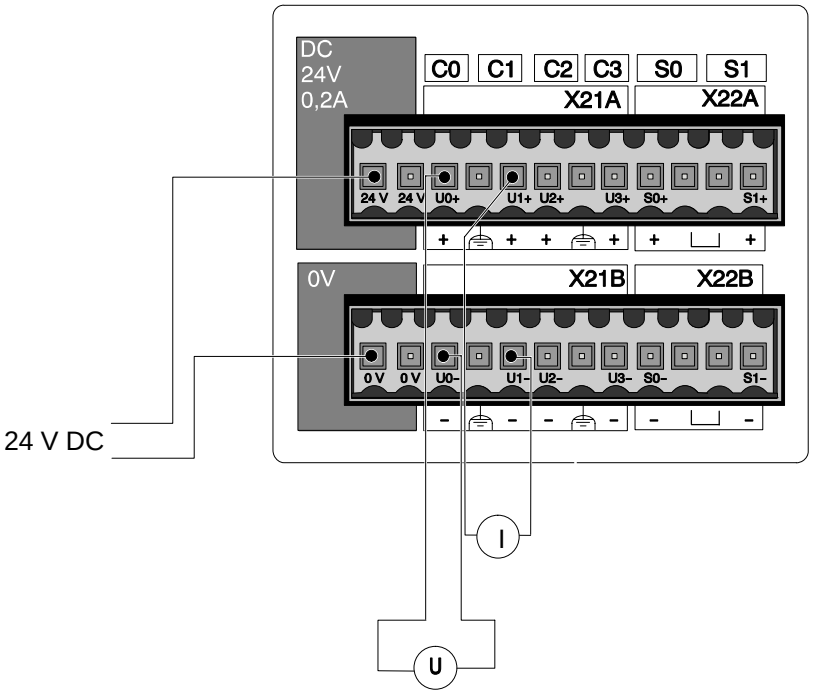
Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
Ux+	Analog inputs 0 to 3 / positive input
Ux-	Analog inputs 0 to 3 / negative input
Sx+	Integrated constant current source / positive connection
Sx–	Integrated constant current source / negative connection

The 4AI_UIT module provides one terminal for shielded connection per channel, U+ and U–.

Connection example

In the case of **voltage measurement**, the positive signal lead is connected to the U_x+ terminal and the negative signal lead to the U_x– terminal.

In the case of **current measurement**, connection is the same as for voltage measurement. In addition, a DIP switch (S2.0 to 2.3) must be closed for each channel to activate the measurement shunt in each case.

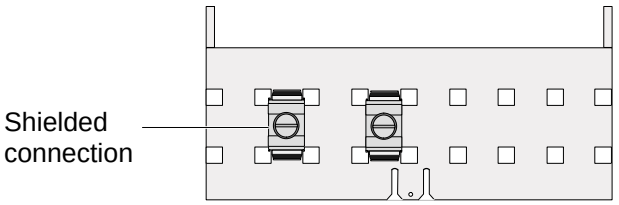


☞ **Example of temperature measurement, see section 9.4.4 and 9.4.5.**

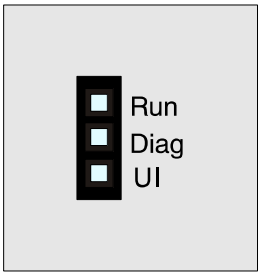
9.2.2 Patching distribution frame

The modules can be extended to include a patching distribution frame. This provides a convenient shielded connection for each channel and ensures the strain relief of the connections.

☞ **The patching distribution frames extend the modules in a downward direction by approx. 4 cm.**



9.2.3 Displays and fault messages

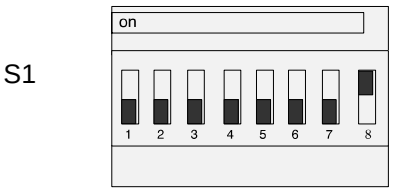


Name	LED	Meaning
RUN	green	fault-free operation
RUN + DIAG	flashing	Hardware defect, module must be replaced
DIAG	red	Fault: • Sensor break (see page 9–8) • Compensation measurement exceeding range • no 24 V power supply (UI flashes) If DIP switch S1.7 = ON, the diagnosis message is routed to the PLC.
UI	green	24 V power supply is OK
	flashes	24 V power supply is not present (LEDs RUN and DIAG light up)

☞ **There is also a hardware defect if all the LED displays remain dark although the module connector plug X52 is inserted, i.e. the module is supplied with voltage.**

9.3 Configuration with DIP switch S1

The measurement method with measuring range is set for all channels at DIP switch S1.



DIP 1 to 5: Measuring range

DIP 6 and 7: mean value formation

DIP 8: Diagnosis

To enable modified settings, the module must be switch off and then on again.

S1.1 to S1.3 The measuring range is set at the DIP switches S1.1 to S1.5.

DIP 1.1	DIP 1.2	DIP 1.3	DIP1.4	DIP1.5	Measuring range
0	0	0	0	0	±10 V straight binary
1	0	0	0	0	±1 V straight binary
0	1	0	0	0	±0.1 V straight binary
1	1	0	0	0	0 to 20 mA
0	0	1	0	0	4 to 20 mA, SB < 3.8 mA
1	0	1	0	0	4 to 20 mA, SB < 3.3 mA
0	1	1	0	0	PT100
1	1	1	0	0	PT500
0	0	0	1	0	PT1000
1	0	0	1	0	NI100
0	1	0	1	0	NI500
1	1	0	1	0	NI1000
0	0	1	1	0	Type R
1	0	1	1	0	Type S
0	1	1	1	0	Type B
1	1	1	1	0	Type J
0	0	0	0	1	Type T
1	0	0	0	1	Type E
0	1	0	0	1	Type K
1	1	0	0	1	±10 V double complement
0	0	1	0	1	±1 V double complement
1	0	1	0	1	±0.1 V double complement

☞ **Other switch settings are invalid.**

S1.6 and S1.7 The number of measurements used to form a mean value is set at DIP switches S1.6 and S1.7.

DIP 1.6	DIP 1.7	Number of measurements
0	0	no mean value formation
0	1	8
1	0	32
1	1	128

A mean value formation can filter out unwanted, high-frequency interference. The time for one measuring cycle increases linearly with the number of mean value formations.

S1.8 At DIP switch S1.8, the setting is made as to whether the module sets a diagnosis message at the CL150 or bus connection in the event of a fault.

DIP 1.7	Diagnosis message in the event of a fault
0	no message
1	message to CL150 or bus connection

9.4 Measuring range and data formats

Validity of data after 'Power on'

The module begins to convert the analog values after 'Power on'. As some time passes before all channels have measured values, FFFF Hex is entered in the measured values until this time. This value indicates to the user that the measured values are not yet valid.

9.4.1 Voltage measurement

Measuring range			**Coding**	
±10 V	**±1 V**	**±0.1 V**	**Double complement left aligned[1)]**	**Straight binary left aligned[1)]**
Sample measured values				
+9.99878 V	+0.999878 V	+0.0999878 V	7FFC	FFFC
0.00122 V	0.000122 V	0.0000122 V	0004	8004
0 V	0 V	0 V	0000	8000
–9.99878 V	–0.999878 V	–0.0999878 V	8004	0004
–10 V	–1 V	–0.1 V	8000	0000
invalid	invalid	invalid	FFFF	FFFF

[1)] In the voltage measurement ranges, bits 0 and 1 remain at the value 0.

9.4.2 Current measurement 0 to 20 mA

For a current measurement, the integrated measuring shunt for each channel must be activated by DIP switches S2.0 to 2.3.

Measuring range	**Coding**
0 to 20 mA	**Straight binary, aligned left**
Sample measured values	
19.99878 mA	FFFC
10.00122 mA	8004
10 mA	8000
0.00122 mA	0004
0 mA	0000
invalid	FFFF

CAUTION
Ensure that no voltages above 5 V are present at the inputs of the module during current measurement.
Higher voltages can destroy the module!

Sensor break

In this measuring range, no sensor break detection is possible.
In the event of currents < 4 mA through the measurement shunt, the measured value 0x0000 is output. This could also be a sensor break.

☞ **Negative currents, e.g. due to polarity inversion, lead to the diagnosis message 'sensor break' of DIP switch S1.8 is set to ON.**

Unused channels

Unused channels always deliver an invalid message. If DIP switch S1.8 = ON, this can lead to a diagnosis message. For this reason, activate the measuring shunt for unused channels. These channels the deliver a measured value around 0x0000.

9.4.3 Current measurement 4 to 20 mA

For a current measurement, the integrated measuring shunt for each channel must be activated by DIP switches S2.0 to 2.3.

Measuring range	**Coding**
4 to 20 mA	**Straight binary, aligned left**
Sample measured values	
19.99902 mA	FFFC
12.00097 mA	8004
12 mA	8000
4.000976 mA	0004
≤ 4 mA	0000
invalid	FFFF
Sensor break	0001

CAUTION
Ensure that no voltages above 5 V are present at the inputs of the module during current measurement.
Higher voltages can destroy the module!

Sensor break

In the case of sensor break detection, 2 monitoring ranges are distinguished, switchable via S1:

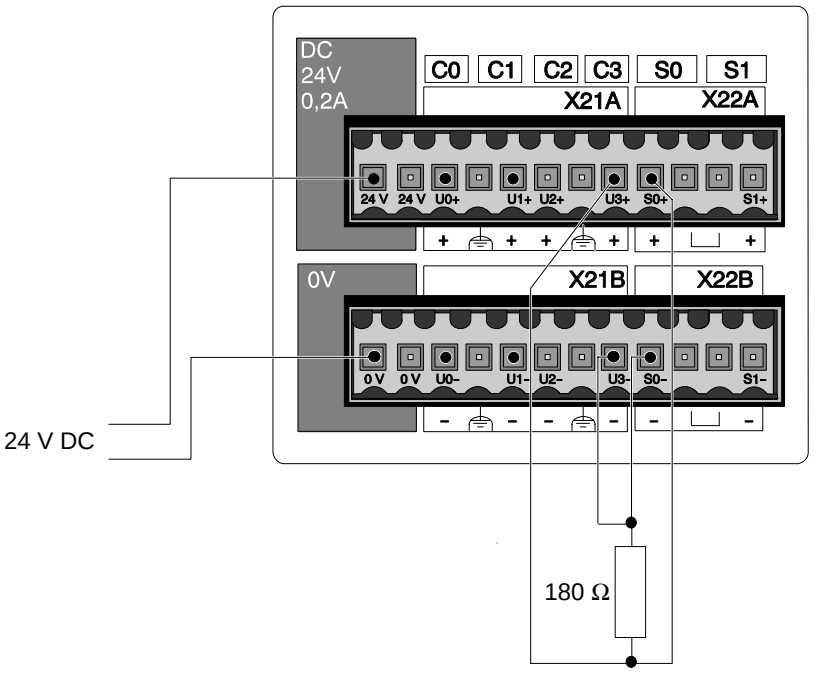
- Sensor break for currents < 3.8 mA or
- Sensor break for currents < 3.3 mA

Sensor break is reported:

- in the measured value; the LSB = 1 is set (0001)
- by means of additional diagnosis message if S1.8 is set to ON

Unused channels

Unused channels always cause a sensor break message. This can be prevented by connecting a 160 Ω resistance on both constant current sources. The voltage drop across this resistance (approx. 4 V) is then given to the open inputs. The measuring shunts of the open channels must not be activated (DIP2.x = OFF).



