B~IO

IO-BOX32
Module Description

Version 101

BOSCH
Automation

B~IO

IO-BOX32
Module Description

1070 072 302-101 (01.06) GB

Table of contents

1 Safety Instructions

Before you start working with the IO-BOX32, we recommend that you thoroughly familiarize yourself with the contents of this manual. Keep this manual in a place where it is always accessible to all users.

1.1 Intended use

This instruction manual presents a comprehensive set of instructions and information required for the standard operation of the described products. The described products serve as decentralised input/output assemblies on the CANopen bus and PROFIBUS-DP.

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.

☞ **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 and project engineers who equip the machines and units with PLC as well as at skilled electrical technicians who install and put the machines into operation. They require special knowledge of PLC, the CANopen bus and the PROFIBUS-DP.

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 devices (ESD)!

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

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 sensitive devices (ESD)!

- The personnel responsible for storage, transport and handling must be trained in ESD protection.
- ESDs must be stored and transported in dedicated protective packaging.
- Out of principle, ESDs may be handled only at special ESD work stations equipped for this particular purpose.
- Personnel, work surfaces and all devices and tools that could come into contact with ESDs 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.
- ESDs 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 ESDs 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

Relevant documentation

The present manual provides the user with comprehensive information about operation and installation of the IO-BOX32.
However, generally applicable processes for project engineering and installation of the CANopen bus systems and the PROFIBUS-DP have been excluded from this manual.

Trademarks

All trademarks referring to software that is installed on Bosch products when shipped from the factory represent the property of their respective owners.

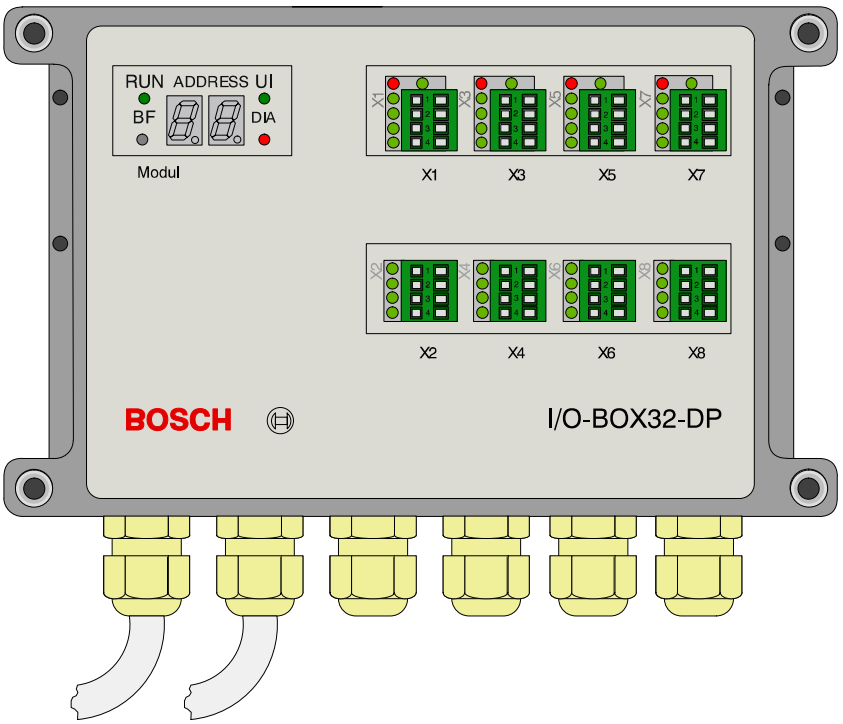
At the time of shipment from the factory, all installed software is protected by copyright. Software may therefore be duplicated only with the prior permission of the respective manufacturer or copyright owner.

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

2 System introduction

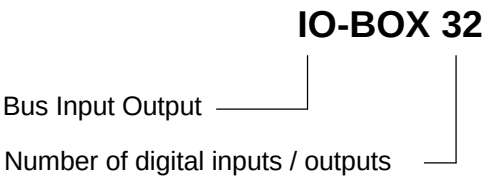
The IO-BOX32 is a decentralised input / output device for the field buses PROFIBUS-DP and CANopen and it provides 32 inputs/outputs per 0.5 A. The device has IP65 protection.

In conjunction with a corresponding bus master circuit, the assembly can be used as a decentralised peripheral.



2.1 Designation

The designation of the devices consists of the following:



2.2 System description

A number of IO-BOX32s can be connected as slaves to PROFIBUS-DP and/or CANopen. The sensors and actuators are connected directly to the relevant connections on the IO-BOX32.

The IO-BOX32 offers the following advantages:

- It can be connected to a wide variety of control systems and
- is in permanent contact with the higher level control system via the PROFIBUS-DP or CANopen, as the case may be.
- The spatial separation of the control system and machine and/or its assemblies enables a clearly laid out system structure.
- The wiring overhead between control system and machine is reduced.
- Simple connection of sensors and actuators with 2-/3-/4-wire connections without intermediate terminals.
- The IO-BOX32 provides 24 V for sensors.
- The IO-BOX32 processes the input signals, e.g. from switches, light barriers, sensors.
- It controls the connected small consumers, e.g. valves, lamps and contactors.
- Extensions can be retrofitted with low overhead.
- Space savings in the switching cabinet due to direct installation at the machine.
- Savings of input and output assemblies in the control system.
- Fault diagnosis is simplified.
- Separate switching of loads is possible.

2.3 Structure

The IO-BOX32 has a die-cast housing. The housing cover has two windows through which the bus address as well as the status LEDs can be read.

All bus and supply cables are led in via metric screw cable fastenings and connected to spring terminals.

The distribution of the 32 IO terminals as inputs and outputs can be chosen in steps:

- 0 digital inputs and 32 digital outputs
- 8 digital inputs and 24 digital outputs
- 16 digital inputs and 16 digital outputs
- 24 digital inputs and 8 digital outputs
- 32 digital inputs and 0 digital outputs

2.4 GSD and EDS files

To map the slave connections, the master uses description files:

- In the case of PROFIBUS-DP : device master data,
  GSD file (German)
  ESD file (English)
- In the case of CANopen : Electronic Data Sheet,
  EDS file

The relevant file can be taken from CD-ROM ”PLC-Tools” (Order number 1070 084 000) or downloaded from the Internet: **http://www.bosch.de/at.** Alternatively, a floppy disk with all Bosch device master data can be ordered (Order number, see section 9.2).

Notes:

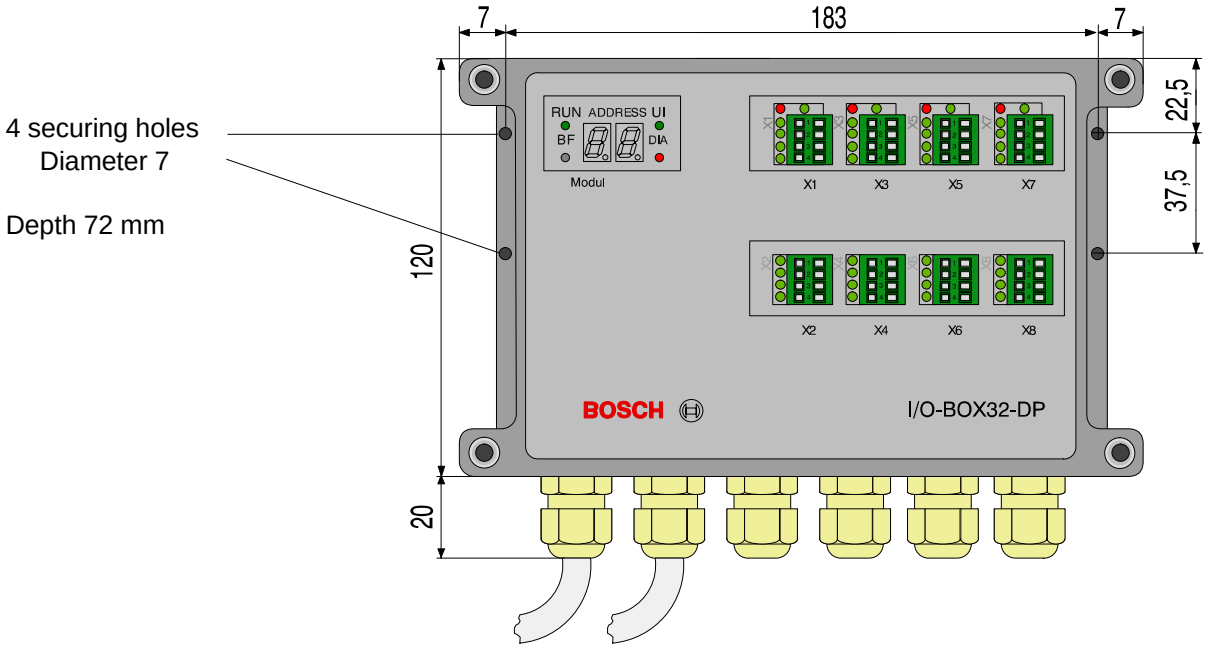
3 Installation of the IO-BOX32

3.1 Installation positions and distances

Installation position

In general, any desired installation position is possible. The IO-BOX32 is attached directly to the machine using 2 to 4 M6 screws.

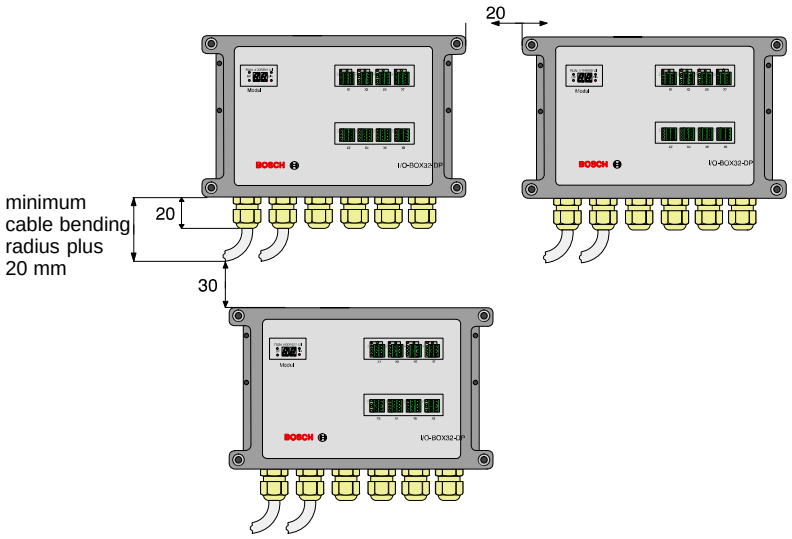
☞ **The earth contact must be a screwed connection to the housing.**



