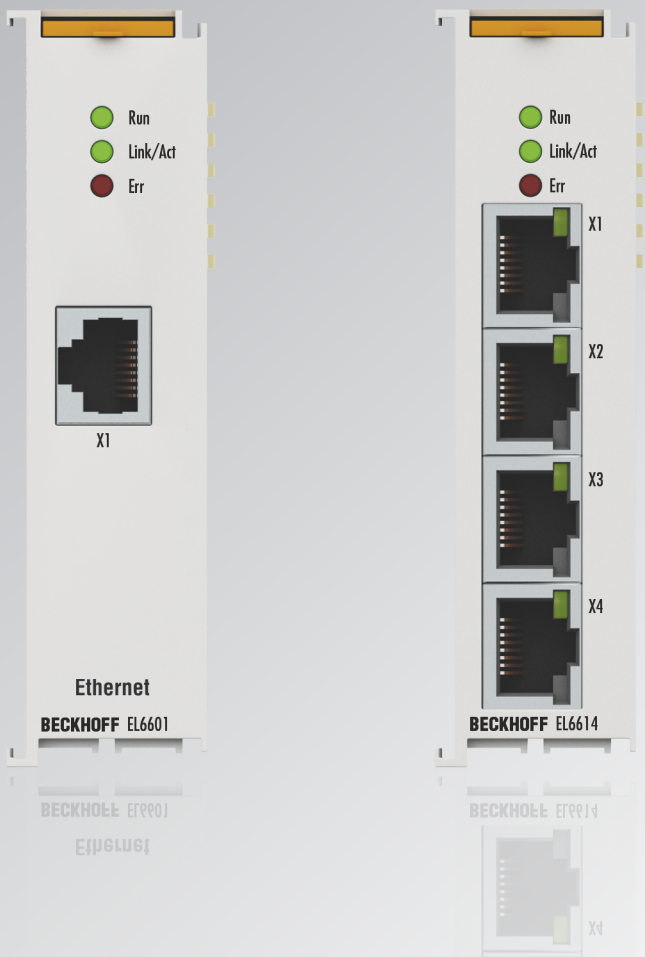
BECKHOFF New Automation Technology

Documentation | EN

EL6601, EL6614

EtherCAT Terminals, communication interface, Ethernet switch port



2026-10-06 | Version: 5.0.0

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1 Foreword

1.1 Product overview Ethernet Switchport Terminals

This documentation covers the following products:

EL6601 [▶ 11]	EtherCAT Terminal, 1-port communication interface, Ethernet switch port
EL6614 [▶ 11]	EtherCAT Terminal, 4-port communication interface, Ethernet switch port

Use the tabular product overview or the product finder to find the right product for your application (https://www.beckhoff.com/IO).

1.2 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.
The qualified personnel is obliged to always use the currently valid documentation.

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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1.3 Guide through documentation

NOTICE



Further components of documentation

This documentation describes device-specific content. It is part of the modular documentation concept for Beckhoff I/O components. For the use and safe operation of the devices described in this documentation, additional cross-product descriptions are required, which can be found in the following table.

Title	Description
EtherCAT System Documentation (PDF)	• System overview • EtherCAT basics • Cable redundancy • Hot Connect • EtherCAT devices configuration
Explosion Protection for Terminal Systems (PDF)	Notes on the use of the Beckhoff terminal systems in hazardous areas according to ATEX and IECEx
Control Drawing I/O, CX, CPX (PDF)	Connection diagrams and Ex markings (conform to cFMus)
Infrastructure for EtherCAT/Ethernet (PDF)	Technical recommendations and notes for design, implementation and testing
Software Declarations I/O (PDF)	Open source software declarations for Beckhoff I/O components

The documentations can be viewed at and downloaded from the Beckhoff website (www.beckhoff.com) via:

- the “Documentation and Download” area of the respective product page,
- the Download finder,
- the Beckhoff Information System.

If you have any suggestions or proposals for our documentation, please send us an e-mail stating the documentation title and version number to: documentation@beckhoff.com

1.4 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our https://www.beckhoff.com/secguide.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at https://www.beckhoff.com/secinfo.

1.5 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.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

Information on handling the product



This information includes, for example:
recommendations for action, assistance or further information on the product.

1.6 Documentation issue status

Version	Comment
5.0.0	• Update revision status • Structural update
4.9.0	• Update chapter "Technical data" • Update chapter "EL66xx and Beckhoff network variables" • Update chapter "Explosion protection" • Update chapter "Installation positions" • Structural update
4.8.0	• Chapter "Recommended mounting rail" removed • Update chapter "Technical data" • Update revision status
4.7	• Chapter "Technical data" • Update revision status • Structural update
4.6	• Chapter “Notes on information security” amended • Structural update
4.5.	• Update chapter "Technical data" • Update chapter "Version identification of EtherCAT devices" • Structural update • Update notes • Update revision status • Chapter Disposal added
4.4	• Update chapter "System examples" • Structure update
4.3	• Update chapter "UL notes" • Update chapter "Technical data" • Update chapter "Firmware compatibility" • Structure update
4.2	• Update chapter "Object description" • Structure update • Revision status updated
4.1	• Note added to the chapter "Address assignment" • Structure update • Revision status updated
4.0	• Migration • Structure update • Revision status updated
0.1 – 3.4	• archived

2 Product description

2.1 Introduction

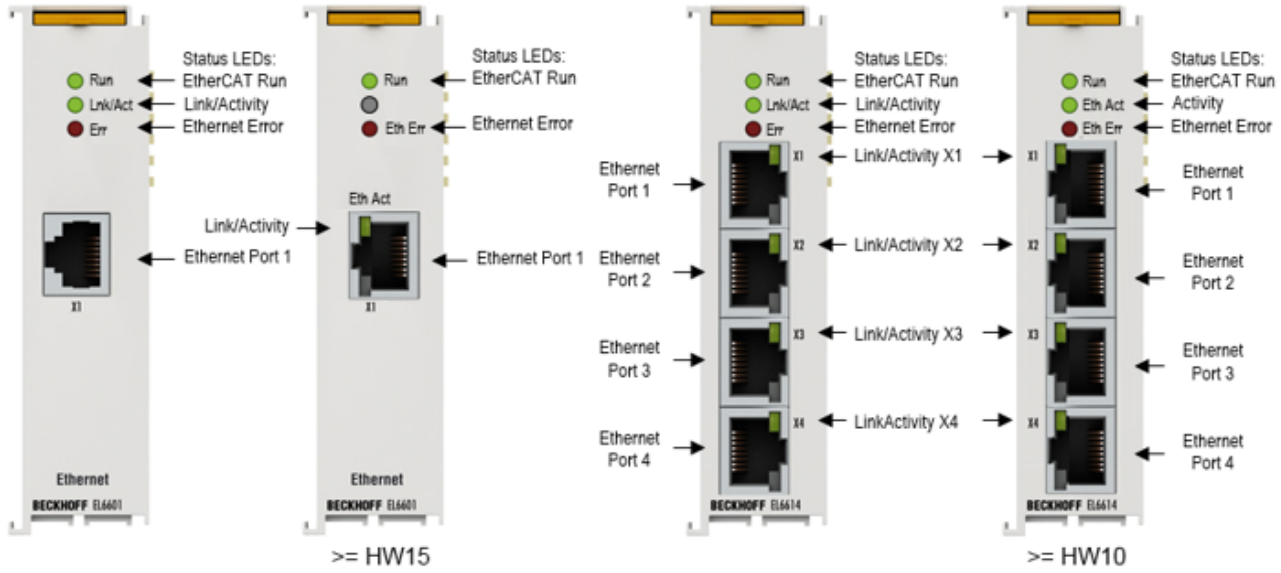


Fig. 1: EL6601, EL6614

EtherCAT Terminals, communication interface, Ethernet switch port

The switch terminals for Ethernet are used for decentralized connection of any Ethernet devices to the EtherCAT Terminal network. The Ethernet communication of the connected devices is forwarded by the EtherCAT system in a fully transparent and collision-free manner.

The EL6614 4-port Ethernet switch terminal forwards the incoming frames from the ports specifically to the target ports. In full duplex mode, it thus enables collision-free communication of the connected devices with each other.

Any number of EL6601/EL6614 devices can be used simultaneously and at any position in the EtherCAT Terminal network. No configuration is required. In conjunction with the network port at the EtherCAT master the EL6601/EL6614 devices operate like a virtual switch whose ports are distributed in the field. The EtherCAT fieldbus is the backbone of this switch.

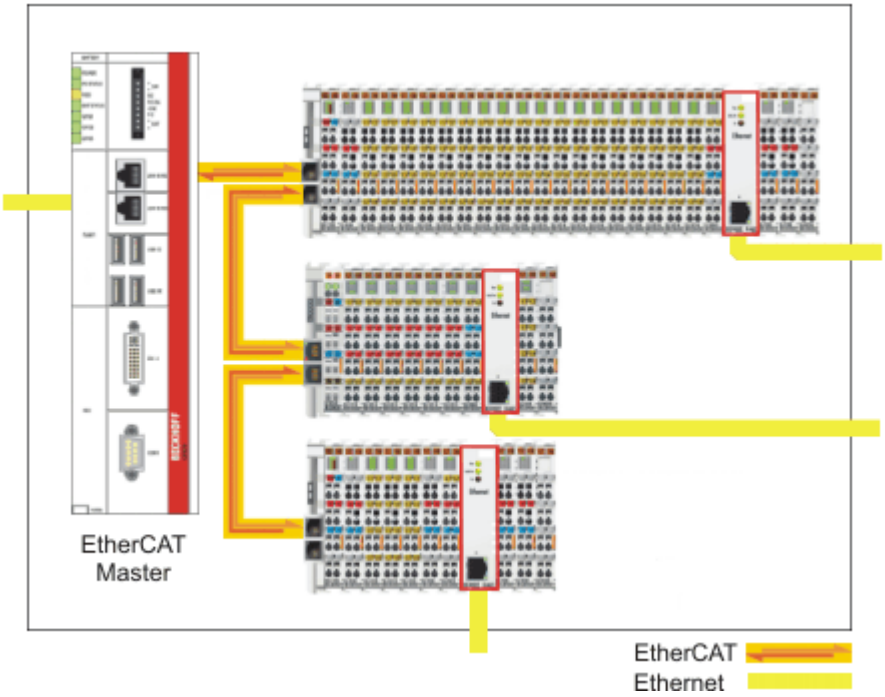


Fig. 2: EL6601 as a virtual, field-distributed switch

Further benefits underline the particular suitability for the application in industrial environments:

- Compact design in EtherCAT Terminal housing
- 10/100 MBaud, half or full duplex, with automatic baud rate detection
- Autocrossing (automatic detection of cross-over cables)

LED

LED	Color	Meaning	
RUN	green	These LEDs indicate the terminal's operating state:	
		off	State of the EtherCAT State Machine: **INIT** = initialization of the terminal or **BOOTSTRAP** = function for terminal firmware updates
		flashing	State of the EtherCAT State Machine: **PREOP** = function for mailbox communication and different default settings set
		Single flash	State of the EtherCAT State Machine: **SAFEOP** = verification of the Sync Manager channels and the distributed clocks. Outputs remain in safe state
		on	State of the EtherCAT State Machine: **OP** = normal operating state; mailbox and process data communication is possible
Link / Act	green	Connection / data exchange fieldbus	
*Link/Act X1 - X4	green	Connection / data exchange Ethernet port X1- X4	
Eth Err	red	Error message EtherCAT (see Diagnostics [▶ 15])	
* only EL6614			