9.4.4 Temperature measurement with thermal elements

The module 4AI_UIT supports the thermal elements TYPE R, S, B, J, T, E, K as standardized in IEC 584. The voltage supplied by the elements is converted directly into degrees.

Two-wire potential-linked and potential-free thermal elements can be connected.

Output format

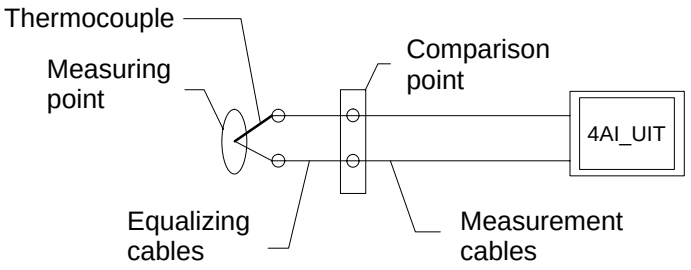
Temperatures are always represented in the format 0.1 degree = 1 bit. Values less than 0x8000 are negative temperatures. Values greater than 0x8000 are positive temperatures.

If a measured temperature is above or below the value range applicable to the particular element, 0xFFFF or 0x0000 is displayed as measured value.

There is no monitoring of whether the range is exceeded.

Measuring principle

Thermal elements consist of the thermocouple (two different metals welded at one end) and the required connection parts.



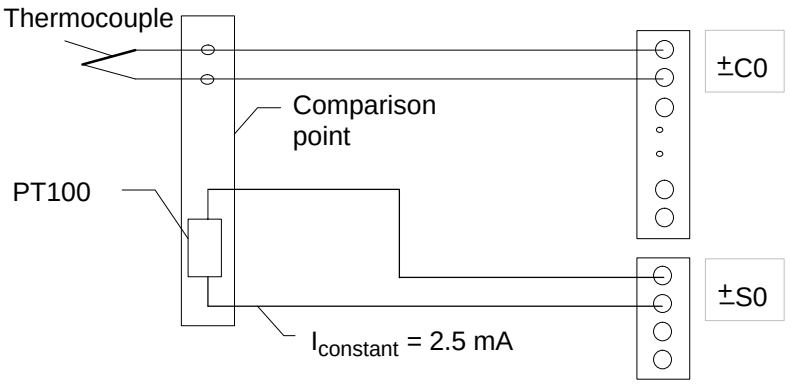
If the measuring point is exposed to a different temperature to that of the free ends of the thermocouple, the thermoelectric force is created between the free ends. It is dependent on the materials used and is proportional to the temperature difference between measuring point and comparison point.

If required, the connections of the thermocouple can be extended by means of equalizing cables to the comparison point. So that the thermoelectric force is not falsified, these cables must always be made of the same material as the thermocouples.
Use copper wires from the comparison point to the input module.

As it is always a temperature difference that is registered, the temperature of the comparison point must be kept constant. However, as this is not possible in practice, the module computes a compensation for the temperature change.

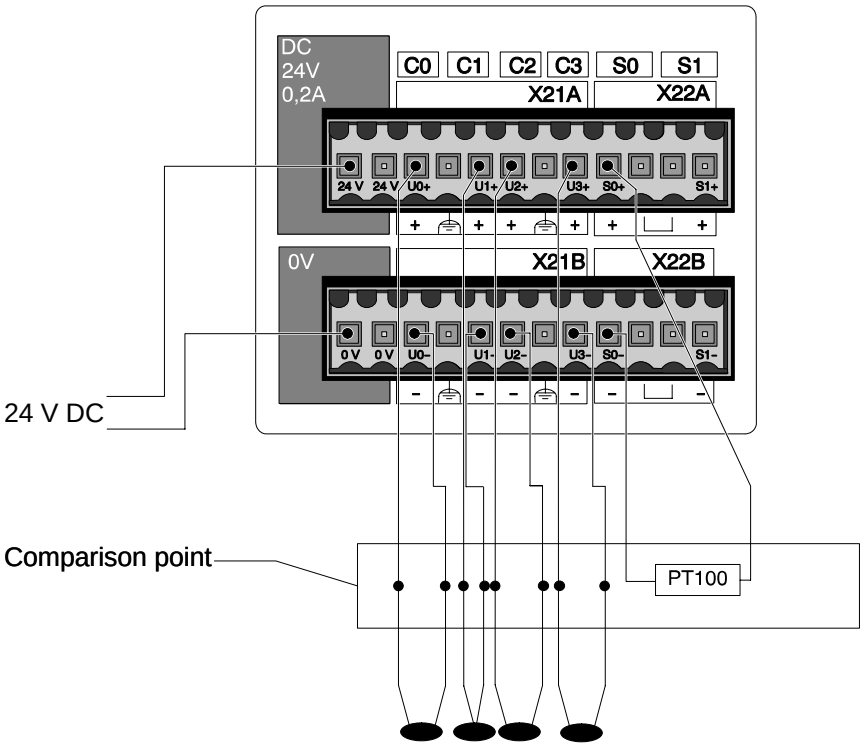
Compensation

To compensate the temperature change, the temperature must be measured at the comparison point. To do so, always connect a 2-wire PT100 resistance thermometer to S0.



If the temperature determined lies outside the temperature range of a PT100, the LED DIAG lights up and a compensation is performed. With DIP switch S1.8 at ON, this diagnosis message is routed to the CL150 or bus connection.

Connection example



Value ranges of the elements

Thermal element type R: Platinum 13 % Rhodium / Platinum

Binary value / hex	Measured value in degrees	Range
FFFF	>1769.1	ER exceeding range
C51A to 7E0C	1769 to -50	NR nominal range
0000	< 50.1	SB sensor break

Thermal element type S: Platinum 10 % Rhodium / Platinum

Binary value / hex	Measured value in degrees	Range
FFFF	> 1769.1	ER exceeding range
C51A to 7E0C	1769 to -50	NR nominal range
0000	< 50.1	SB sensor break

Thermal element type B: Platinum 30% Rhodium / Platinum 6% Rhodium

Binary value / hex	Measured value in degrees	Range
FFFF	> 1200.1	ER exceeding range
AEE0 to 77CC	1200 to -210	NR nominal range
0000	< 210.1	SB sensor break

Thermal element type J: Iron / Copper - Nickel

Binary value / hex	Measured value in degrees	Range
FFFF	> 1820.1	ER exceeding range
C718 to 8000	1820 to -0	NR nominal range
0000	< 0.1	SB sensor break

Thermal element type T: Copper / Copper - Nickel

Binary value / hex	Measured value in degrees	Range
FFFF	> 400.1	ER exceeding range
8FA0 to 7574	400 to -270	NR nominal range
0000	< 270.1	SB sensor break

Thermal element type E: Nickel - Chromium / Copper - Nickel

Binary value / hex	Measured value in degrees	Range
FFFF	>1000.1	ER exceeding range
A710 to 7574	1000 to -270	NR nominal range
0000	< 270.1	SB sensor break

Thermal element type K: Nickel - Chromium / Nickel

Binary value / hex	Measured value in degrees	Range
FFFF	>1372.1	ER exceeding range
B598 to 7574	1372 to -270	NR nominal range
0000	< 270.1	SB sensor break

9.4.5 Temperature measurement with resistance thermometers

The module 4AI_UIT supports the resistance thermometers PT100, PT500, PT1000, NI100, NI500 and NI1000.

4-wire, 3-wire or 2-wire resistance thermometers can be connected.

Output format

Temperatures are always represented in the format 0.1 degree = 1 bit. Values less than 0x8000 are negative temperatures. Values greater than 0x8000 are positive temperatures.

If a measured temperature is above or below the value range applicable to the particular element, 0xFFFF or 0x0000 is displayed as measured value.

There is no monitoring of whether the range is exceeded.

Measuring principle

Resistance thermometers change their resistance in proportion to the temperature.
The constant power source in the module supplies the resistor with constant current of 2.5 mA. The voltage drop across the resistor is measured and converted into degrees. The load resistance of a constant power source must not exceed 4 KΩ.

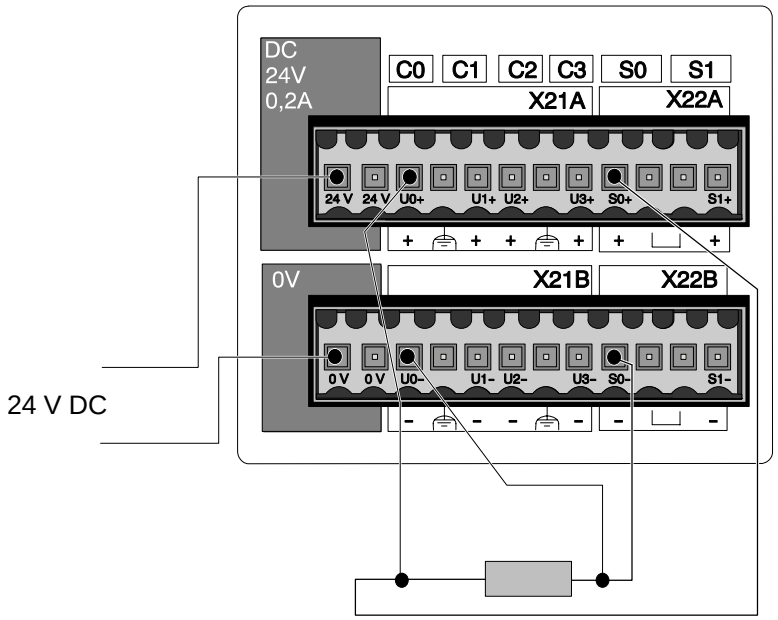
If you want to supply a number of resistance thermometers from one current source, you have to loop the current from one resistor to the next. To do so, you can use the two jumpers on connector strip X22A/B.

The greatest precision is achieved with a 4-wire connection. With this type of connection, the 4 wires lead to the resistor. The voltage drop is measured locally.

