B~IO

K-CAN16DO, K-CAN32DI, K-CAN16DI/16DO
Module Description

Edition 101

BOSCH

Automation

B~IO

K-CAN16DO, K-CAN32DI, K-CAN16DI/16DO Module Description

1070 072 195-101 (00.01) GB

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1 Safety Instructions

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

1.1 Standard Operation

This instruction manual presents a comprehensive set of instructions and information required for the standard operation, i.e., “proper use” of the described products. The products described hereunder comprise decentralized input/output modules designed for use on the CANopen bus.

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 proper operation of the product are followed, there should arise no risk of danger to personnel or property.
- are certified to be in compliance with the
  - EMC Directives on electromagnetic compatibility (89/336/EEC, 93/68/EEC and 93/44/EEC)
  - EEC Directive on operation within certain voltage limits (73/23/EEC)
  - harmonized standards EN 50 081-2 and EN 50 082-2
- are designed for operation in an industrial environment (class A emissions), i.e.,
  - not directly connected to the public low-voltage power supply,
  - connected via a transformer to the medium to high-voltage network.

  The following shall apply to the operation of the described products within a private residence, in business areas, on retail premises or in small-industry settings:
  - Installation in a control cabinet and/or an enclosure providing a high screening factor.
  - All cables exiting from the screened area must be protected by suitable filtering and 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. If this is the case, the user or operator may be required to provide appropriate remedial measures at his own expense.**

The prerequisites for trouble-free service and safe operation of the product are proper transport, handling and storage, placement and installation, plus careful operation of the equipment.

1.2 Qualified Personnel

The requirements pertaining to qualified personnel are based on the job specifications as outlined by the ZVEI (central association of the electrical industry) and VDMA (association of German machine and plant builders) professional associations in Germany. Please refer to the following German-language publication:
Weiterbildung in der Automatisierungstechnik
Publisher: ZVEI und VDMA
MaschinenbauVerlag
P.O. Box 71 08 64
60498 Frankfurt / Germany

This instruction manual is designed for trained electricians familiar with the maintenance and repair of machines and systems containing Programmable Logic Controllers (PLC). However, specific PLC skills are not required.

Chapter 9 of this instruction manual also presents supplementary information for design engineers and project designers concerned with the layout and configuration of machines and systems utilizing PLC components, as well as for electrical engineers charged with installing and commissioning the referred machines and systems. Personnel thus identified requires special knowledge of PLC components and of the CANopen bus.

Interventions in the hardware and software of our products which are not described in this instruction manual may only be performed by specially trained Bosch 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 of property.

Installation and maintenance of the products described hereunder shall be the exclusive domain of trained electricians as per IEV 826-09-01 (modified), who are familiar with the contents of this instruction 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 hazards.
- 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 in this area.

Please note our comprehensive range of training courses. Our training center will be pleased to provide you with further information,
telephone: (++49) ((0)60 62) 78-258.

1.3 Safety Markings on Components

Danger: High voltage!

Danger: Battery acid!

Electrostatically sensitive devices!

Disconnect at mains before opening!

Pin for connecting PE conductor only!

Functional earthing / low noise earth

For screened conductor only!

1.4 Safety Instructions in this Manual

DANGEROUS ELECTRICAL VOLTAGE
This symbol is used to warn of the presence of a **dangerous electrical voltage**. Insufficient or lacking compliance with these instructions can result in **personal injury**.

DANGER
This symbol is used wherever insufficient or lacking compliance with instructions 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 reader to an item of special interest.

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

1.5 Safety Instructions Concerning the Described Product

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

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

DANGER
Retrofits or modifications may adversely affect 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 otherwise indicated, maintenance procedures must always be carried out with the system switched OFF! The system must be protected and secured against inadvertent restart.

In the event that measuring or testing procedures must be carried out while the system is active, these shall be performed by trained electricians.

CAUTION
Danger to the module!
Do not insert or remove the module while the controller is switched ON! This may destroy the module. Prior to inserting or removing the module, switch OFF or remove the power supply module of the controller, external power supply and signal voltage!

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 the dedicated protective packaging specified for this purpose.
- Out of principle, ESDs may only be handled 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 shall be worn. The wrist strap must be connected to the work surface via a cable with an integrated 1 MΩ resistor.
- ESDs may under no circumstances come into contact with objects susceptible to accumulating an electrostatic charge. Most items made of plastics 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, Version and Trademark

Documentation

The present instruction manual contains information about specifications, configuration procedures and operation of the B~IO K-CAN compact modules. However, the manual does not include commonly applicable project planning and installation procedures for the CANopen bus.

Overview of instruction manuals:

Instruction Manuals	Language	Part no.
Katalog, Installationstechnik	German	1070 072 462
Catalogue, Installation Engineering, Bus Systems	English	1070 072 190
Catalogo Tecnica d'installazione Sistemi Bus	Italian	1070 072 242

Trademarks

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

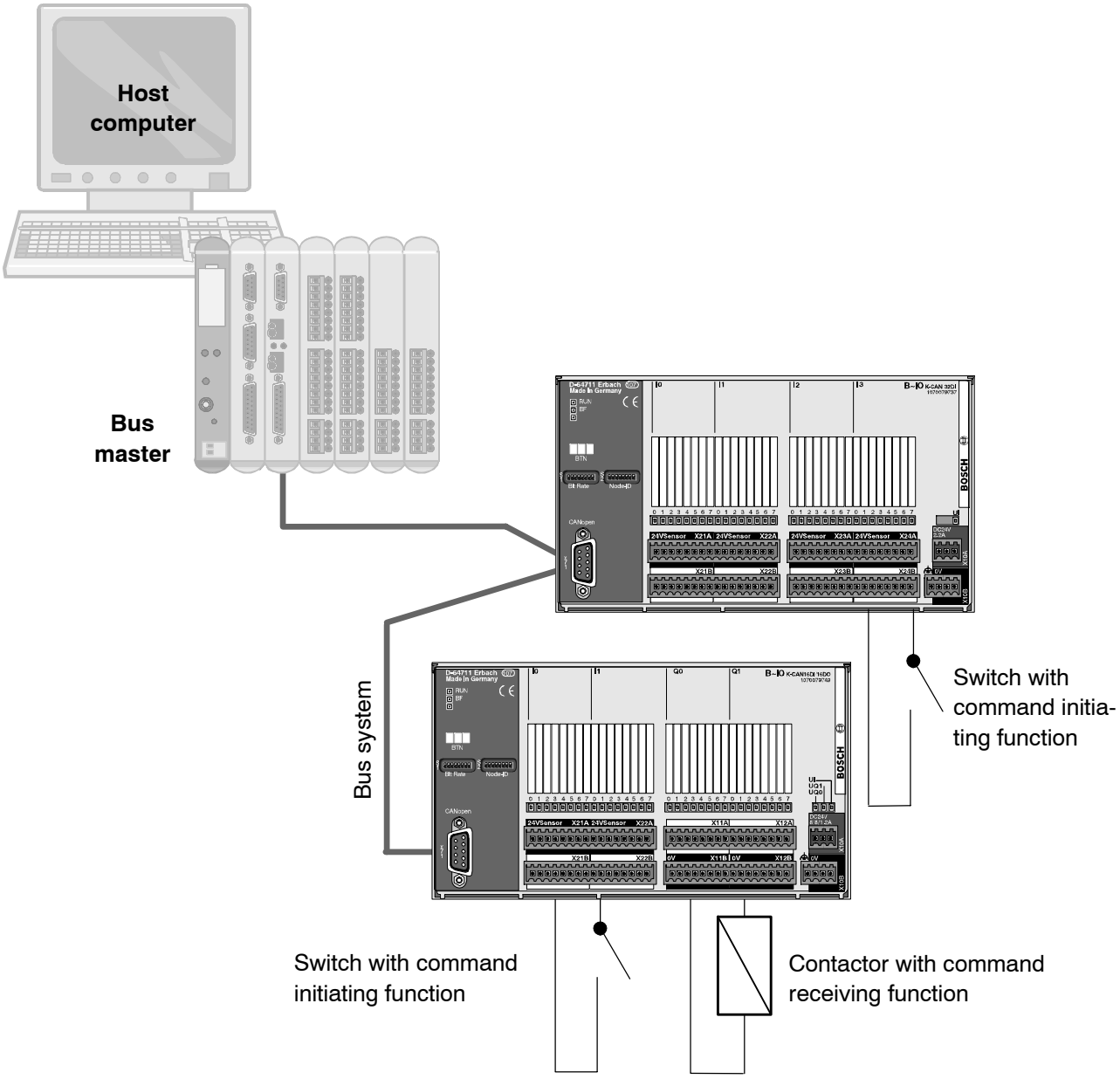
When shipped from the factory, all installed software is protected by copyright. It may therefore be duplicated only with prior permission by Bosch, or in accordance with the licensing agreements with the respective manufacturer or copyright owner.

MS-DOS® and Windows™ are registered trademarks of the Microsoft Corporation.

Notes:

2 System Overview

Die B~IO K-CAN series of hardware modules comprises a family of decentralized terminal devices (slave operation) for Programmable Logic Controllers (PLC), robot controls, or for computers assuming the function of control units. Data transfer is handled via the Controller Area Network Bus (CAN); communication is accomplished with the use of the CANopen transmission protocol. A sample application is depicted below:



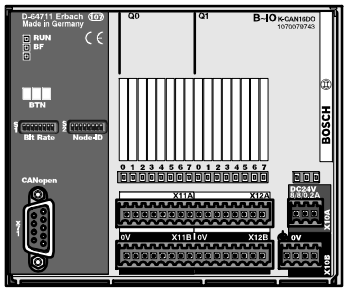
2.1 B~IO K-CAN Series Modules

K-CAN16DO

16-way output module, featuring

- 8 outputs, 0.5 A
- 4 outputs, 1 A
- 4 outputs, 2 A

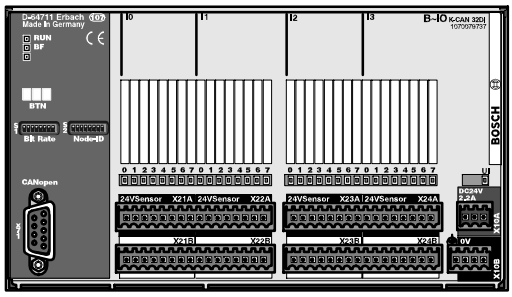
Order no.: 1070 079 743



K-CAN32DI

32-way input module, 24 V DC

Order no.: 1070 079 737

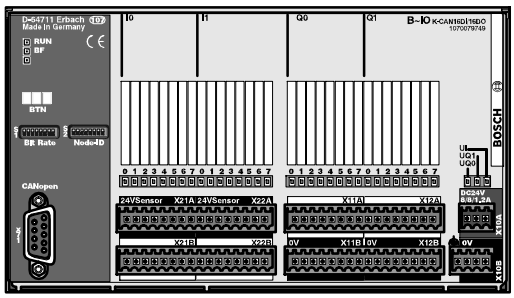


K-CAN16DI/16DO

16-way input/16-way output module, featuring

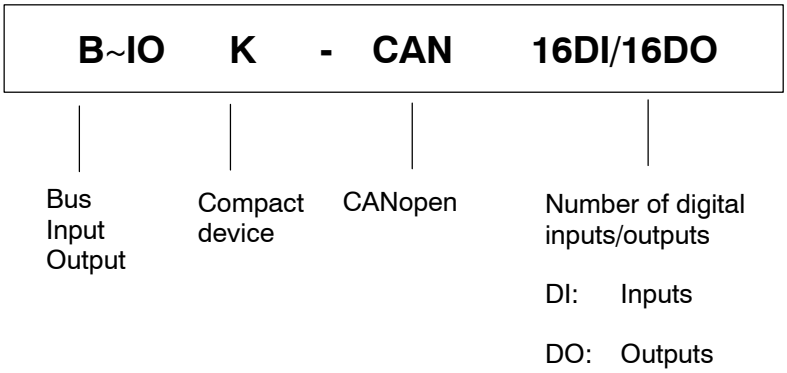
- 16 inputs, 24 V DC
- 8 outputs, 0.5 A
- 4 outputs, 1 A
- 4 outputs, 2 A

Order no.: 1070 079 749



2.2 Module Designations

The module designations are structured as follows:



2.3 Basic Functions

The controller – regardless of the system being used – must be equipped with a CANopen bus interface connection.

A single CANopen bus cable can be used to interconnect several B~IO K-CAN modules. The signal transmitters (sensors) and signal receivers (actuators) are directly connected to the respective connectors on the B~IO K-CAN modules. This means of connectivity provides the following advantages:

- Connectivity compatible with different controller systems.
- The cabling required between controller and machine is reduced.
- Defective modules can be replaced without requiring extensive rewiring.
- The spatial separation between controller and machine, and/or of their respective modules, provides for improved clarity of the system layout.
- Subsequent extensions are possible at minimal cost.
- Space savings in control cabinet.
- Reduced number of input and output modules in the controller.
- Connectivity for large number of bus stations.
- Simple connection of 2, 3, or 4-wire sensors and actuators without requiring intermediate terminals.
- Simplified error diagnostics.

The B~IO K-CAN connection module –

- maintains constant contact with the governing controller via the CANopen bus.

The input section of the compact module –

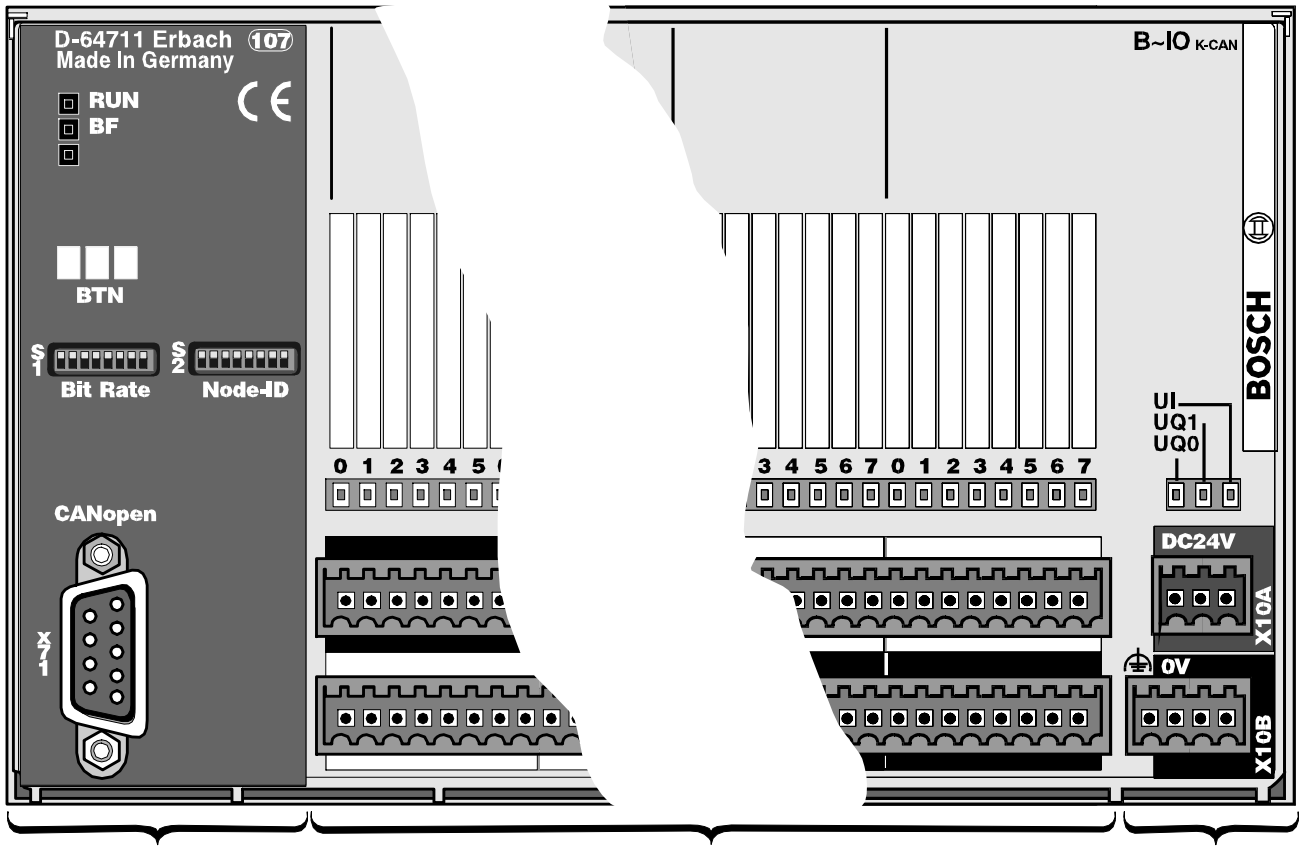
- provides 24 V DC power,
- processes the signals that are inbound from sources such as switches, light barriers, sensors, for example
- forwards the respective signals to the controller via the bus.

The output section of the compact unit –

- receives the controller output signals via the bus, and
- controls the connected small loads, such as valves, lamps, contactors, etc.

2.4 Hardware Configuration

Functional sections



The B~IO K-CAN modules comprise 3 functional sections:

- CANopen connection
- Input/Output ranges
- 24 V power supply

The 24 V power supply is described in the sections discussing the individual modules.

Accessories

- Legend labels
- Bus cables and plug connectors
- Various socket connector sets (screw and spring loaded terminals)
- Extractors for socket connectors
- Terminal blocks for connections of the 3 or 4-wire type

A complete list of spare parts and accessories appears in Chapter 8 of this manual.

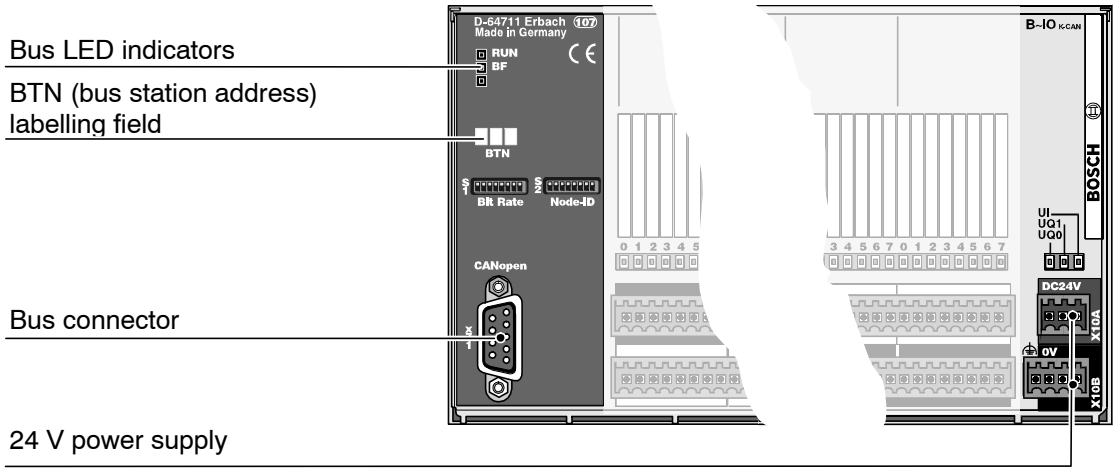
Notes:

3 Introduction & Bus Interface Connection

3.1 Hardware Configuration

The interface connection of the compact module maintains continuous contact with the governing controller via the CANopen bus.