Connections

1 x RJ45 with 10BASE-T/100BASE-TX Ethernet (EL6601)
4 x RJ45 with 10BASE-T/100BASE-TX Ethernet (EL6614)

2.2 Technical data

Technical data	EL6601	EL6614
Bus system	all Ethernet (IEEE 802.3) based protocols	
Number of Ethernet ports	1	4
Ethernet interface	10BASE-T/100BASE-TX Ethernet with 1 x RJ45	10BASE-T/100BASE-TX Ethernet with 4 x RJ45
Cable length	up to 100 m twisted pair	
Data transfer rate	10/100 Mbit/s, IEEE 802.3u auto negotiation, half or full duplex at 10 and 100 Mbit/s possible, automatic settings	
Network variables	EL6601 from Firmware 07, EL6614 from Firmware 03: max 32 publishers with total of max. 1024 bytes total data [▶ 23] max 32 subscribers with total of max. 1024 bytes total data [▶ 23]	
Distributed clocks	no	
Diagnostics	Status-LED, CoE data via ADS	
Power supply	via the E-bus	
Current consumption via E-bus	typ. 260 mA	typ. 310 mA
Electrical isolation	500 V (E-bus/Ethernet)	
Bit width in process image	-	
Configuration	TwinCAT System Manager/EtherCAT master	
Weight	approx. 75 g	approx. 95 g
Permissible ambient temperature range during operation	-25 °C ... +60 °C	Horizontal installation position: -25 °C ... +60 °C *All other installation positions:* -25 °C ... +45 °C, see note [▶ 45]
Permissible ambient temperature range during storage	-40 °C ... +85 °C	-40 °C ... +85 °C
Permissible relative air humidity	95 %, no condensation	
Dimensions (W x H x D)	approx. 26 mm x 100 mm x 52 mm (width aligned: 23 mm)	
Installation	on 35 mm mounting rail, conforms to EN 60715	
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27	
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4	
Protection rating	IP20	
Installation position	variable	see note [▶ 45]
Approvals / markings*	CE, cULus [▶ 39], UKCA, EAC ATEX [▶ 35], IECEx [▶ 36], cFMus [▶ 37], CCC	CE, cULus [▶ 39], UKCA, EAC ATEX [▶ 35], IECEx [▶ 36], CCC

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

Ex markings

Standard	Marking
ATEX	II 3 G Ex ec IIC T4 Gc
IECEx	Ex ec IIC T4 Gc
cFMus	Class I, Division 2, Groups A, B, C, D Class I, Zone 2, AEx/Ex ec IIC T4 Gc

2.3 Basic function principles

The EL66xx Ethernet Switchport terminals have 2 different operating modes, ideal for the tasks required for Ethernet connectivity. The two operating modes, which can be active simultaneously, provide both the real-time-critical transmission and reception of configured network variables as well as the transport of standard Ethernet traffic, which, while it is not real-time-critical, does involve large data flows using, for instance, the IP protocol:

- **Real-time data exchange**: Publisher/subscriber, Beckhoff network variables, EtherCAT Automation Protocol
  The TwinCAT configuration file *.tsm configures an EL66xx when EtherCAT starts up with CoE parameters in such a way that it
  - transmits, as the publisher, data delivered through the cyclical data transfer in the real-time cycle.
  - transmits subscribers received in the same way to the EtherCAT Master over the cyclical EtherCAT data exchange.
    Cyclical data exchange with the EL66xx is configured in the PDO settings of the EL66xx when EtherCAT starts up, and cannot be changed online.
- **Non-real-time data exchange**
  In parallel with this, the EL66xx can transfer Ethernet frames through the acyclic mailbox exchange (EoE = Ethernet over EtherCAT) between the terminal and the EtherCAT Master/TwinCAT. This data exchange is optimized for throughput, and may involve automatic fragmentation - by default, all telegrams that are not transferred in the PDO context are transported through the acyclic channel by means of EoE.

The flow of data in the EL66xx can be represented schematically as follows:

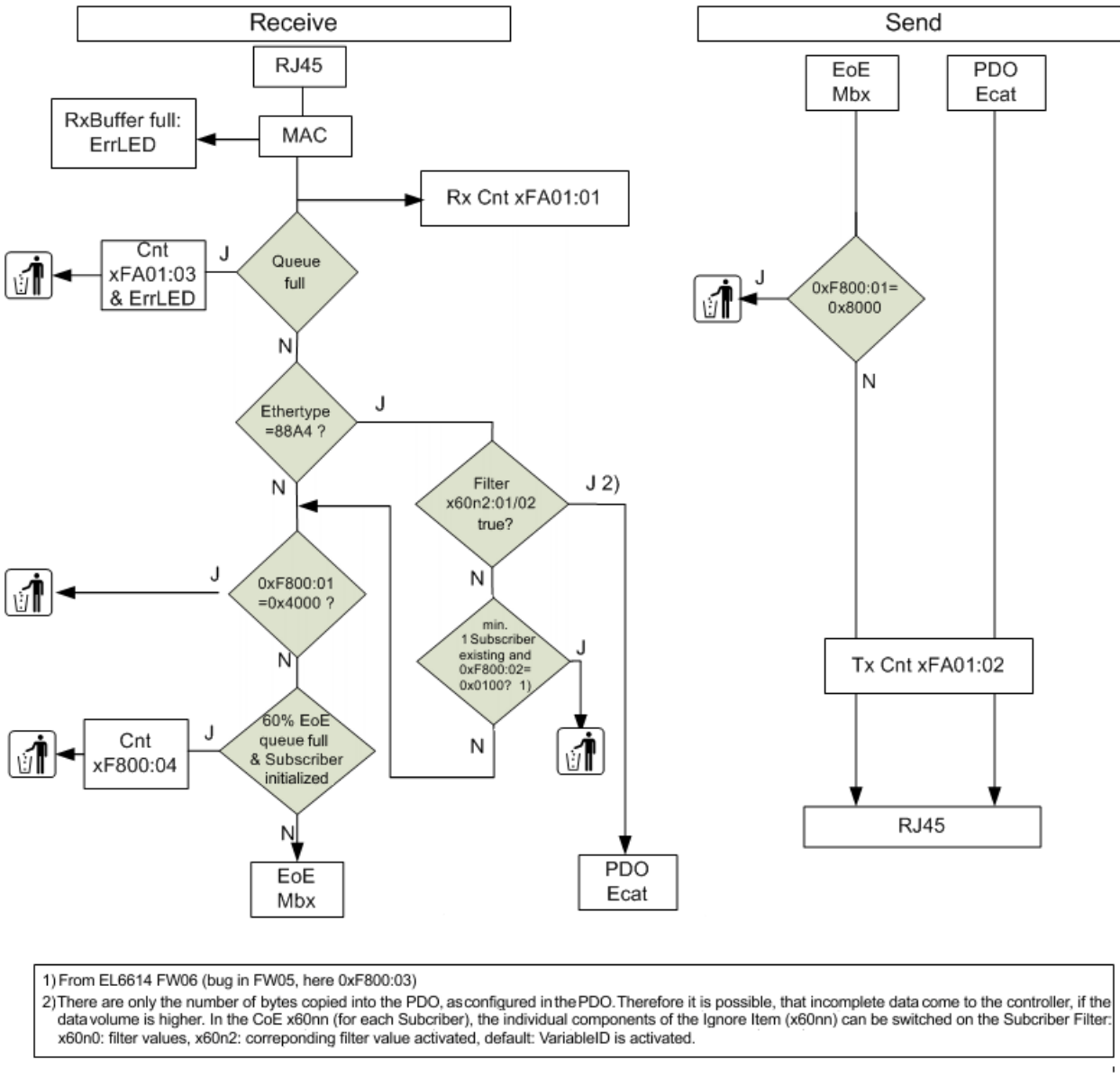


Fig. 3: EL66xx data diagram

The EL6601/EL6614 cannot transport an *EtherNet Industrial Protocol* (*EtherNet/IP*).

Diagnostics

Online diagnostics

The following objects are available for initial diagnostic in the CoE directory:

- 0xFA01, subindex 01: Frame Counter Rx (incoming to RJ45 socket).
- 0xFA01, subindex 02: Frame Counter Tx (outgoing from RJ45 socket).

The values can be read from the controller using PLC function blocks (FB_EcCoeSdoRead in TcEtherCAT.lib).

This and further diagnostic information from the CoE of the EL66xx are accessible via https://infosys.beckhoff.com/content/1033/el6601_el6614/Resources/2349552907.zip .

Error LED

The red Error LED lights up 250 ms in the event of

- Ethernet Receive Overrun --> in general, more Ethernet frames are received at the RJ45 connection than can be transported away via EtherCAT (PDO or mailbox). The telegrams are discarded.
- Ethernet EoE Overrun --> more non-real-time frames are being received at the RJ45 connector than can be transported away by EtherCAT/EoE The data are discarded.
- Ethernet Frame Error

If the occurrence of an overrun causes data to be lost, higher protocol layers in an Ethernet network are responsible for repeating the transmission.

Overruns

The following measures can be used to counter overruns:

- activating the Subscriber Filter [▶ 23] in the EL66xx concerned
- Increasing/decelerating the cycle time of the publisher
- Suppressing temporarily publisher transmission or modulo in the System Manager
- Reducing/accelerating the EtherCAT cycle time of the subscriber, so that more data are fetched by the EL66xx

Cable redundancy

If the EL66xx is operated in a system with cable redundancy, please keep the following in mind:

- real-time operation with network variables is possible
- in the event of non-real-time operation with IP transfer the IP traffic is routed via the primary EtherCAT port. Therefore the Windows IP settings of this port are also used.



Fig. 4: IP settings EtherCAT port

If there is no longer a link to this port, from Windows under TwinCAT 2 or 3 there is also no IP communication to this port currently.
For this reason, do not let the Ethernet connection between the primary EtherCAT port and the first EtherCAT slave fail, since otherwise IP communication is no longer possible via the EL66xx.

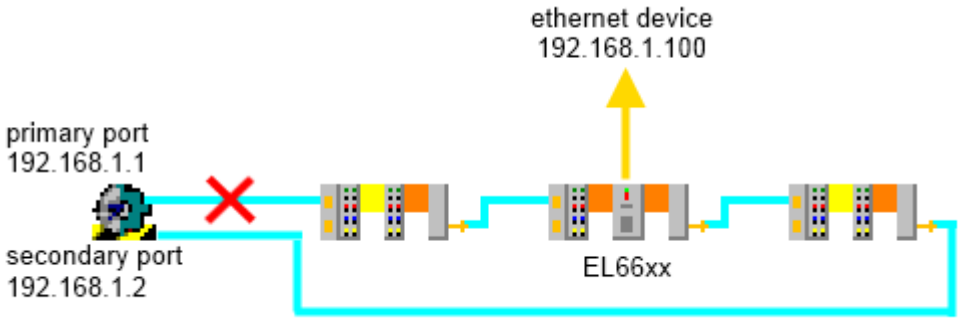


Fig. 5: Connection failure between primary EtherCAT port and 1st slave (X)

2.4 EL66xx - Non Realtime

EL66xx and Ethernet transport via mailbox communication

In addition to regular cyclical process data exchange an EtherCAT master offers a further mechanism for transporting data to an EtherCAT slave or reading data from it. This mechanism is used for one-time or dynamically alternating Data Exchange, such as e.g. the parameterization of an EtherCAT slave. Mailbox communication can also be used for transporting large data blocks acyclically on request from master or slave. This additional communication takes place between the cyclical process data frames (the conventional EtherCAT frames) on the EtherCAT bus.