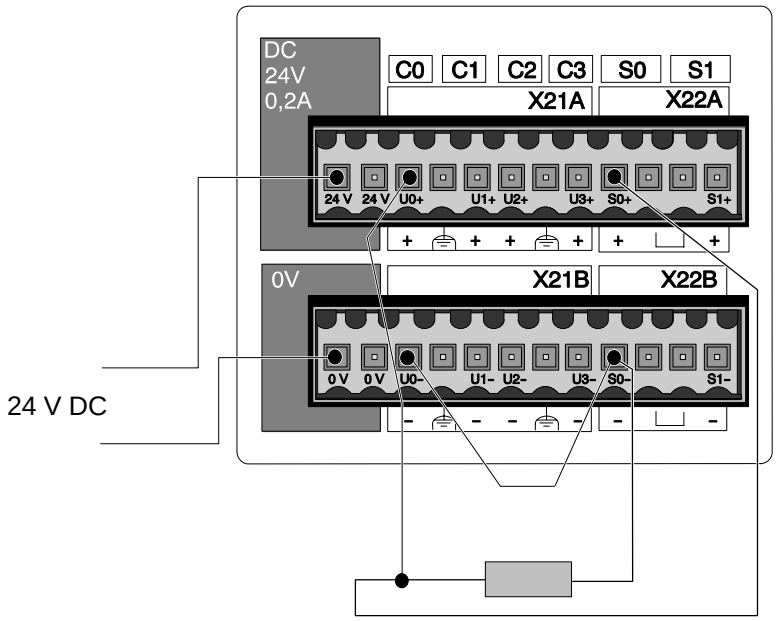
The 3-wire or 2-wire versions save on wiring, but as a rule lead to poorer results.

Connection examples

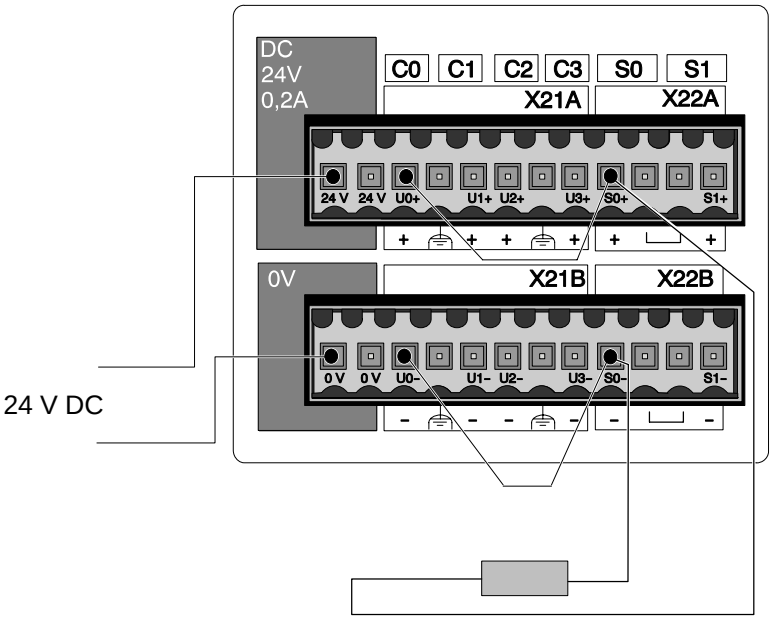
Resistance thermometer with 4-wire connection



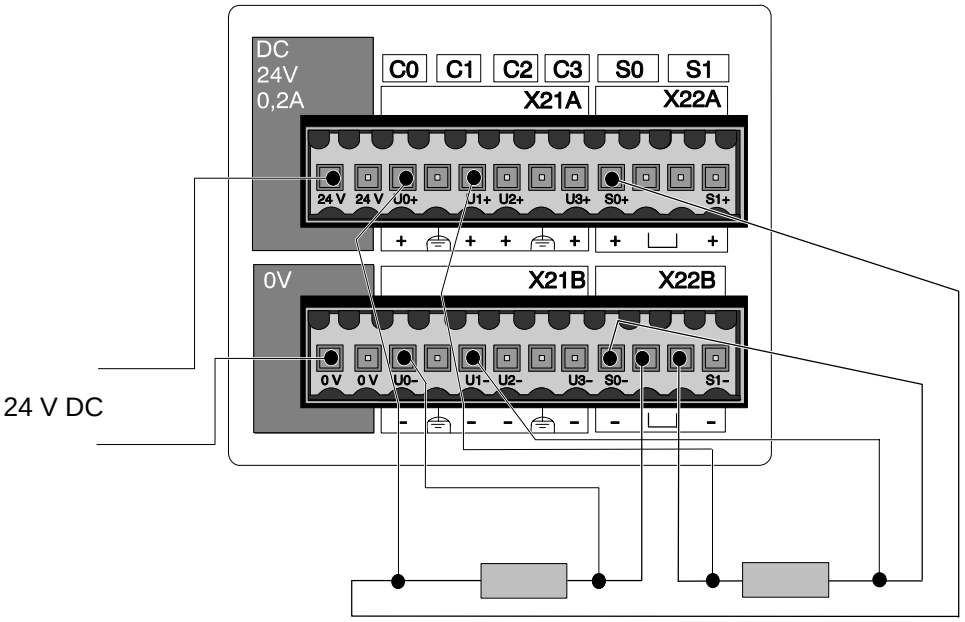
Resistance thermometer with 3-wire connection



Resistance thermometer with 2-wire connection



One constant power source supplies 2 resistance thermometers



Value ranges of the elements

Resistance thermometer PT100 / PT500 / PT1000

Binary value / hex	Measured value in degrees	Range
FFFF	> 850	SB sensor break
A134 to 7830	850 to –200	NR nominal range
0000	< 200	SB sensor break

Resistance thermometer NI100 / NI500 / NI1000

Binary value / hex	Measured value in degrees	Range
FFFF	> 250	SB sensor break
89C4 to 7DA8	250 to –60	NR nominal range
0000	< –60	SB sensor break

9.5 Technical data, accessories, order numbers

Technical data	4AI_UIT
Order no.	1070 080 526
Power supply complying with EN 61 131-2	24 V; 19.2 to 30 V
Current consumption off ● 24 V power supply ● internal bus	 ≤50 mA ≤50 mA
Potential isolation	yes
Inputs complying with EN 61 131-2	4 differential inputs
Input voltage	● ±100 mV ● ±1 mV ● ±10 V measuring ranges via GAIN
Input current	● 0 to 20 mA ● 4 to 20 mA 50 Ω shunt integrated
Equipment features	● 2 constant current sources ● Compensation at thermal elements
Resolution	14 bit incl. preceding sign
Representation	Straight binary or double complement aligned left
Configuration	via DIP switch
Measurement error at $T_{ambient}$ = 5 to 55 °C	<1 %, <2 % in the measuring range ±100 mV
Matching	fully automatic with power on
Diagnosis	● 24 V ● Sensor break, with current measurement 4 to 20 mA ● Compensation measurement exceeding range
Conversion time	all channels within 1 ms, ±10 V, without mean value formation
Dimensions in mm (L x W x D)	102.6 x 105 x 38
Weight	294 g

Accessories	Order no.
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	 1070 080 309
Socket terminal strip sets ● Screw terminals ● Spring terminals	 1070 081 239 1070 081 238
Pulling aid for socket terminal strips, 8-pole	1070 919 513
Patching distribution frame for shielded connection	1070 081 248

9.6 Installation notes

Selection of analog line

★ Use cables with braided shields.

Shielded cables twisted in pairs must be used for the analog lines. These reduce the influence of external interference and guarantee optimum transfer of the analog signals. If cables with foil shields are used, it should be borne in mind that the foil can be very easily damaged by pull or push stresses. This drastically reduces the shielding effect.

The cable length is limited to a maximum of 200 m.

To avoid interaction on the analog signals, the cables must not be installed parallel to high-energy lines (e.g. supply leads).

Shielded connection

Taking the EMC criteria into account, the cable shield must always be earthed at both ends of the cable to increase interference immunity.

If potential differences between the analog inputs and the sensors occur (e.g. due to cut power supply or earthing at various parts of the unit), high compensatory currents can occur at the shield placed on both sides. These can heavily distort the analog signal and even damage the lead.

★ In this case, lay additional low-impedance potential compensation cables (at least 16 mm^2 Cu), connected on a large surface area with the grounder/ protective earth.

It is only in exceptional cases of low interference environments that a cable shield earthed on one side of the analog module can be accepted.

The cable shield is connected as short as possible on the analog module at the

- shield distributor
- or by means of a cable end sleeve at the connector X21B.

★ Use cable end sleeves to connect the signal cables. In doing so, ensure that the terminal connections are absolutely clean and firmly tightened.

Non-insulated measured value encoders

Non-insulated encoders are linked to the local earth potential. As the encoders are attached at different positions, potential differences between the individual earth points in relation to the control potential can occur.

☞ **This can be avoided using potential compensation cables between the individual encoders.**

Insulated measured value encoder

These encoders are not linked to the local earth potential.

★ When connecting the thermal elements, ensure that the positive pole of the elements is connected to the positive pole of the input module.
On most sensors, the positive pole is red in color.

Protection against overvoltage

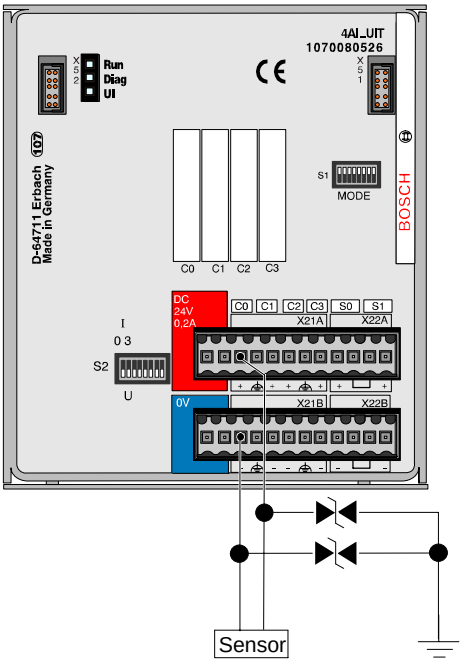
In relation to the maximum (permanent) input voltage of ±14 V specified in the technical data, the module withstands brief overvoltages of ±20 V at the ±inputs.

This voltage can be exceeded due to external interference, for exampledur-ing thunderstorms, and destroy the module.

Protection against overvoltage is provided by:

- e.g. so-called 'lighting ductors' made by Dehn,
- 'bipolar transient diodes'. These should have a breakdown voltage of 14 V to 18 V

☞ **The diodes slightly falsify the measurement result due to correspon-ding offset currents.**



Notes:

10 Analog output module 4AO_U

To control processes, it is required to output analog signals that are processed by actuators, such as values etc.

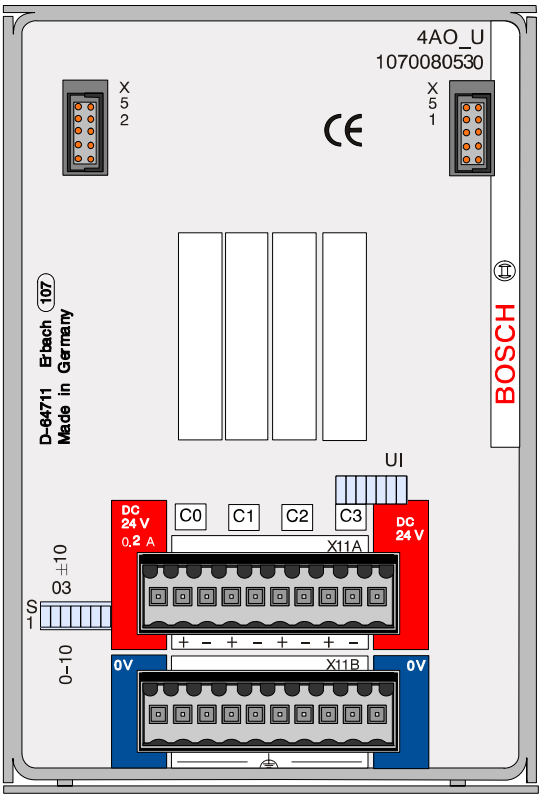
The 4AO_U has 4 voltage outputs which can be individually configured for the ranges –10 V to +10 V or 0 to 10 V.

