BECKHOFF New Automation Technology

Documentation | EN

BC4000

Bus Terminal Controller for Interbus

2022-03-16 | Version: 2.2.0

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1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

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Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

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Copyright

1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Description of instructions

In this documentation the following instructions are used.
These instructions must be read carefully and followed without fail!

⚠ DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTE

Damage to environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation Issue Status

Version	Modifications
2.2.0	• Chapter *Technical data - BC* updated • Chapter *Instructions for ESD protection* added • Chapter *Disposal* added • New title page
2.1	• Technical data updated
2.0	• Migration
1.3	• HTML documentation; valid as from firmware B3

Firmware BC4000

You can determine which firmware was fitted when the Bus Coupler left the factory from the adhesive label underneath (see the fifth and sixth figures of the production number).

Example: 3200B2020000
The firmware in the example is B2.

In order to update your firmware, you require the KS2000 Configuration Software and the serial cable included with that software; as from software version B6, you can update your coupler using the TwinCAT 2.8 system manager. You can get the firmware from the Beckhoff support [▶ 50].

Firmware	Description
B4	Update of the firmware to new hardware from version 09
B3	- Persistent data implemented - Cycle time monitoring implemented - Function *Deleting of the boot project* implemented - PLCSystemBC.lb6 integrated
B2	Released version
B1	Preliminary version B
B0	Preliminary version A

2 Product overview

2.1 BC4000 - Introduction

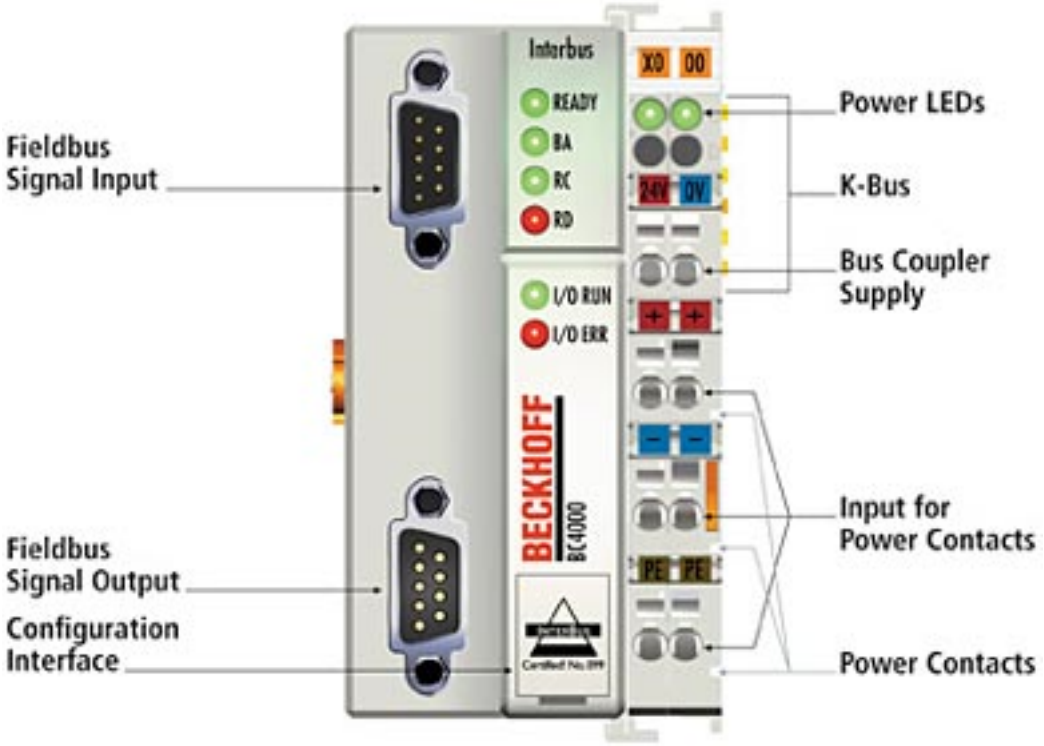


Fig. 1: BC4000 - Bus Terminal Controller for Interbus

The Bus Terminal Controllers are Bus Couplers with integrated PLC functions. The BC4000 has a fieldbus interface for the Interbus system. It can be used as a decentralized intelligence in the Interbus system. The Interbus has a ring structure, and up to 512 stations can be operated in one ring. Data is transferred at 500 kbaud.

The Bus Terminal Controllers are intelligent devices. One unit consists of a Bus Terminal Controller, a number of terminals between 1 and 64 and a bus end terminal. The Bus Terminal Controller is programmed using the TwinCAT PLC Control programming system in accordance with IEC 61131-3. The configuration and programming interface on the BC4000 is used to load the PLC program.

The Bus Terminal Controller recognizes the terminals to which it is connected to and performs the assignment of the inputs and outputs to the words of the process image automatically. The first input/output signal will be added to the first bit of a word (LSB), beginning from the left. The Bus Terminal Controller adds further signals to the word. A clear separation is maintained between inputs and outputs. If the number of inputs or outputs is greater than 16 bits, the Bus Terminal Controller automatically begins a new word.

Since 1987 Interbus has become established as an open fieldbus system. The Interbus has a ring structure, and up to 256 stations can be operated in one ring. Data is transferred at 500 kbaud. The efficient data transfer allows sensor and actuator data to be transmitted quickly over large distances safe from interference.

2.2 Technical data

System data	Interbus
Number of I/O modules	256
Number of I/O points	4096
Data transfer medium	LiYCY 3 x 2 x 0.22 mm²
Distance between modules	400 m
Data transfer rate	500 kbaud
Topology	Ring / line

Technical data	BC4000
Number of Bus Terminals	64
Digital peripheral signals	256 inputs/outputs
Analog peripheral signals	128 inputs/outputs
Protocols	Interbus
Configuration possibility	Via the KS2000 configuration software or the controller (TwinCAT)
Fieldbus byte number	Maximum 64 bytes inputs and 64 bytes outputs
Bus connection	2 x D-sub plug, 9-pin, plug and socket with screening and vibration lock
Power supply	24 V_{DC} (-15%/+20%)
Input current	70 mA + (total K-bus current)/4
Starting current	app. 2.5 x continuous current
Recommended fuse	≤ 10 A
K-bus power supply	up to 1750 mA
Power contact voltage	max. 24 V_{DC}
Power contact current load	max. 10 A
Dielectric strength	500 V (power contact/supply voltage/fieldbus)
Weight	app. 170 g
Mounting [▶ 15]	on 35 mm mounting rail conforms to EN 60715
Permissible ambient temperature at operation	0°C ... +55°C
Permissible ambient temperature for storage temperature	-25°C ... +85°C
Permissible relative humidity	95 % no condensation
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20
Approvals/markings*	CE, UKCA, cULus, EAC, ATEX [▶ 22]

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex marking

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc

2.3 Technical Data for the PLC

PLC data	BC4000
Programmability	via programming interface (TwinCAT)
Program memory	32/96 kbyte
Data memory	32/64 kbyte
Remanent flags	512 byte (default 64 byte)
Max. size of process image	512 bytes input and 512 bytes output
PLC cycle time	Approx. 3 ms for 1000 IL commands (without I/O cycle)
Programming languages	IEC 6-1131-3 (IL, LD, FBD, ST, SFC)

2.4 The principle of the Bus Terminal

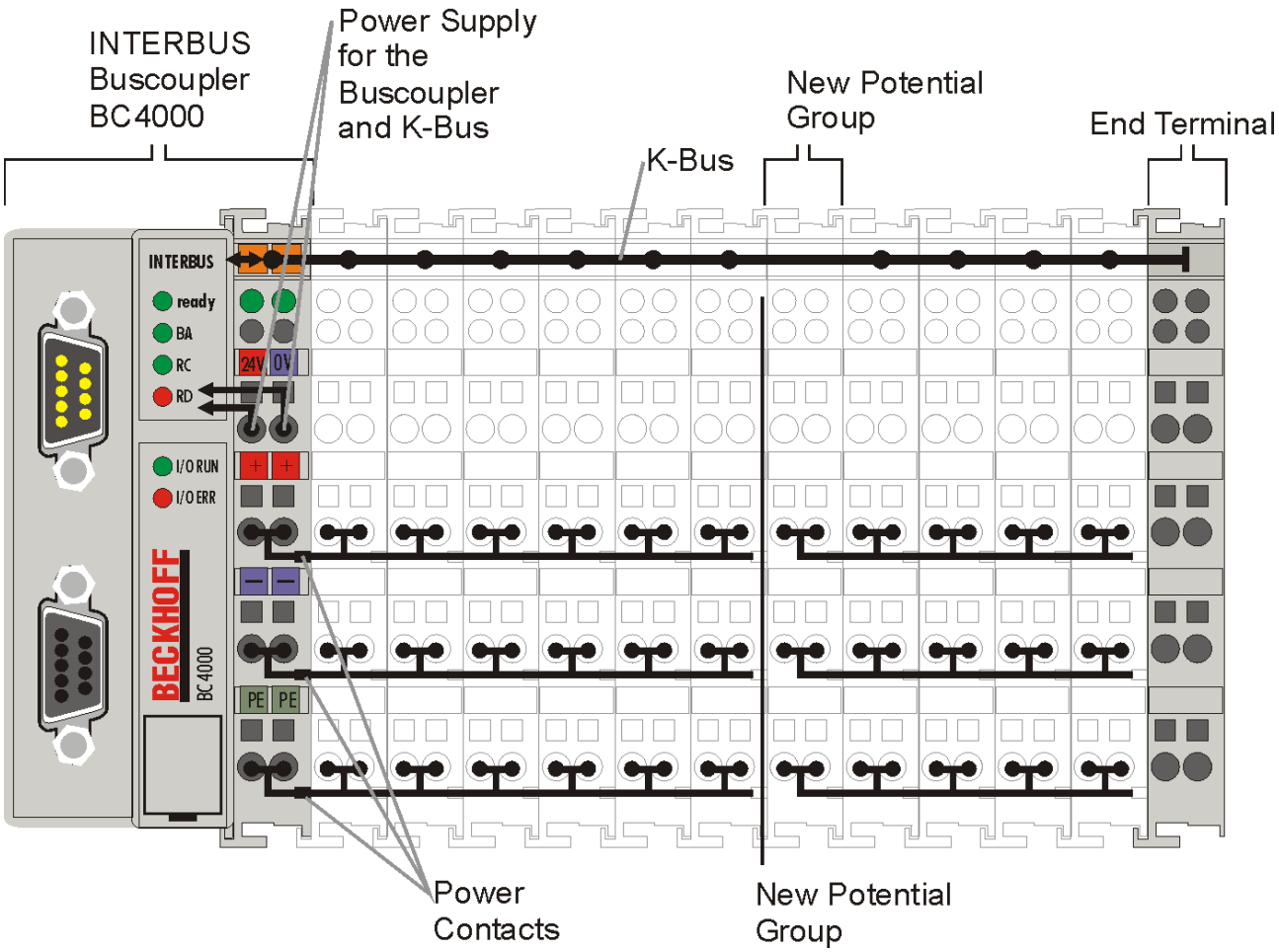


Fig. 2: The principle of the Bus Terminal

2.5 The Beckhoff Bus Terminal system

Up to 256 Bus Terminals, with 1 to 16 I/O channels per signal form

The Bus Terminal system is the universal interface between a fieldbus system and the sensor / actuator level. A unit consists of a Bus Coupler as the head station, and up to 64 electronic series terminals, the last one being an end terminal. Up to 255 Bus Terminals can be connected via the K-Bus extension. For each technical signal form, terminals are available with one, two, four or eight I/O channels, which can be mixed as required. All the terminal types have the same mechanical construction, so that difficulties of planning and design are minimized. The height and depth match the dimensions of compact terminal boxes.

Decentralized wiring of each I/O level

Fieldbus technology allows more compact forms of controller to be used. The I/O level does not have to be brought to the controller. The sensors and actuators can be wired decentrally, using minimum cable lengths. The controller can be installed at any location within the plant.

Industrial PCs as controllers

The use of an Industrial PC as the controller means that the operating and observing element can be implemented in the controller's hardware. The controller can therefore be located at an operating panel, in a control room, or at some similar place. The Bus Terminals form the decentralized input/output level of the controller in the control cabinet and the subsidiary terminal boxes. The power sector of the plant is also controlled over the bus system in addition to the sensor/actuator level. The Bus Terminal replaces the conventional series terminal as the wiring level in the control cabinet. The control cabinet can have smaller dimensions.

Bus Couplers for all usual bus systems

The Beckhoff Bus Terminal system unites the advantages of a bus system with the possibilities of the compact series terminal. Bus Terminals can be driven within all the usual bus systems, thus reducing the controller parts count. The Bus Terminals then behave like conventional connections for that bus system. All the performance features of the particular bus system are supported.

Mounting on standardized mounting rails

The installation is standardized thanks to the simple and space-saving mounting on a standardized mounting rail (EN 60715, 35 mm) and the direct wiring of actuators and sensors, without cross connections between the terminals. The consistent labelling scheme also contributes.

The small physical size and the great flexibility of the Bus Terminal system allow it to be used wherever a series terminal is also used. Every type of connection, such as analog, digital, serial or the direct connection of sensors can be implemented.

Modularity

The modular assembly of the terminal strip with Bus Terminals of various functions limits the number of unused channels to a maximum of one per function. The presence of two channels in one terminal is the optimum compromise of unused channels and the cost of each channel. The possibility of electrical isolation through potential feed terminals also helps to keep the number of unused channels low.

Display of the channel state

The integrated LEDs show the state of the channel at a location close to the sensors and actuators.