Data throughput in mailbox communication

Since mailbox communication can only take place between the regular process data frames, data throughput with this communication method depends on the load of the EtherCAT bus. This means that the Ethernet throughput of the EL6601 also depends on the load of the underlying EtherCAT fieldbus.

The EoE method (Ethernet over EtherCAT) is used for the EL66xx. Dedicated settings are available for this in the System Manager.

Data throughput

The data throughput of the EL66xx in Ethernet frames or bytes/second depends on

- The EtherCAT cycle time on the fieldbus: The shorter the EtherCAT cycle used for the process data, the more acyclical mailbox queries can be completed. If several different EtherCAT cycle times are used in an EtherCAT strand the fastest cycle time is the relevant time
- The time between the process data frames that is available for mailbox communication: The longer the Ethernet line is free for acyclical mailbox communication, the higher the Ethernet data throughput of the EL6601.
- The mailbox size [▶ 19] in bytes: The larger the mailbox, the more Ethernet frames the EL6601 can send to the EtherCAT master or received from it simultaneously.
- The number of terminals in the EtherCAT system that use mailbox communication at the same time.
- The EoE settings [▶ 21] in the TwinCAT System Manager, see the EoE section.

The following values were determined as samples (TwinCAT 2.10, 2.11)

- > 5 Mbit/s from the EL6601 to the Ethernet device
- > 2 Mbit/s from the Ethernet device to the EL6601

with an EtherCAT cycle time of 100 µs and a mailbox size of 1024 bytes.

Tips for shortening the response times

We recommend the following procedure to shorten the response times in your application (e.g. to ping requests): Significantly lower the EtherCAT cycle time currently being used or insert a new task with a lower cycle time, e.g.: 500 µs if up to this point you have been using 2.5 ms EtherCAT cycle. Important: This task must access genuine IO process data from the EtherCAT slaves and be recognizable under Device EtherCAT -> Tab EtherCAT, see Fig. *Real frame structure from the TwinCAT System Manager*

Fra...	Cmd	Addr	Len	WC	Sync Unit	Cycle (ms)	Utilization (...	Size / Duration ...
0	LRD	0x00010000	1	1	<default>	0.500		
0	LRD	0x00080000	1	1		0.500	1.34	42 / 6.72
1	LRD	0x00020000	3	12	<default>	2.500		
1	BRD	0x0000 0x0130	2	15		2.500	0.27	45 / 6.72

Fig. 6: Real frame structure from the TwinCAT System Manager

Note regarding the specified values

These values are typical values without warranty. Throughput rates may differ in different applications depending on boundary conditions.

Address assignment

From FW03 onwards, the EL6601/6614 can also assign IP addresses to connected devices and works as a DHCP or BOOTP server for *one* device. The following settings are required in the System Manager (EL66xx --> Advanced Settings --> Mailbox --> EoE):

- Setting "Switch Port", Fig. *Default setting of the EL66xx as switch port without IP address assignment.* The EL66xx works like a normal switch and passes Ethernet frames transparently through to TwinCAT/ Windows
- Setting for “IP Port”, Fig. *From FW03*: *Settings for dynamically assigned IP address* The EL66xx works with address assignment to *one* connected Ethernet device. A DHCP or a BootP Client must be activated in the device (refer to the network adaptor settings in the operating system). The EL66xx responds to the device’s corresponding DHCP/BootP query by assigning the specified IP address/subnet mask to the device. In the DHCP method this address is regularly queried by the client and assigned to the server/EL66xx.

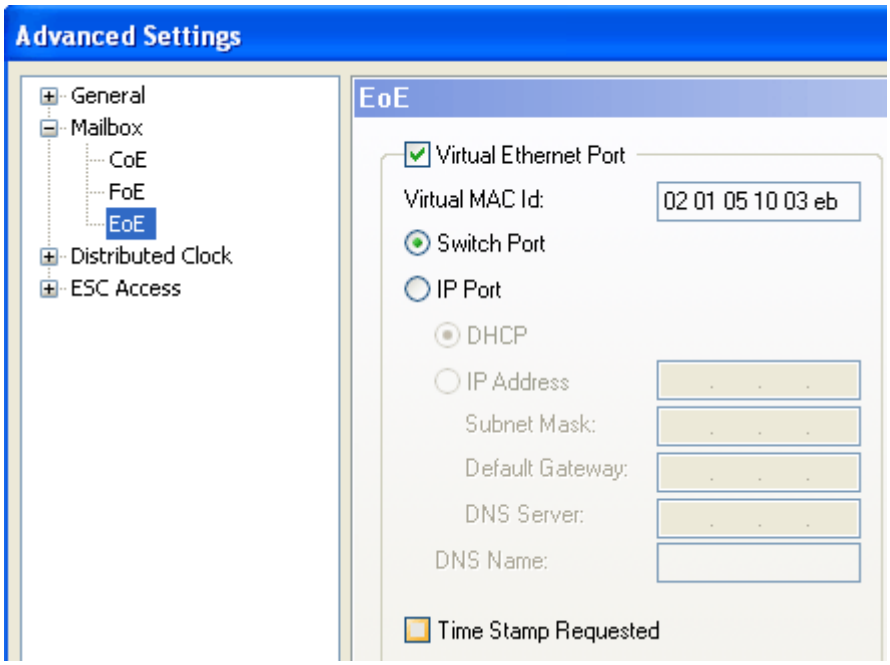


Fig. 7: Default setting of the EL66xx as switch port without IP address assignment

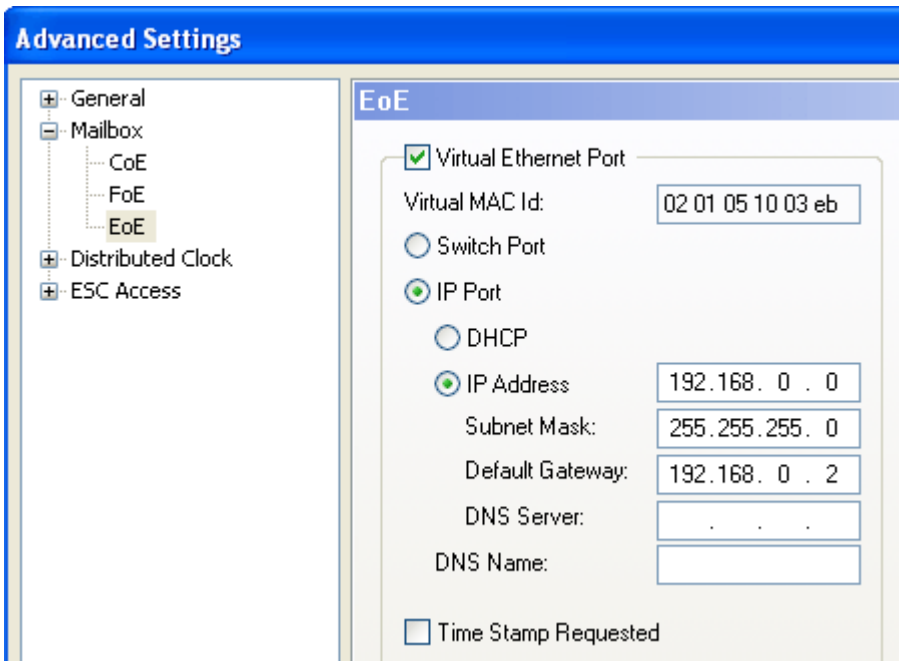


Fig. 8: From FW03: Settings for dynamically assigned IP address

Please note:

- The “DHCP” checkbox must not be used - the “IP address” checkbox activates the DHCP/BootP function in the EL66xx.
- The Gateway, Mask and Server settings are likewise communicated to the client/the device
- Only *one* address can be assigned, i.e. no switch with connected subscribers may follow.
- the address range must be identical to that of the EtherCAT adapter.
- DHCP Server Identifier: several DHCP Servers need a ServerID in the response telegram.
  Solution for the EL6601 from firmware 15: the value 0x1000 has to be entered in the object 0xF800:01.
  If a Default Gateway is registered in the EL6601, it is used as a DHCP Server Identifier.

Mailbox settings

The mailbox size can be modified in the Beckhoff TwinCAT System Manager:

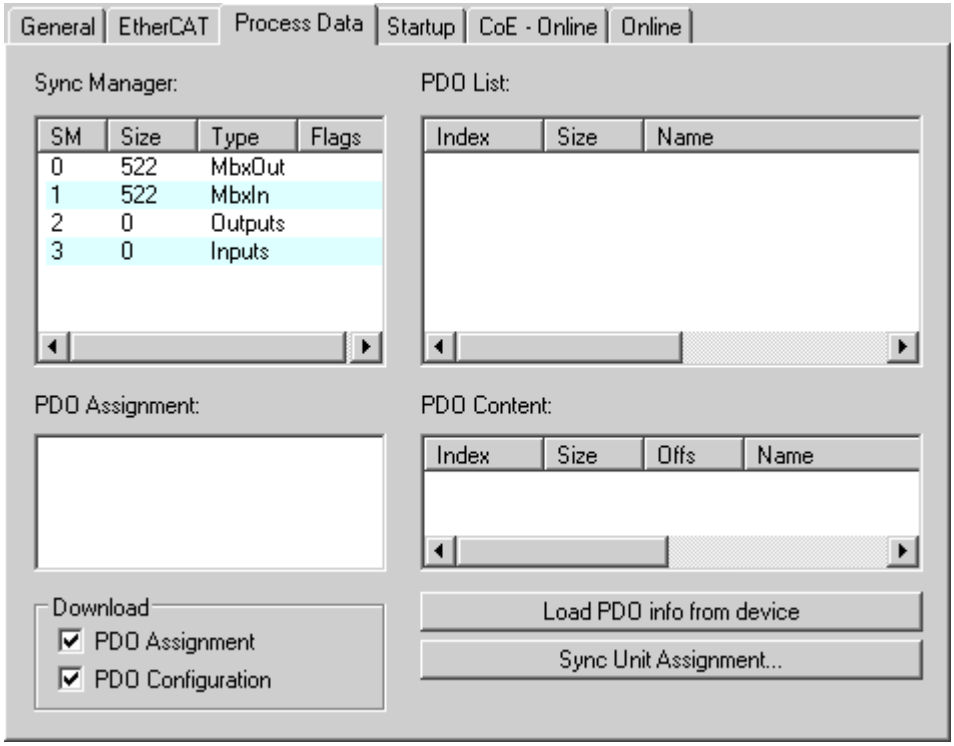


Fig. 9: Default mailbox settings

By default the mailbox is set to 522 Byte Input and 522 Byte Output (20 A_{hex}), see Fig. *Default Settings of the Mailbox*, Entries for SyncManager 0 and 1. To increase the data throughput the size of the mailbox can be increased to 1024 Byte, see Fig. *Increasing the Size of the Mailbox*.

Default mailbox size

As of Revision EL66xx-0000-0018 the mailbox is already set to 1024 Byte by default in both directions, therefore it cannot be further enlarged.
The previous statements apply for terminals with Revision -0000, -0016 or -0017.