10.1 Structure

The output module sets 8 output bytes (2 bytes per channel). The output data can be assigned to any PLC addresses:

- in the CL150 via the I/O configuration of the WinPLC
- in a bus connection via the relevant bus configurator

The module is configured using DIP switches. No function module is required for operation.



Connections for module connector plugs

Labeling fields

LED status indicator UI

DIP switch S1

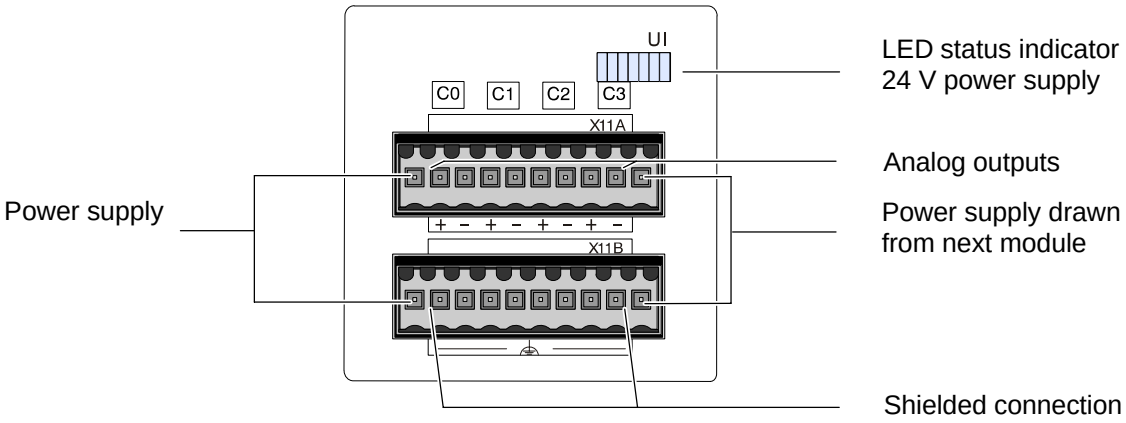
Connector strips for:
- 24 V power supply
- analog outputs

Features

- 4 analog outputs referred to shared ground
- 12-bit resolution
- output range that can be set separately for each channel
- monitoring of missing external power supply

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

10.2 Connections and displays



CAUTION
Applying external voltage to the output terminals can lead to destruction of the analog assembly!

10.2.1 Connections

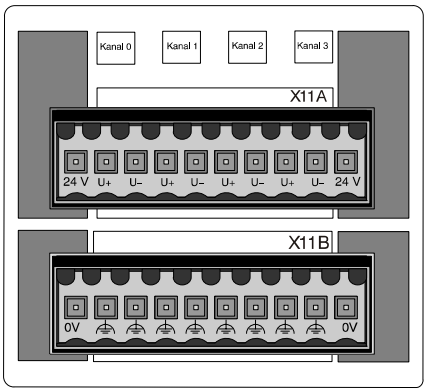
The analog output module provides connector strips for a 3-wire connection (+signal, –signal and shield).

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 10–6):

- Screw terminals
- Spring terminals

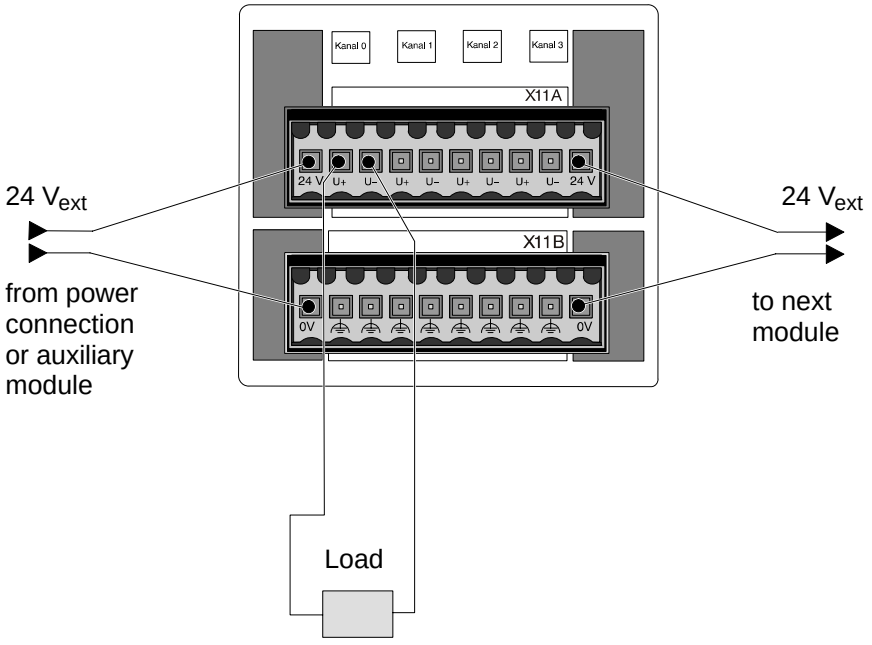
Connection allocation



Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
U+	Analog outputs 0 to 4 / positive output
U–	Analog outputs 0 to 4 / negative output
⏚	Shielded connection

☞ **All [–] outputs of the channels as well as the 0 V connection terminal are bridged.**

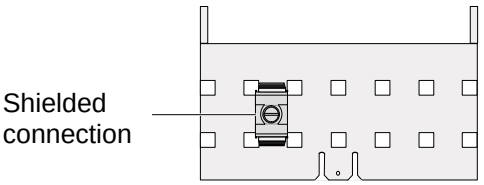
Connection example



10.2.2 Patching distribution frame

The modules can be extended to include a patching distribution frame. This provides a convenient shielded connection for each channel and ensures the strain relief of the connections.

☞ **The patching distribution frames extend the modules in a downward direction by approx. 4 cm.**



10.2.3 Displays and fault messages

LED	Status	Meaning
UI	green	24 V power supply is OK
	off	24 V power supply is not present

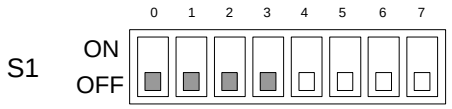
Diagnosis message

A missing 24 V supply of the module is reported via a diagnosis bit at the CL150 or bus connection. This diagnosis message cannot be deactivated.

10.3 Configuration with DIP switch S1

Output range

The voltage outputs can be separately configured using the DIP switch S1 for each channel for the output ranges 0 to 10 V or ±10 V.



Position	DIP 1.0 (channel 0)	DIP 1.1 (channel 1)	DIP 1.2 (channel 2)	DIP 1.3 (channel 3)
ON	±10 V	±10V	±10V	±10 V
OFF	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V

S1.4 to S1.7 are not used.

10.4 Data formats

Digital value	Analog value for output range 0 to 10 V Straight binary left aligned	Analog value for output range ±10 V Double complement left aligned
Sample values		
000xh→ 0000 0000 0000 xxxx	0 V	0 V
001xh→ 0000 0000 0001 xxxx	2.44 mV	4.88 mV
7FFxh→ 0111 1111 1111 xxxx	4.9975 V	9.9951 V
800xh→ 1000 0000 0000 xxxx	5 V	– 10 V
FFFxh→ 1111 1111 1111 xxx	9.9975 V	– 4.88 mV
Resolution 1 LSB = OR * 1/4096	2.44 mV	4.88 mV

x = any, OR = 10 V (unipolar) or 20 V (bipolar)

10.5 Technical data, accessories, order numbers

Technical data	4A0_U
Order no.	1070 080 530
Power supply complying with EN 61 131-2	24 V; 19.2 to 30 V
Current consumption off ● 24 V power supply, outputs activated, without load ● internal bus	 ≤ 200 mA ≤ 30 mA
Potential isolation	yes, in relation to internal bus, outputs have shared GND potential
Outputs complying with EN 61 131-2	4 analog outputs
Outputs ● Voltage	 0 to 10 V ±10 V
Permitted load impedance	≥1 KΩ
Resolution	12-bit
Data format	0 to 10 V: Straight binary (binary code) ±10 V: Double complement
Configuration	via DIP switches for each channel
Greatest error across temperature range	< 0.8 % from SKE
Short-circuit characteristics	Short-circuit-protected outputs, short-circuit current typ. 15 mA
Capacitive interaction	88 nF/500 V between shield and GND 88 nF/500 V between shield and 24_{ext}
Output value on switching power supply on/off	0 V
Dimensions in mm (L x W x D)	75.6 x 105 x 38
Weight	approx. 230 g

Accessories	4A0_U
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	1070 080 309
Socket terminal strip sets ● Screw terminals ● Spring terminals	 1070 080 340 1070 080 347
Pulling aid for socket terminal strips, 8-pole	1070 919 513
Patching distribution frame for shielded connection	1070 081 249

10.6 Installation notes

Selection of analog line

★ Use cables with braided shields.

Shielded cables twisted in pairs must be used for the analog lines. These reduce the influence of external interference and guarantee optimum transfer of the analog signals. If cables with foil shields are used, it should be borne in mind that the foil can be very easily damaged by pull or push stresses. This drastically reduces the shielding effect.

The cable length is limited to a maximum of 200 m.

To avoid interaction on the analog signals, the cables must not be installed parallel to high-energy lines (e.g. supply leads).

Shielded connection

Taking the EMC criteria into account, the cable shield must always be earthed at both ends of the cable to increase interference immunity.

If potential differences between the analog inputs and the sensors occur (e.g. due to cut power supply or earthing at various parts of the unit), high compensatory currents can occur at the shield placed on both sides. These can heavily distort the analog signal and even damage the lead.

★ In this case, lay additional low-impedance potential compensation cables (at least 16 mm^2 Cu), connected on a large surface area with the grounder/ protective earth.

It is only in exceptional cases of low interference environments that a cable shield earthed on one side of the analog module can be accepted.

The cable shield is connected as short as possible on the analog module at the

- shield distributor
- or by means of a cable end sleeve at the connector X21B.

★ Use cable end sleeves to connect the signal cables. In doing so, ensure that the terminal connections are absolutely clean and firmly tightened.

Notes:

11 Analog output module 4AO_I

To control processes, it is required to output analog signals that are processed by actuators, such as values etc.