- It receives the current switching signals at the inputs and, via the CANopen bus, directs them to the governing control unit for further processing.
- It receives the output signals of the governing control unit via the CANopen bus, and directs them to the outputs.



3.2 Connections

3.2.1 24 V Power Supply

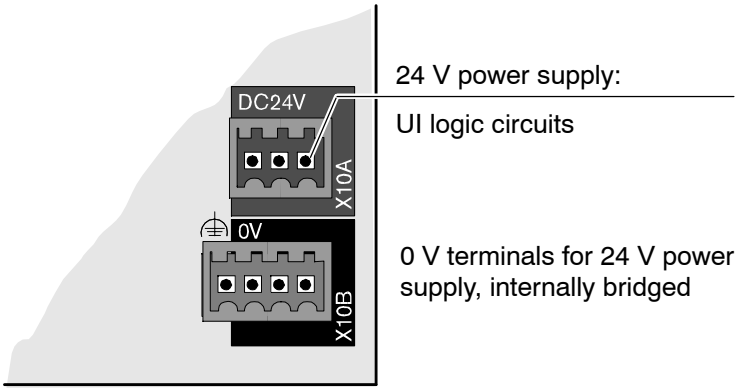
The module requires a 24 V power supply.

The 24 V power supply is used to power:

- The UI logic circuits

The CANopen bus interface is electrically isolated from the 24 V power supply for the UI.

☞ **The 24 V power supply for the UI logic is not electrically isolated from inputs and outputs.**



3.2.2 CANopen

Open System Interconnection (OSI)

The CANopen communication function model is based on the ISO/OSI Basic Reference Model.

- ISO 7498, Information Processing Systems – Open System Interconnection – Basic Reference Model, 1984

CAN

The lower layers of the Basic Reference Model are based on CAN.

- Robert Bosch GmbH, CAN Specification 2.0 Part B, September 1991
- ISO 11898, Road Vehicles, Interchange of Digital Information – Controller Area Network (CAN) for high-speed Communication, November 1993

CANopen

All CANopen requirements and guidelines are stipulated in the CiA specifications:

- CiA/DS 102, CAN Physical Layer for Industrial Applications
- CiA/DS 201, CAN Reference Model, February 1996
- CiA/DS 202-1, CMS Service Specification, February 1996
  CiA/DS 202-2, CMS Protocol Specification, February 1996
  CiA/DS 202-3, CMS Encoding Rules, February 1996
- CiA/DS 203-1, NMT Service Specification, February 1996
  CiA/DS 203-2, NMT Protocol Specification, February 1996
- CiA/DS 204-1, DBT Service Specification, February 1996
  CiA/DS 204-2, DBT Protocol Specification, February 1996
- CiA/DS 205-1, LMT Service Specification, February 1996
  CiA/DS 205-2, LMT Protocol Specification, February 1996
- CiA/DS 206, Application Specific Data Types, February 1996
- CiA/DS 207, Application Layer Naming Specification, Feb. 1996
- CiA/DS 301, CAL-based Communication Profile, Oct. 1996

3.2.3 CANopen Interface

X71 connection

The CANopen bus connection uses a female 9-pin D-SUB (DB-) connector that is secured to the male D-SUB input connector of the B~IO K-CAN module by means of threaded fasteners.

The connector pin assignment conforms to the following CANopen standards:

- CiA/DS 102, CAN Physical Layer for Industrial Applications, Feb. 1996
- CiA/DS 301, CAL-based Communication Profile, Oct. 1996.

Pin assignment

Pin no.	IN, male X71 connector	Meaning	Jacket colour
1	–	Reserved	
2	CAN_L	CAN_L bus line (dominant LOW)	brown
3	CAN_GND	CAN Ground	
4	–	Reserved	
5	CAN_SHIELD	Optional CAN Shield via RC (resistance-capacitance) circuit	
6	–	Reserved	
7	CAN_H	CAN_H bus line (dominant HIGH)	white
8	–	Reserved	
9	–	Reserved	
Housing	Shield		

☞ **Unless indicated otherwise, the CANopen bus installation guidelines and wiring recommendations shall be observed.**

Accessories

- Bus connector, without terminating resistor
- Bus connector, with terminating resistor
- Bus cable

A complete list of spare parts and accessories appears in Chapter 8 of this manual.

Baud rate and bus Node ID

The configuration settings for the B~IO K-CAN bus interface module is selected with the use of DIP switches S1 and S2. Baud rates between 10 kbaud and 1 Mbaud are supported.

- For detailed information on setting the baud rate, refer to Chapter 9.5.3.
- For detailed information on setting the Node ID, refer to Chapter 9.5.2.

3.3 Operation and Indicators

Power-On Sequence

In the event that the B~IO K-CAN module is not powered at the time the governing controller is switched on, the decentralized inputs and outputs will not be available. For this reason, the power supply for the B~IO K-CAN module should be activated prior to starting up the governing control unit.

Procedural sequence:

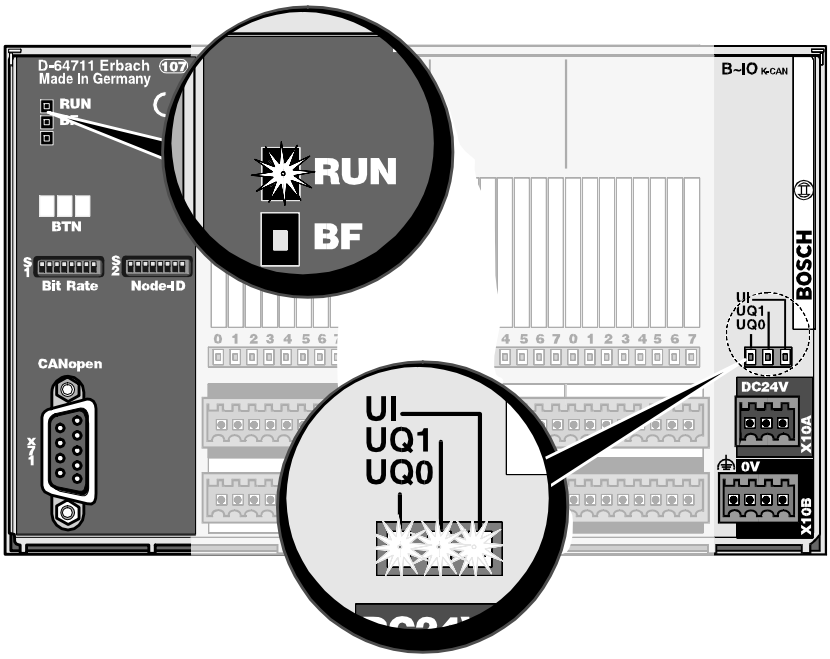
- Switch on power to the B~IO K-CAN module.
- B~IO K-CAN module maintains all outputs at 0 (LOW) state.
- B~IO K-CAN module stands by, waiting for data exchange with governing control unit.

☞ **Observe the relevant information in the operating manual supplied with the governing control unit.**

Ongoing operation

The bus connection module is activated and working properly if –

- the “UI” LED illuminates green
- the “RUN” LED illuminates green
- the “BF” LED remains dark,
- “UQ0” and “UQ1” LEDs illuminate green (output-equipped modules only)



General fault indications

Name	LED	Function
RUN	OFF	Bus connection module in Initialization Mode, bus fault.
	Green	Bus connection module in Operating Mode, incoming bus is fault-free.
BF	OFF	The bus is fully functional.
	Red	Bus fault
UI	OFF	24 V power supply to logic circuits is missing.
	Green	24 V power supply to logics circuits is OK.
	Red	For devices with inputs only: Max. total current of 24 V sensor power supply exceeded.

Fault indications on output-equipped modules

Name	LED	Function
UQ0	OFF	24 V power supply to output byte 0 is missing.
	Green	24 V power supply to output byte 0 is OK.
	Red	Overload condition on one or more outputs of output byte 0. This indication remains only as long as the overloaded output is being addressed.
UQ1	OFF	24 V power supply to output byte 1 is missing.
	Green	24 V power supply to output byte 1 is OK.
	Red	Overload condition on one or more outputs of output byte 1. This indication remains only as long as the overloaded output is being addressed.

☞ **In the event of a fault occurrence, these LED displays attain additional significance beyond that depicted above. Detailed descriptions appear in Chapter 9.6, “Indicators and Error Indications”.**

3.4 Maintenance / Inspection

The bus connection module is maintenance-free. In the event that the module housing needs to be cleaned, no solvent-based or abrasive cleaners may be used.

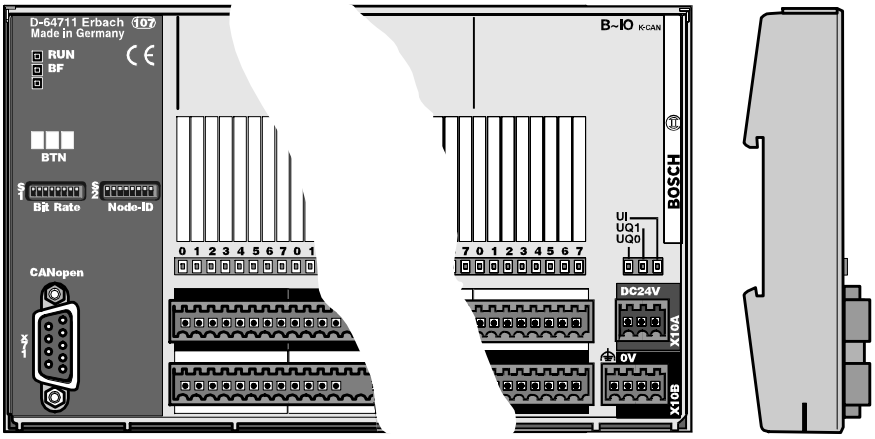
3.5 Installation

Initial Installation / Planning Phase

The information provided at this point is intended to ensure fault-free operation of the B~IO K-CAN module. However, this chapter does not furnish information for design engineers and project designers.

☞ **For more detailed information, refer to Chapter 7, “Module Specifications”, and Chapter 9, “Project Planning & Installation”. The referred chapters presuppose special knowledge with regard to PLC controllers, and to the CANopen bus.**

Attaching the module



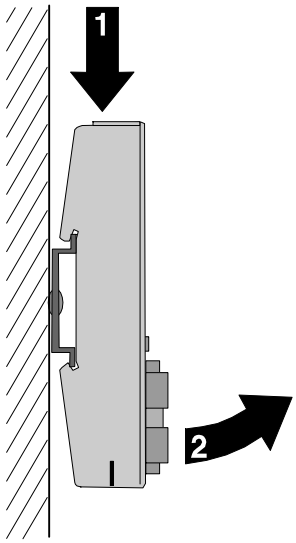
The modules are installed in the control cabinet by direct placement on a standard 35 x 7.5 mm DIN support rail, as per EN 50 022.

To facilitate installation and removal, a clearance of 20 mm should be maintained above and below the modules.

Removing the Module

☞ **Prior to removing the module, all connectors should be labelled. This will prevent accidental connector misplacement upon installation. It is also advisable to make a note of the settings of DIP switches S1 and S2.**

To remove, the module must first be pressed downward to overcome the spring pressure (1). This facilitates unsnapping the lower enclosure claw, and the subsequent removal of the module from the DIN rail, by swinging the unit out at the bottom while lifting in an upward arc (2).



Installation

To install, the module is first hung over the upper lip of the support rail, and then snapped into place while exerting downward pressure. The spring action at the rear of the module housing will exert slight upward pressure, causing the module to lock securely into place.

☞ **Without exception, the routing of all connected cables must provide a measure of strain relief (e.g., cable channel).**

Node ID (bus station address)

The Node ID (bus station address) of the B~IO K-CAN compact module is selected on DIP switch S2. Addresses between 1 and 127 are available. Throughout the entire CANopen bus, each address may be assigned only once.

☞ **The address 0 (zero) may not be used as a Node ID. This would cause a system HALT.**

☞ **It is recommended to write the selected Node ID into the BTN labelling field. In the event that a compact module is replaced, the existing settings must be transferred to the new unit.**

S1 DIP switch

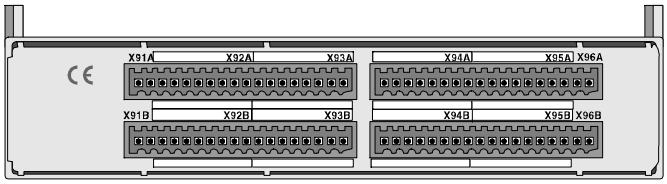
The transmission protocol and baud rate for the B~IO K-CAN module are selected by means of the S1 DIP switch.

Switch							
8	7	6	5	4	3	2	1
Protocol	reserved for Bosch				Baud rate		

☞ **Factory setting when shipped: 1 Mbaud, CANopen protocol. In the event that a compact module is replaced, the existing settings must be transferred to the new unit.**

3 or 4-wire Connections

To facilitate the connection of 3 or 4-wire sensors, terminal blocks are available as optional accessories. The referred terminal blocks consist of a housing and 2 or 4 in-line contact strips containing 18 bridged connectors each. The terminal block is inserted into the module from below, and pushed upward until it snaps into place. When fully seated, it extends the vertical dimension of the module downward by 40 mm. An additional earthing connection is not required.



Accessories

- Identification labels
- Extractors for socket connectors
- Terminal blocks providing extensions for 3 or 4-wire type connections

A complete list of spare parts and accessories appears in Chapter 8 of this manual.

Notes:

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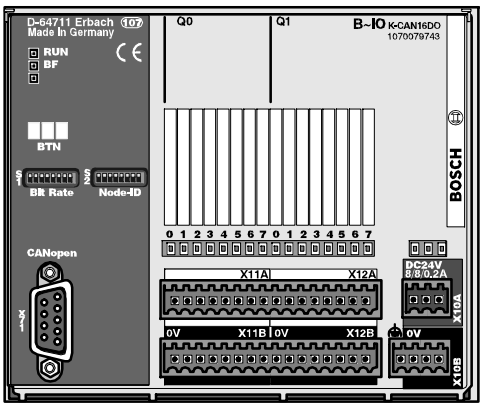


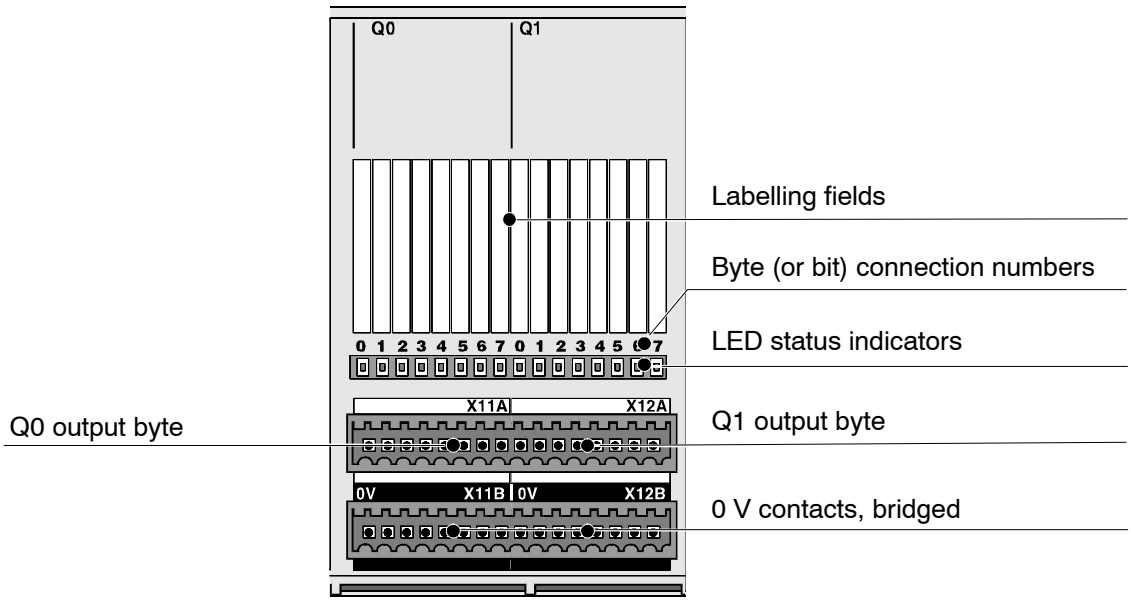
4.1 Hardware Configuration

The bus connection module controls the 16 digital semiconductor outputs. These 24 V outputs are non-latching.

- In the event of a failure of either the UQ0 or UQ1 power supply for the output bytes, the output signal will be reset, and the bus master will not receive an error message. During a restart, and dependent on the incoming signals from the governing control unit, the outputs are again automatically set.
- In the event of a failure of the UI power supply of the bus connection module, the entire bus function will be interrupted.

