

LIGHTBUS

Bus Terminal Controller

BC2000

Technical Documentation

Version 1.1
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BECKHOFF

Please note the following

<i>Target group</i>	This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
<i>Safety requirements</i>	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, and does not represent an assurance of characteristics in the sense of § 459, Para. 2 of the German Civil Code. 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.

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Foreword

Notes on the documentation

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Delivery conditions

In addition, the general delivery conditions of the company Beckhoff Automation GmbH apply.

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Safety Instructions

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.

Description of safety symbols

The following safety symbols are used in this documentation. 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.



Attention

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



Note

This symbol indicates information that contributes to better understanding.

Basic Principles

Description of the BC2000

The BC2000 is a slave with PLC functionality. It has a fieldbus interface, the Lightbus. The bus terminal controller is programmable, and is programmed using the TwinCAT software in the IEC61131-3 programming languages. Applied in combination with the C1220 or FC200x Lightbus PC card and the TwinCAT PLC software, the BC2000 permits decentralisation of the control tasks. This is a way of removing parts of the application out of the central control system to relieve the CPU and the field bus. Distributed counters, controllers and switches are typical applications for the bus terminal controller. The reaction times are dependent upon the bus communication and the overall control system, and maintenance of function is possible even when the bus or control system fails (e.g. an orderly transfer of the processes into a secure condition).

The Beckhoff Bus Terminal System

Up to 64 bus terminals

each having 2 I/O channels for each signal form

De-centralised wiring of each I/O level

IPC as controller

The bus terminal system is the universal interface between a fieldbus system and the sensor / actuator level. A unit consists of a bus terminal controller 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 minimised. The height and depth match the dimensions of compact terminal boxes.

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 de-centrally, using minimum cable lengths. The controller can be installed at any location within the plant. The use of an industry 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 de-centralised input/output level of the controller in the switching 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 switching cabinet. The switching cabinet can have smaller dimensions.

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.

Standard C - rail assembly

The easy, space-saving assembly on a standard C-rail, and the direct wiring of actuators and sensors without cross-connections between the terminals standardises 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 analogue, 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 galvanic isolation through potential feed terminals also helps to keep the number of unused channels low.

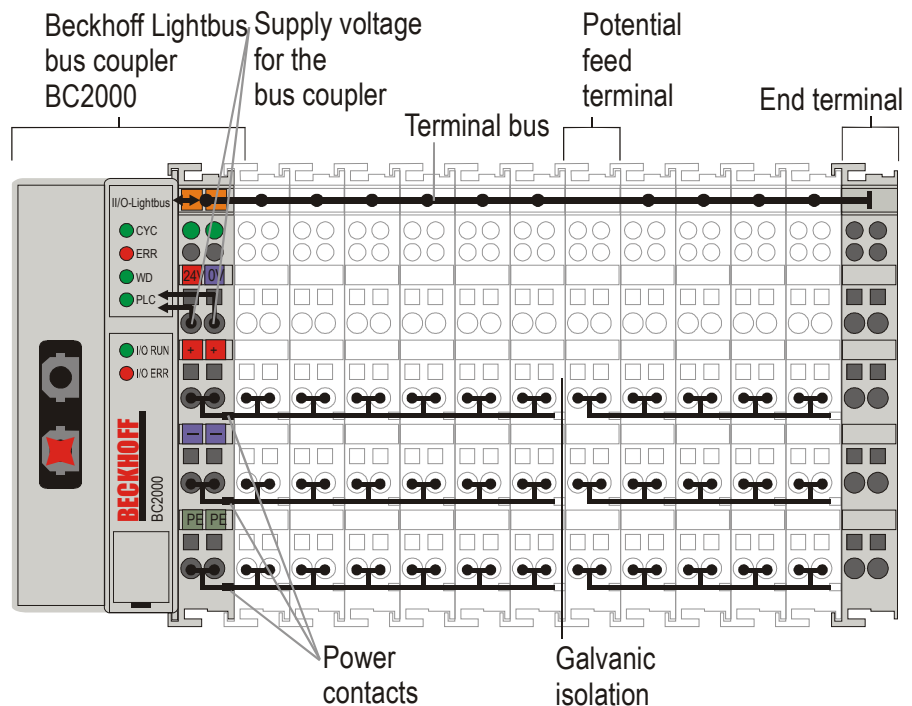
Display of the channel state The integrated LEDs show the state of the channel at a location close to the sensors and actuators.

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

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

Up to 64 terminals can be used within one terminal strip;
Potential feed terminals and end terminals are included in this count.

The principle of the bus terminal



Additional characteristics of the bus terminal controllers The bus terminal controller (BC) differs from the bus coupler (BK) in that in addition to operating the terminal bus, a PLC task runs in the BC2000. Unlike bus couplers, the signals from the terminals are processed by the PLC task, while the fieldbus carries the in- and outputs of the PLC task.

It is also possible to partition the terminals in such a way that some of the terminals are processed by the PLC task while others are passed over the fieldbus to a master.

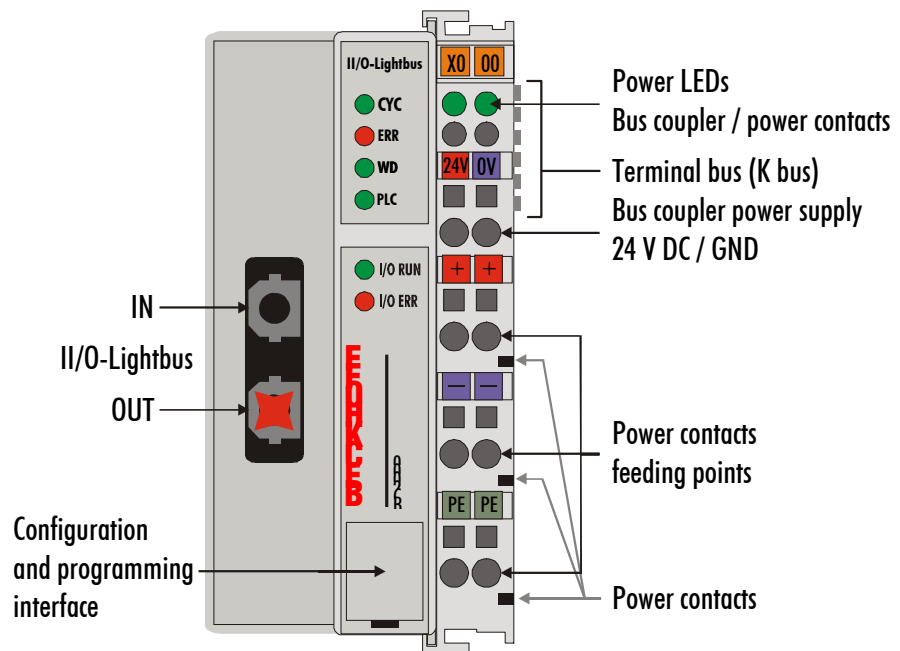
Bus terminal controllers for various fieldbus systems