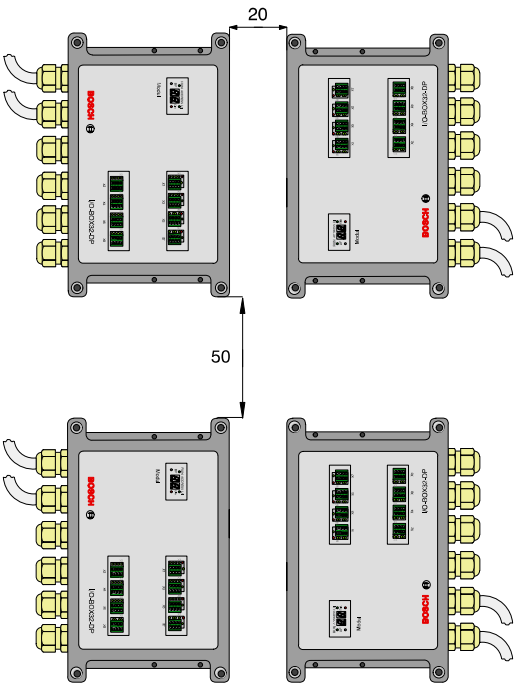
Minimum spacing

The following minimum spacing must be adhered to due to heat:

- Horizontal installation



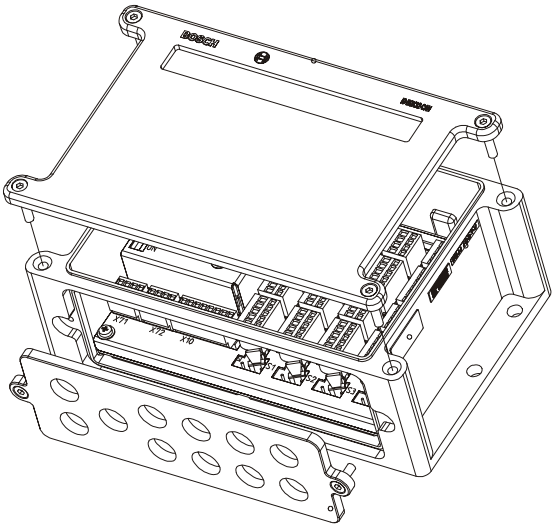
- Vertical installation

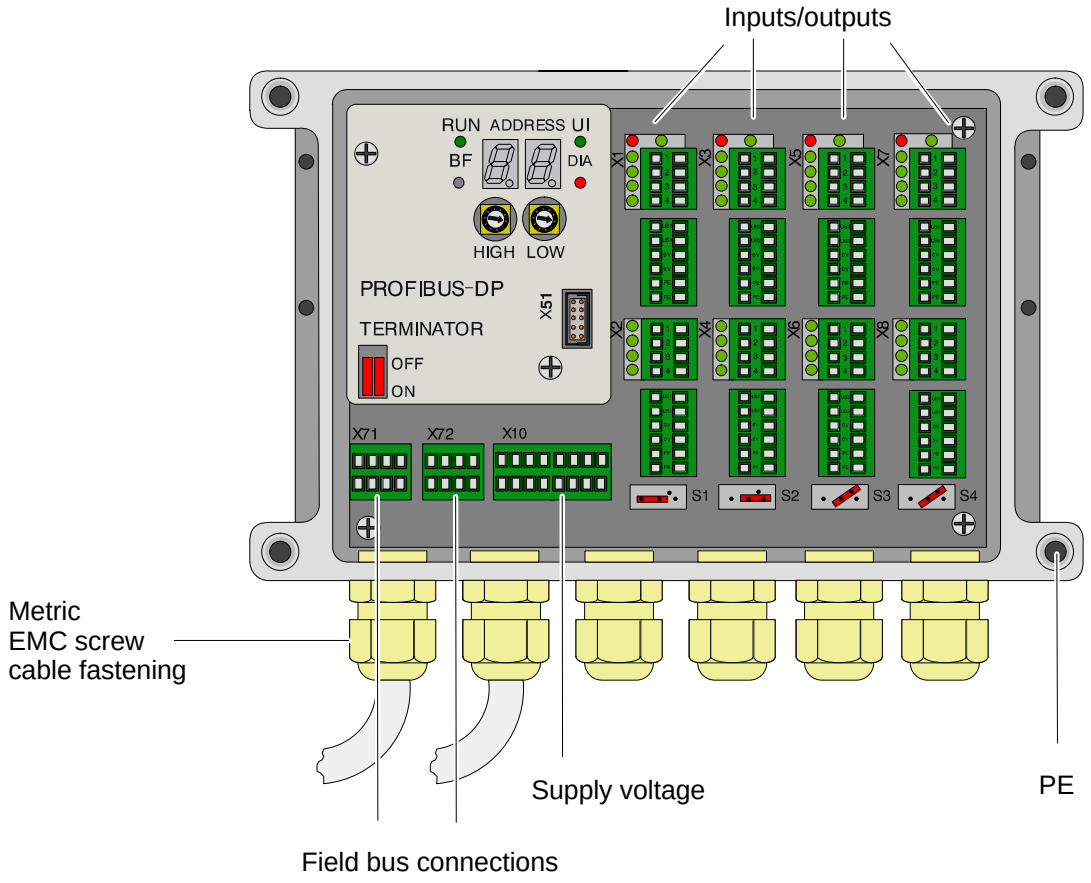


4 Connection

4.1 Overview of connections

All connections of the IO-BOX32 can be plugged in socket terminal strips (grid 3.5 mm). The cover must be opened to enable connection.

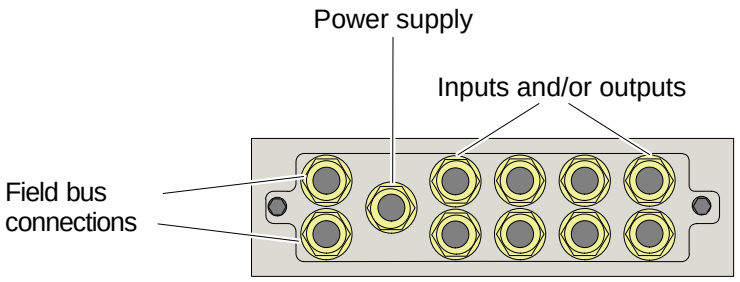




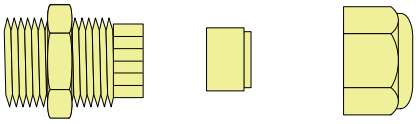
Connector	Connection allocation
X51	Bootstrap connector for loading firmware
X1 to X8	Spring terminals each for 4 digital inputs/outputs with 6-pin terminal for supply
X10	Spring terminal (8-pin) for 24-V voltage supply
X71	Spring terminal (4-pin) for field bus (incoming)
X72	Spring terminal (4-pin) for field bus (outgoing)

Screw cable fastening

All cables are fed through a removeable inlet plate on the underside of the housing. This makes it relatively simple to replace the IO-BOX32. Tight sealing is ensured by metric screw cable fastenings.



Function	Size	Number
Field bus connections	16 mm (resistant to EM interference)	2
Power supply	16 mm	1
I/O	16 mm	8



★ Strip cables.

★ Push cables through all three parts until the cladding on part 3 protrudes by around 3 mm.

★ Connect cables to spring terminals of the socket terminal strips.

★ Close screw fastenings that are not required with dummy plugs.

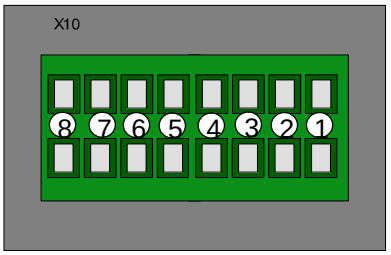
☞ **During installation, ensure there is strain relief at the socket terminal strips.**

4.2 Voltage supply

The IO-BOX32 requires a 24 V power supply. A 3-phase power connection with simple full-bridge rectification is adequate. The superimposed AC voltage proportion must not exceed 5 %. All voltages in the device are electrically coupled, reverse-connect protected and can be drawn from a power connection.

The voltage supply is separate for logic and sensors (US), outputs before EMERGENCY STOP (U1) and outputs after EMERGENCY STOP (U2)

X10



	Pin	Allocation	Current consumption
①	US	24 V logic and sensor supply	approx. 0.1 A (logic only) approx. 0.5 A (for sensor supply per input byte)
②	U1	24 V load supply 1 for outputs, e.g. before EMERGENCY STOP	8 A, no short circuit
③	U2	24 V load supply 2 for outputs, e.g. after EMERGENCY STOP	8 A, no short circuit
④	0 V	0 V for logic, inputs and outputs	
⑤	0 V	0 V for logic, inputs and outputs	
⑥	0 V	0 V for logic, inputs and outputs	
⑦	PE	Protective earth	
⑧		not used	

CAUTION
On devices with an index less than 103, even though the load supply is switched off, there is a flow of current at activated outputs of max. 5 mA if the logic supply remains active.

Possible countermeasures:

- **On switching off the load supply at U1 or U2, make the relevant connection with 0 V.**
- **Connect the relevant connection U1 or U2 permanently via 1 kΩ with 0 V.**

☞ **Information on electrical installation, see chapter 8.**

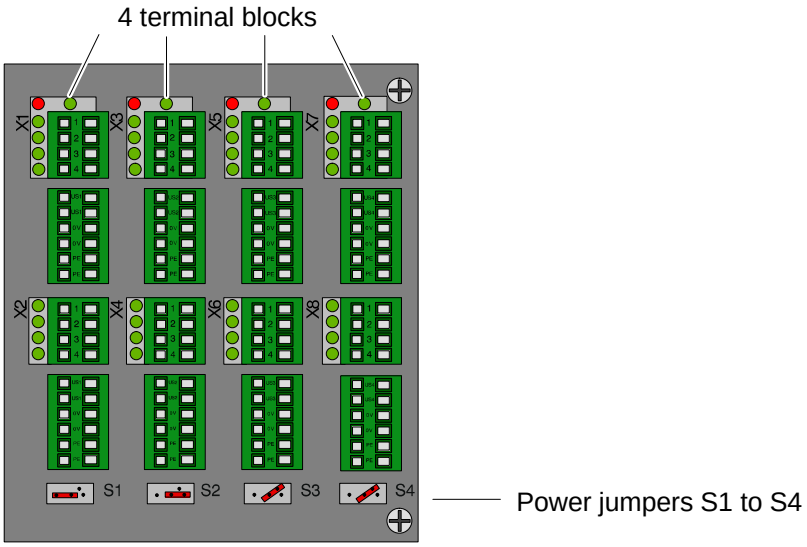
4.3 Inputs/Outputs

4.3.1 Arrangement of inputs/outputs

Power jumpers determine the arrangement in inputs/outputs per terminal block:

- 0 inputs, 32 outputs
- 8 inputs, 24 outputs
- 16 inputs, 16 outputs
- 24 inputs, 8 outputs
- 32 inputs, 0 outputs

CAUTION
It is not permitted to mix inputs and outputs within one byte.
This can lead to undefinable states on the system!

