BECKHOFF New Automation Technology

Documentation | EN

FBB-B903

Fieldbus Box for PROFINET

21.08.2014 | Version: 1.1.1

Table of contents

1 Foreword

1.1 Notes on the documentation

Intended audience

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

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

Disclaimer

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

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

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

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Patent Pending

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

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1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of instructions

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

⚠ DANGER

Serious risk of injury!

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

⚠ WARNING

Risk of injury!

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

⚠ CAUTION

Personal injuries!

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

NOTE

Damage to environment/equipment or data loss

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

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
1.1.1	System overview updated
1.1	Pictures corrected
1.0	First release

1.4 Bus Coupler as a general term

Parts of this manual give general information about Ethernet implementation in Beckhoff products.
Thus in the following often the term *Bus Coupler* is used, that describes not only the IP20 products, but also means the IP67 modules.

2 Product overview

2.1 The Fieldbus Box System

Fieldbus box modules are robust fieldbus stations for a large number of different fieldbus systems. They offer a wide range of I/O functionality. All relevant industrial signals are supported. As well as digital and analog inputs and outputs including thermocouple and RTD inputs, there are also incremental encoder interfaces available for displacement and angle measurement as well as serial interfaces to solve a large number of communications tasks.

Three varieties of signal connection

The digital inputs and outputs can be connected with snap-on 8 mm diameter plugs, screw-in M8 connectors, or with screw-in M12 pendants. The M12 version is provided for analog signals.

All important signal types

Special input and output channels on the combination I/O modules can be used for either input or output. It is not necessary to configure them, since the fieldbus interface is available for every combination channel as well as for input and output data. The combination modules give the user all of the advantages of fine signal granularity.

The processor logic, the input circuitry and the power supply for the sensor are all fed from the control voltage. The load voltage for the outputs can be supplied separately. In those Fieldbus Boxes in which only inputs are available, the load power supply, UP, can optionally be connected in order to pass it on downstream.

The states of the Fieldbus Box, the fieldbus connection, the power supplies and of the signals are indicated by LEDs.

The label strips can be machine printed elsewhere, and then inserted.

Fieldbus Boxes can be combined for greater flexibility

In addition to the Compact Box, the Fieldbus Box series also includes extendable devices, namely the Coupler Box and the Extension Box, as well as intelligent devices, the PLC Boxes.

Compact Box

The Compact Box makes the I/O data from the connected digital and analog sensors and actuators available to the fieldbus.

Coupler Box

The Coupler Box also collects I/O data from the Extension Boxes via an interference-proof optical fiber connection (IP-Link). Up to 120 Extension Boxes can be connected to a Coupler Box. In this way a distributed IP67 I/O network is formed with only one fieldbus interface.

The Coupler Box is capable of automatically recognizing the extension modules connected to it during start-up, and maps the I/O data automatically into the fieldbus process image – a configuration is not necessary. The Coupler Box appears, from the fieldbus point of view, along with all of the networked Extension Boxes, as a single participating bus device with a corresponding number of I/O signals.

The Coupler Box corresponds to the Bus Coupler in the BECKHOFF Bus Terminal system. BECKHOFF fieldbus devices made to protection class IP 20 (Bus Terminals) and IP 67 (Fieldbus Box) can be combined without difficulty – the data is handled in the same way in either case.

IP-Link

The IP-Link is an optical fiber connection with a transmission rate of 2 MBits/s which is capable of transmitting 1000 items of binary I/O data in approx. 1 ms, rapidly and securely. Smaller configurations are correspondingly faster. Because of the high usable data rate, the coupling via IP-Link does not reduce the performance of the fieldbus at all.

Low-priced plug connectors made according to Protection Class IP 67 can be used for the rapid and simple preparation of the IP-Link cable, in situ. The connection does not require special tools, and can be performed quickly and simply. The IP-Link cables can also be obtained with prepared plugs if required.

The separate supply of the output voltage allows output groups to be switched off individually. Differing potentials can also be created within an extension ring without difficulty, since the IP-Link naturally has optimum electrical isolation.

Extension box

Like the Compact Boxes, the Extension Boxes cover the full spectrum of I/O signals, and may be up to 15 m apart. They are remarkably small in size, and lead to particularly economical I/O solutions with high levels of protection. Here again, the digital inputs and outputs may optionally be connected via snap-on 8 mm connectors, or via screw-in connectors (M8 and M12). Analog signal types are provided with the M12 version. The snap-on connectors lock in place positively, forming a shake-proof connection, while the screw-in connectors offer the advantage of high resistance to being pulled out.

PLC Box

The PLC Box is an intelligent Fieldbus Box with PLC functionality for distributed pre-processing of the I/O signals. This allows parts of the application to be farmed out from the central controller. This reduces the load on the CPU and the fieldbus. Distributed counting, controlling and switching are typical applications for the PLC Box. The reaction times are independent of the bus communication and of the higher-level controller.

In the event of a bus or controller failure, maintenance of function (e.g. bringing the process to a safe state in an orderly manner) is possible.

Programming is carried out with TwinCAT in accordance with IEC 61131-3. Five different programming languages are available:

- Instruction List (IL)
- Function Block Diagram (FBD)
- Ladder Diagram (LD)
- Sequential Function Chart (SFC)
- Structured Text (ST)

The program download occurs either via the fieldbus or via the programming interface.

Extensive debugging functions (breakpoint, single step, monitoring, etc) are also available. The PLC Box contains a powerful 16 bit controller, 32/96 kByte program memory and 32/64 kByte data memory. A further 512 bytes of non-volatile memory are available for remanent flags.

PLC Box with IP-Link

The programmable PLC Box with IP-Link provides almost unlimited I/O possibilities. Up to 120 extension modules, with more than 2000 I/Os, can be directly addressed from the PLC program. The PLC Box is thus also suitable for use as a small, autonomous controller for the operation of parts of equipment or small machines.

2.2 Fieldbus Box - Naming conventions

The identifications of the Fieldbus Box modules are to be understood as follows:
IXxxxy-zyyy

IX describes the design:

"IP" stands for the Compact Box design [▶ 12]
"IL" stands for the Coupler Box design (with IP-Link) [▶ 12]
"IE" stands for the Extension Box design [▶ 12]

xxxy describes the I/O connection:

xxx describes the I/O property:
"10x" - 8 x digital inputs
"15x" - counter module
"20x" - 8 x digital outputs
"25x" - PWM module
"23x" - 4 x digital inputs and 4 x digital outputs
"24x" - 8 x digital inputs and 8 x digital outputs
"3xx" - 4 x analog inputs
"4xx" - 4 x analog outputs
"5xx" - incremental encoder or SSI transducer
"6xx" - Gateway module for RS232, RS422, RS485, TTY

y represents the mechanical connection:
"0" stands for 8mm snap-on connection,
"1" stands for M8 bolted connection
"2" stands for M12 bolted connection and
"9" stands for M23 bolted connection

zyyy describes the programmability and the fieldbus system

z distinguishes whether the device is a slave or is a programmable slave:

"B" - not programmable
"C" - programmable (PLC Box)

"yyy" stands for the fieldbus system and the bus connection:
"110" - EtherCAT
"200" - Lightbus
"310" - PROFIBUS
"318" - PROFIBUS with integrated tee-connector
"400" - Interbus
"510" - CANopen
"518" - CANopen with integrated tee-connector
"520" - DeviceNet
"528" - DeviceNet with integrated tee-connector
"730" - Modbus
"800" - RS485
"810" - RS232
"900" - Ethernet TCP/IP with RJ45 for the bus connection
"901" - Ethernet TCP/IP with M12 for the bus connection
"903" - PROFINET
"905" - EtherNet/IP

Compact Box

Compact Box

The Compact Box modules offer a wide range of I/O functionality. All relevant industrial signals are supported. The digital inputs and outputs can be connected either with snap-on 8 mm diameter plugs, screw-in M8 connectors, or screw-in M12 connectors. The M12 version is made available for analog signals.

Depending on the module, the I/O section and the power supply section can differ.

Coupler Box

Coupler Box

There are three versions of the coupler box named IL230x-Bxxx. It differs from the compact box in that this module offers an interface to what are known as extension boxes. This interface is a subsidiary bus system based on the optical fiber what is known as IP Link. This powerful subsidiary bus system can handle up to 120 extension boxes at one coupler box.

Extension Box

Extension Box

Extension Modules, that are independent of the fieldbus and that can only be operated together with a coupler box via IP Link.

PLC Box

PLC Box

A PLC Box differ from the Coupler Box in that this module can be programmed in IEC 61131-3. This means that this slave is also capable of working autonomously, without a master, for instance for control or regulation tasks.

Also see about this

Fieldbus Box - Naming conventions [▶ 12]

2.3 Firmware and hardware issue status

The documentation refers to the hardware and software status that was valid at the time it was prepared. The properties are subject to continuous development and improvement. Modules having earlier production statuses cannot have the same properties as modules with the latest status. Existing properties, however, are always retained and are not changed, so that these modules can always be replaced by new ones. The number beginning with a *D* allows you to recognize the firmware and hardware status of a module.