K-Bus

The K-Bus is the data path within a terminal strip. The K-Bus is led through from the Bus Coupler through all the terminals via six contacts on the terminals' side walls. The end terminal terminates the K-Bus. The user does not have to learn anything about the function of the K-Bus or about the internal workings of the terminals and the Bus Coupler. Many software tools that can be supplied make project planning, configuration and operation easy.

Potential feed terminals for isolated groups

The operating voltage is passed on to following terminals via three power contacts. You can divide the terminal strip into arbitrary isolated groups by means of potential feed terminals. The potential feed terminals play no part in the control of the terminals, and can be inserted at any locations within the terminal strip.

Up to 64 Bus Terminals can be used in a terminal block, with optional K-Bus extension for up to 256 Bus Terminals. This count does include potential feed terminals, but not the end terminal.

Bus Couplers for various fieldbus systems

Various Bus Couplers can be used to couple the electronic terminal strip quickly and easily to different fieldbus systems. It is also possible to convert to another fieldbus system at a later time. The Bus Coupler performs all the monitoring and control tasks that are necessary for operation of the connected Bus Terminals. The operation and configuration of the Bus Terminals is carried out exclusively by the Bus Coupler. Nevertheless, the parameters that have been set are stored in each Bus Terminal, and are retained in the event of voltage drop-out. Fieldbus, K-Bus and I/O level are electrically isolated.

If the exchange of data over the fieldbus is prone to errors or fails for a period of time, register contents (such as counter states) are retained, digital outputs are cleared, and analog outputs take a value that can be configured for each output when commissioning. The default setting for analog outputs is 0 V or 0 mA. Digital outputs return in the inactive state. The timeout periods for the Bus Couplers correspond to the usual settings for the fieldbus system. When converting to a different bus system it is necessary to bear in mind the need to change the timeout periods if the bus cycle time is longer.

The interfaces

A Bus Coupler has six different methods of connection. These interfaces are designed as plug connectors and as spring-loaded terminals.

3 Mounting and wiring

3.1 Instructions for ESD protection

NOTE

Destruction of the devices by electrostatic discharge possible!

The devices contain components at risk from electrostatic discharge caused by improper handling.

- Please ensure you are electrostatically discharged and avoid touching the contacts of the device directly.
- Avoid contact with highly insulating materials (synthetic fibers, plastic film etc.).
- Surroundings (working place, packaging and personnel) should by grounded probably, when handling with the devices.
- Each assembly must be terminated at the right hand end with a KL9010 bus end terminal, to ensure the protection class and ESD protection.

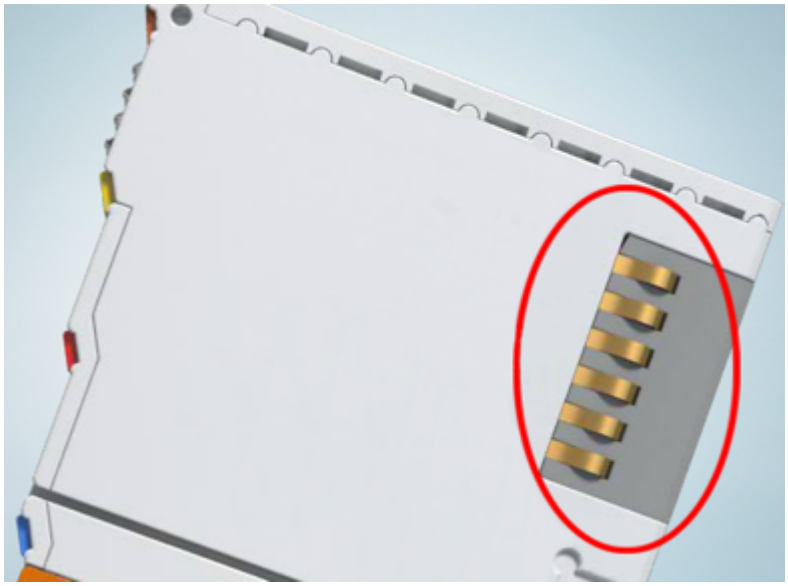


Fig. 3: Spring contacts of the Beckhoff I/O components

3.2 Mounting

⚠ WARNING

Risk of injury through electric shock and damage to the device!

Bring the Bus Terminals system into a safe, de-energized state before starting mounting, disassembly or wiring of the components!

3.2.1 Dimensions

The system of the Beckhoff Bus Terminals is characterized by low physical volume and high modularity. When planning a project it must be assumed that at least one Bus Coupler and a number of Bus Terminals will be used. The mechanical dimensions of the Bus Couplers are independent of the fieldbus system.

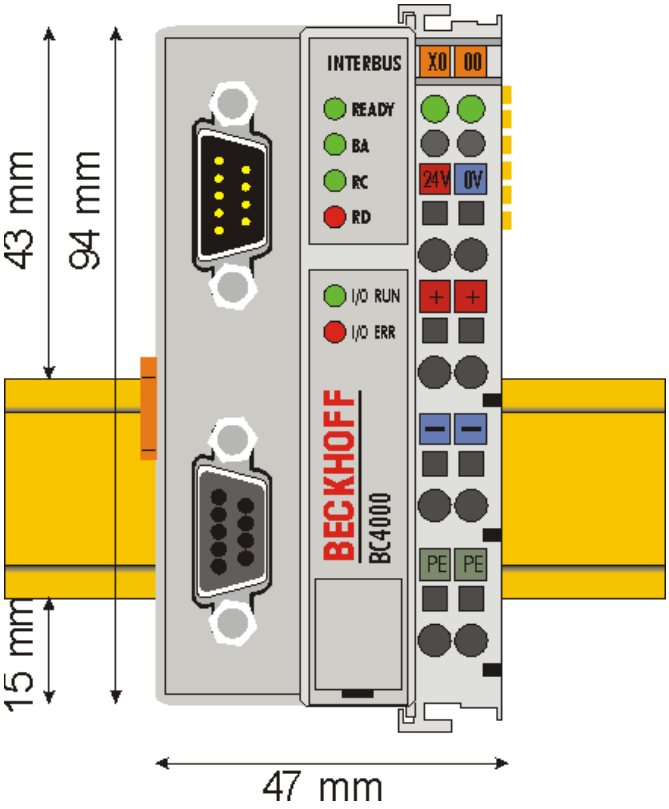


Fig. 4: BC4000 - Dimensions

The total width in practical cases is composed of the width of the Bus Coupler, the KL9010 Bus End Terminal and the width of the bus terminals in use. Depending on function, the Bus Terminals are 12 mm or 24 mm wide. The front wiring increases the total height of 68 mm by about 5 mm to 10 mm, depending on the wire thickness.

3.2.2 Installation on mounting rails

The Bus Coupler and all the Bus Terminals can be clipped, with a light press, onto a 35 mm mounting rail. A locking mechanism prevents the individual housings from being pulled off again. For removal from the mounting rail the orange colored tension strap releases the latching mechanism, allowing the housing to be pulled off the rail without any force.

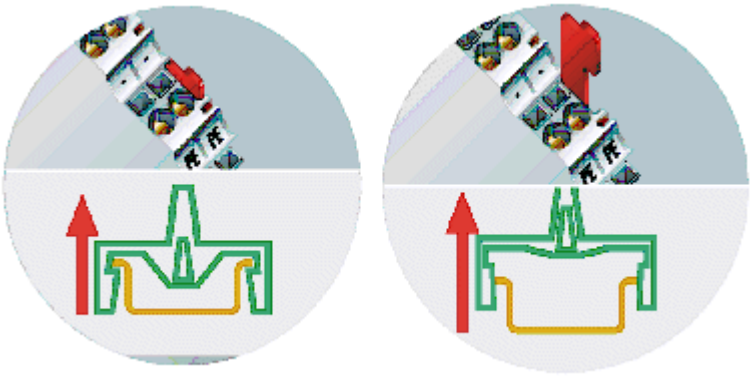


Fig. 5: Release the locking mechanism by pulling the orange tab

Up to 64 Bus Terminals can be attached to the Bus Coupler on the right hand side. When plugging the components together, be sure to assemble the housings with groove and tongue against each other. A properly working connection cannot be made by pushing the housings together on the mounting rail. When correctly assembled, no significant gap can be seen between the attached housings.

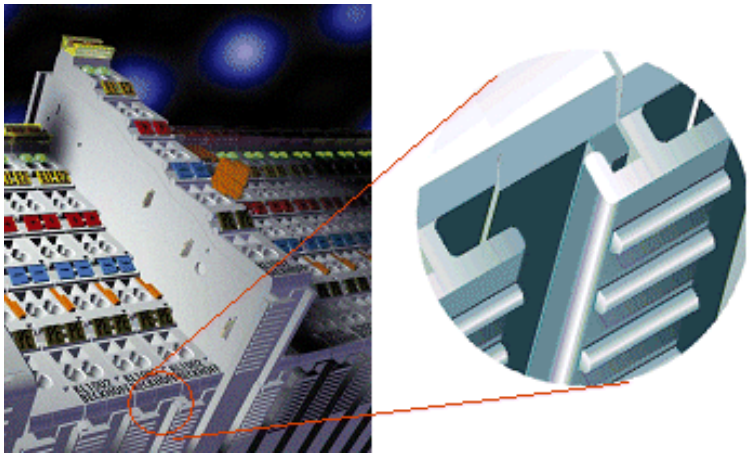


Fig. 6: Groove and tongue of the housings

NOTE

Bus Terminals should only be pulled or plugged in switched-off state.

Insertion and removal of Bus Terminals is only permitted when switched off. The electronics in the Bus Terminals and in the Bus Coupler are protected to a large measure against damage, but incorrect function and damage cannot be ruled out if they are plugged in under power.

3.2.3 Disposal

Products marked with a crossed-out wheeled bin shall not be discarded with the normal waste stream. The device is considered as waste electrical and electronic equipment. The national regulations for the disposal of waste electrical and electronic equipment must be observed.

3.3 Wiring

⚠ WARNING

Risk of injury through electric shock and damage to the device!

Bring the Bus Terminals system into a safe, de-energized state before starting mounting, disassembly or wiring of the components!

3.3.1 Potential groups, insulation testing and PE

Potential groups

A Beckhoff Bus Terminal block usually has three different potential groups:

- The fieldbus interface is electrically isolated (except for individual Low Cost couplers) and forms the first potential group.
- Bus Coupler / Bus Terminal Controller logic, K-bus and terminal logic form a second electrically isolated potential group.
- The inputs and outputs are supplied via the power contacts and form further potential groups.

Groups of I/O terminals can be consolidated to further potential groups via potential supply terminals or separation terminals.

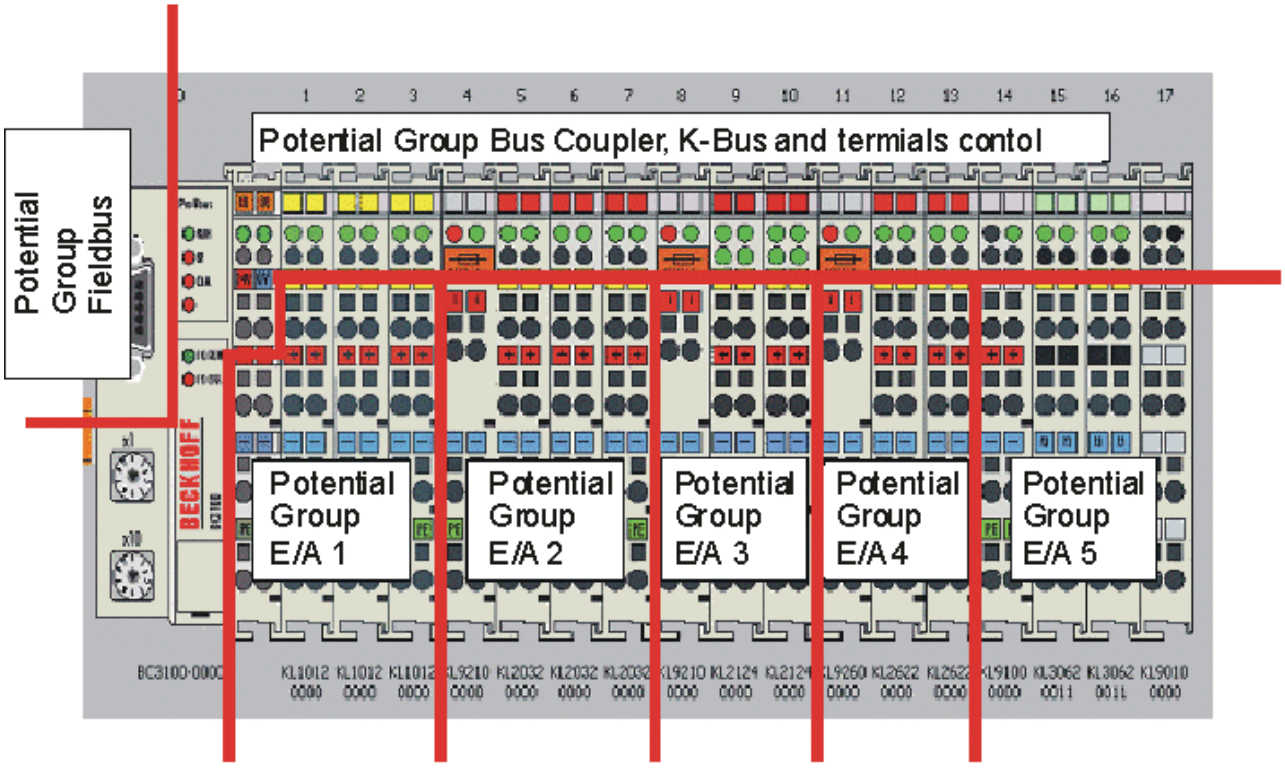


Fig. 7: Potential groups of a Bus Terminal block

Insulation testing

The connection between Bus Coupler / Bus Terminal Controller and Bus Terminals is realized automatically by latching the components. The transfer of the data and the supply voltage for the intelligent electronics in the Bus Terminals is performed by the K-bus. The supply of the field electronics is performed through the power contacts. Plugging together the power contacts creates a supply rail. Since some Bus Terminals (e.g. analog Bus Terminals or 4-channel digital Bus Terminals) are not looped through these power contacts or not completely the Bus Terminal contact assignments must be considered.

