BC3150 - Bus Terminal Controller for PROFIBUS

Version: 1.1.0
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BECKHOFF

Contents

BC3150 - Bus Terminal Controller for PROFIBUS

1. Foreword

Notes on the Documentation

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 following notes and explanations are followed when installing and commissioning these components.

Liability Conditions

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.

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. None of the statements of this manual represents a guarantee (Garantie) in the meaning of § 443 BGB of the German Civil Code or a statement about the contractually expected fitness for a particular purpose in the meaning of § 434 par. 1 sentence 1 BGB. In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning. 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.

Safety Instructions

Safety Rules

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.

State at Delivery

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.

Personnel Qualification

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

Description of safety symbols

The following safety symbols are used in this operating manual. They are intended to alert the reader to the associated safety instructions.

Danger

This symbol is intended to highlight risks for the life or health of personnel.

Warning

This symbol is intended to highlight risks for equipment, materials or the environment.

Note

This symbol indicates information that contributes to better understanding.

Documentation Issue Status

Version	Comment
1.1.0	Notes to meet the UL requirements added.
1.0.1	• Chapter *Creating a boot project* corrected • minor routine corrections (typing errors, orthography etc.) • English version available
1.0.0	First release (only German version available)

Firmware BC3150

To make a firmware update, you need a serial cable and the KS2000 Configuration Software or the firmware update program.

Firmware	Comment
0xB0	Firmware Version 0xB0

The firmware and hardware version (delivery status) can be found on the label at the bottom of the Bus Terminal Controller.

2. Product Overview

BCxx50 - Overview

Bus Terminal Controllers are Bus Couplers with integrated PLC functionality. The BCxx50 Bus Terminal Controllers have a fieldbus interface, are intelligent slaves and can be used as remote intelligence within the system. They are located in a cost-optimized and compact housing. In contrast to the BCxx00 range, the BCxx50 range supports up to 255 Bus Terminals via the K-Bus extension.
The Bus Terminal Controller is programmed using the TwinCAT programming system according to IEC 61131-3. The BCxx50 configuration/programming interface is used for loading the PLC program. If the TwinCAT software PLC is in use, the PLC program can also be loaded via the fieldbus.

The inputs and outputs of the connected Bus Terminals are assigned in the default setting of the mini-PLC. Each individual Bus Terminal can be configured in such a way that it exchanges data directly through the fieldbus with the higher-level automation device. Similarly, pre-processed data can be exchanged between the Bus Terminal Controller and the higher-level controller via the fieldbus.

Fieldbus interface

The variants of the BCxx50 series Bus Terminal Controllers differ in terms of their fieldbus interfaces. Five different versions cover the main fieldbus systems:

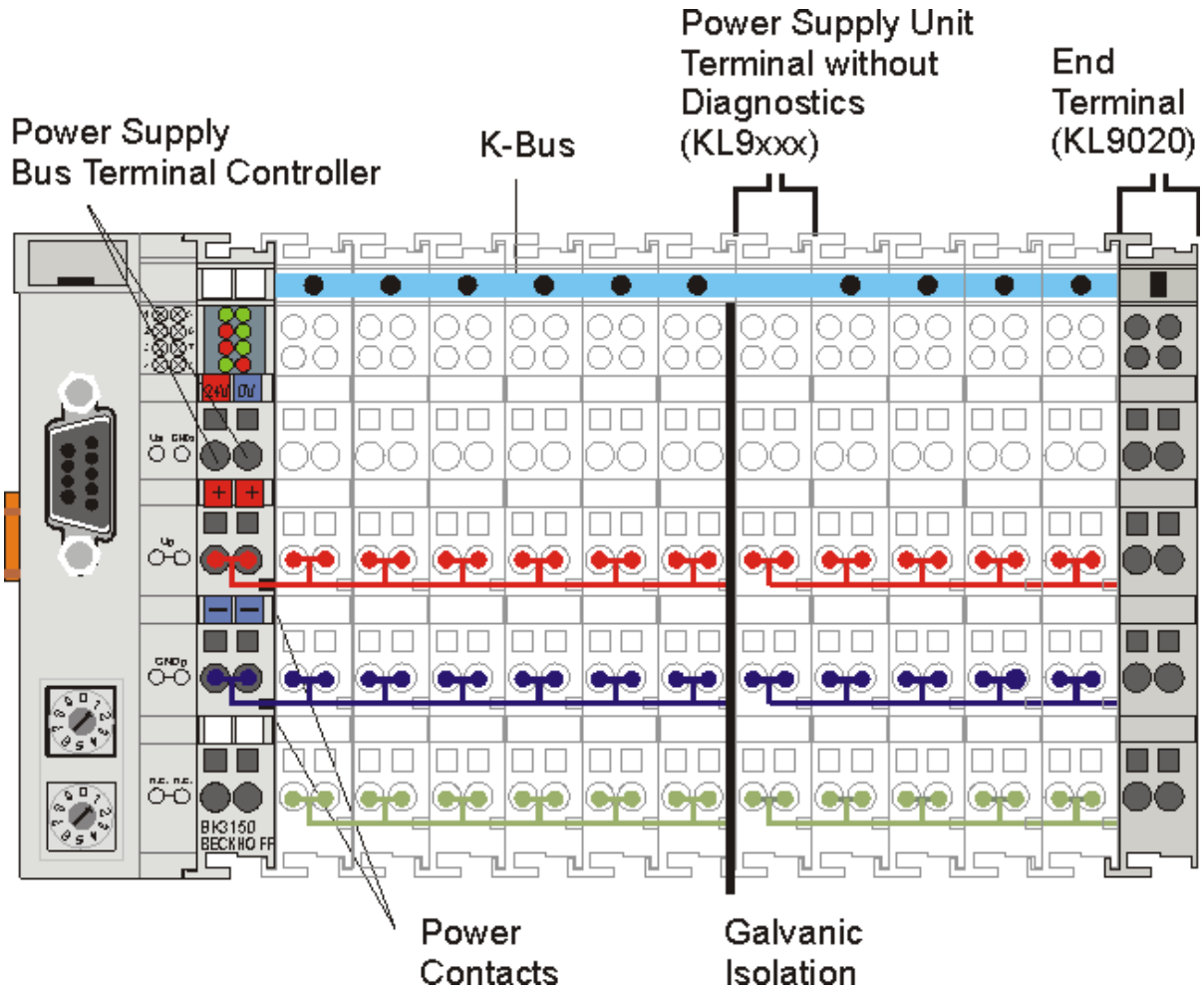
- BC3150: PROFIBUS DP
- BC5150: CANopen
- BC5250: DeviceNet
- BC8150: RS232 or RS485 (without fieldbus interface)

Programming

The BCxx50 devices are programmed according to the powerful IEC 61131-3 standard. Like for all other BECKHOFF controllers, the TwinCAT automation software is the basis for parameterization and programming. Users therefore have the familiar TwinCAT tools available, e.g. PLC programming interface, System Manager and TwinCAT Scope. Data is exchanged optionally via the serial port (COM1) or via the fieldbus through BECKHOFF PC FCxxxx fieldbus cards.

Configuration
The configuration is also carried out using TwinCAT. The fieldbus interface can be configured and parameterized via the System Manager. The System Manager can read all connected devices and Bus Terminals. After the parameterization, the configuration is saved on the BCxx50 via the serial interface. The configuration thus created can be accessed again later.

The Principle of the Bus Terminal



The Beckhoff Bus Terminal System

Up to 64 Bus Terminals each having 2 I/O channels for each 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. For each technical signal form, terminals are available each having two I/O channels, and these can be mixed in any order. 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.

Assembly on standardized C mounting rails

The easy, space-saving, assembly on a standardized C-rail, and the direct wiring of actuators and sensors, without cross-connections between the terminals, standardizes the installation. The consistent labelling scheme also contributes.

The small physical size and the great flexibility of the Bus Terminal system allows 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 terminals can be used within one terminal strip. 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.

Technical Data

Technical Data - BCxx50

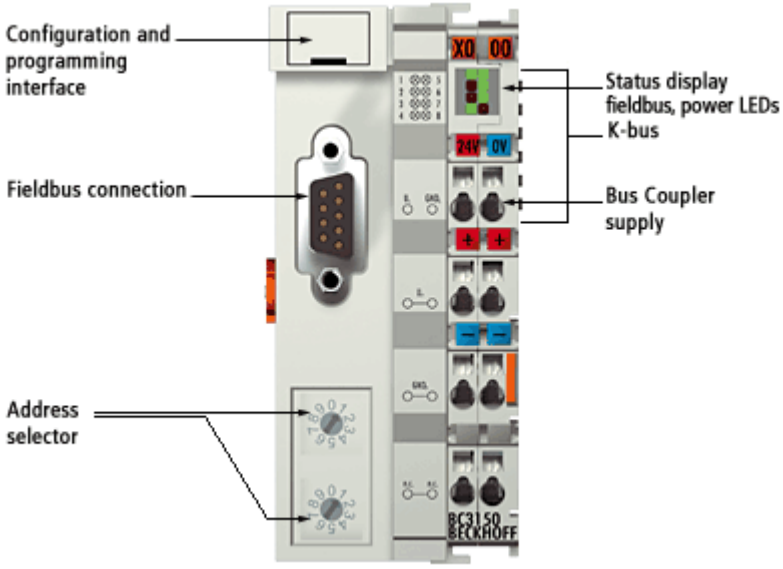
Technical data	BCxx5x
Processor	16 bit micro-controller
Diagnostic LEDs	2 x power supply, 2 x K-Bus
Configuration and programming software	TwinCAT PLC

Fieldbus interface	BC3150	BC5150	BC5250	BC8150	-
Fieldbus	PROFIBUS DP	CANopen	DeviceNet	- Serial ADS - KS8000 Protocol - ModbusRTU - ModbusASCII	-
Interfaces					
Serial interface	COM1 (RS232 for configuration and programming, automatic baud rate detection 9600/19200/38400/57600 baud)				
Terminal Bus (K-Bus)	64 (255 with K-Bus extension)				

Technical data	BC3150	BC5150	BC5250	BC8150	-
Digital peripheral signals	2040 inputs/outputs				
Analog peripheral signals	1024 inputs/outputs				
Configuration possibility	via TwinCAT or the controller				
Maximum fieldbus byte number	depending on fieldbus				
Maximum number of bytes - PLC	2048 bytes of input data, 2048 bytes of output data				
Bus connection	D-sub, 9-pin	Open Style Connector, 5 pin		D-sub, 9-pin	-
Power supply (Us) c UL us LISTED Ind. Cont. Eq.: 24TB For Us and GNDs: Use 4 Amp. fuse or Class 2 power supply. See instructions.	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*!				
Input current (Us)	60 mA + (total K-Bus current)/4				
Starting current	approx. 2.5 x continuous current				
K-Bus current (5 V)	maximum 1000 mA				
Power contact voltage (Up)	maximum 24 V_{DC}				
Power contact current load (Up)	maximum 10 A				
Recommended fuse (Up)	≤ 10 A				
Dielectric strength	500 V_{rms} (power contact / supply voltage / fieldbus)				
Weight	approx. 100 g				
Dimensions (W x H x D)	approx. 44 mm x 100 mm x 68 mm				

Technical data	BC3150	BC5150	BC5250	BC8150	-
Operating temperature	0℃... +55℃				
Storage temperature	-25℃... +85℃				
Relative humidity	95 % no condensation				
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29				
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4				
Installation pos.	Variable				
Protection class	IP20				

Technical Data - PROFIBUS DP



System data	PROFIBUS (BC3150)
Number of I/O modules	126 (BC3150 max. 99 devices)
Number of I/O points	depending on controller
Data transfer medium	shielded copper cable 2 x 0.25 mm², cable type A according to EN 50170
Segment length	up to 1200 m
Number of segments	3
Data transfer rate	up to 12 MBaud
Topology	RS485 line, optical fiber ring
Transmission time	approx. 0.5 ms with 10 stations for 32 bits input/output at 12 MBaud

Technical Data - PLC

PLC data	BCxx5x
Programmability	via serial programming interface or via the fieldbus
Program memory	48 kbyte
Source code memory	128 kbyte
Data memory	32 kbyte
Remanent flags	2 kbyte
PLC cycle time	Approx. 3,0 ms for 1000 IL commands (without I/O cycle)
Programming languages	IEC 6-1131-3 (IL, LD, FBD, ST, SFC)
Run time	1 PLC task
Online Change	Yes
Up/Down Load Code	Yes/Yes

3. Mounting and Wiring

Mounting

Dimensions

The Beckhoff Bus Terminal system 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.

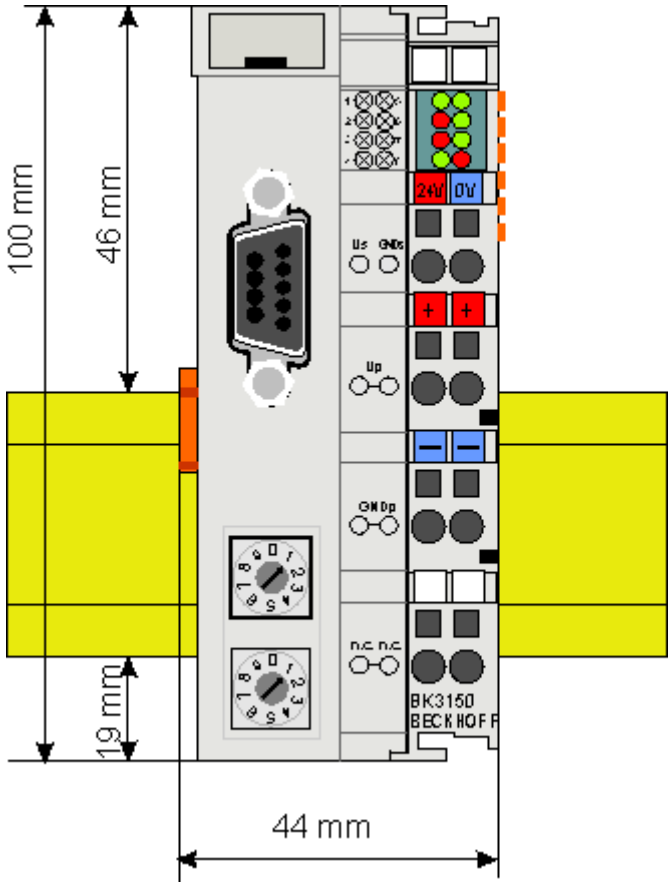


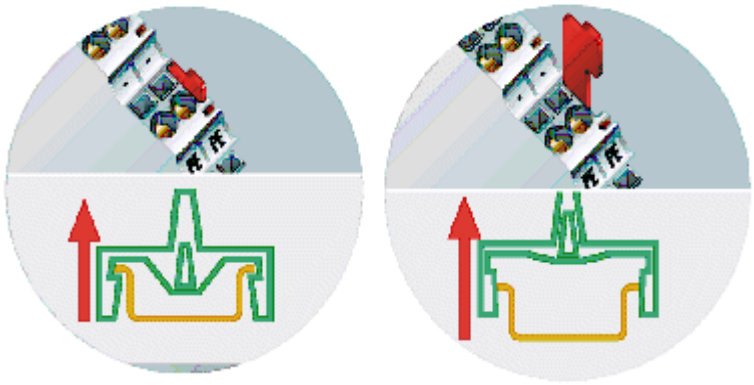
Fig. 1.0 BCxx50

The total width of the fieldbus station is the width of the Bus Coupler/Bus Terminal Controller plus the width of the Bus Terminals being used (incl. KL9010 bus end terminal). Depending on design, the Bus Terminals are 12 or 24 mm wide. The height is 100 mm.

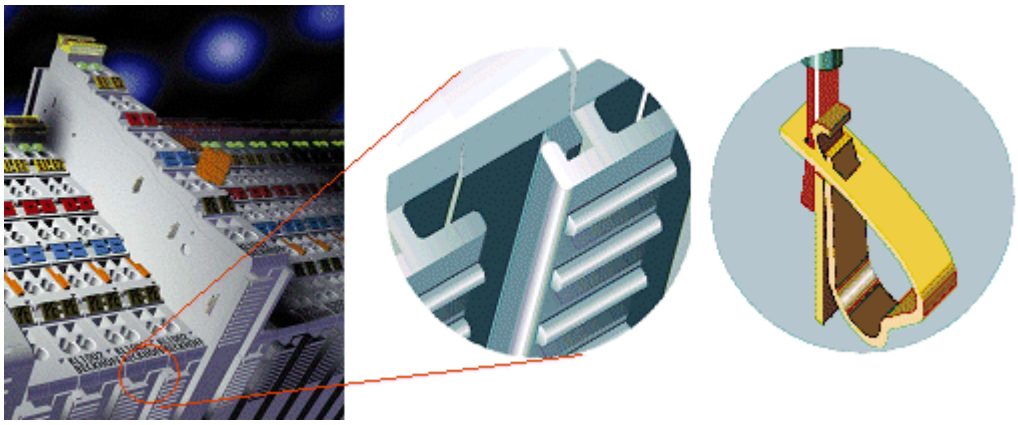
The BCxx50 series Bus Terminal Controllers are 68 mm deep.

Installation

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.



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 can not be made by pushing the housings together on the mounting rail. When correctly assembled, no significant gap can be seen between the attached housings.



Warning 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.

The right hand part of the Bus Coupler can be compared to a Bus Terminal. Eight connections at the top enable the connection with solid or fine wires from 0.08 mm² to 2.5 mm². The connection is implemented with the aid of a spring device. The spring-loaded terminal is opened with a screwdriver or rod, by exerting gentle pressure in the opening above the terminal. The wire can be inserted into the terminal without any force. The terminal closes automatically when the pressure is released, holding the wire securely and permanently.

Wiring

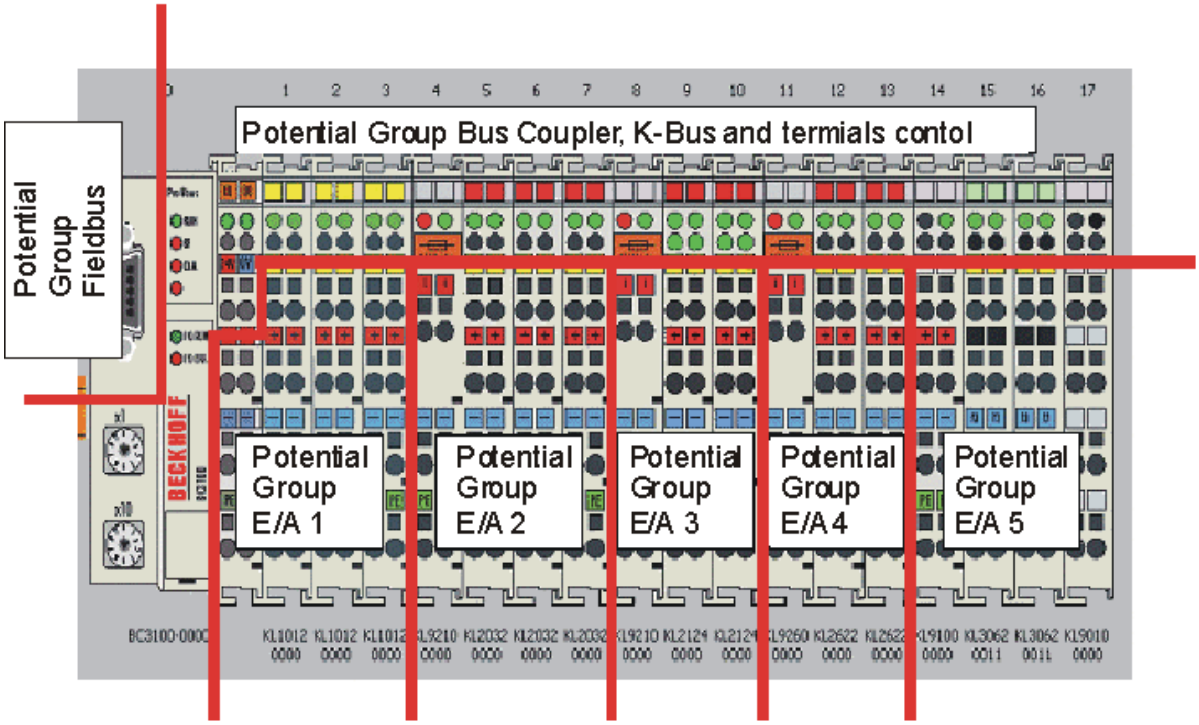
Potential Groups, Insulation Testing and PE

Potential groups

The Beckhoff Bus Terminals stations usually have 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 galvanically separated 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.



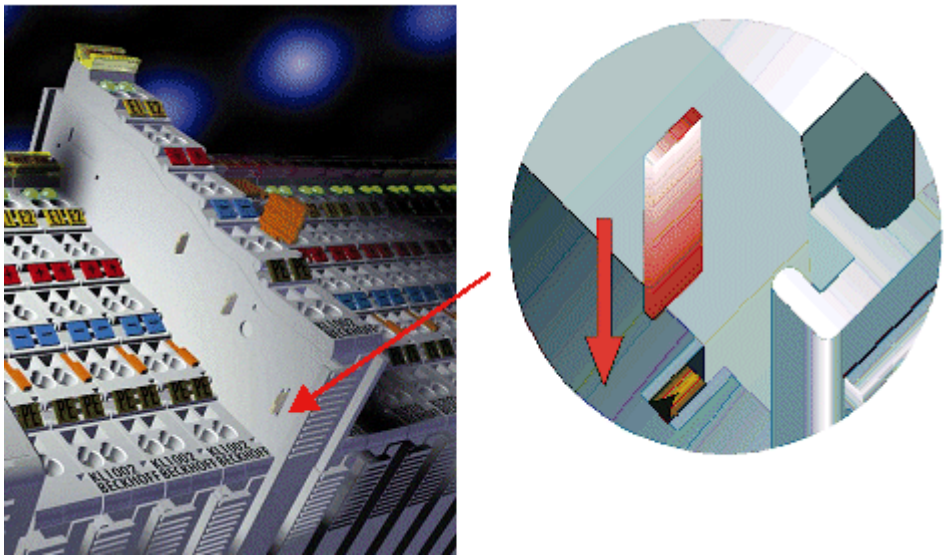
Insulation testing

The connection between the Bus Coupler / Bus Terminal Controller and the Bus Terminals is automatically realized by pushing the components together. 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 made use of to feed 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.



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 conductor to the Bus Coupler / Bus Terminal Controller must be disconnected for the insulation testing. 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.

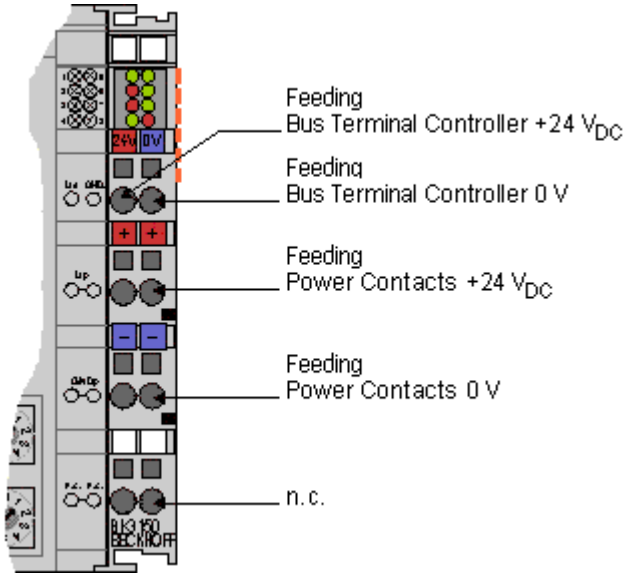
The PE power contact must not be used for other potentials.

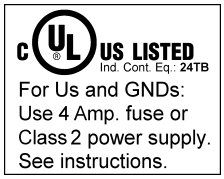
Power supply

Bus Terminal Controller and Bus Terminal supply (Us)

The Bus Terminal Controller requires a supply voltage of 24 V_{DC} for its operation.

The connection is made by means of the upper spring-loaded terminals labelled *24 V* and *0 V*. This supply voltage feeds the Bus Coupler / Bus Terminal Controller electronics and, over the K-Bus, the electronics of the Bus Terminals. It is electrically separated from the potential of the field level.





UL requirements

Danger

For the compliance of the UL requirements Us should only be supplied

- by a 24 V_{DC} supply voltage, supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4 Amp.
- by a 24 V_{DC} power source, that has to satisfy *NEC class 2*.
  A *NEC class 2* power supply shall not be connected in series or parallel with another (class 2) power source!

Danger

To meet the UL requirements, Us must not be connected to unlimited power sources!

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 feed for the power contacts has no connection to the voltage supply for the BC electronics.

The spring-loaded terminals are designed for wires with cross-sections between 0.08 mm^2 and 2.5 mm^2.

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

On the right hand face of the Bus Terminal Controller there are three spring contacts for the power contact connections. The spring contacts are hidden in slots so that they can not 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 and groove guides on the top and bottom of the Bus Terminal Controllers and of the Bus Terminals guarantees that the power contacts mate securely.

Programming cable

Use the KS2000-Z2 programming cable for serial programming of the Bus Terminal Controller. This cable is included in the scope of supply of the KS2000 software, or it can be ordered separately (order number KS2000-Z2).

KS2000-Z2

The programming cable offers the option of programming the BCxx50 via the serial interface.

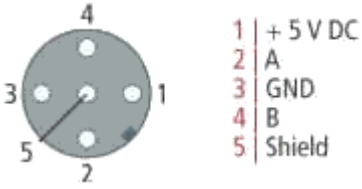
Warning When the programming cable (between BCxx50 and PC) is connected, the ground connection of the Bus Terminal controller must not be interrupted or disconnected, since this may destroy the programming cable.

PROFIBUS Connection

M12 circular connector

The M12 socket is inverse coded, and has five pins. Pin 1 is 5 V_{DC} and 3 is GND for the active termination resistor. These must never be misused for other functions, as this can lead to destruction of the device. Pin 2 and pin 4 are the Profibus signals. These must never be swapped over, as this will prevent communication. Pin 5 is the shield, and this is capacitatively coupled to the Fieldbus Box chassis.

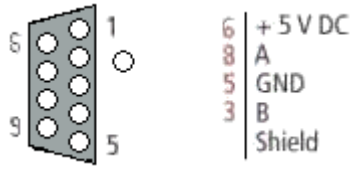
M12 socket pin assignment



Nine pole D-Sub

Pin 6 is 5 V_{DC} und Pin 5 is GND for the active termination resistor. These must never be misused for other functions, as this can lead to destruction of the device. Pin 3 and pin 8 are the Profibus signals. These must never be swapped over, as this will prevent communication. Shield is connected to the D-Sub housing that is coupled with low-resistance to the mounting rail.