Various bus terminal controllers 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 terminal controller 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 terminal controller. Nevertheless, the parameters that have been set are stored in each bus terminal, and are retained in the event of voltage drop-out. Fieldbus, terminal bus and I/O level are galvanically isolated.

The interfaces

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

The Beckhoff BC2000 Lightbus coupler



24 V DC to the topmost terminals "24 V" and "0 V"

Electrical power supply

The bus terminal controllers require a 24 V DC supply for their operation. The connection is made by means of the upper spring-loaded terminals labelled "24 V" and "0 V". The supply voltage feeds the bus terminal controller electronics and, over the terminal bus, the bus terminals. The power supply for the bus terminal controller electronics and that of the terminal bus are electrically separated from the potential of the field level.

Bottom 3 terminal pairs for feed

Power contacts feeding points

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 bus terminal controller. The design of the feed permits voltages of up to 24 V. 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 drawn from the power contacts must not exceed 10 A for long periods. The current rating between two spring-loaded terminals is identical to that of the connecting wires.

Maximum 24 V

Maximum 10 A

Power contacts

Spring contacts on the side

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.

Fieldbus connection

*Beckhoff Lightbus
Fibre optic ring*

Beckhoff Z1000 connector

There is a recessed front face on the left hand side. The typical Beckhoff Lightbus connector can be inserted here. The Beckhoff Lightbus consists of an optical fibre ring into which the bus terminal controller is inserted. Here the plug out of which red light shines when the Beckhoff Lightbus is switched on is inserted into the upper socket. On the figure this is labelled with „IN“. Optical fibre connectors of type Beckhoff Z1000 are required for the connection.

Configuration and Programming Interface

*Serial interface under the
front cover*

The bus terminal controllers have an RS232 interface at the bottom of the front face. The miniature connector can be joined to a PC with the aid of a connecting cable and the KS2000 configuration software. The interface permits the bus terminals to be configured, for example adjusting the amplification factors of the analogue channels. The interface can also be used to change the assignments of the bus terminal data to the process image in the bus terminal controller. The functionality of the configuration interface can also be reached via the fieldbus using string communication facility.

This interface is also used for programming the BC2000. The cable for the interface is supplied along with TwinCAT BC.

Terminal Bus Contacts

6 contacts on the side

In order to connect the bus terminal controller to the bus terminals, the bus terminal controller has gold contacts on the right hand side. When the bus terminals are pushed together the gold contacts automatically make the connection between the bus terminals. The voltage supply to the terminal bus electronics in the bus terminals and the data exchange between the bus terminal controller and the bus terminals is carried out by the terminal bus. A part of the data exchange takes place via a ring structure within the terminal bus. Opening the terminal bus, e.g. by pulling out one of the bus terminals, opens the ring. Data exchange is no longer possible. Special mechanisms nevertheless allow the bus terminal controller to identify the location of the interruption and to report it.

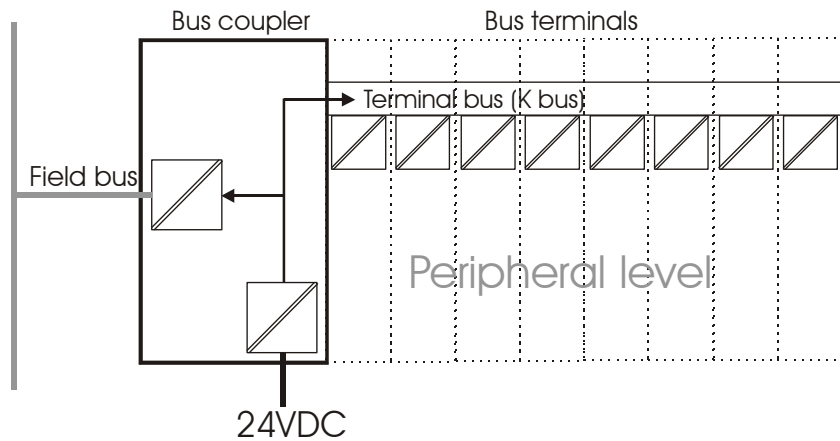
Galvanic isolation

*3 potential groups:
Field bus
Terminal bus (K bus)
Peripheral level*

The bus terminal controllers operate by means of three independent potential groups. The supply voltage feeds the terminal bus electronics in the bus terminal controller and the terminal bus itself, which is electrically separate. The supply voltage is also used to generate the operating voltage for the fieldbus.

Remark: All the bus terminals are galvanically isolated from the terminal bus. The terminal bus is thus galvanically isolated from everything else.