The potential feed terminals interrupt the power contacts, and represent the start of a new supply rail. The Bus Coupler / Bus Terminal Controller can also be used for supplying the power contacts.

PE power contacts

The power contact labelled PE can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.

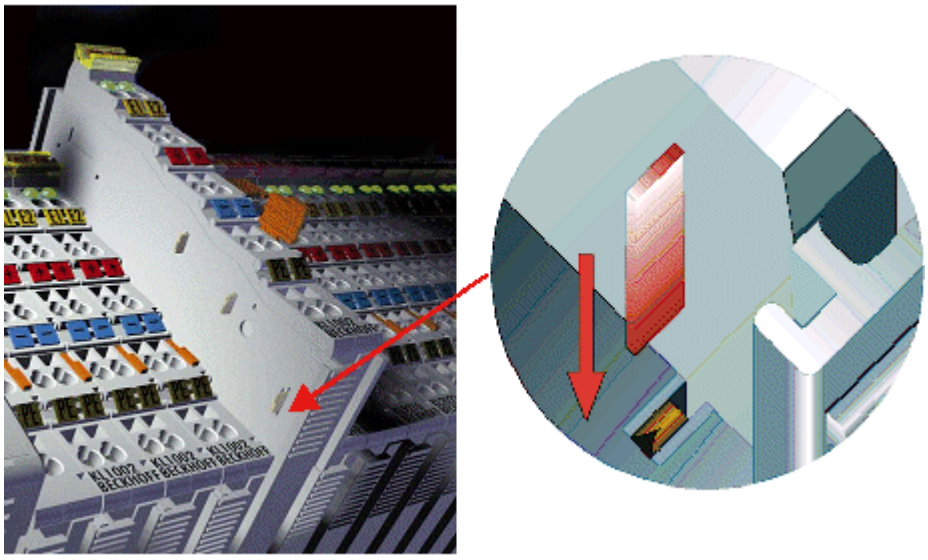


Fig. 8: Power contact on the left

It should be noted that, for reasons of electromagnetic compatibility, the PE contacts are capacitively coupled to the mounting rail. This can both lead to misleading results and to damaging the terminal during insulation testing (e.g. breakdown of the insulation from a 230 V power consuming device to the PE conductor). The PE supply line at the Bus Coupler / Bus Terminal Controller must be disconnected for an insulation test. In order to uncouple further feed locations for the purposes of testing, the feed terminals can be pulled at least 10 mm out from the connected group of other terminals. In that case, the PE conductors do not have to be disconnected.

The power contact with the label PE must not be used for other potentials.

3.3.2 Power supply

Supply of Bus Coupler / Bus Terminal Controller and Bus Terminals (Us)

3.3.2.1 BKxx00, BKxx10, BKxx20 and LCxxxx

The Bus Couplers / Bus Terminal Controllers require an operating voltage of 24 V_{DC}.

The connection is made by means of the upper spring-loaded terminals labelled *24 V* and *0 V*. This supply voltage is used for the electronic components of the Bus Coupler and Bus Terminal Controllers and (via the K-bus) the electronic components of the Bus Terminals. It is galvanically separated from the field level voltage.

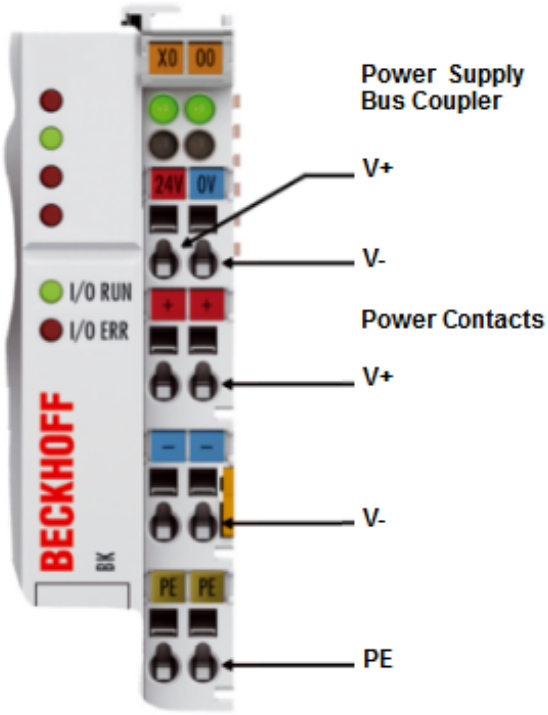


Fig. 9: Power supply connections for BKxx00, BKxx10, BKxx20 and LCxxxx

3.3.2.2 BKxx50 and BKxx51

The Bus Couplers / Bus Terminal Controllers require an operating voltage of 24 V_{DC}. Use a 4 A fuse or a Class 2 power supply to comply with the UL requirements.

The connection is made by means of the upper spring-loaded terminals labelled *Us* and *GNDs*. This supply voltage is used for the electronic components of the Bus Coupler and Bus Terminal Controllers and (via the K-bus) the electronic components of the Bus Terminals. It is galvanically separated from the field level voltage.

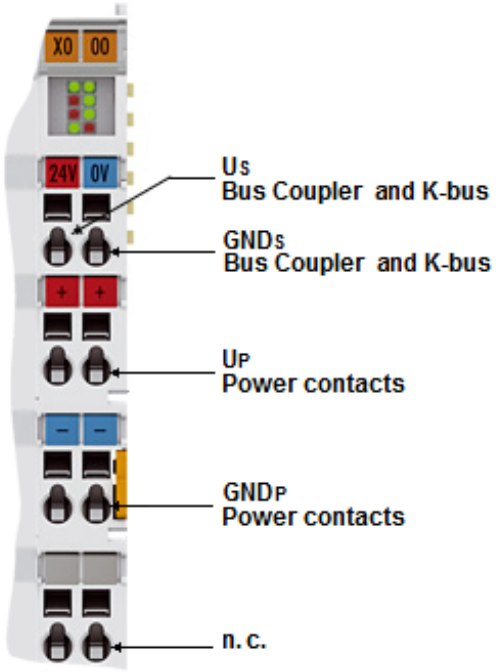


Fig. 10: Power supply connections for BKxx50 and BKxx51

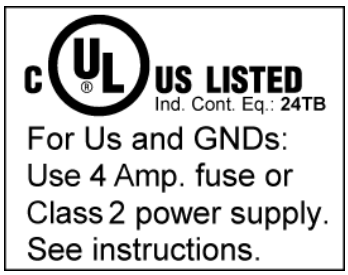


Fig. 11: UL identification

⚠ CAUTION

Note the UL requirements for the power supply.

To comply with the UL requirements, the 24 V_{DC} supply voltage for Us must originate

- from an isolated source protected by a fuse of max. 4A (according to UL248) or
- from a voltage supply complying with NEC class 2.
  An NEC class 2 voltage source must not be connected in series or parallel with another NEC class 2 voltage source!

⚠ CAUTION

No unlimited voltage sources!

To comply with the UL requirements, Us must not be connected with unlimited voltage sources.

3.3.2.3 Configuration and Programming Interface

The standard Bus Couplers have an RS232 interface at the bottom of the front face. The miniature plug connector can be connected to a PC using a connecting cable and the KS2000 configuration software. The interface permits the Bus Terminals to be configured, for example adjusting the amplification factors of the analog channels. The interface can also be used to change the assignments of the bus terminal data to the process image in the Bus Coupler. The functionality of the configuration interface can also be reached via the fieldbus using string communication facility.

3.3.2.4 Electrical isolation

The Bus Couplers / Bus Terminal Controllers operate with three independent potential groups. The supply voltage feeds the K-bus electronics and the K-bus itself. The supply voltage is also used to generate the operating voltage for the fieldbus interface.
Note: All the Bus Terminals are electrically isolated from the K-bus. The K-bus is thus electrically isolated from everything else.

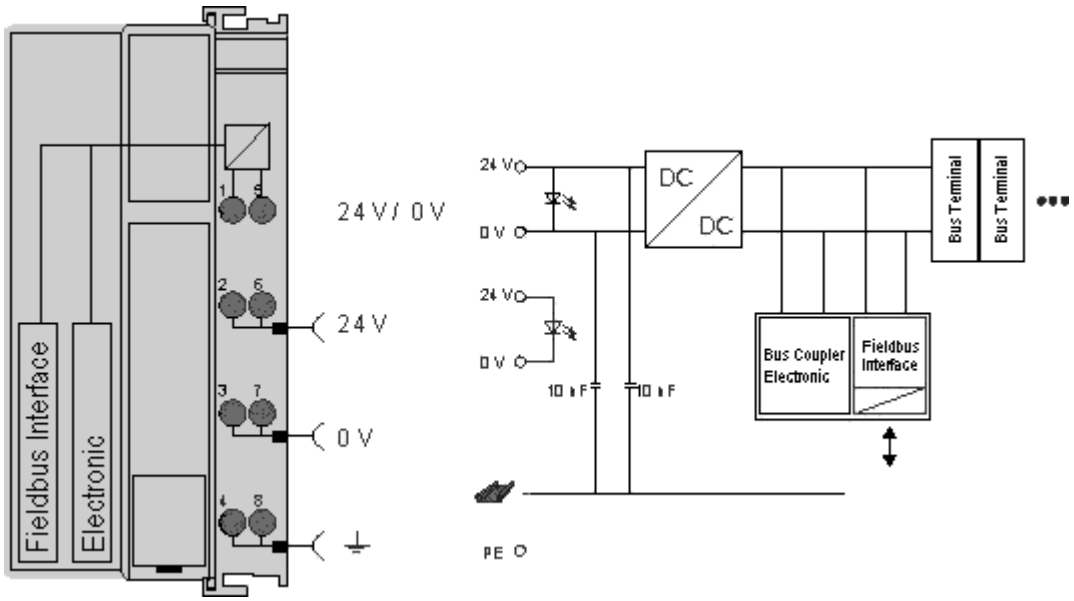


Fig. 12: Potential connection diagram of an EKxxxx

3.3.2.5 Power contacts

Power contacts supply (Up)

The bottom six connections with spring-loaded terminals can be used to feed the supply for the peripherals. The spring-loaded terminals are joined in pairs to a power contact. The power supply for the power contacts has no connection to the power supply for the Bus Couplers / Bus Terminal Controllers.

The spring-loaded terminals are designed for wires with cross-sections between 0.08 mm² and 2.5 mm².

The assignment in pairs and the electrical connection between feed terminal contacts allows the connection wires to be looped through to various terminal points. The current load from the power contact must not exceed 10 A for long periods. The current carrying capacity between two spring-loaded terminals is identical to that of the connecting wires.

Power contacts

Three spring contacts of the power contact connections can be found on the right of the Bus Coupler / Bus Terminal Controller. The spring contacts are hidden in slots so that they cannot be accidentally touched. By attaching a Bus Terminal the blade contacts on the left hand side of the Bus Terminal are connected to the spring contacts. The tongue & groove design of the top and bottom of the Bus Coupler / Bus Terminal Controller and Bus Terminals enables secure fitting of the power contacts.

3.3.3 Wiring the Bus System

The INTERBUS differentiates between remote bus, peripheral bus and remote installation bus. The INTERBUS Bus Coupler is equipped with the remote bus interface. The INTERBUS Bus Coupler has an incoming and outgoing interface based on D-SUB plug and coupling.

INTERBUS topology

INTERBUS is a ring bus system. The INTERBUS line includes the return line. The cabling therefore appears to be a single line.

Bus length

Baud rate	Bus length
500 kbit/s	12.8 km (400 m between 2 stations)

INTERBUS cable

The use of pair-wise twisted, screened cables is recommended for the INTERBUS wiring (3 x twisted pair with screening).

ZB4200 INTERBUS cable

Beckhoff offers an INTERBUS cable with the order number ZB4200.

Cable preparation

Cable colours for using the Beckhoff INTERBUS cable at Bus Terminal and Fieldbus Box:

Pin BK40x0/BC4000		Function	ZB4200 cable color
D sub plug outgoing remote bus	D sub socket incoming remote bus		
6	6	/DO	green
1	1	DO	yellow
7	7	/DI	pink
2	2	DI	grey
3	3	COM	brown
5	-	jumper	-
9	-	jumper	-

INTERBUS D sub coupling ZB4100 and plug ZB4101

For the connection with the INTERBUS cable and the Bus Coupler, we recommend the use of D sub plug and coupling.