D-Sub socket pin assignment



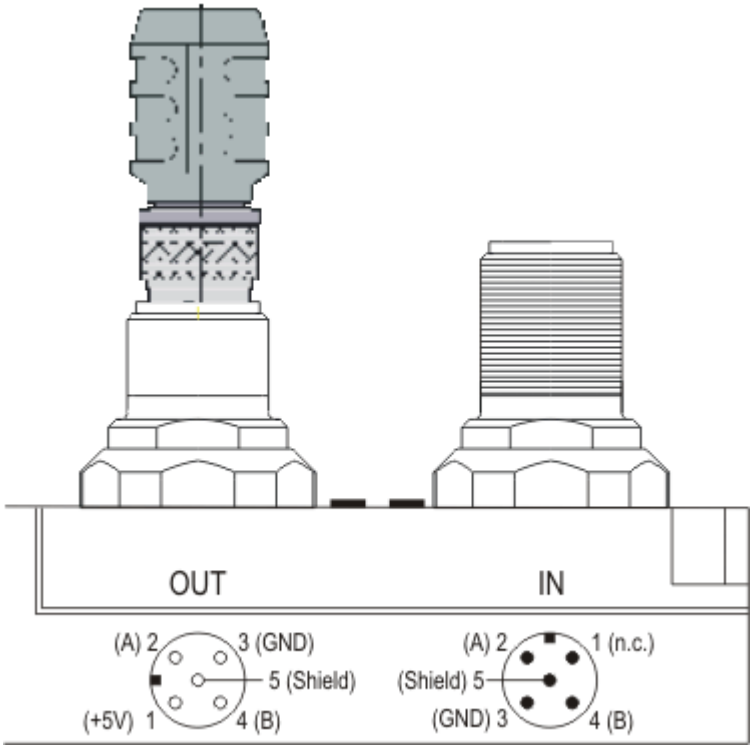
Profibus conductor colors

Profibus conductors	M12	D-Sub
B red	Pin 4	Pin 3
A green	Pin 2	Pin 8

Connection of FieldbusBox modules

The connection of the Fieldbus Box modules is done direct or via a T-piece (or Y-piece).

The B318 series does have a male and female connector, that means no external T-piece is required. The supply voltage (+5V_{DC}) for the termination resistor is only supplied via the female M12 connector. The termination resistor ZS1000-1610 is only available with male connector, therefore the incoming PROFIBUS line should end in a female connector.



Two T-pieces are available:

- ZS1031-2600 with +5VDC on male and female connector for the termination resistor
- ZS1031-2610 with +5VDC only on the female connector

PROFIBUS Cabling

Physical aspects of the data transmission are defined in the Profibus standard (see Profibus layer 1: Physical Layer).

The types of area where a fieldbus system can be used is largely determined by the choice of the transmission medium and the physical bus interface. In addition to the requirements for transmission security, the expense and work involved in acquiring and installing the bus cable is of crucial significance. The Profibus standard therefore allows for a variety of implementations of the transmission technology while retaining a uniform bus protocol.

Cable-based transmission

This version, which accords with the American EIA RS-485 standard, was specified as a basic version for applications in production engineering, building management and drive technology. A twisted copper cable with one pair of conductors is used. Depending on the intended application area (EMC aspects should be considered) the screening may be omitted.

Two types of conductor are available, with differing maximum conductor lengths (see the RS-485 table).

RS485 - Fundamental properties

RS-485 transmission according to the Profibus standard	
Network topology	Linear bus, active bus terminator at both ends, stubs are possible.
Medium	Screened twisted cable, screening may be omitted, depending upon the environmental conditions (EMC).
Number of stations	32 stations in each segment with no repeater. Can be extended to 127 stations with repeater
Max. bus length without repeater	100 m at 12 MBit/s 200 m at 1500 KBit/s, up to 1.2 km at 93.75 KBit/s
Max. bus length with repeater	Line amplifiers, or repeaters, can increase the bus length up to 10 km. The number of repeaters possible is at least 3, and, depending on the manufacturer, may be up to 10.
Transmission speed (adjustable in steps)	9.6 kBit/s; 19.2 kBit/s; 93.75 kBit/s; 187.5 kBit/s; 500 kBit/s; 1500 kBit/s; 12 MBit/s
Plug connector	9-pin D-Sub connector for IP20 M12 round connector for IP65/67

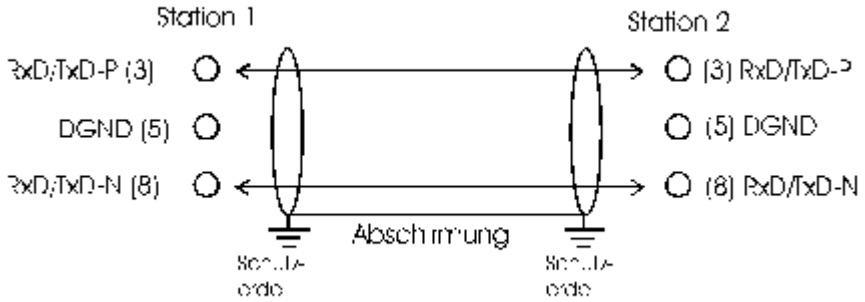
Cabling for Profibus DP and Profibus FMS

Note the special requirements on the data cable for baud rates greater than 1.5 MBaud. The correct cable is a basic requirement for correct operation of the bus system. If a simple 1.5 Mbaud cable is used, reflections and excessive attenuation can lead to some surprising phenomena. It is possible, for instance, for a connected Profibus station not to achieve a connection, but for it to be included again when the neighboring station is disconnected. Or there may be transmission errors when a specific bit pattern is transmitted. The result of this can be that when the equipment is not operating, Profibus works without faults, but that there are apparently random bus errors after start-up. Reducing the baud rate (< 93,75 kBaud) corrects this faulty behavior.

If reducing the baud rate does not correct the error, then in many cases this can indicate a wiring fault. The two data lines maybe crossed over at one or more connectors, or the termination resistors may not be active, or they may be active at the wrong locations.

Note

Installation is made a great deal more straightforward if pre-assembled cables from BECKHOFF are used! Wiring errors are avoided, and commissioning is more rapidly completed. The BECKHOFF range includes fieldbus cables, power supply cables, sensor cables and accessories such as terminating resistors and T-pieces. Connectors and cables for field assembly are nevertheless also available.



Note

In systems with more than two stations all devices are wired in parallel. It is essential that the bus cables are terminated with resistors at the conductor ends in order to avoid reflections and associated transmission problems.

Distances

The bus cable is specified in EN 50170. This yields the following lengths for a bus segment.

Baud rate in kbits/sec	9.6	19.2	93.75	187.5	500	1500	12000
Cable length in m	1200	1200	1200	1000	400	200	100

Stubs up to 1500 kbaud <6.6 m; at 12 Mbaud stub segments should not be used.

Bus segments

A bus segment consists of at most 32 devices. 126 devices are permitted in a Profibus network. Repeaters are required to refresh the signal in order to achieve this number. Each repeater is counted as one device.

IP-Link is the subsidiary bus system for Fieldbus Boxes, whose topology is a ring structure. There is an IP master in the coupler modules (IP230x-Bxxx or IP230x-Cxxx) to which up to 120 extension modules (IExxxx) may be connected. The distance between two modules may not exceed 5 m. When planning and installing the modules, remember that because of the ring structure the IP-Link master must be connected again to the last module.

Installation guidelines

When assembling the modules and laying the cables, observe the technical guidelines provided by the Profibus User Organization (Profibus Nutzerorganisation e.V.) for Profibus DP/FMS (see www.profibus.com).

Checking the Profibus wiring

A Profibus cable (or a cable segment when using repeaters) can be checked with a few simple resistance measurements. The cable should meanwhile be removed from all stations:

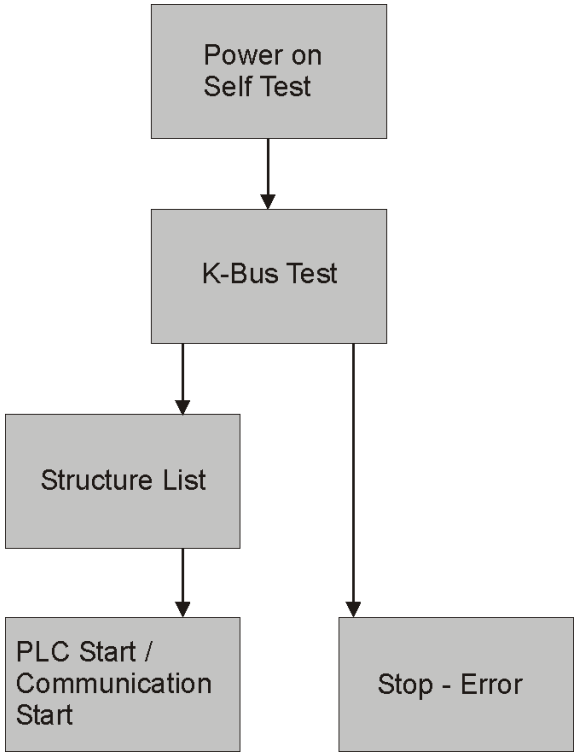
1. Resistance between A and B at the start of the lead: approx. 110 Ohm
2. Resistance between A and B at the end of the lead: approx. 110 Ohm
3. Resistance between A at the start and A at the end of the lead: approx. 0 Ohm
4. Resistance between B at the start and B at the end of the lead: approx. 0 Ohm
5. Resistance between screen at the start and screen at the end of the lead: approx. 0 Ohm

If these measurements are successful, the cable is okay. If, in spite of this, bus malfunctions still occur, this is usually a result of EMC interference. Observe the installation notes from the Profibus User Organization (www.profibus.com).

4. Parameterization and Commissioning

Start-up Behavior of the Bus Terminal Controller

After being switched on, the Bus Terminal Controller checks its state, configures the K-Bus, creates a structure list on the basis of the inserted bus terminals and starts it's local PLC.
The I/O LEDs illuminate and flash as the Bus Coupler starts up. If there are no errors, the I/O LEDs should stop flashing within about 2-3 seconds. In the case of an error, the flash code of the according LED depends on the error type (see Diagnostic LEDs).

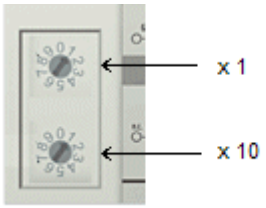


Setting the slave address

The address must be set via the two rotary selection switches. The default setting is 11. All addresses are permitted, although each address may only occur once within the network. For changing an address the Bus Coupler must be switched off. The switches can be set to the required position using a screwdriver. Ensure that the switches engage correctly. The lower switch is the 10-multiplier, the upper switch is the 1-multiplier. The change in address is active as soon as the module is switched on.

Example
You want to set address 34:

- lower rotary selection switch Sx11: 3
- upper rotary selection switch Sx10: 4



Configuration

Overview

Configuration types

DEFAULT-CONFIG
Bus Terminals are mapped in the order they are inserted, i.e. first the complex Bus Terminals followed by the digital Bus Terminals.
The complex Bus Terminals are mapped as follows:

- Word Alignment
- complex representation

The fieldbus slave interface are the PLC variables. The PLC variables have addresses from %QB1000 and %IB1000.

TWINCAT-CONFIG
Bus Terminals and PLC variables can be linked freely in TWINCAT-CONFIG (TC-file required). The configuration is transferred to the coupler via the System Manager and ADS.

The following is required for TwinCAT Config:

- Via the fieldbus (PROFIBUS, CANopen, Ethernet)
  PROFIBUS: (BC3150, BX3100)
  - PC with FC310x from version 2.0 and TwinCAT 2.9 build 1000
  - BX3100 with firmware from 0.28 with CIF60 or CP5412
  - TwinCAT 2.9 build 946
  (**WARNING:** only one ADS communication is permitted with the Hilscher cards, i.e. either System Manager or PLC Control)
  CANopen: (BC5150, BX5100)
  PC with FC510x from version 1.76 or higher and TwinCAT 2.9 build 1030
  DeviceNet: (BC5250, BX5200)
  on request
  Ethernet: (BX9000):
  - TwinCAT 2.10 Build xxxx
- Via serial ADS TwinCAT 2.9 build 1010 for NT4.0, 2000 or XP
  - BX3100 version 1.00
  - BX5100 version 1.00
  - BX5200 version 1.10
  - BX8000 version 1.00
  - BC3150, BC5150, BC5250 Frimware B0
  - BC8150 TwinCAT 2.10 Build 1244

The BX can be parameterised via the System Manager of the TwinCAT program.

- Variable I/O mapping
- Type-specific PROFIBUS data (only BC3150 or BX3100)
- RTC (Real Time Clock) (only BX-controller)
- SSB bus (Smart System Bus) (only BX-controller)
- PLC settings
- K-Bus settings

The configuration can be transferred to the BXxxxx or BCxx50 via fieldbus ADS protocol or with the serial ADS protocol.

The TwinCAT configuration can be used to link variables, I/Os and data. The following is possible:

- PLC - K-BUS
- PLC - fieldbus (e.g. PROFIBUS slave interface)
- K-Bus - fieldbus (only the BX-Controller)

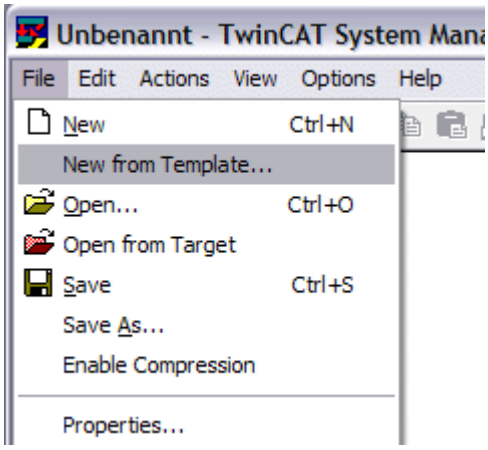
In addition, the TwinCAT configuration can be used to parameterise special behaviour, for example whether data are preserved or set to "0" in the event of a fieldbus error.
The real-time clock can be set via a tab in the system manager.

Individual steps

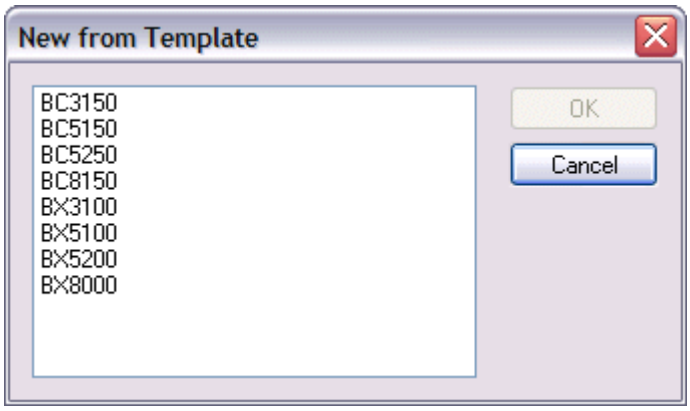
1. Setting the fieldbus address
2. Opening the system manager and creating a TC-file
3. Configuring fieldbus data in the TC-file
4. Saving the TC-file
5. Opening a new system manager, creating a PC file and reading in saved TC-file
6. Creating a link to a PLC task
7. Saving the configuration
8. Starting the TwinCAT system
9. Opening the system manager for the TC-file, completing the configuration and transferring it to the BXxxxx or BCxx50
10. Transferring the program to the BXxxxx or BCxx50
11. Creating a boot project

Creating a BX File

For configuring the BX, a BX file has to be created in the System Manager. To simplify matters, files for the basic units have already been prepared. Open the respective BX Controller via *New from Template*.



Select the associated BX Controller.



All BX Controller components are now available.

- Fieldbus interface
- K-Bus Interface
- PLC Program
- SSB (only BX-Controller)

Please refer to the relevant section for device configuration.

Downloading a BX Configuration

The configuration is transferred to the Bus Terminal Controller via ADS.

ADS serial (all BX and BCxx50-Controller)

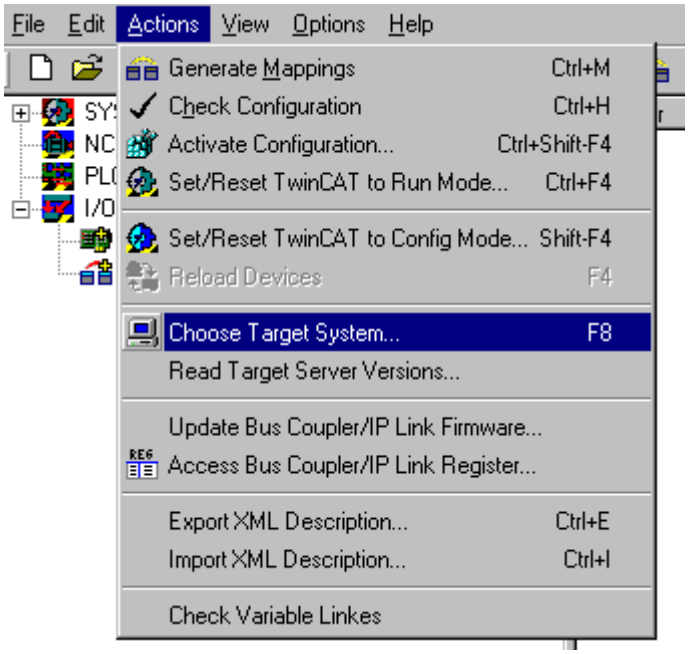
Enter the serial ADS connection, as described in section Serial ADS.

ADS fieldbus (only BX3100, BX5100, BX9000, BC3150, BC5150)

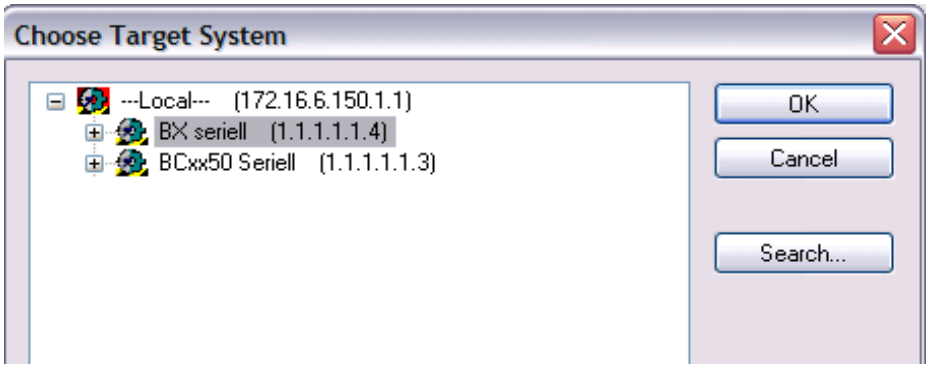
A prerequisite is that TwinCAT operates as the master and data exchange is active, i.e. physical and PROFIBUS, CANopen configuration must be completed, and data must be exchanged from the master (FC310x, FC510x) to the Bus Terminal Controller.

Selecting the target system

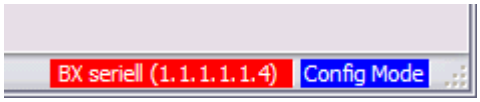
Select the BXxx00 to which you wish to upload the configuration. F8 opens the dialog for downloading the associated device.



Select the associated Bus Terminal Controller.

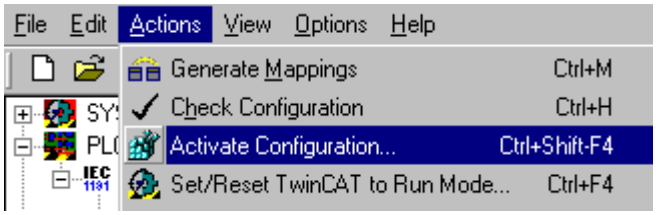


The device state (BX) is displayed at the bottom right of the System Manager.



In *Config Mode / FreeRun* the configuration can now be transferred to the BX. If the BX is in *Stop Mode*, ADS communication has not yet been activated. In this case, the configuration cannot be downloaded.

For activating the configuration select Ctrl+Shift+F4 or *Activate Configuration*.



The current configuration is uploaded to the BX. The display will show *Store Config*, and the BUS and I/O LED will flash. After the configuration has been transferred successfully to the BX, the BX display should show *TwinCAT Config*. The required program can now be transferred to the BX (program download via the fieldbus).

Uploading a BX Configuration

The configuration is transferred to the Bus Terminal Controller via ADS.

ADS serial (all BX and BCxx50-Controller)

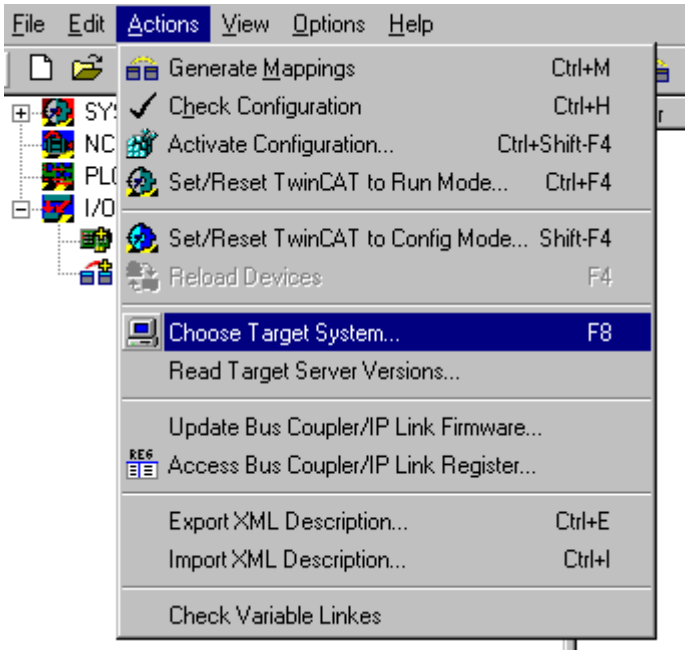
Enter the serial ADS connection, as described in section Serial ADS.

ADS fieldbus (only BX3100, BX5100, BX9000, BC3150, BC5150)

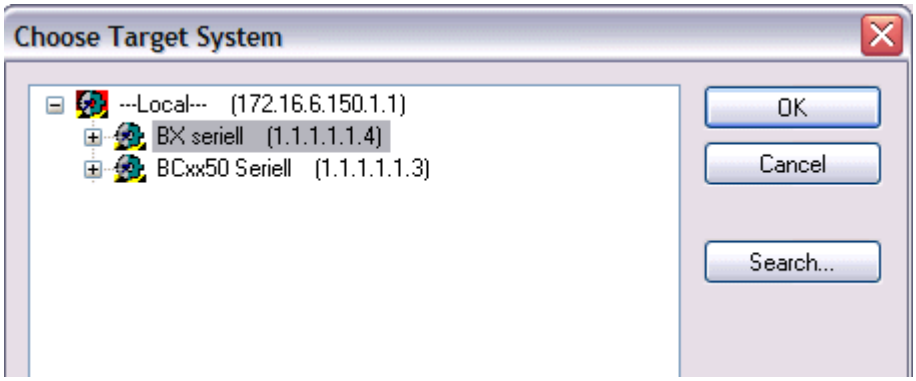
A prerequisite is that TwinCAT operates as the master and data exchange is active, i.e. physical and PROFIBUS, CANopen configuration must be completed, and data must be exchanged from the master (FC310x, FC510x) to the Bus Terminal Controller.

Selecting the target system

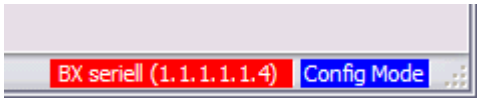
Select the BXxx00/BCxx50 to which you wish to upload the configuration. F8 opens the dialog for downloading the associated device.



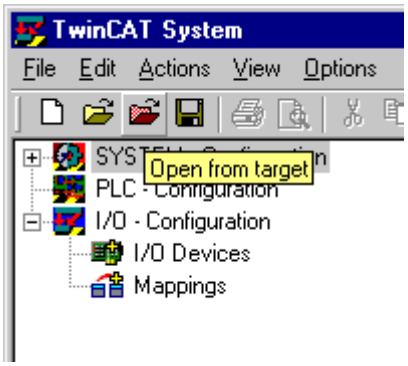
Select the associated Bus Terminal Controller.



The device state (Bus Terminal Controller) is displayed at the bottom right of the System Manager.



Click on the red folder. The TwinCAT configuration will now be uploaded.



Bus Terminal Controller resources

The system manager indicates the memory resources used by the Bus Terminal Controller in the *Resources* tab of the Bus Terminal Controller.

Mapping code

The mapping code is required for calculating the TwinCAT configuration (see Fig. 1). The percentages are added up. In the example from Fig 1., 8% of the memory is used for the mapping calculation.

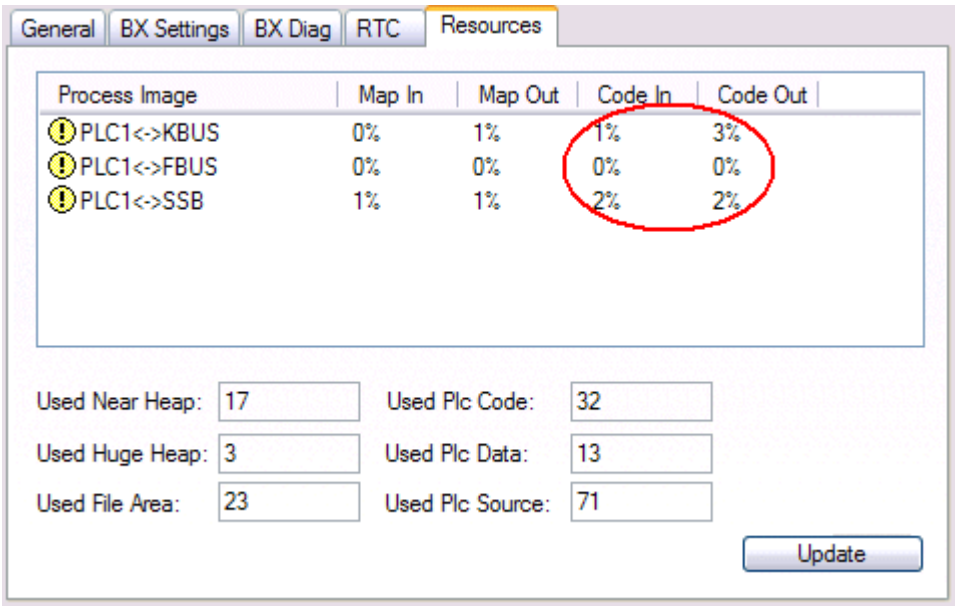


Fig. 1: Memory for code mapping

Data memory mapping

Data memory for mapping. The values are to be considered individually, i.e. each value can be up to 100%.