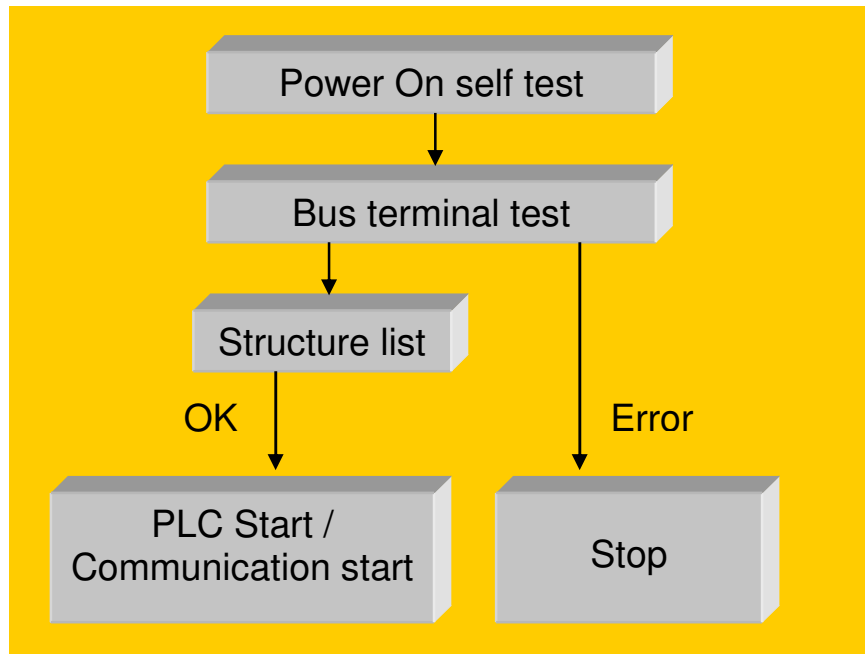
Structure of the potential levels in the bus terminal system



Operating Modes of the Bus Terminal Controller

Immediately after being switched on, the bus terminal controller checks, in the course of a "self test", all the functions of its components and the communication of the terminal bus. The red I/O LED blinks while this is happening. After completion of the self-test, the bus terminal controller starts to test the attached bus terminals (in a „bus terminal test“), and reads in the configuration. The bus terminal configuration is used to generate an internal structure list, which is not accessible from outside. In case of an error, the bus terminal controller enters the „STOP“ state. Once the start-up has completed without error, the bus terminal controller enters the "fieldbus start" state.

Start-up behaviour of the bus terminal controller

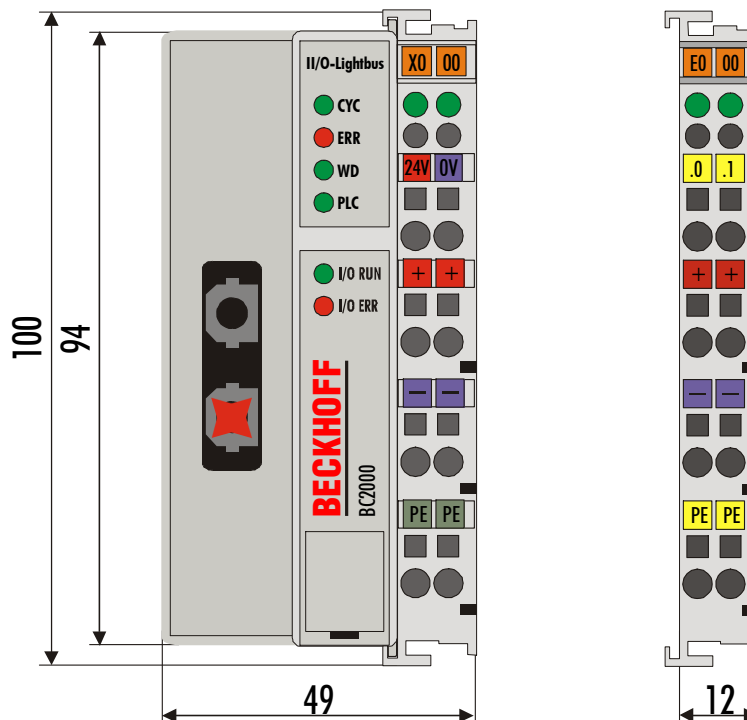


The bus terminal controller can be made to enter the normal operating state by switching it on again once the fault has been rectified.

Mechanical structure

The system of the Beckhoff bus terminals is characterised by low physical volume and high modularity. When planning a project it must be assumed that at least one bus terminal controller and a number of bus terminals will be used. The mechanical dimensions of the bus terminal controllers are independent of the fieldbus system. If optical fibre cable with Z1000 plugs is used, the clearances of the bus terminal controller are not exceeded.

Bus terminal controller dimensions



The total width of the unit is composed of the width of the bus terminal controller with the KL9010 bus end terminal plus the width of the bus terminals being used. Depending on function, the bus terminals are 12 or 24 mm wide. The front wiring increases the total height of 68 mm by about 5 to 10 mm, depending on the wire thickness.

Assembly and connection

The bus terminal controller and all the bus terminals can be clipped by light pressure onto a 35 mm C-mounting rail. A locking mechanism prevents the individual housings from being pulled off again. For removal from the mounting rail the orange coloured 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 terminal controller 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.

The right hand part of the bus terminal controller can be compared to a bus terminal. Eight connections on the top permit connection with solid or fine wires. 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.

The connection between the bus terminal controller and the bus terminals is automatically realised 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 terminal 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. analogue 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 terminal controller can also be made use of to feed the power contacts.

Insulation testing

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 capacitatively 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 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.