ZB4100 incoming remote bus, coupling
ZB4101 outgoing remote bus, plug

3.4 ATEX - Special conditions (standard temperature range)

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components with standard temperature range in potentially explosive areas (directive 2014/34/EU)!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-15! The environmental conditions during use are thereby to be taken into account!
- For dust (only the fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9): The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to EN 60079-31 for group IIIA or IIIB and IP6X for group IIIC, taking into account the environmental conditions under which the equipment is used!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of 0 to 55°C for the use of Beckhoff fieldbus components standard temperature range in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

The fundamental health and safety requirements are fulfilled by compliance with the following standards:

- EN 60079-0:2012+A11:2013
- EN 60079-15:2010
- EN 60079-31:2013 (only for certificate no. KEMA 10ATEX0075 X Issue 9)

Marking

The Beckhoff fieldbus components with standard temperature range certified according to the ATEX directive for potentially explosive areas bear one of the following markings:

II 3G KEMA 10ATEX0075 X Ex nA IIC T4 Gc Ta: 0 … +55°C

II 3D KEMA 10ATEX0075 X Ex tc IIIC T135°C Dc Ta: 0 ... +55°C
(only for fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9)

or

II 3G KEMA 10ATEX0075 X Ex nA nC IIC T4 Gc Ta: 0 … +55°C

II 3D KEMA 10ATEX0075 X Ex tc IIIC T135°C Dc Ta: 0 ... +55°C
(only for fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9)

3.5 Continuative documentation for ATEX and IECEx

NOTE	
	**Continuative documentation about explosion protection according to ATEX and IECEx** Pay also attention to the continuative documentation **Ex. Protection for Terminal Systems** Notes on the use of the Beckhoff terminal systems in hazardous areas according to ATEX and IECEx, that is available for download within the download area of your product on the Beckhoff homepage www.beckhoff.com!

4 Parameterization and Commissioning

4.1 Start-up behavior of the Bus Terminal Controller

When the Bus Terminal Controller is switched on it checks its state, configures the K-bus, creates a configuration list based on the connected Bus Terminals and starts its local PLC.
The I/O LEDs flash when the Bus Terminal Controller starts up. If the system is in an error-free state, the I/O LEDs should stop flashing after approx. 2-3 seconds. In the event of a fault the error type determines which LED flashes (see chapter *Diagnostic LEDs*).

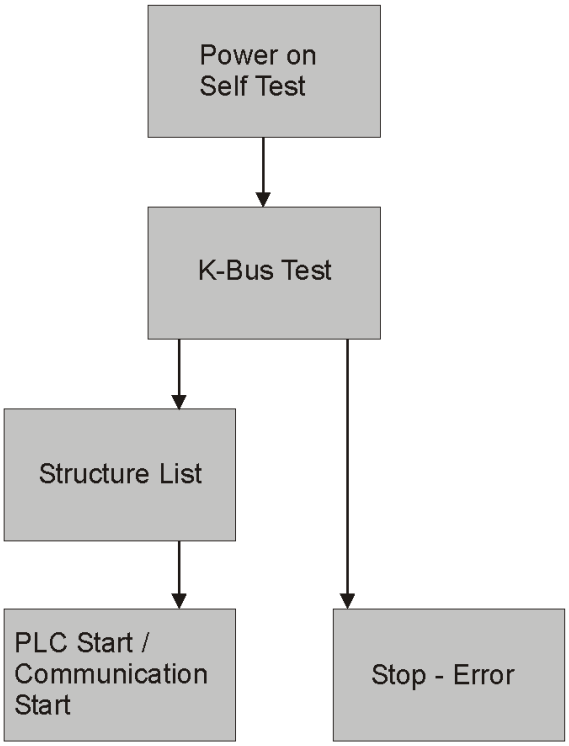


Fig. 13: Start-up behavior of the Bus Terminal Controller

4.2 Addressing

The master addresses Interbus slave devices independently in the order they are connected to it. The user is usually not made aware of the node addressing.

5 Configuration

5.1 Configuration of the Interbus

The Bus Couplers BK4000, BK4010, BK4020, BK4500 and BC4000 can be operated with generation 3 or 4 Phoenix masters. The baud rate for all Bus Couplers is 500 kBaud.

ID code

Signal type	Signal direction	Hex value
Digital	Outputs	0x01
Digital	Inputs	0x02
Digital	Inputs/outputs	0x03
Byte-oriented	Outputs	0x31
Byte-oriented	Inputs	0x32
Byte-oriented	Inputs/outputs	0x33

ID length

Length of the inserted periphery	Register width in the ID code
1 word	1 word
2 words	2 words
3 words	3 words
4 words	4 words
5 words	5 words
6 words	6 words
7 words	7 words
8 words	8 words
9 words	9 words
10 words	10 words
11 -12 words	12 words
13 -14 words	14 words
15 -16 words	16 words
17 -24 words	24 words
25 -32 words	32 words

Default Setting

In the default setting, the BC4000 has 16 bytes of input data and 16 bytes of output data (PLC variables [▶ 34]). This data can be increased or reduced in single-byte steps (see Table 1 Register 1 and 3 [▶ 40]).

ID code: 0x33 ID length 8 words

5.2 Configuration of the master

As already explained above, the Interbus coupler creates a data range with input and output bytes. The assignment of channels of the Bus Terminals to the bits and bytes of the process image is done by the Bus Coupler. The Interbus master exchanges a contiguous input and output data block with each Interbus coupler. The assignment of the bytes from this data block to the addresses of the process image is done via data function blocks in the PLC or the configuration software IBS SYS SWT or IBS CMD SWT G3 and G4 from Phoenix Contact. The corresponding manufacturer's tools should be used for other masters.

Software for the master configuration

Master software	Configuration software	Manufacturer
PLC connection –version lower than 4	IBS SYS SWT IBS CMD SWT G3	Phoenix Contact
PC connection –version lower than 4	IBS SYS SWT IBS CMD SWT G3	Phoenix Contact
PLC connection –version 4 or higher	IBS CMD SWT G4	Phoenix Contact
PC connection –version 4 or higher	IBS CMD SWT G4	Phoenix Contact

Ensuring data consistency

The data consistency of the data from a station is secured by the Interbus transmission protocol. The consistency over the entire process image is secured by synchronous sampling. Inconsistencies may result due to the control CPU (usually a PLC) asynchronously accessing the data range of the Interbus master. Access to 16 bit words and partly to 32 bit double words is secured by most Interbus masters. Please refer to the respective manufacturer's manuals for greater clarity regarding the special methods of accessing the master connections. Common PLC connections are the S5 assemblies IBS S5 DCB and IBS S5 DSC as Interbus masters. The masters with the firmware version 4.0 are particularly easy to operate. The CMD configuration software allows the settings to be made under Windows. The byte-wise and bit-wise assignment of the peripheral data in the address range of the controller is possible. The data consistencies are selectable in groups.

Interbus standard-compliant

The BK4xxx/BC40xx devices work with the SUPI 3 (Serial Universal Periphery Interface) protocol chip. The SUPI 3 protocol chip handles the complete Interbus protocol. In comparison with the predecessor version (SUPI 2), the SUPI 3 offers extended diagnostics and error management. Please refer to the manuals for the Interbus masters used regarding the functions of the SUPI 3 chips that are supported.

5.3 Configuration via TwinCAT

In order to integrate the Bus Coupler into the TwinCAT System Manager, an Interbus master card has to be designed first. The BC4000 can then be attached to this card.

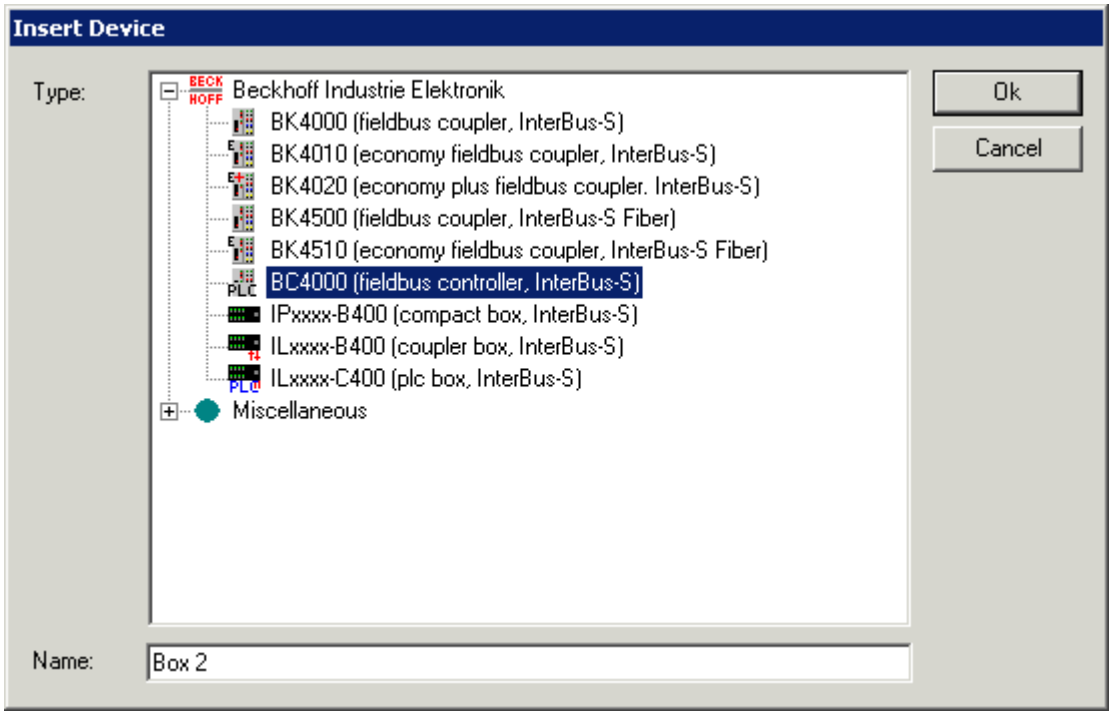


Fig. 14: TwinCAT - Insert Device

In the next step, the Bus Terminals are attached to the coupler. 3 different mapping options are available.

- Compact fieldbus terminal
  In this setting, the Bus Terminal is invisible for the BC4000. The data are mapped directly into the fieldbus process image. Analog Bus Terminals become compact (only user data without control/status are entered). The BC4000 must be notified of this change via KS2000 or via the System Manager.
- Complex PLC Bus Terminal (default)
  All Bus Terminals are assigned to the local BC4000 process image and are not visible for the Interbus. The analog Bus Terminals map with control/status.
- Compact PLC Bus Terminal
  All Bus Terminals are assigned to the local BC4000 process image and are not visible for the Interbus. The analog Bus Terminals map compact (only user data without control/status). The BC4000 must be notified of this change via KS2000 or via the System Manager.

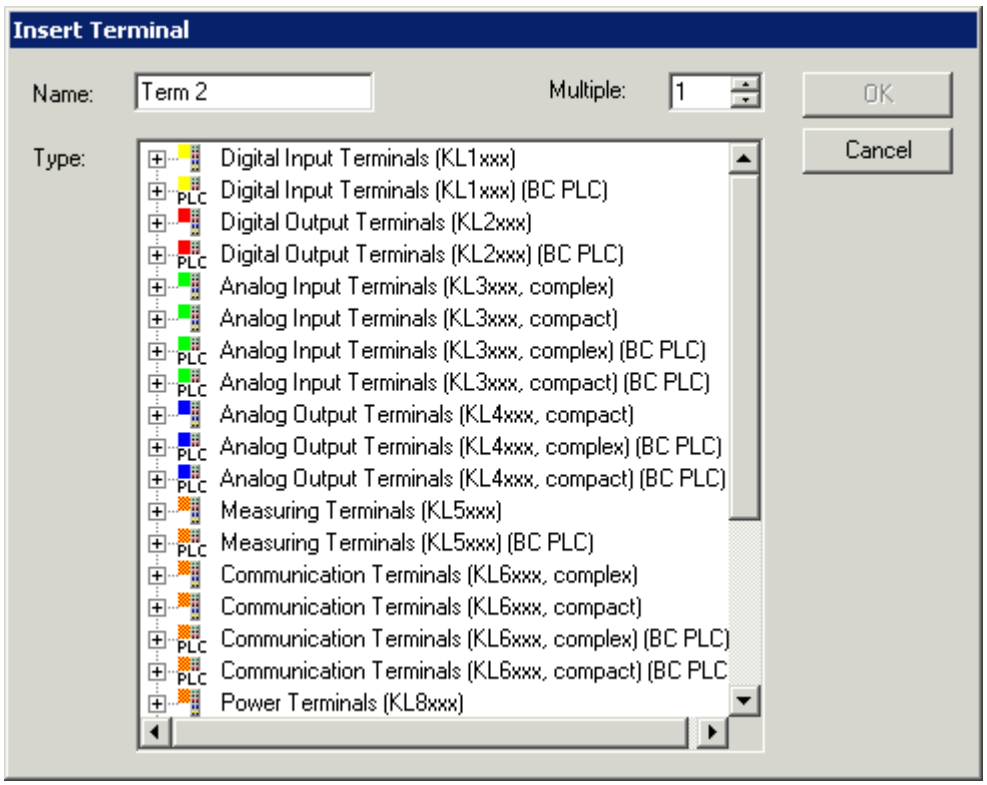


Fig. 15: TwinCAT - Insert Terminal

In the default setting, the PLC variables have 16 byte inputs and 16 byte outputs. The Bus Terminal controllers must be notified of every change.