Syntax:

D . ww yy x y z u

ww - calendar week
yy - year
x - bus board firmware status
y - bus board hardware status
z - I/O board firmware status
u - I/O board hardware status

Example:

D.22081501

- Calendar week 22
- in the year 2008
- bus board firmware status: 1
- bus board firmware hardware status: 5
- I/O board firmware status: 0 (no firmware is necessary for this board)
- I/O board hardware status: 1

2.4 Technical data

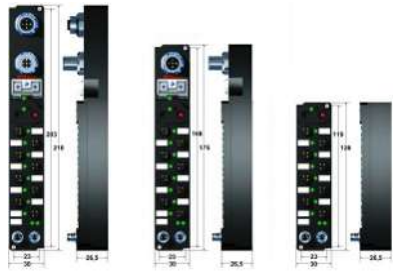
Technical data	IL230x-B903
Extension modules	max. 120
Digital peripheral signals	max. 960 inputs and outputs
Analog peripheral signals	max. 480 inputs and outputs
Transmission medium	4 x 2 twisted pair copper cable; category 5 (100 Mbaud)
Data transfer rate	100 Mbaud
Topology	star wiring
Distance between modules	100 m (hub/switch to Fieldbus Box)
Configuration	via KS2000 or via the controller
Protocols	PROFINET RT (TCP-ADS for access via Ethernet with KS2000 configuration software)
Power supply	Control voltage: 24V_{DC} (-15%/+20%); load voltage: According to I/O type
Control voltage current consumption	According to I/O type + current consumption of sensors, max. 0.5 A
Load voltage current consumption	According to I/O type
Power supply connection	Feed: 1 x M8 plug, 4-pin Onward connection: 1 x M8 female socket 4-pin
Fieldbus connection	1 x M12, d-coded socket
Electrical isolation	Channels/control voltage: no between the channels: no Control voltage/fieldbus: yes
Permissible ambient temperature range during operation	0°C ... +55°C
Permissible ambient temperature range during storage	-25°C ... +85°C
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC immunity/emission	Conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP 65/66/67 (conforms to EN 60529)
Installation position	Variable
Approvals	CE, UL E172151

Note

Detailed technical data for all available I/O variants can be found under Signal variants, Installation, I/O module configuration on Products & Solutions CD from Beckhoff or on the Internet (http://www.beckhoff.com) under Download/Fieldbus Box.

3 Mounting and wiring

3.1 Dimensions



All dimensions are given in millimeters.

General

Technical data	Fieldbus Box
Material	PA6 (polyamide), casting compound: polyurethane
Assembly	2 x fixing holes for M3
Metal parts	Brass, nickel-plated
Contacts	CuZn, gold-plated
Vibration / shock resistance	according to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst / ESD	according to EN 61000-6-2 (EN 50082) / EN 61000-6-4 (EN 50081)
Permissible ambient temperature during operation	0 ... 55°C
Permissible ambient temperature during storage	-25 ... + 85°C
Installation position	any
Type of protection	IP65/66/67 when screwed together
Approvals	CE, UL E172151

IPxxxx-Bxx8, IL230x-Bxx8, IL230x-B110, IXxxxx-B400, IXxxxx-B90x, IXxxxx-C900

Technical data	Compact and Coupler Box with integrated tee connector
Dimensions (H x W x D)	ca. 210 x 30 x 26,5 mm (height to upper edge of fieldbus socket: 30 mm)
Weight	ca. 260 g - 290 g, depending on module type

IPxxxx-Bxx0, IL230x-Bxx0, IL230x-Cxx0

Technical data	Compact and Coupler Box
Dimensions (H x W x D)	Approx. 175 x 30 x 26.5 mm (height to upper edge of fieldbus socket: 30 mm, with T- connector ZS1031-2600 height approx. 65 mm)
Weight	Approx. 250 g - 280 g, depending on module type

IExxxx

Technical data	Extension box
Dimensions (H x W x D)	Approx. 126 x 30 x 26.5 mm
Weight	Approx. 120 g - 200 g, depending on module type

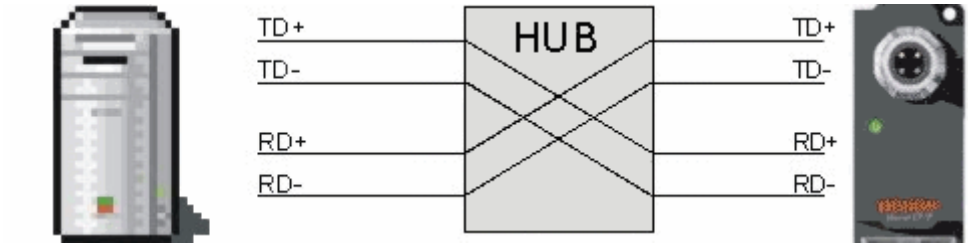
3.2 Ethernet Connection

The connection to the Ethernet bus is made via an d-coded M12 female socket.

The cable should be CAT5 or CAT5e cable.

Cabling

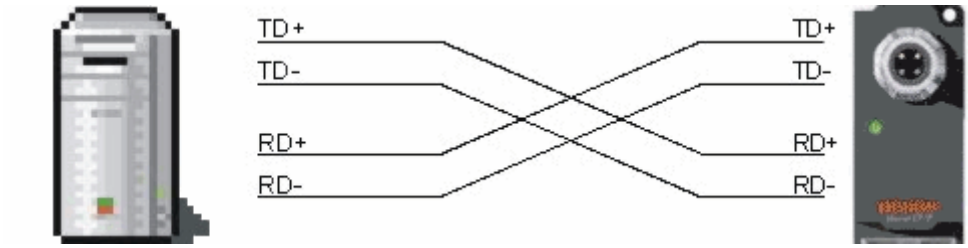
Connection via hub or switch



Connect the PLC's network interface to the hub using a standard Ethernet cable, and connect the hub, again using a standard Ethernet cable, to the Fieldbus Box.

Connection via a switch is done in the same way.

Direct connection between PLC and IL230x-B90x



To connect the PLC directly to the Fieldbus Box, you must use an Ethernet cable in which the pairs of cores have been crossed (a crossover cable).

Pin assignment of the M12 connector

PIN	Signal	Description
1	TD +	Transmit Data +
2	RD +	Receive Data +
3	TD -	Transmit Data -
4	RD -	Receive Data -
housing	Shield	Shield

Note: There is no standardized color setting for the wires!

3.3 Ethernet connector: M12

The connection to the Ethernet is done with an d-coded M12 socket (IP67).

1	TD +
2	RD +
3	TD -
4	RD -
Housing	Shield

4 Ethernet

4.1 Overview

4.1.1 Ethernet

Ethernet was originally developed by DEC, Intel and XEROX (as the DIX standard) for passing data between office devices. The term nowadays generally refers to the *IEEE 802.3 CSMA/CD* specification, published in 1985. Because of the high acceptance around the world this technology is available everywhere and is very economical. This means that it is easy to make connections to existing networks.

There are now a number of quite different transmission media: coaxial cable (10Base5), optical fiber (10BaseF) or twisted pairs (10BaseT) with screen (STP) or without screen (UTP). A variety of topologies such as ring, line or star can be constructed with Ethernet.

Ethernet transmits Ethernet packets from a sender to one or more receivers. This transmission takes place without acknowledgement, and without the repetition of lost packets. To achieve reliable data communication, there are protocols, such as TCP/IP, that can run on top of Ethernet.

MAC-ID

The sender and receiver of Ethernet packets are addressed by means of the MAC-ID. The MAC-ID is a 6 byte identification code unique to every Ethernet device in the world. The MAC-ID consists of two parts. The first part (i.e. the first 3 bytes) is a manufacturer identifier. The identifier for Beckhoff is 00 01 05. The next 3 bytes are assigned by the manufacturer and implement a unique serial number. The MAC-ID can, for example, be used for the BootP protocol in order to set the TCP/IP number. This involves sending a telegram containing the information such as the name or the TCP/IP number to the corresponding node. You can read the MAC-ID with the KS2000 configuration software.

The Internet Protocol (IP)

The internet protocol (IP) forms the basis of this data communication. IP transports data packets from one device to another; the devices can be in the same network, or in different networks. IP here looks after the address management (finding and assigning MAC-IDs), segmentation and routing. Like the Ethernet protocol, IP does not guarantee that the data is transported - data packets can be lost, or their sequence can be changed.

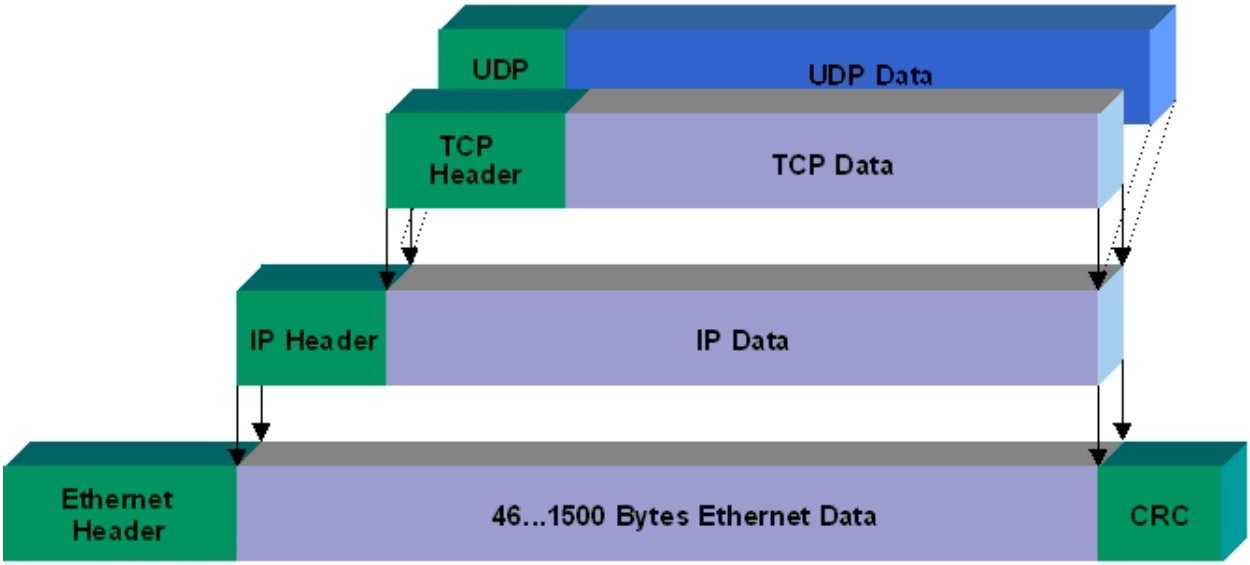
TCP/IP was developed to provide standardized, reliable data exchange between any number of different networks. TCP/IP is thus substantially independent of the hardware or software being used. Although the term is often used as if it were a single concept, a number of protocols are layered together: e.g. IP, TCP, UDP, ARP and ICMP.