PE power contacts

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

Technical data	BC 2000
Number of bus terminals	64
Digital peripheral signals	256 inputs and outputs
Analogue peripheral signals	128 inputs and outputs
Peripheral bytes	512 inputs and 512 outputs
Fieldbus medium	Z1100 optical fibre
Plug connector	Z1000 for Z1100
Baud rate	2.5 Mbaud
Electrical power supply	24 V (- 15% / +20%) EN 61131
Input current	70 mA + (total terminal bus current)/4 500 mA max.
Power-on surge	2.5 x steady operating current
Terminal bus output current	1750 mA max.
Voltage of the power contact	24 V DC / AC
Power contacts current drawn	10 A
Voltage stability	500 V _{eff} (power contact / supply voltage)
Typical weight	170 g
Operating temperature	0°C ... +55°C
Storage temperature	-25°C ... +85°C
Relative humidity	95% without dew formation
Vibration/shock stability	according to IEC 68-2-6 / IEC 68-2-27
EMC immunity, burst / ESD	according to EN 61000-4-4 / EN 61000-4-2, limit values in accordance with EN 50082-2
Installation location	arbitrary
Protection class	IP20

PLC data	BC 2000
Programmability	via the programming interface (TwinCAT BC/TwinCAT) or via optical fibre ring (TwinCAT)
Program memory	32 kbytes / 96 kbytes
Data memory	32 kbytes / 64 kbytes
Remanent flags	512 bytes
Runtime system	1 PLC task
PLC cycle time	approx. 3 ms for 1000 instructions (including terminal bus I/O cycle)
Programming languages	IL, LD, FBD, SFC, ST

Preparing for Operation and Diagnostics

After switching on, the bus terminal controller immediately checks the connected configuration. Error-free start-up is signalled by extinction of the red LED "I/O ERR". If the "I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error. There is a detailed description in the chapter on „The Diagnostic LEDs“.

The diagnostic LEDs

The bus terminal controller has two groups of LEDs for the display of status. The upper group with four LEDs indicates the status of the respective field bus. The significance of the "field bus status LEDs" is explained in the next sections of this manual - it conforms to conventional field bus displays.

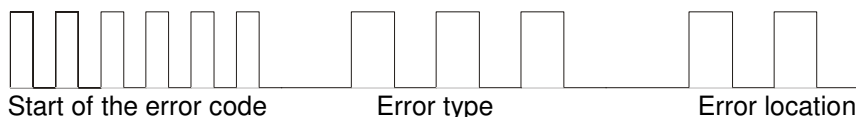
On the upper right hand side of the bus terminal controllers are two more green LEDs that indicate the supply voltage. The left hand LED indicates the 24 V supply of the bus terminal controller. The right hand LED signals the supply to the power contacts.

Local errors

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

Blink code

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



Error code	Error argument	Description	Remedy
Persistent, continuous blinking		EMC problems	<ul style="list-style-type: none"> - Check power supply for overvoltage or undervoltage peaks - Implement EMC measures - If a terminal bus error is present, it can be localised by a restart of the coupler (by switching it off and then on again)
1 pulse	0	EEPROM checksum error	<ul style="list-style-type: none"> - Set manufacturer's setting with the KS2000
	1	Inline code buffer overflow	<ul style="list-style-type: none"> - Connect fewer terminals; too many entries in the table for the programmed configuration - Software update required for the coupler
	2	Unknown data type	
2 pulses	0	Programmed configuration Incorrect table entry / bus coupler	<ul style="list-style-type: none"> - Check programmed configuration for correctness
	n (n > 0)	Incorrect table comparison (terminal n)	<ul style="list-style-type: none"> - Incorrect table entry / bus coupler
3 pulses	0	Terminal bus command error	<ul style="list-style-type: none"> - No terminal connected; attach terminals. - One of the terminals is defective; halve the number of terminals attached and check whether the error is still present with the remaining terminals. Repeat until the defective terminal is located.
4 pulses	0	Terminal bus data error	<ul style="list-style-type: none"> - Check whether the n+1 terminal is correctly connected; replace if necessary.
	n	Break behind terminal n	<ul style="list-style-type: none"> - Check whether the end terminal 9010 is connected.
5 pulses	n	Terminal bus error with register communication with terminal n	<ul style="list-style-type: none"> - Replace terminal n.
9 pulses	0	Checksum error in program flash memory	<ul style="list-style-type: none"> - Set manufacturer's setting with the KS2000
	n	Terminal n is not consistent with the configuration that existed at boot image entry	<ul style="list-style-type: none"> - Set manufacturer's setting with the KS2000, which will delete the boot project
14 pulses	n	Terminal n has the wrong format	<ul style="list-style-type: none"> - Start the coupler again, and if the error occurs again then exchange the terminal
15 pulses	n	Number of terminals is no longer correct	<ul style="list-style-type: none"> - Start the coupler again, and if the error occurs again after this, use the KS2000 software to set manufacturer's settings
16 pulses	n	Length of the terminal bus data is no longer correct	<ul style="list-style-type: none"> - Start the coupler again, and if the error occurs again after this, use the KS2000 software to set manufacturer's settings

Error location

The number of pulses indicates the position of the last bus terminal before the fault. Passive bus terminals, such as a power feed terminal, are not included in the count.

When the error is rectified, the bus terminal controller does not stop flashing. Operating state of the bus terminal controller: „Stop“. The bus terminal controller can only be re-started by switching off the supply voltage.

Fieldbus errors

The fieldbus status LEDs indicate the operational state of the fieldbus. The functions of the Beckhoff Lightbus are indicated by the „CYC“, „ERR“ and „WD“ LEDs.

The meaning of the first three LEDs is:

CYC the LED lights up for the duration of each telegram

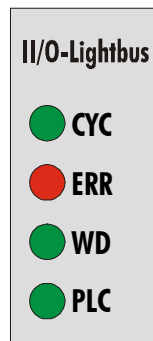
ERR is switched on by a faulty telegram, and switched off again by three correct telegrams

WD watchdog, lights for 100 ms after the bus terminal controller has been addressed

PLC LED

If the PLC LED lights, the program has started on the BC2000. The LED flashes while a boot project is being created.

Diagnostic LEDs on the BC2000



The bus terminal controller interrogates the configuration of the bus terminals after it has been switched on, then performs exchange of data with the terminals. This means that the red I/O LED goes out after a fault-free start-up, and the green I/O LED lights. The green I/O-LED lights with the PLC timing on the bus terminal controller. If no program is running on the BC2000, the pre-set cycle time for triggering the terminal bus is used.