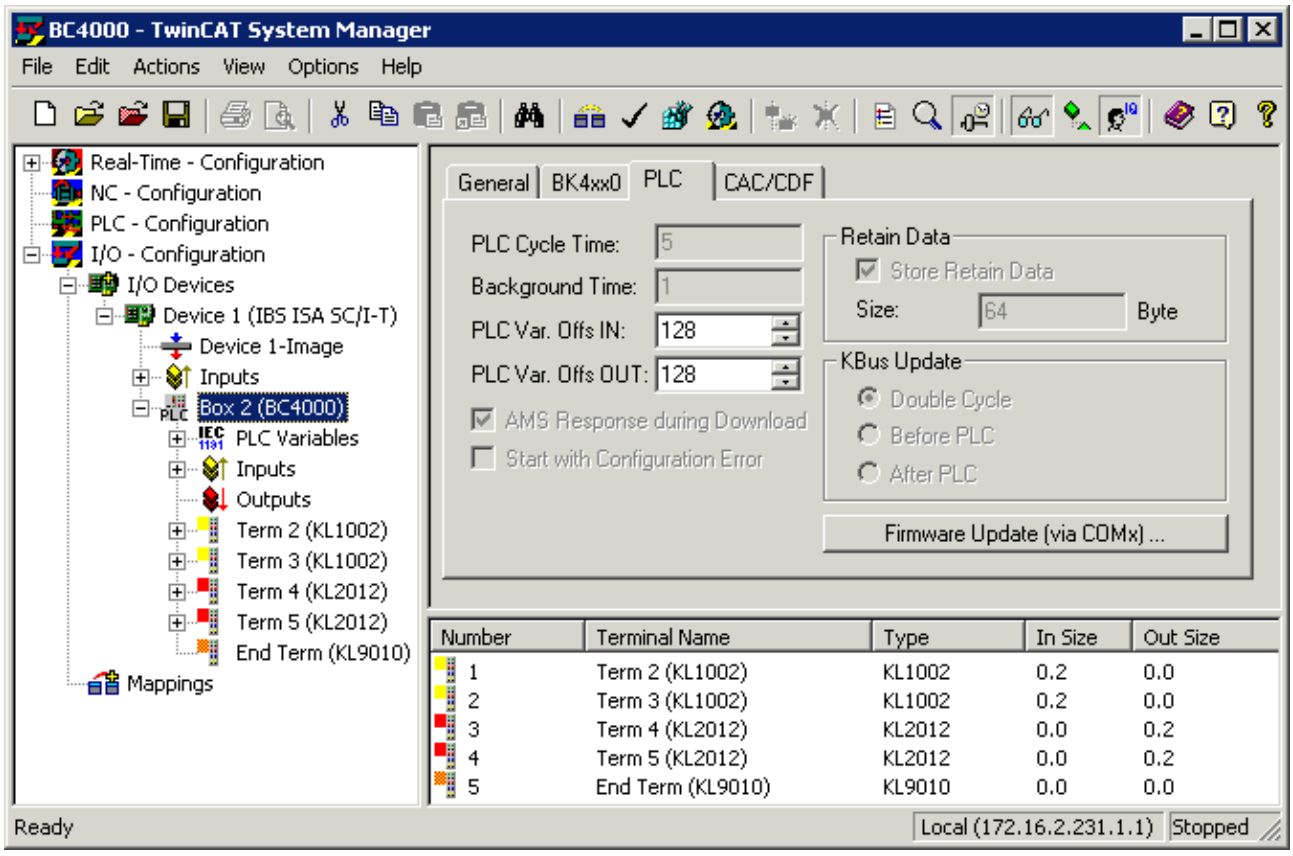


Fig. 16: TwinCAT - PLC Variables

Displaying the local BCxxxx variables

If you do not know the address of the Bus Terminals that you have assigned to the local PLC (BCxx00): Perform your hardware configuration in the System Manager. After you have entered all the Bus Terminals and PLC variables, click with the right mouse button on the BCxx00 in the hardware tree, and select the menu item *Export variables information*.... A file is saved, and this file can be inserted in the System Manager under *Import Project*. Now you will have the entry *TwinCAT import* under the global variables, and you will find here all the variables that you have assigned to the local PLC (BCxx00).

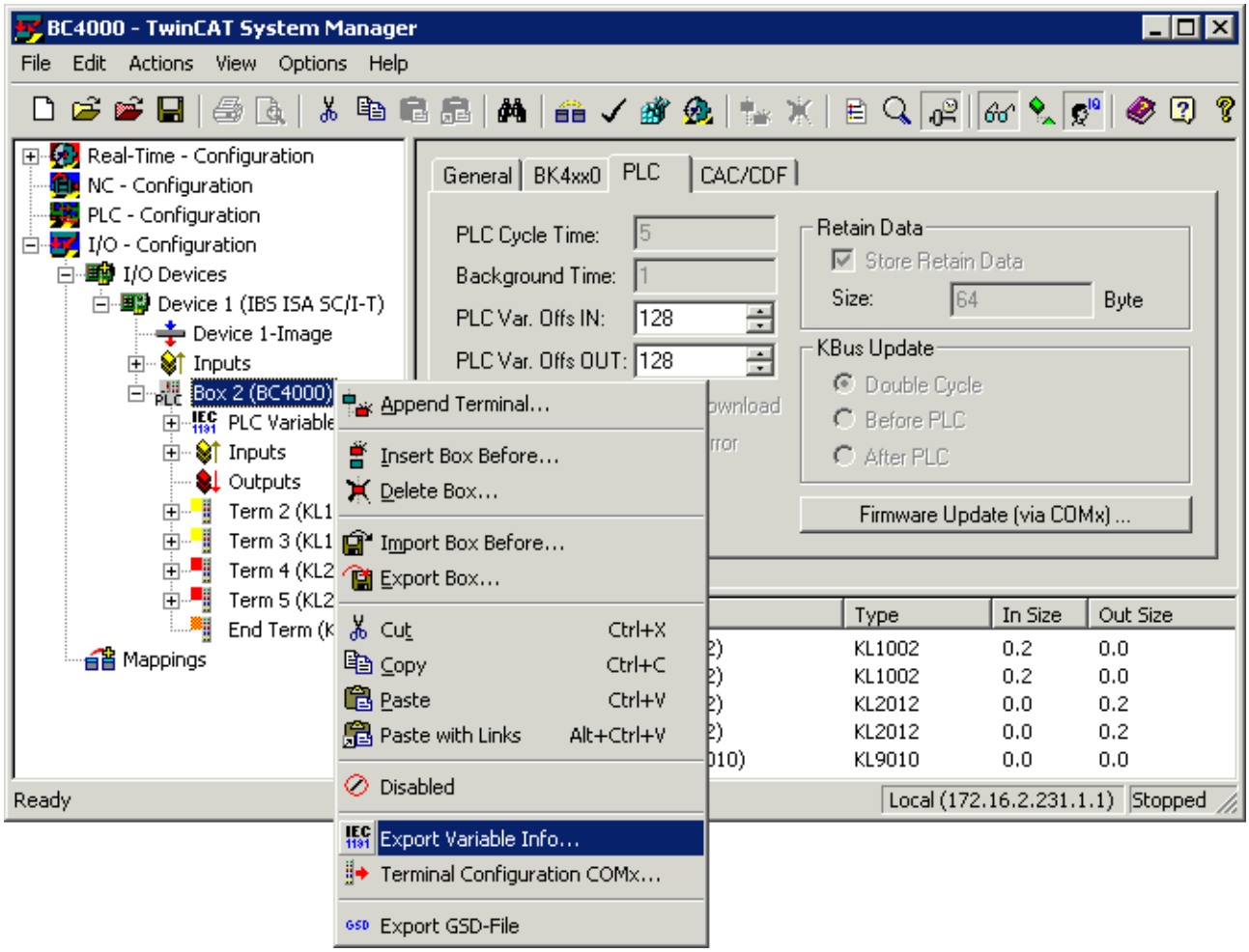


Fig. 17: TwinCAT - Export Variables Info

Bus Terminal configuration, changing PLC variables

The change of the default setting (PLC variables, Bus Terminals) can be downloaded to the Bus Coupler with the KS2000 configuration software or in the TwinCAT System Manager. The Bus Terminal configuration/PLC variables, PLC offset can then be transferred to the Bus Terminal controller with the KS2000 cable.

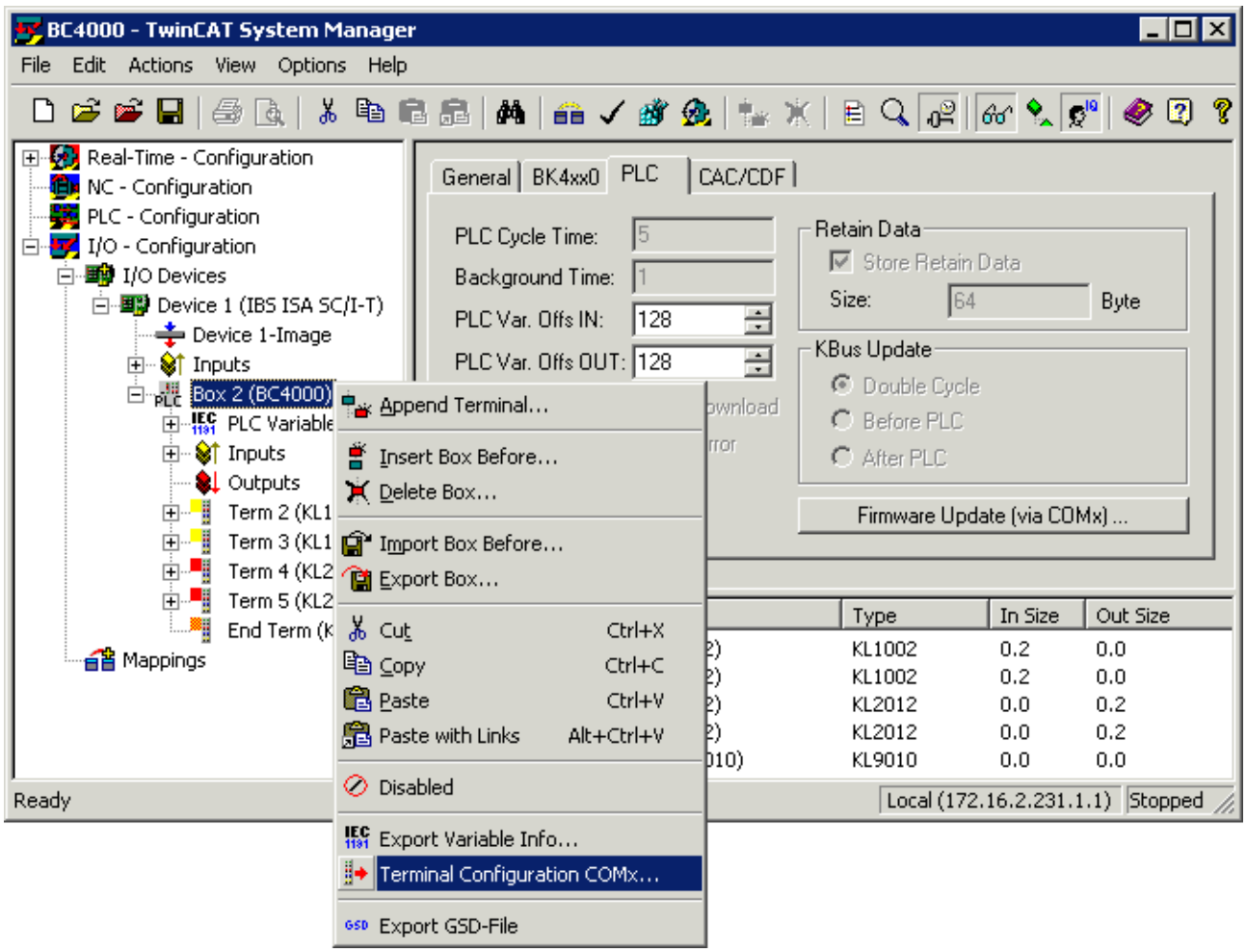


Fig. 18: TwinCAT - Terminal Configuration

6 Programming

6.1 TwinCAT PLC

The Beckhoff TwinCAT Software System turns any compatible PC into a real-time controller with a multi-PLC system, NC axis control, programming environment and operating station. The TwinCAT programming environment is also used for programming the BCxx00 Bus Terminal Controller. If you have installed TwinCAT PLC you can use the fieldbus connection or the serial interface for program downloading and debugging.

Programming via the fieldbus

The following Bus Terminal controllers enable programming with TwinCAT PLC via the fieldbus interface:

BC2000 Lightbus
BC3100, BC3150 PROFIBUS
BC5150 CANopen
BC5250 Device Net
BC9000 Ethernet

Programming via the serial port

Programming with TwinCAT PLC is possible via the serial interface with the following Bus Terminal Controllers:

BC2000: Lightbus
BC3100, BC3150: PROFIBUS
BC4000: Interbus
BC5150: CANopen
BC5250: DeviceNet
BC7300: Modbus
BC8000: RS 485
BC8100: RS 232
BC9000: Ethernet

Program and data memory

The BCxx00 Bus Terminal Controller has 64 kbyte memory in the delivery state. 2 kbyte are required for internal PLC functions. The slider can be individually adjusted in order to increase the program memory or the data memory share. In the large model, the memory allocation is fixed at 96 kbyte for the code and 62 (128) kbyte (BC9000) for the data memory.
Disadvantages of the large model:

- No flow control possible
- Significantly slower execution of the program code (BC9000 only)
- Execution from the flash (max. 25,000 accesses permitted)

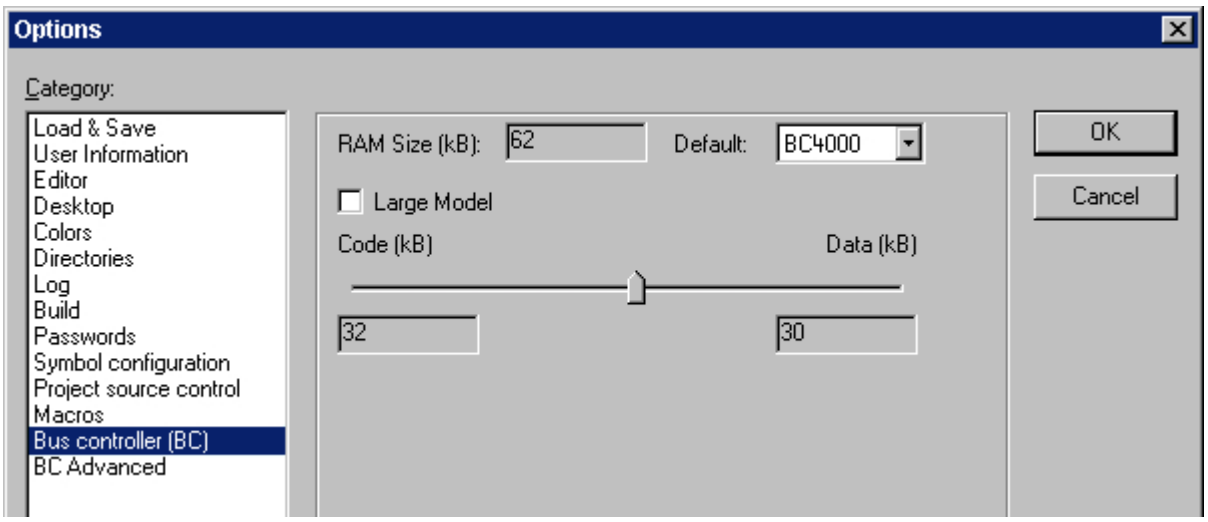


Fig. 19: Program and data memory

6.2 PLC Cycle Time

The PLC cycle time determines the program's repetition frequency. This time is not deterministic. This means that the PLC cycle time can become longer in some programs, and can exceed the cycle time that has been set. If the program requires less time than has been set, it is repeated within the set cycle time, and the remaining duration is padded with background time.
The processing of the Ethernet and the serial interface runs in the background time. This should be set to somewhere between 20 and 50 % of the PLC cycle time.