Transmission Control Protocol (TCP)

The Transmission Control Protocol (TCP) which runs on top of IP is a connection-oriented transport protocol. It includes error detection and error handling mechanisms. Lost telegrams are repeated.

User Datagram Protocol (UDP)

UDP is connectionless transport protocol. It provides no control mechanism when exchanging data between sender and receiver. This results in a higher processing speed than, for example, TCP. Checking whether or not the telegram has arrived must be carried out by the higher-level protocol.

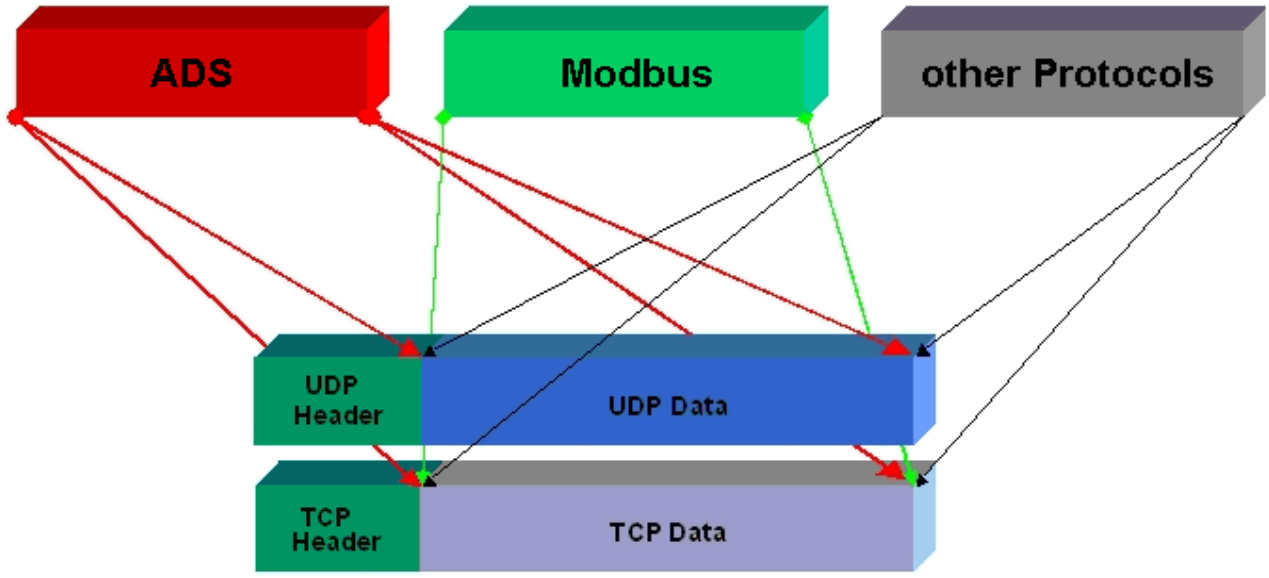


Protocols running on top of TCP/IP and UDP/IP

The following protocols can run on top of TCP/IP or UDP:

- ADS
- ModbusTCP

Both of these protocols are implemented in parallel on the Bus Coupler, so that no configuration is needed to activate the protocols.



ADS can be used on top of either TCP or UDP, but ModbusTCP is always based on TCP/IP.

4.1.2 Topology

In 10BaseT and 100BaseT a number of stations are star connected according to the Ethernet standard.

Star topology

The simplest form of a star LAN consists of a single point-to-point connection. All messages pass via a central node (the hub or switch), which then passes the information to the desired device according to the destination address.

Tree topology

A tree topology consists of a number of connected star networks. As soon as the network contains a number of hubs or switches, the topology is classified as a tree. Ideally the connections between the star couplers have a particularly wide bandwidth, since these transport the most traffic. When constructing tree topologies, the repeater rule must be observed. This is also known as the 5-4-3 repeater rule. There must be no more than two pairs of repeaters (or of hubs) in the transmission path between any two stations, unless they are separated by bridges, switches or routers. A transmission path may consist of at most five segments and four repeater sets (two repeater pairs). Up to three of these segments may be coaxial segments to which the stations are connected. The remaining segments must consist of point-to-point connections; these are also known as IRL (inter repeater link) connections.

Cabling guidelines

Structured cabling provides general guidelines for constructing the cabling for a LAN. It specifies maximum permitted cable lengths for the wiring within the grounds, building or floor. Standardized in EN 50173, ISO 11801 and TIA 568-A, *structured cabling* provides the basis for an advanced, application-independent and economical network infrastructure. The wiring standards are applicable to a range defined as having a geographical extent of up to 3 km and an office area of up to one million sq meters, with between 50 and 50,000 end devices. Recommendations for the structure of a cabling system are also given. The figures can vary, depending on the topology selected, the transmission media and coupling modules used under industrial conditions, and on the use of components from various manufacturers in one network. The given figures should therefore only be considered as recommendations.

4.1.3 Ethernet Cable

Transmission standards

10Base5

The transmission medium for 10Base5 consists of a thick coaxial cable ("yellow cable") with a max. transmission speed of 10 MBaud arranged in a line topology with branches (drops) each of which is connected to one network device. Because all the devices are in this case connected to a common transmission medium, it is inevitable that collisions occur often in 10Base5.

10Base2

10Base2 (Cheapernet) is a further development of 10Base5, and has the advantage that the coaxial cable is cheaper and, being more flexible, is easier to lay. It is possible for several devices to be connected to one 10Base2 cable. It is frequent for branches from a 10Base5 backbone to be implemented in 10Base2.

10BaseT

Describes a twisted pair cable for 10 MBaud. The network here is constructed as a star. It is no longer the case that every device is attached to the same medium. This means that a broken cable no longer results in failure of the entire network. The use of switches as star couplers enables collisions to be reduced. Using full-duplex connections they can even be entirely avoided.

100BaseT

Twisted pair cable for 100 MBaud. It is necessary to use a higher cable quality and to employ appropriate hubs or switches in order to achieve the higher data rate.

10BaseF

The 10BaseF standard describes several optical fiber versions.

Short description of the 10BaseT and 100BaseT cable types

Twisted pair copper cable for star topologies, where the distance between two devices may not exceed 100 meters.

UTP

Unshielded twisted pair
This type of cable belongs to category 3, and is not recommended for use in an industrial environment.

S/UTP

Screened/unshielded twisted pair (screened with copper braid)
Has a general screen of copper braid to reduce influence of external interference. This cable is recommended for use with Bus Couplers.

FTP

Foiled shielded twisted pair (screened with aluminum foil)
This cable has an outer screen of laminated aluminum and plastic foil.

S/FTP

Screened/foiled-shielded twisted pair (screened with copper braid and aluminum foil)
Has a laminated aluminum screen with a copper braid on top. Such cables can provide up to 70 dB reduction in interference power.

STP

Shielded twisted pair
Describes a cable with an outer screen, without defining the nature of the screen any more closely.

S/STP

Screened/shielded twisted pair (wires are individually screened)
This identification refers to a cable with a screen for each of the two wires as well as an outer shield.

ITP

Industrial Twisted-Pair
The structure is similar to that of S/STP, but, in contrast to S/STP, it has only one pair of conductors.

5 Parameterization and commissioning

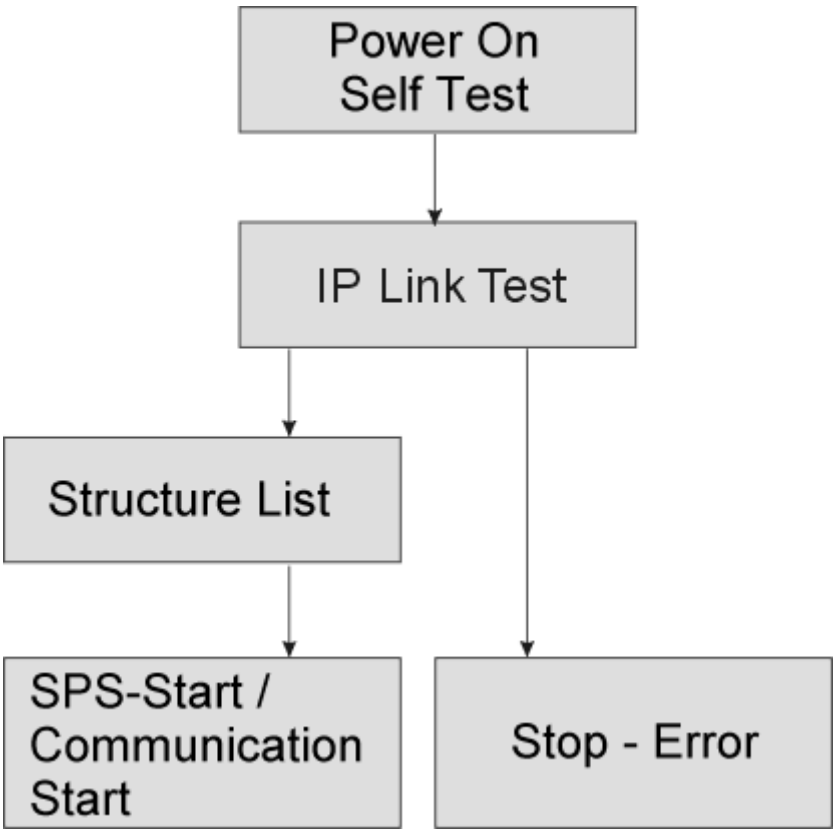
5.1 Note about parameterization

Note

Changes, e.g. the MAC-ID, that were done with the KS2000 configuration software are only stored in the volatile memory (RAM) of the Fieldbus Box.After the changes a software reset is required. By this, the changes will be copied into the flash memory and are permanent.A Cold-Start (Power-ON/ OFF) is not enough. It has to be a software reset!