CYC	ERR	WD	Meaning	Remedy
lit	off	lit	Telegrams are passing cyclically along the ring Inputs are read and outputs are set.	Everything is satisfactory
lit	off	lit	I/O-RUN flashes	The PLC cycle time that has been set is too long > 100 ms
lit	off	off	The ring is functioning, but the bus terminal controller is not being addressed	Re-examine the control software or the assignment list
blinking	off	off	The controller only occasionally accesses the bus. The outputs drop away.	Re-examine the control software
off	lit	off	(Physical) bus fault, faulty telegrams are circulating in the ring, e.g. optical fibre damaged, previous module faulty, plug not properly inserted	Check: - whether the optical fibre cable is inserted - whether the optical fibre cable is broken - whether previous module is ready for operation
off	blinking	off	Occasional CRC error (green I/O LED lights) Inputs are read; outputs are not updated;	Optical fibre connection damaged
off	off	off	No operating voltage, serious fault, no function	- Electrical power supply

The Beckhoff BC2000 Lightbus Coupler

Introduction to the Beckhoff Lightbus System

The Beckhoff Lightbus has achieved wide acceptance in the world of automation engineering through its speed and its compatibility across manufacturers. The Beckhoff Lightbus was developed within a control concept for the implementation of NC axes on the industry PC. The goal of the project was to develop a fast, secure I/O level for the PC suitable for industrial application. Nowadays a large number of various products are available from independent manufacturers. The operation of different Beckhoff Lightbus devices in one bus system is ensured by the implementation support and the protocol ASICs from BECKHOFF.

The Beckhoff Lightbus is designed for fast data exchange on the sensor / actuator level. Central control devices (such as, for example, programmable logic controllers) communicate here over a fast serial connection with distributed input and output devices. Data is exchanged with these distributed devices cyclically, and, if necessary, with different priorities. The central controller (master) reads the input information from the slaves, and sends the output information to the slaves. The bus cycle time must here be shorter than the central controller's program cycle time, which in many applications is less than 1 ms.

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 the Beckhoff Lightbus.

For the transmission of 512 bits of input data and 512 bits of output data distributed over 32 bus devices, the Beckhoff Lightbus needs approx. 0.8 ms at a transmission rate of 2.5 Mbit/s. The demand for a short system reaction time is thus ideally satisfied.

System configurations and device types

A single master system can be implemented with the Beckhoff Lightbus. A maximum of 254 slaves can be connected to one bus. In the BC2000 bus terminal controller, a station address between 1 and 254 is automatically selected during the start-up phase. 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. Every Beckhoff Lightbus system consists of different device types

A Beckhoff Lightbus slave is a peripheral device (sensor/actuator) 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. Typical Beckhoff Lightbus slaves are devices with binary inputs/outputs for 24 V or 230 V, analogue inputs, analogue outputs, counters, incremental encoders etc.. The quantity of input and output information is device-dependent, and is limited to 32 bits of input data and 32 bits of output data for each protocol ASIC. For slaves that handle more than 32 bits of data, such as, for instance, the BC2000, an extended procedure is utilised. Using an addressed access procedure, reading and writing up to 256 x 16 bits is possible. This means that a system can handle up to 254 stations x 508 bytes (not all of the 512 bytes are available for user data) with only one Beckhoff Lightbus system. For reasons of expense, and for technical reasons associated with implementation, the masters that are available nowadays work with a max. user data length of 3 kbyte (24000 inputs and outputs).

Master interfaces supporting the bus terminal controller are the PC cards C1220 as from Version 4.01, and the FC200x. These cards are supported by TwinCAT software as from version 2.6 (build 315).

Fundamental properties of optical fibre transmission technology

The Medium		
Network topology	Ring system, active devices between the cable sections	
Medium	Z1100 plastic optical fibre Z1101 plastic optical fibre with PU cladding Z1110 HCS – optical fibre Z1111 HCS – optical fibre	
Number of stations	254 stations in the ring	
Transmission rate	2.5 Mbit/s	
	with plastic optical fibre	with HCS optical fibre
Max. bus length	0.3 m to 45 m	up to 300 m
Min. bending radius	3 cm	4 cm
Plug connector	Z1000 standard plug for plastic optical fibres	Z1010 standard plug for HCS optical fibres

Settings in the TwinCAT System Manager

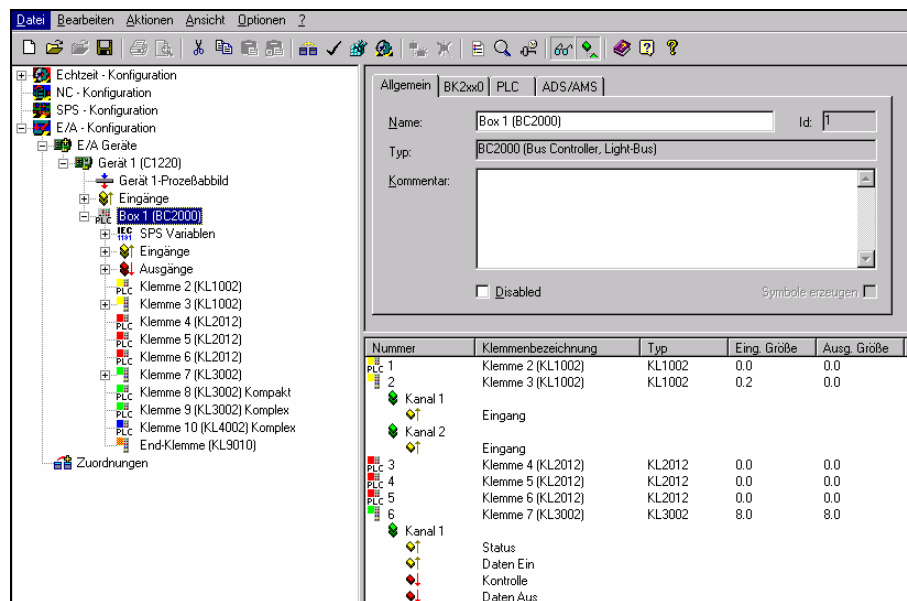
Basic Settings

The basic properties of the bus terminal controller are handled in the system manager.