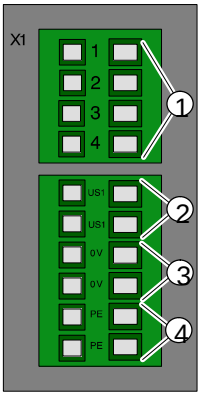


Terminal block	Power jumper	Input byte	Output byte
X1/2	S1	E0	A0
X3/4	S2	E1	A1
X5/6	S3	E2	A2
X7/8	S4	E3	A3

	Jumper setting S1 to S4	Operating mode	Load supply
	Left	Output	U2
	Right	Output	U1
Device index greater than 103 (standard)	Centre - top (factory setting)	Input	–
Device index less than 103	Open	Input	–

4.3.2 Connection

X1 to X8



	Pin	Allocation
①	1 to 4	Digital input/output of a terminal block
②	USn	Sensor supply, byte-wise (n = 1 to 4), short–circuit monitored
③	0 V	0 V for return current or sensors and/or load
④	PE	Protective earth

Connection techniques

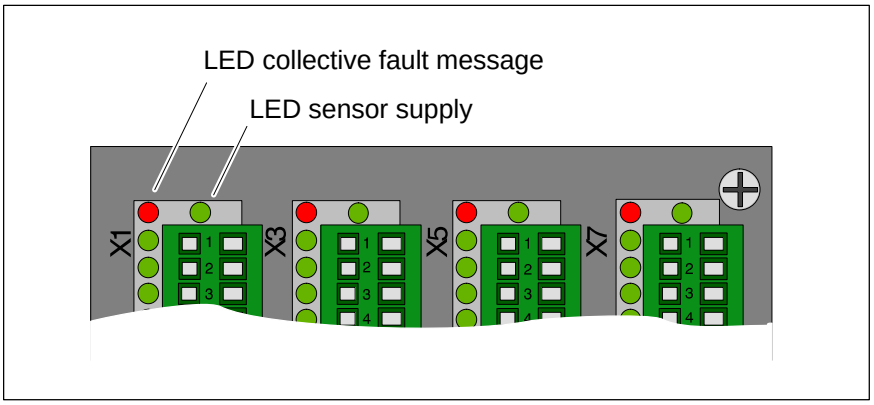
The following connection techniques are possible:

- 2-wire technology
  sensors with 24 V and signal; actuators with signal and 0 V
- 3-wire technology
  sensors with 24 V, signal and 0 V; actuators with signal, 0 V and PE
- 4-wire technology
  sensors with 24 V, signal, 0 V and PE
  (complete wiring without intermediate terminals permitted)

Outputs

- Outputs are protected against short-term polarity inversion
- Nominal current per output: maximum 0.5 A at 100 % simultaneity
- Maximum 4 outputs on one terminal can be grouped into a circuit to implement 2-A outputs. These must be activated synchronously in the PLC program
- Overload protection for each output
- Diagnosis in the case of overload (one LED per byte, messages to the master as collective diagnosis per byte)

LED display per output byte



4 x LED red Collective fault message

The LED lights up in the event of overload or short circuit in the corresponding output byte.

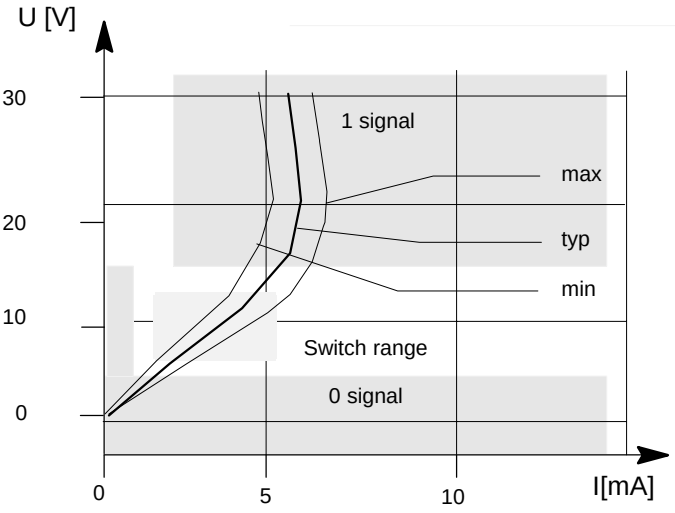
4 x LED green Sensor supply

The LED lights up when the supply for sensors in the corresponding terminal block is active. In the event of overload or short circuit, the LED goes out.

Inputs

- 2-wire proximity switches can be connected.
- Inputs are protected against polarity inversion.

Input characteristic curve



4.4 Field bus

★ Connect cable for incoming field bus via metric EMC screw cable fastening to X71.

★ Connect cable for outgoing field bus via metric EMC screw cable fastening to X72.

Assembly of the screw cable fastening

★ Strip cable, widen shield, place around shield ring and cut off protruding twisted wire.

★ Guide the stranded wires through the housing.

★ Fit shield ring, sealing ring, terminal basket and cover.

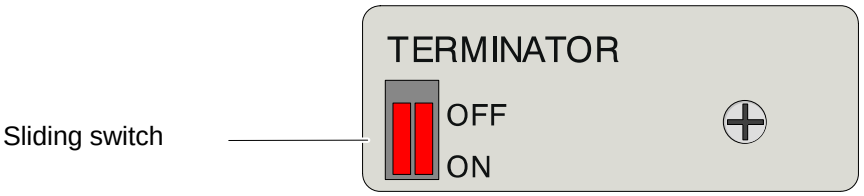
★ Turn the pressure screw to fix the cable in position. Screw on stranded wires.

★ In the case of bus terminations, close screw fastenings that are not required with dummy plugs.

☞ **On assembly, ensure that the connectors are relieved of strain from the weight of the cables.**

Bus termination

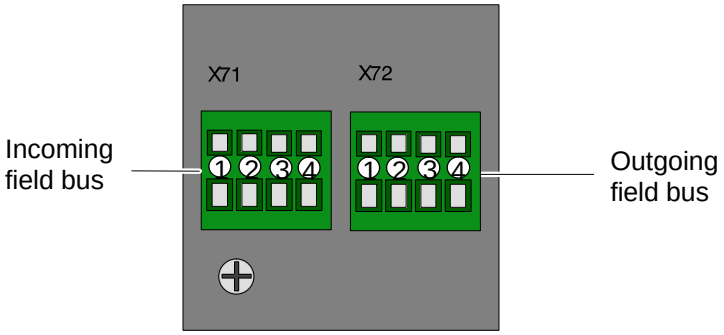
If the IO-BOX32 is the last device on the bus, the integrated bus termination must be added to the circuit by means of a sliding switch.



☞ **If the bus termination is active, X72 is switched off.**

4.4.1 Connection

X71, X72



The pin assignment is different for the PROFIBUS-DP and CANopen.

PROFIBUS-DP

	Pin	Allocation	Meaning
①	B–H	A cable	Bus cable 1
②	B–L	B cable	Bus cable 2
③	GND	ISO ground	Insulated GND of interface
④	SHL	Shield	Shielded connection ☞**Pins X71/SHL and X72/SHL are only connected to one another. They have no connection to the function earth.**

CANopen

	Pin	Allocation	Meaning
①	B–H	CAN_H	Bus cable 1
②	B–L	CAN_L	Bus cable 2
③	GND	ISO ground	Insulated GND of interface
④	SHL	Shield	Shielded connection ☞**Pins X71/SHL and X72/SHL are only connected to one another. They have no connection to the function earth**

4.4.2 Interface to the field bus

The IO-BOX32 occupies the following addresses on the field bus:

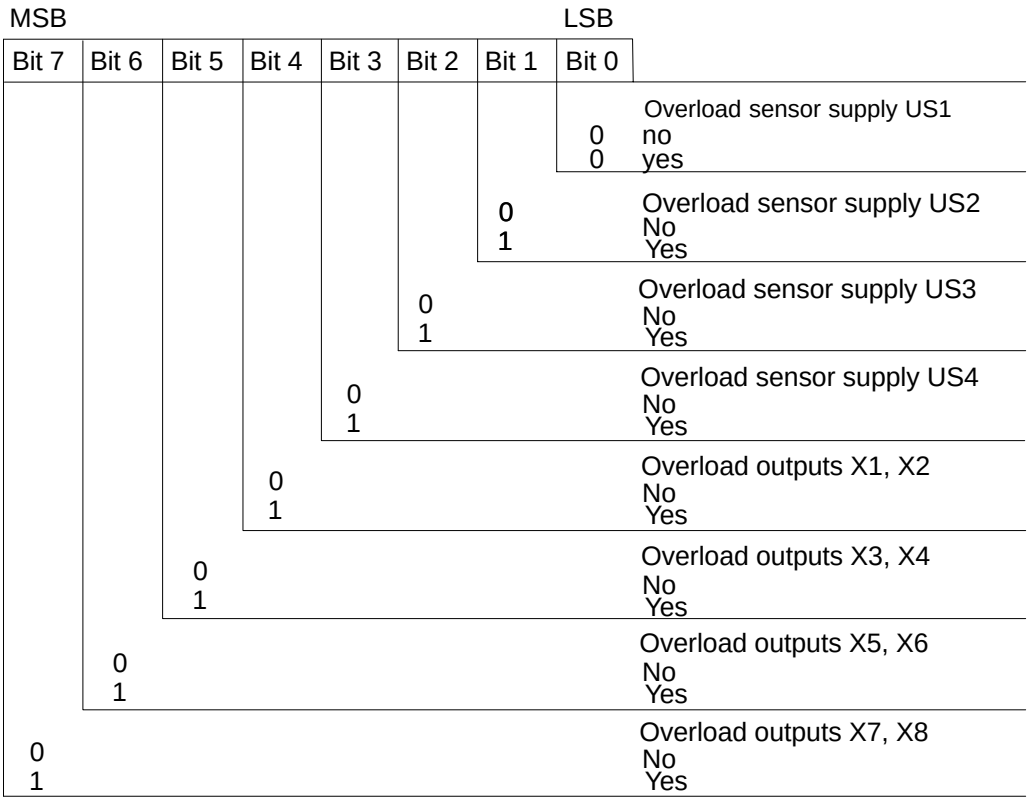
- I/O data, no diagnosis

Input field	Output field	Terminal block
E0	A0	X1, X2
E1	A1	X3, X4
E2	A2	X5, X6
E3	A3	X7, X8

- I/O data, with device diagnosis embedded in the input field

Input field	Output field	Terminal block
E0	A0	X1, X2
E1	A1	X3, X4
E2	A2	X5, X6
E3	A3	X7, X8
Device diagnosis	Blank byte	–