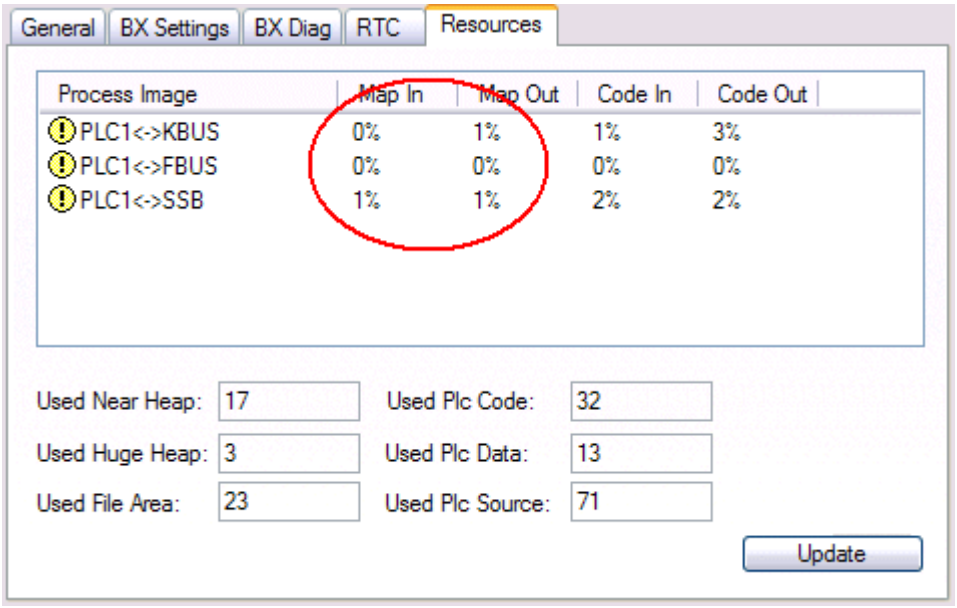


Fig. 2 Data memory mapping

Used code and data memory

Fig. 3 (1): "Used PLC code" in %.
Fig. 3 (2): "Used PLC data" in % of memory.
Fig. 3 (3): "Used PLC Source" in %.

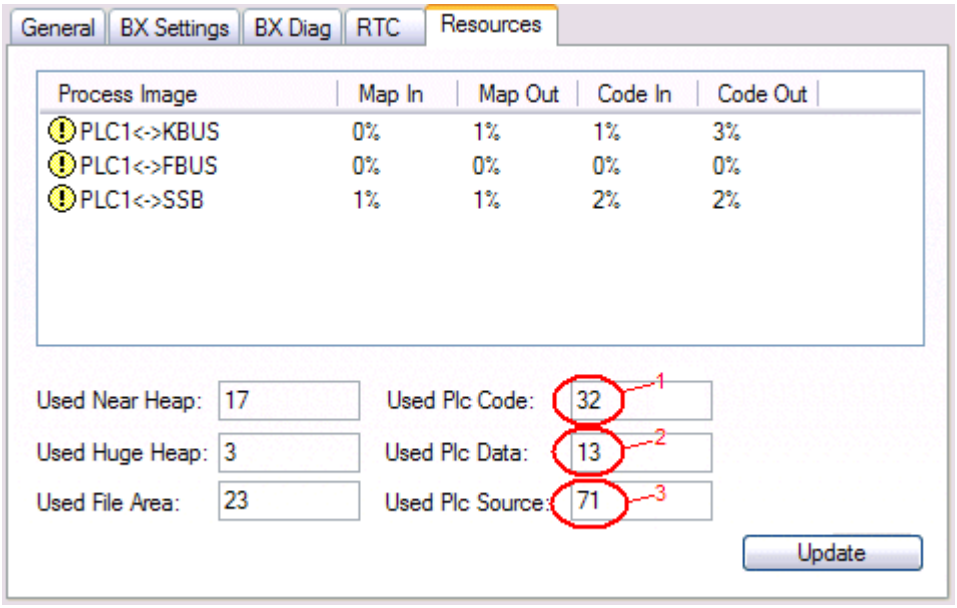


Fig. 3: Code and data memory

Other memory

Fig.4 (1): "Used Near Heap" is required for the COM interface and SSB. % values.
Fig.4 (2): "Used Huge Heap" is required for ADS communication. % values. This value should be less than 30 %.
Fig.4 (3): "Used file Area" is required for TwinCAT configuration, the TSM file and 16kB flash access. % values.

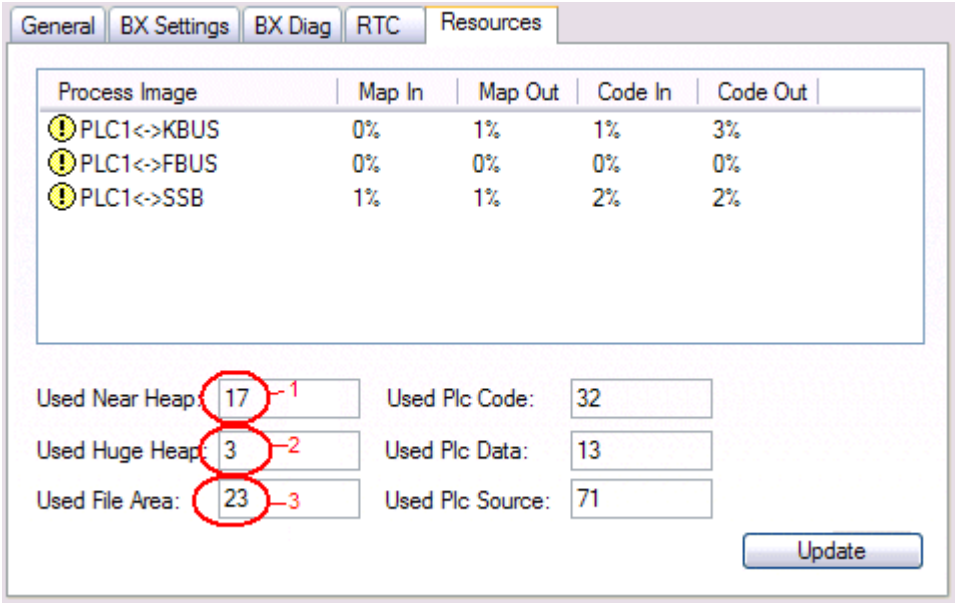


Fig.4: Other memory

ADS via Serial

ADS Connection via Serial Interface

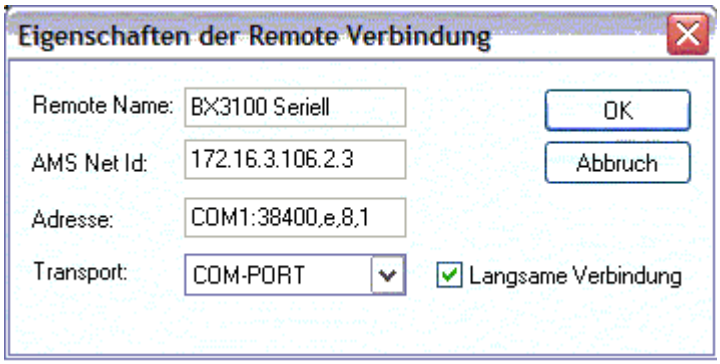
(from firmware version 1.xx or 0.99x - Bus Terminal Controller of BX series and at all BCxx50)

for TwinCAT 2.9 build 1010 (TwinCAT level PLC, NC or NCI)

Note To ensure correct function of the serial ADS connection, only one connection is permitted. After successful configuration via the System Manager, close the System Manager before starting programming.

Initializing the ADS connection

Enter the Bus Terminal Controller in the remote connection under TwinCAT. Click on the TwinCAT icon and open the feature menu. The following settings can be made under the >AMS Remote< tab.



Remote Name: Any
AMS Net Id: 1.1.1.1.1.1 (Default)
Address: Com Port: baud rate, parity, data bits, stop bits
Transport: "COM port" is to be chosen here

Note No strings can be entered under address when the dialog is first called (see above). Enter name, AMS Net ID, and transport type and close the dialog. When the dialog is called again you can enter your COM port.

Communication starts as soon as TwinCAT is in Config or RUN mode. The COM port is not closed until TwinCAT stops, after which it is available for other programs.

Reading AMS Net ID

The AMS Net ID can be read from the menu via the display of the Bus Terminal Controller of the BX series.

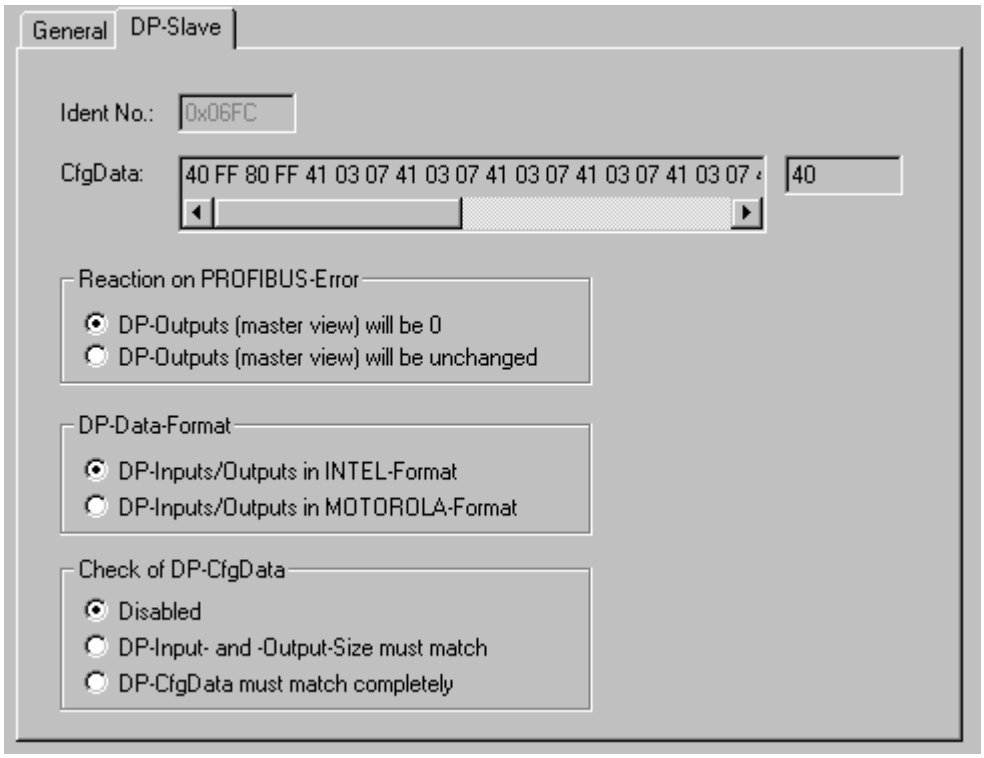
AMS 1.1.1.1.1.1	AMS Net ID

Note If the Bus Terminal Controller has been addressed via a fieldbus ADS connection before the serial ADS connection was used, the System Manager will automatically have changed the AMS Net ID. Read the current ADS number.

PROFIBUS

PROFIBUS Settings

The PROFIBUS-relevant settings are made in the DP slaves tab.



Reaction to PROFIBUS Error

In the event of a PROFIBUS error (e.g. PROFIBUS cable is pulled), the output data of the PROFIBUS master are retained unchanged or set to 0 (depending on the parameterization). From the BX3100 perspective these are input data that are transferred from the PROFIBUS master to the BX3100.

DP data format

The PROFIBUS data can be transferred in Intel or Motorola format.

Checking the DP configuration data

The configuration data can

- not be checked at all;
- checked for correct length; or
- checked for length and content

Master Configuration

Basic Device File (GSD)

All field devices with PROFIBUS slave interface are described via the GSD file. The BC3150 is a PROFIBUS DP slave. For data exchange, the GSD file has to be inserted in the master configuration tool. The maximum length of input and output data 128 bytes in each direction.

Download GSD file (German): 
Download GSD file (English): 

The GSD file can describe the following data types:

Variable	Length
Integer 8	1 byte
UnInteger 8	1 byte
Integer 16	2 bytes
UnInteger 16	2 bytes
Integer 32	4 bytes
UnInteger 32	4 bytes
Float 32	4 bytes

Data types that are not listed, e.g. BOOL variables, can be described via the length. For this purpose, the GSD file includes configuration data starting with a byte and ending with 64 words.

Creating a TwinCAT PC File

DEFAULT CONFIG

DEFAULT-CONFIG contains the PROFIBUS data from the address %IB1000 input and %QB1000. The data length depends on the number of configured PROFIBUS data. A maximum of 244 bytes of input date and 244 bytes of output data can be parameterised. No further settings are required for this configuration type.

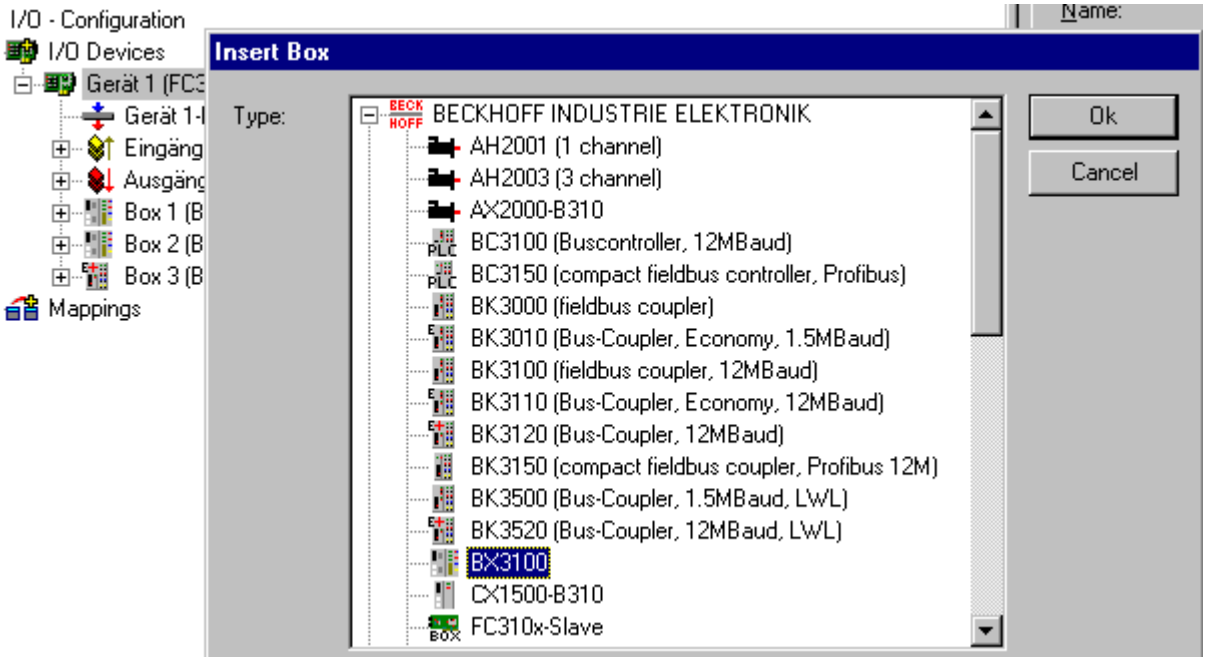


Fig.1: Inserting BX3100.

Inserting the BX3100 in a PROFIBUS master via the System Manager

Select your PROFIBUS master PC card in the System Manager and right-click on your PROFIBUS master card. The PROFIBUS devices will then be offered for selection, among them a BX3100. Select this and confirm with OK.

Opening an existing BX file

If you wish to work with the DEFAULT-CONFIG, interrupt the process at this point (see Creating PROFIBUS data in DEFAULT-CONFIG). Otherwise select your configured BX file. If no such file exists, you have to create one (Creating a BX file). Once you have selected your BX file, all required PROFIBUS data are copied automatically into your project from this file. You now have to create a link to your task and set the PROFIBUS address. The configuration can then be saved and the TwinCAT system started.

Creating PROFIBUS data in DEFAULT-CONFIG

The PROFIBUS data can now be created. Various variables are available:
- Integer 8 bit
- Integer 16 bit
- Integer 32 bit
- UnInteger 8 bit
- UnInteger 16 bit
- UnInteger 32 bit
- FLOAT 32 bit

They have to match the variable types currently projected in the BX.
Data sizes from 1 byte to 64 words are available.

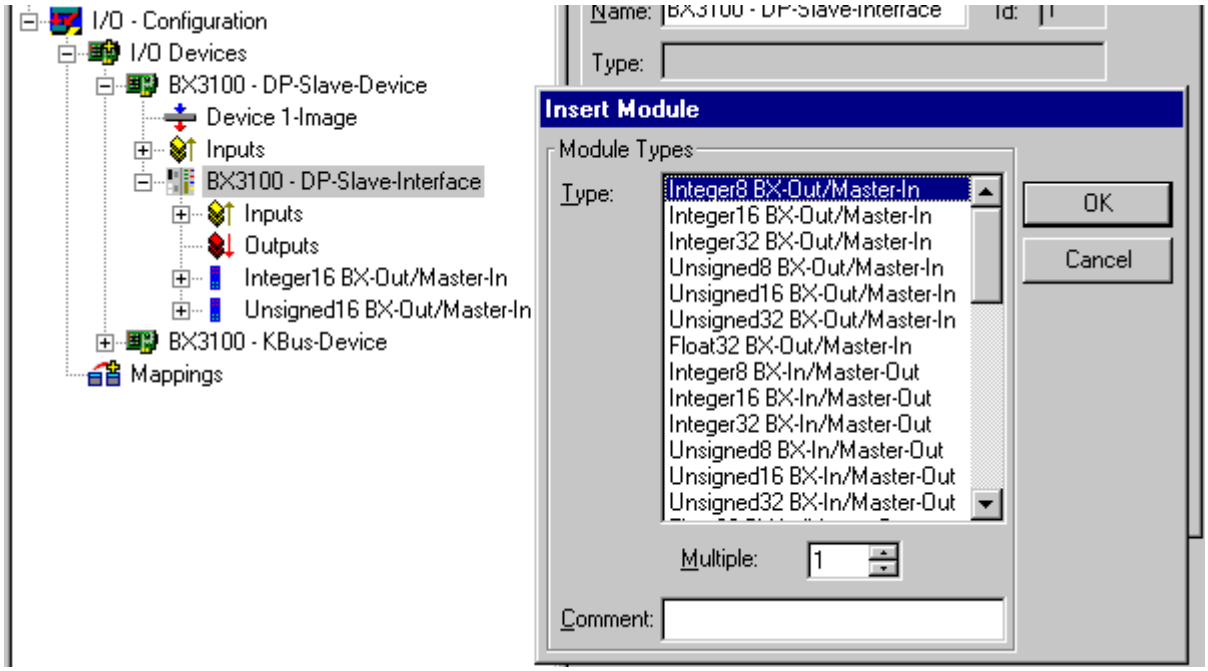
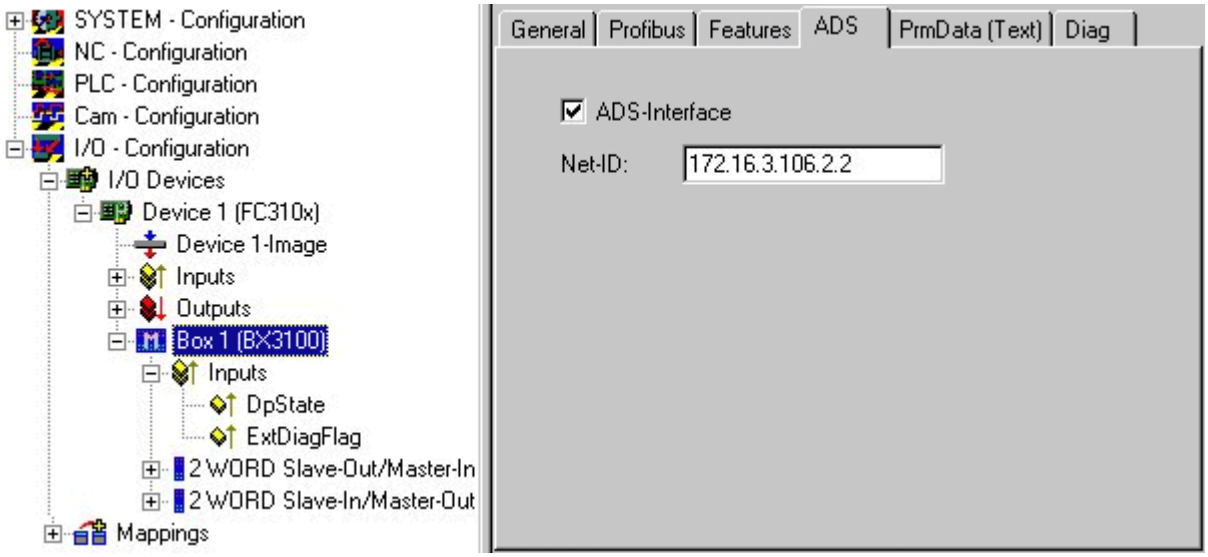


Fig.2: Creating PROFIBUS data

ADS Communication has to be selected for preparing the configuration. If the configuration data are to be transferred via the fieldbus, data communication has to be active, i.e. the BX must exchange data with the controller.



Variable Mapping - PROFIBUS DP

Creating the PROFIBUS data.

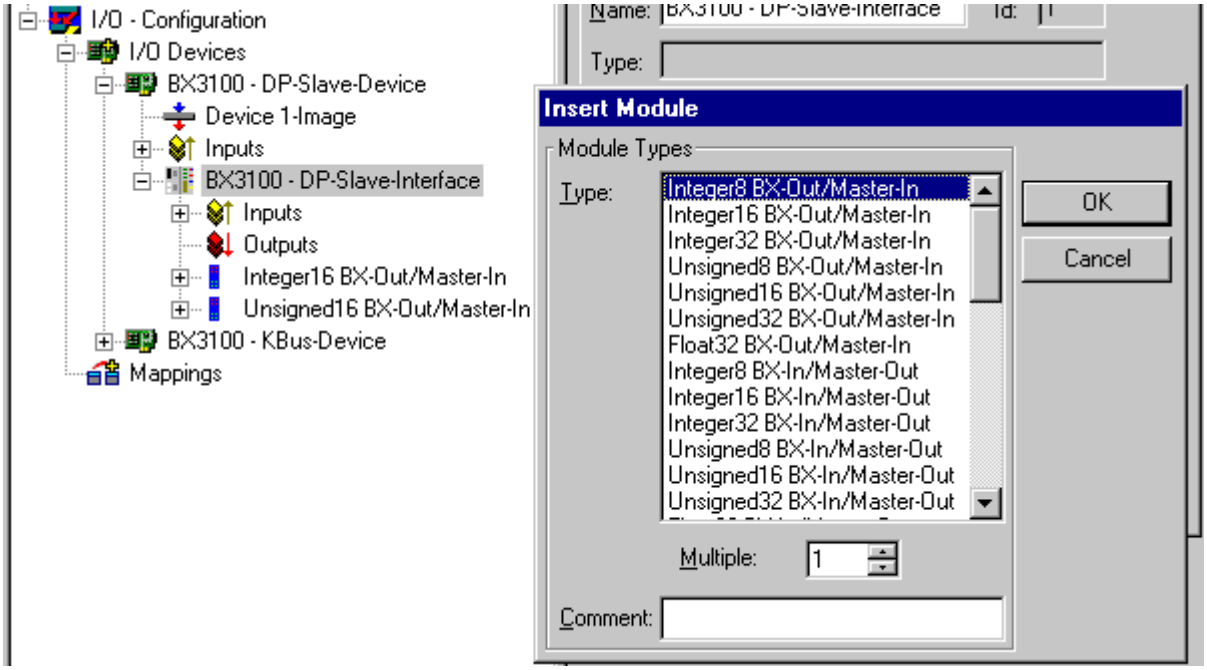


Fig. 1: Creating PROFIBUS data

For linking with the PLC project, the PLC program must be read in. Add your PLC program under PLC Configuration. The PLC variables can now be linked with the fieldbus variables.

Note

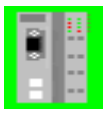
Ensure that the maximum permissible number of PROFIBUS data is not exceeded
(BX3100: max. 244 bytes inputs and 244 bytes outputs)!
(BC3150: max. 128 bytes inputs and 128 bytes outputs)!

BC3150 at 3rd party controller
SIEMENS S7
Configuration - Siemens S7 Controller

Inserting the images

In order to assign an image to the devices in the Siemens software, the following graphics must be copied into the *Step7\S7Data\ncbmp* directory.

BC3150d.DIB



BC3150n.DIB

BC3150s.DIB

Inserting the GSD files

- Go to *Extras\Install new GSD* in the hardware catalog for your Step7.
- Select the directory in which the BECKHOFF GSD is located, and import the files.
- You will then find them in the hardware catalog under *Profibus DP\Other field devices\I/O*.