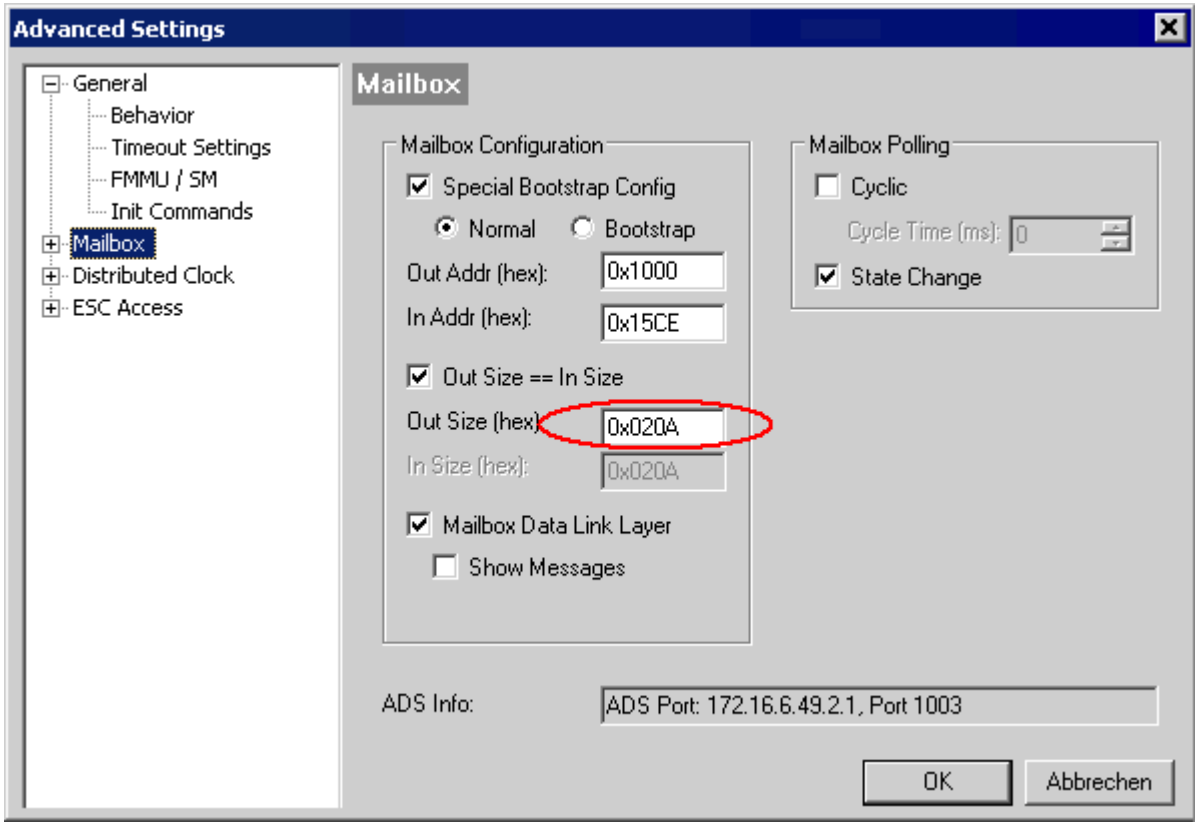


Fig. 10: Increasing the mailbox

Under EL6601 -> EtherCAT tab -> "*Advanced Settings…*" -> "*Mailbox*" the "Out Size" can be set to hexadecimal values between $42_{dec}/2A_{hex}$ and $1024_{dec}/400_{hex}$ bytes. Ethernet frames that are larger than the EL6601 mailbox are fragmented by the EL6601 or the EtherCAT master and reassembled after passing through the EtherCAT system.

Virtual switch setting

The EL66xx devices in the TwinCAT system generally appear as virtual switches, with the EtherCAT system as the "backbone".

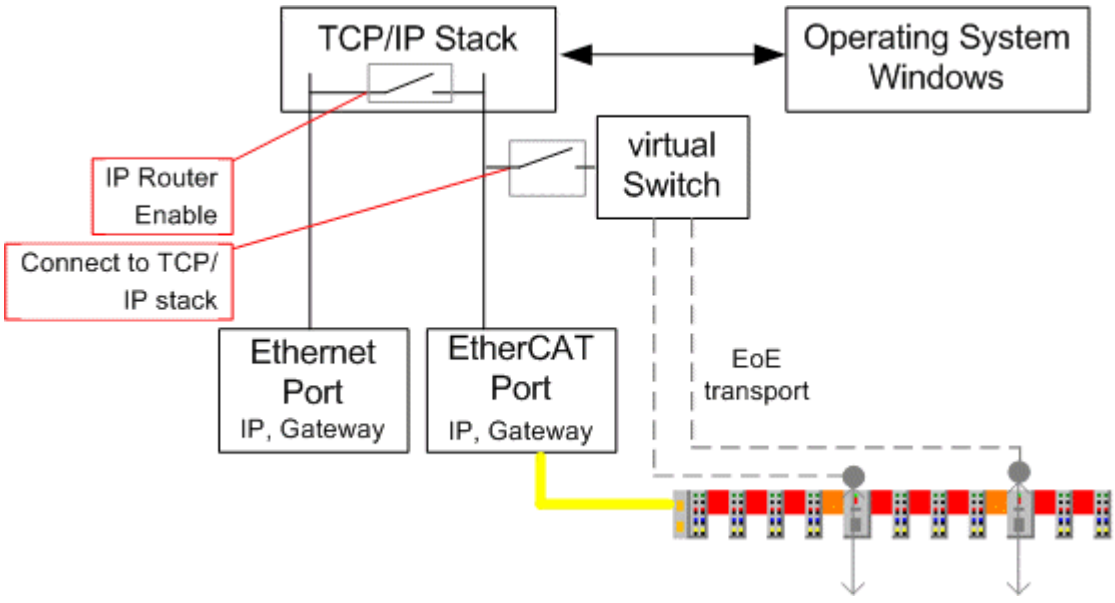


Fig. 11: TwinCAT 2.11, virtual TwinCAT switch

The required settings will be found under TwinCAT | EtherCAT device | Advanced settings

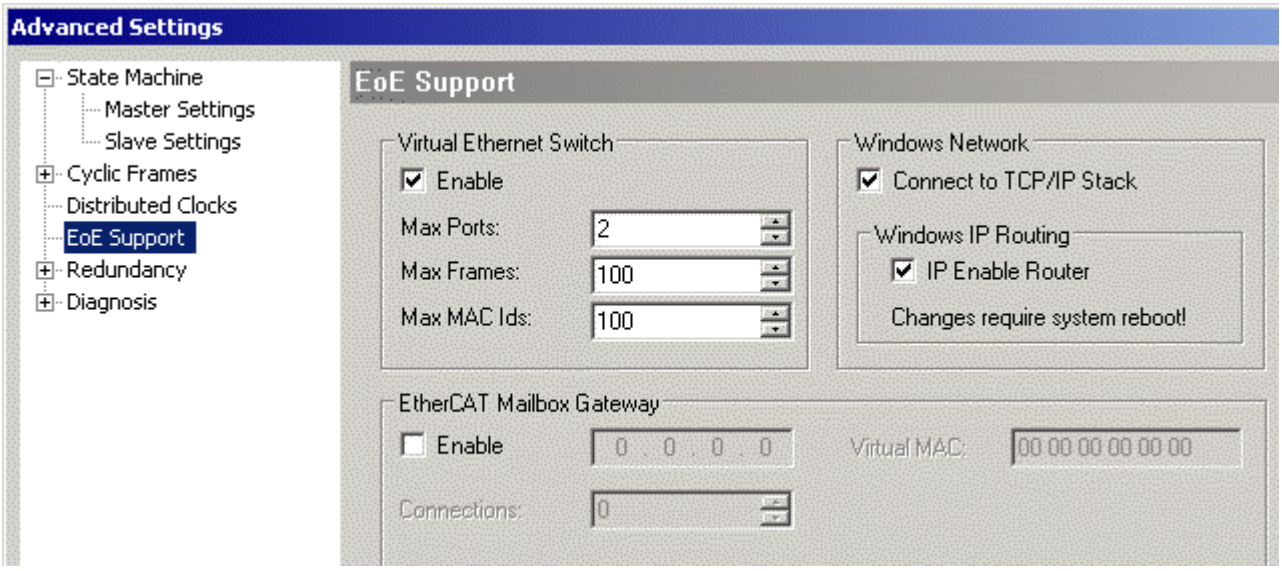


Fig. 12: TwinCAT 2.11, virtual TwinCAT switch

Notes

- If a large number of EL66xx devices are used along the EtherCAT strand it may be helpful to increase the value of *MaxFrames*
- If the EL66xx is used exclusively to transfer network variables, ConnectToTcpStack should be deactivated
- IP-routing is active by default. This can also be checked by entering "ipconfig /all" on the command line (Windows)

2.5 EL66xx and Beckhoff network variables

2.5.1 Explanation network variables

Network variables

The EL66xx support sending/receiving network variables. This applies for the EL6601 as of Firmware 07, for the EL6614 as of Firmware 03.

A maximum of 32 for each, publishers and subscriber, are permitted per EL66xx.

Hardware replacement

If the system was designed with a previous EL6601 version (EL6601-0000-0000), this can be replaced with versions from EL6601-0000-0017 without problem. If the system was designed for version EL6601-0000-0017 or higher, replacement with a previous version is not possible due to unsupported network variables.

Network variables are specially configured Ethernet frames that enable Beckhoff devices to communicate with each other in real-time via Ethernet. Such device can send (publisher) or receive (subscriber) messages.
An Ethernet frame is sent for each publisher (Ethernet-based). A maximum of 1500 bytes of data can thus be sent per publisher. Within a publisher/subscriber several variables (publisher and subscriber variables) can be created.
Generally, several publishers/subscribers can be configured for each sending/receiving device (e.g. IPC or EL6601).

Based on the sample of a data sender the hierarchy therefore consists of

- the sending device with a minimum of one Ethernet interface: IPC, CX, FC9011, EL6601, ...
  - FastEthernet/100 MBit and 1 GBit are supported
  - This Ethernet interface is configured in the local TwinCAT System Manager as a real-time Ethernet device
- 1..n configured publishers - each publisher is sent as an independent Ethernet frame and can therefore contain a maximum of 1500 bytes
- 1..n publisher variables contained therein for linking with the task/PLC
  - For each publisher variable the user data and diagnostic data [▶ 23] are transferred

On the receiver side the configuration is mirrored.

The EL66xx can also process publishers and subscribers which are frame data

- Max. 32 publishers and/or subscribers
- For each transmit direction (publisher or subscriber) the following maxima apply:
  - all publishers: 1024 bytes total data [▶ 23]
  - all subscribers: 1024 bytes total data [▶ 23]

Update of the terminal

The values above apply for a EL6601/6614-0000-0018. Version -0017 only supports a maximum of 300 bytes per publisher/subscriber. If a -0017 terminal is used, the values specified above can be achieved by an update to revision -0018. Please contact our technical support.

With appropriate EtherCAT cycle time and depending on the scale and number of the publishers/subscribers configured in the EL66xx, real-time cycle times down to 500 µs or below are possible.

Typical throughput values for EL6601, FW08, Rev. EL6601-0000-0018 are

- 1 publisher with 1000 bytes, 1 subscriber with 1000 bytes, simultaneous bidirectional operation: 2 ms
- 1 publisher with 100 bytes, 1 subscriber with 100 bytes, simultaneous bidirectional operation: 300 µs

Both characteristic values were determined with this sample program (https://infosys.beckhoff.com/content/1033/el6601_el6614/Resources/17350688139.zip) . TwinCAT from version 2.11 is required for the *.tsm System Manager file.

The EL6601 is used as a sample to explain configuration as publisher or subscriber for network variables. The dialogs under TwinCAT 2.10 and TwinCAT 2.11 here are slightly different.

The following descriptions of the dialogs of the EL6601 in the TwinCAT System Manager can be applied equally to the EL6614.