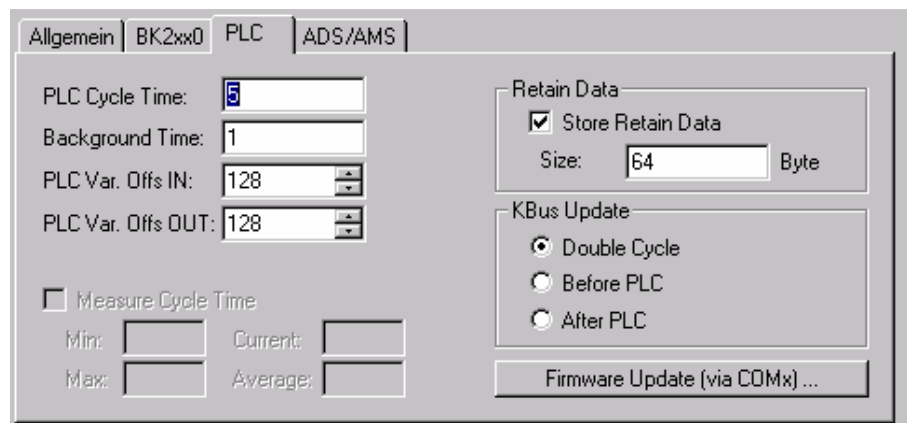
The terminals of the bus terminal controller can be assigned directly to the Lightbus master or to the BC2000. Terminals that are assigned directly to the BC2000 are displayed in the system manager with „PLC“, and are not visible to the master. A further distinction between „Complex“ and „Compact“ is also made in the analogue terminals.

- Complex: complete representation of the analogue terminals with control/status, 4 bytes input/output per channel
- Compact: user data only, 2 bytes per channel

The terminals that are assigned to the master are invisible to the bus terminal controller. If it is desired to make a terminal visible to both systems, the terminal must first be assigned to the BC2000, and then the data from the terminal are transmitted to the master via the PLC variables.



The settings for the PLC in the bus terminal controller are found under the „PLC“ tab. All the basic settings that control the properties of the PLC in the BC2000 are handled there.



PLC Cycle Time

PLC Cycle Time

The PLC cycle time determines the program's repetition frequency. This time is not deterministic. This means that when the program in the bus terminal controller needs more time, the PLC cycle time rises. If the program needs less than the cycle time, it is repeated at intervals of the set cycle time.

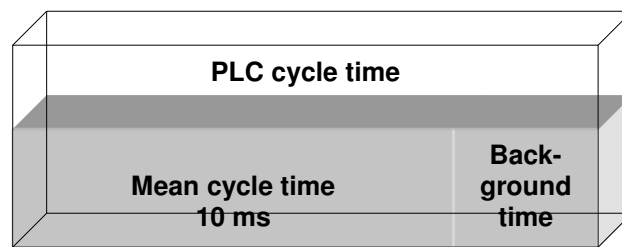
The processing of the Lightbus and the serial interfaces is executed in the background time. This should be set to approx. 20 % of the PLC cycle time.

PLC Cycle Time:

Background Time:

The „mean cycle time“ is measured in order to optimise the system. You will find this item in PLC Control under Online\Coupler. About 20% – 30% is added to this, and the result entered as the PLC cycle time. The background time is then set to 20% of the PLC cycle time.

Example of cycle time optimisation



$PLC\ cycle\ time = mean\ cycle\ time + 20\% = 10\ ms + 20\% = 12\ ms$

$Background\ time = PLC\ cycle\ time * 0,2 = 12\ ms * 0,2 = 2,4\ ms \approx 2\ ms$

Mean cycle time

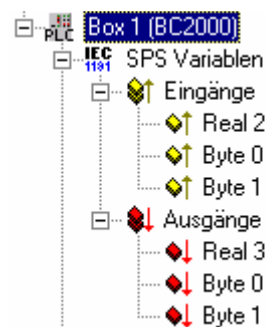
The measured cycle time also includes that required for the terminal bus update. This results in a connection between the number of terminals that are inserted and the cycle time. Before initiating the program, the bus terminal controller executes a terminal bus update, in order to interrogate the inputs. After the program has been executed, the BC2000 carries out another terminal bus update, in order to write the current outputs. The background time follows this. The cycle time can also be shortened, if the terminal bus update is carried out simultaneously for inputs and outputs (see Terminal Bus Update).

PLC Variables

PLC variables are variables that are situated in the BC2000 from addresses %IB128 and %QB128. This offset can be shifted. These addresses are not assigned to any terminal, so that signals or data can be transmitted to or received from the master via the PLC variables.

PLC Var. Offs IN:

PLC Var. Offs OUT:



Remanent Variables

Retained or remanent variables are data that retain their value when voltage is not present. In PLC Control this data is placed in the allocated flags area. Following the default setting, this means that all the variables from %MB0 - %MB63 are RETAIN data. The maximum setting is 512 bytes.

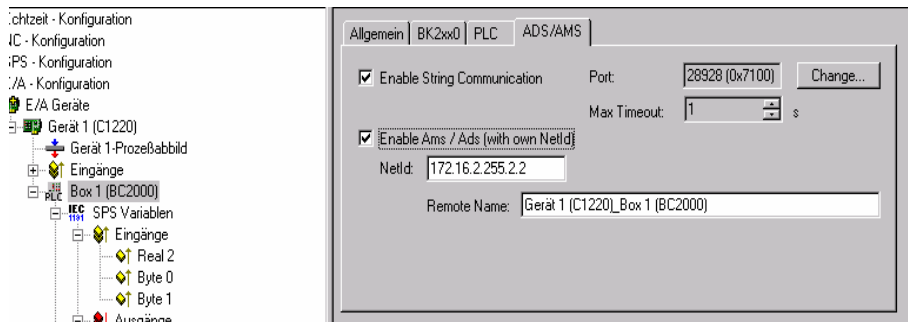


Terminal Bus Update

- Double Cycle Terminal bus inputs before the PLC cycle
 Terminal bus outputs after the PLC cycle
- Before PLC Terminal bus inputs and outputs before the PLC cycle
- After PLC Terminal bus inputs and outputs after the PLC cycle

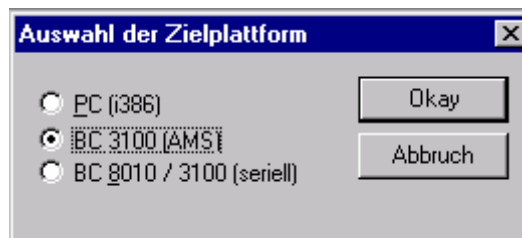
Program Download via the Fibre Optic Ring

TwinCAT offers a facility for transferring the program to the BC2000 over the optical fibre ring. To do this, string communication and the Ams/Ads must be activated in the system manager under the ADS/AMS tab. The TwinCAT system is started after the configuration has been saved. Now the BC2000 target system can be selected in PLC Control.