The following outputs are provided for actuators or small loads (such as valves, lamps, contactors, etc.):

- 8 outputs, 0.5 A
- 4 outputs, 1 A
- 4 outputs, 2 A



4.2 Connectors

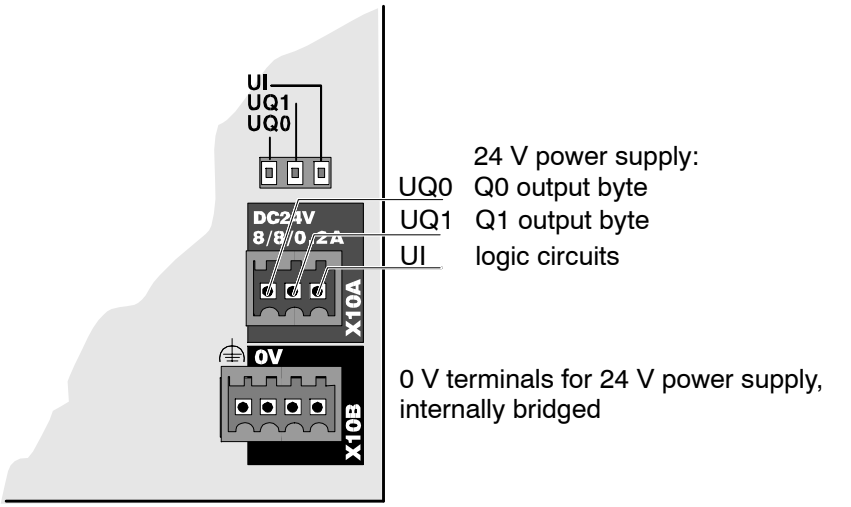
4.2.1 24 V Power Supply

The module requires a 24 V power supply for the following:

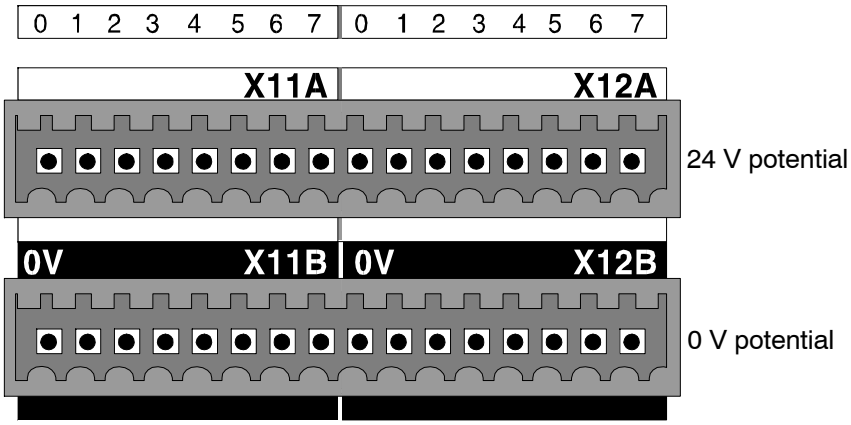
- UI logic circuits
- UQ0, output byte Q0
- UQ1, output byte Q1

The CANopen bus interface is electrically isolated from the 24 V power supply for the UI.

☞ **The 24 V power supply for the UI logic is not electrically isolated from inputs and outputs.**



4.2.2 Outputs



The following applies to output bytes Q0 and Q1:

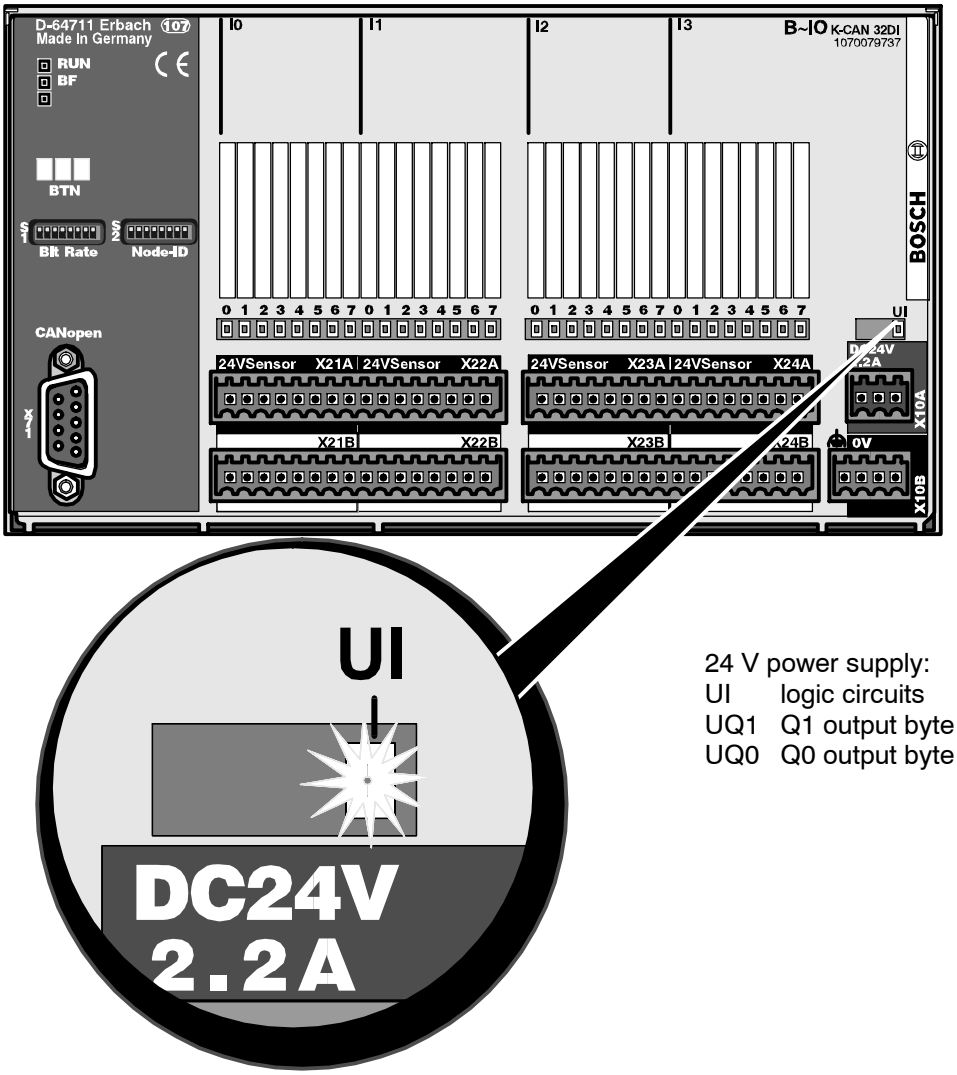
- 0.5 A outputs, bits 0 through 3
- 1 A outputs, bits 4 and 5
- 2 A outputs, bits 6 and 7

All 0 V potentials required for two-wire load connections are interconnected on the module.

The LED status indicator illuminates green when the output is active on the load side.

4.3 Functions and Indicators

The outputs are addressed via the bus connection module of the CANopen bus.

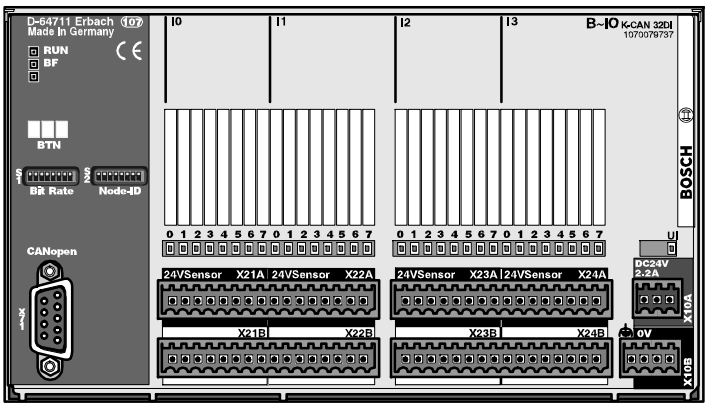


24 V power supply:
UI logic circuits
UQ1 Q1 output byte
UQ0 Q0 output byte

The module is active when the “RUN”, “UI”, “UQ0” and “UQ1” LEDs illuminate green.

☞ **For information on fault indications, refer to Chapter 3.3, “Operation and Indicators”.**

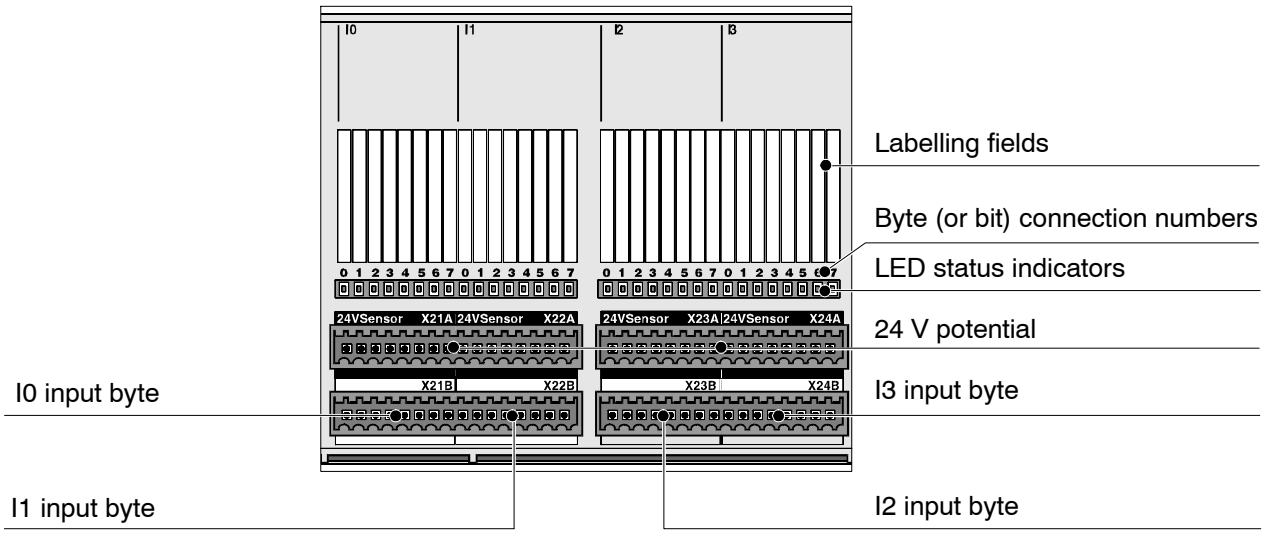
5 K-CAN32DI



5.1 Hardware Configuration

The module provides 32 inputs for sensors (switches, light barriers, induction-type pulse generators, etc.). The bus connection module receives the switching signals from the referred semiconductor inputs, and directs them via the bus to the governing controller for further processing.

In the event of a failure of the UI power supply of the bus connection module, the entire bus function will be interrupted.



5.2 Connectors

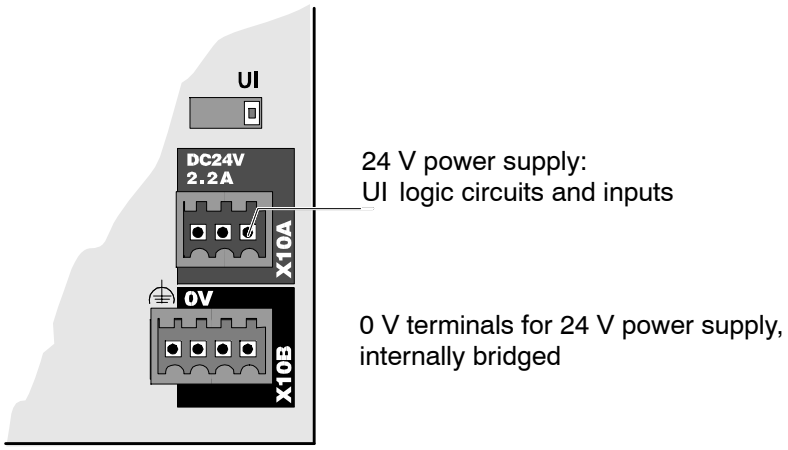
5.2.1 24 V Power Supply

The module requires a 24 V power supply for the following:

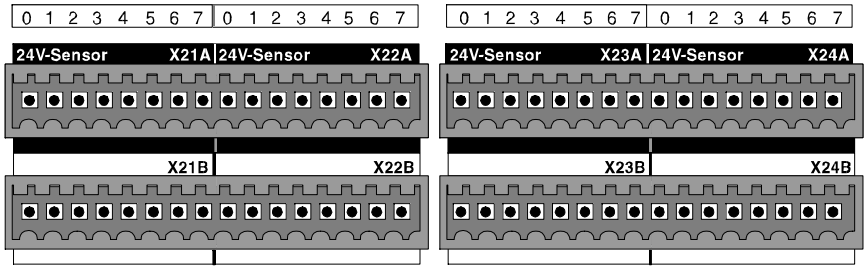
- UI logic circuits and inputs

The CANopen bus interface is electrically isolated from the 24 V power supply for the UI.

☞ **The 24 V power supply for the UI logic is not electrically isolated from inputs and outputs.**



5.2.2 Inputs

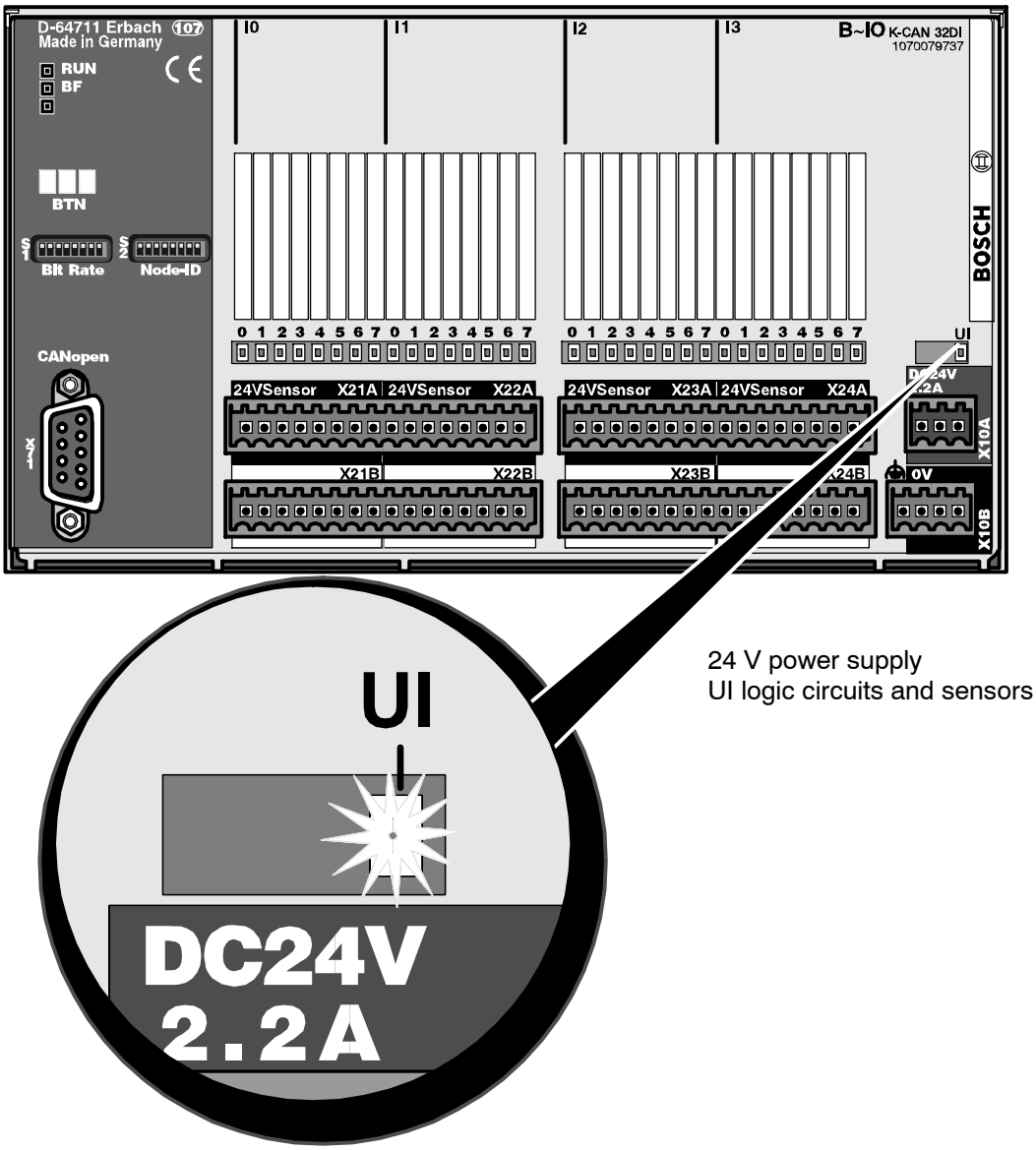


The following applies to input bytes I0 through I3:

- All 24 V potentials for sensor connections are interconnected on the module.
- All sensor connections are monitored for short-circuit and/or overload conditions (total current greater than 2 A).
- The green “UI” LED verifies the proper operation of the sensor power supply.
- Inputs I0.0 through I3.7 are Type 1 digital inputs, as per EN 61 131-2.
- The LED status indicator illuminates green when the respective input I0.0 through I3.7 is logical HIGH.

5.3 Functions and Indicators

The inputs are queried via the bus connection module of the CANopen bus.

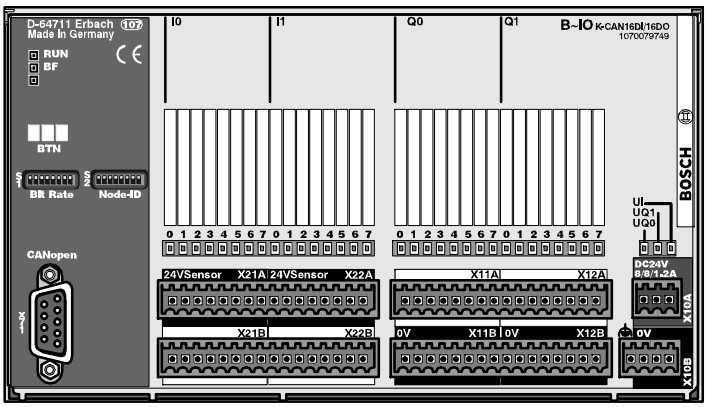


24 V power supply
UI logic circuits and sensors

The module is active when the “UI” and “RUN” LEDs illuminate green.

☞ **For information on fault indications, refer to Chapter 3.3, “Operation and Indicators”.**

6 K-CAN16DI/16DO



6.1 Hardware Configuration

The module provides –

- 16 inputs for sensors (switches, light barriers, induction-type pulse generators, etc.), and
- 16 outputs for actuators and small loads (such as valves, lamps and contactors, etc.).

In the event of a failure of the UI power supply of the bus connection module, the entire bus function will be interrupted.

Inputs

The bus connection module receives the switching signals from the semiconductor inputs, and directs them via the bus to the governing controller for further processing.