Note regarding the term total data

For each data direction the EL6601/EL6614 from Rev. -0018 can transfer a maximum of 1024 byte total data. The total data consist of the user data (e.g. a UDINT) and the diagnostic data for the EL66xx.

Formula for number of diagnostic data bytes

- Publisher direction: 2 + ((number of publishers) * 2)
- Subscriber direction: 2 + ((number of subscriber variables) * 4)

If the configured data quantity exceeds 1024 bytes, a corresponding message window appears when activation is attempted:

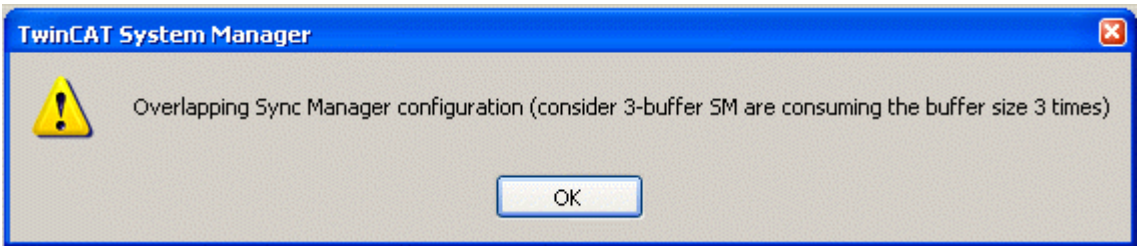


Fig. 13: Notice on exceeding configured data volume

Note regarding the amount of data

The EL66xx (EL6601 from FW07, EL6614 from FW03) has 8 kB of usable memory, which is allocated as follows by default:

Type	Usable extent	Operation mode	Used memory
Mailbox Out	1024 bytes		1024 bytes (fixed)
Mailbox In	1024 bytes		1024 bytes (fixed)
Publisher	1024 bytes	3-buffer mode	3072 bytes
Subscriber	1024 bytes	3-buffer mode	3072 bytes

If more Publisher or Subscriber data are required for an application, the SyncManagers can be adjusted by reducing the amount of data used by the other function. The mailbox cannot be modified.

2.5.2 Settings in the System Manager

Appearance of the variables

Depending on the platform used (PC or EL66xx), the publisher/subscriber will appear differently. A publisher/subscriber can be created:

- on a PC network interface, see Beckhoff network variables - Settings [▶ 64]
- on an EL66xx

The following sample illustrates the setup for a publisher and a subscriber variable (each with a size of a 16-bit word) on an EL6601 under TwinCAT 2.10.

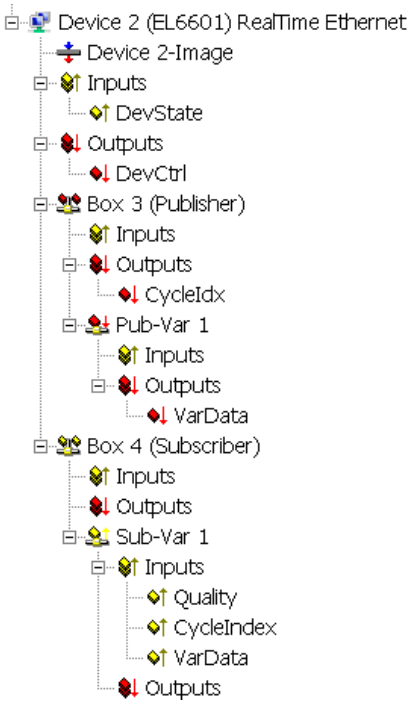


Fig. 14: Network variable sample configuration on an EL6601

Process data:

- "CycleIdx": must be served by the application in order to be evaluated on the subscriber side
- "CycleIndex": CycleIdx counterpart on the subscriber side.
- "VarData": the data to be sent.

2.5.3 Notes

- The RT statistics displays are not supported under TwinCAT for an EL66xx-RT device.
  Solution: As an alternative, corresponding CoE parameters can be read for diagnostic purposes.
- The publisher features of "OnChangeOnly" and "DataExchange (divider/modulo)" are not supported together with the EL66xx.
  Solution: [from FW08] Transmitting the configured publisher variables can be cyclically suppressed by DevCtrl.
- If a publisher is set up on an EL66xx, the publisher's CycleIndex [▶ 65] must be taken care of by the user. On a PC, on the other hand, they are incremented by TwinCAT.
- The following is recommended for diagnosis of a network variable connection:
  1. Monitor the link status in the "*DevState*" of the RT device (Device --> Inputs --> DevState). The expected state is *DevState* = 0.
  2. Monitor the *Quality* and *CycleIndex* in the subscriber.
- The link LED in the EL66xx only indicates the status of the cable connection, not that of any network variable connection that may exist.
- If the EL66xx is used exclusively to transfer network variables, ConnectToTcpStack [▶ 22] should be deactivated.
- A maximum of 32 for each, publishers and subscriber, are permitted per EL66xx.

2.5.4 Suppress publisher

Applicable: TwinCAT from version 2.11, EL6601 from FW08, EL6614 from FW04

If the EL66xx is operated with a short cycle time and with publishers configured, this can place a high loading on the connected network. For this reason, the EL66xx can be configured in such a way that the transmission of individual publishers can be blocked through the *DevCtrl* variable. The object 0xF800:02 must be occupied in the CoE (CanOpenOverEtherCAT) for this purpose.

Groups of publisher boxes can be blocked by setting appropriate bits (publisher frames). The topmost 4 bits (the high nibble of high byte) from 0xF800:02 specify the granularity of the groups 1..15, i.e. how many publisher frames are handled together as one group:

The upper 8 bits of *DevCtrl* (format: 16 bits) then block the transmission of the publisher frames located in the corresponding group in the current cycle.

High byte of *DevCtrl* :

- 0 = no blocking
- n = each bit in *DevCtrl* corresponds to a group of n publishers, where n has a value in the range [1..31]

It follows that a maximum of 8 groups of publishers can be blocked.

Sample:

DevCtrl.10 = true and 0xF800:02 = 0x2000 signifies that the third group will be blocked in this PLC cycle. One group consists of 2 publisher frames, which means that in this case all the publisher variables that are located in publisher frames 5 and 6 will not be transmitted.

NOTICE

Suppressing individual publishers

The structure of a "publisher" as a publisher box in the System Manager is
- an Ethernet frame containing
- n publishers
The individual bits in DevCtrl each block a group of publisher frames.

The success achieved in this way can be observed using, for instance, a network monitor such as Wireshark.

Changes in the CoE

The CoE contents can, if writable, be changed online using the TwinCAT System Manager. However, after the terminal or the EtherCAT system is restarted, this change will no longer be present; default values will apply. As a result, any permanent change must be stored in the terminal's CoE startup list.

Note: In this documentation, bit counting starts from 0: value.0, value.1, ...

2.5.5 Filter subscribers

Applicable: TwinCAT from version 2.11, EL6601 from FW08, EL6614 from FW06

Depending on how the Ethernet network is configured, large or small numbers of the publisher telegrams being used there arrive at the EL66xx devices included in the network. At the start, the EL 66xx is configured by the EtherCAT Master to the subscriber variables that it is to receive: source AMS Net ID and ID of the variables are loaded into the CoE for each subscriber. The CoE objects 0x60n0:01 and 0x60n0:02 then respectively contain the AmsNetId and Variables ID to be checked. The EL66xx devices can therefore filter according to the incoming publisher IDs, and compare them with their own subscriber IDs. For this purpose the publisher variables contained in the Ethernet frames received are disassembled and checked individually.

If an incoming subscriber

- corresponds to a configured AMS Net ID and Variables ID, then the contents are transferred to EtherCAT via PDO.
- does NOT correspond to the above, then the contents are transferred as standard to the acyclic mailbox interface for transmission to the Master.

This is the standard setting of the EL66xx.

The second way generates a high acyclic EtherCAT transport load, because subscribers received by the EL66xx are transported that should not be transported by this EL66xx at all. For this reason the subscriber filter can be activated by the **CoE entry 0xF800:02 = 0x0100 (bit 8 = TRUE).** The subscriber data that do not correspond to the AmsNetID/Variables ID filter are then discarded in the terminal and are not transferred to the mailbox.

Filter subscribers

Activation of the subscriber filter is recommended.
Since the EL66xx needs to be re-initialized with each INIT-OP transition, it is essential to set the named CoE entry in the startup list.

Note: In this documentation, bit counting starts from 0: value.0, value.1, ...

2.5.6 Setting up TwinCAT 2.10

Once the EtherCAT bus and its devices have been configured, the EL6601 is appended as a separate device in the configuration tree.

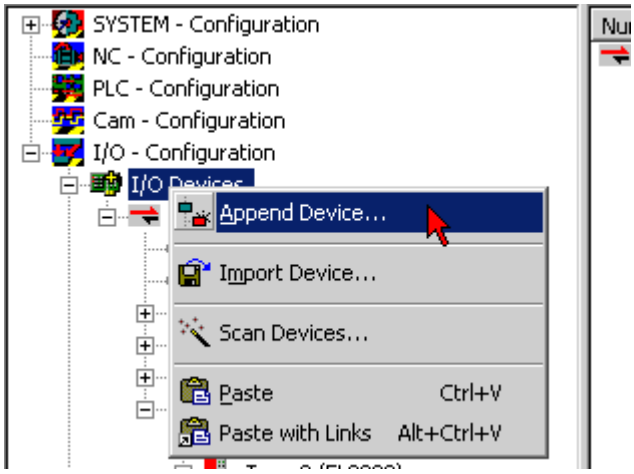


Fig. 15: Append device

In the selection dialog an EL6601 is offered as a real-time Ethernet device. The EL6601 must also be selected here when an EL6614 is being used.

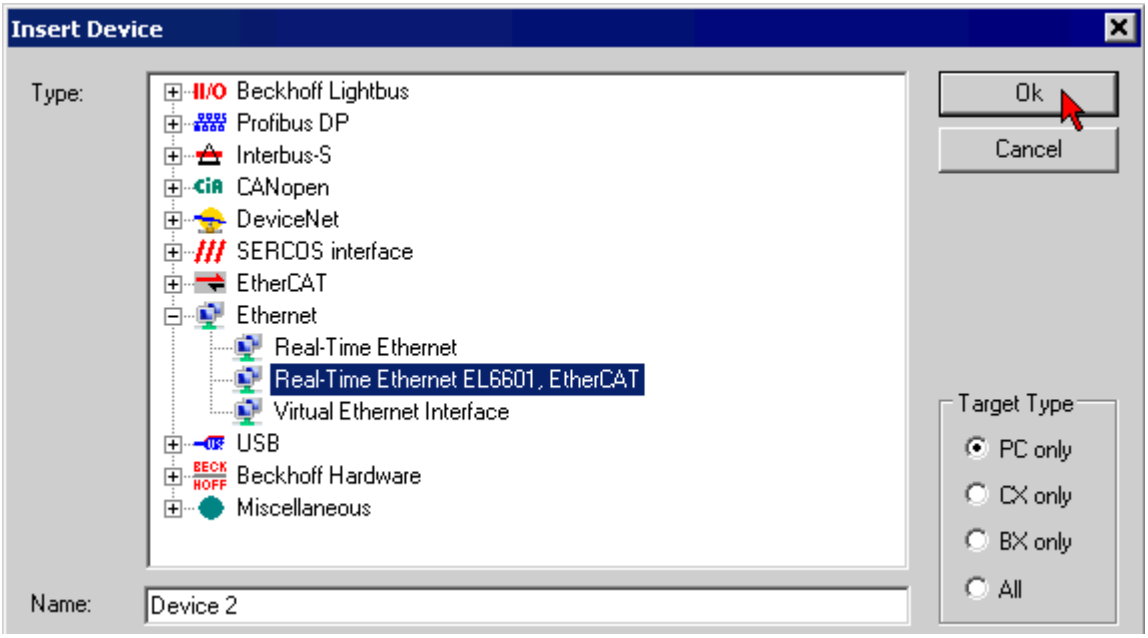


Fig. 16: Select EL6601

An imaginary box is now appended to the EL6601 as publisher or subscriber.