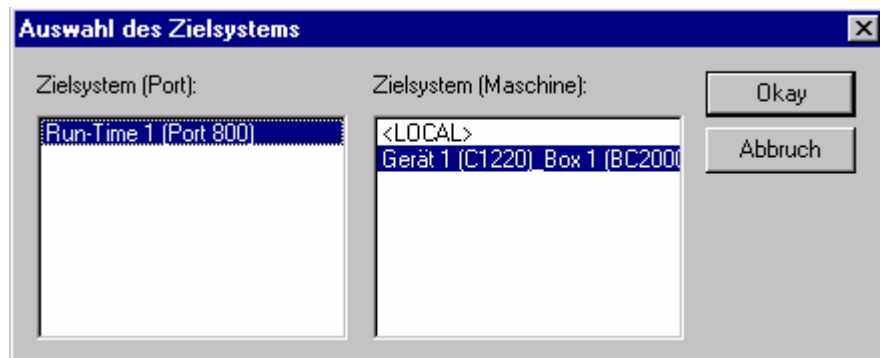
Selection of the target platform (Only for TwinCAT)

When TwinCAT PLC Control is restarted, the program asks for the target platform, i.e. the device on which the user will want his program to run. TwinCAT offers two target platforms, the PC as a controller and the BC2000 coupler. For the program transfer with the bus terminal controller there are again two possibilities. „AMS“ is for communication over the fieldbus, while the „serial“ communication takes place via the PC’s serial interface and the BC2000 programming interface.



Selection of the target system

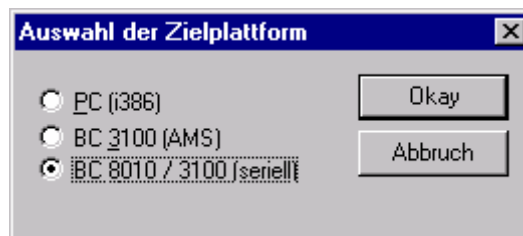
Once the program has been written, the target system is selected under the „Online“ symbol bar. In this example, the C1220 with the Box1 and the Run-Time1 of the bus terminal controller.



Program Download via the RS232 Interface

Every bus terminal controller offers the possibility of being programmed via the PC's RS232 interface. This can be implemented with the aid of a special cable (included when TwinCAT BC is supplied).

For this purpose, the serial interface is selected in PLC Control.



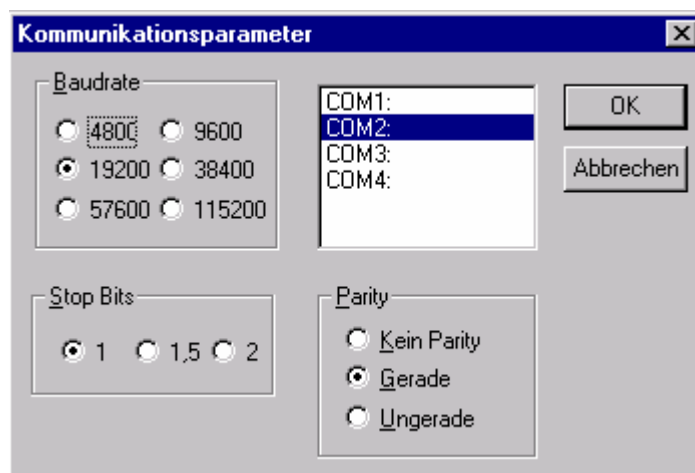
Communication parameters The settings for the serial interface, port number, baud rate etc. are found under Online/Communication parameters in PLC Control.

The bus terminal controller requires the following setting:

Baud rate 19200

Stop bits: 1

Parity: even



ADS Functions

General

The ADS functions provide a method for accessing the bus terminal controller information directly. ADS function blocks can be used in TwinCAT PLC Control for this. The function blocks are contained in the „PLCSystem.lib“ library. It is also equally possible to call the ADS functions from AdsOCX. The properties of the PLC runtime system can be retrieved through port number 800, while port number 100 give access to the

registers of the bus terminal controller and the terminals.

PLC Runtime System

Port 800

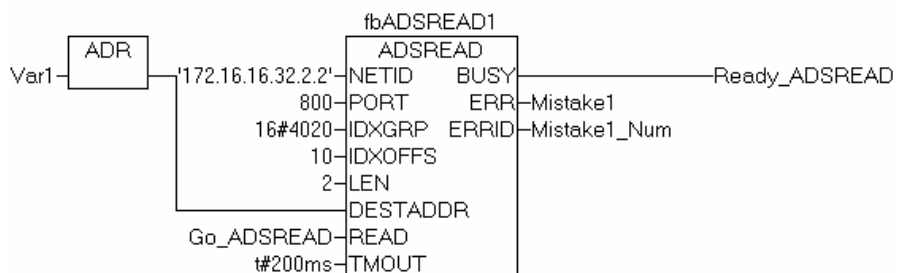
The port number in the BC2000 for the PLC is fixed at 800.