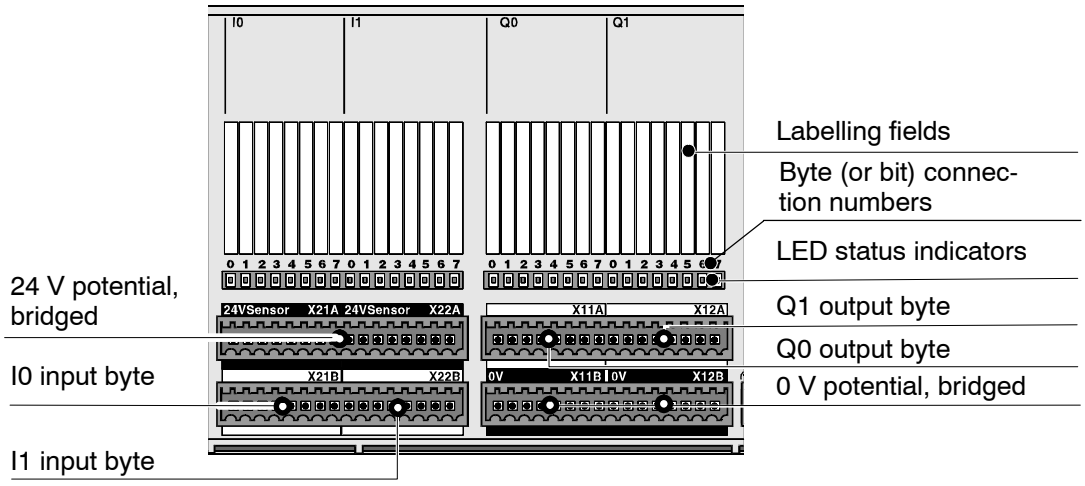
Outputs

The bus connection module controls the 16 digital semiconductor outputs. These 24 V outputs are non-latching.

In the event of a failure of either the UQ0 or UQ1 power supply for the output bytes, the output signal will be reset, and the bus master will not receive an error message. During a restart, and dependent on the incoming signals from the governing control unit, the outputs are again automatically switched.

The following outputs are provided:

- 8 outputs, 0.5 A
- 4 outputs, 1 A
- 4 outputs, 2 A



6.2 Connectors

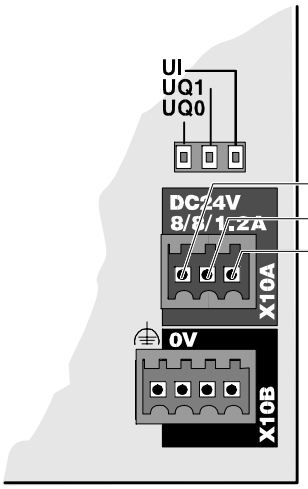
6.2.1 24 V Power Supply

The module requires a 24 V power supply for the following:

- UI logic circuits and inputs
- UQ0, output byte Q0
- UQ1, output byte Q1

The CANopen bus interface is electrically isolated from the 24 V power supply for the UI.

☞ **The 24 V power supply for the UI logic is not electrically isolated from inputs and outputs.**

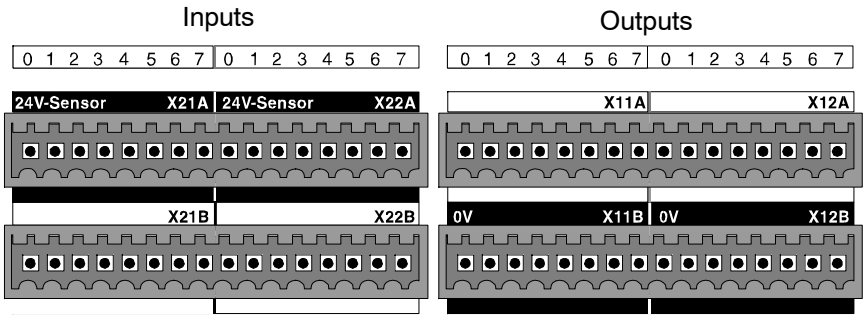


24 V power supply:

UQ0	Q0 output byte
UQ1	Q1 output byte
UI	Logic circuits and inputs

0 V terminals for 24 V power supply, internally bridged

6.2.2 Inputs and Outputs



Inputs

The following applies to input bytes I0 and I1:

- All 24 V potentials for sensor connections are interconnected on the module.
- All sensor connections are monitored for short-circuit and/or overload conditions (total current greater than 2 A).
- The green “UI” LED verifies the proper operation of the sensor power supply.
- Inputs I0.0 through I1.7 are Type 1 digital inputs, as per EN 61 131-2.
- The LED status indicator illuminates green when the respective input I0.0 through I1.7 is logical HIGH.

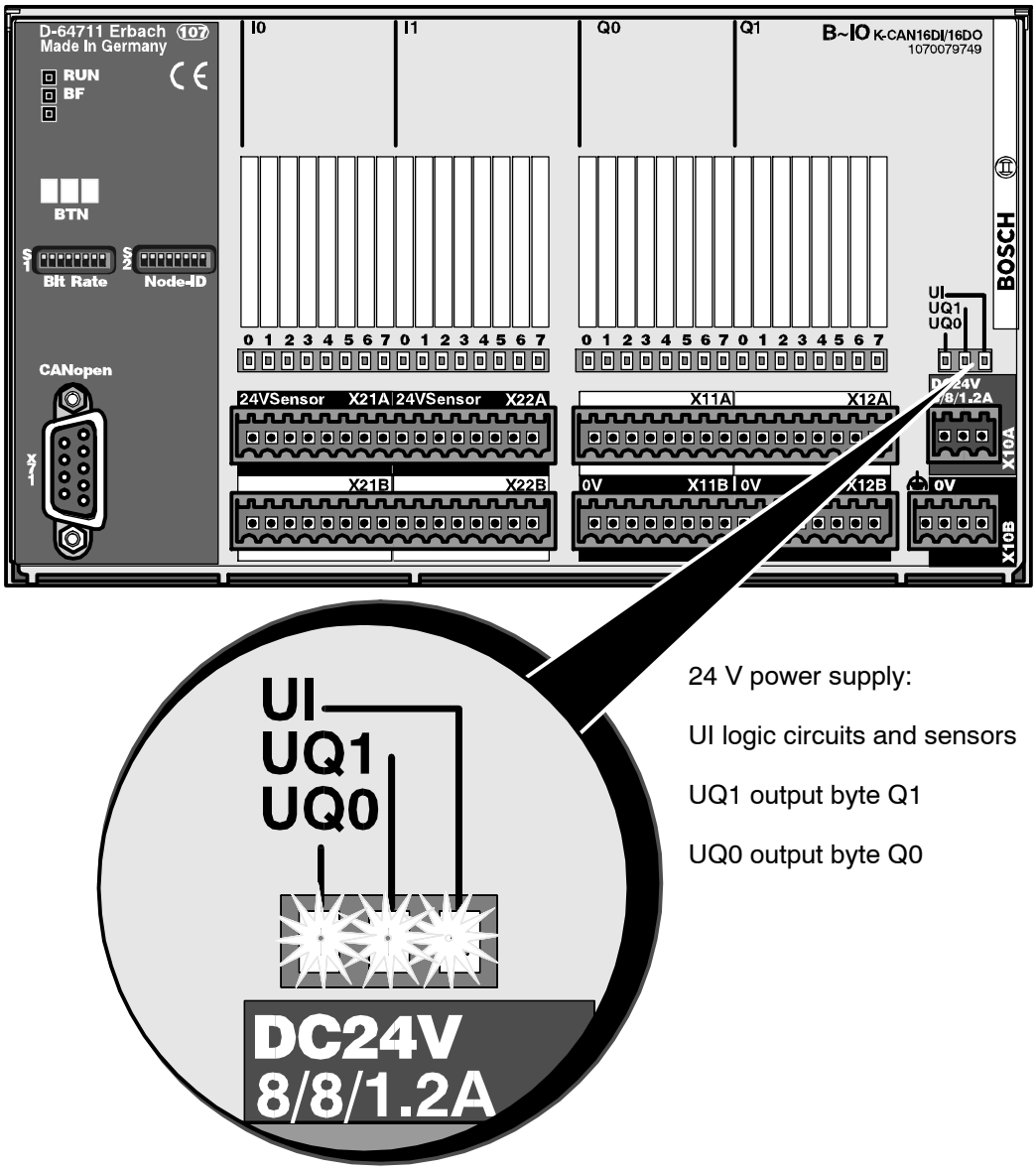
Outputs

The following applies to output bytes Q0 and Q1:

- 0.5 A outputs, bits 0 through 3
- 1 A outputs, bits 4 and 5
- 2 A outputs, bits 6 and 7
- All 0 V potentials required for two-wire load connections are interconnected on the module.
- The LED status indicator illuminates green when the output is active on the load side.

6.3 Functions and Indicators

The inputs are queried via the bus connection module of the CANopen bus. The outputs are addressed via the bus connection module of the CANopen bus.



24 V power supply:

UI logic circuits and sensors

UQ1 output byte Q1

UQ0 output byte Q0

The module is active when the “RUN”, “UI”, “UQ0” and “UQ1” LEDs illuminate green.

☞ **For information on fault indications, refer to Chapter 3.3, “Operation and Indicators”.**

Notes:

7 Module Specifications

7.1 B~IO K-CAN Specifications

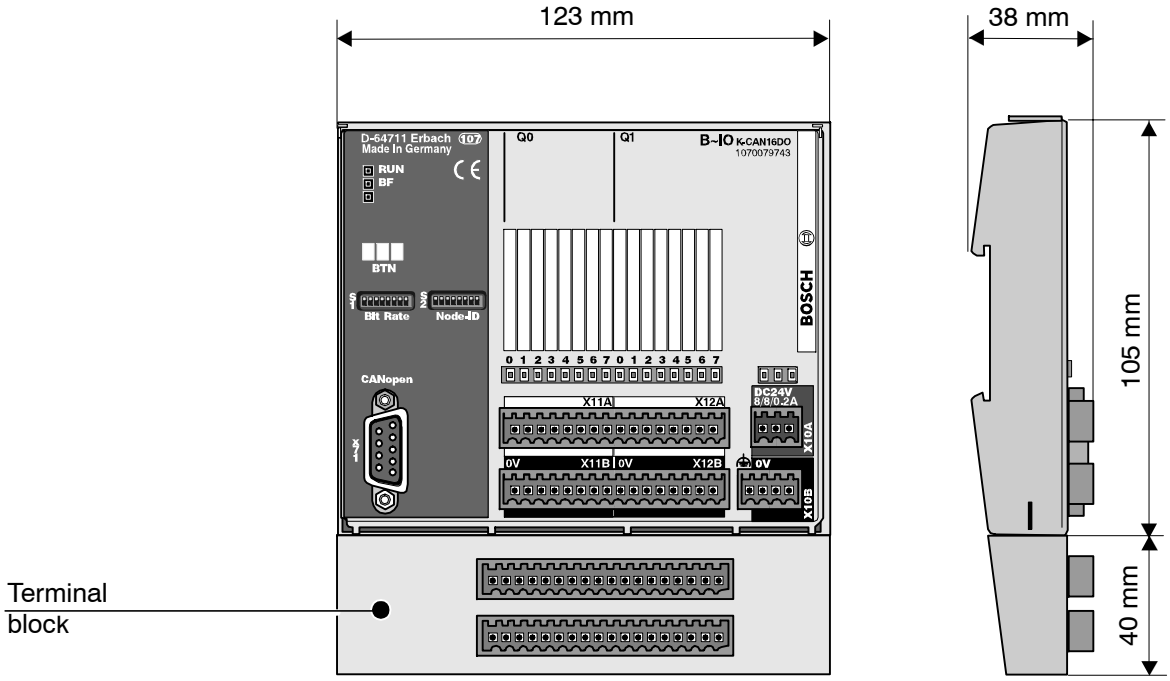
Specifications	B~IO K-CAN
Conforms to the following standards:	• EN 61 131-2 • DIN VDE 0110 • EN 60 204-1 (corresponds to VDE 0113) • EMC Directive 93/68/EEC and amending directives
Power supply, as per EN 61 131-2	24 V; 19.2 through 30 V
Insulation test voltage	• 350 V AC • 500 V DC • 500 V pulsed, at 1.2 µs/50 µs
Corrosion / chemical resistance	The ambient air must be free of elevated concentrations of acids, alkali, corrosives, salts, metallic vapours, or other electrically conductive pollutants.

Shock and vibration resistance
• Vibration, sinewave oscillations about X, Y and Z axes, EN 61 131-2
	• 10 through 57 Hz
	  • 0.0375 mm, constant amplitude
	  • 0.075 mm, random amplitude
	• 57 through 150 Hz
	  • 0.5 g constant
	  • 1 g occasional

• Shock, impact on X, Y, Z axes, EN 61 131-2	11 ms semi-sinewave, 15 g
Degree of contamination, as per EN 61 131-2 and DIN VDE 0470-1	2 Dust-free ambient air is required throughout the operating environment of our built-in units. Installation compartments must provide a minimum rating of protection category IP 54.
Protection category, as per DIN VDE 0470-1 and EN 60 529	IP 20
Safety class, as per EN 50 178	1
Humidity rating, as per EN 61 131-2	RH-2; 5 through 95 %, condensation should not occur.
Range of operating temperature	5 through 55 °C, at a maximum average temperature of 50 °C over a 24-hour period.
Storage temperature range, as per EN 61 131-2	–25 through +70 °C
Atmospheric pressure, as per EN 61 131-2	Operation up to 2000 m above sea level

Specifications	B~IO K-CAN
Transportability, as per EN 61 131-2	Drop height, in package: 1.0 m
Electrical isolation • CANopen bus from logic circuits • Logic circuits from inputs/outputs	 Yes No
Diagnostic message to controller	No
Interference radiation • Harmful radiation • Radio interference suppression, enclosure, as per EN 50 081-2	 None Class A, as per EN 55 011 • Frequency 30 through 230 MHz limit value 40 dB (mV/m) at 10 m • Frequency 230 through 1000 MHz limit value 47 dB (mV/m) at 10 m
EMI resistance • High-frequency electromagnetic fields, as per EN 61 131-2, EN 50 082-2 and EN 61 000-4-3, criterion A • Electrostatic discharge on exposed enclosure components, as per EN 50 082-2, EN 61 131-2 and EN 61 000-4-2	 Test field strength, 10 V/m Frequency band, 27 through 1000 MHz AM, 80 % at 1 kHz sweep rate, 0.0015 dec./s • ESD resistance 4 for humidity rating RH-2 • Test voltage: Air discharge 15 kV Contact discharge 4 kV
Line transient interferences of mains supply • 24 V power supply, as per EN 61 131-2 and EN 50 082-2 • Digital inputs/outputs, as per EN 61 131-2 and EN 50 082-2	 • HF interference, asymmetrical, 10 V, 150 kHz through 80 MHz, 80 % AM, 1 kHz, as per EN 61 000-4-6 • Rapid burst pulses, direct coupling, 2 kV, as per EN 61 000-4-4, criterion A • Dampened sinewave, 1 MHz, symmetrical 1 kV, as per EN 61 000-4-12
Line transient interferences on CANopen data bus, as per EN 61 131-2 and EN 50 082-2	• HF interference, asymmetrical, 10 V, 80 % AM, 1 kHz, as per EN 61 000-4-6 • Rapid burst pulses, direct coupling, 2 kV, as per EN 61 000-4-4, criterion A

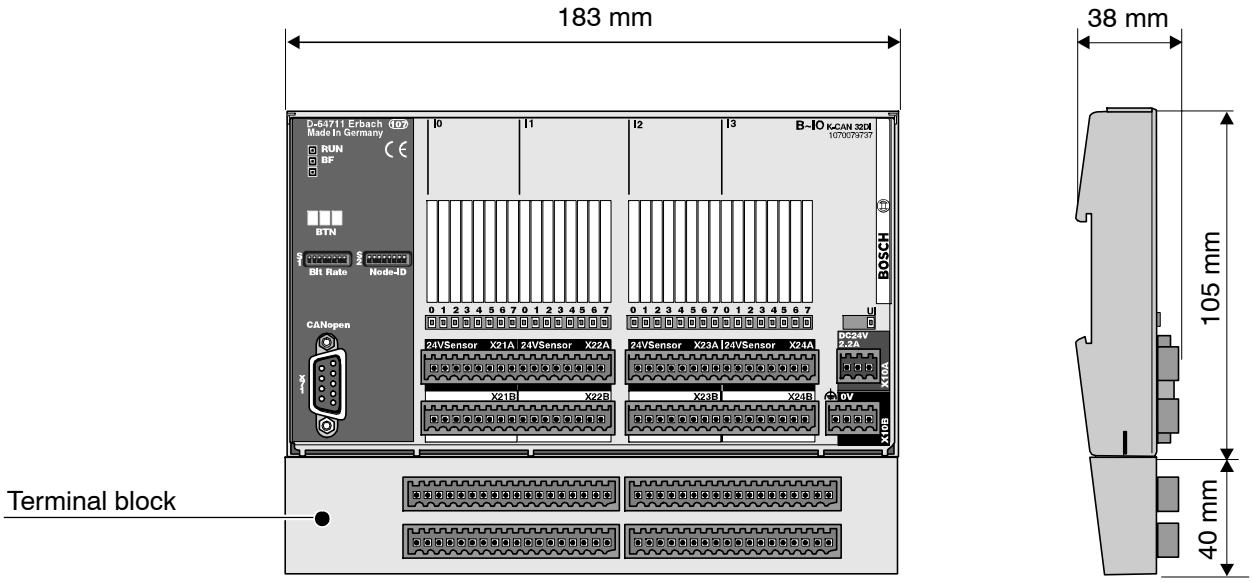
7.2 K-CAN16DO Specifications



Specifications	K-CAN16DO
Order no.	1070 079 743
Power supply, as per EN 61 131-2	3 x 24 V; 19.2 through 30 V
Current draw from 24 V power supply • UI, logic circuits • UQ0, externally supplied power for output byte 0 • UQ1, externally supplied power for output byte 1	 ≤ 1.2 A ≤ 8 A ≤ 8 A
Electrical isolation between outputs	No
Potentials	Common 0 V potential
Reverse voltage protection	Guaranteed only when external power supply not connected
Weight	approx. 350 g