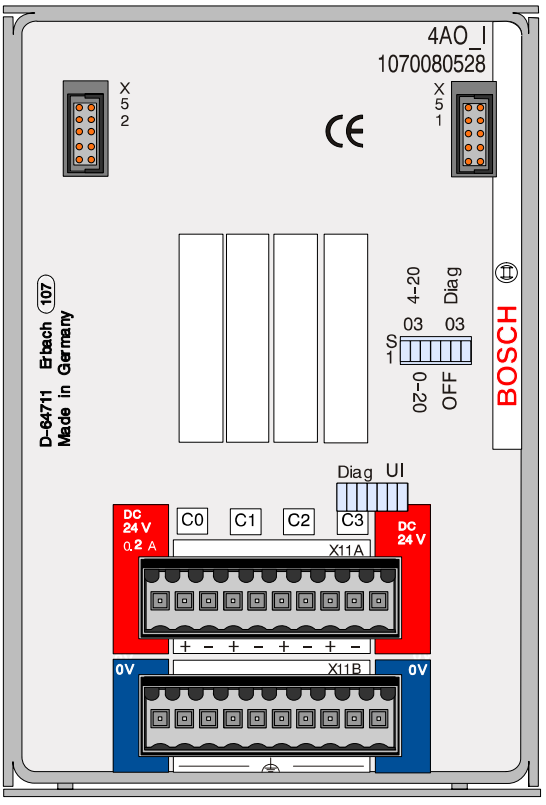
The 4AO_I has 4 voltage outputs which can be individually configured for the ranges 0 to 20 mA or 4 to 20 mA using DIP switches.

11.1 Structure

The output module sets 8 output bytes (2 bytes per channel). The output data can be assigned to any PLC addresses:

- in the CL150 via the I/O configuration of the WinPLC
- in a bus connection via the relevant bus configurator

The module is configured using DIP switches. No function module is required for operation.



Connection for module connector plug

Switch S1

Labeling fields

LED status indicator

Connector strips for:
- 24 V power supply
- analog outputs

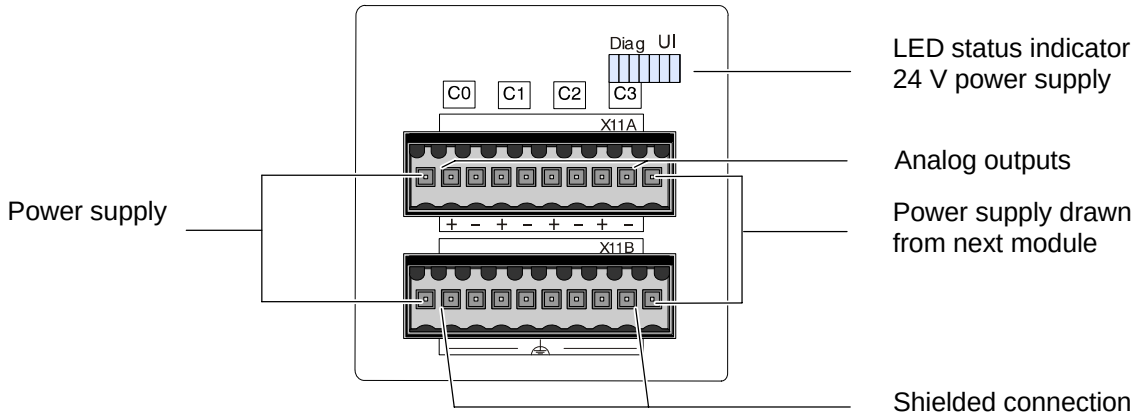
Features

The output module has the following features:

- 4 analog outputs, 0 to 20 mA or 4 to 20 mA, shared ground
- 16-bit resolution
- output range that can be set separately for each channel
- monitoring for wire break
- monitoring of missing external power supply

☞ **Module connector plugs and socket terminal strip sets must be ordered separately.**

11.2 Connections and displays



CAUTION
Applying external voltage to the output terminals can lead to destruction of the analog assembly!

11.2.1 Connections

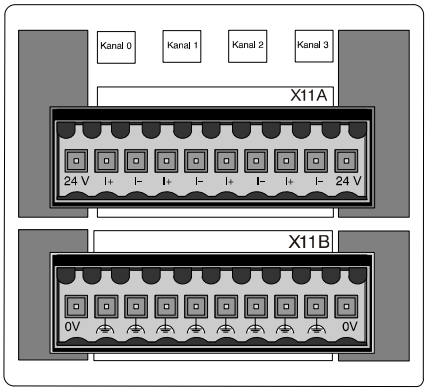
The analog output module provides connector strips for a 3-wire connection (+signal, –signal and shield).

Socket terminal strips

For each module and patching distribution frame, socket terminal strip sets with various connection technologies are available (ordering information, see page 11–7):

- Screw terminals
- Spring terminals

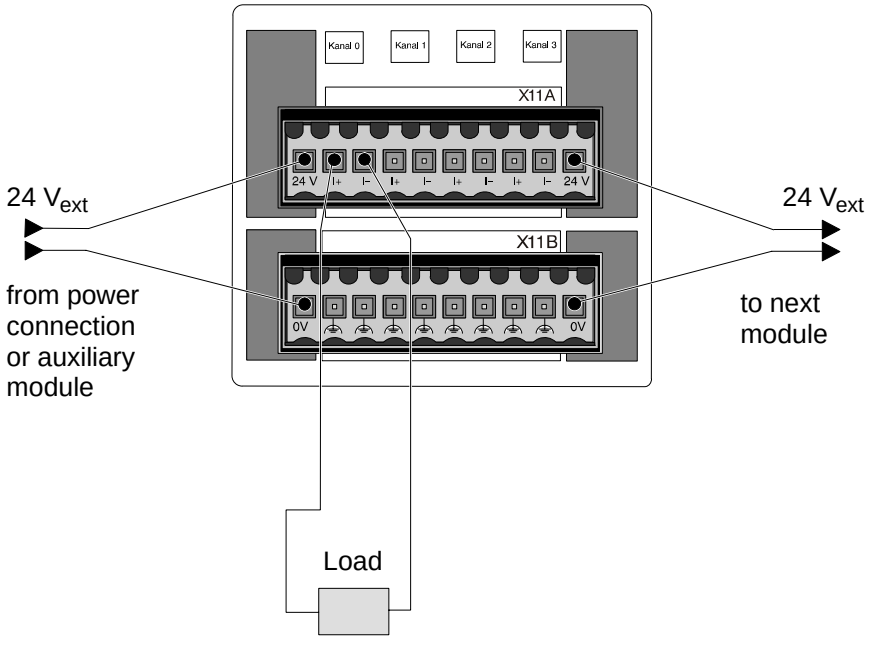
Connection allocation



Terminal	Allocation
24 V	24 V power supply, 24 V potential
0 V	Power supply, 0 V potential
I+	Analog outputs 0 to 4 / positive output
I–	Analog outputs 0 to 4 / negative output
⏚	Shielded connection

☞ **All [–] outputs of the channels as well as the 0 V connection terminal are bridged.**

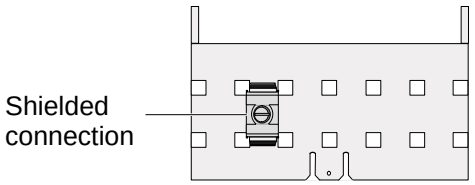
Connection example



11.2.2 Patching distribution frame

The modules can be extended to include a patching distribution frame. This provides a convenient shielded connection for each channel and ensures the strain relief of the connections.

☞ **The patching distribution frames extend the modules in a downward direction by approx. 4 cm.**



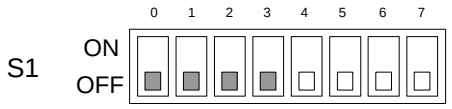
11.2.3 Displays and fault messages

LED	Status	Meaning
UI	green	24 V power supply is OK
	off	24 V power supply is not present
DIAG	red	• Wire break • $R_L$oad > 600 Ω in the case of one or more (non-deactivated) output channels
	off	Outputs are OK

11.3 Configuration with DIP switch S1

Output range

The current outputs can be separately configured using the DIP switch S1 for each channel for the output ranges 0 to 20 mA or 4 to 20 mA.



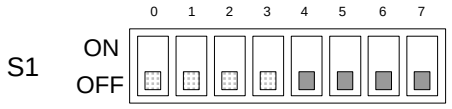
Position	DIP 1.0 (channel 0)	DIP 1.1 (channel 1)	DIP 1.2 (channel 2)	DIP 1.3 (channel 3)
ON	4 to 20 mA	4 to 20 mA	4 to 20 mA	4 to 20 mA
OFF	0 to 20 mA	0 to 20 mA	0 to 20 mA	0 to 20 mA

Diagnosis message

Each current output is monitored for wire breaks.

If a current output does not reach the given target value (cause: wire break or load impedance > 600 Ω), this is signaled to the CL150 or bus connection via a shared module diagnosis bit.

The diagnosis messages on the output channels that are not connected must be deactivated using DIP switch S1. Otherwise, fault messages are generated.



Position	DIP 1.4 (channel 0)	DIP 1.5 (channel 1)	DIP 1.6 (channel 2)	DIP 1.7 (channel 3)
ON	Diagnosis message, if: ● 24 V power supply is not OK or ● cable break / overload			
OFF	Diagnosis message if 24 V power supply not OK			

☞ **Diagnosis message regarding 24 V power supply cannot be deactivated.**

11.4 Data formats

Digital value	Analog value for output range 0 to 20 mA	Analog value for output range 4 to 20 mA
0000 0000 0000 0000	0 mA	4 mA
0000 0000 0000 0001	0.305 µA	4.000244 mA
1111 1111 111 1 1111	20 mA	20 mA
Resolution 1 LSB = 1/65536	0.305 µA	0.244 µA

11.5 Technical data, accessories, order numbers

Technical data	4A0_I
Order no.	1070 080 528
Power supply complying with EN 61 131-2	24 V; 19.2 to 30 V
Current consumption off • 24 V power supply • internal bus	 ≤ 200 mA (outputs activated, without load) ≤ 30 mA
Potential isolation	yes, in relation to internal bus, outputs have shared GND potential
Outputs complying with EN 61 131-2	4 analog outputs
Outputs • Current	 0 to 20 mA 4 to 20 mA
Permitted load impedance	≤ 600 KΩ
Resolution	16 bit
Data format	Straight binary
Configuration	via DIP switches for each channel
Greatest error across temperature range	< 0.4 % from SKE
Capacitive interaction	22 nF/500 V between shield and GND 22 nF/500 V between shield and 24_{ext}
Output value on switching power supply on/off	depending on measuring range, 0 mA or 4 mA
Dimensions in mm (L x W x D)	75.6 x 105 x 38
Weight	approx. 220 g

Accessories	4A0_I
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	1070 080 309
Socket terminal strip sets • Screw terminals • Spring terminals	 1070 080 340 1070 080 347
Pulling aid for socket terminal strips, 8-pole	1070 919 513
Patching distribution frame for shielded connection	1070 081 249

11.6 Installation notes

Selection of analog line

★ Use cables with braided shields.