Coding the device diagnosis

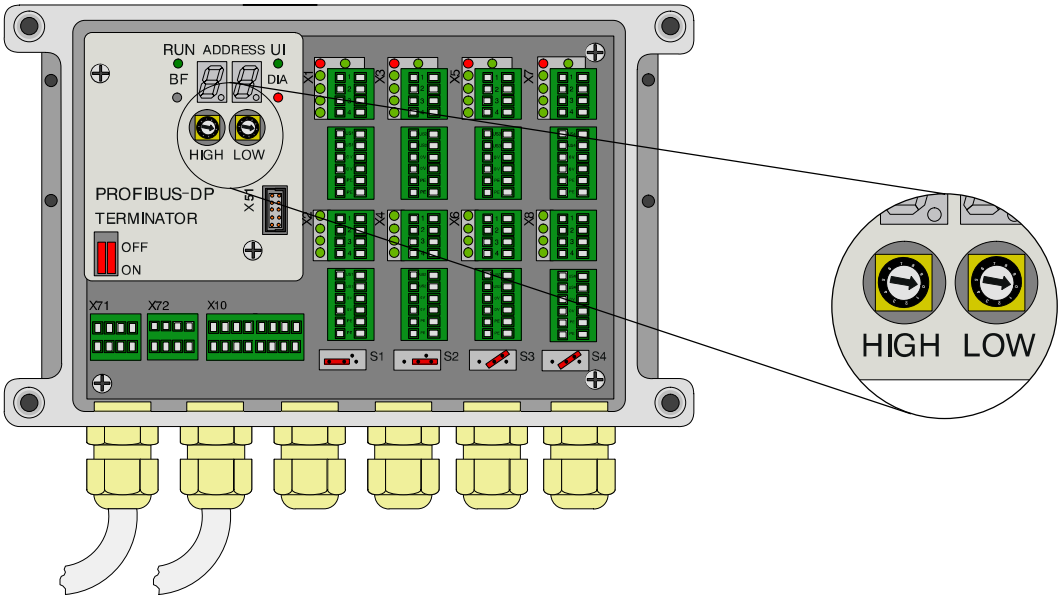


Notes:

5 Operation with PROFIBUS-DP

5.1 Rotary switch for bus address

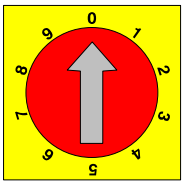
The rotary switches for setting the bus address are located beneath the housing cover.



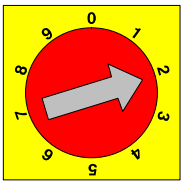
Each IO-BOX32-DP must be assigned its own bus participant address. This may only be assigned once in the entire PROFIBUS-DP. The bus participant address is set using rotary switches. Addresses 0 and 1 are reserved and therefore not permitted.

☞ **Shipped state: Address 2**

Bus address ten positions



High



Low

Bus address one position

★ Set the bus address. To do so, use a small screwdriver to turn the arrow-shaped recess into the right position. The rotary switch must click into place.

- The set bus address is shown in the 7-segment display.
- A bus address that is changed during operation only takes effect after a new 'power on'.

5.1.1 Baud rate

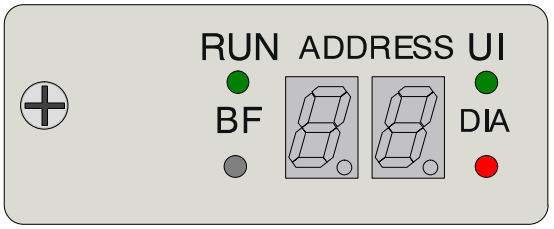
The baud rate is detected automatically at “power on”.

Supported baud rates:

12	MBaud
6	MBaud
3	MBaud
1.5	MBaud
500	kBaud
187.5	kBaud
93.75	kBaud
19.2	kBaud
9.6	kBaud

5.1.2 Displays

LED displays



Light-emitting diodes								Meaning
RUN		UI		DIA		BF		
green	off	green	off	red	off	red	off	
●								Cyclic I/O data interchange (normal operation)
	○							No connection to the DP master. Possible causes: • Bus error (see LED BF) • Incorrect bus address • Bus address has multiple assignment on bus • Activation monitoring period has elapsed • Error in the master parameter set (GSD file defective)
●	○							Configuration error
		●						24 V power supply present
			○					No 24 V power supply present
				●				Overload at an output or sensor supply
					○			No diagnosis
						●		IO-BOX32 is searching for the baud rate
							○	IO-BOX32 has detected and adopted the baud rate
						○	●	Invalid parameter data

Explanations:

○ Display does not light up

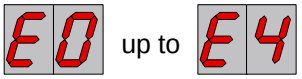
● Display lights up

○● Display flashes (0.8 s on / 0.2 s off)

7-segment displays

The 7-segment displays show:

- the set bus address
- Errors that have led to a system halt



In the case of a system halt,

- the outputs of the IO-BOX32 are place in the safe state (“0”)
- the bus traffic to the bus master is discontinued

A system halt can only be cancelled by means of “power off”. In this case, contact Bosch Service.

5.1.3 Configuring and setting parameters

A DP configuration program (DP configurator) is required for configuration and setting of parameters.

The DP configurator is used to:

- set parameters for the IO-BOX32-DP
- create the target configurations
- assign the PLC addresss to the decentralised inputs and outputs
- set the bus parameters
- display diagnosis information
- evaluate the GSD data

☞ **WinDP is used for Bosch control systems. For the operation of a DP bus master assembly from another manufacturer, the corresponding DP configuator must be used.**

Setting parameters

The parameter setting telegram of the bus master provides the IO-BOX32-DP with the data for control of the diagnosis characteristics.

The following settings can be made by the user in the DP configuration program. The states printed in bold indicate default settings.

Parameter	Status	Meaning
Status message Revison_Number	**Deactive (value 0)**	Status message Revision_Number is not transferred
	Active (value 1)	Status message Revision_Number is transferred
Diag_Data	Fixed length (value 0)	Diagnostic data are transferred with constant length
	Variable length (value 1)	Diagnostic data are transferred with variable length
Diagnosis **"**sensor supply**"**	**Deactive (value 0)**	Diagnosis **"**Short circuit monitoring of the sensor supply**"** is deactivated[1)]
	Active (value 1)	Diagnosis **"**Short circuit monitoring of the sensor supply**"** is activated
Diagnosis **"**Outputs supply**"**	**Deactive (value 0)**	Diagnosis **"**Short circuit monitoring of the outputs**"** is deactivated[1)]
	Active (value 1)	Diagnosis **"**Short circuit monitoring of the outputs**"** is activated

☞ **[1)]If the diagnosis is deactivated, only the PROFIBUS-DP-specific diagnosis messages are suppressed. The device diagnosis information embedded in the input field is transmitted (if configured).**

The following diagnosis information is delivered to the DP master if the diagnosis is enabled:

- **"**Overload sensor supply US1**"**
- **"**Overload sensor supply US2**"**
- Overload sensor supply US3**"**
- **"**Overload sensor supply US4**"**
- **"**Overload outputs X1,X2**"**
- **"**Overload outputs X3,X4**"**
- **"**Overload outputs X5,X6**"**
- **"**Overload outputs X7,X8**"**

Configuring

The DP configurator can be used to set the following I/O configurations:

Module	Inputs (bytes)	Outputs (bytes)
32DI/32DO	4	4
32DI, 8Diag/32DO, 8Dummy	4 +1 diagnosis byte	4 +1 blank byte
32DI, 8Diag/32DO	4 +1 diagnosis byte	4

Cyclical useful data interchange

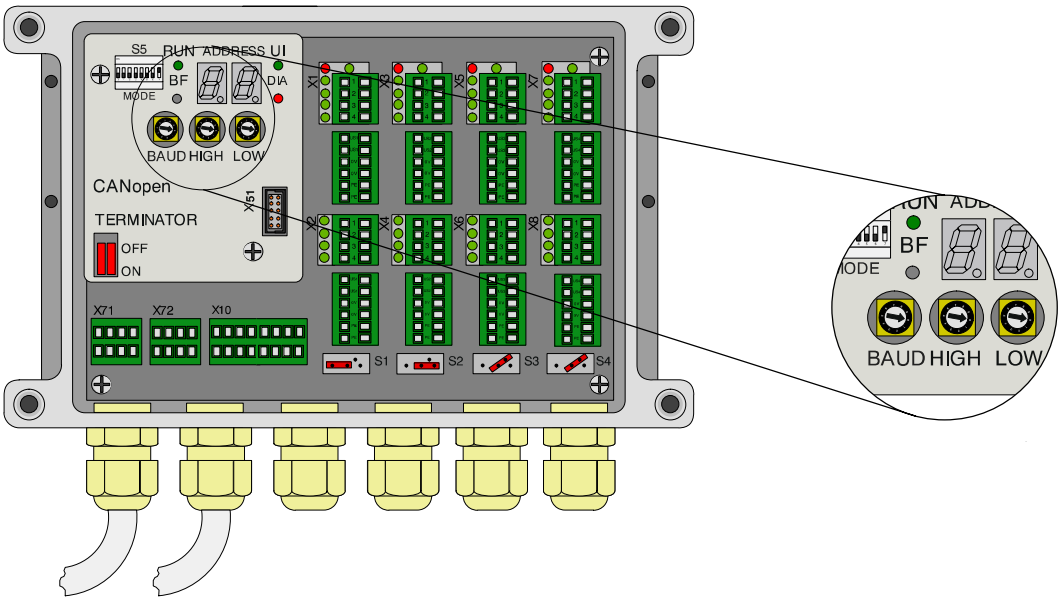
If the parameters for the IO-BOX32-DP have been set and configured without errors, the input and output data is transferred in cycles via PROFIBUS to the PLC.

The following operating modes can be enabled by the DP master during the cyclical useful data interchange:

- **SYNC mode**
  The IO-BOX32-DP works in the SYNC mode when it receives a SYNC command from the DP master. This freezes the outputs in the current state. In the subsequent useful data transmission, the output data is stored, but the output states remain unchanged. It is only when the next SYNC command has been received that the saved output data is switched through to the outputs. An UNSYNC command of the DP master terminates the SYNC mode. This enables synchronisation of the **outputs** of several DP slaves.
- **Freeze mode**
  The IO-BOX32-DP works in the Freeze mode when it receives a Freeze command from the DP master. This freezes the states of inputs in the current state. The input data is only updated again when the DP master has sent the next Freeze command. An Unfreeze command terminates the Freeze mode. This enables synchronisation of the **inputs** of several DP slaves.
- **“Fail_Safe” mode**
  The IO-BOX32-DP supports the den “Fail_Safe” mode of the PROFIBUS-DP standard. As long as the DP master keeps “Fail_Safe” active, all the outputs of the bus connection are in a safe state (’0’).
- **Diagnosis**
  Insofar as the diagnosis messages have been enabled, diagnosis information that arises is delivered to the DP master.