Configuration: Siemens S7 Controller with BX3100

BX3100 parameter data

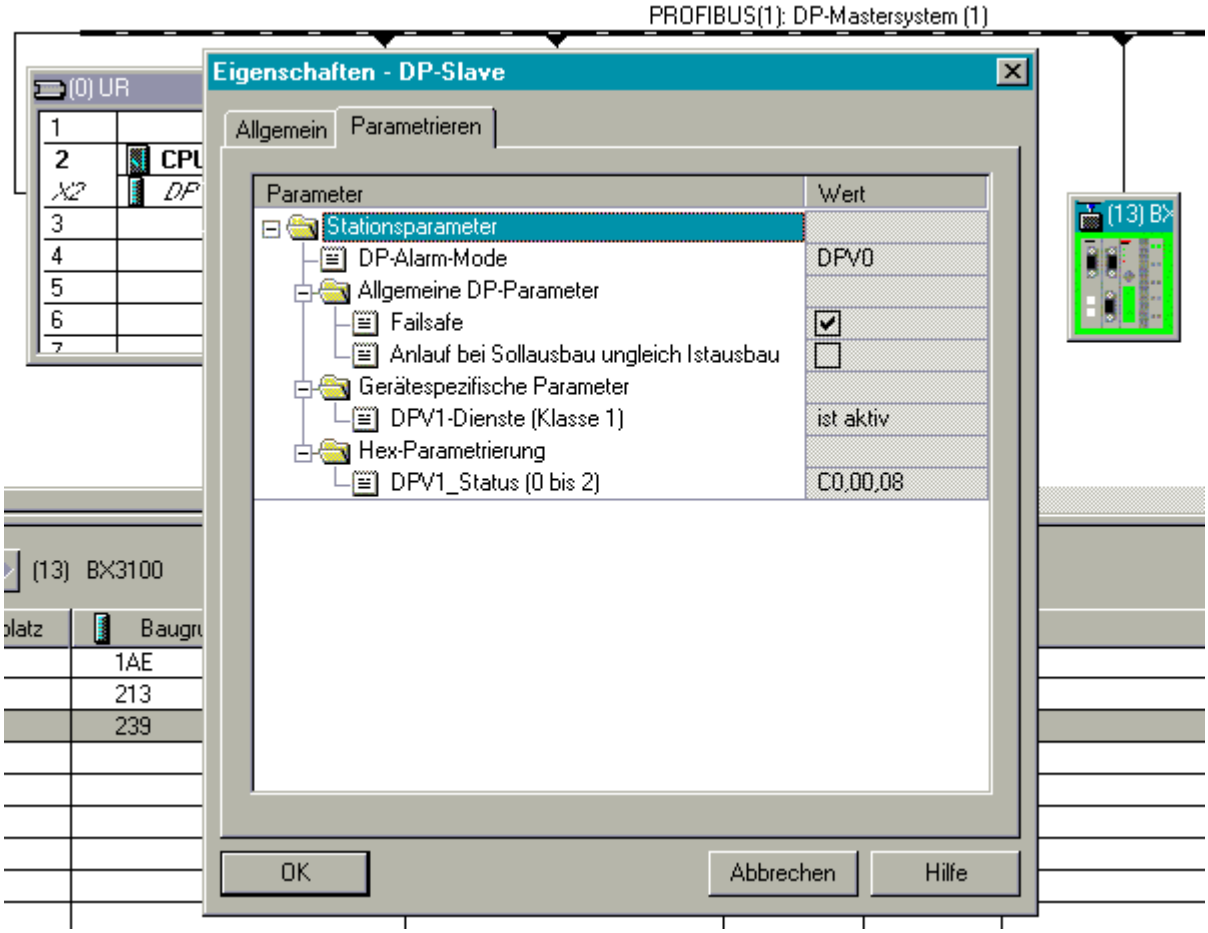


Fig. 1: Settings

BX3100 module configuration

Example 1
1 x BX3100

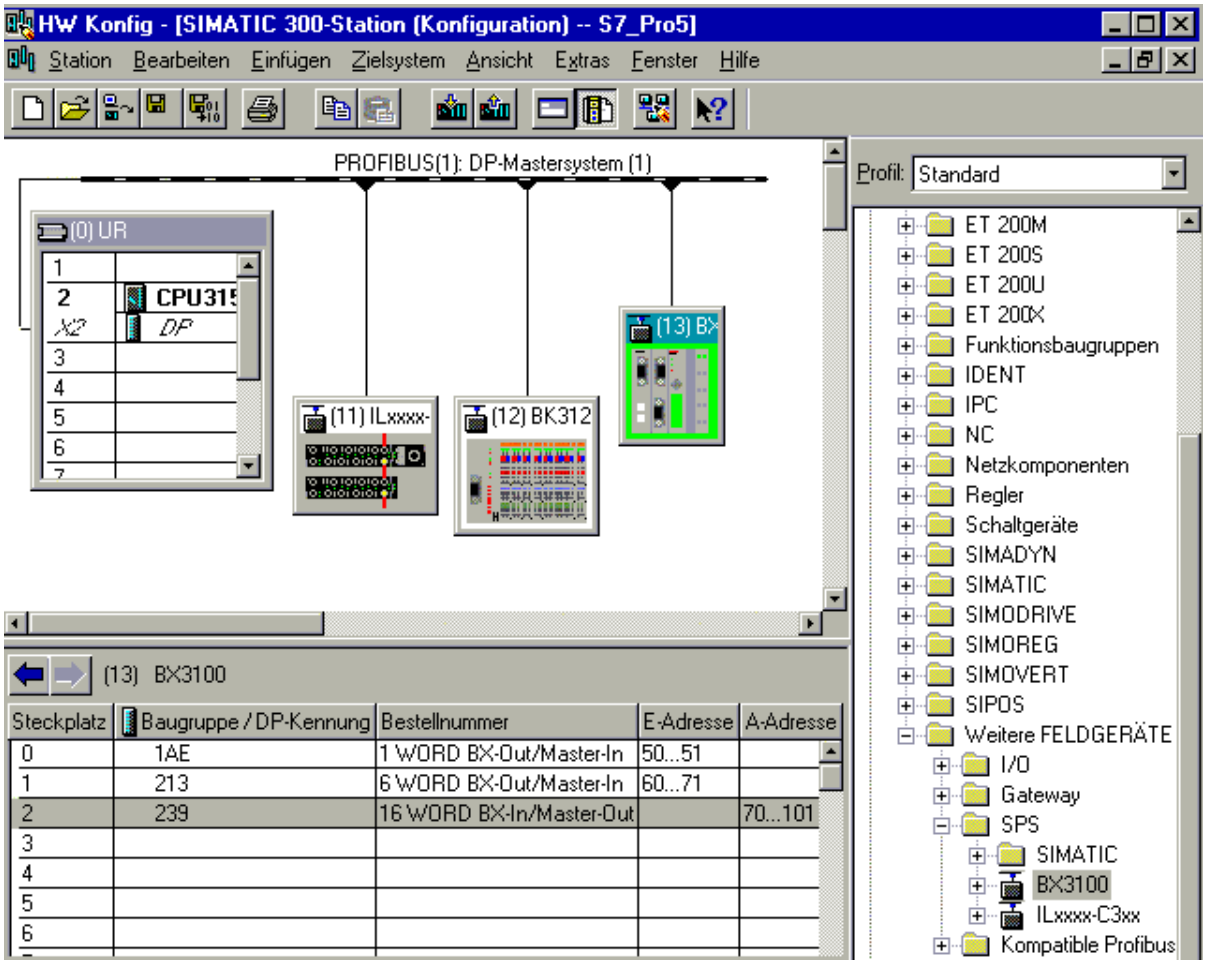


Fig. 2: Example for entering individual bytes. Note: Each individual byte requires one byte of ConfigData.

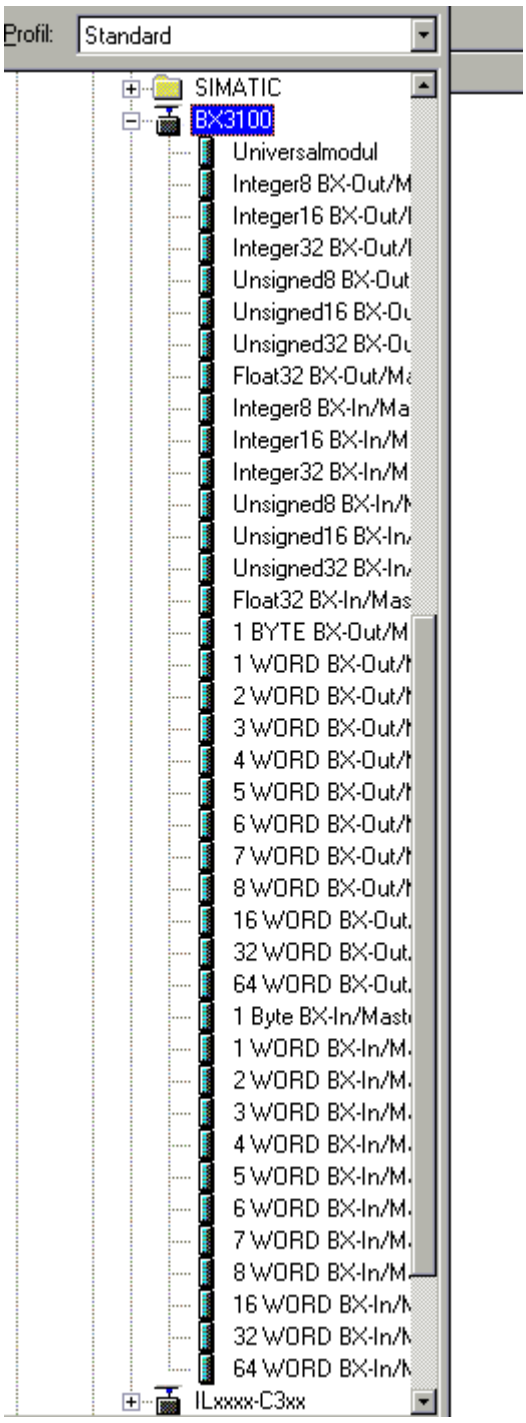
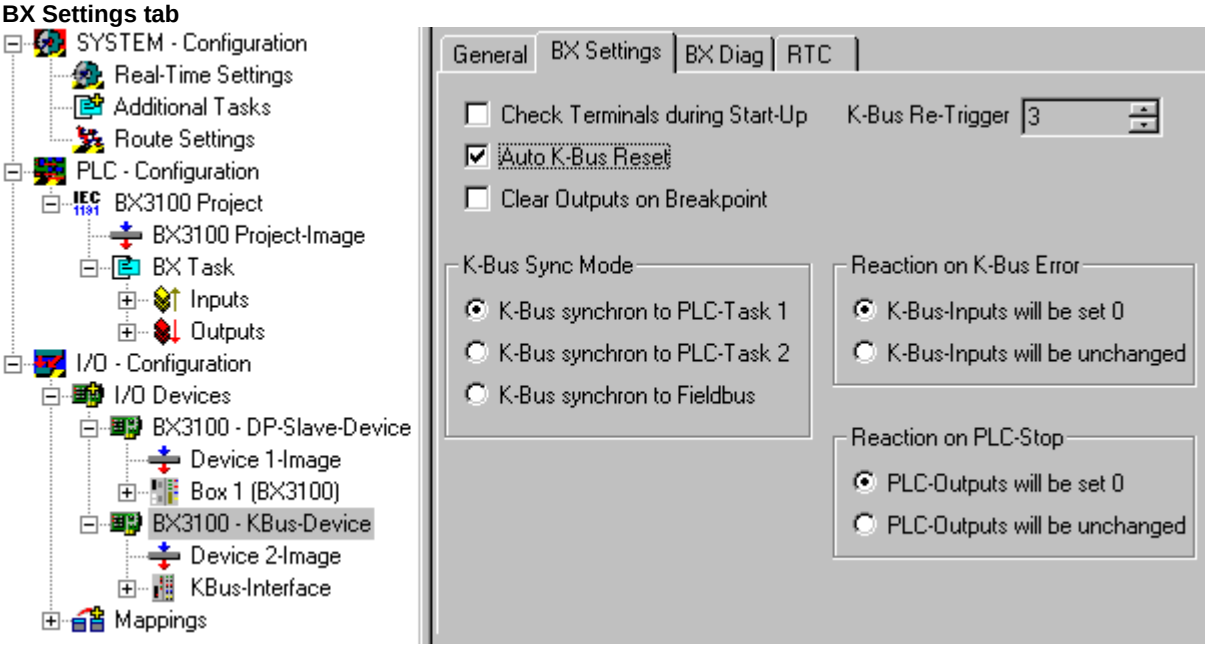


Fig. 3: Example for entering associated bytes.

K-Bus

K-Bus

BX Settings tab



Check Terminals during Start-up
When a boot project is created, the current Bus Terminal configuration is stored. The connected Bus Terminals are checked when the BX is restarted. If this option is selected, the Bus Terminal Controller will not commence data exchange. The PLC project will not be started.

Auto K-Bus Reset
After correction of a K-Bus fault, the Bus Terminal Controller will automatically re-commence data exchange.

Warning Ensure that the outputs are reactivated immediately and that analog outputs retain their programmed value, if this is not dealt with in your PLC project.

Clear Outputs on Breakpoint
If break points are set in PLC Control, the K-Bus is no longer processed, i.e. the outputs are set to a safe state (zero).

K-Bus Sync Mode
Writing and reading of the Bus Terminals can occur synchronous with Task1, Task2 or the fieldbus.

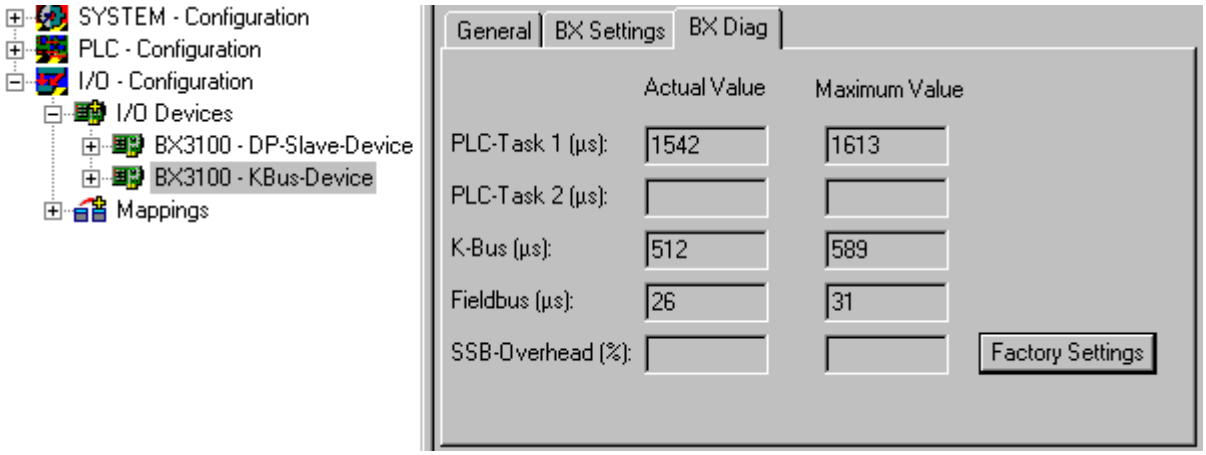
K-Bus Re-Trigger
If the processor is busy dealing with the PLC project or the SSB, the K-Bus cannot be processed for a certain amount of time. This leads to triggering of the Bus Terminal watchdog and dropping of the outputs. The Bus Terminal Controller is set to re-trigger the K-Bus watchdog 3 times after 85 ms respectively. The K-Bus watchdog would then be activated.
K-Bus Re-Trigger 0: 100 ms
K-Bus Re-Trigger 1: 2 x 85 ms = 70 ms
K-Bus Re-Trigger 2: 3 x 85 ms = 255 ms
K-Bus Re-Trigger 3: 4 x 85 ms = 340 ms

Reaction on K-Bus Error
In the event of a K-Bus error, the K-Bus inputs are set to "0" or retain their last state.

Response on PLC-Stop
The user can set the behavior of the fieldbus output data in the event of the PLC project being stopped. The master will use these data as input data. In the event of a PLC stop, the data can be set to "0" or remain unchanged.

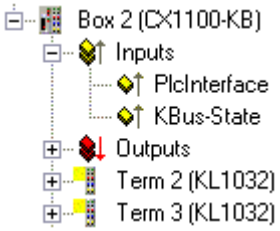
BX Diag tab

Display of cycle time for task 1, task 2, K-Bus, fieldbus processing and SSB overhead.



Factory Settings - the Bus Terminal Controller is set back to its delivery state. These settings are reactivated via Restart System or by switching the system off and on again (display shows DEFAULT-CONFIG).

K-Bus variables



PLCInterface: Not supported (only included for moving CX or BX projects)

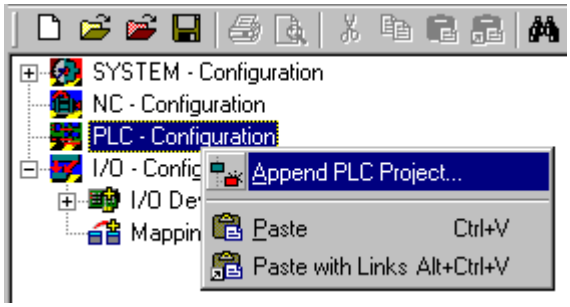
KBus-State: see Diagnostics

PLC

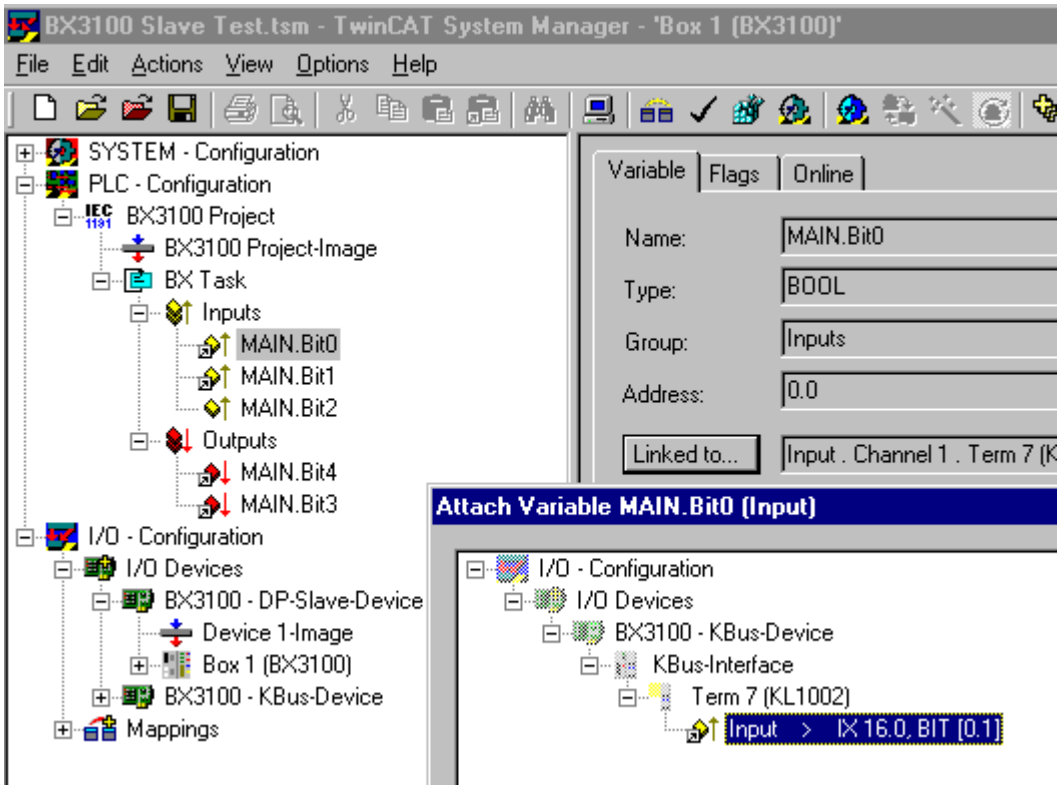
Inserting a PLC project

For variable mapping, configuration has to be specified in the system manager. This is where the link between PLC and hardware is specified. The variables can process and link bit, byte, word or data structures. Automatic addressing via the System Manager is possible, but should be checked for offset.

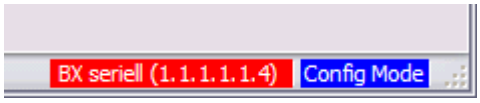
A valid project has to be compiled and saved in PLC Control. These data are saved as a *.tpy file. For inserting a PLC project, right-click on *PLC - Configuration*. Select your current PLC project.



Link the PLC variable with the hardware (e.g. digital Bus Terminal).

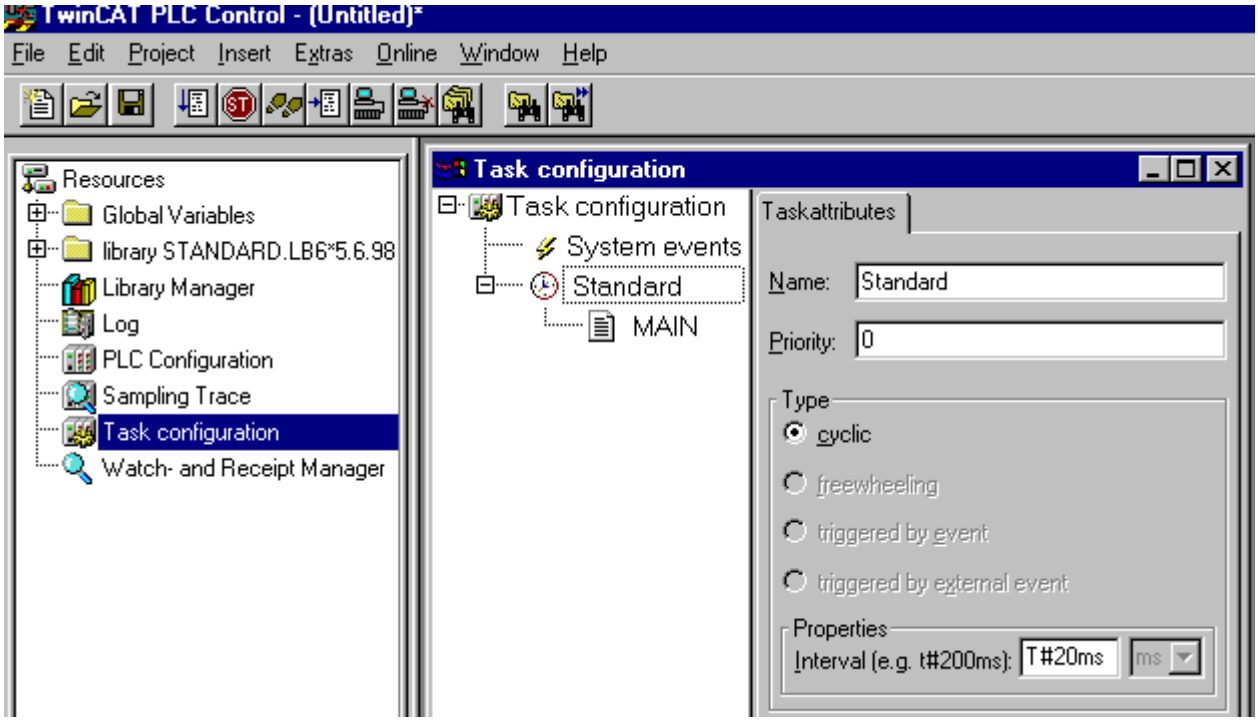


Once all links have been created, activate the configuration *Actions/Activate Configuration* (Ctrl+Shift+F4) and start TwinCAT *Set/Reset TwinCAT to Run Mode*. Ensure that the correct target system is selected (bottom right in the System Manager window).

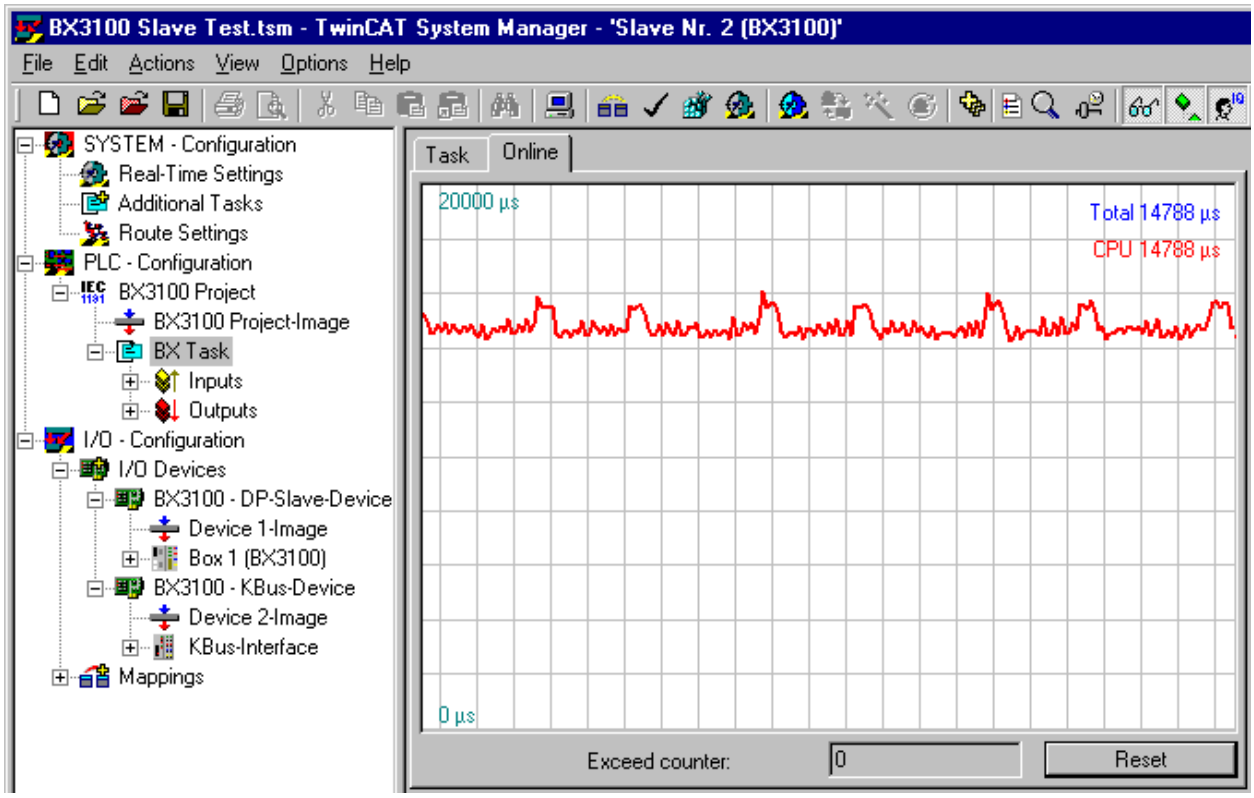


Measuring the PLC Cycle Time

The task time is set in PLC Control. The default setting is 20 ms.



In the default setting, the PLC program is called every 20 ms, as long as the general cycle time is less than 20 ms. The cycle time can be measured in the System Manager in order to determine your system load. To ensure trouble-free operation, the set task time should be 20 to 30 % higher than the measured cycle time. A precise cycle time breakdown can be found under K-Bus tab description.



KS2000

KS2000

The KS2000 software can provide assistance for the configuration or diagnosis of the connected Bus Terminals. The KS2000 software cannot be used for parameterization or configuration of Bus Terminal Controller of BX series and BCxx50. The TwinCAT System Manager has to be used for the settings.

Note

The COM 1 interface features automatic baud rate detection between 9.6 and 56.4 kBaud*.

Note

The BXxxxx Controller is supported from version 4.3.14.

5. Programming

BCxx50 PLC features

Description	Value
Data memory	32 kbyte
Program memory	48 kbyte minus task-configuration minus POUs during online change
Source code memory	128 kbyte
RETAIN	2 kbyte
INPUT	2 kbyte
OUTPUT	2 kbyte
FLAG	4 kbyte
Max. variable size	16 kbyte
Max. POUs	Limited by memory

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 BC/BX. If you have TwinCAT PLC (Windows NT4/2000/XP) installed, you can use the fieldbus connection or the serial port for downloading and debugging software. If you are programming with TwinCAT BC (also compatible with Windows 95/98/ME), the connection to the BC is made exclusively via the serial port.

TwinCAT I/O or TwinCAT PLC can also be used as the Ethernet Master (host), in order to exchange process data with the Bus Terminal Controller. TwinCAT provides you with the System Manager as a configuration tool, as well as the drivers and the ADS protocol.

Bus Terminal Controller of BX series and BCxx50
These 2nd-generation Bus Terminal Controllers are configured with the TwinCAT System Manager and programmed with TwinCAT PLC Control. TwinCAT PLC has to be installed (Windows NT4, Windows 2000, Windows XP) for these couplers.