The *mean cycle* time is measured in order to optimize the system. You will find this in PLC Control under the *Online/Coupler* menu item. About 50 % is added to the time determined there, and the result entered as the PLC cycle time. Set the background time to between 20 and 50 % of the PLC cycle time.

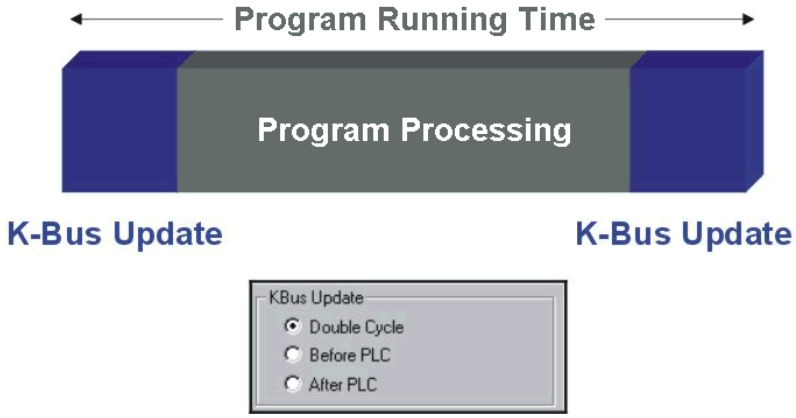


Fig. 20: Program running time

The program running time is composed of the program processing and the K-Bus time. Before the program is called, the Bus Terminal Controller carries out a K-bus update, and reads the current inputs. **Following the processing of the program, a second K-bus update takes place in order to write the outputs. The K-Bus time depends on the number and type of Bus Terminals inserted.**

The program running time can be shortened by operating only one K-Bus cycle, and this may either be done before or after program processing. In that case, inputs are read and outputs written in a single K-Bus cycle. You can make these settings either with the aid of the KS2000 configuration software, or through ADS.

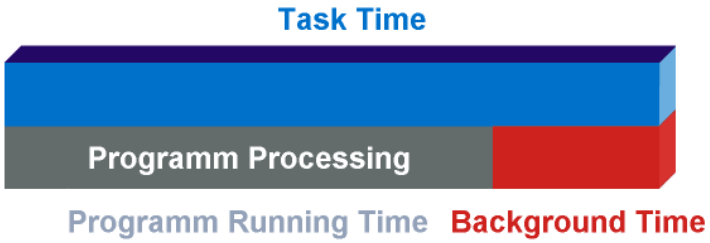


Fig. 21: Task Time

6.3 Remanent and persistent data

There are special flags for remanent and persistent data in the higher memory region.

Remanent data

The remanent data is located in the flags area. The default setting is for 64 remanent bytes, i.e. from %MB0 to %MB63. This region can be expanded to a maximum size of 512 bytes. It should be borne in mind that the task time increases with the quantity of remanent data (approx. 0.5 ms for 512 bytes). The settings for the remanent data can be made via the (TwinCAT) System Manager, or with the KS2000 configuration software (Table 1, Register 15, default value 64 max. 512 bytes).

Persistent data

Persistent data is even more stable, and is retained even through a program download. The number of persistent data must be greater than or equal to the number of remanent data! Like the remanent data, the persistent data is located in the region allocated for flags (%MBxx). You can make the settings for the persistent data using the KS2000 configuration software (Table 1, Register 18, default value 0, max. 512 bytes).

Example

400 bytes of remanent data, of which 200 bytes are to be persistent
Register 15 400 (%MB200 - %MB399)
Register 18 200 (%MB0 - %MB199)

Cycle Time Measuring

The flags area includes a timing system with a resolution of one millisecond for each digit. The data type is UDINT (unsigned double integer). This value can be overwritten by the program, in order to align with a controller. The timer rolls over in about 48 days.

Flag byte	Meaning	
%MB504-507	4 byte	
	Type	UDINT
		0..4.22 billion ms / 0.. about 48 days
	Resolution	1 ms / digit

Diagnostics

It is possible to read the diagnostic data in the Bus Terminal controller. This information is located in the flags area.

Flag byte	Meaning	
%MB508-509	Bit 0	Interbus communication ("1" - no communication)
	Bit 1-15	reserved
%MB510-511	Bit 0	K-bus error
	Bit 1	Configuration error
	Bit 2-15	reserved

6.4 PLC Variables

The PLC variables act as the interface between the local process image of the bus controller and the fieldbus process image for a higher-level controller. This will first be explained on the basis of the default setting.

Bus Terminals in the BC's local process image

All the connected Bus Terminals are assigned to the local process image. The PLC variables are located from address 128 onwards. You can change both this starting address and the length of these data (default 16 bytes).

Data that is to be read by a higher level controller is written into the output process image. This is input data for the higher level controller. Data that is to be transferred from the higher level controller to the BC is output data for the controller and input data for the BC. The following diagram may clarify this.

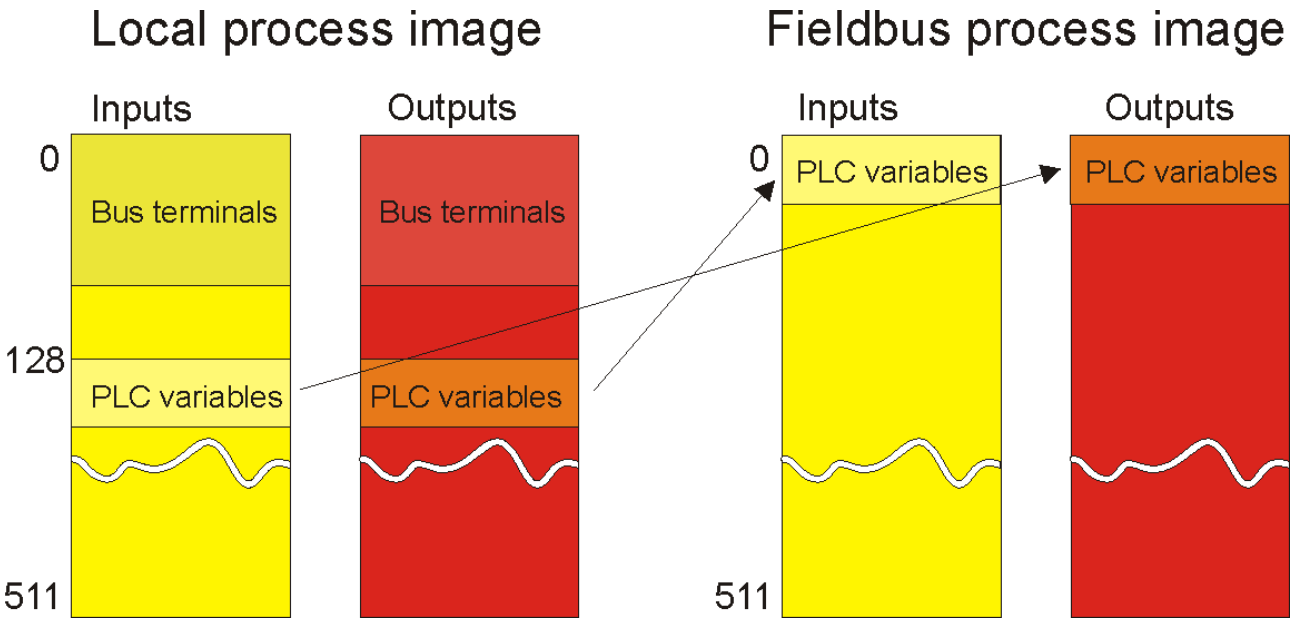


Fig. 22: Bus Terminals in the BC's local process image

Assign bus terminals to the higher level controller

You can also assign the Bus Terminals directly to the higher level controller. The general scheme of the fieldbus process image is such that the analog Bus Terminals are mapped into this process image first. The digital Bus Terminals then follow, while the PLC variables come last.

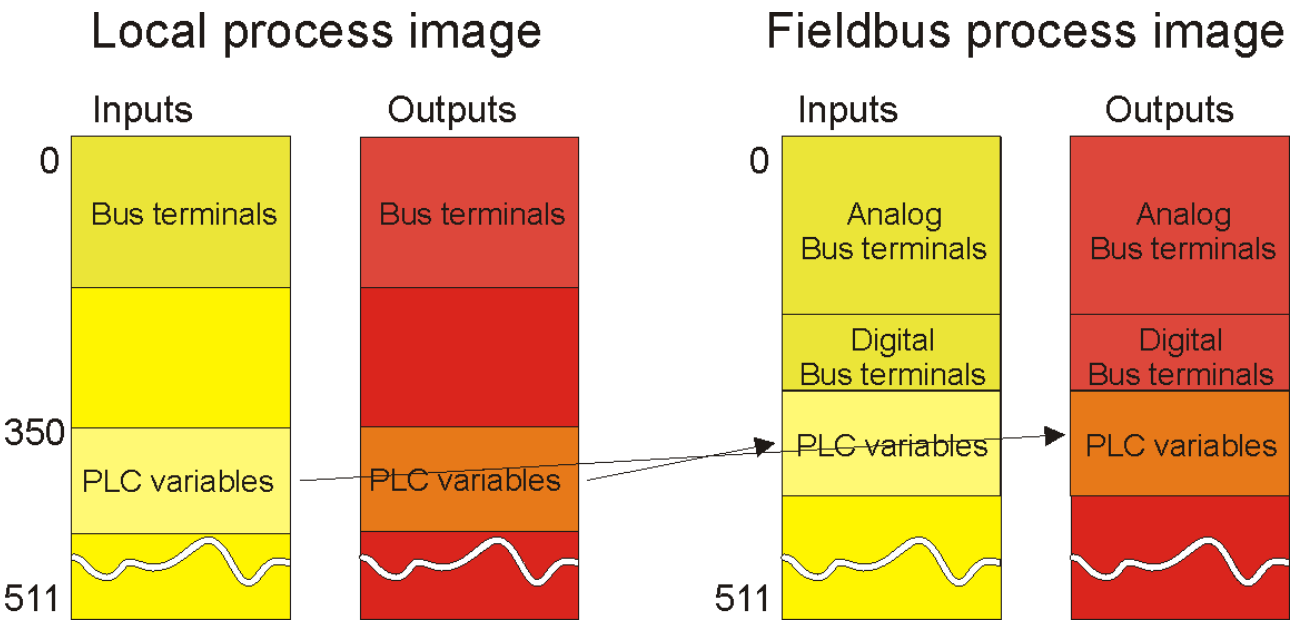


Fig. 23: Assign bus terminals to the higher level controller

Remember that none of the process images in use may be larger than 512 bytes.

6.5 Mapping the Bus Terminals

The precise assignment of the byte-oriented Bus Terminals may be found in the configuration guide for the particular bus terminal. This documentation can be found on the Internet at http://www.beckhoff.de.

Byte oriented Bus Terminals	Bit oriented Bus Terminals
KL15x1	KL10xx, KL11xx, KL12xx, KL17xx, KM1xxx
KL25xx	KL20xx, KL21xx, KL22xx, KL26xx, KL27xx, KM2xxx
KL3xxx	
KL4xxx	
KL5xxx	
KL6xxx	
KL7xxx	
KL8xxx	
	KL9110, KL9160, KL9210, KL9260

6.6 Local process image

All connected bus terminals are assigned in the default setting to the local process image of the BC/BX.

Mapping within the Bus Terminal Controller is carried out according to the following rule:
First come all the complex Bus Terminals, in whatever sequence they are physically inserted, followed by the digital Bus Terminals which are padded to a whole byte.

The default mapping of the complex Bus Terminals is:

- complete evaluation
- Intel format
- Word alignment

Example

1 x BCxxxx or BXxxxx
1 1 x KL1012
2 1 x KL1104
3 1 x KL2012
4 1 x KL2034
5 1 x KL1502
6 1 x KL3002
7 1 x KL4002
8 1 x KL6001
9 1 x KL9010

Bus Terminal	Position	Input image	Output image
KL1502	5	%IB0...%IB5	%QB0...%QB5
KL3002	6	%IB6...%IB13	%QB6...%QB13
KL4002	7	%IB14...%IB21	%QB14...%QB21
KL6001	8	%IB22...%IB29	%QB22...%QB29
KL1012	1	%IX30.0 to %IX30.1	-
KL1104	2	%IX30.1 to %IX30.5	-
KL2012	3	-	%QX30.0 to %QX30.1
KL2034	4	-	%QX30.2 to %QX30.5
KL9010	9	-	-

Address of the Bus Terminals, which you have assigned to local PLCs (BCxx00)

If you don't know the address at which the Bus Terminals are located, which you have assigned to the local PLC of your BC/BX:

Perform your hardware configuration in the System Manager.
Once you have entered all Bus Terminals and PLC variables, right-click on the BC/BX in the hardware tree of the System Manager and select the menu item Export Variable Info...