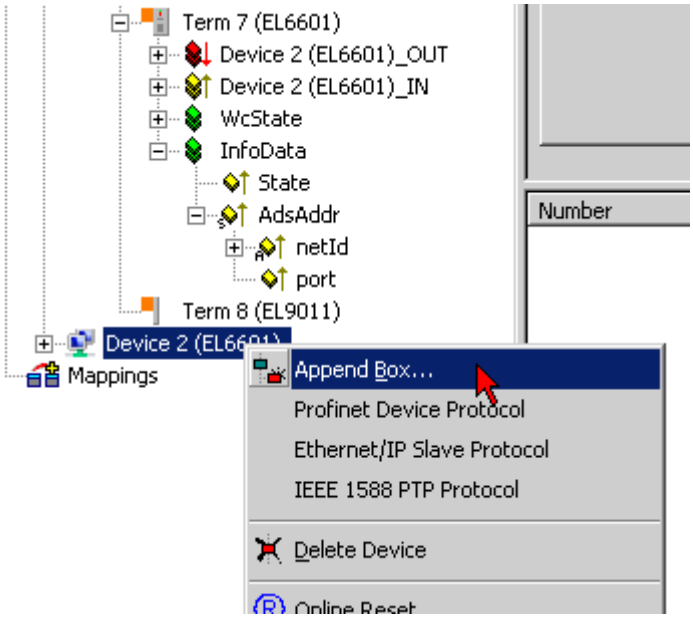


Fig. 17: Append box



Fig. 18: Append network variable

The "EL6601 device" is now linked to the actual EL6601 or EL6614 in the selection dialog ("Adapter" tab -> "*Search...*").

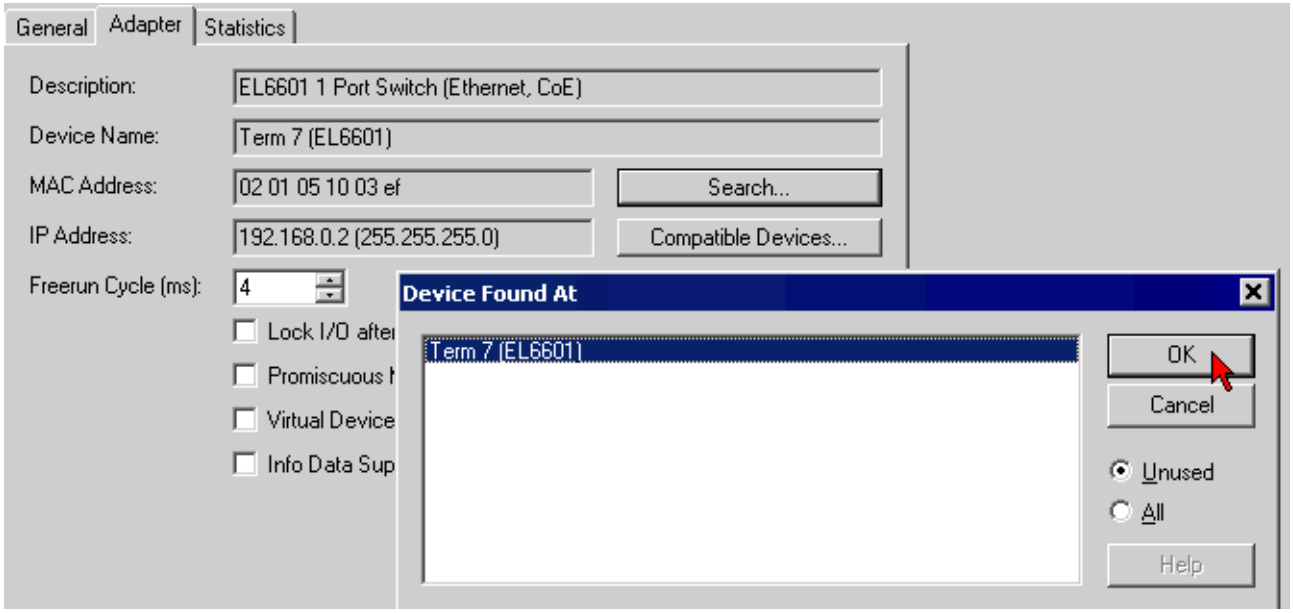


Fig. 19: Link device with EL6601

All further steps are done as described in the preceding sections.

2.5.7 Setting up TwinCAT 2.11

If the EtherCAT configuration has been created manually or scanned from the field itself you can now configure an EL66xx as a transmitter/receiver of network variables.

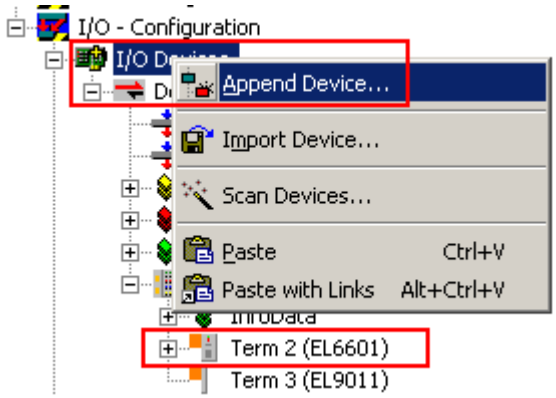


Fig. 20: Append new device

Select the EtherCAT Automation Protocol in the device dialog:



Fig. 21: Select EtherCAT Automation Protocol

The new device is automatically assigned to an available EL66xx, or this can also be done manually:

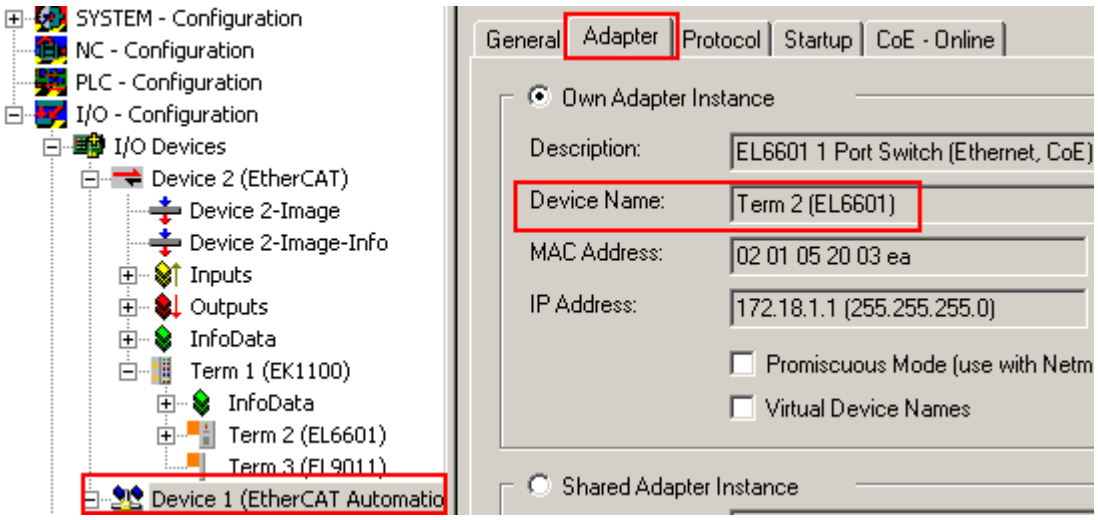


Fig. 22: Device assignment to the EL66xx

Transmitter/receiver variables must now be created:

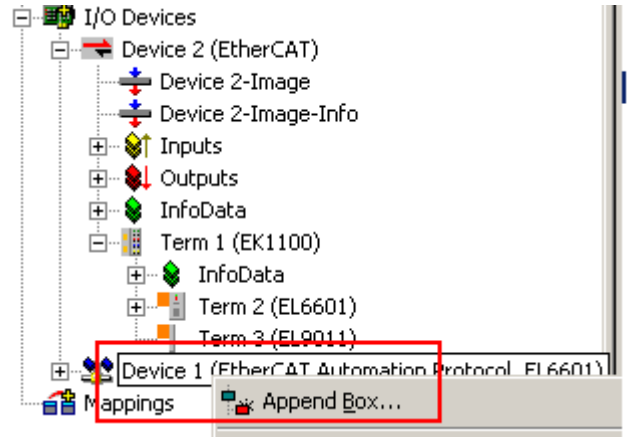


Fig. 23: Append box

Multiple publishers and subscribers can be created for each EtherCAT Automation Protocol device.

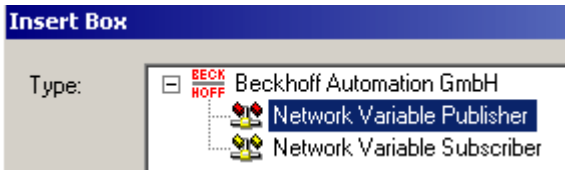


Fig. 24: Publisher/Subscriber

An EtherCAT Automation Protocol device appears as follows in the topology view:

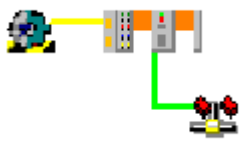


Fig. 25: Topology view

All further steps are done as described in the preceding sections.

2.6 Configuration in the CX20x0 and CX50x0 system

The embedded PCs of the CX20x0 and CX50x0 series offer the unique feature of an integrated I/O interface for E-bus and K-bus with automatic switchover. The EL66xx devices in the TwinCAT system act as a virtual switch, with the EtherCAT system as the "backbone". In the CX20x0 and CX50x0 system, the internal interface connection is not implemented through a network interface, but through an FPGA.