Shielded cables twisted in pairs must be used for the analog lines. These reduce the influence of external interference and guarantee optimum transfer of the analog signals. If cables with foil shields are used, it should be borne in mind that the foil can be very easily damaged by pull or push stresses. This drastically reduces the shielding effect.

The cable length is limited to a maximum of 200 m.

To avoid interaction on the analog signals, the cables must not be installed parallel to high-energy lines (e.g. supply leads).

Shielded connection

Taking the EMC criteria into account, the cable shield must always be earthed at both ends of the cable to increase interference immunity.

If potential differences between the analog inputs and the sensors occur (e.g. due to cut power supply or earthing at various parts of the unit), high compensatory currents can occur at the shield placed on both sides. These can heavily distort the analog signal and even damage the lead.

★ In this case, lay additional low-impedance potential compensation cables (at least 16 mm^2 Cu), connected on a large surface area with the grounder/ protective earth.

It is only in exceptional cases of low interference environments that a cable shield earthed on one side of the analog module can be accepted.

The cable shield is connected as short as possible on the analog module at the

- shield distributor
- or by means of a cable end sleeve at the connector X21B.

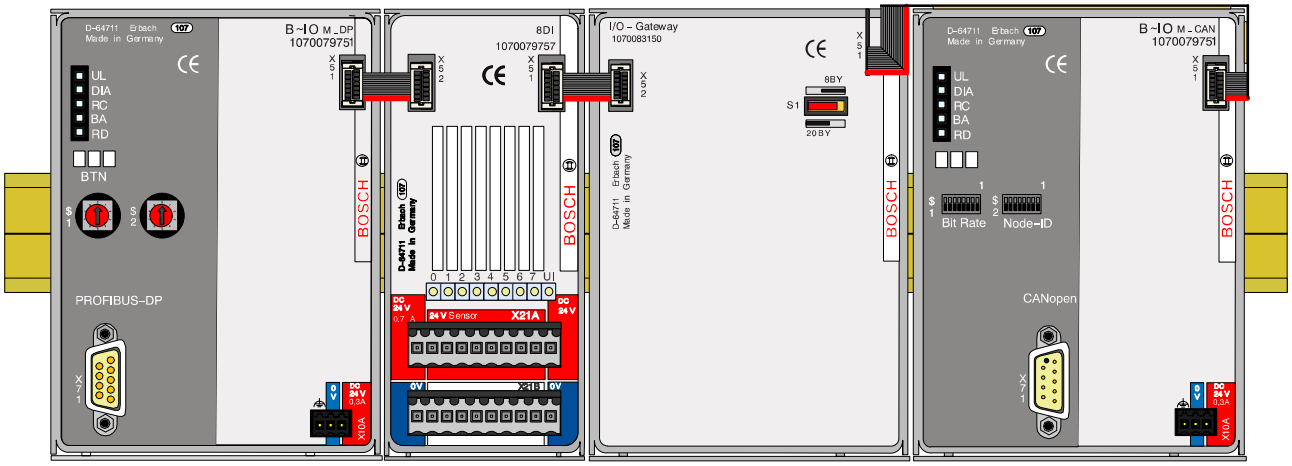
★ Use cable end sleeves to connect the signal cables. In doing so, ensure that the terminal connections are absolutely clean and firmly tightened.

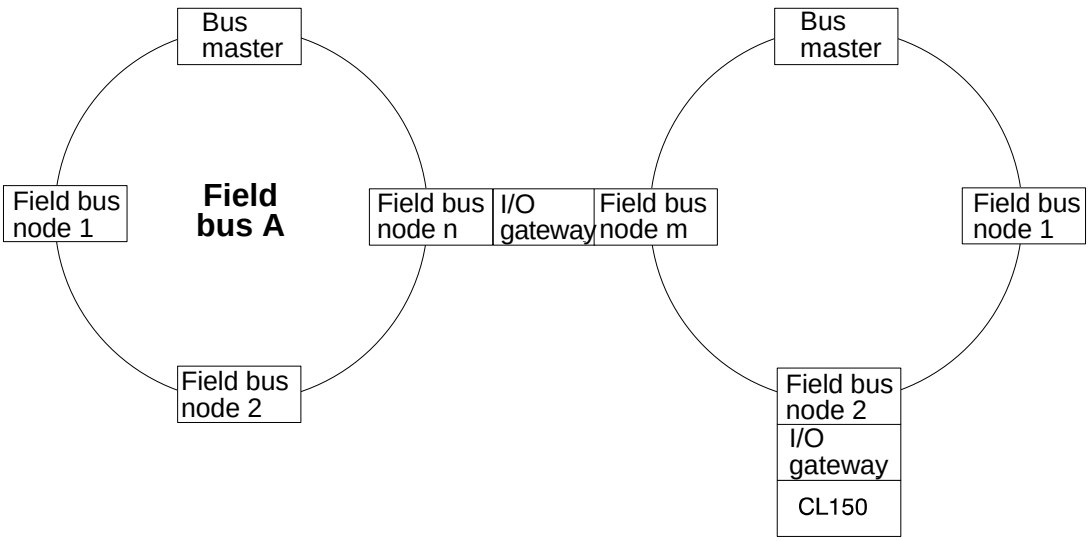
12 I/O gateway

The I/O gateway enables the transfer of data between two different field bus systems (PROFIBUS-DP, CANopen, CANrho, DeviceNet and INTERBUS-S) or between a field bus system and a CL150. The I/O gateway can also be used between two bus systems of the same type. Here, the linked systems exchange 20 bytes of input and 20 bytes of output information (reduction to 8 bytes I / 8 bytes O possible).

12.1 Layout, deployment options

The I/O gateway links two standard bus connections or a CL150 and a standard bus connection.





The following restrictions apply:

- Any B~IO modules can be connected to the left-hand modular system (field bus system B~IO or CL150). The I/O gateway **must** be connected as the last module by means of a module connector plug.

- No other B~IO modules can be connected to the right-hand modular system (only field bus system B~IO). A fixed module connector plug is used to connect the I/O gateway to the B~IO bus connection.

12.1.1 Connections

The I/O gateway has no external power supply.

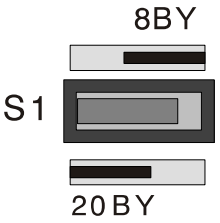
The current consumption from the left-hand modular system is a maximum of 10 mA. This must be taken into account in the sum current analysis of the left-hand system.

The current consumption from the right-hand modular system (maximum 10 mA) is irrelevant, as no other I/O modules may be connected to it.

12.1.2 Configuration with DIP switch S1

The switching matrix width of the I/O gateway module is 20 bytes of input and 20 bytes of output data. DIP switch S1 can be used to reduce this to 8 input bytes/8 output bytes if other I/O modules are connected to the left-hand field bus node.

Example of switching matrix reduction:
In the case of INTERBUS-S, the maximum number of I/O bytes has already been reached with the I/O gateway (20 bytes I/20 bytes O). If there are other modules in the system, the switching range must be reduced to 8 bytes I/8 bytes O.



Position	Switching matrix width
left	20 bytes I/O
right	8 bytes I/O

12.2 Diagnosis message

The I/O gateway is ready for operation when 5 V is applied from both sides across the connector plugs.

If one side is not connected to the I/O gateway, the module diagnosis message 'No 5 V from other side' is generated on the 'other' supplied side:

- This message is displayed at the modular bus connection by the flashing red LED DIA.
- In the CL150, a corresponding field message is created in the system area (see CL150, control manual).

12.3 Data consistency

PROFIBUS-DP

The I/O gateway can be selected as a consistent or non-consistent module in the PROFIBUS configurator (e.g. WinDP). For the selection of consistency/non-consistency, no setting is necessary on the assembly.

INTERBUS-S (IBS)

The data interchange to the IBS bus master is always constant due to the system itself. Further consistency in the direction of the PLC is dependent on the possibilities of the bus master.

CAN

The bus connection B~IO-M CAN supports up to a maximum of 32 bytes of process data inputs and up to 32 bytes of process data outputs.
Here, the process data is arranged in 4 PDOs, each consisting of 8 bytes. Due to the system itself, data consistency can only be guaranteed within a PDO.

In the factory settings, the bus connection uses the default mapping, i.e., that the input and/or output data of all I/O modules is arranged in sequence dependent on the installation sequence. If data consistency is required for the gateway switching data, observe the order of the connected I/O modules.

Example:

In the order 16DI – 16 DO – 8DO – I/O gateway(8):

- the input range of the I/O gateway is consistent within the first 6 bytes. The following 2 bytes are in turn consistent, but not with the first 6 bytes.
- the output range of the I/O gateway is consistent within the first 5 bytes. The following 3 bytes are in turn consistent, but not with the first 5 bytes.

Input range																													
PDO 1 (NODE-ID)								**PDO 2 (NODE-ID)**								**PDO 1 (NODE-ID + 1)**								**PDO 2 (NODE-ID + 1)**							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
16 DI		← I/O gateway (8 bytes) →																													
← consistent range →								← consistent range →								← consistent range →								← consistent range →							
Output range																															
PDO 1 (NODE-ID)								**PDO 2 (NODE-ID)**								**PDO 1 (NODE-ID + 1)**								**PDO 2 (NODE-ID + 1)**							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
16 DI		8 DO	← I/O gateway (8 bytes) →																												
← consistent range →								← consistent range →								← consistent range →								← consistent range →							

DeviceNet

Consistency handling is completely dependent on the bus master.

CL 150

Consistency is assured across the entire switching range.

12.4 Technical data, accessories, order numbers

Technical data	I/O gateway
Order no.	1070 083 150
Switching matrix width	20 bytes I/20 bytes O (8 bytes I/8 bytes O)
Power supply	via internal bus
Current consumption	10 mA at X51 10 mA at X52
Dimensions in mm (W x H x D)	75.6 x 105 x 38
Weight	240 g

Accessories	I/O gateway
Module connector plugs	1070 079 782
Labels 10 DIN A4 sheets, each with 20 labels	1070 080 309
Pulling aid for socket terminal strips, 8-pole	1070 919 513

Notes:

13 Installation guidelines

On setting up a system in which electrical equipment such as control systems are deployed, the following regulations must always be complied with:

- DIN VDE 0100
- EN 60 204-1
- EN 50 178

DANGER

Hazard to persons and property!

- **Dangerous states of the system that can lead to personal injury or damage to property must be prevented!**
- **The regulations for the setup of EMERGENCY STOP devices in accordance with EN 60 204-1 must be observed!**
- **It must be excluded that machines start up of their own accord after reconnection of the mains voltage, e.g. following an EMERGENCY STOP!**
- **Protection against direct and indirect contact must be ensured by the prescribed measures (connection with protective earth, insulation, etc.)!**

13.1 Power connection

The power connection must be equipped with safe isolation complying with EN 50 178, section 5.2.18.1. Transformers with safe isolation must be designed complying with EN 60 742.