Minimum requirement: TwinCAT from Version 2.9 build 940

Programming and program transfer

- via the serial interface
- via the fieldbus interface (only at Bus Terminal Controllers for PROFIBUS, CANopen and Ethernet)

Online Change

The Bus Terminal Controller of BX series and BCxx50 supports online change. This means that the PLC program is replaced with a new program without interrupting the program. The switch-over to the new program occurs after the task is completed. This means that two versions of the PLC program have to be stored. 512 kB are available, which therefore have to be divided by 2, leaving 256 kB for the actual program. In addition, several kB are required for task configuration etc. During an online change, dynamic data are stored in memory. Should a program approach the memory limit (program size greater than 240 kB), the online change may no longer work, even though the program may still be written to the BX after "Rebuild all".

When is online change not available?
Online change is not available under certain conditions

- Inserting of a new library
- Change in task setting
- "Rebuild all"
- Controller memory limit is almost reached (PLC program greater than 90%)

TwinCAT PLC error codes

Error type	Description
PLC compiler error	Maximum number of POUs (...) exceeded
PLC compiler error	Out of global data memory ...

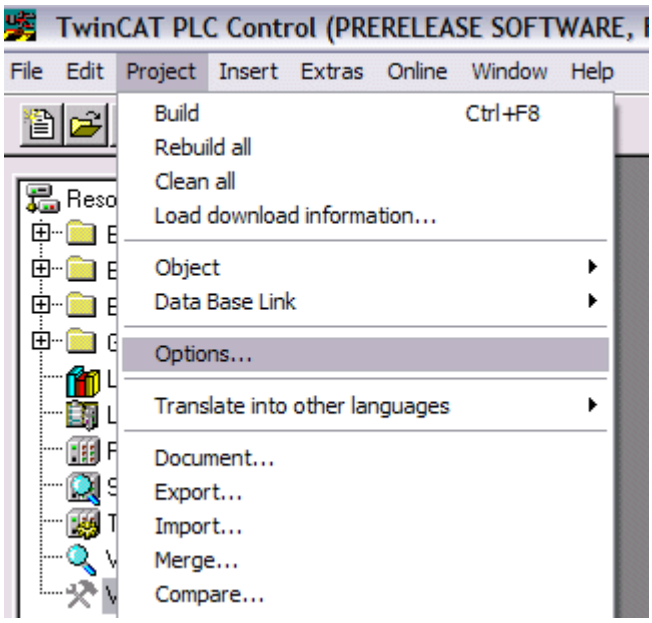
Error POUs

For each block one POU (process object unit) is created. 256 blocks are available by default.

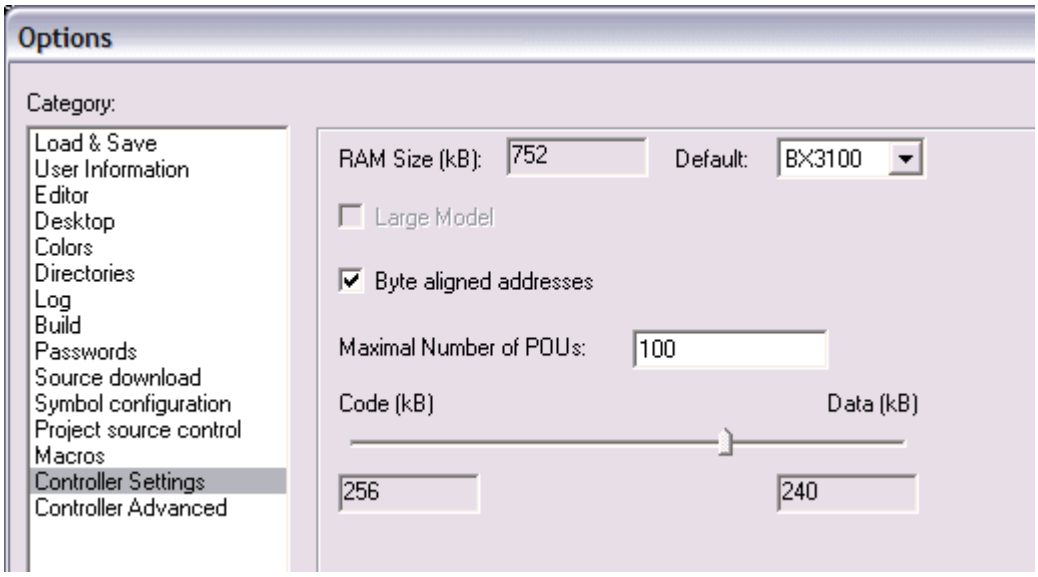
Error 3612: Maximum number of POUs (100) exceeded! Compile is aborted.
Data allocation
1 Error(s), 0 Warning(s).

If libraries are integrated this value may be insufficient. In this case, the number of POUs should be increased.

To this end, open



the controller settings in the PLC Control under Projects/Options.

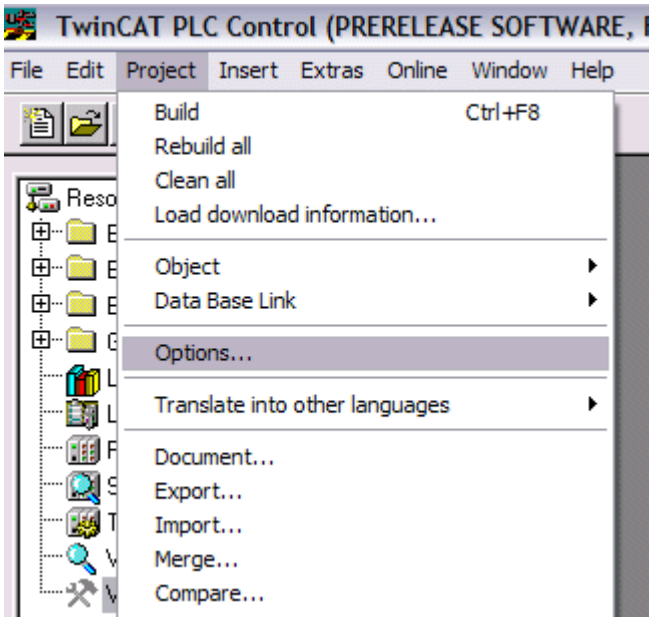


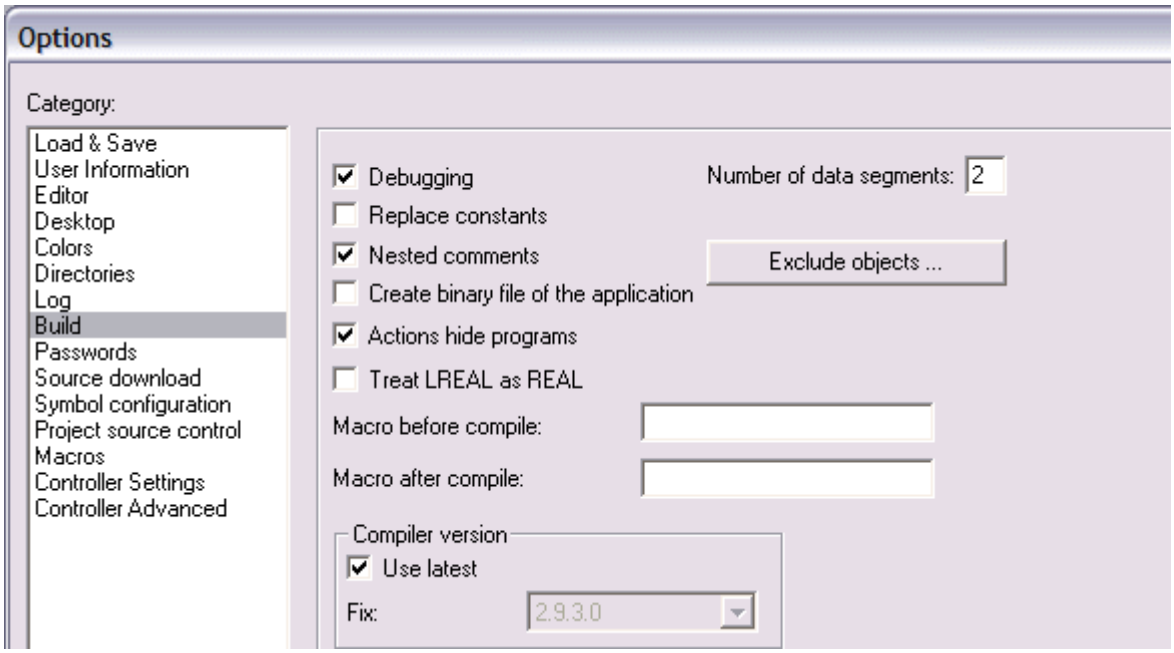
Changing these settings will deactivate online changes.

Global memory error

```
Interface of POU 'MAIN'
Data allocation
Error 3803: MAIN (7): Out of global data memory. Variable 'Test_', 16002 bytes.
1 Error(s), 0 Warning(s).
```

2 x 16 kB of data are available by default. If large data quantities are to be used, this range should be increased. A maximum of 14 data segments are possible for the BX.





Remanent data

2 kB of remanent data are available for the BX controller. These data are declared as VAR RETAIN in PLC Control: Example:

```
VAR RETAIN
    Test    :BOOL;
    Count   :INT;
END_VAR
```

Retain data are located between VAR RETAIN and END_VAR. These data are stored in a NOVRAM and are consistent across the whole 2 kB range. The RETAIN data are stored in the NOVRAM after each cycle. For 2 kB approx. 2 ms are required (for 1 kB approx. 1 ms). The variables can be configured locally or globally. Variables are located (%I...,%Q.., %M...) are not use as a Retain data.

Note VAR_RETAIN should not be used in function blocks. All FB data are copied into the retain memory. This leads to an unnecessary increase in cycle time, and the retain memory is filled with unnecessary data.

Note Variables, they have an address (%I...,%Q.., %M...), are not allowed to declare as a retain variables.

Example for remanent data in the function block

Because all the data in a function block will be saved if even only one remanent bit is included, this should be avoided if at all possible. A programming example can be found below.

Function block Test (no program code required - in ST a semicolon is sufficient)

```
FUNCTION_BLOCK Test

VAR_INPUT
END_VAR
VAR_OUTPUT
END_VAR
VAR
END_VAR
VAR_IN_OUT
    Counter   :INT;
END_VAR
```

MAIN program

```
PROGRAM MAIN

VAR
    fb_Test:Test;
END_VAR
VAR RETAIN
    iCounter1:INT;
END_VAR
```

```
fb_Test(Counter:=iCounter1);
```

Allocated Flags

4 kB of allocated flags are available. They can be used to assign different variable types to the same address, e.g. for converting strings to bytes. Data can also be placed here that can be read or written via ADS by the controller.

Note

The BX Controllers do **not** save the allocated variables as remanent data.

Reading/writing of allocated flags via ADS

The flags may also be read via the controller and ADS. In PROFIBUS, the DPV-1 services are used for this purpose, in CANopen SDO communication is used.
The AmsNetId can be taken from the System Manager, or it can be displayed in the BX menu.
The PLC port number is 800.

Index group	Meaning	Index offset (value range)
0x4020	Flag (only BXxxx0)	0..4096

Example
BX program

```
VAR
    Flag_01 AT %MB0: WORD;
END_VAR
```

TwinCAT PC/CX Master Programm

```
VAR
    fbADRSREAD: ADSREAD;
    Flag_M: WORD;
END_VAR
```

```
fbADRSREAD(
    NETID:='172.16.3.0.2.3' ,  (* AMSNetId BX *)
    PORT:=800 ,                (* 800 - PLC *)
    IDXGRP:=16#4020 ,          (* 0x4020hex flags *)
    IDXOFFS:=0 ,               (* byte offset *)
    LEN:=2 ,                   (* Lenght byte *)
    DESTADDR:=ADR(Merker) ,
    READ:=TRUE ,
    TMOUT:=t#1s );
IF NOT fbADRSREAD.BUSY THEN
    fbADRSREAD(READ:=FALSE);
END_IF
```

Local process image in delivery state

The process image of the BX controller consists of an input, output and flag area. In addition, there are unallocated data without fixed address. They are created without specifying an address. For this type of variable, 256 kbyte (48 kbyte BCxx50) of memory are available on the BX Controller. The maximum size of a variable or structure (array) is 16 kbyte. For the allocated data 2048 bytes of input data and 2048 bytes of output data are available. The BX has 4 kbyte of memory for the allocated flag area. In the delivery state (default configuration) of the BX, fixed addresses are allocated for all connected Bus Terminals. The data for PROFIBUS communication start from address offset 1000_{dec}. The length of the PROFIBUS data depends on the number of configured data. The maximum length is 244 bytes (BX3100) / 128 bytes (BC3150).

Inputs	Outputs
Bus Terminal %IB0 ...	Bus Terminal %QB0 ...
PROFIBUS data (PLC variable) %IB1000 ...	PROFIBUS data (PLC variables) %QB1000 ...
... %IB2047 Maximal	... %QB2047 Maximal

Addressing of the connected Bus Terminals

The default setting is for all the connected Bus Terminals to be assigned to the local process image. 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 structure

Bus Terminal Controller: 1 x BXxxxx/BCxx50
Position 1: 1 x KL1012
Position 2: 1 x KL1104
Position 3: 1 x KL2012
Position 4: 1 x KL2034
Position 5: 1 x KL1501
Position 6: 1 x KL3002
Position 7: 1 x KL4002
Position 8: 1 x KL6001
Position 9: 1 x KL9010

Process image

Bus Terminal	Position	Input image	Output image
KL1501	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..30.1	-
KL1104	2	%IX30.1..30.5	-
KL2012	3	-	%QX30.0..30.1
KL2034	4	-	%QX30.2..30.5
KL9010	9	-	-

Note

If you do not know the address of the Bus Terminals that you have assigned to the local PLC (BC/BXxx00):
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 BC/BXxx00 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 *Project - Import*. 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 (BC/BXxx00).

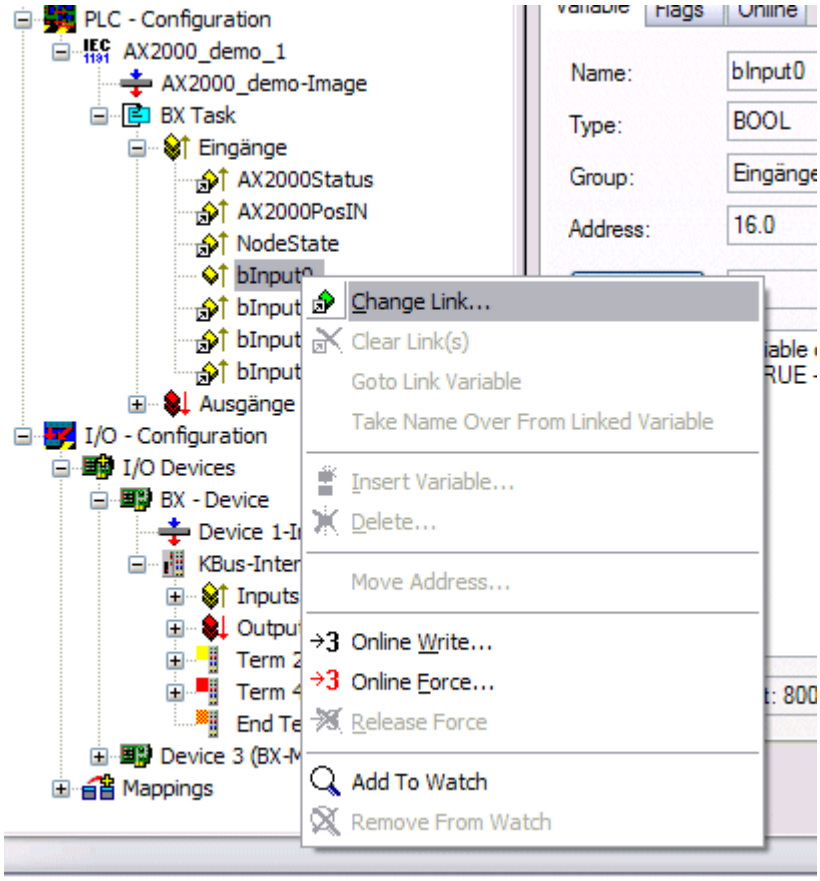
Mapping of the Bus Terminals

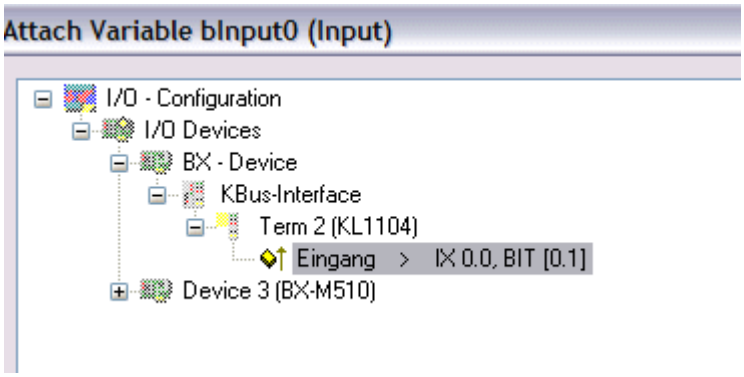
The precise assignment of the byte-oriented Bus Terminals may be found in the configuration guide for the particular bus terminal. This documentation is available on the Beckhoff CD *Products & Solutions* or on the Internet under http://www.beckhoff.com.

Byte oriented Bus Terminals	Bit oriented Bus Terminals
KL1501	KL10xx, KL11xx, KL12xx, KL17xx
KL25xx	KL20xx, KL21xx, KL22xx, KL26xx, KL27xx
KL3xxx	
KL4xxx	
KL5xxx	
KL6xxx	
KL8xxx	
	KL9110, KL9160, KL9210, KL9260

Local process image in the TwinCAT configuration

The TwinCAT configuration (TwinCAT CONFIG) enables free mapping between PROFIBUS / K-Bus / PLC variables. Variables can be linked independent of their address via the System Manager.





In the TwinCAT configuration, all Bus Terminals have fixed addresses. If a Bus Terminal is inserted, the whole address range may be shifted. Many data are unnecessary and take up valuable address memory space. The TwinCAT configuration rectifies this disadvantage. Allocated variables can be linked freely with a Bus Terminal. Parameterization is carried out in the System Manager, and the configuration is then transferred to the BX (see TwinCAT configuration).

Creating a boot project

Approximately 250 kB of flash are available.

For creating a boot project

- on the Bus Terminal Controller of BX-Series app. 250 kByte of flash are available
- on the Bus Terminal Controller of BCxx50-Series app. 48 kByte of flash are available

PLC Control

After logging in, a boot project can be created in TwinCAT PLC Control.

- Opening a PLC project
- Selecting the target system (or selection the serial interface)
- BX/BCxx50 login
- Creating the boot project (Online\Create boot project)

Once a valid boot project is present on the BX/BCxx50 controller, the green PLC LED is on.

At the Bus Terminal Controller of BX-Series the PLC LED will flash orange during the creation of the boot project. If no boot project is available on the BX the PLC LED shines orange.

Deleting a boot project

A boot project can be deleted from the BX/BCxx50. The following steps must be followed:

- Opening the project
- BX/BCxx50 login
- Deleting the boot project (Online\Delete boot project)

Once the boot project was deleted, the PLC LED will be orange.

Note After an online change, the boot project is still the old project. To use the current project (after the online change) as the boot project, the boot project has to be recreated.

Bypassing the start of the boot project*

At the Bus Terminal Controller of BX-Series the start up of an existing boot project can be avoided by pressing the Navi switch during booting. This will not delete the boot project. The project can still be used when the controller is switched on again.

* from version 0.85

Communication between TwinCAT and BX/BCxx50

It makes sense to define a data structure for transferring data between TwinCAT and Bus Terminal Controller. Please note the following to account for the differences in data management on the two systems.

- If two different data types are sent in sequence (e.g. byte and INT), the following variable is set to the next even address offset
- Boolean variables should never be allocated individually within a structure, since they would invariably occupy 1 byte. Boolean expressions should always be masked in a byte or word.

Example 1: Structure on the BX and on the PC

Variable	BX memory	PC memory (TwinCAT)
Byte	%..B0	%..B0
INT (1)	%..B2	%..B1
INT (2)	%..B4	%..B3

Because the first byte is followed by a different variable type (INT), it was set to the next free even address in the BX/BCxx50. In order to achieve the same data structure on both systems, a dummy byte has to be inserted in the PC project (see example 2).

Example 2: Structure on the BX and on the PC with identical memory allocation

Variable	BX memory	PC memory (TwinCAT)
Byte	%..B0	%..B0
Byte (Dummy)	%..B1 (not necessarily required, since the system deals with this itself if the variable does not exist)	%..B1
INT (1)	%..B2	%..B2
INT (2)	%..B4	%..B4

Data structure

```
Type PB_Data
STRUCT
    wVar_1:WORD;
    iValue_1:INT;
    iValue_2:INT;
    iValue_3:INT;
END_STRUCT
END_TYPE
```

Creating a variable structure

```
VAR_Global
    strData_Out AT %QB1000:PB_Data; (*PLC Variables *)
    bInput_01 AT %IX0.0:BOOL; (* Input from a terminal *)
END_VAR
```

Small programming example

```
strData_Out.wVar_1.0:=bInput_01;
```

Note

A mixed data structure should not contain any Real values. If it does, the High and Low word must be swapped in the BX/BCxx50or in the TwinCAT master project. It is better to use an array of Real values or to transfer the Real values individually.

Note

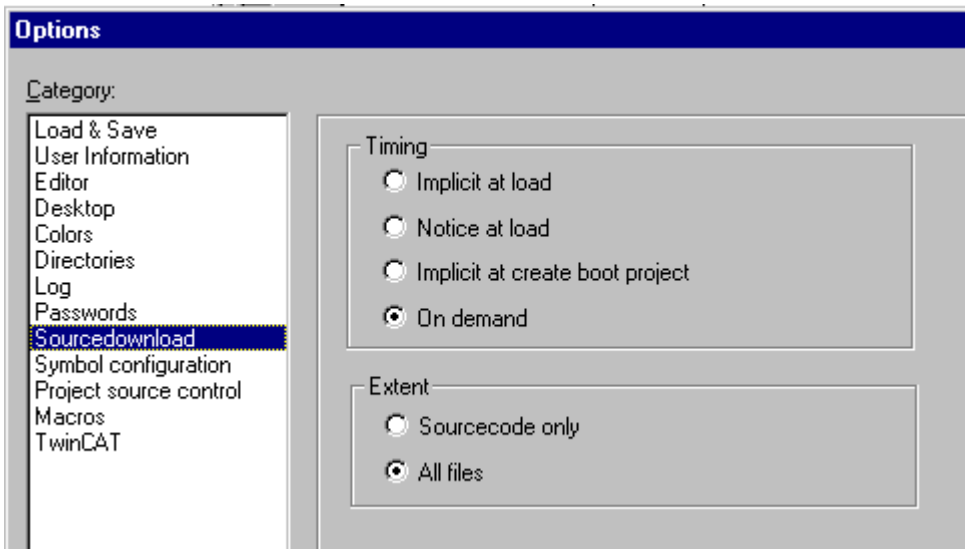
It is also possible to transfer larger fieldbus data blocks, in order to leave a reserve for your structure. Disadvantage: These reserves are then transferred with each fieldbus telegram, causing additional load for the fieldbus communication.

Up- and downloading of programs

The Bus Terminal Controller has 256 kB of memory for the source code. It can be used for storing the program, the task configuration, and the libraries. Should the memory be insufficient, the source code may be stored without task configuration and libraries. This takes up significant less memory space!

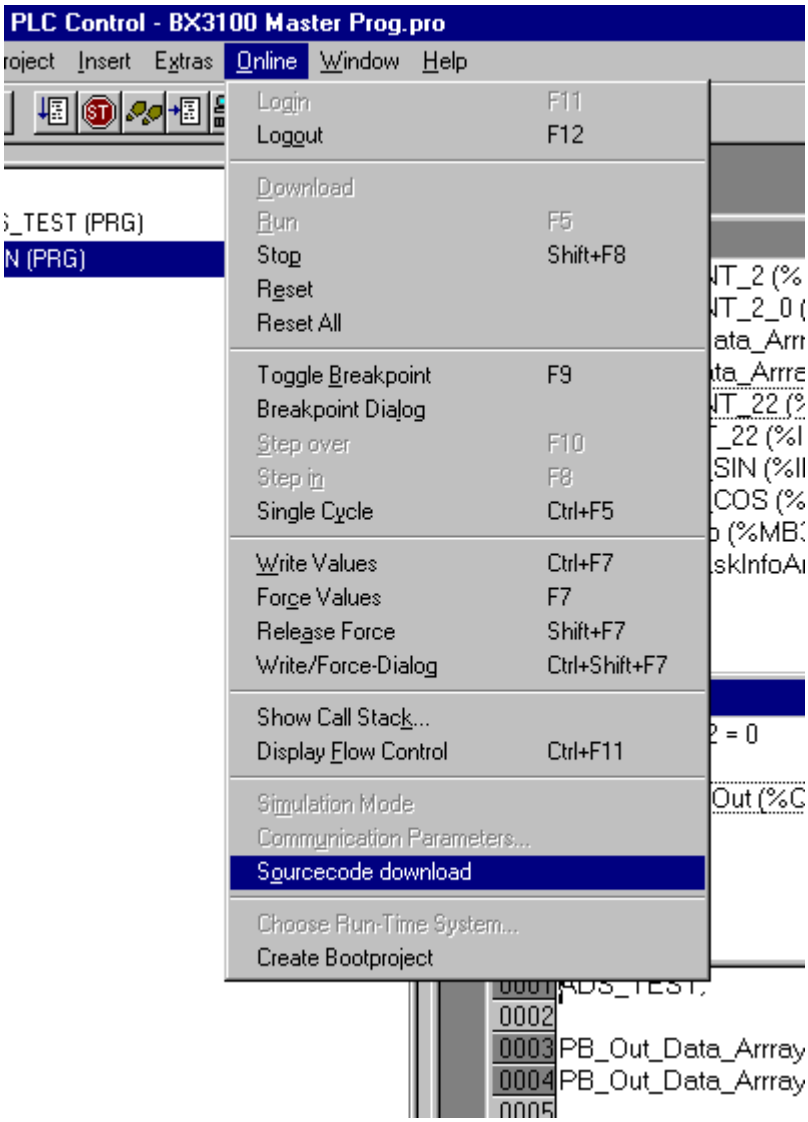
General Settings

The timing of the source code download to the target system can be specified via Edit/Options.

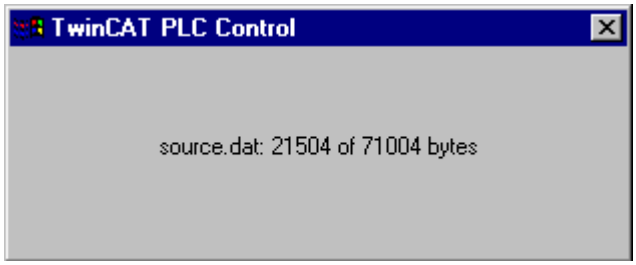


Downloading a program

The source code can be transferred to the target system on request. This requires the user to be logged in with his program. Under Online/Sourcecode download the program code can now be transferred to the Bus Terminal Controller.