Specifications	**Outputs**		
	0.5 A **Q0.0 through Q0.3** **Q1.0 through Q1.3**	**1 A** **Q0.4, Q0.5** **Q1.4, Q1.5**	**2 A** **Q0.6, Q0.7** **Q1.6, Q1.7**
Number of outputs	16 semiconductor outputs, non-latching, protected, with automatic restart, w/ power output		
Output voltage	Nominal 24 V, voltage drop with HIGH signal ≤ 1.5 V		
Output current ● Nominal value ● Maximum value ● HIGH signal ● LOW signal, leakage current	 0.5 A 0.6 A 2 mA through 0.6 A ≤ 0.5 mA	 1 A 1.2 A 2 mA through 1.2 A ≤ 0.5 mA	 2 A 2 A 2 mA through 2 A ≤ 0.5 mA
Overload protection ● Minimum cut-off level ● Automatic restart interval with reduced load	 0.6 A, typ. 1.2 A approx. 10 ms	1.2 A, typ. 2.4 A	2 A, typ. 2.4 A
Switching frequency ● Resistive load ● Inductive load	 100 Hz Dependent upon function (contactor)		
Status indication	Via LEDs, pick-off on load side		
Contact rating	Max. 8 A per contact / T_U = 55 °C		
Cable length, unscreened	Max. 100 m		
Connector pin spacing	3.5 mm		
Simultaneity factor	Refer to “Derating Curve”, Chapter 7.5		
Inductive cut-off voltage	typ. -26 V		typ. -12 V
Parallel-switching of outputs	Yes, from Q0.0 through Q0.3, as well as Q1.0 through Q1.3	Yes, of Q0.4 with Q0.5, as well as Q1.4 with Q1.5	Yes, of Q0.6 with Q0.7, as well as Q1.6 with Q1.7
Output delay interval	< 500 µs		
Contactor size at 1 Hz	SG1; 6.2 W	SG2; 11.7 W	SG8; 30 W, Bosch NG6 hydraulic valve
Lamp load at 8 Hz	5 W	8 W	15 W

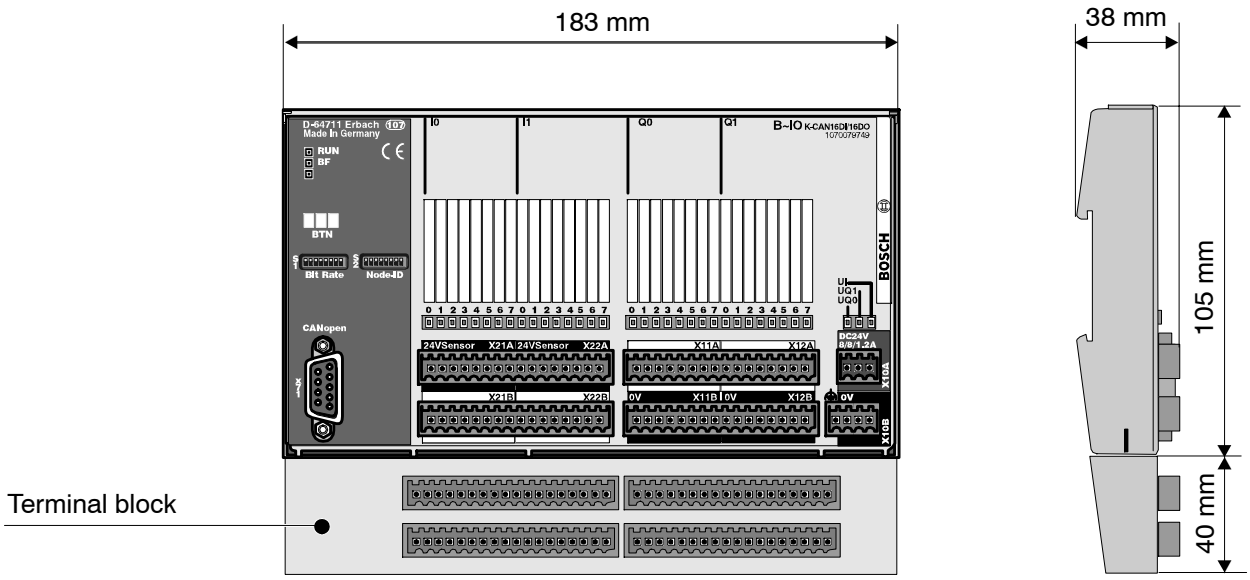
7.3 K-CAN32DI Specifications



Specifications	K-CAN32DI
Order no.	1070 079 737
Power supply, as per EN 61 131-2	24 V; 19.2 through 30 V
Current draw from 14 V power supply, incl. sensor power	≤ 2.2 A
Electrical isolation	No
Reverse voltage protection	Yes
Weight	approx. 500 g

Specifications	Inputs
Inputs, as per EN 61 131-2	32 digital inputs Type 1
Input voltage ● Nominal voltage ● LOW signal ● HIGH signal	 24 V –3 through 5 V 11 through 30 V
Input current ● LOW signal ● HIGH signal	 ≤ 2.5 mA 2.8 through 6 mA
Power supplied to sensors ● Output voltage ● Nominal output current (total) ● Short-circuit/overvoltage protection	 typ. $U_{ext.}$ –1 V 2 A 2.8 through 5.6 A
Delay time ● 0 → 1 ● 1 → 0	 3.5 ms 1.5 ms
Status indication	Via LEDs, pick-off on load side
Contact rating	Max. 8 A per contact / T_U = 55 °C
Cable length, unscreened	Max. 100 m
Connector pin spacing	3.5 mm
2-wire proximity switch ● Closed-circuit current ● Voltage drop	 ≤ 2.5 mA ≤ 8 V

7.4 K-CAN16DI/16DO Specifications

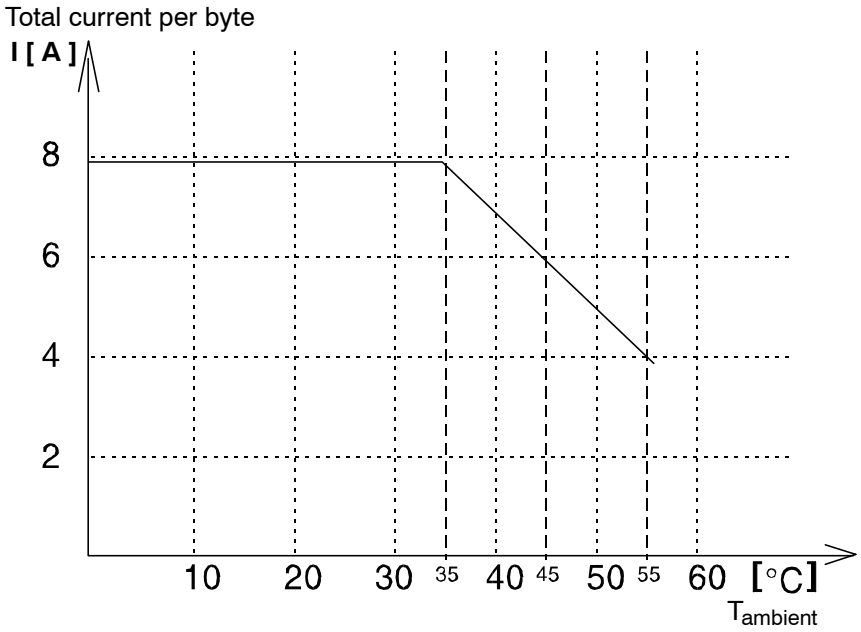


Specifications	K-CAN16DI/16DO
Order no.	1070 079 749
Power supply, as per EN 61 131-2	3 x 24 V; 19.2 through 30 V
Current draw from 24 V power supply • UI, logic circuits and sensor power • UQ0, externally supplied power for output byte 0 • UQ1, externally supplied power for output byte 1	 ≤ 1.2 A ≤ 8 A ≤ 8 A
Electrical isolation	No
Potentials	Common 0 V potential
Reverse voltage protection	Guaranteed only when external power supply not connected
Weight	approx. 500 g

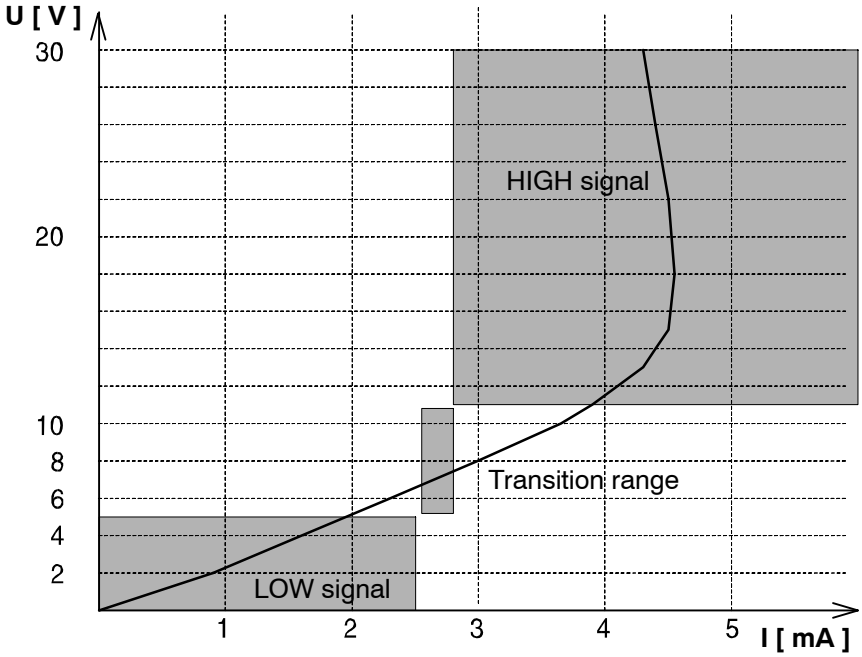
Specifications	Inputs
Inputs, as per EN 61 131-2	16 digital inputs Type 1
Input voltage ● Nominal voltage ● LOW signal ● HIGH signal	 24 V –3 through 5 V 11 through 30 V
Input current ● LOW signal ● HIGH signal	 ≤ 2.5 mA 2.8 through 6 mA
Power supplied to sensors ● Output voltage ● Nominal output current (total) ● Short-circuit/overvoltage protection	 typ. $U_{ext.}$ –1 V 1 A 1.4 through 2.8 A
Delay time ● 0 → 1 ● 1 → 0	 3.5 ms 1.5 ms
Status indication	Via LEDs, pick-off on load side
Contact rating	Max. 8 A per contact / T_U = 55 °C
Cable length, unscreened	Max. 100 m
Connector pin spacing	3.5 mm
2-wire proximity switch ● Closed-circuit current ● Voltage drop	 ≤ 2.5 mA ≤ 8 V

Specifications	**Outputs**		
	0.5 A **Q0.0 through Q0.3** **Q1.0 through Q1.3**	**1 A** **Q0.4, Q0.5** **Q1.4, Q1.5**	**2 A** **Q0.6, Q0.7** **Q1.6, Q1.7**
Number of outputs	16 semiconductor outputs, non-latching, protected, with automatic restart, w/ power output		
Output voltage	Nominal 24 V, voltage drop with HIGH signal ≤ 1.5 V		
Output current ● Nominal value ● Maximum value ● HIGH signal ● LOW signal, leakage current	 0.5 A 0.6 A 2 mA through 0.6 A ≤ 0.5 mA	 1 A 1.2 A 2 mA through 1.2 A ≤ 0.5 mA	 2 A 2 A 2 mA through 2 A ≤ 0.5 mA
Overload protection ● Minimum cut-off level ● Automatic restart interval with reduced load	 0.6 A, typ. 1.2 A approx. 10 ms	 1.2 A, typ. 2.4 A	 2 A, typ. 2.4 A
Switching frequency ● Resistive load ● Inductive load	 100 Hz Dependent upon function (contactor)		
Status indication	Via LEDs, pick-off on load side		
Contact rating	Max. 8 A per contact / T_U = 55 °C		
Cable length, unscreened	Max. 100 m		
Connector pin spacing	3.5 mm		
Simultaneity factor	Refer to “Derating Curve”, Chapter 7.5		
Inductive cut-off voltage	typ. –26 V		typ. –12 V
Parallel-switching of outputs	Yes, from Q0.0 through Q0.3, as well as Q1.0 through Q1.3	Yes, of Q0.4 with Q0.5, as well as Q1.4 with Q1.5	Yes, of Q0.6 with Q0.7, as well as Q1.6 with Q1.7
Output delay interval	< 500 µs		
Contactor size at 1 Hz	SG1, 6.2 W	SG2, 11.7 W	SG8, 30 W, Bosch NG6 hydraulic valve
Lamp load at 8 Hz	5 W	8 W	15 W

7.5 Derating Curve



7.6 Typical Input Characteristic



8 Spare Parts & Accessories

8.1 B~IO K-CAN

Designation	Order no.	Application
B~IO K-CAN16DO	1070 079 743	Compact module featuring 16 outputs
B~IO K-CAN32DI	1070 079 737	Compact module featuring 32 inputs
B~IO K-CAN16DI/16DO	1070 079 749	Compact module featuring 16 inputs and 16 outputs

8.2 Terminal Blocks

The terminal connectors are designed to facilitate 4-wire connections. They extend vertical module dimension downward by approx. 40 mm.

Designation	Order no.	Application
RV2x18K	1070 080 157	• K-CAN16DO, Compact module featuring 16 outputs
RV4x18K	1070 080 155	• K-CAN32DI, Compact module featuring 32 inputs • K-CAN16DI/16DO, Compact module featuring 16 inputs and 16 outputs

8.3 Socket Connector Sets

The socket connector sets make up the connection between the machine wiring and the B~IO K-CAN. Using the matching socket connector extractors, they can be removed quickly and easily. Therefore, to exchange a B~IO K-CAN module, disconnecting individual wires is not required.

Three different types of socket connectors are available:

- Threaded terminals
- Top-screw terminals
- Spring clamp terminals

The socket connector sets consist of several single socket connectors. Socket connector sets for compact modules contain, besides the input and output socket connectors, also the socket connectors for the power supply.

The following conductors, with cross-sections as listed, can be connected:

Conductor type	**Threaded terminals and top-screw terminals**	**Spring clamp terminals**
“e” single-wire H05 (07) V-U	0.08 through 1.5 mm^2	0.5 through 1.5 mm^2
“f” filament wire H05 (07) V-K	0.08 through 1.5 mm^2	0.5 through 1.5 mm^2
“f” with wire-end ferrule DIN 46 228/1	0.08 through 1.5 mm^2	0.5 through 1.5 mm^2 Die A; Crimping tool die for AEH PZ 1.5 or PZ 6.5
AWG-standard conductor	28 through 16	24 through 16

Socket connector sets, threaded terminals (SA)

Designation	**Order no.**	**Application**
BL-SET-SA-K16	1070 080 342	• K-CAN16DO, Compact module featuring 16 outputs
BL-SET-SA-K32	1070 080 343	• K-CAN32DI, Compact module featuring 32 inputs • K-CAN16DI/16DO, Compact module featuring 16 inputs and 16 outputs
BL-SET-SA-RV2x18K	1070 080 345	• RV2x18K, Terminal block, 2 x 18 contacts for K-CAN16DO
BL-SET-SA-RV4x18K	1070 080 346	• RV4x18K, Terminal block, 4 x 18 contacts for K-CAN32DI or K-CAN16DI/16DO

Socket connector sets, Top-screw terminals (TP)

Designation	Order no.	Application
BL-SET-TP-K16	1070 080 363	• K-CAN16DO, Compact module featuring 16 outputs
BL-SET-TP-K32	1070 080 364	• K-CAN32DI, Compact module featuring 32 inputs • K-CAN16DI/16DO, Compact module featuring 16 inputs and 16 outputs
BL-SET-TP-RV2x18K	1070 080 366	• RV2x18K, Terminal block, 2 x 18 contacts for K-CAN16DO
BL-SET-TP-RV4x18K	1070 080 367	• RV4x18K, Terminal block, 4 x 18 contacts for K-CAN32DI oder K-CAN16DI/16DO

Socket connector sets, spring clamp terminals (FK)

Designation	Order no.	Application
BL-SET-FK-K16	1070 080 349	• K-CAN16DO, Compact module featuring 16 outputs
BL-SET-FK-K32	1070 080 350	• K-CAN32DI, Compact module featuring 32 inputs • K-CAN16DI/16DO, Compact module featuring 16 inputs and 16 outputs
BL-SET-FK-RV2x18K	1070 080 352	• RV2x18K, Terminal block, 2 x 18 contacts for K-CAN16DO
BL-SET-FK-RV4x18K	1070 080 353	• RV4x18K, Terminal block, 4 x 18 contacts for K-CAN32DI or K-CAN16DI/16DO

8.4 Socket Connector Extractor

Designation	Ordre no.	Application
Socket connector extractor, 3-wire	1070 919 512	
Socket connector extractor, 8-wire	1070 919 513	

8.5 Identification Labels

One set of labels contains 10 A4 size sheets.

The module labelling fields are designed for marking as follows:
- Manually, with a permanent marker.
- Via the Word for Windows template named “Biolabel.dot” supplied on the “Device Specification” diskette, and a laser printer.

Designation	Order no.	Application
Identification labels	1070 080 309	Suitable for all components
Device specifications	1070 075 547	Printing identification labels

8.6 Device Specifications, EDS File

The EDS file contains all data required to connect the module to any CANopen bus master.

Designation	Order no.	Application
Device specification, EDS files	1070 075 547	All CAN modules

8.7 Bus Connection Accessories

Male bus connectors

Designation	Order no.	Application
Male DB-9 CAN SW connector, IP 20, 9-pin D-Sub coupling, black, without terminating resistor; loop-through connector	1070 919 029	Suitable for all components
Male DB-9 CAN SW connector GR, IP 20, 9-pin D-Sub coupling, green, with terminating resistor	1070 919 030	Suitable for all components

Bus cable

Designation	Order no.	Application
Bus cable CAN LI2YCY (TP) 2x2x0.25 mm^2 LAPP, screened	1070 919 189	Suitable for all components

9 Project Planning & Installation

When designing and assembling a machine plant or system that will be subject to the deployment of electrical operating resources, such as control systems, etc., the regulations identified below – or similar or corresponding guidelines of the country in which the machine plant will be operating – must be observed without exception:

- DIN VDE 100
- EN 60 204-1 or VDE 0113
- VDE 0160

DANGER

Risk to personnel and property!

- **Hazardous system conditions that could cause personal injury or property damage must be prevented!**
- **Strict adherence is required to the regulations governing the configuration and installation of Emergency-STOP devices, as stipulated in EN 60 204-1!**
- **Uncontrolled restart of machinery upon restoration of power, e.g., subsequent to an Emergency-STOP occurrence, must not be possible!**
- **The protection of personnel against direct or indirect contact must be ensured through the introduction of suitable measures prescribed by pertinent regulations, directives and guidelines (connection to PE conductor, insulation, etc.)!**

9.1 Mechanical Construction

Installation Method

☞ **To facilitate module installation and removal, a clearance of 20 mm should be maintained above and below the compact modules.**

☞ **Without exception, the routing of all connected cables must provide a measure of strain relief (e.g., cable channel).**

The modules are installed in the control cabinet by direct placement on a standard 35 x 7.5 mm support rail, as per EN 50 022.

To install, the module is first hooked over the upper lip of the support rail, and then snapped into place while exerting downward pressure. The spring action at the rear of the module housing will exert slight upward pressure, causing the module to lock securely into place.