A file is saved that you can insert in the PLC control under Import Project.

Under the global variables you now have the entry TwinCAT Import in which all variables are located that you have assigned to the local PLC of your BC/BX.

6.7 Interbus process image

Data transferred via the fieldbus are accessible via the PLC variables [▶ 34] for the BCxxxx. In the default setting, 16 bytes of output data are transferred to the Bus Terminal controller, and 16 bytes of input data are read. The local PLC, i.e. the BCxxxx, recognizes the master output data as inputs in the memory area %IB128...143 and writes its output data %QB128...143 to input data in the master control. The offset and the length of the PLC variables [▶ 34] can be changed in Table 1 [▶ 40].

6.8 Programming

6.8.1 Transmission via the serial interface

Everything that can be programmed and parameterized with TwinCAT BC can also be handled with TwinCAT. A special feature of TwinCAT BC is that it operates both under Windows 95/98/ME or under NT/2000/XP. Program download via Ethernet, however, is not possible with TwinCAT BC.

Every Bus Terminal Controller can be programmed via the PC's RS232 interface. A special cable to be used for this purpose is supplied along with TwinCAT BC and the KS2000 configuration software.

Select the serial interface in TwinCAT PLC Control.

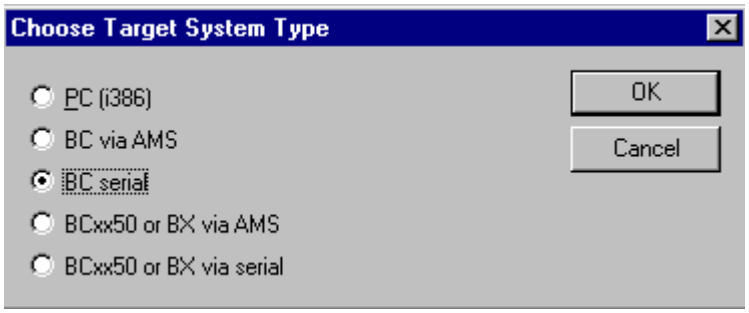


Fig. 24: Selecting the data transfer route - serial interface

The settings for the serial interface, port number, baud rate etc. are found under Online/Communication parameters in PLC Control. The Bus Terminal Controller requires the following setting:
Baud Rate: 19200
Stop bits: 1
Parity: even

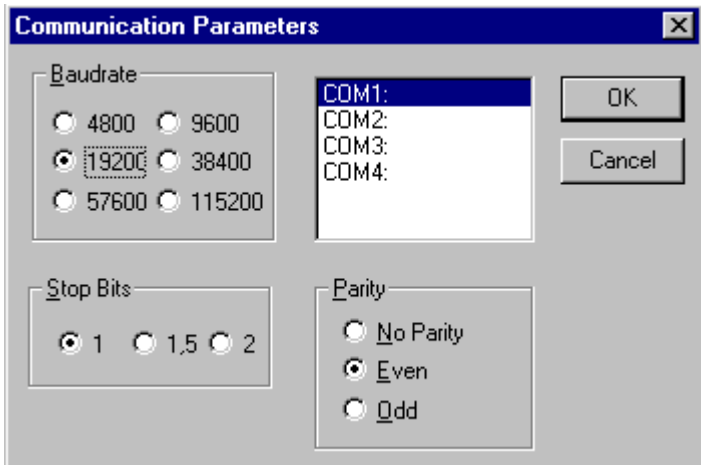


Fig. 25: Parameterization of the serial interface

6.8.2 Overview

Various libraries are available for the Bus Terminal Controllers (Bus Coupler with PLC functionality: BCxxxx) (see Beckhoff Information System).

TwinCAT PLC Library: System BC

The library contains function blocks for access to the Bus Terminal Controller's (BCxxxx) system functions.

TwinCAT PLC Library: Utilities BC

The library contains useful function blocks for the Bus Terminal Controller (BCxxxx). In addition to the RTC blocks, the library contains a function block for decoding the DCF-77 time signal, along with a number of conversion functions. Internally, the Bus Terminal controller's system functions are called.

TwinCAT PLC Library: Helper BC

The *PlcHelper.lb6* library contains a number of functions which provide direct access to memory areas in the Bus Terminal Controller's (BCxxxx) PLC runtime system.

7 Fieldbus system

7.1 Interbus - introduction

Introduction to the system

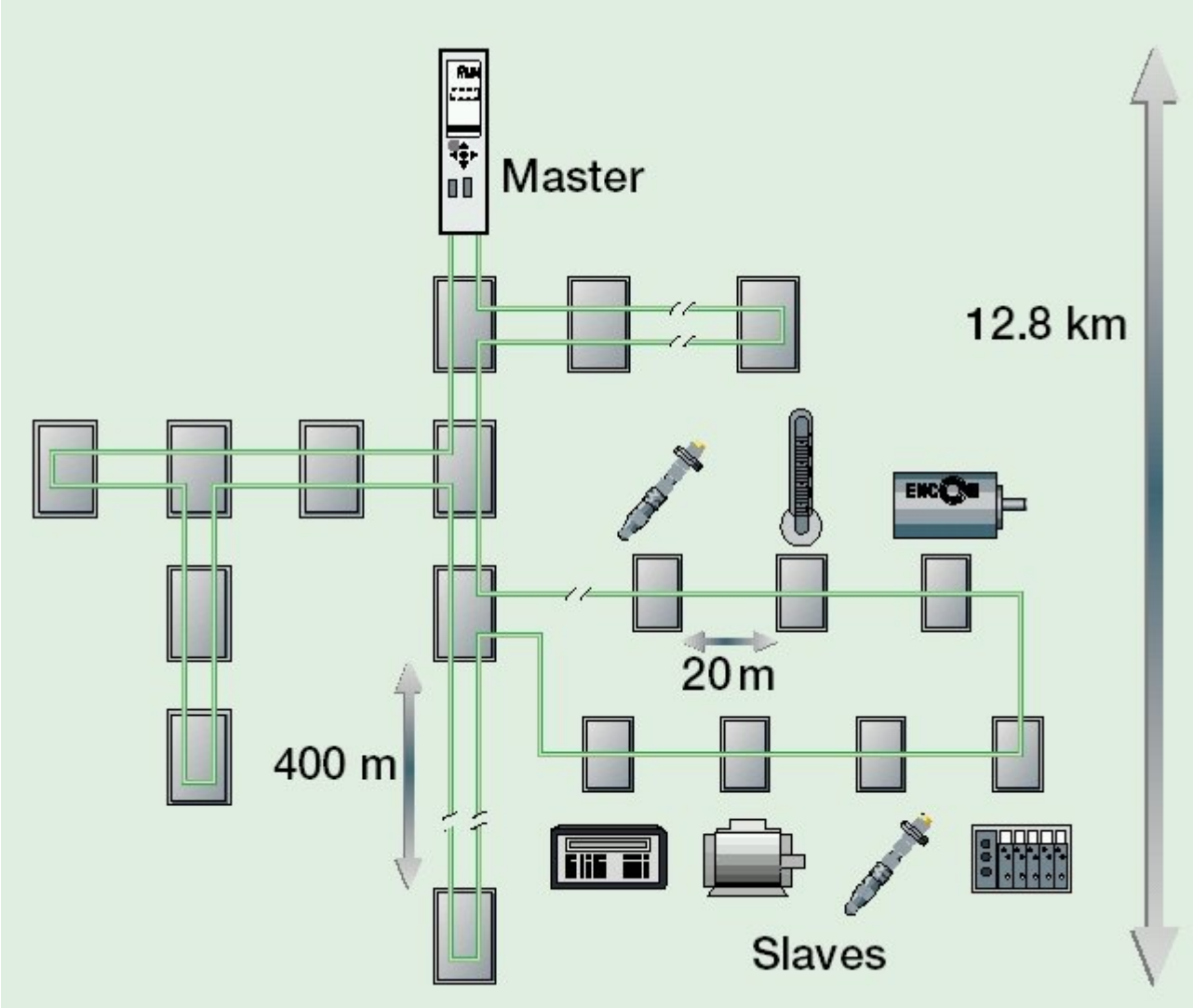


Fig. 26: Interbus data ring

The Interbus system is configured as a data ring with a central master/slave access procedure. It has the structure of a spatial distributed shift register. Each device, with its registers of different length, is part of the shift register ring. The master pushes data through the ring serially. The use of the ring structure offers the option of sending and receiving data simultaneously. The two data directions of the ring are located in a single cable. Each Interbus system device has an ID register (identification register). This register contains information about the module type, the number of input and output registers, and status and error conditions. The Interbus system basically knows two operating modes:

- **The ID cycle**,
  which is carried out for the initialization of the Interbus system and on demand. In the ID cycle, the coupling module reads the ID registers of all devices attached to the bus system and uses this information to build the process image.
- **The data cycle**;
  this is the actual duty cycle dealing with the data transmission. In the data cycle, the input data are transferred from the registers to the coupling module, and the output data from the coupling module the devices.

System configuration and device types

The Interbus club has a large number of different ID codes. Apart from 6 ID codes, Phoenix Contact has assigned these ID codes to couplers with digital and analog periphery. The manufacturer can therefore not be identified via the ID code. (Detailed commentary in Chapter "ID code and ID length"). The handling of the BK4xx0/BC4xx0 Interbus couplers does not differ from the equipment of other manufacturers.

7.2 Description of parameters

7.2.1 Bus Terminal Controller properties

7.2.1.1 Register settings, Table 0

Using the KS2000 configuration software you can set the register values via the dialog window or write them directly into the registers.

Register	Description	Default	Bus Terminal Controller
19	Byte offset digital outputs %Q...	0	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
20	Byte offset digital inputs %I...	0	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000

7.2.1.2 Register settings, Table 1

Using the KS2000 configuration software you can set the register values via the dialog window or write them directly into the registers.

Register	Description		Default	Bus Terminal Controller
0	Byte offset PLC variables %I.		128	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
1	Length of the PLC variables %I...		16	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
2	Byte offset PLC variables %Q...		128	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
3	Length of the PLC variables %Q...		16	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
4-11	Bus Terminal assignment			BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
4.0-4.1	Assignment of the 1st Bus Terminal		11_{bin}	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
	0_{bin}	Fieldbus process image complex		
	10_{bin}	Fieldbus process image compact		
	11_{bin}	Local process image		
4.2-4.3	Assignment of the 2st Bus Terminal		0_{bin}	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
m.n-1..m.n	Assignment of the nth Bus Terminal		0_{bin}	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
12	PLC cycle time		5 ms (20 ms in the case of BC9000/BC9100)	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
13	Background Time		2 ms (10 ms in the case of BC9000/BC9100)	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
14.0	Activate remanent data		1_{bin}	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
14.2-14.3	Execution of the K-Bus update		0_{bin}	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
	0_{bin}	before and after the PLC		
	01_{bin}	before the PLC		
	10_{bin}	after the PLC		
14.6	Switch on Bus Terminal checking		1_{bin}	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
15	Size of the NOVRAM (remanent data)		64 [bytes]	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
17.0-17.7	Terminal bus autorefresh: Cycle in [ms]		0x0000 Disable (0x005F in the case of BC9000) (0x035F in the case of BC9100)	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
17.8-17.15	Terminal bus autorefresh: max. retries			
18	Size of the NOVRAM Persistent data R18<R15		0	BC2000, BC3100, BC4000, BC7300, BC8x00, BC9000
27	Byte offset KL6xx1 bus terminal emulation %Q...		500	BC8x00
28	Byte offset KL6xx1 bus terminal emulation %I...		500	BC8x00
32	Baud rate		2	BC8x00
	0	38400Bd		
	1	19200Bd		
	2	9600Bd		
	3	57600Bd		
	4	1200Bd		
	5	2400Bd		
	6	4800Bd		
33	Mode		2	BC8x00
	0	7 data bits, even parity		
	1	7 data bits, odd parity		
	2	8 data bits, no parity		
	3	8 data bits, even parity		
	4	8 data bits, odd parity		
34	Number of stop bits		0	BC8x00
	0	one stop bit		
	1	two stop bits		

7.3 Topology

- Ring bus system with active coupling
- 400 m between two fieldbus devices
- 12.8 km total length
- max. number of devices 256

All Beckhoff Bus Couplers BK4xxx and BC4000 are remote bus devices and can only be operated as such on the INTERBUS.

Coupling modules

Examples for INTERBUS master controls:

PC cards:
Hilscher CIF 30-IBM
Hilscher CIF 40-IBM
Hilscher CIF 50-IBM
Hilscher CIF 60-IBM
Hilscher CIF 104-IBM
Phoenix IBS PC ISA SC/I-T
Phoenix IBS PC ISA SC/RI/RT-LK
Phoenix IBS PC PCI SC/I-T
Phoenix IBS PC PCI SC/RI/RT-LK

Modules:
Phoenix IBS S5 DCB/I-T
Phoenix IBS S5 DSC/I-T
Phoenix 100 CB-T

7.4 Propagation delay and reaction time of the Interbus

The transmission of the signals from the input into the controller and from the controller to the outputs is subject to a propagation delay. **It is composed of a number of elements: Transmission from the controller into the master; transmission via the Interbus and transmission from the Bus Coupler to the outputs, this applies in the reverse order to the return path.** Please refer to the master manufacturer's data for the reaction time from the controller to the master. The newly transmitted data only become valid after the complete transmission of a cycle. The reaction time TIBS on the INTERBUS is composed as follows. The constants SW, M, N and TBIT form the sum for the cycle time in milliseconds. The reaction in the worst case is 2 x cycle time, as the data only become valid after the end of the cycle.