6 Operation with CANopen

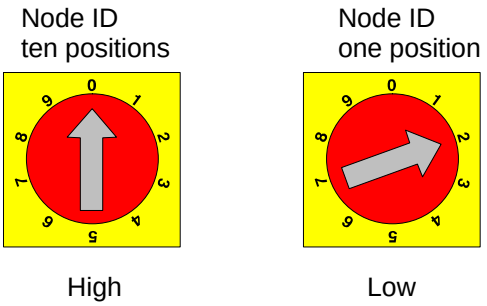
The rotary switches for setting the bus address and baud rate are located under the housing cover.



6.1 Rotary switches for node ID

Each IO-BOX32-DP must be assigned its own bus participant address (node ID). This may only be assigned once in the entire CANopen. The node ID is set using rotary switches. Node ID 0 is not permitted; this leads to a system halt.

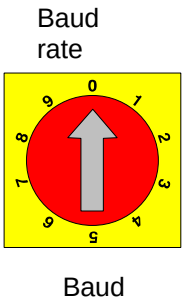
☞ **Shipped state: Address 2**



★ Set the node ID. To do so, use a small screwdriver to turn the arrow-shaped recess into the right position. The rotary switch must click into place.

- The node ID is shown in the two 7-segment displays.
- A node ID that is changed during operation only takes effect after a new 'power on', after 'NMT_Reset_Node' or after 'NMT_Reset_Communication'.

6.1.1 Rotary switch for baud rate

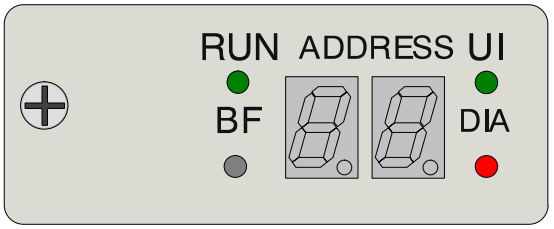


★ Select the baud rate prior to 'power on'. To do so, use a small screwdriver to turn the arrow-shaped recess into the right position. The rotary switch must click into place.

Switch position	S3 baud rate (kBaud)
0	10
1	20
2	50
3	125
4	250
5	500 (factory setting)
6	Reserved
7	1000
8	Reserved
9	Reserved

6.1.2 Displays

LED displays



Light-emitting diodes								Meaning
RUN		UI		DIA		BF		
green	off	green	off	red	off	red	off	
●								IO-BOX32 is in the Operational mode (normal mode)
	○							IO-BOX32 is in the Initialization mode
●	○							IO-BOX32 is in the Preoperational mode
		●						24 V power supply present
			○					No 24 V power supply present
				●				Overload at an output or sensor supply
					○			No diagnosis
						●		Bus off
							○	IO-BOX32 has detected and adopted the baud rate
						○	●	Invalid node ID or synchronisation error
						○	●○	Bus Warning Level exceeded

Explanations:

○ Display does not light up

● Display lights up

○● Display flashes (0.8 s on / 0.2 s off) slowly

○●○ Display flashes (0.125 s on / 0.125 s off) quickly

7-segment displays

The 7-segment displays show:

- the set bus address
- errors that have led to a system halt

E0 up to E4

In the case of a system halt,

- the outputs of the IO-BOX32 are place in the safe state (’0’)
- the bus traffic to the bus master is discontinued

A system halt can only be cancelled by means of ’power off’. In this case, contact Bosch Service.

6.1.3 Operating characteristics CANopen

The characteristics of the bus connection IO-BOX32-CAN depend on the properties of the field bus CANopen as well as on the operating parameters that can be set by the user.

PDO channels:

CAN telegrams have a maximum data capacity of 8 bytes and therefore enable per CAN node 2 channels for transmission and 2 channels for reception of PDOs (Process Data Objects).

The IO-BOX32-CAN occupies a maximum of 5 bytes inputs and/or outputs, so that 1 transmission and 1 reception PDO are sufficient.

SDO channel:

There is one SDO channel (Service Data Object) available per CAN node in transmit and receive direction.

Start-up characteristics

’**Power On’:**

After the 24-V logic supply has been applied, the hardware components of the IO-Box32 are tested:

- In the event of a fault, the assembly is placed on system halt.
- After a successful start-up test, the CAN controller is initialized in accordance with the settings of the rotary switches S1 to S3.

Preoperational Mode:

After successful initialization, the assembly is in the ’Preoperational’ mode. It can be set in the ’Operational’ mode by the CAN master by means of an ’**NMT START**’ telegram.

Operational Mode:

In the Operational mode, process data can be transferred via PDO.

Diagnosis

Diagnosis is supported and can be enabled/disabled by means of parameter bytes (2040).

Shipped state: No diagnosis

The diagnosis case is reported to the master by means of an Emergency (EMCY) telegram. The diagnostic data is stored in an SDO and can be picked up by the master.
The structure of the EMCY telegram corresponds to the specifications of the CANopen Communication Profile DS 301 V3.0.

Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	EMCY error code		Error-Reg1001h	Manufacturer-specific error field				
Error reset	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
missing RxPDO1	0x01	0xFF	ErrorReg	0x01	0x01	0x00	0x00	0x00
missing RxPDO2	0x01	0xFF	ErrorReg	0x01	0x02	0x00	0x00	0x00
missing RxPDO3	0x01	0xFF	ErrorReg	0x01	0x02	0x00	0x00	0x00
missing RxPDO4	0x00	0xFF	ErrorReg	0x01	0x04	0x00	0x00	0x00
Guarding failure	0x00	0x81	ErrorReg	0x02	0x00	0x00	0x00	0x00
BUSOFF	0x00	0x81	ErrorReg	0x00	0x00	0x00	0x00	0x00
Common Error	0x00	0x81	ErrorReg	0x00	0x00	0x00	0x00	0x00
Diagnosis	0xFF	0xFF	ErrorReg	Diag status 2020sub1	DiagData-Len 2020sub0	Diag Data0 2020sub2	0x00	0x00

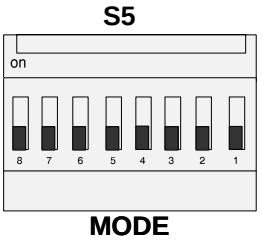
6.1.4 Setting parameters via DIP switches

The DIP switches S5.1 to S5.3 are used to:

- enable diagnosis
- set the method of transfer for the diagnostic information

The DIP switches S5.4 to S5.8 are used to set:

- the CAN operating modes



☞ **Shipped state: S5.8 to S5.1 = 00000000**

Diagnosis (S5.1...S5.3)

DIP switch	Status	Meaning
S5.1	OFF	Diagnosis message ”Overload/short circuit of a sensor supply US1–US4” disabled
	ON	Diagnosis message ”Overload/short circuit of a sensor supply US1–US4” enabled
S5.2	OFF	Diagnosis message ”Overload/short circuit outputs” disabled
	ON	Diagnosis message ”Overload/short circuit outputs” enabled
S5.3	OFF	I/O data, without embedded device diagnosis information
	ON	The byte of device diagnosis is mapped in the PDO behind the I/O data.

Operating modes (S5.4...S5.8)

S5.8	S5.7	S5.6	S5.5	S5.4	Transmission type		Input transmit characte-ristics
on	OFF	OFF	OFF	OFF	CANrho		all PDOs
OFF	ON	ON	OFF	OFF	CANopen	253 (RTR, only asynchro-nous)	
OFF	ON	OFF	OFF	OFF		SYNC 1 (cyclical synchronous)	all PDOs
OFF	OFF	ON	OFF	OFF		254 (asynchronous manufacturer-specific)	1 PDO
OFF	OFF	OFF	OFF	OFF		254 (asynchronous manufacturer-specific)	all PDOs

☞ **These settings can be changed again via the bus according to the CANopen specifications.**

CANopen:

For CANopen, 4 variants with 3 transmission types can be set:

- cyclical synchronous
- RTR (Remote Transmission Request), only asynchronous
- asynchronous manufacturer-specific
  - Transmit characteristics ’all PDOs’:
    If one or more inputs are changed, the IO-BOX32-CAN transmits the PDOs of all inputs
  - Transmit characteristics ’1 PDO’:
    If one or more inputs are changed, the IO-BOX32-CAN only transmits the PDO(s) of the inputs that have changed

The set transmission type applies to all PDOs. A PDO-related setting must by made via the bus with the corresponding CANopen service.

☞ **In synchronous mode, the Sync telegram always leads to transmission of all input PDOs.**

CANrho:

For communication characteristics conforming to CANrho, the following properties are different to those of CANopen:

- All PDOs have been set at the factory not to acyclical but to cyclical, synchronous data interchange
- The SYNC message is not set to 128, but to 100
- The switch from ’Preoperational’ into ’Operational’ status is automatic via the content of the first data byte of the SYNC message:
  - ’0’: Initialization phase
  - ’1’: Cyclical operation

6.1.5 Setting parameters via the CAN master

The Object Dictionary (OD) is used to, among other things, specify which communication objects are provided and in what way.

General OD objects

For general OD objects, the CiA DS-301 specifies the following types of entries:

Entry	Use
Constants	Information on module states, version codes, etc.
Readable entries	
Writable entries	For control and configuration of the module, deviating from the default settings. E.g. reassigning objects, changing identifiers, etc.
Readable and writable entries	

☞ **All of the values in the OD changed by the user or changed by situations during runtime are lost in the event of a power failure. After a new power on, all the objects are at their default values.**

All OD objects are described in the device master data (EDS files) in ASCII format. They can be downloaded from the Internet or ordered on CD-ROM (see page 9–1).

Manufacturer-specific OD objects

Over and above the OD objects specified by the CiA, there is an area reserved for manufacturers in which device-specific objects are entered and thus made accessible to the user:

Index (HEX)	Subindex (HEX)	Object description	see page
1002	0	**Manufacturer Status Register (MSR**) The MSR is not located in the area reserved for manufacturers; however, the coding of this object is a matter for the manufacturer.	6–10
2000	0	**Module Control Register (MCR)** Influences the characteristics in the event of an error and the input transmit characteristics.	6–10
2020		**Diagnostic Information**	6–12
	0	**Number of diagnosis entries**	
	1	**Diagnostic Status** Higher-level information on the set diagnosis. It is transmitted via the Emergency object. Additional details can be obtained via subindex 2 per SDO.	
	2	**Diagnostic Data** Detailed error information.	
2030		**Configuration Information**	6–13
	0	**Number of detected modules** always = 1	
	1	**Configuration Data** hardware coding byte	
2040		**Parameter Information**	6–13
	0	**Number of parameter data**	
	1	**Parameter Info** Enabling and disabling diagnosis.	
	2	**Device Parameter Data** as Subindex 1	

Index 1002
Subindex 0

Manufacturer Status Register (MSR)

The MSR contains status information of the IO-Box32.