Removing the Module

☞ **Prior to removing the module, all connectors should be labelled. This will prevent accidental connector misplacement upon installation.**

To remove, the module must first be pressed downward to overcome the spring pressure. This facilitates unsnapping the lower enclosure claw, and the subsequent removal of the module from the support rail, by swinging the unit out at the bottom while lifting in an upward arc.

Labelling Fields

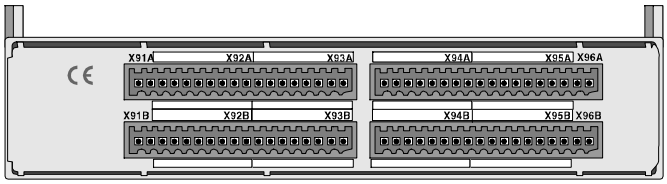
Labelling fields are provided on the modules for the purpose of recording the bus station address, and to identify the various inputs and outputs. Labelling fields are designed to accept the ink of a permanent marker.

In addition, for printing labels with an ink jet or laser printer, adhesive-backed labelling strips are available as an optional accessory.

Connections of 2, 3 or 4-wire type

The B~IO K-CAN compact modules provide 2-wire terminals to effect the connection of sensors and actuators.

The standard 2-wire terminals can be easily extended for 3 or 4-wire connections through the use of plug-on, two-tier terminal blocks. This arrangement will not require any further wiring subdistribution. The referred terminal blocks are available as optional accessories.



☞ **When plugged into the bottom of a compact module, terminal blocks add approx. 40 mm to its vertical dimension.**

Thermal management and mechanical aspects

The service life of electronic devices, such as the B~IO series of modules, depends to a major extent on the ambient temperature in which they are operating. As high temperatures will cause rapid aging of all electronic components, care must be taken to provide an ambient operating temperature that is as moderate as possible.

Installation orientation

The following installation orientations are permitted:

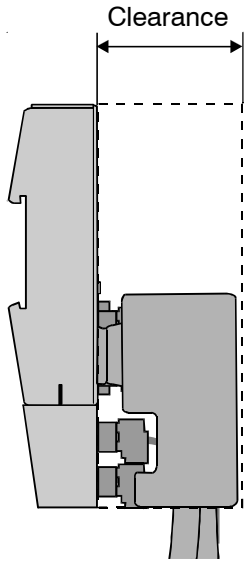
- Vertical, e.g., on back panel of control cabinet; bus connector to be located at bottom left
- Horizontal

Minimum clearances

Sufficient clearances must be provided for module installation, removal, and for cable ports. Unobstructed circulation of ambient air must be ensured.

Front panel clearance

The required front panel clearances for B~IO series modules are in each case determined by the protrusion dimensions of the required plug connectors and cable ports.



9.2 Electrical Installation

All B~IO series modules are powered by a 24 V power supply.

B~IO K-CAN16DO

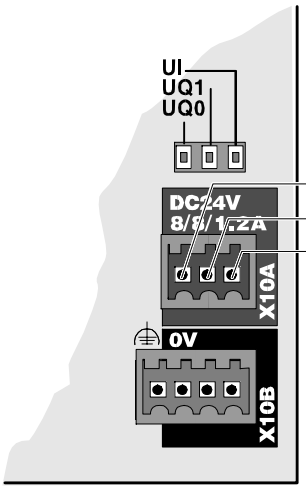
- UI, power supply for logic circuits
- UQ0, power supply for output byte 0
- UQ1, power supply for output byte 1

B~IO K-CAN16DI/16DO

- UI, power supply for logic circuits and sensors
- UQ0, power supply for output byte 0
- UQ1, power supply for output byte 1

B~IO K-CAN32DI

- UI, power supply for logic circuits and sensors



24 V power supply:

UQ0 Q0 output byte

UQ1 Q1 output byte

UI logic circuits and inputs

0 V terminals for 24 V power supply, internally bridged

9.2.1 Power Supply

The power supply must feature protective separation, as per DIN VDE 0551.

A 3-phase power supply with single full-bridge rectification is adequate. The offset AC voltage components must not exceed 5 per cent.

Provided that the foregoing applies, the 24 V power supply shall be acceptable as a supply of functional DC voltage in compliance with DIN VDE 0100 part 410, section 4.2, and/or EN 60 204.

All cables connected to the 24 V power supply are required –

- to be installed separate from high-voltage lines, OR
- to be protected by special insulation, with insulation rating to be suitable for the highest voltage occurring in the system (refer to EN 60 204).

The separate feeds of output power facilitate the bytewise disabling of outputs in the event of an Emergency-STOP condition. This arrangement ensures that both the inputs and the outputs not assigned to the Emergency-STOP circuit will remain functional.

9.2.2 Connecting Peripherals

Without exception, all peripheral devices, such as digital sensors and actuators, that are connected to any interfaces of the B~IO series modules, must comply with the full complement of protective separation criteria of electrical circuits.

The 24 V power supply provides two connection options:

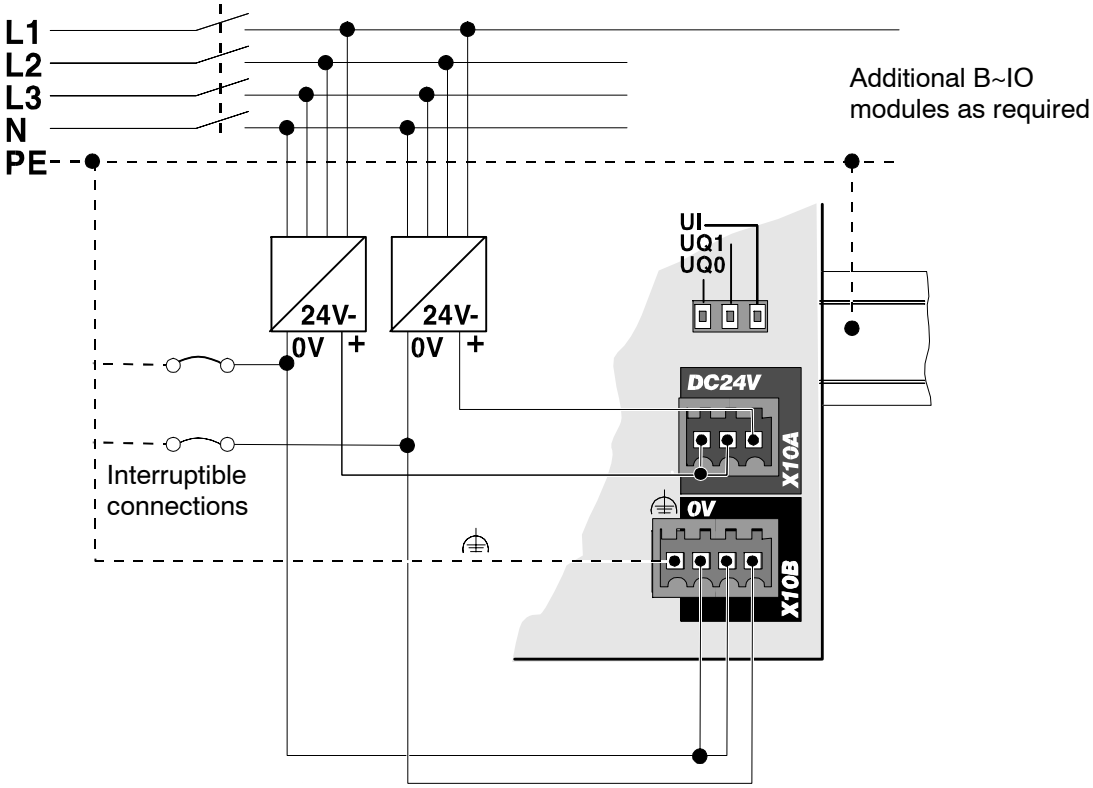
- Reference conductor connected to PE conductor, refer to Chapter 9.2.3.
- Reference conductor not connected to PE conductor, refer to Chapter 9.2.4.

9.2.3 Reference Conductor Connected to PE Conductor

The compact modules of the B~IO K-CAN series can be powered by one or more power supply units.

The reference conductor (N, 0 V) is connected, together with all interconnected PE connections, with the PE conductor system of the higher voltage.

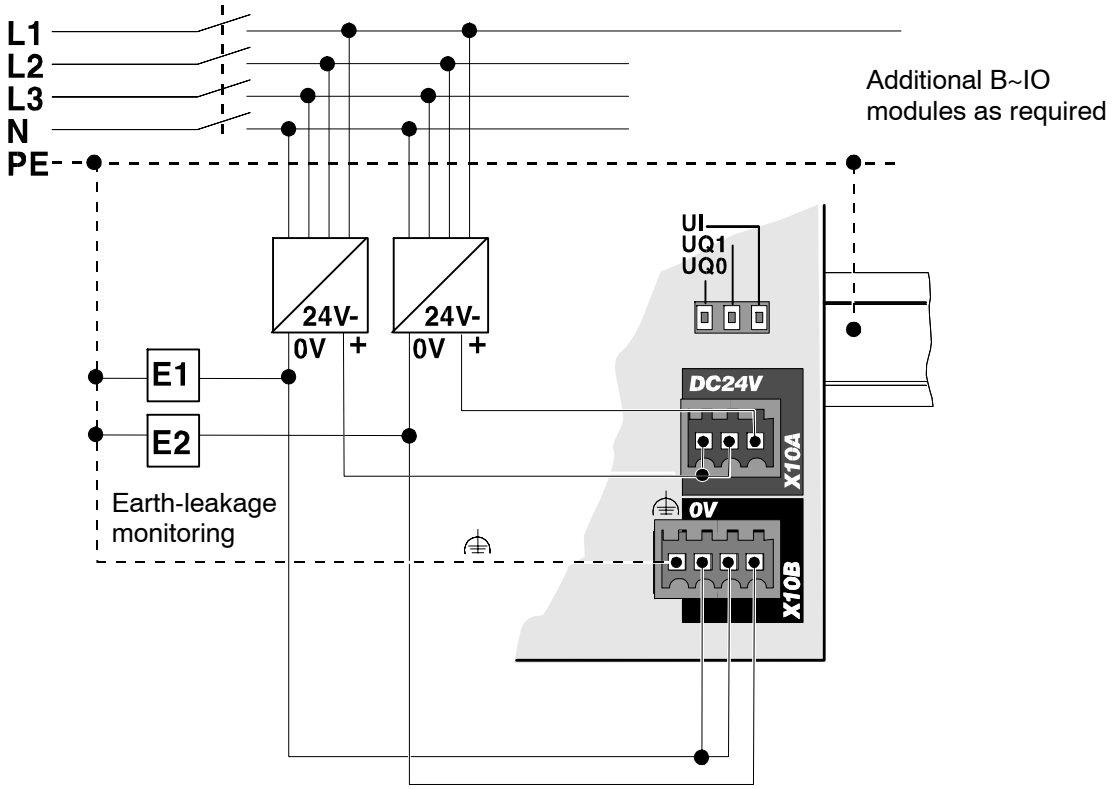
The interconnection between reference conductor and PE conductor must be made at the power supply module. To facilitate the measuring of insulation resistances of all devices within the system, this connection must be both easily accessible and readily interruptible, as per DIN VDE 0100-725.



9.2.4 Reference Conductor Not Connected to PE Conductor

The compact modules of the B~IO K-CAN series can be powered by one or more power supply units.

If the reference conductor (N, 0 V) is not to be interconnected with the PE system, an earth-leakage monitor must be employed for the purpose of detecting ground faults. The earth-leakage monitor must allow for capacitances between the live conductors and the PE conductor.



9.2.5 Capacitive Load

For the purpose of interference suppression, the B~IO series modules feature built-in capacitive loads between the power supply lines and the PE conductor.

Designation	Order no.	24 V → PE	0 V → PE
B~IO K-CAN 16DO	1070 079 743	3 x 5 nF	5 nF
B~IO K-CAN 32DI	1070 079 737	5 nF	5 nF
B~IO K-CAN 16DI/16DO	1070 079 749	3 x 5 nF	5 nF

9.2.6 Power Supply Rating

The rating of power supplies must account for the maximum currents, as per VDE 0100 part 523. A voltage of 24 V (+20 % , –15 %) must be measured at the device input.

☞ **The various 24 V power supply terminals are not bridged on the compact module.**

The rated voltage must be maintained even in the presence of –

- Mains voltage fluctuations, e.g., due to uneven mains and load utilization.
- Varying load conditions on B~IO series modules, such as short-circuit, standard load, lamp load or idle status.

The maximum cable cross-section for the power supply terminals on B~IO modules is 1.5 mm^2.

Voltage dips

To ensure uninterrupted operation, the logic circuit power supply integrated in the B~IO compact module is capable of bridging voltage dips of up to 10 milliseconds.

9.2.7 Master Switch

A master switch conforming to VDE 0100 requirements must be provided for B~IO series modules, sensors and actuators.

9.2.8 Fuses

Fuses are required to protect the cables and devices.

When selecting fuses, a variety of criteria must be considered. The major criterion comprises the nominal current of the electrical circuit to be protected – refer also to VDE 0100 part 430. The nominal current also dictates the conductor cross-section, as per VDE 0100 part 523.

For additional information, refer to the German-language publication:

Handbuch Nr. 32 (manual no. 32)
VDE Schriftenreihe (VDE publication series)
“Bemessung und Schutz von Leitungen und Kabeln nach DIN 57 100, VDE 0100-430 und -523” (“Dimensioning and Protection of Wiring and Cables, as per DIN 57 100, VDE 0100-430 and -523”)

In addition, relevant information is available from many manufacturers of fuses and circuit breakers.

9.2.9 Wiring

Connections for B~IO series modules must be routed individually from the terminal blocks in the control cabinet to the terminals corresponding to each bus station. Sensors and actuators are connected directly to the device by means of 2-wire connections. Sensors and actuators utilizing 3 or 4-wire connections are connected by means of the terminal blocks that are available as optional accessories.

☞ **Without exception, the routing of all connected cables must provide a measure of strain relief (e.g., cable channel).**

9.2.10 Parallel Routing of Data Cables and Power Cables

The parallel installation in close proximity between data or input/output signal cables with interference-prone cables, such as motor power cables and cables leading to poorly filtered contactors, must be avoided.

The smaller the distance between parallel-routed cables, the higher the degree of interference.

In cable channels and control cabinets, the power and data cables must be installed as spatially separate as possible, maintaining a minimum distance of 100 mm; installation in separate, screened compartments is preferred.

Data cables shall cross power cables at a 90° angle.

9.2.11 Earthing Arrangements

Functional earthing

B~IO series compact modules must be installed on a metallic carrier that is properly grounded, e.g., the rear panel of a control cabinet.

The modules are installed on 35 x 7.5 mm support rails, as per EN 50 022. The support rails must be earthed, with any passivation or finish coating at the connection point removed for optimum electrical contact.

To provide optimum interference protection, functional earthing will be required. The functional earthing connection must be as short as possible or, most ideally, consist of a ground strap.

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

In the event that low interference levels may be expected, functional earthing via the GND terminals of the power supply connections between the terminal on the B~IO K-CAN module and the GND connection will also be an option.

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

Equipotential bonding

Equipotential bonding, as per DIN VDE 0100 part 540, must exist between system components and power supply.

9.3 Connectors

9.3.1 Inputs

All inputs feature common 24 V and 0 V potentials.

Any 2-wire proximity switch meeting the following conditions can be used:

- Closed-circuit current ≤ 2.5 mA
- Voltage drop ≤ 8 V

The following 2-wire proximity switches are unsuitable for connection:

- 2-wire proximity switches that largely utilize the IEC 947-5-2 standard
- 2-wire proximity switches conforming to the NAMUR standard

9.3.2 Outputs

Inductive loads

In principle, most controller outputs utilize built-in DC clamp diodes to keep inductive switching peaks at a safe level. This also applies to the outputs of the B~IO system.

However, an inductive load may be introduced by the occurrence of a cable break, by removing the plug connector of an inductive load (e.g., solenoid valves, contactors, etc.), or the deliberate deenergizing through a mechanical contact causes very high interference voltages that may spread throughout the system via electrical, inductive or capacitive coupling. To attenuate these interferences, the inductive load must be connected across an appropriate interference suppression device (freewheeling diode, varistor, or resistance-capacitance circuit).

All commonly used interference suppressors may be used.

Due to their universal applicability, the use of bidirectional suppressor diodes is recommended. These consist either of a pair of reverse-polarity, series-connected suppressor diodes or of a single polarized suppressor diode with bridge rectifier. Premanufactured assemblies of this type are readily available in the trade.

Another suitable means of interference suppression are varistor modules that are offered by contactor manufacturers for the respective contactors, for example.

For additional information, please consult the German-language manual “Handbuch zur Entstörung von geschalteten Induktivitäten”, available from:

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

Output paralleling

Output connections can be used in parallel to increase output currents. This requires all corresponding output bits in the control unit to be set. Paralleling requires the observance of all module-specific requirements.

Reverse voltage protection

Reverse voltage protection connections are ensured only when no external power supply is connected.

CAUTION!
Damage to the module may be caused by the following:

- **Polarity switching with simultaneous short-circuit of output cables.**
- **Polarity switching with simultaneous connection of external polarized suppressor diodes at the output cables.**
- **Application of an external voltage exceeding 24 V.**

GND continuity protection

The 0 V reference potential of connected loads must be returned to the 0 V terminal of the outputs of modules featuring outputs. A two-wire load connection must be established. If the 0 V reference potential is not returned (single-wire connection), GND continuity will not be ensured.

If in this case the outputs are addressed via the CANopen bus (logical 1), a leakagecurrent may flow although the module does not feature a 0 V connection.

In the event that the outputs are not addressed via the CANopen bus (logical 0), the following leakage current may flow:

- up to 25 mA per 0.5 A output
- up to 50 mA per 1 A output
- up to 50 mA per 2 A output

In the event that outputs are parallelled, the current will multiply accordingly.