5.2 Start-up behavior of the Fieldbus Box

After power up, the Fieldbus Box checks its state, configures the IP-Link (if present) and refers to the extension modules to create a structure list. If the Fieldbus Box contains a decentralized controller (IL230x-C310) the local PLC is started once the structure list has successfully been created.
The I/O LEDs illuminate and flash as the module starts up. If there are no errors, the I/O LEDs should stop flashing within about 2-3 seconds. If there is an error, then the LED that flashes will depend on the type of that error (see Diagnostic LEDs [▶ 37]).



5.3 Network Classes

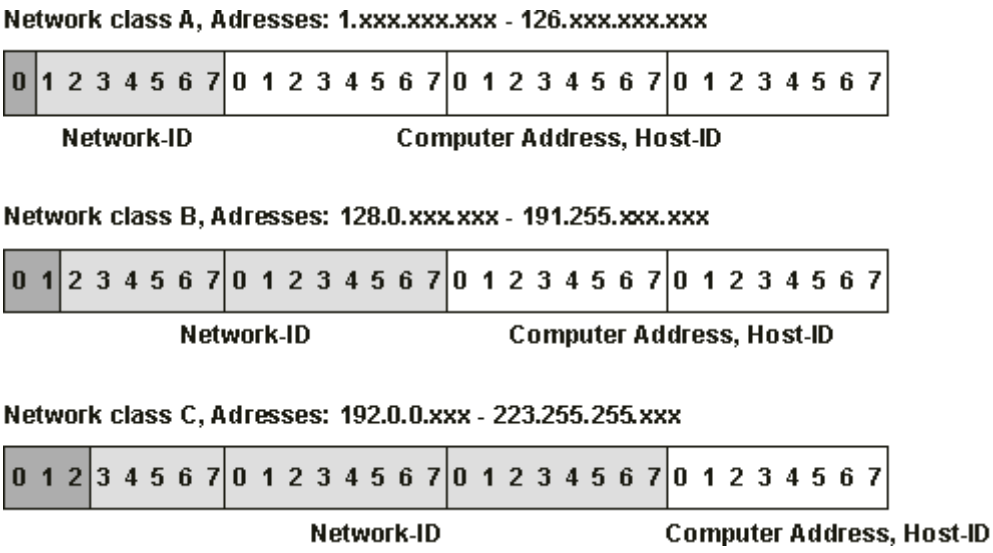
Three different network classes are distinguished. They specify how many address bits are reserved for the Network -ID and how many for the computer number (or node number). The difference is located in the first 3 bits of the IP address.

Network-class	Number of bits for the Network ID	Possible number of networks	Number of bits for the node address	Possible number of nodes per network
A	7	126	24	16 777 214
B	14	16 382	16	65 536
C	21	2 097 150	8	254

NOTE

Warning

An IP address must be unique within the entire connected network!



Note

In a communication with another Ethernet devices, the IP address set must have the same network class. Example: Your PC has address 172.16.17.55, which means that the Bus Coupler must have address 172.16.xxx.xxx (each xxx stands for a number between 0...255. The 0 is normally used for routers/switches, and should therefore be reserved).

In order to see the PC's own address, the command *ipconfig* can be entered into a DOS window under Windows NT/2000/XP.

5.4 IP address, PROFINET name

5.4.1 Address switch settings

Via the address switch you can select between different addressing options and assign the PROFINET name.

Note

The device is PROFINET-compliant if switches x10 and x1 are set to 0xEx or > 0xF1.

All other modes are available as options.

PROFINET name via switch

This is where the name "il230x-b903-xx" is formed. xx corresponds to the switch setting. "il" is must be lower case!

Hex switch x16	Hex switch x1	Description	Restart behaviour	Behaviour with factory settings
0x0 - D	0x0 - F	IP address via switch	- PN name from memory - IP address via switch	- PN name becomes empty string - IP address via switch 172.16.18.xxx (xxx switch) SNM 255.255.0.0
0xF	0x0	IP address via DHCP	- PN name from memory - IP address and SNM via DHCP	- PN name becomes empty string - IP address and SNM via DHCP
0xF	0x1	IP address via BootP	- PN name from memory - IP address and SNM via BootP	- PN name becomes empty string - IP address = 0.0.0.0, - SNM = 0.0.0.0
0xE	0x0 - F	PN name via switch x1	- PN name via switch* (il230x-b903-xx, with xx = 0...15) - IP address from memory	- PN name via switch - IP address = 0.0.0.0, - SNM = 0.0.0.0
0xF	0x2 - F	PROFINET-compliant	PN name from memory - IP address from memory	- PN name becomes empty string - IP address = 0.0.0.0, - SNM = 0.0.0.0

*) The PROFINET name cannot be overwritten by the controller.

Legend

PN - PROFINET
SNM - SubNetMask
DHCP - Dynamic Host Configuration Protocol
DNS - Domain Name Server

5.4.2 Address setting with coding switches and KS2000

One of the ways to set the TCP/IP address is via the two hexadecimal address coding switches.

Only the last byte is changed. The other values are read directly from table 100 of the box. They can only be adapted with the configuration software KS2000. Before switching on, the rotary coding switch x10 must have a value not equal 0xF.

To change the IP address it is necessary to reset the write protection in the KS2000. Once the address has been changed, the coupler has to be reset.

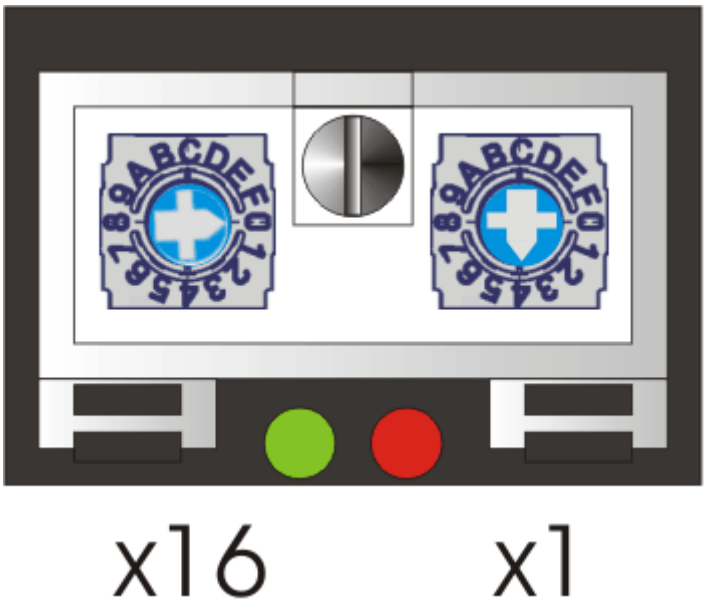
Table 1: Table 100

Register	High byte	Low byte
0	IP byte 2	IP byte 1
1	Not used	IP byte 3

Table 2: Default

IP byte	Default value (hex)	Default value (dec)
1	0xAC	172_{dec}
2	0x10	16_{dec}
3	0x12	18_{dec}
4	(rotary coding switch)	(0 to 223_{dec})

Example



Switch	x16	x1	
Valence	16	1	
In this example	**Switch settings**	0	4
Value	0	4_{dec}	
IP address	172.16.18.**4**		

5.4.3 Setting the IP Address Using the Beckhoff BootP Server

For address setting with the Beckhoff BootP server set the rotary coding switch to 0x F1. The *TCP/IP ERROR LED* flashes while the address is being allocated.

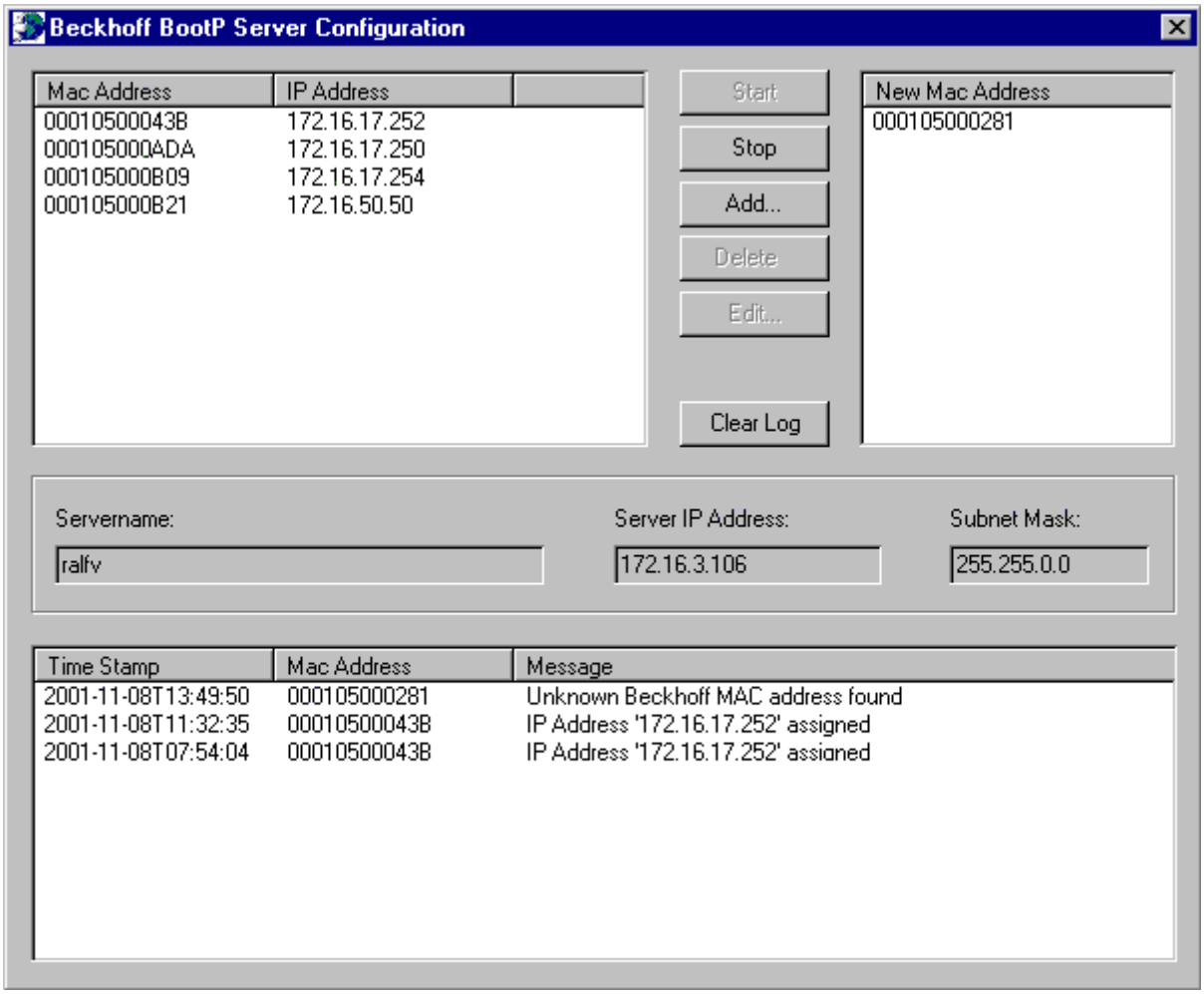
IP address save modes

Rotary coding switch in position 0x F1

The IP address assigned by the BootP server is only valid until the module is switched off. The BootP server must assign a new IP address to the module at the next cold start.
The address is, however, retained through a software reset of the module.