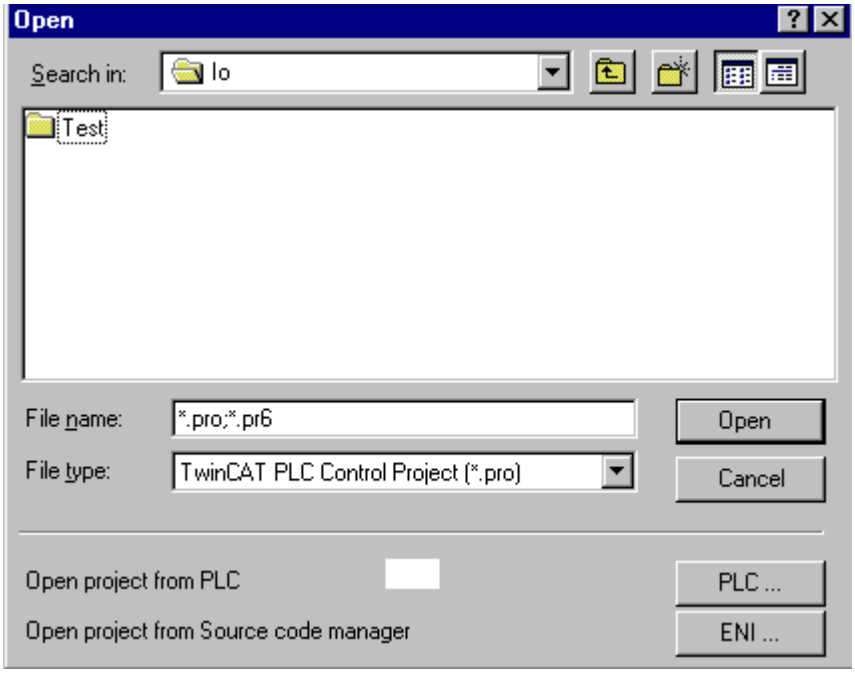


After a short delay, a window will open that indicates the download progress.

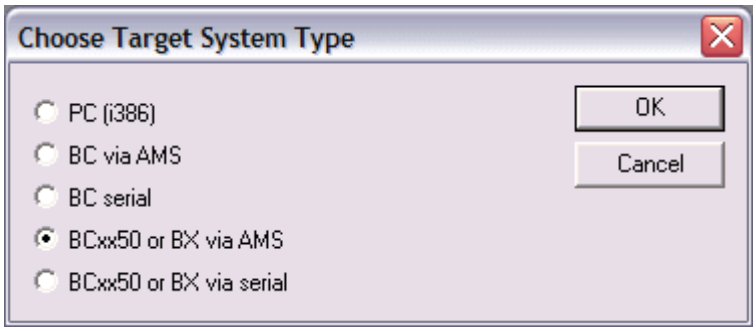


Uploading a program

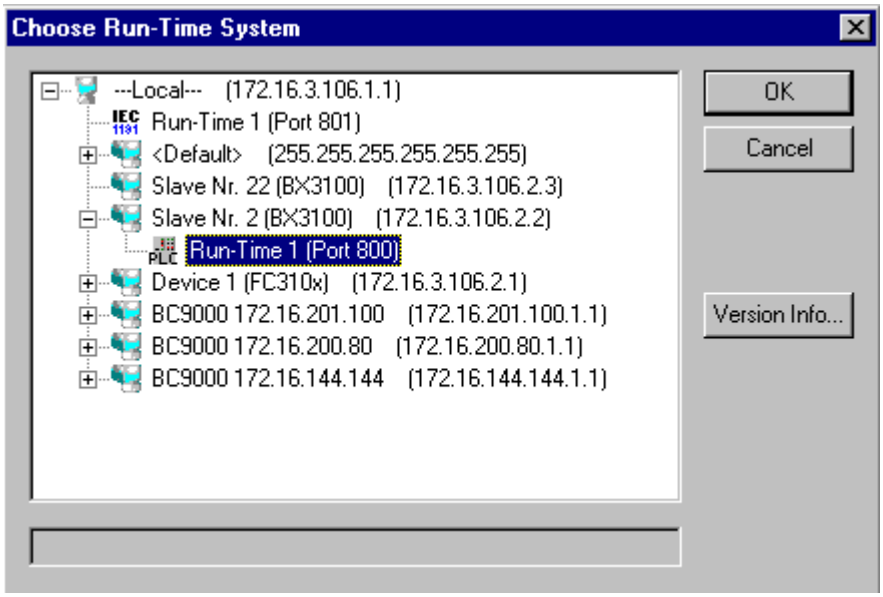
For uploading the program code again, open a new file in PLC Control. Then click on the PLC button.



Select the data transfer route. For the Bus Terminal Controller
- *BCxx50 or BX via AMS*, if they are connected via the fieldbus with the BX, or
- *BCxx50 or BX via serial*, if they are connected via the serial interface.



Then select the device and confirm with OK.



The source code will now be uploaded.

Password

You can protect your project with a password (in PLC Control Project/Options/Passwords).

Libraries

Libraries overview

The TwinCAT Automation Software offers various libraries for the BCxx50 series Bus Terminal Controllers (Bus Coupler with PLC functionality) (see BECKHOFF information system).

Download

The libraries are also included in this documentation. For extracting the libraries, click on the disk icon with the left mouse button and copy the libraries into the directory TwinCAT\PLC\LIB.

- Standard
- TcSystemBCxx50 TcSystemBCxx50 requires the TcBaseBCxx50 library.
- TcBaseBCxx50
- ChrAscBX.lbx

Note Always use the latest libraries in conjunction with the latest BC firmware. If you update the firmware of your Bus Terminal Controller, please also update the libraries. Copy the new libraries into the LIB folder, remove them from your project and re-insert them.

TcSystemBCxx50

ADS	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
ADSREAD		B0	B0	B1	B0	-
ADSWRITE		B0	B0	B1	B0	-
ADSRDWRT		B0	B0	B1	B0	-
ADSWRTCTL		B0	B0	B1	B0	-
ADSRDSTATE		B0	B0	B1	B0	-
ADSRDDEVINFO		B0	B0	B1	B0	-
Bit Functions	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
CLEARBIT32		B0	B0	B1	B0	-
CSETBIT32		B0	B0	B1	B0	-
GETBIT32		B0	B0	B1	B0	-
SETBIT32		B0	B0	B1	B0	-
Controller	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
FB_BasicPID	-	B0	B0	B1	B0	-
-	-	-	-	-	-	-
File Access	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
FB_ReadFromFile		-	-	-	-	-
FB_WriteToFile		-	-	-	-	-
FB_ReadWriteFile		-	-	-	-	-

Memory Functions	Version	Firmware				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
MEMCMP		B0	B0	B1	B0	-
MEMCYP		B0	B0	B1	B0	-
MEMMOVE		B0	B0	B1	B0	-
MEMSET		B0	B0	B1	B0	-
NOVRAM Functions	**Version**	**Firmware**				
		BX3100	**BX5100**	**BX5200**	**BX8000**	**-**
-	-	-	-	-	-	-
SFC	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
AnalyzeExpression		-	-	-	-	-
AppendErrorString		-	-	-	-	-
SFCActionControl		-	-	-	-	-
System / Time / TBus	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
DRAND		B0	B0	B1	B0	-
SYSTEMTIME_TO_DT		B0	B0	B1	B0	-
DT_TO_SYSTEMTIME		B0	B0	B1	B0	-
GetSysTick		B0	B0	B1	B0	-
PresetSysTick		B0	B0	B1	B0	-
Reboot		B0	B0	B1	B0	-
Debug	**Version**	**Firmware**				
		BC3150	**BC5150**	**BC5250**	**BC8150**	**-**
F_ReadDebugTimer						-
F_StartDebugTimer						-

TcBaseBX

System Task Info

```
VAR_GLOBAL
        SystemTaskInfo   :  SYSTEMTASKINFOTYPE;
END_VAR
```

System flags are implicitly declared variables. Using the Input Assistant, a variable SystemTaskInfoArr can be found under system variables. This variable is a field with four structures of type SYTEMTASKINFOTYPE. The structure definition can be found in the system library. The index in this field is the task ID.

Development environment	Target system type	PLC libraries to be linked
TwinCAT v2.9.0	BCxx50 Controller	TcBaseBCxx50.lbx

System task info type

```
TYPE SYSTEMTASKINFOTYPE
STRUCT
        active                  :       BOOL;
        taskName                :       STRING(16);
        firstCycle              :       BOOL;
        cycleTimeExceeded               :       BOOL;
        cycleTime                       :       UDINT;
        lastExecTime            :       UDINT;
        priority                :       BYTE;
        cycleCount              :       UDINT;
END_STRUCT
END_TYPE
```

Key
active: This variable indicates whether the task is active.
taskName: the task name.
firstCycle: during the first PLC task cycle, this variable has the value TRUE.
cycleTimeExceeded: this variable indicates whether the set task cycle time was exceeded.
cycleTime : set task cycle time in multiples of 100 ns.
lastExecTime: cycle time required for the last cycle in multiples of 100 ns.
priority: set task priority.
cycleCount: cycle counter.

Development environment	Target system type	PLC libraries to be linked
TwinCAT v2.9.0	BCxx50 Controller	TcBaseBCxx50.lbx

System Info

```
VAR_GLOBAL
    SystemInfo     : SYSTEMINFOTYPE;
END_VAR
```

System flags are implicitly declared variables. Using the Input Assistant, a variable System Info can be found under system variables. The type SYSTEMINFOTYPE is declared in the system library. For accessing the variable, the system library has to be integrated in the project.

Development environment	Target system type	PLC libraries to be linked
TwinCAT v2.9.0	BCxx50 Controller	TcBaseBCxx50.lbx

System Info Type

```
TYPE SYSTEMINFOTYPE
STRUCT
        runTimeNo               :       BYTE;
        projectName             :       STRING(32);
        numberOfTasks           :       BYTE;
        onlineChangeCount               :       UINT;
        bootDataFlags           :       BYTE;
        systemStateFlags        :       WORD;
END_STRUCT
END_TYPE
```

Key
runTimeNo: specifies the number of the runtime system (1).
projectName: project name as STRING.
numberOfTasks: number of tasks contained in the runtime system (max. 1).
onlineChangeCount: number of online changes since the last complete download.
bootDataFlags: Reserved
systemStateFlags: Reserved

Development environment	Target system type	PLC libraries to be linked
TwinCAT v2.9.0	BCxx50 Controller	TcBaseBCxx50.lbx

ADS

Local ADS Port Numbers

Port number	Description
100_{dec}	Reading and writing of registers and tables from the coupler and the complex Bus Terminals
801_{dec}	Local PLC process image

ADS Services

Local process image task 1 port 801

Data can be read from and written to the local process image. If it is necessary for outputs to be written, it is important to ensure that they are not used by the local PLC, because the local controller will overwrite these values. The data is not associated with a watchdog, and therefore must not be used for outputs that would have to be switched off in the event of a fault.

Index group	Meaning	Index offset (value range)
0xF020	Inputs	0...2047
0xF030	Outputs	0...2047
0x4020	Flags	0...4095

ADS services

AdsServerAdsState

Data type (read only)	Meaning
String	Start - the local PLC is running Start - the local PLC is stopped

AdsServerDeviceState

Data type (read only)	Meaning
INT	0 – Start - the local PLC is running 1 – Stop - the local PLC is stopped

AdsServerType

Data type (read only)	Meaning
String	BX PLC Server

Register port 100

The ADS port number in the Bus Terminal Controller for register communication is fixed, being set at 100.

	Index offset (value range)		
Index group	Hi-Word	Low Word	Meaning
0 [READ ONLY]	0..127	0..255	Registers in the Bus Coupler High word, table number of the Bus Coupler Low word, register number of the table
1-255	0-3	1-255	Register of the Bus Terminal High word, channel number Low word, register number of the Bus Terminal

Note Note when reading the register that the time out for the ADS block is set to a time longer than 1 second.

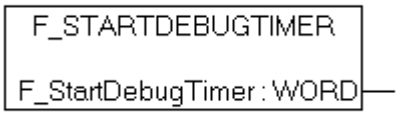
Note Note when writing to the registers that the password is set (see the documentation for the particular Bus Terminal).

BX Debug Function

BX Debug Function - Overview

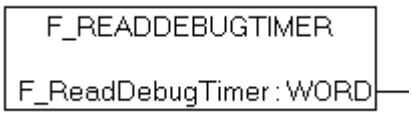
These functions can be used for measuring command execution times in a PLC project. The unit is a tick. One tick corresponds to 5.12 µs.

Start Debug Timer function



Calling this function starts the timer. The return value is "0".

Read Debug Timer function



This function reads the timer value. The return value has to be multiplied with 5.12 µs.

Example

```
VAR
    Timer_BX     :WORD;
    i            :INT;
END_VAR
```

Program

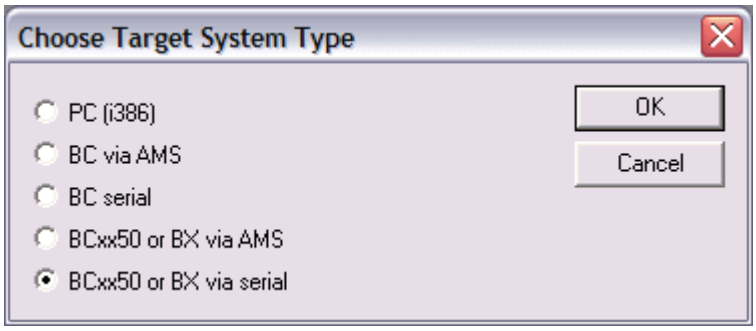
```
F_STARTDEBUGTIMER();
For i:=0 to 1000 do
    ;
END_FOR
Timer_BX:=F_READDEBUGTIMER();
```

Program Transmission

Transmission via Serial Interface

Every Bus Terminal Controller can be programmed via the PC's RS232 interface.

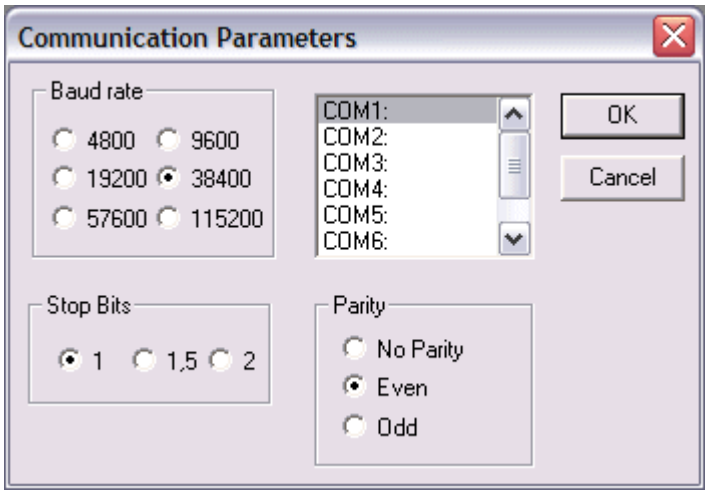
Select the serial interface in TwinCAT PLC Control.



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:

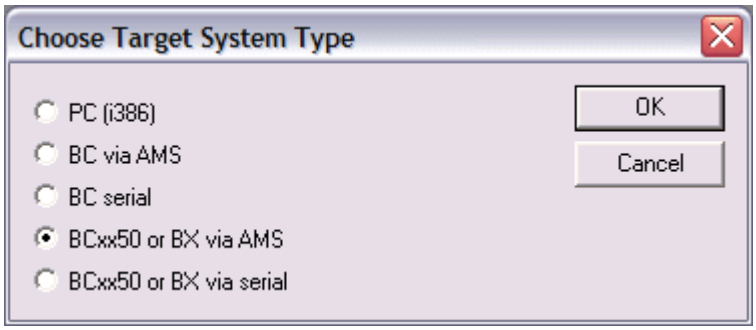
- Baud Rate: 9600/19200/38400/57600 baud (automatic baud rate detection)
- Stop bits: 1
- Parity: even



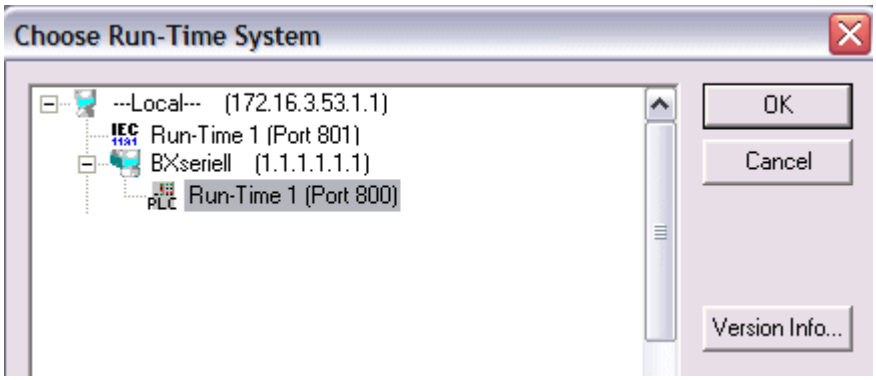
Transmission via the serial interface and ADS

The Bus Terminal Controller can be programmed via the PC's RS232 interface. Before it can be used, the TwinCAT has to be made aware of the Bus Terminal Controller (see serial ADS).

Select the ADS connection in TwinCAT PLC Control.



PLC Control can be accessed via *Online/Communication Parameters...*.



Transmission via PROFIBUS

TwinCAT offers a facility for transferring the application program to the BC/BX via the fieldbus. The BC/BX can be selected as the target system in PLC Control, after saving in the registry and restarting the TwinCAT system. The TwinCAT-level TwinCAT PLC is necessary.

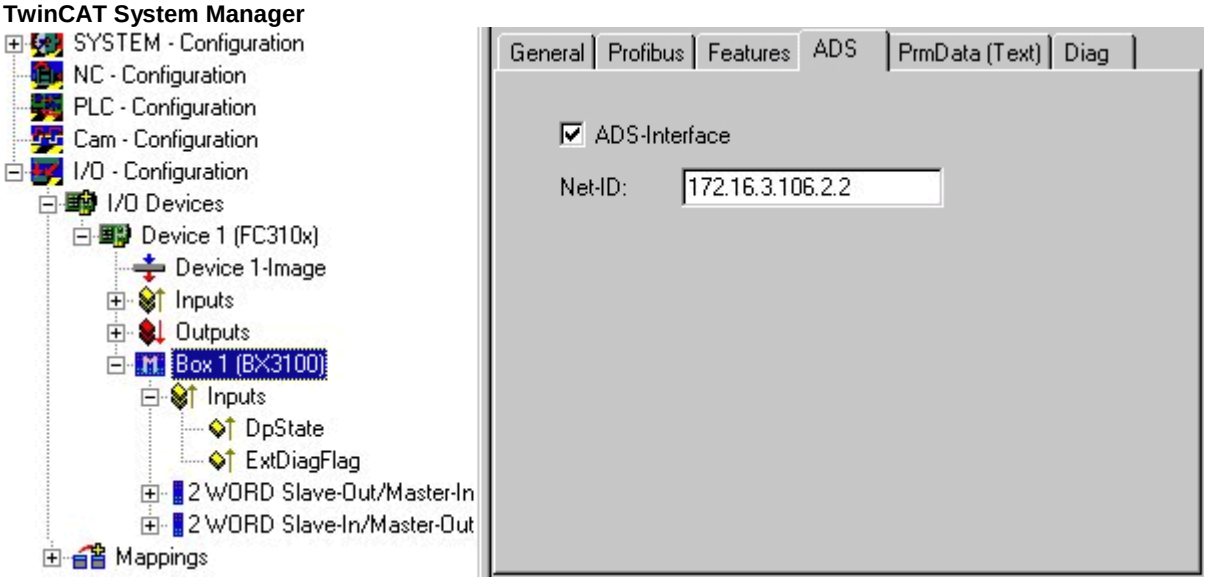
Minimum requirements:

- FC310x with firmware from 2.0
- TwinCAT 2.9 build 945

Initializing the BC/BX

The coupler must first be made known to the system before it can be selected in PLC Control.
Enter the Bus Terminal Controller in the System Manager, specify type, quantity and size of the fieldbus variables and link them with a task. For the subsequent program download via PROFIBUS, the ADS interface has to be activated in the ADS tab of the BC/BX. Save your settings and activate the configuration. Then start the TwinCAT system and the cyclic task.

TwinCAT System Manager

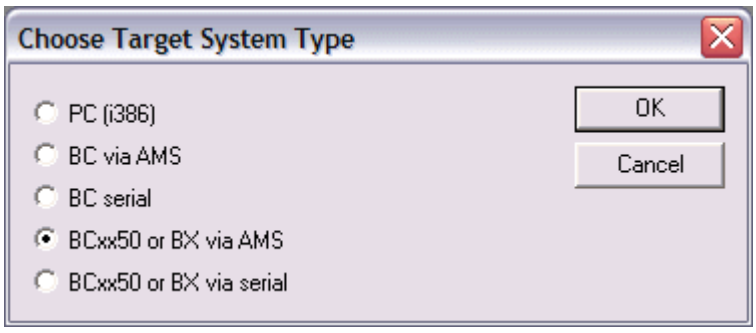


PLC Control

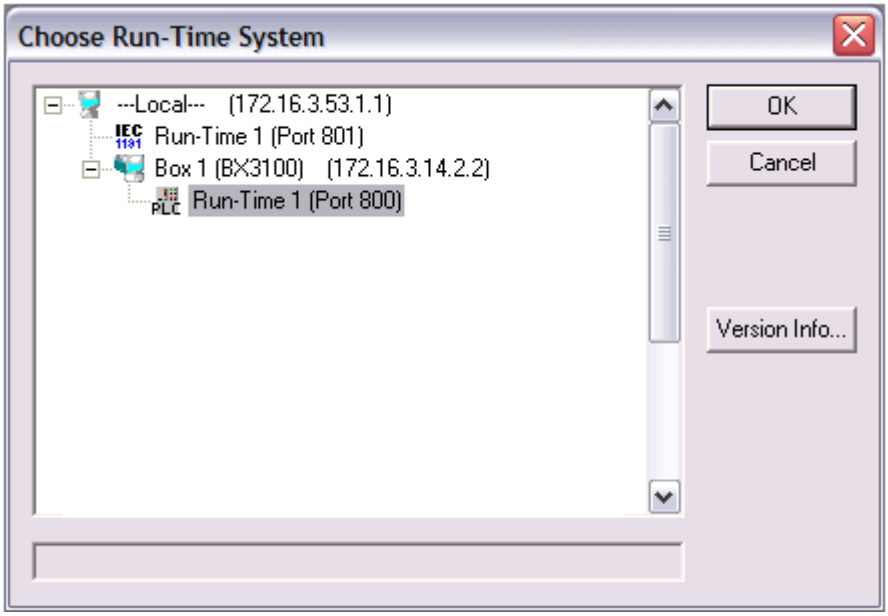
When TwinCAT PLC Control is restarted, TwinCAT asks for the target platform, i.e. the device on which the user program is later to run. TwinCAT offers two target platforms for the controller, the PC or the Bus Terminal Controller.

Two routes are available to you for transmission to the Bus Terminal Controller:

- AMS for BCxx00 (Bus Terminal Controller without online change, one task)
- AMS for BCxx50 and BX (Bus Terminal Controller with online change, two tasks)
- BC serial - serial cable for communication via the RS232 interface of the PC and the programming interface of the Bus Terminal Controller



After your program has been created, select the target system under the *Online* toolbar. TwinCAT must be running to do this. In the example, this is the Ethernet card with Box 1 and the Runtime 1 of the Bus Terminal Controller.



Process Image

PROFIBUS process image

The BC3150 is a PROFIBUS slave device. A basic device file (GSD) is available for the configuration on the master side, which has to be integrated in the respective master configuration software. The type and quantity of the data to be transferred to the PROFIBUS master is specified on the slave side, i.e. in the BC3150 . The BC3150 can process a maximum of 128 bytes of input data and 128 bytes of output data. Two configuration types are available.

No special configuration is required for the DEFAULT CONFIG. The PROFIBUS data start at a certain address offset. The type and quantity of data is configured in the master.

TWINCAT CONFIG requires the TwinCAT System Manager. It can be used for byte-wise linking of PROFIBUS data with PLC data, or for linking data from the K-Bus to the PROFIBUS directly.

The input data of the BC3150 are output data of the master, and output data of the BC3150 are input data of the slave.

DEFAULT CONFIG

In DEFAULT CONFIG, all allocated variables with address 1000 or greater are transferred to the master. The type and number of variables is configured on the master side.

Example
Var_1 AT %IB1000 :INT; a 2-byte output variable has to be configured on the master side.
Var_2 AT %IB1002 :DINT; a 4-byte output variable has to be configured on the master side.

The order of the variables on the master side must be adhered to. Address gaps are only permitted if they are configured on the master side. Otherwise, addressing must be continuous from address 1000.

TWINCAT CONFIG

For the TwinCAT CONFIG, a configuration must be created via the System Manager. The System Manager is used for specifying the type and number of variables and for linking the variables. The PROFIBUS data may therefore be located anywhere in the permissible allocated process image.

Permissible process image:
INPUT %IB0 - %IB2047
OUTPUT %QB0 - %QB2047

6. PROFIBUS

System Introduction

Fieldbus Overview

Profibus is a manufacturer - independent, open fieldbus standard with a wide range of applications in manufacturing and process automation. Manufacturer-independence and openness are guaranteed by the International standards EN 50170 and EN 50254. Profibus allows devices from different manufacturers to communicate without the need for specially adapted interfaces. Profibus is suitable both for fast, time-critical applications and for complex communication tasks.

Profibus offers communication protocols of different functional levels: DP and FMS. According to the application, RS-485, IEC 1158-2 or optical fiber are available as transmission techniques.

Profibus specifies the technical features of a serial fieldbus system with which distributed digital automation devices can be networked together, from the field level up to the cell level. Profibus is a multi-master system, and therefore permits common operation of a number of automation, engineering or visualization systems with their distributed peripheral devices on one bus.

Profibus distinguishes the following device types:
Master devices determine the data traffic on the bus. A master may transmit messages without having received an external request when it is in possession of the bus access authorization (token). Masters are also referred to as active devices.

Slave devices are peripheral devices such as input/output devices, valves, drives, measuring transducers and the Beckhoff Profibus slaves from the BK3xx0, BC3xx0, IPxxxx-B310, IL230x-B310 and IL230x-C310 series. They do not receive any bus access authorization, so that they are only allowed to acknowledge messages that have been received, or to send messages in response to a request from master. Slaves are referred to as passive devices. They only require a small proportion of the bus protocol, which means that they can be implemented with little effort.