TIBS = (SW + (13 x (6 + N) + 1.5 x M) x TBIT) x 2
SW = 0.2 ms
M = number of Bus Couplers
N = number of the effective byte lengths
TBIT = 0.002 ms
Observe the number of bytes and not the word length when calculating the times.

Delays in the case of transmission errors

Observe special delays in the case of transmission errors. The Interbus requires 5 cycle times before the next valid data can be exchanged.

8 Error handling and diagnosis

8.1 Diagnostic LEDs

After switching on, the Bus Coupler immediately checks the connected configuration. Error-free start-up is indicated when the red *I/O ERR* LED goes out. If the *I/O ERR* LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error.

The Bus Coupler has two groups of LEDs for the display of status. The upper group with four LEDs indicates the status of the respective fieldbus. The significance of the fieldbus status LEDs is explained in the appropriate sections of this manual. It corresponds to the usual fieldbus display.

On the upper right hand side of the Bus Couplers are two more green LEDs that indicate the supply voltage. The left hand LED indicates the presence of the 24 V supply for the Bus Coupler. The right hand LED indicates the presence of the supply to the power contacts.

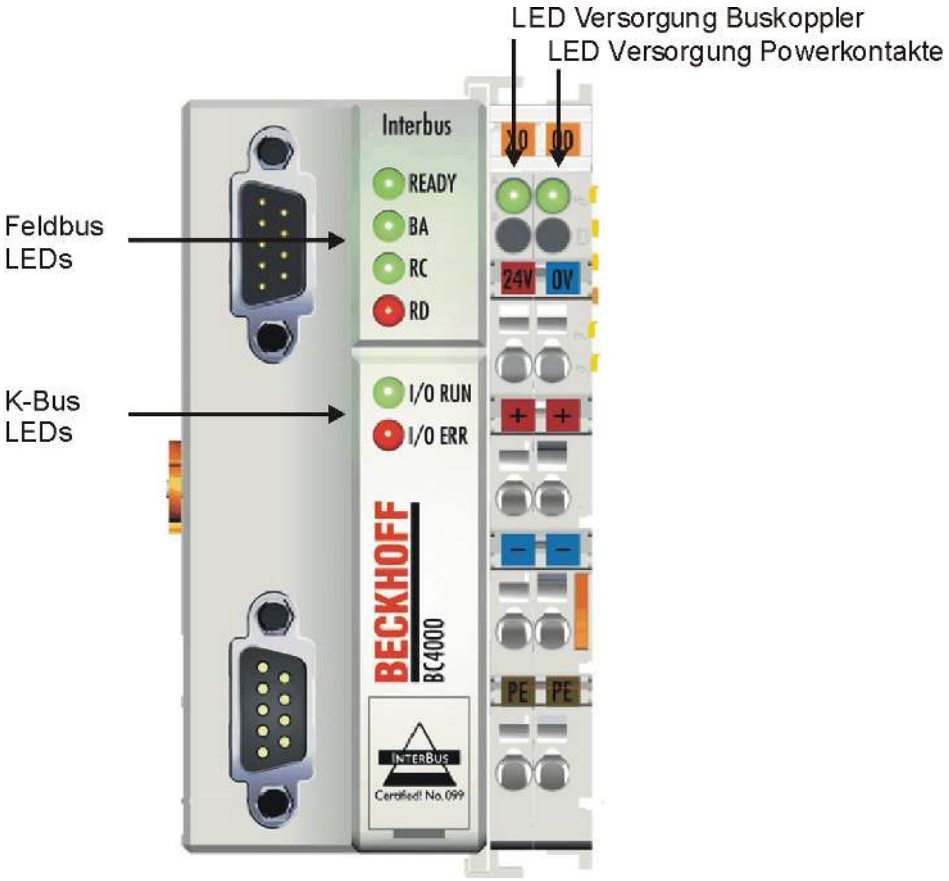


Fig. 27: BC4000 - Diagnostic LEDs

LEDs for power supply diagnostics

LED	Meaning
Left LED off	Bus Coupler has no power
Right LED off	No power supply 24 V_{DC} connected at the power contacts

LEDs for fieldbus diagnosis

The four upper left LEDs indicate the operating status of the INTERBUS communication.

Ready	BA	RC	RD	Meaning	Remedy
on	off	off	off	The Bus Coupler is operational	
on	on	on	off	Remote bus active Data transmission with master running	
on	off	on	off	Incoming remote bus connection is established, no communication	
on	on	off	on	Remote continuation bus is switched off due to cable fault or by the master	Find cable interruption or short circuit, switch over master
off	off	off	off	No function, power failure	

LEDs for K-bus diagnostics

Two LEDs, the "I/O LEDs", in the area below the fieldbus status LEDs referred to above, serve to indicate the operating status of the Bus Terminals and the connections to these terminals. The green LED lights up in order to indicate fault-free operation. "Error-free" means that the communication with the fieldbus system is also running. The red LED blinks with two different frequencies in order to indicate an error. The error is encoded in the blinks as follows:

Flashing Codes

Fast blinking	Start of the error code
First slow sequence	Error code
Second slow sequence	Error code argument

Fig. 28: Start of the Error Code Error code Error argument

Error code	Error code argument	Description	Remedy
Persistent, continuous flashing		EMC problems	- Check power supply for overvoltage or undervoltage peaks - Implement EMC measures - If a K-Bus error is present, it can be localized by a restart of the coupler (by switching it off and then on again)
1 pulse	0	EEPROM checksum error	Enter factory settings with the KS2000 configuration software
	1	Code buffer overflow	Insert fewer Bus Terminals. Too many entries in the table for the programmed configuration
	2	Unknown data type	Software update required for the Bus Coupler
2 pulses	0	Programmed configuration has an incorrect table entry	Check programmed configuration for correctness
	n (n > 0)	Table comparison (Bus Terminal n)	Incorrect table entry
3 pulses	0	K-bus command error	- No Bus Terminal inserted - One of the Bus Terminals is defective; halve the number of Bus Terminals attached and check whether the error is still present with the remaining Bus Terminals. Repeat until the defective Bus Terminal is located.
4 pulses	0	K-bus data error, break behind the Bus Coupler	Check whether the n+1 Bus Terminal is correctly connected; replace if necessary.
	n	Break behind Bus Terminal n	Check whether the KL9010 Bus End Terminal is connected
5 pulses	n	K-bus error in register communication with Bus Terminal n	Exchange the nth Bus Terminal
6 pulses	0 ,n (n>0)	Data width more than 32 words at the Bus Coupler	Reduce the fieldbus data
7 pulses *	0	Note: cycle time was exceeded (see Table 1, Register 17 [▶ 40])	Warning: the set cycle time was exceeded. This indication (flashing LEDs) can only be cleared by booting the Bus Coupler again. Remedy: increase the cycle time
9 pulses *	0	Checksum error in Flash program	Transmit program to the BC again
	1	Incorrect or faulty library implemented	Remove the faulty library
10 pulses *	n	Bus Terminal n is not consistent with the configuration that existed when the boot project was created	Check the nth Bus Terminal. The boot project must be deleted if the insertion of an nth Bus Terminal is intentional.
14 pulses	n	nth Bus Terminal has the wrong format	Start the Bus Coupler again, and if the error occurs again then exchange the Bus Terminal
15 pulses	n	Number of Bus Terminals is no longer correct	Start the Bus Coupler again. If the error occurs again, restore the manufacturers setting using the KS2000 configuration software
16 pulses	n	Length of the K-bus data is no longer correct	Start the Bus Coupler again. If the error occurs again, restore the manufacturers setting using the KS2000 configuration software

The number of pulses in the fault segment indicates the position of the last Bus Terminal before the fault. Passive Bus Terminals, such as a power feed terminal without diagnostics, are not included in the count. When the error is rectified, the Bus Coupler does not stop flashing. The Bus Coupler stays in the "Stop" state. The Bus Coupler can only be re-started by switching the power supply off and on again. Insertion and removal of Bus Terminals is only permitted when switched off. The electronics in the Bus Terminals and in the Bus Coupler are protected to a large measure against damage, but incorrect function and damage cannot be ruled out if they are plugged in under power.

8.2 General errors

Mapping of the digital and the byte-oriented Bus Terminals onto a fixed address

- **Problem**
  You want a constant start address for the digital inputs and outputs.
- **Solution**
  With the KS2000 software, you can enter an offset start value for the digital inputs and outputs in table 0. The byte-oriented Bus Terminals should not jut into this process image, i.e. no overlap should occur. Table 0: Register 19 Offset for digital outputs, Register 20 Offset for digital inputs: "0" is the default setting (automatic Bus Terminal mapping)
- **Example**
  You have a KL3002 and a KL2012. In the default case, the KL3002 maps onto %IB0- %IB7 and %QB0-QB7 in the memory. The digital output terminal would now map to %QX8.0 and %QX8.1. As soon as you now plug another byte-oriented Bus Terminal, the process image of the digital Bus Terminal is moved to a higher memory. You can now pre-empt this by entering 20 in register 19. This means that KL2012 now maps onto %QX20.0 and %QX20.1.

Drop of the digital outputs

- **Problem**
  Your digital outputs drop away.
- **Solution**
  Your program takes longer than 100 ms. Because the internal K-Bus runs synchronous with your PLC program, it is no longer triggered early enough, and the Bus Terminal watchdog becomes active. This can be rectified by triggering a short refresh of the K-Bus. The setting can be carried out with the KS2000 software. Table 1 Register 17 LowByte cycle time for K-Bus refresh (<= 80 ms) HighByte Retries
- **Recommendation**
  Enter 0x0350 in Table 1 Register 17. This means three retries, once every 80 ms. Note that this causes the Bus Terminal watchdog to increase to 240 ms during a fault condition (this is not true in case of a K-Bus error, where the watchdog will remain at 100 ms).

9 Appendix

9.1 Bibliography

Interbus

www.Interbusclub.com

9.2 General operating conditions

The following conditions must be met in order to ensure flawless operation of the fieldbus components.

Environmental conditions

Operation

The components may not be used without additional protection in the following locations:

- in difficult environments, such as where there are corrosive vapors or gases, or high dust levels
- in the presence of high levels of ionizing radiation

Condition	Permissible range
Permissible ambient temperature during operation	see technical data
Installation position	variable
Vibration resistance	conforms to EN 60068-2-6
Shock resistance	conforms to EN 60068-2-27
EMC immunity	conforms to EN 61000-6-2
Emission	conforms to EN 61000-6-4

Transport and storage

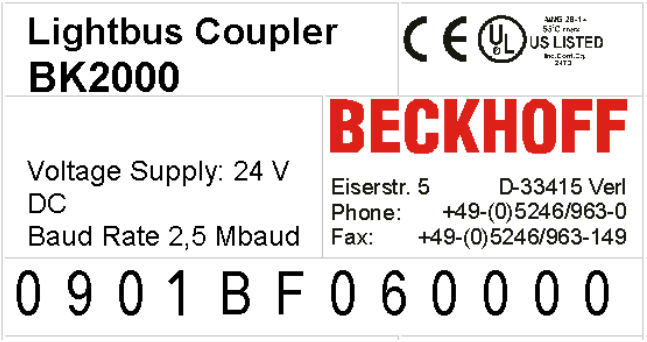
Condition	Permissible range
Permissible ambient temperature during storage	-25°C... +85°C
Relative humidity	95 %, no condensation
Free fall	up to 1 m in the original packaging

Protection classes and types

Condition	Permissible range
Protection class in accordance with IEC 536 (VDE 0106, Part 1)	A protective conductor connection to the profile rail is necessary!
Protection class conforms to IEC 529	IP20 (protection against contact with a standard test finger)
Protection against foreign objects	Less than 12 mm in diameter
Protection against water	no protection

Component identification

Every supplied component includes an adhesive label providing information about the product's approvals. For sample, on the BK2000 Bus Coupler:



The following information is printed on the label:

Printed item	Meaning for this label
Precise product identification	Lightbus Coupler BK2000
Supply voltage Us	24 V_{DC} (Use a 4 A fuse or a Class 2 power supply to meet UL requirements)
Data transfer rate	2.5 Mbaud
Manufacturer	Beckhoff Automation GmbH & Co. KG
CE mark	Conformity mark
UL mark 	Mark for UL approval. UL stands for the Underwriters Laboratories Inc., the leading certification organization for North America, based in the USA. C = Canada, US = USA, UL file number: E172151
Production identification	From left to right, this sequence of characters indicates the week of production (2 characters), the year of production (2 characters), the software version (2 characters) and hardware version (2 characters), along with any special indications (4 characters). In this case the device is a BK2000 - produced in calendar week 9 - of 2001 - with firmware version BF - in hardware version 6 - without special designation

9.3 Approvals

UL E172151

Conformity mark

CE

Protection class

IP20 conforms to EN60529

9.4 Test standards for device testing

EMC

EMC immunity

EN 61000-6-2

Electromagnetic emission

EN 61000-6-4

Vibration / shock resistance

Vibration resistance

EN 60068-2-6

Shock resistance

EN 60068-2-27

9.5 List of Abbreviations

IP (20)

Bus Terminal protection class

IPC

Industrial PC

I/O

Inputs and outputs

K-bus

Terminal bus

KS2000

Configuration Software

PE

The PE power contact can be used as a protective earth.

TwinCAT

The Windows Control and Automation Technology

9.6 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

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- and extensive training program for Beckhoff system components

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- spare parts service
- hotline service

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