Beckhoff BootP server

Beckhoff supply a BootP server for Windows 98, ME, NT4.0, NT2000 and XP. The installation version can be found on the Beckhoff TwinCAT CD in folder Unsupported Utilities or under http://download.beckhoff.com/download/Software/TwinCAT/TwinCAT2/Unsupported Utilities/TcBootP Server.



As soon as the BootP server has started, the *New MAC Address* window shows all the Beckhoff nodes that are working in BootP mode and still have not received an IP address. The allocation MAC ID [▶ 30] for IP address takes place via button "<<". Successful assignment is displayed in the log window.
To start the BootP server automatically when your PC boots, it is only necessary to provide a shortcut in the Windows autostart folder. Include the */Start* parameter in the shortcut (.../TcBootPDlg.exe/start).

5.4.4 Address Configuration via DHCP Server

To set the address by means of a DHCP server, set the rotary switches to 0xF0. In this state, the DHCP service is switched on, and the module is automatically assigned an IP number by the DHCP server. For this purpose the DHCP server must know the module's MAC-ID [▶ 30]. The IP address should be set statically. The *TCP/IP Error* LED flashes while the address is being allocated.

5.4.5 Subnet mask

The subnet mask is subject to the control of the network administrator, and specifies the structure of the subnet.

Small networks without a router do not require a subnet mask. The same is true if you do not use registered IP numbers. A subnet mask can be used to subdivide the network with the aid of the mask instead of using a large number of network numbers.

The subnet mask is a 32-bit number.

- Ones in the mask indicate the subnet part of an address region.
- Zeros indicate that part of the address region which is available for the host IDs.

Description	Binary representation	Decimal representation
IP address	10101100.00010000.00010001.11001000	172.16.17.200
Subnet mask	11111111.11111111.00010100.00000000	255.255.20.0
Network ID	10101100.00010000.00010000.00000000	172.16.16.0
Host ID	00000000.00000000.00000001.11001000	0.0.1.200

Standard subnet mask

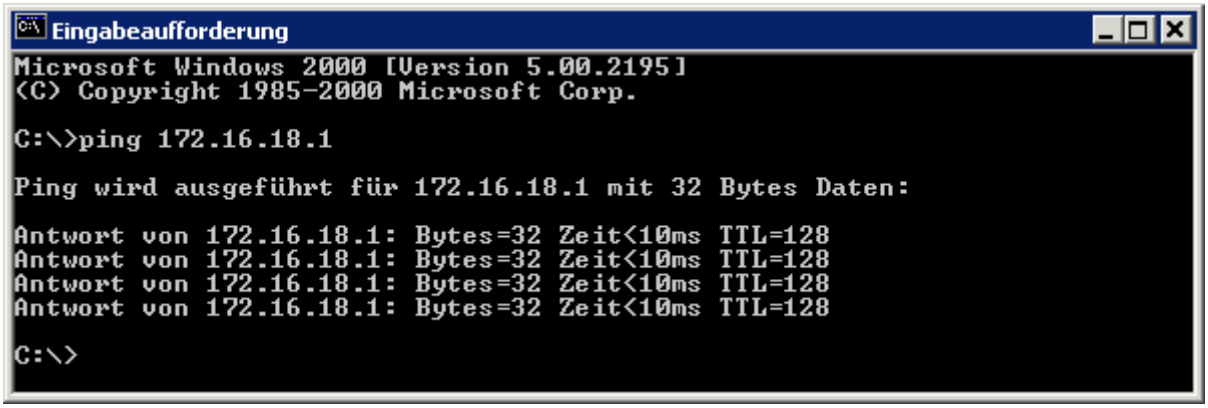
Address class	Standard subnet mask (decimal)	Standard subnet mask (hex)
A	255.0.0.0	FF.00.00.00
B	255.255.0.0	FF.FF.00.00
C	255.255.255.0	FF.FF.FF.00

Note

Neither subnet 0 nor the subnet consisting only of ones may be used. Neither host number 0 nor the host number consisting only of ones may be used! If the IP address is set using the KS2000 configuration software, it is necessary for the subnet mask also to be changed with the KS2000 configuration software. If ARP addressing is used, the associated standard subnet mask, based on the IP address, is entered. Under BootP or DHCP the subnet mask is entered by the server.

5.4.6 Testing the IP Address

Use the *Ping* command to test the IP address.



5.4.7 Reading the MAC-ID

Proceed as follows to read the MAC-ID:

- Change the IP address of your PC to 172.16.x.x and the Subnet mask to 255.255.0.0
  The default IP address of the Ethernet Fieldbus Boxes is 172.16.18.1 (rotary switch setting: 0, 1).
- Start the DOS Window
- Send a Ping to IP address 172.16.17.1
- Read the MAC-ID with *arp -a*.

6 Configuration

6.1 GSDML configuration file

Download the configuration file for the PROFINET master from the Beckhoff website at www.beckhoff.com

If required, a firmware update is available via support@beckhoff.com.

Figure illustrating the application with Siemens Step7

The corresponding image (*.bmp) can also be found on the Beckhoff website.

Copy the image into the following directory: "\Siemens\Step7\S7DATA\NSBMP".

6.2 Mapping of the Coupler Box

The signals of the Coupler Box and the connected expansion boxes are mapped in the order in which the hardware is connected.

For digital boxes always at least one byte is reserved.
If the boxes have less than 8 bits, the rest is filled with zeros.

The data are represented with WORD alignment, i.e. for analog modules the first WORD contains the status byte and an empty byte.
Example: IE2301 4 digital inputs, 4 digital outputs, 8-bit input, 8-bit output; the first four bits 0-3 are assigned. Bits 4-7 are not used.

Complex boxes are represented with input and output process image.

Example

IE3102, 4-channel analog input: per channel 1 byte control or status information, 1 empty byte, 2 bytes data.

6.3 DAP (Device Access Point) of the Coupler Box

The device model chosen for PROFINET is the distributed periphery, which is familiar from PROFIBUS DP.

The slots of the modular devices are represented via slots and sub slots.

Slot 0 is designated as device access point (DAP). This is where writing to the module takes place.

The current value of the control bit is returned in the status bits. Also, in bits 8 - 15 an IP-Link counter or the current IP-Link cycle time is displayed, depending on "S" in control bit 6.

Status bits

31 - 24	23 - 16	15 - 8	7	6	5	4	3	2	1	0
IP-Link error argument	IP-Link error code	IP-Link counter or IP-Link cycle timer	-	S	-	-	L2	-	R1	K1