Size: 1 byte

MSB							LSB	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
								Status:
					0	0	0	Initialization
					0	0	1	not used
					0	1	0	not used
					0	1	1	not used
					1	0	0	not used
					1	0	1	Preoperational
					1	1	0	Operational
					1	1	1	undefined state
								Reserved
								Error collection bit:
0								no error
1								at least one error

Index 2000
Subindex 0

Module Control Register (MCR)

The MCR can be used to change the characteristics of the IO-Box32:

- Bit 0 to bit 3 specify the characteristics in the event of an error or after receipt of an NMT service
- Bit 8 (high byte) controls the input transmit characteristics.

Size: 2 bytes

high byte		low byte								
Bits 9 to 15	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
										Module status in the event of an error
									0	preoperational (factory setting)
									1	operational
										Outputs in the event of an error
							0	0		CLAB: Outputs are disabled (factory setting)
							0	1		Last state: Outputs retain last state
										EMCY reaction
						0				Emergency object is transmitted (factory setting)
						1				Emergency object is not transmitted
										Reserved
										Input transmit characteristics
										(no relation to error!)
	0									after input change, all active PDOs are transmitted
	1									after input change, only the PDO of the changed input is transmitted (factory setting)
										Reserved

Characteristics in the event of an error:

Error	Module status	Outputs	EMCY reaction
BUS OFF The 'transmit error counter' of the CAN controller has exceeded the limit of 256.	according to MCR bit 0	according to MCR bit 2,1	according to MCR bit 3
Missing PDO (SYNC mode) Missing receive PDO in synchronous cyclical mode.	according to MCR bit 0	according to MCR bit 2,1	according to MCR bit 3
Guarding Failure Node guard monitoring period has elapsed. (Only if Node Guarding enabled by CAN master.)	according to MCR bit 0	according to MCR bit 2,1	according to MCR bit 3

Characteristics after reciept of an NMT service:

NMT service	Module status	Outputs	EMCY reaction
NMT_RESET_NODE	Preoperational	all outputs deleted	no EMCY
NMT_RESET_COM	Preoperational	according to MCR bit 2, all	no EMCY
NMT_STOP	Preoperational	according to MCR bit 2,1	no EMCY
NMT_DISCONNECT	Preoperational	according to MCR bit 2,1	no EMCY
NMT_PREOPERATIONAL	Preoperational	according to MCR bit 2,1	no EMCY

Index 2020 **Diagnostic Information**

Diagnosis information can be read via this index.

Size: 1 byte

Index 2020
Subindex 0 **Number of diagnosis entries**

Length of current diagnostic data:

1: Diagnosis active
0: Diagnosis not active.

Index 2020
Subindex 1 **Diagnostic Status**

After a change in the diagnosis, the diagnosis status is transmitted via the Emergency Object. Additional details can be obtained via subindex 2 per SDO.

00 hex: no diagnosis message present

01 hex: diagnosis message present

Index 2020
Subindex 2 **Diagnostic Data**

Diagnosis byte of the IO-Box32-CAN.

MSB							LSB	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
							0	no message
							1	Overload sensor supply US1
						0		no message
						1		Overload sensor supply US2
					0			no message
					1			Overload sensor supply US3
				0				no message
				1				Overload sensor supply US4
			0					no message
			1					Overload outputs X1, X2
		0						no message
		1						Overload outputs X3, X4
	0							no message
	1							Overload outputs X5, X6
0								no message
1								Overload outputs X7, X8

Index 2030 **Configuration Information**

Index 2030
Subindex 0

Number of detected modules

Number of modules = 1

Index 2030
Subindex 1

Configuration data

Contains the hardware code of the activated IO-Box32:

33_{hex}: 4 bytes I/O without embedded diagnosis

34_{hex}: 5 bytes I/O with embedded diagnosis

Index 2040 **Parameter Information**

This index is used to set parameters for the IO-Box32-CAN.

Index 2040
Subindex 0

Number of parameter data

Number of data = 1

Index 2040
Subindex 1

Parameter information

The set parameters can be read or new parameter data can be loaded into the B~IO67-CAN.

MSB Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB Bit 0	
								Overload sensor supply
							0	Diagnosis blocked
							1	Diagnosis enabled
								Overload outputs
						0		Diagnosis blocked
						1		Diagnosis enabled
0	0	0	0	0	0			Reserved

Index 2040
Subindex 2

Device Parameter Data

Special case, as no modules are present, corresponds to coding = 1.

6.1.6 CAN identifiers

In the shipped state, following start-up of the IO-Box32-CAN, the identifiers are set according to the specifications of the CIA DS-301 (master/slave connection set):

- the B~IO67-CAN system acts completely as a slave.
  An application master, DBT master or NMT master can use the node ID of the slave to calculate its identifier.
- no communication between slaves.

Via SDO, a DBT master can change the identifiers of the IO-BOX32-CAN in any way so that direct communication of process data is possible among slaves.

Standard identifier assignment (ID length 11 bits = range of 0 to 2047) according to specifications of the 'predef. Master/Slave Connection Set'.

hex	decimal	
0	0	NMT services
1 to 0x7F	1 to 127	reserved by CAL
0x80	128	SYNC message (CANrho mode: 0x64)
0x81 to 0xFF	129 to 255	Emergency Messages
0x100	256	Time Stamp
0x181 to 0x1FF	385 to 511	PDO1 (Transmit)
0x200	512	reserved by CAL
0x201 to 0x27F	513 to 639	PDO1 (Receive)
0x280	640	reserved by CAL
0x281 to 0x2FF	641 to 767	PDO2 (Transmit)
0x300	768	reserved by CAL
0x301 to 0x37F	769 to 895	PDO2 (Receive)
0x400 to 0x580	896 to 1408	reserved by CAL
0x581 to 0x5FF	1409 to 1535	SDO (Transmit)
0x600	1536	reserved by CAL
0x601 to 0x67F	1537 to 1663	SDO (Receive)

hex	decimal	
0x680 to 0x6E0	1664 to 1760	reserved for SDO
0x701 to 0x77F	1793 to 1919	Node Guarding
0x760 to 0x7EF	1888 to 2031	reserved for NMT
0x7F0 to 0x7FF	2032 to 2047	reserved by CAL

The identifiers of the PDO channels as well as for the SYNC object can be redefined in any way via the Object Dictionary, see section 6.1.5.

Node ID independent identifier definitions

Object	Identifier	Direction
NMT	0	Transmit/Receive
SYNC	128 (CANopen) 100 (CANrho)	Receive

Node ID dependent identifier definitions

Object	Identifier	Direction
Emergency	128 + Node ID	Transmit
NMT Node Guarding	1792 + Node ID	Transmit/Receive
SDO	1408 + Node ID	Transmit
SDO	1536 + Node ID	Receive
PDO1	384 + Node ID	Transmit
PDO2	640 + Node ID	Transmit
PDO1	512 + Node ID	Receive
PDO2	768 + Node ID	Receive

Example: Set node ID = 4

Object	Identifier	Direction
Emergency	132	Transmit
NMT Node Guarding	1796	Transmit/Receive
SDO	1412	Transmit
SDO	1540	Receive
PDO1	388	Transmit
PDO2	644	Transmit
PDO1	516	Receive
PDO2	772	Receive

☞ **The factory setting for the IO-BOX32-CAN is that only the PDO1 is assigned for transmission and reception.**

6.1.7 Range of functions

Performance/Function independent of protocol	Features	Comments
Baud rates in kBaud	10, 20, 50, 125, 250, 500, 1000	CANopen
	125, 250, 500, 1000	CANrho
Max. input data	32 bytes	max. 5 bytes used
Max. output data	32 bytes	max. 5 bytes used
Diagnosis	1 byte	
Actual config. information	no	

CANopen	Features	Comments
Asynchronous mode	yes	individually configurable for each PDO
Synchronous mode	yes	
Number SDO (transmit)	1	
Number SDO (receive)	1	
Number PDO (transmit)	maximum 4	The PDOs can be configured is any way (asynchronous, synchronous, cyclical synchronous, acyclical synchronous, etc.)
Number PDO (receive)	maximum 4	
Emergency Object	1	
Time Stamp	no	not supported
SYNC object	1	only reception is supported, not transmission
NMT Service support	• Stop Start • Disconnect • Enter Preoperational • Reset Node • Reset Communication	
Default und variables mapping	yes	
Node Guarding	yes	
Simple Boot Up	yes	
Extended Boot Up	no	
Device Profile	no	no profile supported

7 Technical data

7.1 IO-BOX32

Technical data	IO-BOX32
corresponds to the standards	• EN 61 131-2 corresponds to IEC 1131-2 • EN 61 131-2/A11 • EN 50 178 corresponds to VDE 0160 • EN 60 204-1 corresponds to VDE 0113, Part 1 • EN 50 081-2 corresponds to VDE 0839, Part 81-2 • EN 50 082-2 corresponds to VDE 0839, Part 82-2 • EN 60 529 corresponds to DIN VDE 0470-1 • EMC law of 25.09.1998 as well as revisions
Spring terminal	
Terminal range	0.08 to 1.5 mm^2
• “e” one-wire H05(07) V-U	0.5 to 1.5 mm^2
• “f” fine-wire H05(07) V-K	0.5 to 1.5 mm^2
• ”f” with wire terminating sleeve complying with DIN 46228/1	0.5 to 1.5 mm^2
• AWG conductors	28 to 16
• Insulation diameter	Diameter ≤2.9 mm
Voltage supply complying with EN 61 131-2	
• Rating	24 V DC
• permitted range	20.4 to 28.8 V DC
• superimposed AC	≤5 % absolute limits: 19.2 to 30.0 V
Current consumption from 24-V logic and sensor supply US	
• Only logic supply	approx. 0.1 A
• Sensor supply per input byte	0.5 A (no short circuit)
Current consumption from the 24-V load supply U1	8 A (no short circuit)
Current consumption from the 24-V load supply U2	8 A (no short circuit)
Reverse polarity protection	All supply voltages are reverse-connect protected
Insulation testing voltage	with measurement voltage ≤50 V
Basic insulation	• 350 VAC • 500 V DC • 500 V impulse peak 1.2/50 µs