Profibus DP

Profibus DP is designed for efficient data exchange at the field level. The central automation devices such as PLC/PCs or process control systems communicate here over a fast serial link with distributed field devices such as I/O, drives, valves etc.. Data is primarily exchanged with these distributed devices cyclically. The communication functions required for this are specified by the basic DP functions in accordance with EN 50170.

In addition to these basic functions, Profibus DP also offers extended acyclic communication services for such purposes as parameterization and other operations. These are also supported by the Beckhoff Profibus slaves of the IPxxxx-B310, IL230x-B310 and IL230x-C310 series. A central controller (master) cyclically reads the input information from the slaves, and writes the output information cyclically to the slaves. The bus cycle time here should be shorter than the central automation system's program cycle time, which lies around 10 ms in many applications.

A high data throughput is not in itself sufficient for successful use of a bus system. Ease of handling, good diagnostic facilities and secure transmission technology are also of the utmost importance if the user’s demands are to be satisfied. These properties are ideally combined in Profibus DP.

System configuration and device types

Profibus DP allows **single master or multi-master** systems to be implemented. This permits a high level of flexibility in system configuration. A maximum of 126 devices (master or slaves) can be connected to one bus. A station address between 0 and 99 can be chosen for the Beckhoff Profibus slaves from the IPxxxx-B310, IL230x- B310 and IL230x-C310 series. The specifications for the system configuration contain the number of stations, the assignment of the station addresses to the I/O addresses, data consistency of the I/O data and the format of the diagnostics messages and the bus parameters being used. Every Profibus DP system consists of different device types.

Three types of device are distinguished:

DP master class 1 (DPM1) e.g. Beckhoff PC master card FC310x	This involves a central controller that exchanges information cyclically with the distributed stations (slaves) in a specified message cycle. Typical devices include, for instance, programmable logic controllers (PLCs) or PCs.
DP master class 2 (DPM2)	Devices of this type are engineering, project design or operating devices. They are used for commissioning, for servicing and diagnosis in order to configure the connected devices, to evaluate measured values and parameters and to interrogate the status of devices.
DP slave e.g. Beckhoff Bus Coupler IPxxxx-B310	A Profibus DP slave is a peripheral device (I/O, drive, measuring transducer etc.) that reads input information and passes output information on to the peripherals. It is also possible to have devices that only handle either input or output information. The quantity of input and output information is device-dependent, and may not exceed 246 bytes of input data and 246 bytes of output data.

In **single master systems** only one master is active on the bus in the operating phase of the bus system. The PLC controller is the central control element. The distributed slaves are coupled to the PLC controller via the transmission medium. The shortest bus cycle time is achieved with this system configuration.

In a **multi-master mode** there is more than one master on the bus. They either form sub-systems that are independent of one another, each consisting of one DPM1 and the associated slaves, or additional project design and diagnostic devices. All the DP masters can read the input and output images of the slaves. Writing the outputs is only possible for one DP master (the one assigned as DPM1 during the project design). Multi-master systems achieve a medium bus cycle time. In time-critical applications, the increase in bus cycle time should be observed by adding a diagnostic tool.

Basic device files (GSD)
In Profibus DP, the performance characteristics of devices are documented by the manufacturers and made available to users in the form of a device data sheet and of a basic device file. The structure, content and coding of these basic device files (GSD) is standardized. They make it easy to plan a project with any Profibus DP slaves using project planning devices from a various manufacturers. The Profibus User Organization (Profibus Nutzer Organization - PNO) archives this information for all manufacturers, and will provide information about the GSD from any manufacturer on request. The GSD files are read by a Profibus master configuration software, and appropriate adjustments are transferred to the Profibus master. Please see the appropriate software manual from the master manufacturer for a description.

The Beckhoff GSD files may be obtained from the internet under www.beckhoff.com.

Diagnostic functions

The extensive diagnostic functions of Profibus DP allow rapid fault localization. Diagnosis of the Beckhoff Bus Coupler is not activated in the default setting of the type file or the GSD file. The diagnostic messages are transmitted over the bus and collated by the master.

They are divided into three levels:

Diagnosis type	Description
Related to the station	Messages relating to the general readiness of a device for operation such as over-temperature or under-voltage
Related to the module	These messages indicate that diagnostic signals are pending within a specific I/O sub range of the device (e.g. an 8 bit output module)
Related to the channel	Here the cause of an error is related to a single input/output bit (channel), such as a short circuit on output 2

The Beckhoff Profibus slaves from the IPxxxx-B310, IL230x-B310 and IL230x-C310 series support the Profibus DP diagnostic functions. Assessment of the diagnostic data by means of the controller depends on the support for the Profibus master. Please refer to the device manuals for the master interfaces for details of how to handle the diagnosis.

Sync and Freeze Mode

In addition to the user data traffic related to the device, which is automatically dealt with by DPM1, a DP master has the option of sending control commands to one DP slave, to a group of them or to all of them at the same time. These control commands are transmitted as multicasts. These control commands can be used to specify the sync and freeze operating modes, in order to synchronize the DP slave. They permit event-controlled synchronization of the DP slaves.

The DP slaves start **sync mode** when they receive a sync control command from the assigned DP master. In this operating mode, the outputs of all the addressed DP slaves are frozen at their current values. In the following user data transmissions, the DP slaves store the output data, but the output states themselves nevertheless remain unchanged. Only when the next sync control command is received from the master the stored output data is switched through to the outputs. Sync operation is ended with an unsync control command.

A freeze control command similarly causes the addressed DP slaves to enter **freeze mode**. In this operating mode the states of the inputs are frozen at their current value. The input data is only updated again when the DP master has sent the next freeze control command to the devices concerned. Freeze operation is ended with an unfreeze command.

System behavior

The system behavior is also standardized in Profibus DP, so that devices can to a large extent be interchanged. It is largely determined by the operating condition of the DPM1. This can either be controlled locally, or over the bus by the project design device.

The following three principal conditions are distinguished:

Operation mode	Description
Stop	There is no data traffic between the DPM1 and the DP slaves. The Bus Coupler only addresses the Bus Terminals once after the power has been switched on (none of the I/O LEDs are lit).
Clear	The DPM1 reads the input information from the DP slaves, and maintains the outputs of the DP slaves in a safe state (depending on the reaction to fieldbus errors, the green I/O LED is lit and the outputs are set).
Operate	The DPM1 is in a data transfer phase. In the course of cyclic data traffic the inputs of the DP slaves are read and the output information is transmitted to the DP slaves (the green I/O LED is lit).

The DPM1 sends its local status at a configurable time interval using a multicast command cyclically to all the DP slaves that have been assigned to it. The reaction that the system has to the occurrence of an error during the DPM1's data transfer phase, such as the failure of a DP slave, is specified in the *Auto-Clear* operating parameter. If this parameter is set to *True*, then the DPM1 switches the outputs of all the associated DP slaves into a safe state as soon as one DP slave is no longer ready for the transfer of user data. The DPM1 then switches into the Clear state. If the parameter is *False* then the DPM1 remains in the operating state even after a fault, and the user can himself specify the system's reaction.

Data traffic between the DPM1 and the DP slaves

The data traffic between the DPM1 and the DP slaves that have been assigned to it is automatically executed by the DPM1 in a specified, continuously repeated sequence. The user specifies the assignment of a DP slave to the DPM1 when the bus system's project is being planned. Those DP slaves that are included in or excluded from the cyclic user data traffic are also defined.

The data traffic between the DPM1 and the DP slaves is divided into the parameterization, configuration and data transfer phases.

Before a DP slave is included in the data transfer phase, the DPM1 checks, in the parameterization and configuration phase, whether the theoretical configuration that has been planned agrees with the actual configuration of devices. The check requires the device type, the format and length information, as well as the number of inputs and outputs, to be in agreement. The user is thus provided with reliable protection against errors in parameterization. In addition to the transfer of user data, which is automatically carried out by the DPM1, it is possible to send new parameterization data to the DP slaves at the user's request.

Protection mechanisms

In the context of distributed peripherals it is necessary, for reasons of safety and reliability, for the system to be given extremely effective functions to protect against incorrect parameterization or the failure of the transmission mechanisms. Profibus DP uses monitoring mechanisms in the DP Master and in the DP Slaves. They are implemented in the form of time monitors. The monitoring interval is specified in when the DP system project is planned.

Protection mechanisms	Description
At the DP Master	The DPM1 monitors the slave's transfer of user data with the Data_Control_Timer. An individual monitoring timer is used for each assigned slave. The time monitor triggers if a proper transfer of user data does not take place within the monitoring interval. In this case the user is informed. If automatic error reaction is enabled (Auto_Clear = True) then the DPM1 leaves the *Operate* state, switches the outputs of the assigned slaves into a safe state, and then goes into the *Clear* operating mode.
At the DP Slave	The slave uses communication monitoring in order to detect errors of the master or in the transmission segment. If data is not transferred with the assigned master within the communication monitoring interval the slave switches the outputs into the safe state itself. The slave inputs and outputs further require access protection in multi-master systems, to ensure that direct access is only made from the authorized master. The slaves will make an image of the inputs and outputs available to other masters, and this can be read by any other master even if it does not have access authorization.

Ident number

Every DP slave and every DPM1 must have an individual identification number. This is required so that a DP master can identify the types of the connected devices without any significant protocol overhead. The master compares the identification numbers of the connected DP devices with the identification numbers in the project planning data specified by DPM2. The transfer of user data only starts if the correct device types are connected to the bus at the correct station addresses. This provides protection from project planning errors. Manufacturer-specific identification numbers are issued by the Profibus User Organization (PNO). The PNO administers the identification numbers along with the basic device data (GSD).

PROFIBUS DP

In PROFIBUS DP systems, a master (PLC, PC etc.) usually communicates with a large number of slaves (I/Os, drives etc.). Only the master may here actively access the bus (send telegrams on its own initiative), while a DP slave only sends telegrams when it is requested to do so by a master.

DP StartUp

Before the master and slave can cyclically exchange data, the parameter and configuration data is transmitted from the master to the slaves during the DP StartUp phase. After the parameter and configuration data has been sent, the master interrogates the slave's diagnostic data until the slave indicates that it is ready for data exchange. Depending on the extent of the calculations that the slave must carry out after receiving the parameter and configuration data, it can take up to a few seconds before it is ready for data exchange. For this reason the slave possesses the following states:

Parameter data

The parameter data is sent from the master to the slave in the SetPrmLock request telegram. The SetPrmLock response telegram does not contain any data, and therefore consists of a single byte, the short acknowledgement. The parameter data consists of DP parameters (e.g. the setting of the DP watchdog or checking the IdentNumber (unique to each DP device)), of DPV1-/DPV2 parameters and of application-specific parameters that only have to be transmitted once during the StartUp. If an error is found in the parameter data, this is indicated in the diagnostic data, and the slave either remains in or enters the WAIT-PRM state.

Configuration data

The configuration data is sent from the master to the slave in the ChkCfg request telegram. The ChkCfg response telegram does not contain any data, and therefore consists of a single byte, the short acknowledgement. The configuration data describes the assignment of the DP modules to the cyclic I/O data that is to be exchanged between the master and slave via the Data_Exchange telegram in the cyclic data exchange phase. The sequence of the DP modules added to a slave in the DP configuration tool determines the sequence of the associated I/O data in the Data_Exchange telegram.

Diagnostic data

The diagnostic data is requested by the master using a SlaveDiag request telegram without any data. The slave replies with the diagnostic data in a SlaveDiag response telegram. The diagnostic data consists of the standard DP diagnostics (e.g. the state of the slave, the IdentNumber) and of application-specific diagnostic data.

Cyclic data exchange

The heart of the PROFIBUS DP protocol is cyclic data exchange, during which the master carries out an exchange of I/O data with every slave during a PROFIBUS DP cycle. This involves the master sending the outputs to each slave with a DataExchange request telegram, while the slave replies with the inputs in a DataExchange response telegram. This means that all the output and/or input data is transmitted in one telegram, in which the DP configuration (the sequence of DP modules) specifies the assignment of the output and/or input data to the slave's actual process data.

Diagnosis during cyclic data exchange

A slave can send a diagnostics signal to the master during cyclic data exchange. In this case, the slave sets a flag in the DataExchange response telegram, whereby the master recognises that there is new diagnostic data in the slave. It then fetches that data in the SlaveDiag telegram. This means that diagnostic data is not transmitted to the controller with the cyclic I/O data in real-time, but is always at least one DP cycle later.

Synchronisation with Sync and Freeze

The Sync and Freeze commands in the GlobalControl request telegram (broadcast telegram) allow the master to synchronise the activation of the outputs (Sync) or the reading of the inputs (Freeze) in a number of slaves. When the Sync command is used, the slaves are first switched into Sync mode (a process that is acknowledged in the diagnostic data). The I/O data is then exchanged sequentially with the slaves in the DataExchange telegram. Transmitting the Sync command in the GlobalControl telegram then has the effect of causing the slaves to generate the most recently received outputs. In Freeze operation a Freeze command is first sent in the GlobalControl telegram, in response to which all the slaves latch their inputs. These are then fetched sequentially by the master in the DataExchange telegram.

States in the master

The master distinguishes between the CLEAR state (all outputs are set to the Fail_Safe value) and the OPERATE state (all outputs have the process value). The Master is usually switched into the CLEAR mode when, for instance, the PLC enters STOP.

Class 1 and Class 2 DP Masters

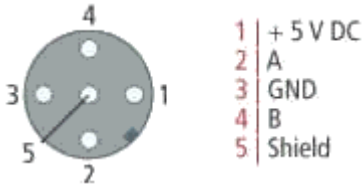
The Class 1 master refers to the controller that carries out cyclic I/O data exchange with the slaves, while a Class 2 master is a B&B device that generally only has read access to the slaves' I/O data.

PROFIBUS DPV1

PROFIBUS DPV1 refers primarily to the acyclic read and write telegrams, with which data sets in the slave are acyclically accessed. A distinction between a Class 1 and a Class 2 master is also made for DPV1. The difference between acyclic Class 1 (C1) and Class 2 (C2) connections is that the acyclic C1 connection is established during the DP StartUp phase of cyclic DP operation. Once the slave has reached the WAIT-CFG state it is possible for acyclic DPV1-C1 read and write telegrams to be sent from the master to the slave, whereas the C2 connection is established separately, independently of the cyclic DP connection. This is usually carried out by a second (C2) master so that, for instance, a manufacturer-specific project configuration and diagnostic tool can access the slave's data.

When two masters are used, however, is must always be borne in mind that these share bus access (a token is exchanged), so that time relationships are less favourable than in the case of a single master system.

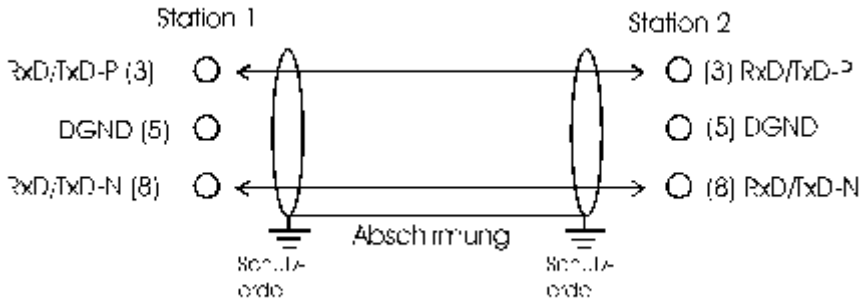
Cables, Plugs and Switches

The Medium: Plugs and Cables	
The physics of the transmission	Physical aspects of the data transmission are defined in the Profibus standard. See Profibus layer 1 (physical layer). The types of area where a fieldbus system can be used is largely determined by the choice of the transmission medium and the physical bus interface. In addition to the requirements for transmission security, the expense and work involved in acquiring and installing the bus cable is of crucial significance. The Profibus standard therefore allows for a variety of implementations of the transmission technology while retaining a uniform bus protocol. Cable-based transmission: This version, which accords with the American EIA RS-485 standard, was specified as a basic version for applications in production engineering, building management and drive technology. A twisted copper cable with one pair of conductors is used. Depending on the intended application area (EMC aspects should be considered) the screening may be omitted. Two types of conductor are available, with differing maximum conductor lengths; see the „RS-485“ table. The pin assignment at the plug and the wiring are illustrated in the diagram. Note the special requirements on the data cable for baud rates greater than 1.5 Mbaud. The correct cable is a basic requirement for correct operation of the bus system. If a „simple“ 1.5 Mbaud cable is used, reflections and excessive attenuation can lead to some surprising phenomena. This could, for example be that some station is not connected, but when the neighbouring station is unplugged the connection appears again. Or there may be transmission errors when a specific bit pattern is transmitted. The result of this can be that when the equipment is not operating, Profibus works without faults, but that there are apparently random bus errors after start-up. Reducing the baud rate (< 93.75 kbaud) corrects this faulty behaviour. If reducing the baud rate does not correct the error, then in many cases this can indicate a wiring fault. The two data lines maybe crossed over at one or more connectors, the termination resistors may not be switched on, or they may be active at the wrong locations.
Cable-related malfunctions	
Note	Installation is made a great deal more straightforward if pre-assembled cables from Beckhoff are used. Wiring errors are avoided, and commissioning is more rapidly completed. The range includes fieldbus cables, power supply cables, sensor cables and accessories such as terminating resistors and T-pieces. Connectors and cables for field assembly are nevertheless also available.
Profibus Connection of the fieldbus box modules	The M12 socket is inverse coded, and has five pins. Pin 1 is 5 V DC and 3 is GND for the active termination resistor. These must never be misused for other functions, as this can lead to destruction of the device. Pin 2 and pin 4 are the Profibus signals. These must never be swapped over, as this will prevent communication. Pin 5 is the shield, and this is capacitatively coupled to the Fieldbus Box chassis. **Profibus socket pin assignment**  **Profibus conductor colours** **Profibus conductors** / **M12** / **D-Sub** B red / Pin 4 / Pin 3 A green / Pin 2 / Pin 8

RS485 Fundamental properties

RS-485 transmission according to the Profibus standard	
Network topology	Linear bus, active bus terminator at both ends, stubs are possible.
Medium	Screened twisted cable, screening may be omitted, depending upon the environmental conditions (EMC).
Number of stations	32 stations in each segment with no repeater. Can be extended to 127 stations with repeater
Max. bus length without repeater	100 m at 12 Mbit/s 200 m at 1500 Kbit/s, up to 1.2 km at 93.75 Kbit/s
Max. bus length with repeater	Line amplifiers, or repeaters, can increase the bus length to the order of 10 km. The number of repeaters possible is at least 3, and, depending on the manufacturer, may be up to 10
Transmission speed	9.6, 19.2, 93.75, 187.5, 500, 1500 Kbit/s, up to 12 Mbit/s, adjustable in stages
Plug connector	9-pin D-Sub connector for IP20 M12 round plugged connector for IP65/67

Cabling for Profibus DP and Profibus FMS

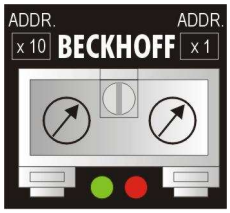


Setting of station addresses

The Profibus address must be set using the two rotary selection switches behind the transparent cover. The default setting is 11. Any address is permitted, but each address may only be used once within the network. The address is changed while the Fieldbus Box is switched off. To do this, unscrew the cover and use a screwdriver to move the switches to the desired position. Make sure that the switches engage properly. The change in address is active as soon as the device is switched on.

Address Fieldbus Box

The switch on the left represents the tens, while that on the right represents the units.



Address Buscoupler

The switch S311 represents the tens, while that S310 represents the units.

Note	In systems with more than two stations all devices are wired in parallel. It is essential that the bus cables are terminated with resistors at the conductor ends in order to avoid reflections and associated transmission problems.

Topology

- A bus segment may consist of a maximum of 32 devices (including the repeaters).
- The maximum conductor length of a segment depends on the transmission speed in use and on the quality of the bus cables being used.
- No more than 9 repeaters may be installed between two devices.
- Stubs are to be avoided, and are not permitted above 1.5 Mbaud.
- The maximum number of devices is 127
- Interrupting the supply voltage from cable ends by switching off the repeater/slave, or by pulling out the plug, is not permitted.

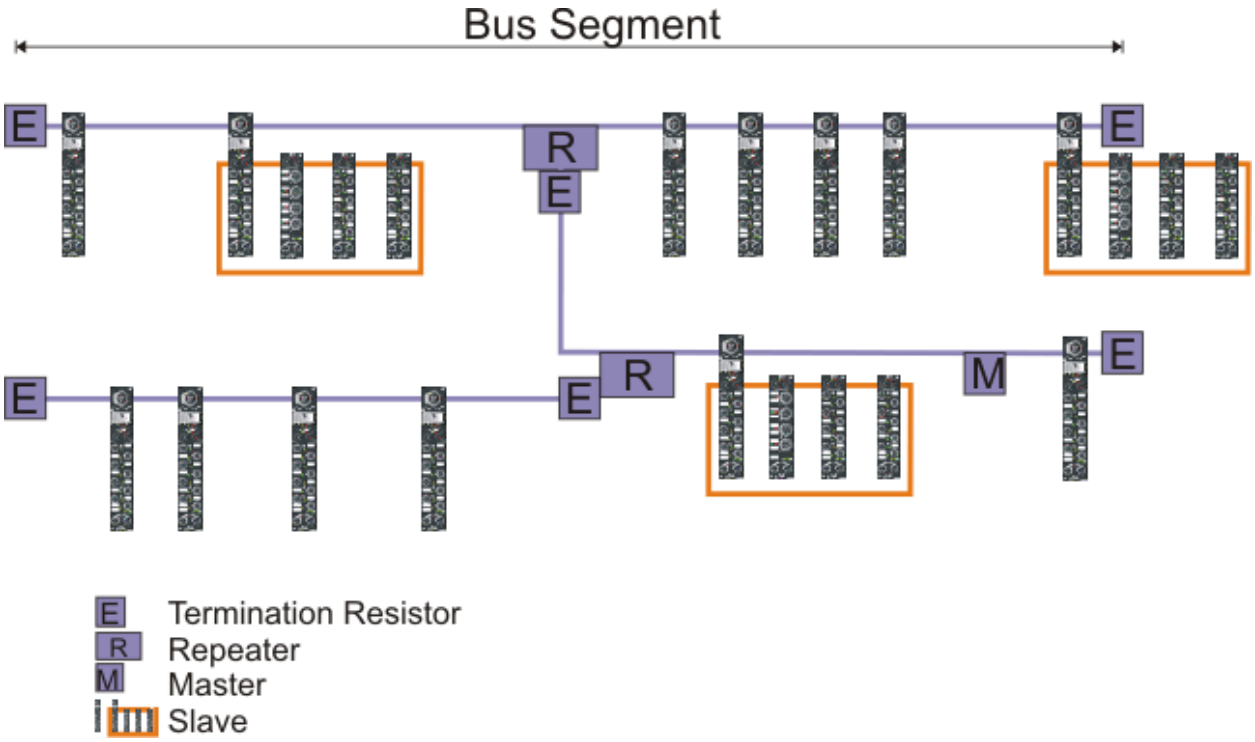


Fig. 1: RS485 topology with 3 segments and 2 repeaters.

7. Error handling and diagnosis

Diagnostics

PROFIBUS state

In many cases it is important to know whether the communication with the higher-level master is still OK. To this end, link the *DpState* variable with your PLC program.

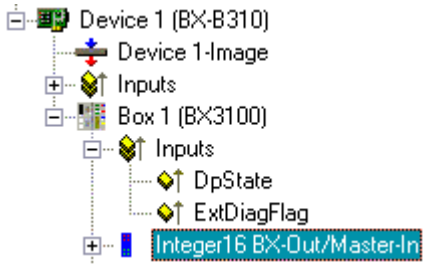


Fig. PROFIBUS diagnostics byte in the System Manager

Error number	Description	Remedy
0	No error	-
129	Waiting for configuration data	Start PROFIBUS
130	Waiting for parameter data	Start PROFIBUS
131	No master available	Check PROFIBUS cables and connectors

Example
If the PROFIBUS is interrupted, e.g. because the cable was pulled or the PLC was switched off, the BX3100/BC3150 reports this as 130 in the DP state. This means the BX3100/BC3150 is waiting for parameter data from the master.
Slave boot sequence after a timeout or starting of the master:
parameter data - configuration data - data exchange

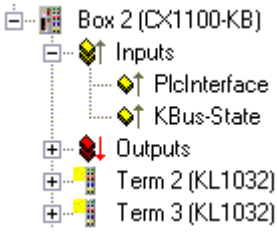
Read the fieldbus state via ADS

In the default configuration and TwinCAT configuration you can read the field bus state about ADSREAD.

Parameter ADSREAD function block	description
NetID	local - empty string
Port	1
IndexGroup	16#0006
IndexOffset	BX3100: 16#000C_A0F4 BC3150: 16#000C_A080
LEN	1

State of the K-Bus

An internal bus or Bus Terminal error is indicated in the K-Bus state. A more precise fault description can be obtained via a function block (in preparation). To this end, link the *K-Bus state* variable with your PLC program.



Error bit	Description	Error type
0	No error	No ERROR.
Bit 0	K-Bus error	ERROR
Bit 2	K-Bus is re-triggered	NOTE

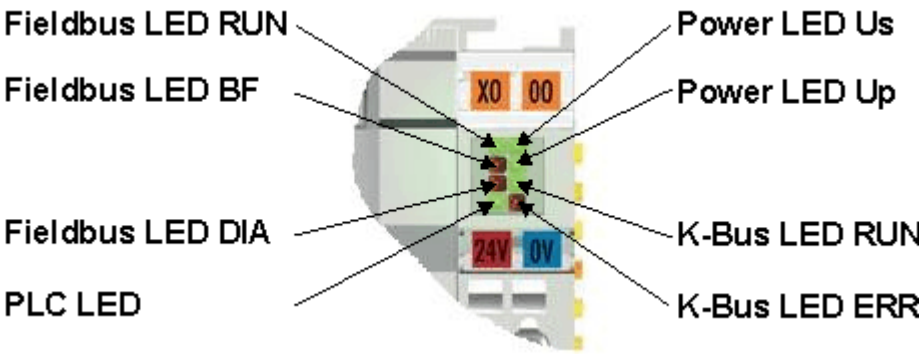
Read the K-Bus state via ADS

In the default configuration and TwinCAT configuration you can read the K-Bus state about ADSREAD.

Parameter ADSREAD function block	Description
NetID	local - empty string
Port	1
IndexGroup	16#0006
IndexOffset	16#000C_9000
LEN	1

Diagnostic LEDs

The Bus Coupler features status indicator LEDs. The row of LEDs on the left describes the status of the fieldbus and of the PLC. The row of LEDs on the right indicates the supply voltage and the K-Bus state.