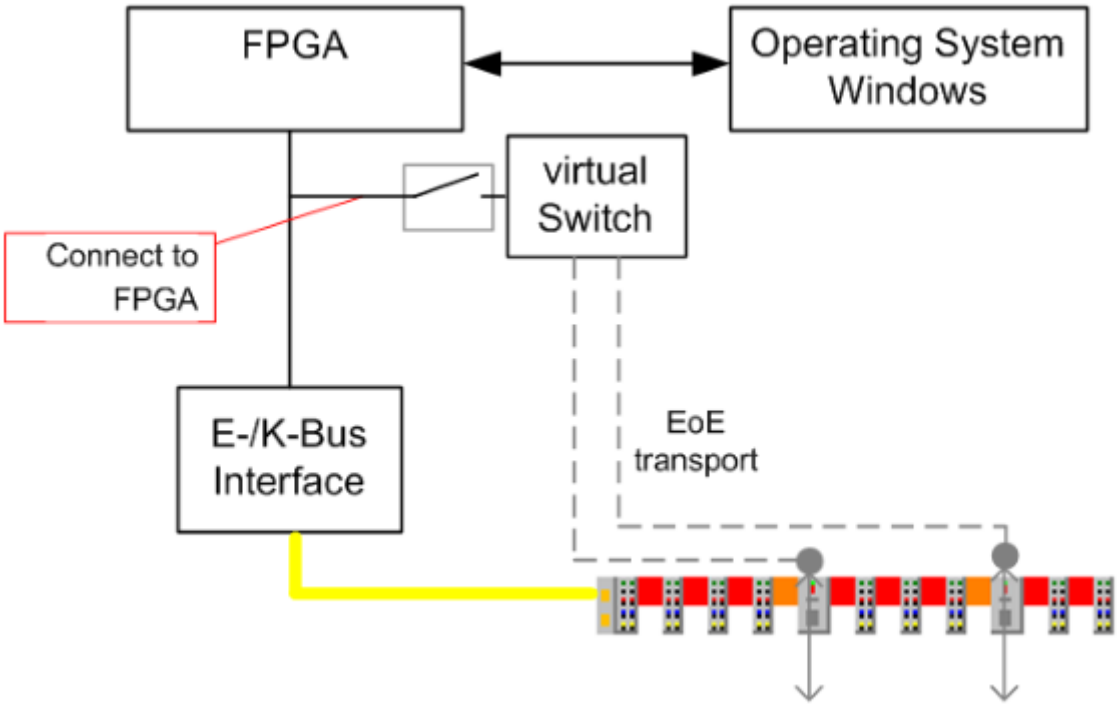


Fig. 26: Virtual TwinCAT switch in the CX20x0 and CX50x0 system

Due to the internal connection via FPGA and the automatic E-bus / K-bus detection, with offline configuration the Ethernet port only becomes visible when the configuration is activated. To configure the Ethernet port offline, proceed as follows:

- Due to the automatic E-bus and K-bus switching, any terminal should be connected with the appropriate bus
- The internal PCI™ port is detected during offline configuration and must be selected

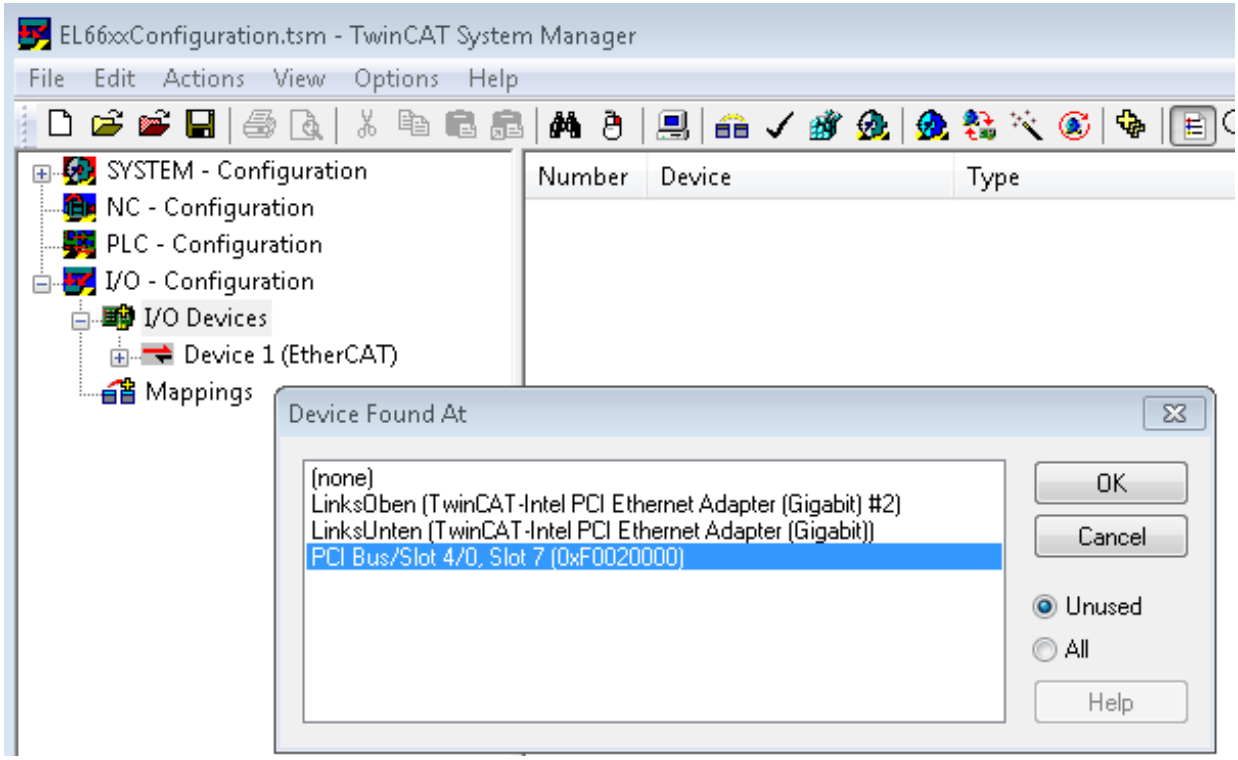


Fig. 27: Dialog for selection of the PCI™ port

- The customer-specific configuration can be created, and the EL66xx can be inserted in the configuration

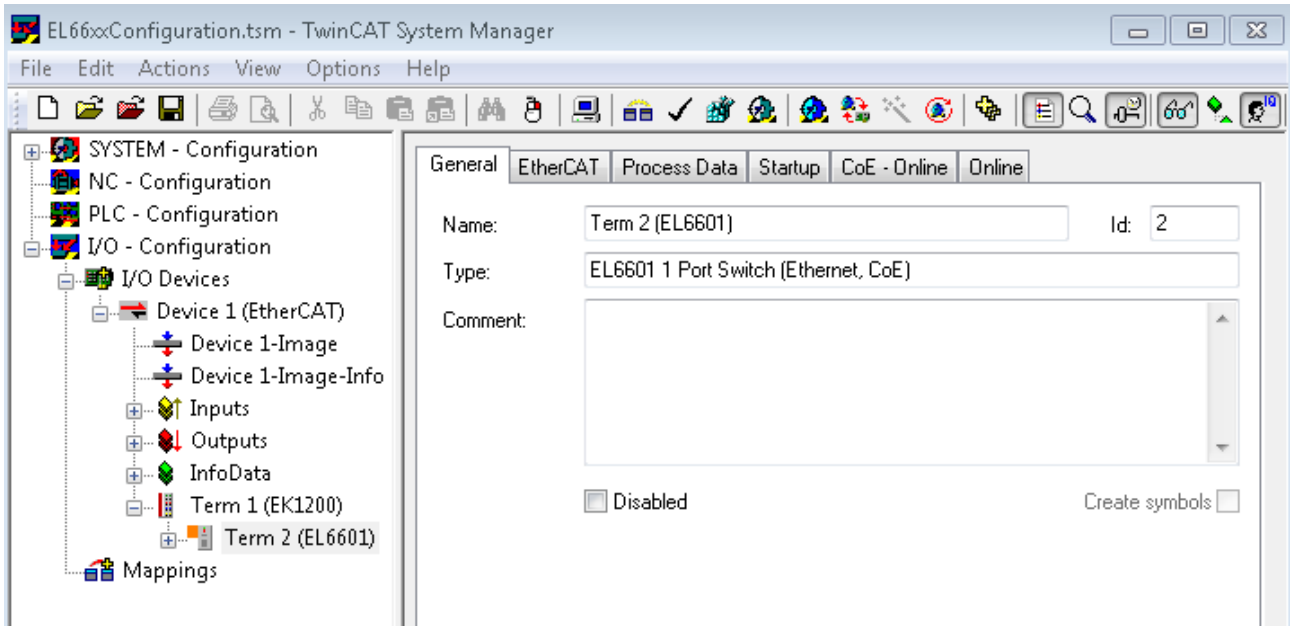


Fig. 28: Insertion of the EL66xx in the configuration

- The Ethernet port is detected after "Reloading the I/O devices" (F4) and then appears under network connections
- as "Local Area Connection 4"

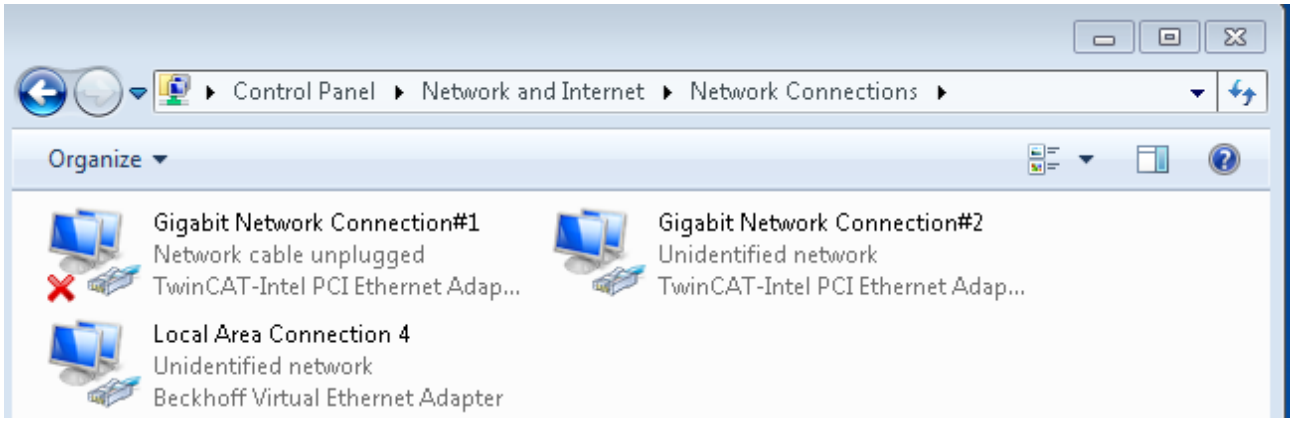


Fig. 29: New Network “Local Area Connection” in the Windows network connections

- The port can now be configured as required. The settings are applied and saved. Even if the port disappears again, the settings are retained for subsequent commissioning.

If the problem persists, i.e. if the Ethernet port of the EL66xx still fails to show up in the network connection, this may be due to the following causes. These should be checked and the listed countermeasures taken.

Requirements

Check the following:	
Virtual Ethernet switch is not enabled	Check the virtual switch settings [▶ 21] and the corresponding notes
TwinCAT 2 and TwinCAT 3 are installed simultaneously	Possible driver conflict, please contact Beckhoff support

3 Mounting and wiring

3.1 Notes on ESD protection

NOTICE

Devices can be destroyed by electrostatic charging!

The devices contain electrostatically sensitive components which can be damaged by improper handling.

- When handling the components, take care to avoid electrostatic discharge; also, prevent direct contact with the spring-loaded contacts (see illustration).
- Contact with highly insulating materials (synthetic fibers, plastic films, etc.) should be avoided when simultaneously handling components.
- When handling the components, ensure proper earthing of the environment (workplace, packaging, and persons).
- Each bus station must be terminated with the EL9011 or EL9012 end cap on its right side to guarantee the protection rating and ESD protection.