The 24 V power supply is then regarded as extra-low voltage with safe isolation complying with EN 50 178, section 5.2.8.1. It can be designed either as safety extra-low voltage (SELV) without earthing of the reference lead or as protective extra-low voltage (PELV) with earthing of the reference lead.

A 3-phase power connection with simple full-bridge rectification is adequate. The superimposed AC voltage proportion must not exceed 5 %.

All cables of the 24 V power supply must

- be laid separate from cables with higher voltages or
- be specially insulated, whereby the insulation must be designed for the highest occurring voltage, see EN 60 204-1: 1997, section 14.1.3.

The isolated supply of output supplies means that these, for example in the event of EMERGENCY STOP, can be deactivated byte by byte. This means that the inputs and the outputs not assigned to the EMERGENCY STOP circuit remain functional.

☞ **All peripheral devices such as digital sensors/actuators or other bus connections connected to the interfaces of the I/O modules must also meet the criteria of safe isolation from power circuits.**

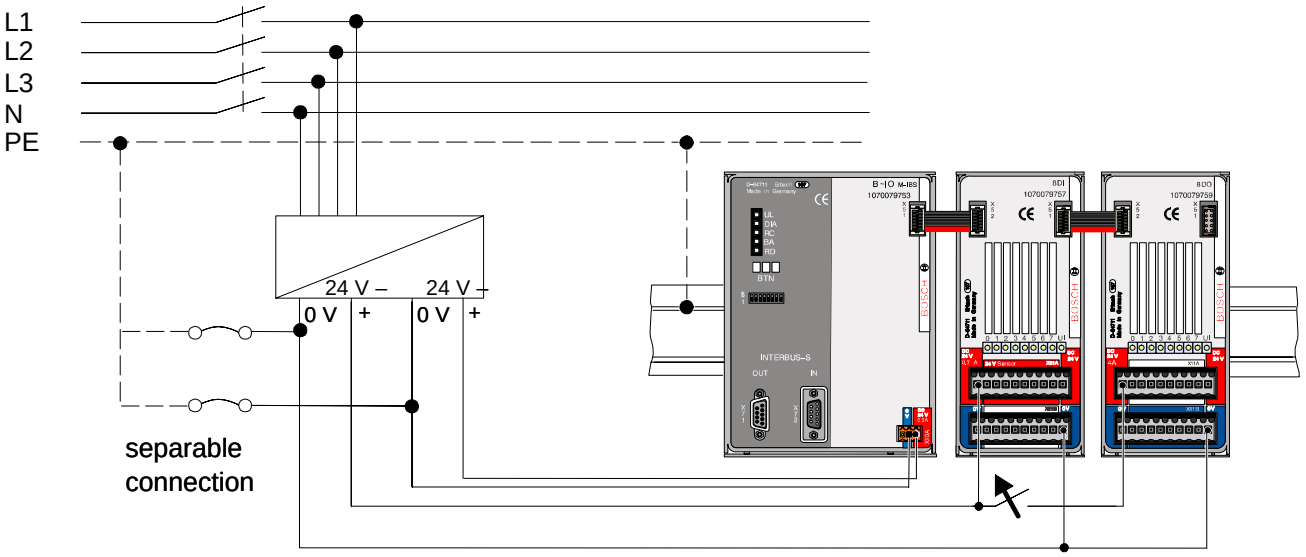
13.2 24 V power supply

There are two connection options for the 24 V power supply:

- Reference lead connected to the protective earth, see item 13.2.1.
- Reference lead not connected to the protective earth, see item 13.2.2.

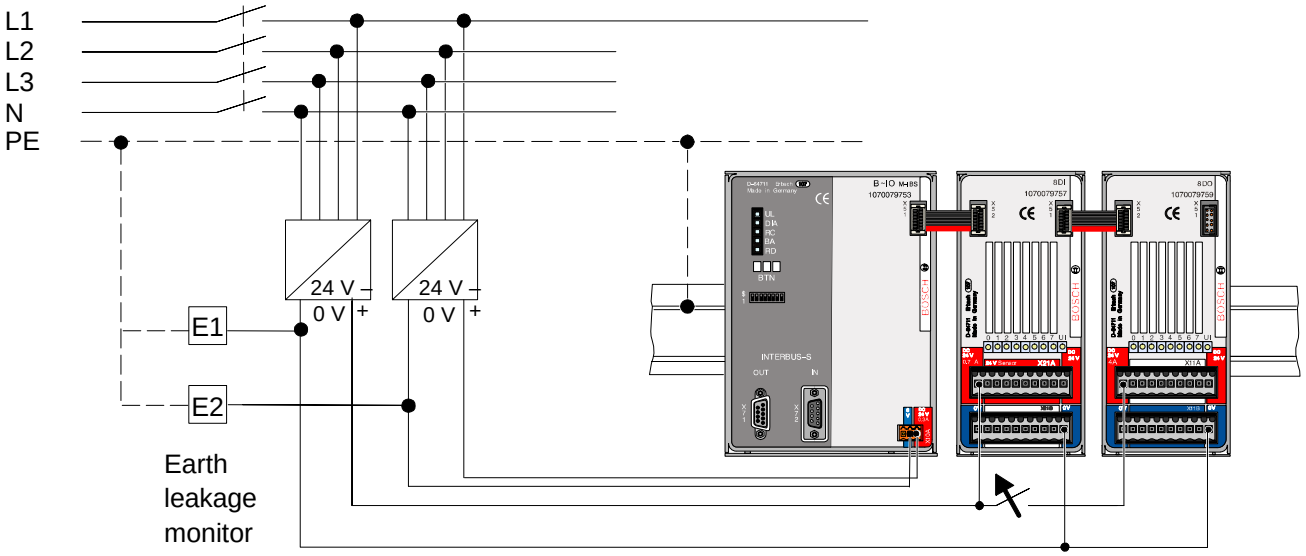
13.2.1 Reference lead connected to the protective earth

If the reference lead (N, 0 V) is connected to the protective earth system, this connection must be arranged at a central position, e.g. at the load power connection or the isolating transformer, and it must be separable for measurement of earth currents. This type of connection is to be used where possible. The supply circuit is thus a PELV circuit, see also section 13.1.



13.2.2 Reference lead not connected to the protective earth

If the reference lead (N, 0 V) is not connected to the protective earth system, a corresponding earth fault monitoring device must be deployed to detect earth faults in order to avoid inadvertent activation in the case of insulation faults. The supply circuit is thus a SELV circuit, see also section 13.1. Please note that other connected resources can nullify the earth-free layout.



13.2.3 Capacitive load of the power supply

Capacitances are installed in the I/O modules between the supply leads and protective earth for interference suppression. This is to be taken into account if an earth fault monitoring device is deployed.

Module	Order number	Capacitance 24 V → PE	Capacitance 0 V → PE
8DO	1070 079 759	5 nF	5 nF
8DO/2A	1070 080 151	5 nF	5 nF
8DO R	1070 080 680	5 nF	5 nF
16 DO	1070 081 858	5 nF	5 nF
8DI	1070 079 757	5 nF	5 nF
16DI	1070 080 144	5 nF	5 nF
8 DO/DI	1070 080 709	5 nF	5 nF
4AI_UI	1070 080 526	–	–
4AI_UIT	1070 080 526	88 nF	88 nF
4AO_U	1070 080 530	88 nF	88 nF
4AO_I	1070 080 528	22 nF	22 nF
I/O gateway	1070 083 150	–	–

13.2.4 Dimensioning of the power supply

When dimensioning the power supply, the maximum currents are to be taken into account, see VDE 0100-523. Directly at the device, there must be a voltage of 24 V (+ 20 %, – 15 %).

The voltage must also be retained in the case of

- fluctuations in the mains voltage, e.g. caused by varying loads on the power supply
- different load states, e.g. short-circuit, normal load, lamp load or idling.

The maximum cable cross-section for the power supply of I/O modules is 1.5 mm^2.

13.2.5 Master switch

A master switch complying with VDE 0100 must be fitted for modules, sensors and actuators.

13.2.6 Fuses

Fuses and cable circuit breakers are used to protect the supply leads in a network. The cables of the power supply for I/O modules must be secured with fuses/circuit breakers. Here, the supply of sensors and actuators should be secured separately with fuses/circuit breakers. If the supply leads are shorter than 3 m, and installed so that they are secured against earth faults and short circuits, these fuses/circuit breakers can be omitted.

In choosing fuses/circuit breakers, a large number of criteria must be considered. The most important aspect is the rated current of the circuit to be protected, see also VDE 0100-430. The rated current determines the cable cross-section, see VDE 0100-523.

Other criteria regarding the selection of fuses/circuit breakers include:

- Rated voltage
- Temperature
- Internal resistance of the fuses
- Activation currents
- Cable lengths
- Pre-impedance of the power supply
- Possible defect location
- Vibrations

Other information, see:

Manual no. 32
VDE publications
Rating and protection of leads and cable complying with DIN 57 100, VDE 0100-430 and -523.

In addition, many manufacturers of fuses and circuit breakers offer appropriate information.

13.2.7 Earthing

Function earthing

The I/O modules must be fitted on a metallic, earthed support, e.g. rear panel of switching cabinet.
Installation is on 35 x 7.5 mm support rails complying with EN 50 022. The support rail must be earthed, whereby any chrome coating or similar at the connection point must be removed.

For optimum interference immunity, function earthing is required. The function earthing must be connected across a cable that is as short as possible, or better an earthing strap.

Guide value:	Cable length	max. 1 m
	Cross-section	6 mm^2

If low interference levels are to be expected, function earthing via the earth contacts of the power supply connections is also possible.

Guide value:	Cable length	max. 0.5 m
	Cross-section	1.5 mm^2

Potential equalization

Between the system components and the power supply, potential equalization in accordance with VDE 0100 Part 540 must be ensured.

13.3 I/O connections

13.3.1 Inputs

All inputs have shared 24 V and 0 V potentials.

Any two-wire encoder (sensor) that meets the following conditions can be connected:

- Quiescent current, low state ≤ 2.6 mA
- Voltage drop, high state ≤ 6 V

The following two-wire encoders cannot be connected:

- 2-wire proximity switches largely using the standard IEC 947-5-2
- 2-wire proximity switches based on the NAMUR standard

13.3.2 Outputs

Inductive loads

In general, most outputs limit inductive deactivation peaks to a level that causes no problems by means of built-in terminal diodes.

However, the occurrence of a wire break, pulling off a connector for inductive load, e.g. solenoid valve, contactor etc., or the deliberate deactivation by means of a mechanical contact lead to very high interference levels. This can spread in the system due to galvanic, inductive or capacitive interaction and under certain circumstances lead to malfunctions of the system or other systems. To dampen this interference level, a corresponding interference suppression element (free-wheeling diodes, varistors, RC elements) must be fitted directly at the inductive load. Especially when a switch is fitted in line with the inductive load, e.g. for safety locks, the cancel connection must not be omitted.

All commercially available interference suppression filters can be used.

Due to their universal application, it is recommended to use bidirectional suppressor diodes. These consist either of two opposingly poled, in-line switched suppressor diodes or one poled suppressor diode with bridge rectification. Corresponding modules are commercially available.
Also suitable are varistor modules which, for example, are offered by the manufacturers of contactors for the relevant contactors.