LEDs for power supply diagnosis

LED (Power LEDs)	Meaning
LED Us	LED off: Bus Coupler has no voltage 24 V_{DC}
LED Up	LED off: No 24V_{DC} power connected to the power contacts

LEDs for K-Bus diagnostics

LED (Power LEDs)	Meaning
LED RUN	LED off: no K-Bus update, LED on, flashing: K-Bus running
LED ERR	LED off: no error, LED flashing: see K-Bus error code

K-Bus error code diagnostics

Error code	Error argument	Description	Remedy
0	-	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	0	EEPROM checksum error	Set factory settings with the KS2000 configuration software
	1	Code buffer overflow	Insert fewer Bus Terminals. The programmed configuration has too many entries in the table
	2	Unknown data type	Software update required for the Bus Coupler
2	-	Reserve	-
3	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.

Error code	Error argument	Description	Remedy
4	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 Bus End Terminal KL9010 is connected.
5	n	K-Bus error in register communication with Bus Terminal n	Exchange the nth bus terminal
6	0	Error at initialisation	Exchange Bus Coupler
	1	Internal data error	Perform a hardware reset on the Bus Coupler (switch off and on again)
	2	DIP switch changed after a software reset	Perform a hardware reset on the Bus Coupler (switch off and on again)
7	0	Note: Cycle time was exceeded	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	0	Checksum error in Flash program	Re-transfer the program to the Bus Terminal Controller
	1	Incorrect or faulty library implemented	Remove the faulty library
10	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	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	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	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

LED bus - fieldbus diagnosis

LED	Meaning
LED RUN	no fieldbus connected, Bus Coupler searches for baud rate
LED BF	error flashing - error type - display
LED DIA	Bus Coupler has found baud rate, waiting for config and parameter data

LED RUN	LED BF	LED DIA	Meaning
off	off	off	no fieldbus connected, Bus Coupler searches for baud rate
on	on	on	
on	on	off	Bus Coupler has found baud rate, waiting for config and parameter data
on	off	off	no error, coupler in data exchange
on	off	flashing	error, see error code

LED PLC - PLC diagnosis

LED	Meaning
PLC LED	LED on: PLC running, LED off: PLC stopped

8. Appendix

First steps with the BC3150

For the following example, the following hardware and software components are required:

Hardware

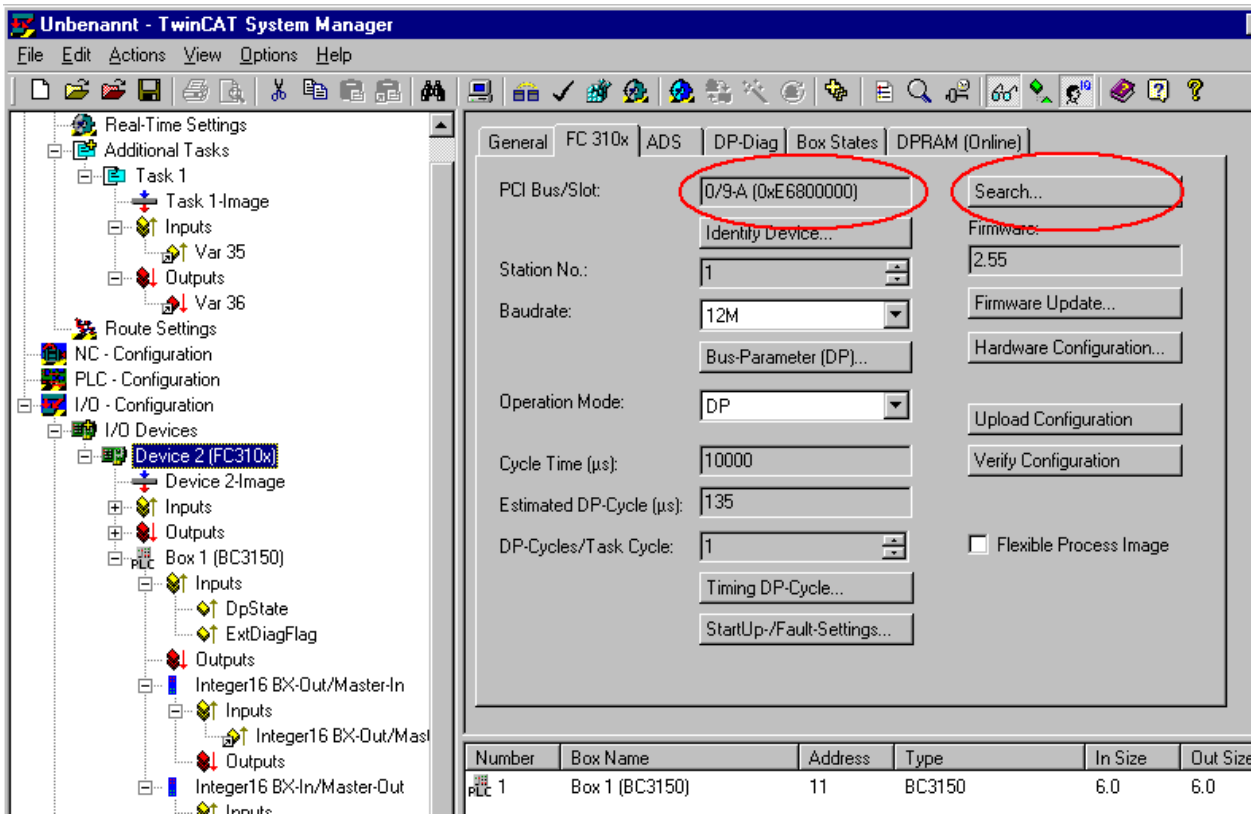
- FC310x from firmware 2.0
- BC3150
- KL10x4
- KL20x4
- KL9010
- PROFIBUS cable + cabling material (such as 24 V_{DC} power supply unit etc.)

Software

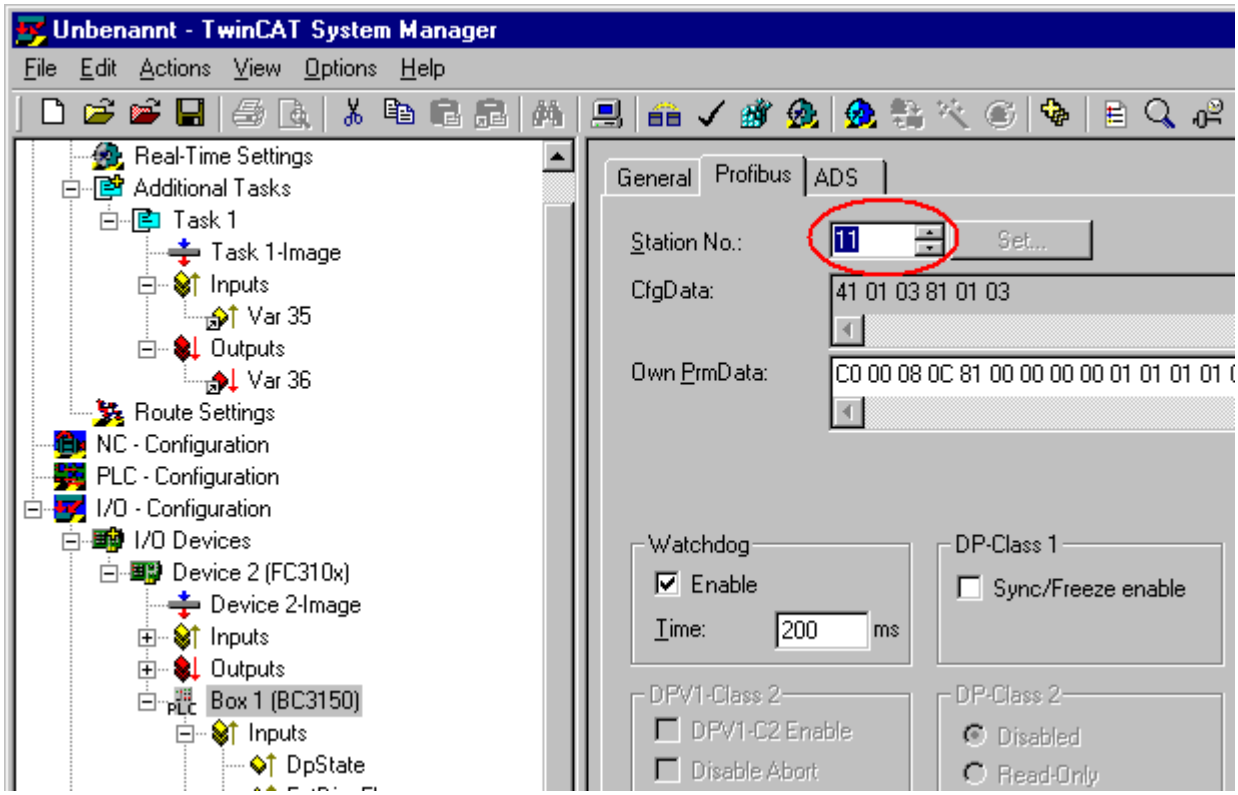
- TwinCAT 2.9 build 1020 (minimum TwinCAT PLC level)

Example 1: Default Configuration

a.) Open the following file . This file contains the System Manager file for the master configuration with the FC310x card and the BC3150 slave. Select the correct PCI address for the FC3101

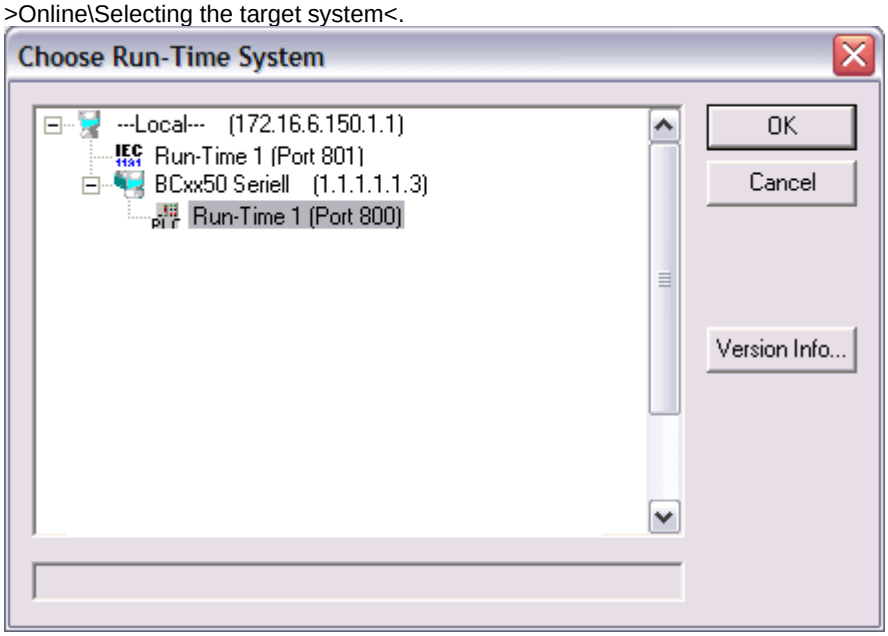


and set PROFIBUS address 11 on the BC3150.



Activate the configuration and start the system. The TwinCAT icon (bottom right on the desktop) should be green. The bus LED on the BC3150 should also be green. Should this not be the case, check the BC3150 address and the physical connection to the PROFIBUS master (terminal resistances etc.).

b.) Open the following file . This file is the PLC project for the BC3150. Select the BC3150 under >Online\Selecting the target system<.



Load the project into the controller (>Online\Login<) and Start the program (>Online\Start<). The PLC LED on the BC3150 should now be orange.

Program description

The program increments a value >Profibus_Out_1< as long as the variable Profibus_Input_1 contains the value 0_{bin}. At the same time, the first digital output cycles with approx. 2 Hz. In the System Manager, the variable >Var 36< can be forced to a value unequal zero. This stops the counter, and the first digital output is set to a fixed value of 1_{bin}.

Moving between the controllers

Moving from BCxx00 to BCxx50

File names

At Bus Terminal Controller of BCxx50 series, libraries are called *.lbx, and programs are saved as *.prx.

Flag variables

The flag variables

- of BCxx00 are allocated from %MB0...%MB511 (except BC9000/BC9100: %MB0...%B4095)
- of BCxx50 are allocated from %MB0...%B4095

Status information such as K-Bus/fieldbus status or cycle tick is not copied to the BCxx50 (this information is available as a function in TcSystemBCxx50.lbx).
The allocated flags **don't** operate as retain variables.

Retain data

The retain data have to be declared as VAR_RETAIN. Up to 2 kByte are available.

PLC variables

In the default configuration, the PLC variables start at %IB1000 and %QB1000.

Large model

No longer available in the BCxx50 version. Max. memory 48kByte.

Task time

The task time is specified in the PLC Control. It should be set to a realistic value (measuring of PLC cycle time and K-Bus). The background time is no longer used.

Task configuration

A maximum of one task is available. This task has to be configured.

PLC and Field Bus Terminals

On standard bus terminal controllers (BCxx00) it was possible to choose if a bus terminal is allocated to the fieldbus or to the local PLC. In default configuration of an BCxx50 all bus terminals are allocated to the local PLC. An allocation to the fieldbus is not possible here.

Moving from BCxx00 to BXxx00

File names

At Bus Terminal Controller of BXxx00 series, libraries are called *.lbx, and programs are saved as *.prx.

Flag variables

Flag variables

The flag variables

- of BCxx00 are allocated from %MB0...%MB511 (except BC9000/BC9100: %MB0...%B4095)
- of BXxx00 are allocated from %MB0...%B4095

Status information such as K-Bus/fieldbus status or cycle tick is not copied to the BX (this information is available as a function in TcSystemBX.lbx).
The allocated flags **don't** operate as retain variables.

Retain data

The retain data have to be declared as VAR_RETAIN. Up to 2 kByte are available.

PLC variables

In the default configuration, the PLC variables start at %IB1000 and %QB1000.

Large model

No longer available in the BX version. Max. memory BX-Controller 256 kByte/ BCxx50 Controller 48kByte.

Task time

The task time is specified in the PLC Control. It should be set to a realistic value (measuring of PLC cycle time and K-Bus). The background time is no longer used.

Task configuration

A maximum of one task is available. This task has to be configured.

PLC and Field Bus Terminals

On standard bus terminal controllers (BCxx00) it was possible to choose if a bus terminal is allocated to the fieldbus or to the local PLC. In default configuration of an BXxx00 all bus terminals are allocated to the local PLC. An allocation to the fieldbus is not possible here.

Moving from PC to BCxx50/BXxx00

File names

At Bus Terminal Controllers of BCxx50 and BXxx00 series, libraries are called *.lbx, and programs are saved as *.prx.

Allocated variables

The BX offers a limited number of allocated data
Inputs 2kB, %IB0..2048
Outputs 2 kB, %QB0..2048
Flags 4 kB, %MB0..4095

Task configuration

A maximum of one task is available. A sensible task time should be selected. Adjust the task time to your application by measuring the required system time (PLC + K-Bus + fieldbus + other).

Retain data

The Bus Terminal Controllers of BCxx50 and BXxx00 series offer up to 2 kB of retain data. Ensure that no (or only very few) retain data are used in function blocks (see RETAIN data).

Firmware Update

Firmware update program

The firmware update program is required for loading a new firmware to the Bus Coupler. The program is transferred via the serial interface.

Note for BX3100:
Firmware version 0.64 or lower of BX3100 cannot be updated. Should an update be required for this devices, the BX3100 should be sent in to manufacturer, requesting an update.

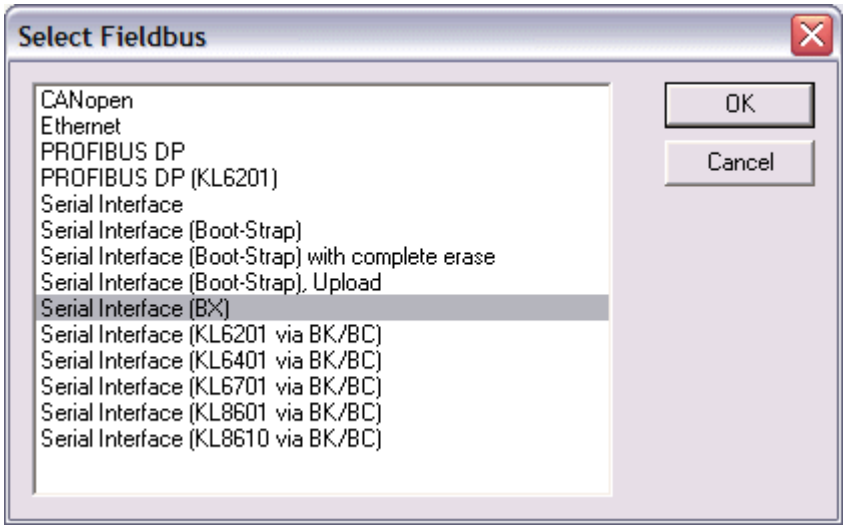
Beckhoff Automation
Department Service
Eiserstr. 5
D-33415 Verl, Germany

Firmware update program 241 71 kB (for Windows NT4.0 SP6, 2000, XP)

The program *FirmwareUpdate.exe* and the file *TcRouterHelper.dll* have to be in the same directory. Open the program by double-clicking on *FirmwareUpdate.exe*.

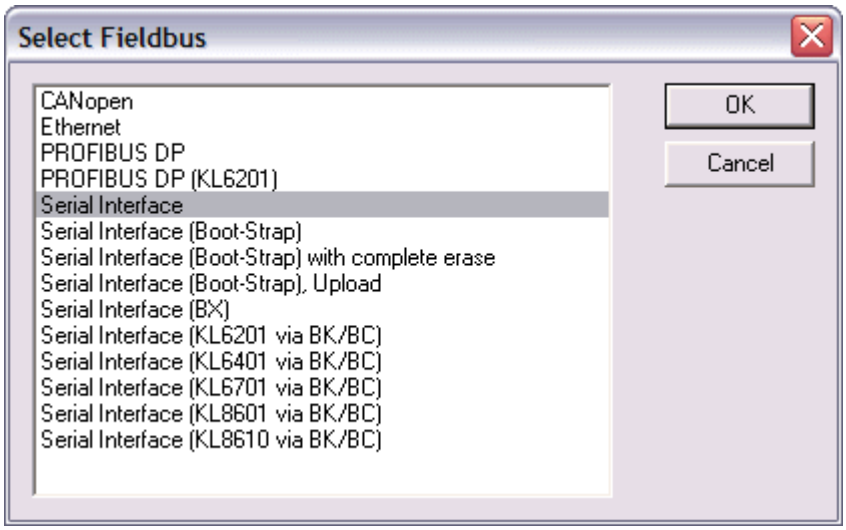
Update for Bus Terminal Controller

BX Series
Select the appropriate device of - in this example "Serial interface (BX)".



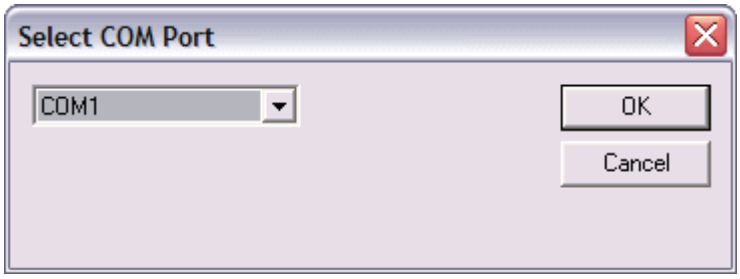
BCxx50 Series

Select the appropriate device of - in this example "Serial interface".

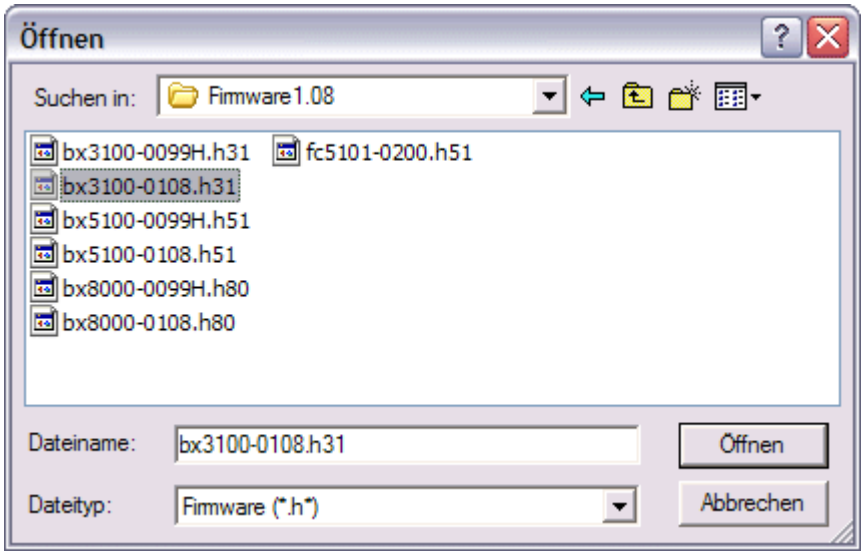


BX and BCxx50 Series

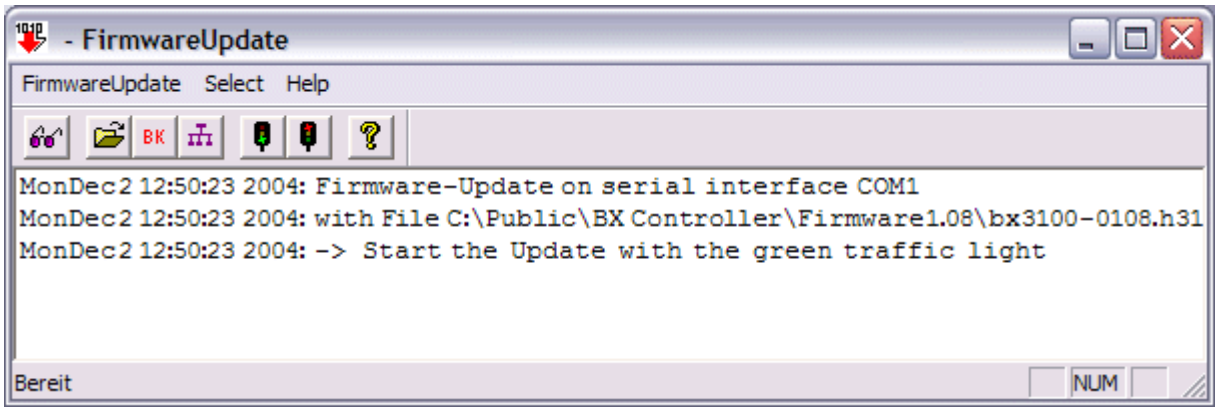
Then select the COM port.



Open the file you wish to download.



Start the download via the green 'traffic light'. The download begins after about a minute, and is then also shown on the BX's display. Once the download is complete (approx. 2-3 minutes), the coupler will reboot automatically (from FW 0.37).



General Operating Conditions

The following conditions must be observed if the fieldbus components are to function without error.

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 range during operation	0℃ ... +55℃
Permissible relative humidity during operation	95 %, no condensation
Installation position	variable
Vibration resistance	conforms to EN 60068-2-6
Shock resistance	conforms to EN 60068-2-27, EN 60068-2-29
EMC resistance burst	conforms to EN 61000-6-2
ESD emission	conforms to EN 61000-6-4

Transport and storage

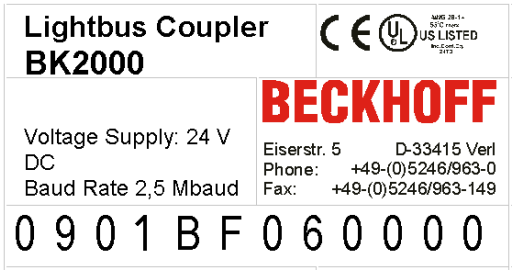
Condition	Permissible range
Permissible ambient temperature range during storage	-25 ℃ ... +85℃
Permissible relative humidity	95 %, no condensation
Free fall	up to 1 m in the original packaging

Protection classes and types

Condition	Permissible range
Protection class in accordance with IEC 536 (VDE 0106, Part 1)	A protective conductor connection to the mounting rail is necessary!
Protection class according 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 example, on the BK2000:



The following information is printed on the label:

Printed item	In this particular example:
Precise product identification	Lightbus Coupler BK2000
Supply voltage Us	24 V_{DC} (To meet the UL requirements use 4 A fuse or class 2 power supply!)
Data transfer rate	2.5 MBaud
manufacturer	Beckhoff Automation GmbH
CE mark	Conformity mark
UL mark c UL US LISTED Ind. Cont. Eq.: 24TB Use 4 Amp. fuse or Class 2 power supply. See instructions.	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 production week (2 characters), the production year (2 characters), the software version (2 characters) and hardware version (2 characters), along with any special indications (4 characters). This case therefore is a BK2000 - produced in the 9th calendar week - of the year 2001 - containing the BF firmware version - and using the 6th hardware version - with no special indications

Standards for Device Testing

EMV

EMC resistance burst
EN 61000-6-2

ESD
EN 61000-6-4

Vibration / Shock resistance

Vibration resistance
EN 60068-2-6

Shock resistance
EN 60068-2-27, EN 60068-2-29

Bibliography

German books

PROFIBUS

- PROFIBUS-DP/DPV1
  Grundlagen, Tipps und Tricks für Anwender (Principles, Tips for Users)
  by Manfred Popp
  ISBN: 3778527819

General fieldbus technology

- Gerhard Gruhler (Pub.): **Feldbusse und Geräte-Kommunikationssysteme** (Fieldbus and Device Communication Systems)
  Praktisches Know-How mit Vergleichsmöglichkeiten (Practical Know-how with Comparative Resources)
  Franzis Verlag, 2001
  244 pages
  ISBN 3-7723-5745-8

English books

(in preparation)

PROFIBUS-DP standards

- IEC 61158 and IEC 61784
- DIN 19245, Part 3
- Euronorm EN 50 170

Web sites

- http://www.profibus.com

List of Abbreviations

DP
Distributed Peripherals. PROFIBUS protocol for fast cyclic data exchange

FMS
Fieldbus Message Specification. The PROFIBUS transmission protocol

Freeze mode
This command makes the slave freeze its inputs

GSD file
Basic device file (in German)

GSE file
Basic device file (in English)

IP20, IP65, IP66, IP67
Protection class (contact, water, dust)

K-Bus
Terminal bus - internal bus for communication between the coupler and Bus Terminals

PNO
PROFIBUS User Organisation

Repeater
Provides signal conditioning, connecting individual bus segments

PLC
Programmable logic controller

Sync mode
This command makes the slave hold its outputs unchanged until it receives the Sync telegram.

Support and Service

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Support offers you comprehensive technical assistance, helping you no only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- world-wide support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

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e-mail:	support@beckhoff.com

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- spare parts service
- hotline service

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You will also find further documentation for Beckhoff components there.