K1: IP-Link reset was triggered

R1: Reboot of IL230x-B903 was triggered

L2: IP-Link stop in the event of Profinet error

Control bits

31 - 24	23 - 16	15 - 8	7	6	5	4	3	2	1	0
-	-	-	-	S	-	-	L2	-	R1	K1

K1: 0 -> 1 trigger IP-Link reset

R1: Reboot of IL230x-B903 was triggered

L2: IP-Link stop in the event of PROFINET error

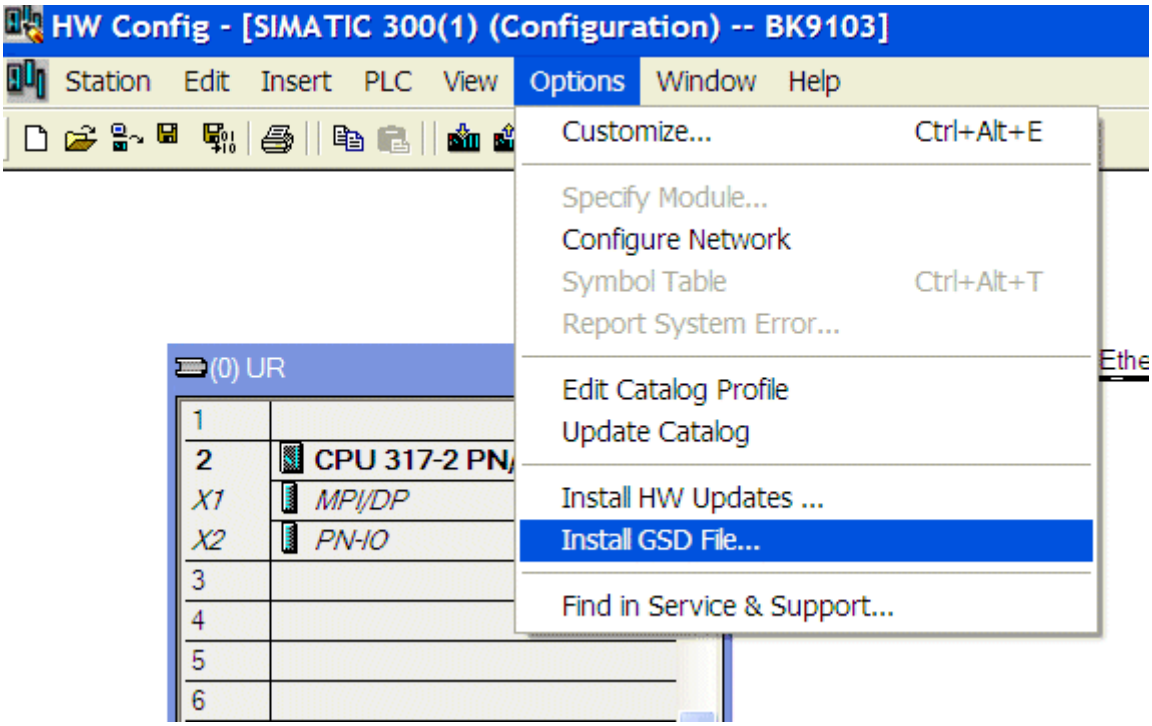
S: =1 IP-Link cycle time in ms

6.4 Configuration with S7

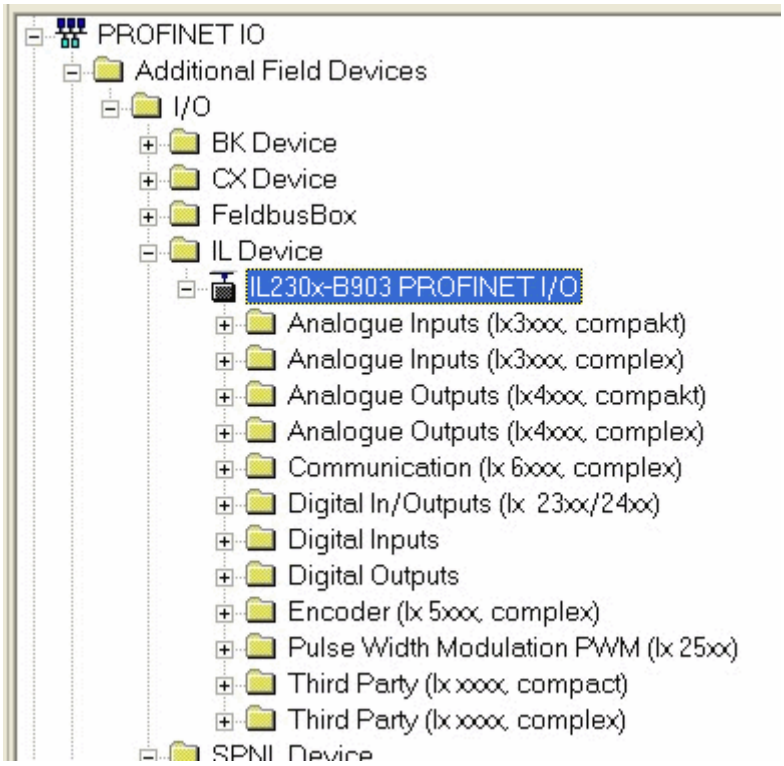
6.4.1 Example with Step 7

Install the GSDML file (Step 7 from version 5.4 + SP1)

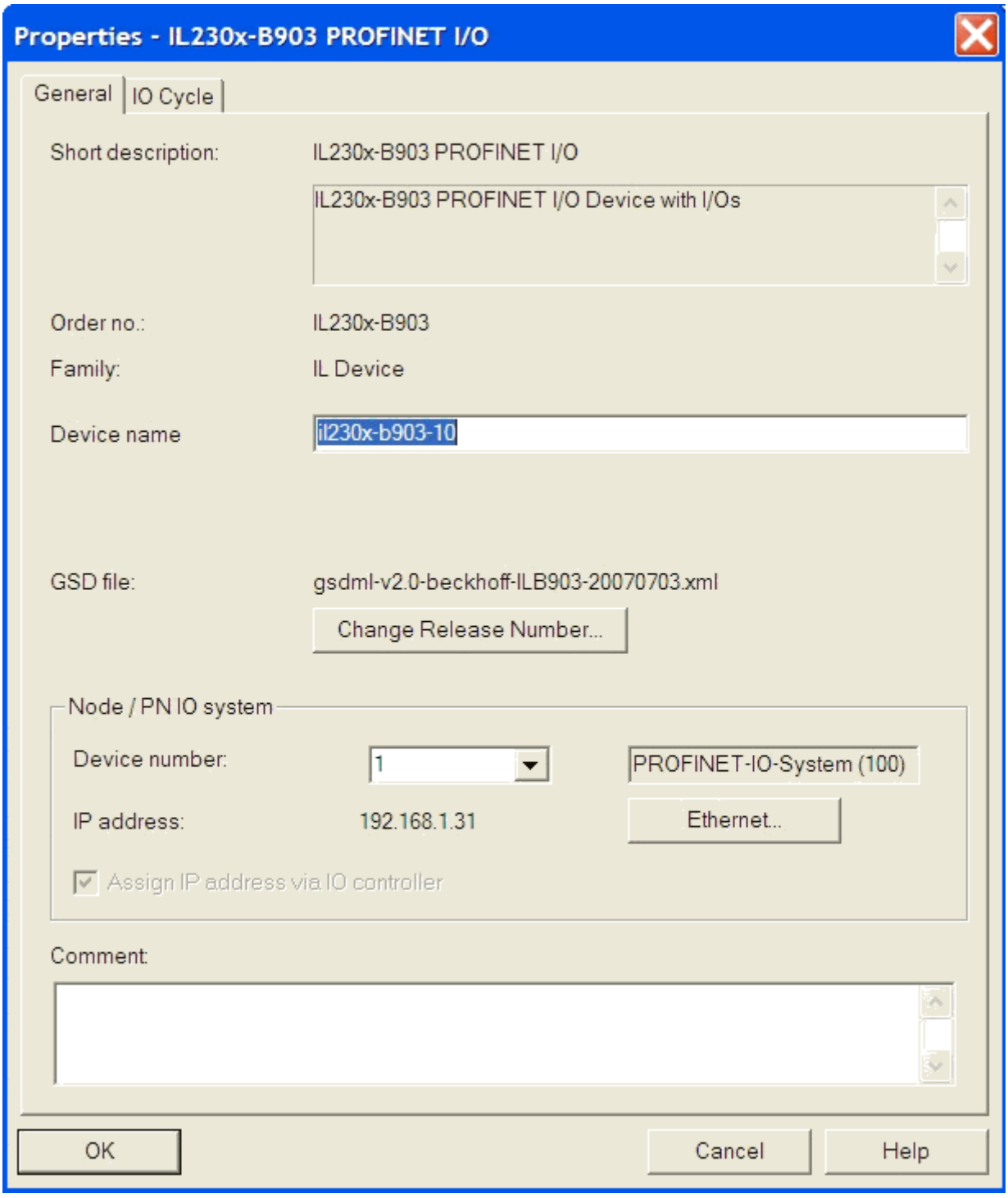
To this end open the hardware manager. Install the GSDML file.



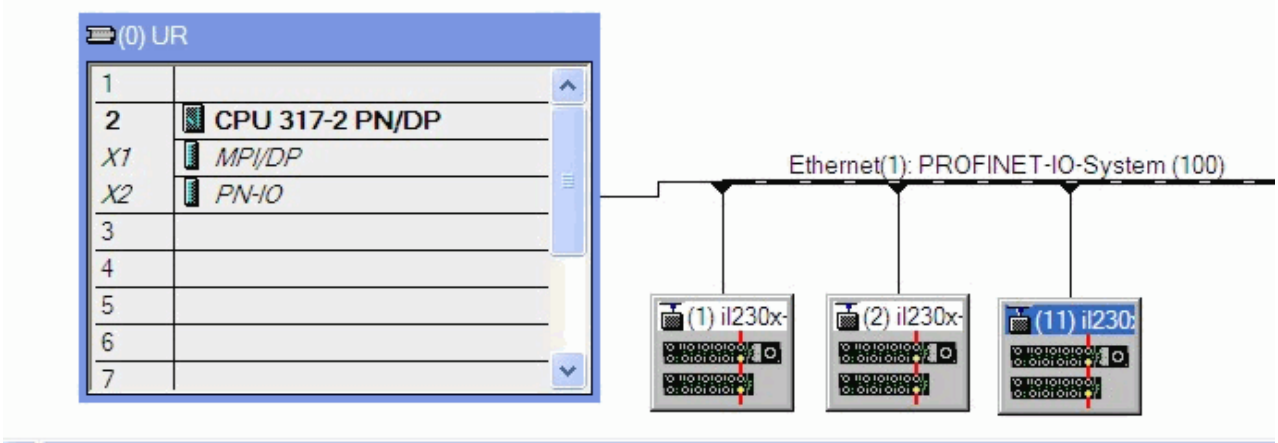
Add an IL230x-B903 node in your Manager and add the expansion modules according to your configuration.



Set the name of the PN device, e.g. "il230x-b903-10" ["il" must be in lower case] (set the address switches of the box to 0xFF, then switch on then the coupler).



The configuration will now look as follows, for example. Load the configuration into your control system.