Overload protection

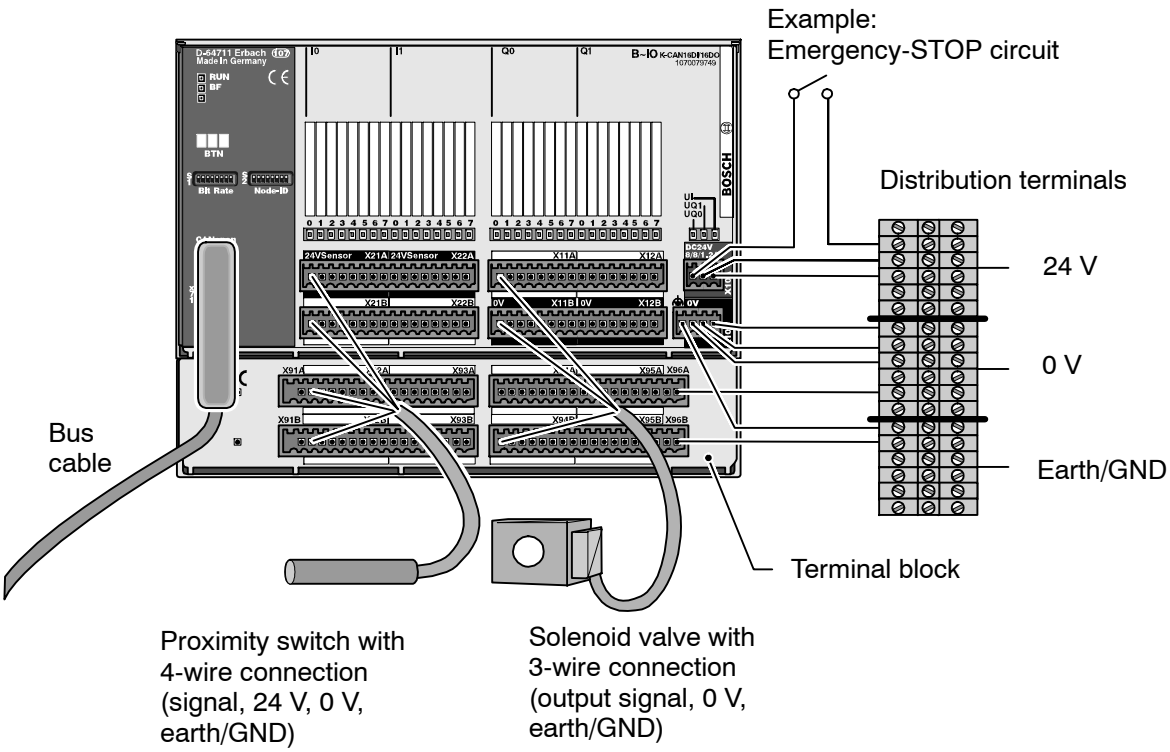
☞ **In the course of system design procedures, it should be noted that, in a departure from EN 61 131-2, the 2 A outputs guarantee a maximum output current of only 2 A in the presence of a supply voltage of up to 30 V.**

9.3.3 Coupling Inputs and Outputs

The interconnection of inputs and outputs is permitted. The connection of an additional load is not required.

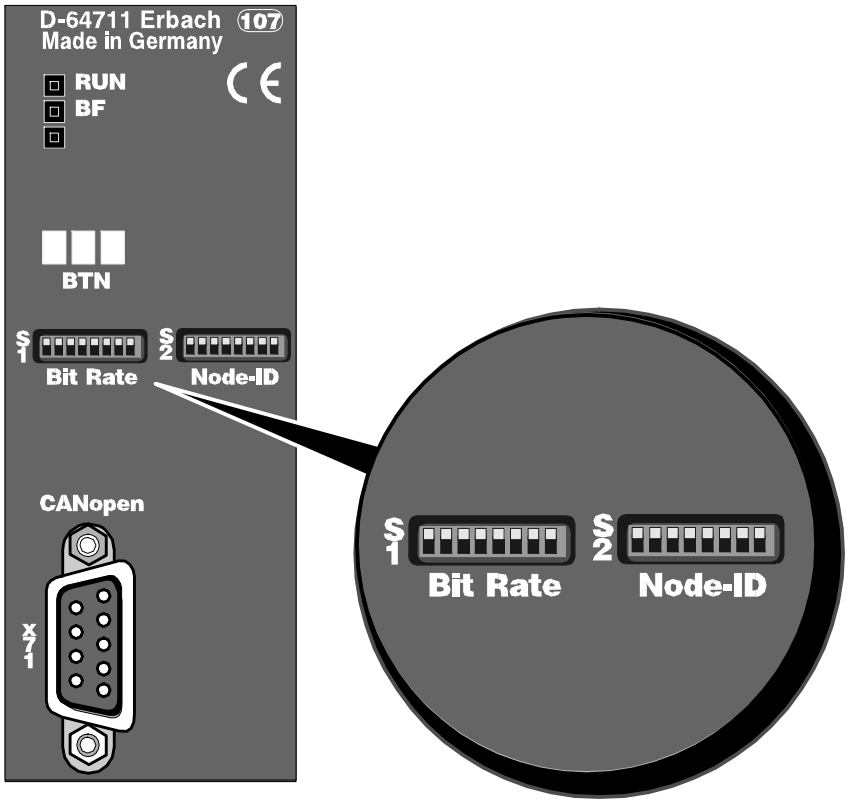
9.4 Sample Connection

The example below illustrates the connection of a B~IO K-CAN 16DI/16DO (compact module with 16 inputs and 16 outputs), representing the last bus station:



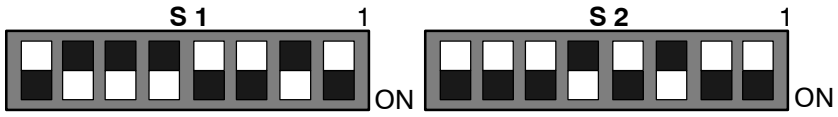
9.5 Configuring CANopen Modules

9.5.1 DIP Switches S1 and S2



The baud rate for the B~IO K-CAN bus connection module is selected via the S1 DIP switch.

The node ID (bus station ID) for the B~IO K-CAN bus connection module is selected via the S2 DIP switch.



Byte

One byte consists of 8 bits. Several bytes can be grouped into (data) words.

Bit

Digit within a byte. A value of 0 (LOW) or 1 (HIGH) may be assigned to the bit. The switch controlling the bit with the designation “0” is marked.

Bit weight

The weight of a bit depends on its position within the byte. For example, bit no. 4 has a weight of $2^4 = 2 \times 2 \times 2 \times 2 = 16$.

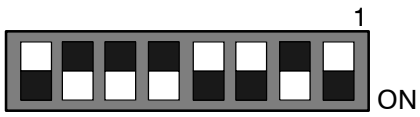
Bit value

If the bit 0 is assigned 0, its value is also 0. If the bit is assigned 1, its value will be equal to its weighting. In the preceding example, bit 4 can therefore represent the value 0 or the value 16.

Byte value

The value of a byte represents the combination of the values of its bits.

- The lowest value of a byte is 0 when all of its bits are 0.
- The highest value of a byte is 255 when all of its bits are 1.

Byte							
Switch segment	8	7	6	5	4	3	2	1
Bit	7	6	5	4	3	2	1	0
Weight	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	128	64	32	16	8	4	2	1
Example	Off 0	On 1	On 1	On 1	Off 0	Off 0	On 1	Off 0
114 = Sum of	0	64	32	16	0	0	2	0

9.5.2 Setting the Node ID (Bus Station ID)

Each CANopen bus station (node) must be assigned its own node ID (bus station address).

The node ID within the range of 1 through 127 is set by means of the S2 DIP switch on the B~IO K-CAN module.

DIP switch S2

Switch segment							
8	7	6	5	4	3	2	1
reserved	Node ID (1 through 127)						

☞ **Subsequent to Power-On, the selected node ID is queried and adopted only once during the startup routine of the module.**

The node ID can be written into the labelling field on the front panel.

Node ID	Switch segment							Explanation
	7	6	5	4	3	2	1	
0	off	off	off	off	off	off	off	not available
1	off	off	off	off	off	off	on	
2	off	off	off	off	off	on	off	
3	off	off	off	off	off	on	on	
4	off	off	off	off	on	off	off	
through								
126	on	on	on	on	on	on	off	
127	on	on	on	on	on	on	on	not permitted with more than 16 bytes inputs or more than 16 bytes outputs

9.5.3 Selecting Baud Rate and Protocol

Both the baud rate and the communication protocol for the B~IO K-CAN bus connection module are selected by means of the S1 DIP switch.

DIP switch S1

Switch segment							
8	7	6	5	4	3	2	1
Protocol	reserved for Bosch				Baud rate		

☞ **Factory setting: 1 Mbaud, CANopen**

☞ **Please observe also the limitations and specifications of the governing control unit.**

Protocol

Switch segment		**Explanation**
8	off	CANopen conformity
	on	for Bosch rho3 / rho4 robot control

Baud rate

The following baud rates are supported:

Baud rate	**Switch segment**			**max. cable length**	**Explanation**
	3	**2**	**1**		
1 Mbaud	on	on	on	25 m	
–	on	on	off		reserved
500 kbaud	on	off	on	100 m	
250 kbaud	on	off	off	250 m	
125 kbaud	off	on	on	500 m	
50 kbaud	off	on	off	1 km	
20 kbaud	off	off	on	2.5 km	
10 kbaud	off	off	off	5 km	min. baud rate

9.5.4 Electronic Data Sheet (EDS)

The EDS is a CiA-defined ASCII file that describes the objects of a CANopen device. The referred files are provided for all compact modules of the B~IO K-CAN series.

Module	from Index no.	EDS filename
K-CAN 16DI/16DO	101	RB01BK00.EDS
	104	RB02BK00.EDS
K-CAN 32DI	101	RB01BK01.EDS
	104	RB02BK01.EDS
K-CAN 16DO	101	RB01BK02.EDS
	104	RB02BK02.EDS

To provide a comfortable configuration solution, the EDS file may be loaded into specific CANopen configuration tools (e.g., Nodemaster, configuration tool by Vektor, etc.).

9.5.5 Cyclical Data Exchange

In cyclical operation, the exchange of input and output data between the PLC and the B~IO K-CAN modules is handled via the CANopen bus.

No diagnostic messages are transferred to the bus master.

9.6 Indicators and Error Indications

9.6.1 Standard Error Indications

Light-emitting diodes				Explanation
RUN	BF	UI		
Green	Red	Green	Red	
		●		24 V power supply is present.
		○		24 V power supply not available.
●				Bus connection module is in Operational (“operating”) Mode.

●●				Bus connection module is in Preoperational (“preoperating”) Mode.
				• Slave has not yet received an NMT_Start node message.
				• Guarding Failure.
				• Synchronization error (missing PDO’s in SYNC Mode).
				• CAN-Master has placed slave into Preoperating Mode, due to the following:
				  • NMT_RESET_NODE
				  • NMT_RESET_COM
				  • NMT_STOP
				  • NMT_DISCONNECT
				  • NMT_PREOPERATIONAL

○				Bus connection module is in Initialization Mode:
				• Wrong Node ID (Node ID = 0 or Node ID >127).
				• Partner not reachable.
				  • Remaining CAN bus stations switched off.
				  • Bus cable removed or defective.
				  • Incorrect baud rate was selected.

	○			Bus ok
	●			Bus off
	●●			• Invalid Node ID (Node ID = 0, • OR Node ID >127). • Alternatively, synchronization error (while in SYNC Mode, a SYNC message was received without the correct number of PDO’s having been transferred first).
	●●●●			Bus Warning Level exceeded.

Key to symbols:

○	LED remains dark.
●	LED illuminates.
●●	LED flashes slowly, e.g., 0.8 s on / 0.2 s off.
●●●●	LED flashes rapidly, e.g., 0.125 s on / 0.125 s off.
	Display has no significance in this context.

9.6.2 Error Indications on Input / Output Sections

Light-emitting diodes						Explanation
UI		UQ0		UQ1		
Green	Red	Green	Red	Green	Red	
●						24 V sensor power is OK.
	●					Max. total current draw on 24 V sensor power supply has been exceeded.
○						24 V externally supplied voltage for sensors is not available.
		●				24 V externally supplied voltage for output byte 0 is OK.
			●			Overload condition on one or more outputs of output byte 0.
		○				24 V externally supplied voltage for output byte 0 is not available.
				●		24 V externally supplied voltage for output byte 1 is OK.
					●	Overload condition on one or more outputs (output byte 1).
				○		24 V externally supplied voltage for output byte 1 is not available.

Key to symbols:

○	LED remains dark.
●	LED illuminates.
●●	LED flashes slowly, e.g., 0.8 s on / 0.2 s off.
●●●●	LED flashes rapidly, e.g., 0.125 s on / 0.125 s off.
	Display has no significance in this context.

9.7 Complement of Functions & Features

Protocol-independent functions

Function	Features	Comments
Baud rates, in kbaud	10, 20, 50, 125, 250, 500, 1000	
Max. input data	32 Byte	Current utilization, max. 4 bytes
Max. output data	32 Byte	Current utilization, max. 2 bytes
Channel-specific diagnostics	No	
ID-specific diagnostics	No	
Actual-configuration information	No	

CANopen functions

Function	Features	Comments
Asynchronous Mode	Yes	Individually configurable for each PDO.
Synchronous Mode	Yes	Individually configurable for each PDO.
Number of SDO (XMIT)	1	
Number of SDO (RCV)	1	
Number of PDO (XMIT)	max. 4	The process data objects (PDO) can be configured as desired (asynchronous, synchronous, cyclical synchronous, acyclical synchronous, etc.).
Number of PDO (RCV)	max. 4	The process data objects (PDO) can be configured as desired (asynchronous, synchronous, cyclical synchronous, acyclical synchronous, etc.).
Emergency Object	1	
Time stamp	No	Not supported.
SYNC Object	1	Receiving (RCV) a SYNC object is supported; sending (XMIT) a SYNC object is not supported.
Default and variable mapping	Yes	
Node Guarding	Yes	
Simple Boot-Up	Yes	
Extended Boot-Up	No	
NMT Service support	• Stop • Start • Disconnect • Enter Preoperational • Reset Node • Reset communication	

9.8 Operating Characteristics

The operating characteristics of the B~IO K-CAN bus connection module depends on the CAN and CANopen properties on the one hand, and on the I/O configuration on the other.

CAN data messages encompass a maximum data capacity of 8 bytes. However, with CANopen, and with the use of the requirements for “Pre-defined Master-Slave Connection Set”, two channels for sending and two channels for receiving PDO’s (process data objects) can be defined for each CAN node.

In addition, one SDO (service data object) channel in XMIT and RCV direction is available on each CAN node.

9.8.1 Module Startup

After switching on the module (energizing with 24 V logic power), the hardware components are tested. If faults are detected, the B~IO K-CAN module will be placed in System HALT state.

Once the startup test has been successfully completed, the CAN controller is initialized in accordance with the DIP switch settings.

Subsequent to successful initialization, the module enters the “Preoperational” (preoperating) status. It can now be placed into Operational Mode (operating Mode) by an NMT START message from the CAN Master.

Process data can be transferred by means of the PDO’s only once the module has entered the Operational Mode (operating Mode).

9.8.2 Object Dictionary (OD)

Among other definitions, the object dictionary (OD) defines which of the real-world communication objects shall be made available, and also the manner in which they will be made available.

Standard OD objects

Various entries in the OD are defined in the CiA DS-301.

The OD contains constants, write-accessible entries, read-accessible entries, as well as entries that are both read and write-accessible.

Using the constants and read-accessible entries, the user can obtain information (station statuses, version ID's, etc.).

Other than the default settings, the write-accessible entries are used for both control and configuration of the compact module.

Here, the user can change the assignment of objects, and modify the ID, to name just two examples.

☞ **In the event of a power failure, all OD values changed by the user or modified as a consequence of runtime situations will be lost.**

☞ **Subsequent to a restart, all objects will again be using their respective default values.**

Detailed information on the structure of the OD can be obtained by means of the respective electronic data sheets (EDS). Provided in ASCII format, these files describe all objects of the B~IO K-CAN.

The corresponding electronic data sheets are listed in Chapter 9.5.4.

Manufacturer-specific OD objects

Beyond the CiA-specified objects, there exists an area that is reserved for manufacturers. Here, device-specific objects can be entered and thus made available to the user. The OD of the B~IO K-CAN defines the following manufacturer-specific objects:

Index [hex]	Subindex [hex]	Object description
1002	0	Manufacturer Status Register (MSR). Although the MSR is not located in the OD area reserved for manufacturers, the encoding of this object is the responsibility of the manufacturer.
2000	0	Module Control Register (MCR)
2030		Configuration Information
	0	Number of recognized bus stations, max. 16. For compact devices, the number of devices is 1.
	1	Configuration Data. In the case of compact modules, this subindex returns the hardware ID.
		One ID byte per bus station.
		The configuration list can be read via an “Upload Multiplexed Domain Segment Protocol”.

Manufacturer Status Register (MSR) – Index 1002, Subindex 0

In the OD, the MSR is located at Index 1002, Subindex 0. Of the 4 possible status information bytes, only byte 1 is being used at this time. The bus station status and 1 bit for a error summary message (error summary bit) are encoded here.

MSB							LSB	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
					0	0	0	Module initialization
					0	0	1	Disconnected (not used at this time)
					0	1	0	Connecting (not used at this time)
					0	1	1	Preparing (not used at this time)
					1	0	0	Prepared (not used at this time)
					1	0	1	Preoperational
					1	1	0	Operational
					1	1	1	Undefined status
								reserved
x								Error summary bit

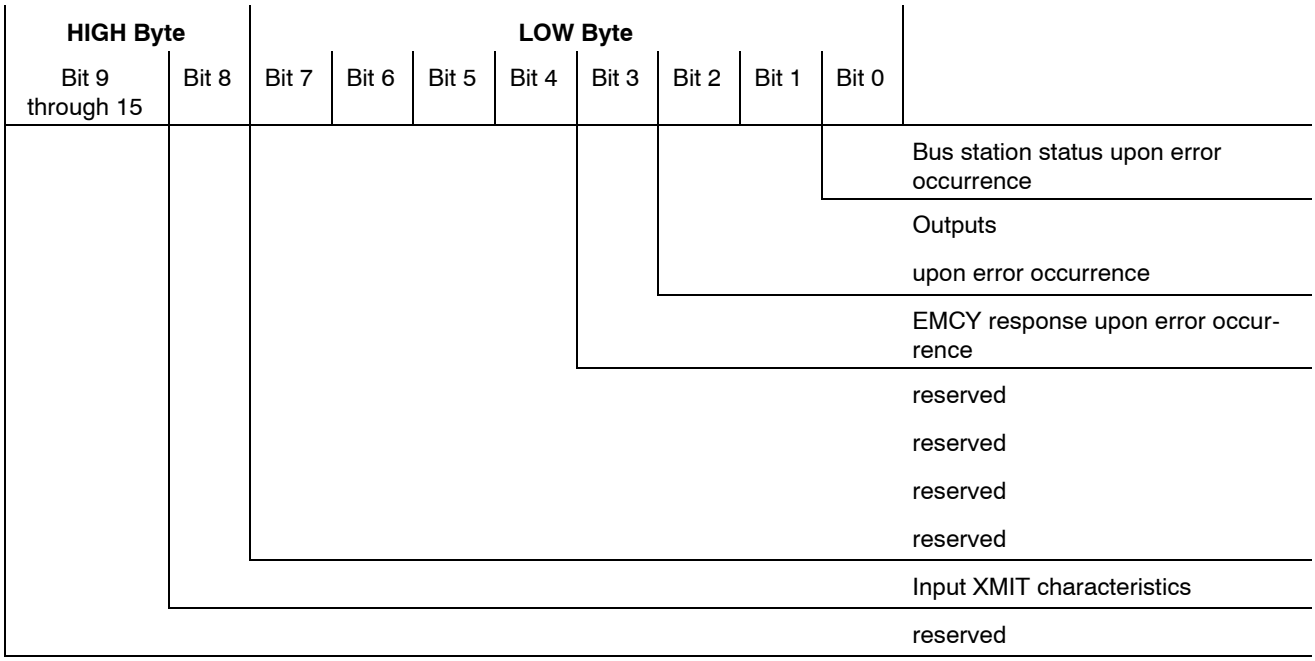
x = 0: No error

x = 1: At least one error is present

Module Control Register (MCR) – Index 2000, Subindex 0

The 16 bit wide module control register (MCR) is located at Index 2000, Subindex 0 of the OD. It can be used to modify the operating characteristics of the B~IO K-CAN.