Technical data	IO-BOX32
Temperature	
● Operation complying with EN 61 131-2	0 to 50 ˚C with a maximum average temperature of 45 ˚C over 25 hours
● Storage/Transport complying with EN 61 131-2	25 to 70 ˚C corresponds to 2K3 complying with EN 60 721-3-1 to 4
Humidity resilience	
● Operation complying with EN 50178	3K3 complying with EN 60 721-3-1 to 4 (5 % to 85 %, no dewfall)
● Storage/Transport complying with EN 50178	1K3 complying with EN 60 721-3-1 to 4 (5 % to 95 %)
Corrosion/resistance to chemicals	
● SO_2	< 0.5 ppm, relative humidity < 60 %, no dewfall
● H_2S	< 0.1 ppm, relative humidity < 60 %, no dewfall
Overvoltage category	II
Degree of contamination	
● Printed circuit boards, components	2
● Connectors to field devices	2
● for housing	3
Air gaps	
● PCBs and components on PCBs	0.20 mm
● Field connection terminals	1.60 mm, complying with EN 61 131-2
Leakage distances	
● PCBs and components on PCBs	0.04 mm (compyling with EN 50 178)
● other components	0.53 mm
● Field connection terminals	1.20 mm (complying with EN 61 131-2)
Air pressure	
● Operation complying with EN 61 131-2	up to 2000 m above sea level
● Storage/Transport complying with EN 50 178	1K4 complying with EN 60 721-3-1 to 4 (86 kPa to 106 kPa)
Hard radiation	No hard radiation present

Technical data	IO-BOX32
Radio interference suppression	Requirement from EN 50 081-2, Measurement complying with EN 55 011, class A
• Housing (radiated variables), test conditions	
• Frequency 30 to 230 MHz	Limit value 40 dB (µV/m) in 10 m
• Frequency 230 to 1000 MHz	Limit value 47 dB (µV/m) in 10 m
• Mains AC current connection	
• Frequency 0.15 to 0.5 MHz	Limit value 79 dB (µV) with Q[1)] 66 dB (µV) with M[2)]
• Frequency 0.5 to 30 MHz	Limit value 73 dB (µV) with Q[1)] 60 dB (µV) with M[2)]
	☞**[1)]Q = measurement complying with EN 55 011 with quasi peak value rectifier** **[2)]M = measurement complying with EN 55 011 with the mean value rectifier**
Conducted interference interaction	Requirement from EN 61 131-2, Measurement complying with EN 61 131–2
• Resolution	PS2
• Voltage drop for DC	≤ 10 ms
• Output voltage in the case of interruption	≥ 24 V
• Repeat rate	≥ 1 s
Burst interference interaction	Requirements from EN 50 082-2 or EN 61 131-2 Measurement complying with EN 61 000-4-4
• Transient overvoltage	2 kV with DC supplies (direct integration) 2 kV with digital I/Os (capacitive tong-test instrument) 1 kV serial interface (capacitive tong-test instrument)
1 MHz interaction	Requirement from EN 61 131-2 Measurement complying with EN 61 000-4-12
• dampened sinus 1 MHz symmetrical	1 kV for DC supplies and digital I/Os
Interaction of high-frequency voltages	Requirement from EN 50 082-2 Measurement complying with EN 61 000-4-6
• on supply lines (interaction network) • on input/output lines • shielded cables (coupling pliers)	Testing voltage: 10 V frequency band: 0.15 to 80 Mhz Modulation: 80 % amplitude modulation 1 KHz
Interaction of non-conducted interference	Requirements from EN 50 082-2 or EN 61 131-2 Measurement complying with EN 61 000-4-3

Technical data	IO-BOX32
• HF interaction on the inspection unit	Testing voltage: 10 V/M frequency band: (26 MHz) 80 MHz to 1000 MHz Modulation: 80 % amplitude modulation 1 KHz
Electrostatic discharge Discharges to metal parts (connectors, heads of screws):	Requirement from EN 50 082-2, EN 61 131-2, Measurement complying with EN 61 000-4-2
• direct and/or air discharge	ESD complying with EN 50 082–2, 4 kV
• Coupling plate	ESD complying with EN 61 131–2, 15 kV
Transport resilience	Inspection based on BOSCH standard N42 AP450. Original packaging complying with EN 61 131-2
Transport shock test	
• Duration of load	20 h
• Acceleration	10 g to 15 g Pendulum shock test: 1 impact with 800 and 1 with 1000 mm deflection on 2 side faces
Fall insensitivity	
• Fall height with original packaging complying with EN 61 131-2	1.0 m, 5 tests, Test based on EN 068-2-31
Vibration resilience	Sinusoidal oscillations in all 3 axes complying with EN 60 068-2-6
• Frequency range	10 to 75 Hz
• Continuous load	with 0.35 mm, constant amplitude
• Occasional load	with 0.7 mm, constant amplitude
• Frequency range	57 to 150Hz
• Continuous load	with 5 g, constant acceleration
• Occasional load	with 10 g, constant acceleration
Shock resilience	
• Schock resilence in all 3 axes complying with EN 60 068-2-27	11 ms semi-sinusoidal, 30 g
Protection type complying with EN 60 529	IP 65 (protection against dust and spray water)
Protection class complying with EN 50 178	1
Dimensions and weights	
• Width	197 mm
• Height	72 mm
• Depth	120 mm
• Weight with screw cable fastening	1600 g
• Weight without screw cable fastening	1300 g

7.2 PROFIBUS-DP

Technical data	PROFIBUS-DP
corresponds to standard	EN 50 170, Part 2
Potential isolation	yes, dielectric strength 500 V DC
Bus address (setting via rotary switch)	2 to 99 shipped state: 2
Baud rate (automatically detection)	9.6 kBaud 19.2 kBaud 93,75 kBaud 187,5 kBaud 500 kBaud 1.5 MBaud 3 MBaud 6 MBaud 12 MBaud
Diagnosis	yes

7.3 CANopen

Technical data	CANopen
corresponds to specifications and directives	CiA/DS 102 to CiA/DS 301
Potential isolation	yes, dielectric strength 500 V DC
Bus address (node ID) (setting via BCD rotary switch)	1 to 99 shipped state: 2
Baud rate (setting via BCD rotary switch)	• 10, 20, 50, 125, 250, 500, 1000 kBaud for CANopen • 125, 250, 500, 1000 kBaud for CANrho
DIP switch, 8-fold (shipped state: SW8 to SW1 = 00000000)	at ”power on” factory setting: • Diagnosis disabled • 4 bytes I/O (no embedded diagnosis) • CANopen • asynchronous manufacturer-specific • all PDOs
Number of participants	32
Diagnosis	yes

7.4 Inputs

Technical data	Inputs
Inputs complying with EN 61 131-2	maximum 32 digital inputs, type I
Reverse polarity protection	yes
Input voltage • Rated voltage	 24 V DC
Sensor supply US1 to US4 • Current consumption	 maximum 0.5 A
Status indicator	via LEDs
Short circuit/overload display of sensor supply	via LEDs
2-wire proximity switches • Quiescent current • Voltage drop	 <1.5 mA <8 V

7.5 Outputs

Technical data	Outputs
Outputs	maximum 32 digital outputs, return readable
Reverse polarity protection	protected against short-term polarity inversion
Output current	per output max. 0.5 A at 100 % simultaneity
Output voltage	Rating 24 V DC
Parallel switching	yes, maximum 4 outputs the outputs must be set to one terminal
Overload protection	for each output
Diagnosis in the case of overload	one LED per byte, messages to the master as collective diagnosis per byte
Status indicator	via LEDs

8 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.)!**

8.1 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%.

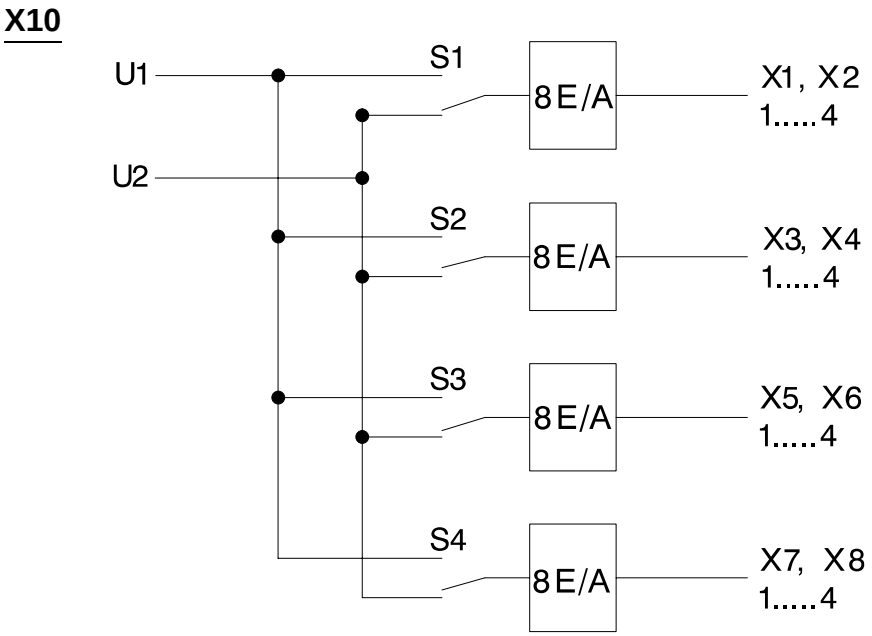
All cables of the 24 V power supply must

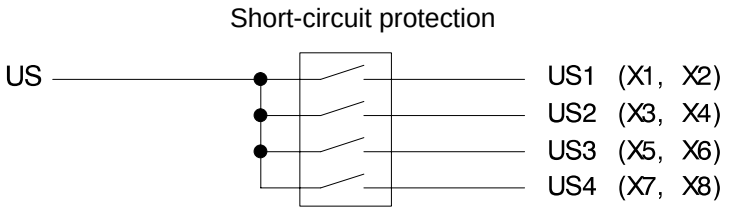
- be laid separate from cables with higher voltages or
- be specially insulated, whereby the insulation must be designed for the highest occurring voltage, see EN 60 204-1: 1997, section 14.1.3.