(11) il230x-b903-11

Slot	Module	Order Number	I Address	Q address	Diagnostic address
0	il230x-b903-11	IL230x-B903			8186*
1	4K. Eingang, 4K. Ausg		245	250	
2	Ix 4404, Festo CPV1x-G		246...248	251...253	
3	8 Bit digitale Eingänge		249		
4	8 Bit digitale Eingänge		250		
5	8 Bit digitale Eingänge		251		
6	8 Bit digitale Eingänge		252		
7	8 Bit digitale Eingänge		254		
8	8 Bit digitale Eingänge		255		
9	8 Bit digitale Eingänge		272		
10	8 Bit digitale Eingänge		273		
11	8 Bit digitale Eingänge		274		
12	8 Bit digitale Eingänge		275		
13	8 Bit digitale Eingänge		276		
14	8 Bit digitale Eingänge		277		
15	Ix3112, 4 K. ana. Einga^		278...293	256...271	
16	Ix3112, 4 K. ana. Einga^		294...309	272...287	

7 Error handling and diagnosis

7.1 Diagnostic LEDs - Overview

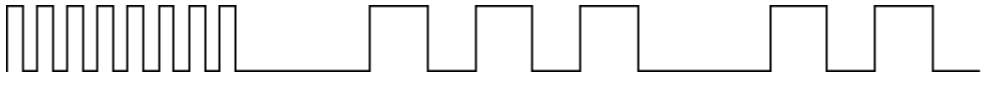
Error diagnosis

There are 2 sorts of errors:

- Fieldbus Errors [▶ 38]
- Local Errors [▶ 41] on Compact Box or Coupler Box

Blink Codes

Blink sequence	Meaning
Fast flashing	Beginning of the Blink Code
first slow sequence	Error code
second slow sequence	Error argument
third slow sequence (optional)	Error argument



Beginning Error code Error argument

7.2 Diagnostic LEDs for PROFINET

After switching on, the module immediately checks the connected configuration. Error-free start-up is signalled by the red LED *I/O ERR* being extinguished. Flashing of LED *I/O ERR* indicates an input/output error. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error.

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

At the bottom of the module there are two further green LEDs that indicate the supply voltage. The LED on the left indicates the 24 V_{DC} logic supply of the module. The LED on the right indicates the supply of the outputs.

Fig. 1: B90x_DiaLED

LEDs for Ethernet diagnostics

LED	On	Off
SPEED	Port setting 100Mbit/s	Port setting 10Mbit/s
ACT	On: Physical connection present Flashing: Bus traffic present	No connection

LEDs for PROFINET diagnostics

DIAG R (green)	DIAG E (red)	Configuration/diagnostics
on	off	OK
0.5s	off	Flashing (triggered by a Profinet tool)
0.1s	off	Offline PLC Stop
off	0.5s	TimeOut
1	Slot number	Wrong module
2	Slot number	Missing module (physical)
3	Slot number	Missing module (in the configuration)
4	off	No Profinet name allocated
5	Slot number	Substitute

Note:

- In the event of several errors the last faulty module is displayed.
- Substitute - is set if modules are configured incorrectly but are nevertheless capable of running (Example: IE3112 is configured but IE3102 is inserted in slot)

Example

You have configured an IE3112 as a fifth module, but only four modules are actually connected.

- Start Error Code: Red DIAG E LED flickers rapidly, green DIAG R LED is off
- Red DIAG E LED is on, green LED shows the error code and flashes twice (0.5 sec)
- Red and green LED off
- Red DIAG E LED shows the error argument and flashes 5 times (0.5 sec, slot number here), green LED is off

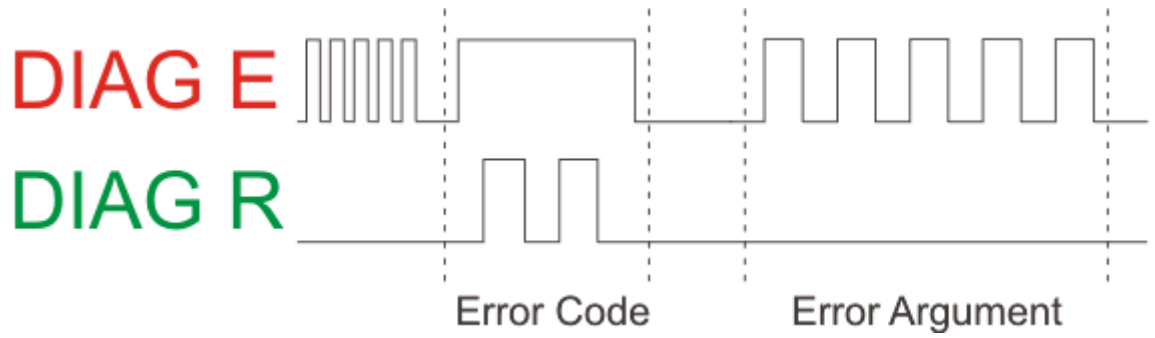


Fig. 2: FBB_power_LED

LEDs for power supply diagnosis

LED	Meaning
Left LED off	Module has no voltage
Left LED red	Short-circuit monitoring of the sensor supply (< 500mA) is activated. Sensors/inputs are no longer supplied.
Right LED off	No 24 V_{DC} voltage supply for outputs connected

7.3 Diagnostic LEDs for local errors

Local error in a Coupler Box (IL230x-Bxxx/Cxxx)

The term *local error* means that an error has occurred in the Fieldbus Box or the IP-Link. IP-Link errors most often turn out to be a result of inappropriate use of the optical fiber.

LED green	LED red			Description	Remedy
off	off			No data exchange	Module in synchronous mode or - activate PROFIBUS cyclic data
off	1	0		EEPROM checksum error	Set manufacturer's setting with the KS2000 software
off	2			Reserved	-
off	3			Break location has been recognized	interruption before the master's receiver
	3	n		Break location has been recognized	n-th module before the master's receiver
	3	n	m	Break location has been recognized	(n*10)+m-th module before the master's receiver
off	4	n		Too many faulty telegrams have been detected (more than 25%)	The optical fiber wiring in front of the nth extension module should be checked
off	5	n		Register access to complex modules has failed	Check the nth module
off	11	n		Complex module working incorrectly	Exchange the nth module
off	12	n		More than 120 modules in the ring	Connect fewer modules
off	13	n		nth module unknown	Firmware update required
on	off			Module is exchanging data	no error

Local errors in an Extension Box

LED green	LED red	Description
off	on	No data is being received over the IP-Link
off	blinks, flickers	Faulty IP-Link protocols are being received (very poor data connection)
blinks, flickers	blinks, flickers	Faulty IP-Link protocols are being received (poor data connection), does not necessarily lead to an error
on	off	IP-Link protocols are being received, no error

Faulty protocols can occur, because of:

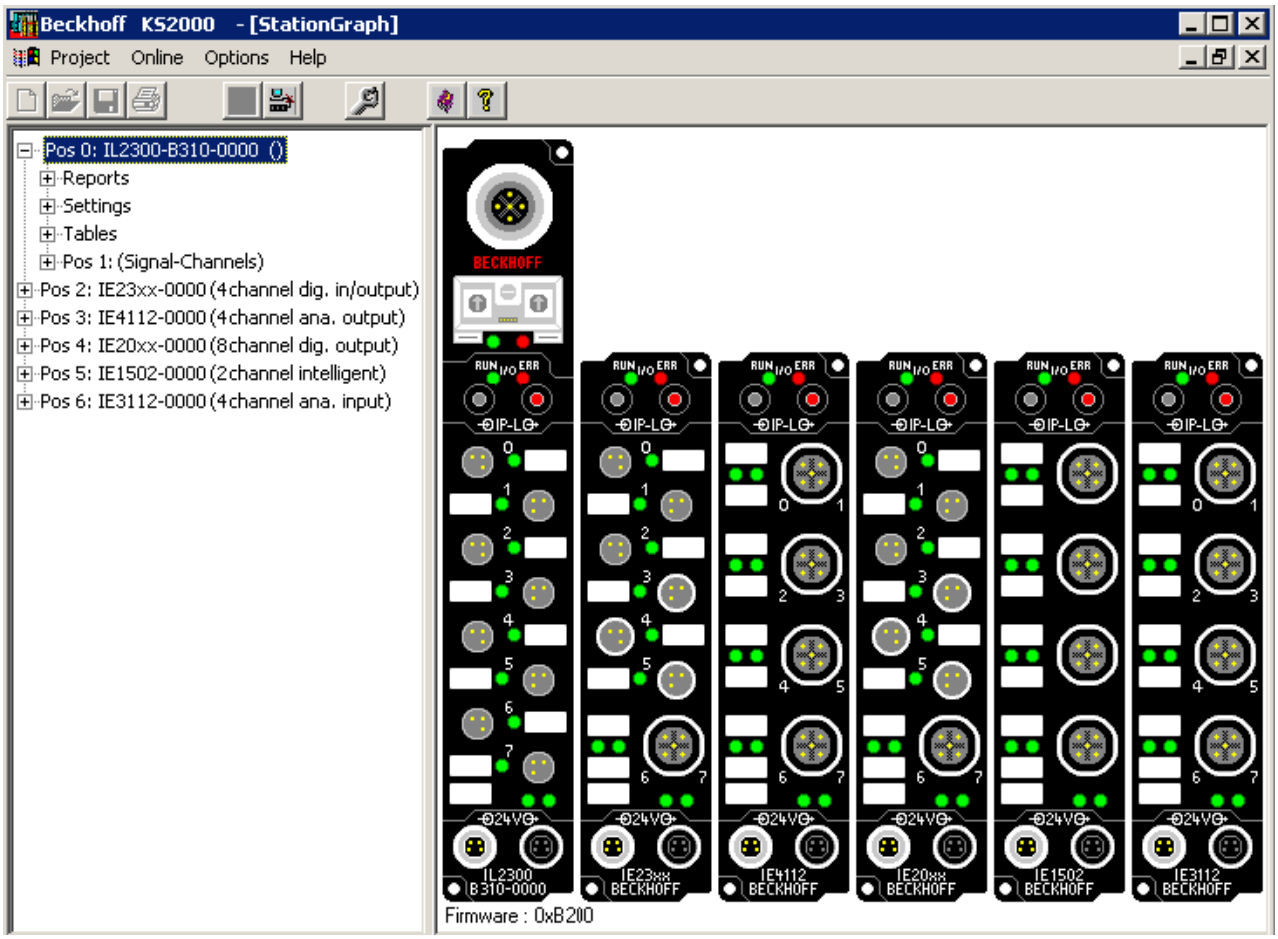
- bad configured IP-Link connectors
- IP-Link cable with higher dampening, e.g. because of a sharp curve
- contaminated sender LED (module before the faulty one)
- contaminated receiver

The internal IP-Link error counter [▶ 43] of the Coupler Box can be read with the KS2000 software.