Overview of the significance of the individual bits:



The 4 least significant bits (bits 0 through 3) of the MCR can be used to influence the behavioural characteristics of the module in the event that one of the following error conditions occurs, and subsequent to receiving an NMT Service.

Bit 8 (HIGH byte) controls the input XMIT behaviour of the B~IO K-CAN bus station.

Response to error occurrence:

Error occurrence	Bus station status	Outputs	EMCY response
BUS OFF	as per MCR Bit 0	as per MCR Bit 2, 1	as per MCR Bit 3
Missing PDO (SYNC Mode)	as per MCR Bit 0	as per MCR Bit 2, 1	as per MCR Bit 3
Guarding Failure	as per MCR Bit 0	as per MCR Bit 2, 1	as per MCR Bit 3

Error occurrence:

- BUS OFF, CAN controller is in BUS OFF, i.e., the XMIT error counter of the CAN controller has exceeded the limit of 256.
- Missing PDO, missing RCV PDO during synchronous cyclical operation.
- Guarding Failure, node guard monitoring interval has elapsed. Condition occurs only when node guarding was enabled by the CAN master.

Response to NMT Service:

NMT Service	Bus station status	Outputs	Response
NMT_RESET_NODE	Preoperational	All outputs cleared	No EMCY
NMT_RESET_COM	Preoperational	as per MCR Bit 2, 1	No EMCY
NMT_STOP	Preoperational	as per MCR Bit 2, 1	No EMCY
NMT_DISCONNECT	Preoperational	as per MCR Bit 2, 1	No EMCY
NMT_PREOPERATIONAL	Preoperational	as per MCR Bit 2, 1	No EMCY

Bus station status upon error occurence

Bit 0	Comments
0	Preoperational (default)
1	Operational

Outputs upon error occurrence

Bit 2	Bit 1	Comments
0	0	CLAB: Outputs are disabled (default)
0	1	Last state: Outputs remain in their last state
1	0	reserved
1	1	reserved

EMCY response

Bit 3	Comments
0	Emergency message (EMCY) is dispatched (default).
1	No emergency message (EMCY) is dispatched.

Input XMIT behaviour: No connection with error occurrence!

Bit 8	Comments
0	An input change causes all input information to be dispatched via all active PDO's.
1	An input change causes only the dispatch of the PDO to which the input is assigned.

9.8.3 CAN Identifier

Subsequent to startup, the default settings for the B~IO K-CAN system take effect. These settings are defined in accordance with the requirements of the CIA DS-301 (Master/Slave Connection Set).

In this process, the default assignment of the identifiers is predicated upon a master/slave relationship, whereby the complete B~IO K-CAN system acts as the slave. A corresponding application master, DBT master or NMT master can calculate the slave identifier by utilizing its node ID.

The default distribution of the identifiers does not permit communication between the slaves.

In a departure from the default settings, a DBT master can randomly modify the B~IO K-CAN identifiers via the SDO in a manner facilitating the direct communication of process data among slaves.

Default identifier assignment

Identifier size: 11 bits = Range between 0 and 2048, as per stipulations of the predefined Master/Slave Connection Set:

hex	dec	Explanation
0	0	NMT Services
1 through 0x7F	1 through 127	Reserved via CAL
0x80	128	SYNC message (rho Mode: 0x64)
0x81 through 0xFF	129 through 255	Emergency messages
0x100	256	Time stamp
0x181 through 0x1FF	385 through 511	PDO1 (Transmit)
0x200	512	Reserved via CAL
0x201 through 0x27F	513 through 639	PDO1 (Receive)
0x280	640	Reserved via CAL
0x281 through 0x2FF	641 through 767	PDO2 (Transmit)
0x300	768	Reserved via CAL

hex	dec	Explanation
0x301 through 0x37F	769 through 895	PDO2 (Receive)
0x400 through 0x580	896 through 1408	Reserved via CAL
0x581 through 0x5FF	1409 through 1535	SDO (Transmit)
0x600	1536	Reserved via CAL
0x601 through 0x67F	1537 through 1663	SDO (Receive)
0x680 through 0x6E0	1664 through 1760	Reserved for SDO
0x701 through 0x77F	1793 through 1919	Node guarding
0x760 through 0x7EF	1888 through 2031	Reserved for NMT
0x7F0 through 0x7FF	2032 through 2047	Reserved via CAL

Identifier assignment

The default identifier assignment is set automatically, provided that 16 bytes inputs and 16 bytes outputs are not exceeded.

In this case, the identifier assignment follows the stipulations for CANopen (CIA-DS301).

The definitions for the PDO channel identifiers as well as for the SYNC object can be changed as desired via the object dictionary (OD).

Only the number of PDO channels and of corresponding identifiers required on the basis of I/O equipping are activated.

Node ID-independent identifier definitions

Node ID-independent identifiers, 2 PDO's

Object	Identifier	Direction
NMT	0	XMIT / RCV
SYNC	128, to conform to rho robot control requirements, the identifier is set to 100 (0x64).	RCV

Node ID-dependent identifier definitions

Node ID-dependent identifiers, 2 PDO's

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

Example

Identifier, 2 PDO's (Node ID setting = 4)

Object	Identifier	Direction
Emergency	132	XMIT
NMT Node Guarding	1796	XMIT / RCV
SDO	1412	XMIT
SDO	1540	RCV
PDO 1	388	XMIT
PDO 2	644	XMIT
PDO 1	516	RCV
PDO 2	772	RCV

9.8.4 Setting Conforming to Bosch rho robot control

For the Bosch robot controls, a rho-conform communications mode can be selected by setting switch segment 8 on the S1 DIP switch to the “on” position.

This causes the following differences regarding the properties specified in CANopen:

- By default, all PDO’s are not set for acyclical but cyclical synchronous data exchange.
- The SYNC message is set to 128 but to 100.
- The SYNC message contains a data byte. This is interpreted by the B~IO K-CAN as follows:
  - 0 in 1st data byte = initialization phase
  - 1 in 1st data byte = cyclical operation

The B~IO K-CAN systems switchover from Preoperational Status to Operational Status is caused by the contents of the 1st data byte of the SYNC message.

9.9 Electromagnetic Compatibility

According to VDE, electromagnetic compatibility (EMC) is the property of a machine plant or of a system as an entity to provide satisfactory operation within its electromagnetic environment and, in so doing, not to unduly interfere with the referred environment that also includes other facilities.

9.9.1 Introduction

An essential objective in automation is the achievement of the highest possible degree of system reliability. It is therefore of primary importance to prevent system downtime caused by the effects of interference.

9.9.2 Interference Sources

For the user, possible interference sources are listed below:

- Self-generated interferences, e.g., from frequency converters, inductive loads, etc.
- Externally generated interferences, e.g., from lighting discharges, mains fluctuations, etc.

The subject interference sources affect the disturbed device – the interference sink – in various ways. The major transfers of interference are the following:

- Radiated interference injection
- Line transient interference of mains supply.
- Electrostatic discharges.

Line transient interference can convert to radiated interference injection, and vice versa. For example, a line transient interference generates a field on a cable, which in turn also causes a line transient interference via radiation onto an adjacent parallel-routed cable.

9.9.3 Signal-to-Noise Ratio

The signal-to-noise ratio describes the capability of a device or construction component to tolerate, without operational limitations, interference up to a certain level. Electronic devices, e.g., control units, have a significantly lower signal-to-noise ratio than other types of electrical operating resources, such as contactors, for example.

9.9.4 EMC Statute and CE Mark of Conformity

A system or machine compound as a whole must comply with specific minimum requirements with regard to its interference immunity. The compliance with the referred requirements is the responsibility of the process plant engineering company, and/or of the vendor of the machine compound. This fact is stipulated in the EMC Statute, which is based on the EEC Directive on electromagnetic compatibility.

The minimum requirements for compliance with the EMC Statute are defined in standards for products or product families. In the absence of such standards, generic standards are utilized. The conformity with the respective regulations is signified by the application of the CE Mark of Conformity.

While the CE Mark of Conformity signals conformity and compliance with all relevant directives of the Council of the European Communities, it neither represents a seal of quality nor an assurance of specific properties but exclusively addresses the governing authorities.

Depending on product and area or application, several directives may be applicable. In addition, the manufacturer is obliged to issue an appropriate Declaration of Conformity which, in the event of an official inspection, must be presented to the authorities.

Compliance with these requirements shall be verified by means of standard tests that are described in the so-called “basic standards”, e.g., in EN 61 000-4, equalling VDE 0843, etc. To ensure interference immunity also in the field, the user is also required to observe the preconditions for installation provided by the manufacturer.

The installation of the system or machine compound requires, besides observance of the EMC Directive, also compliance with the Low-voltage Directive, the EU Declaration of Conformity, and possible additional directives and/or guidelines that refer to specific types of systems or machine compounds.

9.9.5 EMC Characteristics of B~IO Modules

The B~IO system itself is in full compliance with the EMC requirements resulting from the relevant standards; refer to the descriptions of individual modules.

Conformity with applicable standards was tested in conjunction with specific system configurations. This does not mean, however, that this will automatically result in guaranteed EMC compliance with any given system configuration. The responsibility for the entire system rests solely with the plant engineering supplier.

A sufficient measure of electromagnetic compatibility can be achieved only through the conscientious observance of the installation guidelines. This is an indispensable prerequisite for the assumption that a system composed of individual CE-labelled units will, as an entity, also meet the protection objectives of the directive of the Council of the European Communities.

A fairly comprehensive overview of the application appears in the publication entitled “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”, which was issued in its 23 May 1997 version by the European Commission.

Testing for surges

The EN 50 082-2 generic standard contains an appendix which, at the time of this writing, is not a part of the standard. This appendix makes mention of the surge test for DC power supplies and interfaces serving in process control. This test is of significance in cases where cables exit buildings, e.g., due to hazards of lightning (atmospheric electrical discharges), or where they are routed in close quarters with interference-prone high-voltage cables.

Provided that the following preconditions are met, the cited requirements can be fulfilled by a system encompassing the B~IO:

- All power supplies energizing the controller shall be connected via external varistor modules, e.g., Phoenix MODUTRAB VAR/3S-24AC.
- All digital inputs and outputs to be protected shall be connected via surge suppressor terminals, e.g., Phoenix TERMITRAB SLKK 5/24DC, TERMITRAB UK5/24V, or the corresponding modules of the MODUTRAB series.

  It goes without saying that the protective modules from other manufacturers are also suitable. Detailed information regarding selection and connection can be furnished on demand.

Radiant emittances & Radio interference

The B~IO series complies with the EN 50 081-2 generic standard which defines the limit values for interference emissions. The referred standard applies exclusively to applications in an industrial environment, and may not be confused with the standard applying to applications in residential areas. The industrial standard is characterized by the following stipulations:

- No connection to the public mains network.
- Availability of a separate high or medium voltage transformer.
- Operation in an industrial setting, or in close proximity to industrial supply networks.

The term “industrial area” does not refer to the German building code stipulation differentiating industrial and residential areas.

The limit values for industrial applications are higher than for applications in a residential area. For this reason, if the use of the equipment in a residential area is intended, the user will be required to provide additional measures:

- Installation of the I/O system in a control cabinet, and/or in an enclosure providing a high screening factor.
- An I/O system is normally characterized by a large number of peripheral interfaces. These represent a major pathway for the transfer of radiated interference. To maintain reduced emission levels, all cables exiting a screened area, e.g., control cabinet filtering and screening measures must be implemented.

Prior to the intended application of systems containing B~IO components that are to be used within a personal residence, in business areas, on retail premises or in a small-industry setting, 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.

Protection from electrostatic discharges

All B~IO series modules belonging to the I/O system incorporate components which may be destroyed by electrostatic discharges (ESD). A resulting defect in a module must not necessarily be noticeable with immediate effect but may also manifest itself in the form of occasional or delayed failures.

Compliance with the appropriate measures prescribed for handling electronic components and modules must be strictly observed. In particular, it is not permitted to remove and insert connectors from and into live equipment, respectively. Prior to touching or grasping a module, the respective person must ensure electrostatical discharge of his/her body potential.

9.9.6 Installation Measures Ensuring Interference Immunity

Without exception, priority shall be given to the prevention and/or removal of interference at its source. In this regard, the following items shall be observed:

Earth / GND connection

To facilitate the dispersion of interference potentials acting between the device and the ground reference plane, the device housing or chassis must have a low-impedance connection to ground. The inductive susceptibility of simple cables comprises a significant obstruction to the dispersion of interference, especially in the case of pulse-shaped interferences with rise times in the nanosecond range. Grounding straps exhibit significantly better high-frequency properties, and shall therefore be preferred.

Screening

A major source of interference has its origin in the magnetic or electrical transfer. The prevention of this type of injection may be achieved through sufficient screening and spatial separation. This results in the demand for the installation of potentially interference-prone components, e.g., power supply and motor cables, contactors, frequency converters, etc., either separate or screened from components having a lower interference signal-to-noise ratio, e.g., signal cables, electronic controllers, etc.

The systematic spatial separation of potential sources and sinks of interference as early as in the planning phase of a machine compound represents the most cost-efficient measure toward maximizing the interference immunity of the system.

Preference shall be given to the employment of transformers featuring shielding winding because these ensure a very effective attenuation of interferences at higher voltage levels.

Twisted-pair wiring

The measure of twisted-pair wiring is employed mainly for data cables but also for power supply cables.The tightly twisted conductors prevents the occurrence of interference potentials between the conductors.

It is essential that the twisted-pair cables are made up of forward and return line. As a consequence, the flowing currents add up to zero. This is the case not only with many data transmission methods but normally also with power supplies.

Parallel routing of data cables and interference-prone high-voltage cables

A parallel installation of data cables or input/output signal cables, and interference-prone cables such as motor cables or cables connecting contactors with poor interference suppression, must be avoided. The smaller the distance between the parallel-routed cables, the greater the injected interference.

In cable channels and control cabinets, the power cables and data cables must be routed at the largest possible distance from each other, i.e., at a minimum distance of 100 mm and preferably in screened compartments. Data cables shall cross power cables at a 90° angle.

Interference suppression of inductive loads

In principle, most controller outputs utilize built-in DC clamp diodes to keep inductive switching peaks at a safe level. This also applies to the outputs of the B~IO system.

However, an inductive load may be introduced by the occurrence of a cable break, by removing the plug connector of an inductive load (e.g., solenoid valves, contactors, etc.), or the deliberate deenergizing through a mechanical contact causes very high interference voltages that may spread throughout the system via electrical, inductive or capacitive coupling. To attenuate these interferences, the inductive load must be connected across an appropriate interference suppression device (freewheeling diode, varistor, or resistance-capacitance circuit).

Due to their universal applicability, the use of bidirectional suppressor diodes is recommended. These consist either of a pair of reverse-polarity, series-connected suppressor diodes or of a single polarized suppressor diode with bridge rectifier. Premanufactured assemblies of this type are readily available in the trade.

Another suitable means of interference suppression are varistor modules that are offered by contactor manufacturers for the respective contactors, for example.

Filter

In normal operation, the interference immunity of B~IO components is sufficient to guarantee a given function even in an environment that is relatively strongly contaminated by interference. To attain a further improvement of EMC properties, it may become necessary to implement additional filtering measures. These interference countermeasures must be checked for each individual case. Suitable filters can be selected from a wide range of available products.

Voltage Dips

To ensure uninterrupted operation, the logic circuit power supply integrated in the B~IO compact module is capable of bridging voltage dips of up to 10 milliseconds. This makes an interruption of the bus operation through brief voltage dips highly unlikely. No voltage bridging is available for outputs. Accordingly, brief voltage dips may cause contactors and other actuators to drop off.

In normal circumstances, the falsification of input data due to voltage dips is normally prevented already by filters in the input circuits. Customary response intervals are around 3 milliseconds. In the event that interruptions of greater durations occur, the introduction of suitable measures will be required. For example, magnetic IR drop compensators can be employed on the AC side, or backup batteries and/or backup capacitors on the DC side.

Additional module-specific measures

Additional specific instructions must be observed in the context of various B~IO modules. The referred directions appear in the respective instruction manuals.

Notes:

A Appendix

A.1 Abbreviations

Abbreviation	Meaning
B~IO	Bus Input Output
BF	Bus Fault
Bit	Smallest logical unit, with a value of “zero” or “one”
BTN	Bus station address
Byte	A continuous group of 8 bits
CAN	Controller Area Network
CANopen	(Open) transmission protocol on the Controller Area Network bus
DI	Digital inputs
DO	Digital outputs
EDS	Electronic Data Sheet
EMC	Electromagnetic compatibility
ESD	Electro Static Discharge
GSD	Device specification file
MCR	Module Control Register
MSR	Manufacturer Status Register
OD	Object Dictionary
OSI	Open System Interconnection
PDO	Process Data Object
PE	Protective Earth, GND
PLC	Programmable Logic Controller
Q0	Output byte
Q1	Output byte
SDO	Service Data Object
UI	24 V power supply for logic circuits
UQ0	24 V power supply for output byte Q0
UQ1	24 V power supply for output byte Q1

A.2 Index

Notes:

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