Index Group / Index Offset

Index Group	Meaning	Index Offset
16#4020	Allocated flags area %MB	0 .. 511
16#4021	Allocated bit flags area %MX	0 .. 4095
16#4080	Cycle time and basic settings	0: minimum cycle time in 1/125 ms WORD 1: maximum cycle time in 1/125 ms WORD 2: current cycle time in 1/125 ms WORD 3: mean cycle time in 1/125 ms WORD 4: Number of PLC cycles after the start DWORD 5: Nominal cycle time in ms WORD 6: Background time in ms WORD 7: Length of the remanent flags from %MB0 WORD 8: Start(1)/Stop(0) of the cycle time measurement WORD 9: Time of the terminal bus cycle WORD 0: Double Cycle 1: Before Cycle 2: After Cycle
16#F020	Input %IB	0 .. 511
16#F021	Input bit %IX	0 .. 4095
16#F030	Output %QB	0 .. 511
16#F031	Output bit %QX	0 .. 4095

Example

The variable in the flags area %MB10 is read directly by the PLC programme in TwinCAT. The NetId of the target system is given for this purpose. This number is found in the system manager, and is entered as a string. The variable „Var1“ is declared as a 2 byte variable (INT or WORD). As soon as Go_ADSREAD is switched to TRUE, the function block is active, and the value contained in the BC2000 at %MB10 and %MB11 is returned in „Var1“.



Registers of the Bus Terminal Controller

Port 100

The port number in the BC2000 for register communication is fixed at 100.

Index Group / Index Offset

Index Group	Index Offset		Meaning
	High WORD	Low WORD	
0	0-127	0-255	Controller registers High WORD table number of the controller Low WORD register number of the table
1-64	0-3	1-64	Terminal registers High WORD channel number Low WORD register number of the terminal



Note

When reading registers it should be noted that the time out for the ADS block is set to a time longer than 1 sec.

Diagnostics in the BC2000

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

Flag byte	Meaning
%MW508	Bit 0: Fieldbus error Bits 1-15: reserved
%MW510	Bit 0: Terminal bus error Bit 1: Configuration error Bits 2-15: reserved

Settings in TwinCAT PLC

Some of the settings for the BC2000 are only possible in PLC Control. These are primarily a matter of properties that have a direct effect on the program.

The points that follow here are found in PLC Control under „ONLINE“ „Coupler“.



Terminal Bus Reset

The terminal bus reset has its effect on the coupler's internal bus. If there is an error, which can be seen by the flashing of the „I/O ERR“ LED, the terminal bus can be re-started. At the same time the number of connected terminals is shown to the user in a message box.

Coupler Reset

The coupler will go through the same initialisation sequence as occurs when the coupler is switched on.

Manufacturer's Configuration

The coupler's default values are written into the tables, and any boot project that may be present is de-activated. The manufacturer's configuration is only activated after the coupler is reset.

Cycle Time Measurement

This measurement is related to the running time needed for the program to execute and the terminal bus update. (See the chapter on „PLC Cycle Time“)

Boot Project

In order to save the program, „Create a boot project“ is found under the „Online“ menu item. This permits the program to be started automatically after switching on. If the boot project is saved in the bus terminal controller the „PLC“ LED on the BC2000 flashes.

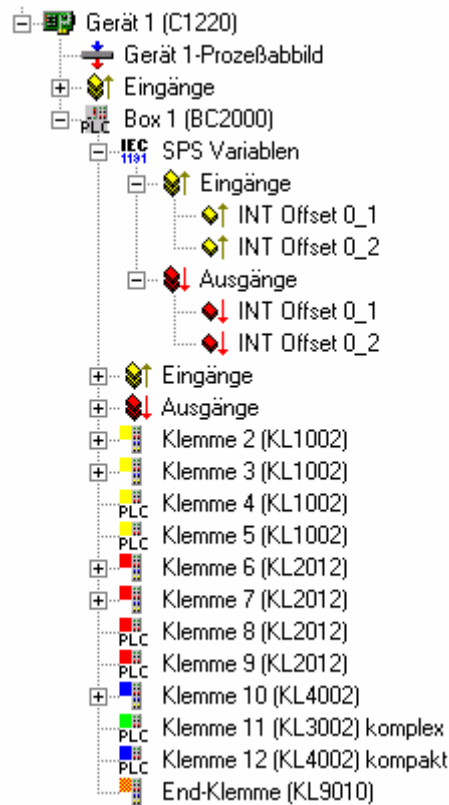
Coupler Options

The maximum size of the program memory and of the data memory can be set in PLC Control under „Projects“, „Options“, „Coupler“. In the „small memory model“, a variable size for the data and program memories is possible. The maximum memory size is 64 kbyte. In the „large memory model“ a maximum of 96 kbyte program memory and 64 kbyte data memory are the upper limits.

It should be noted that in the „large memory model“ the EEPROM is also used.

Appendix

Absolute Addressing in the BC2000



Input		Output	
KL3002	%IB0 Status	KL3002	%QB0 Control
KL3002	%IB1 Empty	KL3002	%QB1 Empty
KL3002	%IB2 D0	KL3002	%QB2 D0
KL3002	%IB3 D1	KL3002	%QB3 D1
KL3002	%IB4 Status	KL3002	%QB4 Control
KL3002	%IB5 Empty	KL3002	%QB5 Empty
KL3002	%IB6 D0	KL3002	%QB6 D0
KL3002	%IB7 D1	KL3002	%QB7 D1
2 x KL1002	%IX8.0.. %IX8.3	KL4002	%QB8 D0
		KL4002	%QB9 D1
		KL4002	%QB10 D0
		KL4002	%QB11 D1
		2 x KL2012	%QX12.0.. %QX12.3
...
PLC variable INT Offset0_1 Inputs	%IB128..129	PLC variable INT Offset0_1 Outputs	%QB128..129
PLC variable INT Offset0_2 Inputs	%IB130..131	PLC variable INT Offset0_2 Outputs	%QB130..131

Terminals 2, 3, 6, 7 and 10 are directly assigned to the Lightbus master, and are therefore neither visible to the BC2000, nor do they appear in the PLC's input and output process image.

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