Other information can be found, for example, in the manual for interference suppression of switched inductivities. This can be ordered from:

Friedrich Lütze GmbH & Co
Abteilung Marketing
Bruckwiesenstraße 17–19
D-71384 Weinstadt (Großheppach)

Polarity inversion

Protection against polarity inversion is only guaranteed without load connection.

CAUTION
Modules can be destroyed by polarity inversion with simultaneous short-circuit of the output leads, polarity inversion with simultaneous connection of external poled cancel diodes on the output leads or application of external voltage greater than the power supply!

GND protection against breaks

The 0 V reference of the connected loads must be returned to the 0 V terminal of the output modules (2-pole connection of load). If the 0 V reference is not returned (1-pole connection), the GND protection against breaks is not guaranteed.

If in this case the outputs are activated (logical 1), a load current can flow although the module has no 0 V connection.

If the outputs are not activated (logical 0), a leakage current of up to 25 mA per output can flow.

In the case of parallel-switched outputs, the current is multiplied accordingly.

13.4 Electromagnetic compatibility

The electromagnetic compatibility (EMC) is the capability of an electrical unit to operate satisfactorily in its electromagnetic environment without influencing this environment, to which other units belong, to more than a permitted degree (EN 61 000-4-1).

13.4.1 Interference

An important aim in automation technology is to achieve the greatest possible level of system availability. For this reason, there is a strong interest in avoiding standstill times due to interference.

Possible sources of interference for the user are:

- self-generated interference, e.g. by frequency converter, inductive loads etc.
- externally generated interference, e.g. lightning discharge, mains fluctuations etc.

These sources of interference affect the device, the interference trough, in different ways. The main interaction paths of the interference are:

- emitted interference interaction
- conducted interference interaction
- electrostatic discharges

Conducted interference can change into emitted interference and vice versa. For example, the conducted interference on a cable causes a field which emits onto a cable fitted in parallel and also causes conducted interference.

13.4.2 Signal-to-interference ratio

The signal-to-interference ratio is the ability of a device or component to tolerate interference up to a certain level without restriction. Electronic units such as control units have a significantly lower signal-to-interference ratio than other electrical equipment, e.g. contactors.

13.4.3 EMC legislation and CE identification

As a whole, the system must meet certain minimum requirements as regards interference immunity. The system manufacturer or seller of the overall machine is responsible for complying with these specifications. This is specified by the EMC legislation based on the EMC Directive of the Council of Europe.

The minimum requirements to comply with EMC legislation is specified in product (family) standards. If these standards do not exist, basic technical standards are applied. Conformity with the corresponding regulations is indicated by attachment of the CE identification.

The CE identification indicates conformity with all the relevant directives of the Council of Europe. However, it is not a seal of approval, and does not guarantee any properties; it is only intended for the monitoring authorities.

Depending on the product and area of application, a number of directives can be relevant. In addition, the manufacturer must draw up a corresponding declaration of conformity, which must be made available to the authorities on request.

Conformity is usually evidenced by standard tests, described in the so-called base standards, e.g. in EN 61 000-4-x = VDE 0847-4-x. However, to ensure interference immunity on site, the user must also adhere to the installation conditions specified by the manufacturer.

On setting up the system or machine, the EMC Directive, the Low Voltage Directive, the Machine Directive and possibly other directives relating to special types of system must be observed.

13.4.4 EMC characteristics of I/O modules

The I/O modules already meet the EMC requirements from the relevant standards (see descriptions of the individual assemblies or specifications).

Compliance with standards has been tested on certain system configurations. However, this fact certainly does not mean that the required electromagnetic compatibility of the system is ensured in every configuration. Responsibility for the overall system lies with the system/plant manufacturer alone.

Adequate electromagnetic compatibility can only be achieved with conscientious adherence to the installation guidelines. It is only when this condition is met that it can be assumed that an entire system composed of units – each with their own CE identification – will comply with the aims for protection in the Council of Europe directive.

A comprehensive summary of the application of the directive is provided by the publication 'Guidelines on the application of Council Directive 89/336/EEC of May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility', issued on 23 May 1997 by the European Commission. A German translation is available from the regulating authority for telecommunications and post, RegTP, and the Central Association of the Electrical and Electronics Industry, ZVEI.

Test of transient overvoltages (surge)

The appendix of the technical base standard EN 50 082-2, which is currently not part of the standard, contains a description of the surge test for direct current supplies and interfaces used for process control. This test is significant if cables exit from the building, e.g. danger of lightning, or are linked to power cables with interference.

Under the following conditions, the requirements of a system with I/O modules can be met:

- All power supplies of the control must be equipped with external varistor modules (e.g. Phoenix MODUTRAB VAR/3S-24AC) or with overvoltage protection modules.
- All digital inputs and outputs to be protected must be fitted with overvoltage protection terminals (e.g. Phoenix TERMITRAB SLKK 5/24DC, TERMITRAB UK5/24V or corresponding modules from the MODUTRAB range).

Emissions, radio interference

I/O modules meet the technical base standard EN 50 081-2 that specify the limit values for interference emissions. This standard only applies to use in the industrial area. In contrast to a residential area, the industrial area is characterized by the following specifications:

- no connection to the public low voltage power supply
- existence of a separate high-voltage or medium-voltage transformer
- operation in industrial environments or in the immediate vicinity of industrial supply networks

The expression 'industrial area' has nothing to do with the legal division (in part, specifically German) between industrial and residential areas.

The limit values for use in industry are higher than those for use in residential areas. For this reason, the user must implement additional measures if the system is to be used in residential areas:

- Installation of the system in a switch cabinet or a housing with high transmission loss shielding.
- An I/O system usually has a large number of peripheral interfaces. These are the major path for the emission of radio interference. To comply with the reduced emission values, all cables that exit from the shielded area must be fitted with filters and shielding.

For systems in residential areas (residential, office and commercial areas, small enterprises), specific approval must be obtained from authorities or inspection bodies. In Germany, this specific approval is given the Federal Bureau of Post and Telecommunications and local bureaus.

Protection against electrostatic discharges

All modules contain components that can be destroyed by electrostatic discharges (ESD). A defective assembly will not necessarily be recognizable immediately, but can become apparent in the form of occasional or delayed failures.

The relevant measures for handling electronic components and assemblies must be observed without fail. In particular, it is not permitted to connect or disconnect plugs under voltage. Before an assembly is touched directly, the person involved must be electrostatically discharged.

13.4.5 Installation measures to ensure interference immunity

As a general principle, prevention and rectification of interference at the source have priority. In this connection, the following points must be noted:

Earthing

To draw off interference potentials that take effect between the device and the reference earth, the device housing must be connected to earth by a low-impedance connection. Especially in the case impulse interference with rise times in the nanosecond range, the very inductive lining of simple cables inhibits the distributed leakage of interference to a considerable extent. Earthing straps have considerably better high-frequency characteristics and should therefore definitely be used.

Shielding

A significant source of interference results from magnetic or electrical interaction. Interactions can be avoided by adequate shielding and spatial separation. This means that it is a requirement that potentially interfering components (e.g. power supply and motor cables, contactors, frequency converters, etc.) are installed isolated or shielded from components with low signal-to-interference ratios (e.g. signal circuitry, electronic controls).

This systematic spatial separation of potential sources of interference and interference troughs as early as the planning phase of a system is the cheapest way to maximize the interference immunity of the system.

Deployment of transformers with shielded coils is preferred, as these produce very good damping of the interference in the higher voltage level.

Twisting

Mainly in the data lines, but also in the power supply lines, the technique of twisting in pairs is used. The close intermingling of the wires means that interference voltages caused by interaction between the wires cannot occur.

It is important that the twisted cable consists of a two-way line, i.e. that the flowing currents add up to zero. This is the case with many data interchange processes, but also as a rule with power supplies.

Parallel laying of data lines and power cables with interference

A close parallel installation of data lines or input/output lines and interfering cables such as motor cables or leads to contactors with poor interference suppression must be avoided. The smaller the spacing between the parallel installed cables, the greater the interacting interference.

In cable ducts and switch cabinets, cables and data lines must be arranged at the greatest possible distance to one another, spacing of at least 10 cm and preferably in separate, shielded chambers. Data lines to be crossed by power lines at an angle of 90°.

Interference suppression of inductive loads

In general, most control outputs limit inductive deactivation peaks to a level that causes no problems by means of built-in terminal diodes. This also applies to the output modules described.

However, the occurrence of a cable break, pulling put a connector for inductive load, e.g. valves, lamps or contactors etc.) or the deliberate deactivation by means of a mechanical contact lead to very high interference levels which can spread in the system due to galvanic, inductive or capacitive interaction. To dampen this, a corresponding interference suppression element (freewheeling diodes, varistors, RC elements) must be fitted directly at the inductive load.

Due to their universal application, it is recommended to use bidirectional suppressor diodes. These consist either of two opposingly poled, in-line switched suppressor diodes or one poled suppressor diode with bridge rectification. Corresponding modules are commercially available.

Also suitable are varistor modules which, for example, are offered by the manufacturers of contactors for the relevant contactors.

Filters

Normally, the interference immunity of the modules is sufficient that a function is assured even in an environment with relatively strong interference. To improve the EMC properties even further, it might be necessary to implement additional filtering measures. These measures are to be examined for each individual case. Suitable filters can be selected from the wide range available.

Voltage drops

The logic supply can bridge voltage drops of up to 10 milliseconds to ensure the continuity of your operation. This means that a disruption of bus operation by brief voltage drops is unlikely. Drops in supply at outputs are not covered here. This means that, in the event of voltage drops of this kind, contactors and other actuators can be de-energized.

Falsified input data due to voltage drops are usually prevented by filters in the input circuits. The usual activation times are approx. 3 ms. If longer interruptions in the power supply occur, suitable measures must be initiated. For example, magnetic voltage stabilizers can be used on the AC voltage side or stand-by batteries or support capacitors on the DC voltage side.

Notes:

A Appendix

A.1 Abbreviations

Abbreviation	Description
AC	alternating current
AO	analog output
CAN	Controller Area Network
Cu	copper
DC	direct current
Dev	DeviceNet
DI	digital input
DO	digital output
DP	PROFIBUS-DP
DIP	Dual Inline Package
EGB	electrostatically endangered components!
EMC	electromagnetic compatibility
ESD	Electro-Static Discharge Abbreviation for all terms relating to electro-static discharge, e.g. ESD protection, ESD hazards, etc.
GND	ground
GSD	device master data
I	current
IBS	InterBus-S
LED	light emitting diode, i.e. status indicator
LSB	least significant bit
M	modular
MSB	most significant bit
PE	Protective Earth
PDO	process data object
PLC	Programmable Logic Control
R	relay
RV	Patching distribution frame
S	switch
T	temperature
U	voltage

A.2 Index

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1070 072 259-102 (02.03) GB · **HB IN** · BRC/EPY · Printed in Germany