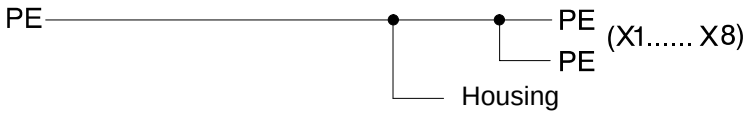
☞ **All peripheral devices such as digital sensors / actuators or other bus connections connected to the interfaces of the IO-BOX32 must also meet the criteria of safe isolation from power circuits.**

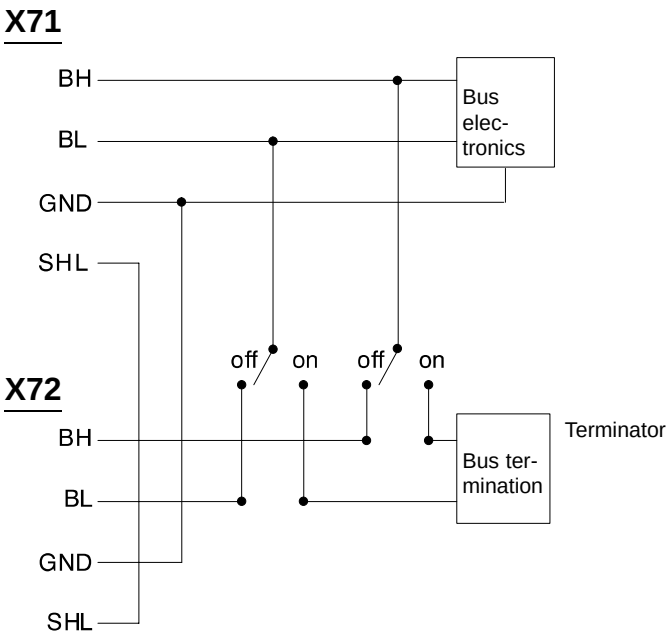
8.2 Circuit diagrams

Structure of IO-BOX32



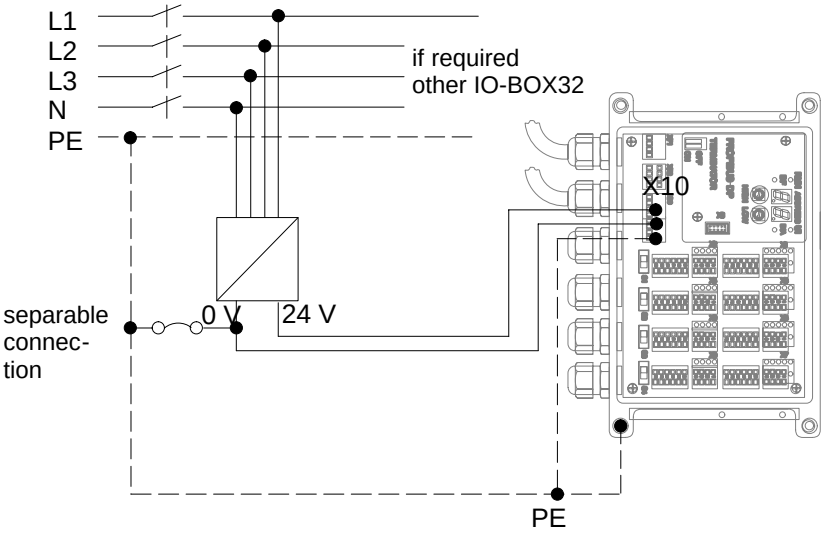






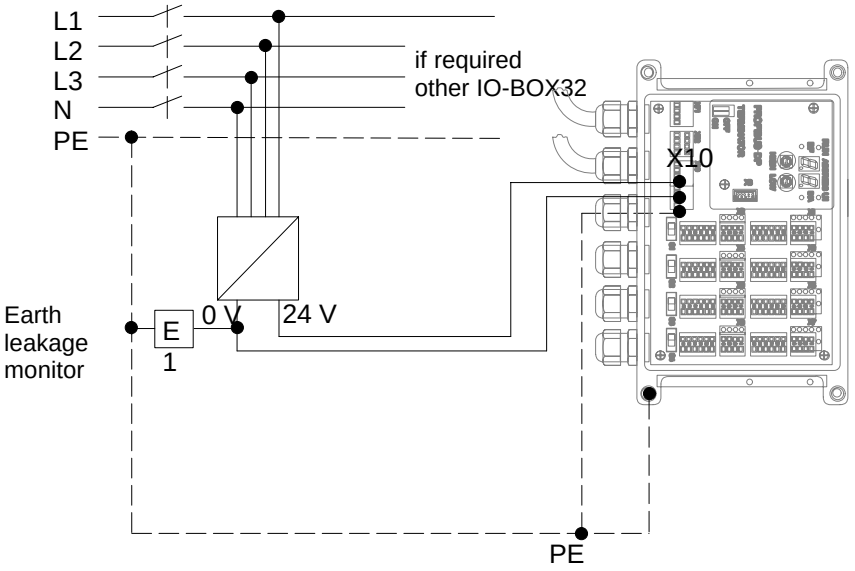
8.2.1 Reference lead connected to the protective earth

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 8.1.



8.2.2 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 8.1. Please note that other connected resources can nullify the earth–free layout.



8.2.3 Capacitive load of the power supply

Capacitances are installed in the IO-BOX32 between the power supply leads and protective earth for interference suppression. This is to be taken into account if an earth fault monitoring device is deployed.

IO-BOX32	**Capacitance against PE**
US	5 nF
U1	5 nF
U2	5 nF
0 V shared reference potential for US, U1, U2	22 nF

8.2.4 Dimensioning the voltage 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 19.2 to 30.0 V.

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 the IO-BOX32 is 1.5 mm^2.

Voltage drops

The IO-BOX32 logic supply can bridge voltage drops of up to 10 milliseconds to ensure the continuity of its operation.

8.2.5 Master switch

A master switch complying with VDE 0100 must be fitted for the IO-BOX32, sensors and actuators.

8.2.6 Fuses

Fuses and cable circuit breakers are used to protect the supply leads in a network. The cables of the power supply for the IO-BOX32 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.

8.2.7 Earthing

Connection of the protective earth PE

The earth (PE) is connected via the power supply connector to the IO-BOX32. In addition, the housing must also be connected to the PE.

Connection of the function earth PE

The function earth is connected by mounting the IO-BOX32 on a conducting base.
If the base is non-conducting, the function earth is connected to the housing by means of a screw contact.

The cable shield of the bus line is:

- connected via the EMC screw cable fastening with the housing (function earth) or
- connected via pins X71/SHL and X72/SHL, without connection to the function earth.

☞ **The second connection option should only be used in environments with low interference levels**

8.3 I/O connections

8.3.1 Outputs

Inductive loads

In general, the outputs of the IO-BOX32 limit inductive deactivation peaks to a level that causes no problems by means of built-in terminal diodes.

However, the occurrence of a cable break, pulling put a connector for inductive load, e. g. solenoid valves, contactors 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)

8.3.2 Inputs

All inputs have shared 24 V and 0 V potentials.

On the digital inputs of the IO-BOX32, all commercial available switch contacts as well as all types of three-wire sensors for an operating voltage of 24 V can be connected. Any two-wire encoder (sensor) that meets the following conditions can be connected:

- Quiescent current, low state < 1.5 mA
- Voltage drop, high state < 8 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

8.4 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).

8.4.1 General

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.

8.4.2 Interference

Possible sources of interference for the user are:

- internally 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.

8.4.3 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.

8.4.4 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.

8.4.5 EMC characteristics of IO-BOX32

The IO-BOX32 already meets the EMC requirements from the relevant standards.

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.

Test of transient overvoltages (surge)

The appendix of the technical base standard EN 50 082-2, which is 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 the IO-BOX32 can be met:

- All voltage supplies must be fitted either with external varistor modules, e. g. Weidmüller DK4U or MCZ OVP Varistor 30 V, or with overvoltage protection modules, e. e. Weidmüller RSU 24 VAC/DC.
- All digital inputs and outputs must be equipped with external varistor modules or with overvoltage protection modules.

Emissions, radio interference

IO-BOX32 meets the technical base standard EN 50 081-2 that specifies 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 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 device in a HF-sealed sleeve, e. g. a perforated plate cage or similar.
- 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, office and commercial areas or small enterprises, specific approval must be obtained from authorities or inspection bodies.

Protection against electrostatic discharges

All assemblies of the I/O system IO-BOX32 contain components that can be destroyed by electrostatic discharges (ESD = Electro-Static Discharge). 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.

8.4.6 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. B. voltage supply and motor cables, contactors, frequency rectifiers etc., must be installed separately or shielded from components with low interference voltage distance, 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. Standard bus lines are supplied with twisting.

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 reduce inductive deactivation peaks to a level that causes no problems by means of built-in terminal diodes. This also applies to the outputs of the IO-BOX32.

However, the occurrence of a cable break, pulling put a connector for inductive load, e. g. solenoid valves, 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 (free-wheeling diodes, varistors, RC elements) must be fitted 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.

Filter

Normally, the interference immunity of the IO-BOX32 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 on the market.

Voltage drops

The IO-BOX32 logic supply can bridge voltage drops of up to 10 milliseconds to ensure the continuity of its 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:

9 Ordering data and accessories

9.1 IO-BOX32

Designation	Order no.
IO-BOX-DP with PROFIBUS-DP	1070 083 818
IO-BOX-DP with CAN-Bus	1070 083 819

9.2 Accessories

Designation	Order no.
Screw cable fastening M16 (resistant to EM interference)	on request
Screw cable fastening M16	on request
Device master data (EDS/GSD files) on floppy disk	1070 075 547

☞ **The EDS/GSD files can also be downloaded from the Internet: http://www.bosch.de/at.**

Notes:

A Appendix

A.1 Abbreviations

AC	alternating current
BTN	bus participant (address)
CAN	Controller Area Network
CANopen	(open) transfer protocol on the bus of the Controller Area Network
CANrho	CANrho conforming communication characteristics on the bus of the Controller Area Network
DC	direct current
DI	Digital inputs
DIP	Dual Inline Package
DO	Digital outputs
DP	Field bus PROFIBUS-DP
EMC	Electromagnetic compatibility
GND	Ground
GSD	Device master data
I	Input
IO	Input/Output
LED	light emitting diode, i.e. status indicator
LSB	least significant bit
MSB	most significant bit
MPS	Master parameter set
O	Output
PDO	Project Data Object
RUN	Operating mode of the CAN-Bus
SDO	Service Data Object
PLC	Programmable Logic Control
U	Voltage
US	24 V logic and sensor supply

A.2 Index

Notes:

Bosch Automation Technology

Australia
Robert Bosch (Australia) Pty. Ltd.
Head Office
Cnr. Centre - McNaughton Roads
P.O. Box 66
AUS-3168 Clayton, Victoria
Fax (03) 95 41 77 03

Great Britain
Robert Bosch Limited
Automation Technology Division
Meridian South Meridian Business Park
GB-LE3 2WY Braunstone
Leicestershire
Fax (01 16) 28-9 28 78

Canada
Robert Bosch Corporation
Automation Technology Division
6811 Century Avenue
CAN-Mississauga, Ontario L5N 1R1
Fax (905) 5 42-42 81

USA
Robert Bosch Corporation
Automation Technology Division
Fluid Power Products
7505 Durand Avenue
USA-Racine, Wisconsin 53406
Fax (414) 5 54-81 03

Robert Bosch Corporation
Automation Technology Division
Factory Automation Products
816 East Third Street
USA-Buchanan, MI 49107
Fax (616) 6 95-53 63

Robert Bosch Corporation
Automation Technology Division
Industrial Electronic Products
40 Darling Drive
USA-Avon, CT 0 60 01-42 17
Fax (860) 4 09-70 80

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BOSCH

Robert Bosch GmbH
Geschäftsbereich
Automationstechnik
Antriebs- und Steuerungstechnik
Postfach 11 62
D-64701 Erbach
Fax +49 (0) 60 62 78-4 28

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