7.4 Check of the IP-Link connection

A correct assembled IP-Link cable will assure an error free transmission.

An additional testing of the transmission quality and error diagnostics is possible with the KS2000 configuration software.



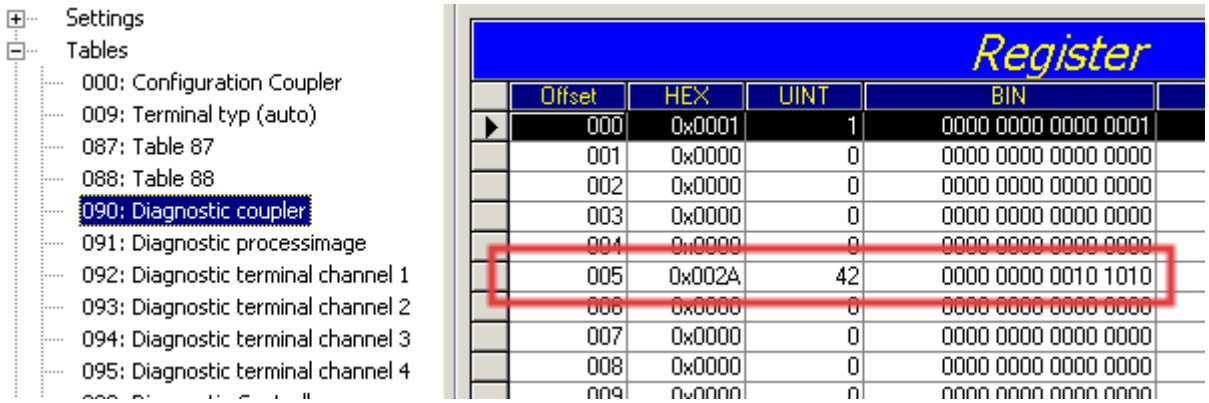
For this test, the fieldbus master (e.g. a PROFIBUS PC Card) should be on the bus and it should transmit data cyclical. Another way to generate cyclic data is, to switch the coupler to *free running* via the KS2000 software.

The result should be, that the I/O RUN LED flashes in a bright green. This shows, that a data exchange with the connected extension boxes takes place. A red blinking I/O ERR LED shows faulty IP-Link telegrams. These faulty telegrams will be repeated automatically like in any other fieldbus system. This way a transmission of the data is guaranteed.

Error counter

Table 90, offset 005 shows possible IP-Link errors. Sporadic appearing errors do not mean any problem for the communication, as long as they do not reach a critical limit.

This error counter is only reset by the Power ON/OFF.



If lots of errors occur in a very short time, this will be interpreted as a heavy disturbance of the communication and the coupler box will report this error. This can be seen at offset 006 and 007. Both values will show a value > 200 and the I/O ERR LEDs of the coupler box will blink the according error code.

Note

The KS2000 Configuration Software communicates with the Coupler Box via the serial channel. The content of the registers will not be refreshed automatically.

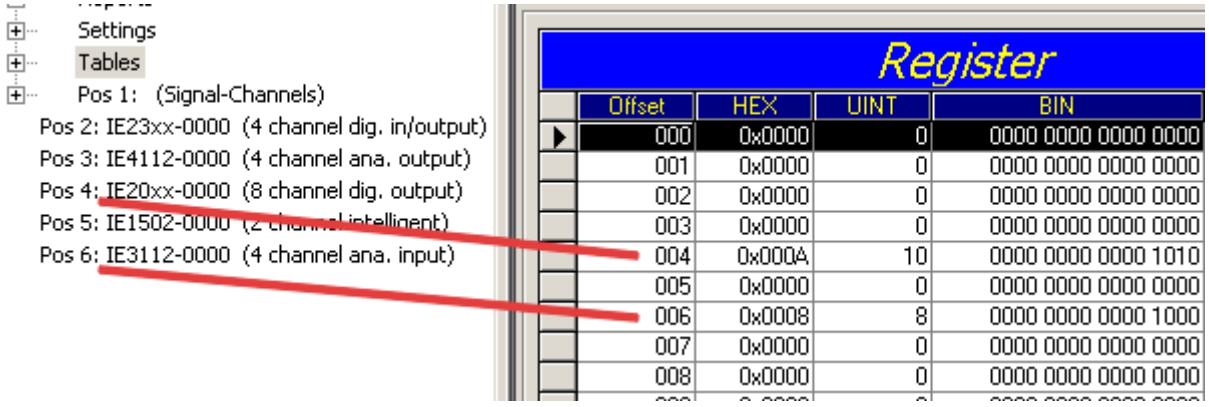
Position of the error

In case of an IP-Link error, the Coupler Box tries to read the error location from the register of the Extension Box. If the fiber optic ring is interrupted or the communication is heavily disturbed, this is not possible. Only the position of the last functioning Extension Box before the receiver of the Coupler Box can be recognized. The box will then flash this error code via the I/O ERR LED.

If the communication via IP-Link is still running, table 87 shows the error counter of each Extension Box.

The offset register corresponds to the position of the Extension Box in the KS2000 tree (left side of graphic). This example shows errors at offset 004 and 006.

In the "real" world the faulty IP-Link telegram was reported from the IE20xx and the IE3112, that means the problem has to looked for before these modules.



The error can be up to:

- the sending module
- the receiving module
- the IP-Link cable
- the connectors

If there is an error in table 90 and none in table 87, the faulty transmission is between the last Extension Box and the Coupler Box.

In most cases the transmission errors can be traced back to bad configured IP-Link connectors or a too high attenuation of the cable due to sharp bending.

The values of table 87 directly come from the extension boxes. In case of an IP-Link interruption these values will be set to zero and only table 90 can be used.

Note

If you want to operate a Coupler Box (e.g. IL2300-Bxxx, IL2301-Bxxx or IL2302-Bxxx) totally without Extension Box Modules (IExxxx), you have to connect the send and receive socket of this Coupler Box directly by using an IP Link Cable! For this the IP Link Jumper ZK1020-0101-1000 fits perfect.

8 Accessories

8.1 Fieldbus Box accessories

The necessary accessories for the Fieldbus Box Modules are also available from Beckhoff in protection class IP67. You may get an overview from the Beckhoff catalog or from our internet pages (http://www.beckhoff.com).

Fieldbus Accessories

- Pre-assembled cable
- Plug
- Distributor

Power supply

- Pre-assembled cable
- Plug
- Distributor

Sensor power supply

- Pre-assembled cable
- Plug
- Distributor

IP-Link

- Pre-assembled cable
- Plug

8.2 Power cables

Ordering data

Order designation	Power lead	Screw-in connector	Contacts	Cross-section	Length
ZK2020-3200-0020	Straight socket, open end	M8	4-pin	0.34 mm^2	2.00 m
ZK2020-3200-0050					5.00 m
ZK2020-3200-0100					10.00 m
ZK2020-3400-0020	Angled socket, open end				2.00 m
ZK2020-3400-0050					5.00 m
ZK2020-3400-0100					10.00 m
ZK2020-3132-0001	Straight socket, straight socket				0.15 m
ZK2020-3132-0005					0.50 m
ZK2020-3132-0010					1.00 m
ZK2020-3132-0020					2.00 m
ZK2020-3132-0050					5.00 m
ZK2020-3334-0001	Angled socket, angled socket				0.15 m
ZK2020-3334-0005					0.50 m
ZK2020-3334-0010					1.00 m
ZK2020-3334-0020					2.00 m
ZK2020-3334-0050					5.00 m

Further available power cables may be found in the Beckhoff catalog or on our internet pages (http://www.beckhoff.com).

Technical data

Technical data	
Rated voltage according to IEC60 664-1	60 V_{AC} / 75 V_{DC}
Contamination level according to IEC 60 664-1	3/2
Insulation resistance IEC 60 512-2	>10^9W
Current carrying capacity according to IEC 60512-3	4 A
Volume resistance according to IEC 60512-2	< 5 mW
Protection class according to IEC 60529	IP65/66/67, when screwed together
Ambient temperature	-30°C to +80°C

9 Appendix

9.1 General operating conditions

Protection degrees (IP-Code)

The standard IEC 60529 (DIN EN 60529) defines the degrees of protection in different classes.

1. Number: dust protection and touch guard	Definition
0	Non-protected
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of Ø50 mm
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of Ø12,5 mm.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects Ø2,5 mm.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects Ø1 mm.
5	Protected against access to hazardous parts with a wire. Dust-protected. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire. Dust-tight. No intrusion of dust.

2. Number: water* protection	Definition
0	Non-protected
1	Protected against water drops
2	Protected against water drops when enclosure tilted up to 15°.
3	Protected against spraying water. Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water. Water splashed against the disclosure from any direction shall have no harmful effects
5	Protected against water jets
6	Protected against powerful water jets
7	Protected against the effects of temporary immersion in water. Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water for 30 min. in 1 m depth.

*) These protection classes define only protection against water!

Chemical Resistance

The Resistance relates to the Housing of the Fieldbus Box and the used metal parts.

Character	Resistance
Steam	at temperatures >100°C: not resistant
Sodium base liquor (ph-Value > 12)	at room temperature: resistant > 40°C: not resistant
Acetic acid	not resistant
Argon (technical clean)	resistant

Key

resistant: Lifetime several months
non inherently resistant: Lifetime several weeks
not resistant: Lifetime several hours resp. early decomposition

9.2 Approvals

Approvals

UL E172151

Conformity mark

CE

Type of protection

IP65/66/67 in accordance with EN60529

9.3 Test standards for device testing

EMC

Resistance: EN 61000-6-2

Emission: EN 61000-6-4

Resistance to Vibration

EN 60068-2-2 Vibration test, Amplitude 2 g (Standard 1 g)

EN 60068-2-27 Shock Test, Shock count 1000 (Standard 2)

9.4 Support and Service

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

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages: https://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

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

Hotline:	+49 5246 963 157
Fax:	+49 5246 963 9157
e-mail:	support@beckhoff.com

Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

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