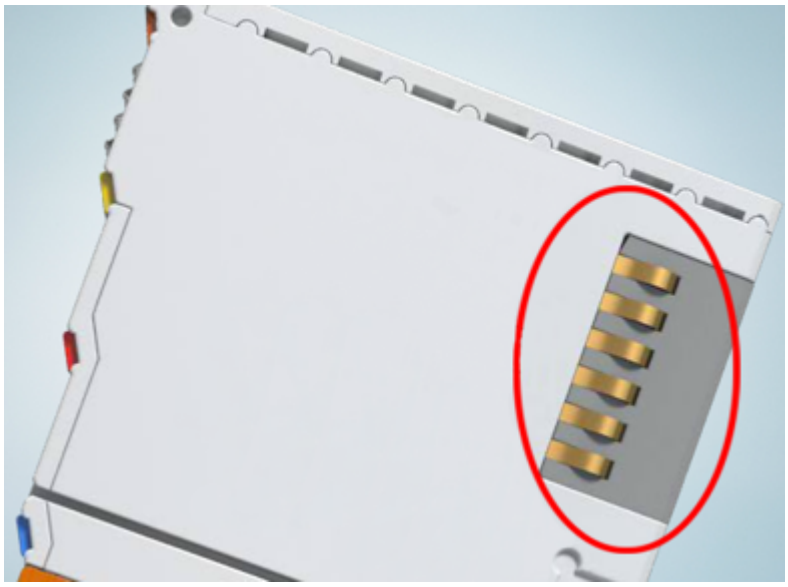


Fig. 30: Spring contacts of Beckhoff I/O components

3.2 Explosion protection

3.2.1 ATEX - Special conditions (extended temperature range)

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-7! The environmental conditions during use are thereby to be taken into account!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of -25 to 60°C for the use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

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

- EN IEC 60079-0:2018
- EN 60079-7:2015+A1:2018

Marking

The Beckhoff fieldbus components with extended temperature range (ET) certified according to regulations for potentially explosive areas bear the following marking:



II 3 G Ex ec IIC T4 Gc
KEMA 10 ATEX0075 X
DEKRA 22UKEX6024X
Ta: -25 ... + 60°C

3.2.2 IECEx - Special conditions

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas!

- For gas: The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to IEC 60079-7, taking into account the environmental conditions under which the equipment is used!
- The equipment shall only be used in an area of at least pollution degree 2, as defined in IEC 60664-1!
- Provisions shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 119 V!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range for the use of Beckhoff fieldbus components in potentially explosive areas!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The front hatch of certified units may only be opened if the supply voltage has been switched off or a non-explosive atmosphere is ensured!

Standards

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

- IEC 60079-0:2017 (Edition 7.0)
- IEC 60079-7:2017 (Edition 5.1)

Marking

Beckhoff fieldbus components that are certified in accordance with IECEx for use in areas subject to an explosion hazard bear the following marking:

IECEx DEK 16.0078 X

Ex ec IIC T4 Gc

3.2.3 Continuative documentation for ATEX and IECEx

NOTICE



Continuative documentation about explosion protection according to ATEX and IECEx

Pay also attention to the continuative documentation

Ex. Protection for Terminal Systems
Notes on the use of the Beckhoff terminal systems in hazardous areas according to ATEX and IECEx,

that is available for download within the download area of your product on the Beckhoff homepage www.beckhoff.com!

3.2.4 cFMus - Special conditions

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas!

- The equipment shall be installed within an enclosure that provides a minimum ingress protection of IP54 in accordance with ANSI/UL 60079-0 (US) or CSA C22.2 No. 60079-0 (Canada).
- The equipment shall only be used in an area of at least pollution degree 2, as defined in IEC 60664-1.
- Transient protection shall be provided that is set at a level not exceeding 140% of the peak rated voltage value at the supply terminals to the equipment.
- The circuits shall be limited to overvoltage Category II as defined in IEC 60664-1.
- The Fieldbus Components may only be removed or inserted when the system supply and the field supply are switched off, or when the location is known to be non-hazardous.
- The Fieldbus Components may only be disconnected or connected when the system supply is switched off, or when the location is known to be non-hazardous.

Standards

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

M20US0111X (US):

- FM Class 3600:2018
- FM Class 3611:2018
- FM Class 3810:2018
- ANSI/UL 121201:2019
- ANSI/ISA 61010-1:2012
- ANSI/UL 60079-0:2020
- ANSI/UL 60079-7:2017

FM20CA0053X (Canada):

- CAN/CSA C22.2 No. 213-17:2017
- CSA C22.2 No. 60079-0:2019
- CAN/CSA C22.2 No. 60079-7:2016
- CAN/CSA C22.2 No.61010-1:2012

Marking

Beckhoff fieldbus components that are certified in accordance with cFMus for use in areas subject to an explosion hazard bear the following markings:

FM20US0111X (US):	**Class I, Division 2, Groups A, B, C, D** **Class I, Zone 2, AEx ec IIC T4 Gc**
FM20CA0053X (Canada):	**Class I, Division 2, Groups A, B, C, D** **Ex ec T4 Gc**

3.2.5 Continuative documentation for cFMus

NOTICE	
	**Continuative documentation about explosion protection according to cFMus** Pay also attention to the continuative documentation **Control Drawing I/O, CX, CPX** Connection diagrams and Ex markings, that is available for download within the download area of your product on the Beckhoff homepage www.beckhoff.com!

3.3 UL notice

⚠ CAUTION
Application Beckhoff EtherCAT modules are intended for use with Beckhoff's UL Listed EtherCAT System only.

⚠ CAUTION
Examination For cULus examination, the Beckhoff I/O System has only been investigated for risk of fire and electrical shock (in accordance with UL508 and CSA C22.2 No. 142).

⚠ CAUTION
For devices with Ethernet connectors Not for connection to telecommunication circuits.

Basic principles

UL certification according to UL508. Devices with this kind of certification are marked by this sign:



3.4 Note on power supply

⚠ WARNING

Power supply from SELV / PELV power supply unit!

SELV / PELV circuits (safety extra-low voltage / protective extra-low voltage) according to IEC 61010-2-201 must be used to supply this device.

Notes:

- SELV / PELV circuits may give rise to further requirements from standards such as IEC 60204-1 et al, for example with regard to cable spacing and insulation.
- A SELV supply provides safe electrical isolation and limitation of the voltage without a connection to the protective conductor, a PELV supply also requires a safe connection to the protective conductor.

3.5 Mounting and demounting - top front unlocking

The terminal modules are fastened to the assembly surface with the aid of a 35 mm mounting rail (e. g. mounting rail TH 35-15).

Fixing of mounting rails

The locking mechanism of the terminals and couplers extends to the profile of the mounting rail. At the installation, the locking mechanism of the components must not come into conflict with the fixing bolts of the mounting rail. To mount the recommended mounting rails under the terminals and couplers, you should use flat mounting connections (e.g. countersunk screws or blind rivets).

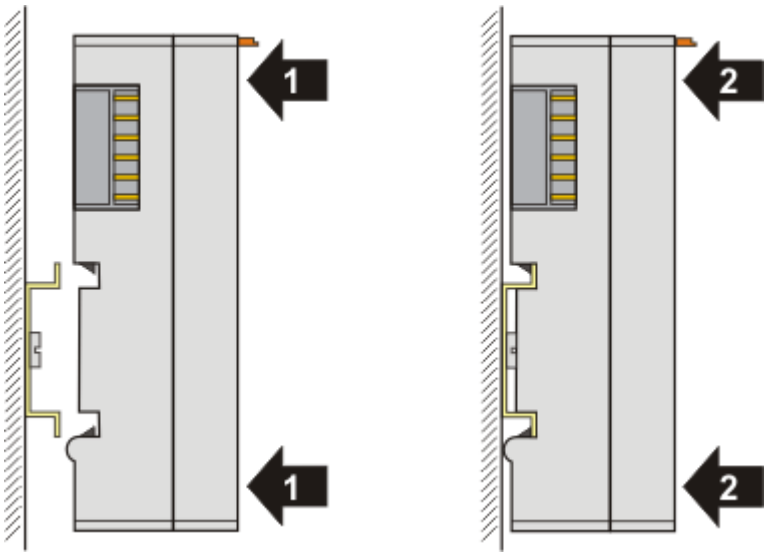
⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the Bus Terminals!

Mounting

- Fit the mounting rail to the planned assembly location.

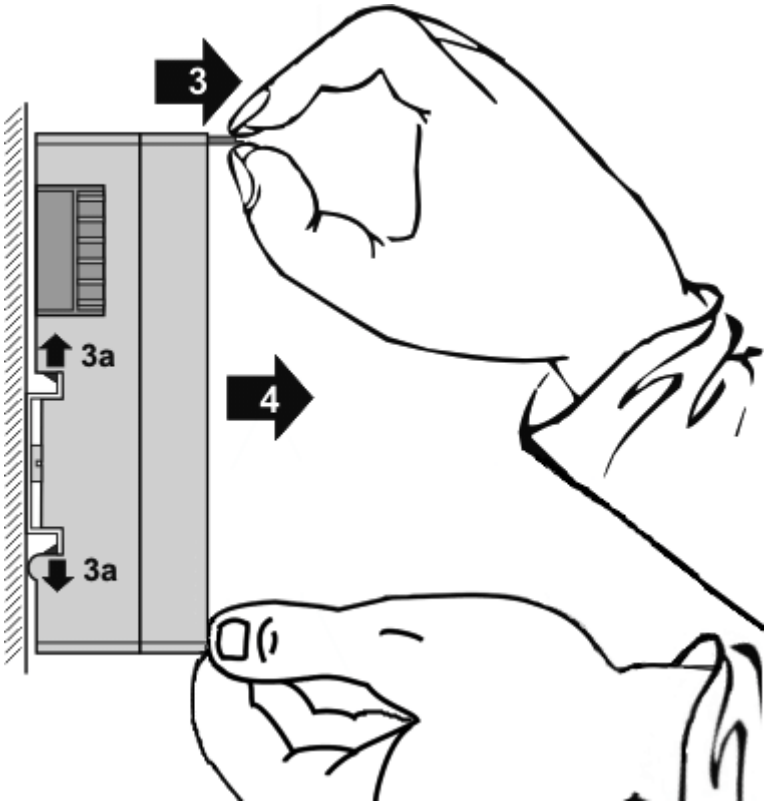


and press (1) the terminal module against the mounting rail until it latches in place on the mounting rail (2).

- Attach the cables.

Demounting

- Remove all the cables.
- Lever the unlatching hook back with thumb and forefinger (3). An internal mechanism pulls the two latching lugs (3a) from the top hat rail back into the terminal module.



- Pull (4) the terminal module away from the mounting surface.
  Avoid canting of the module; you should stabilize the module with the other hand, if required.

3.6 Positioning of passive terminals

Note on the placement of passive terminals in the bus terminal block

EtherCAT Terminals that do not take part in active data exchange within the bus terminal block are referred to as passive terminals. These terminals can be recognized because they do not consume power from the E-bus. To ensure optimal data exchange, no more than two passive terminals may be connected directly to each other!

Examples of the placement of passive terminals (highlighted in light color)

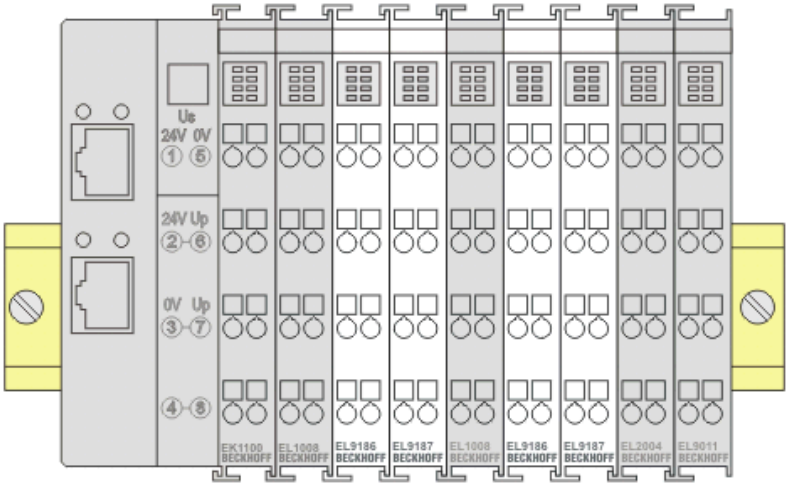


Fig. 31: Proper positioning

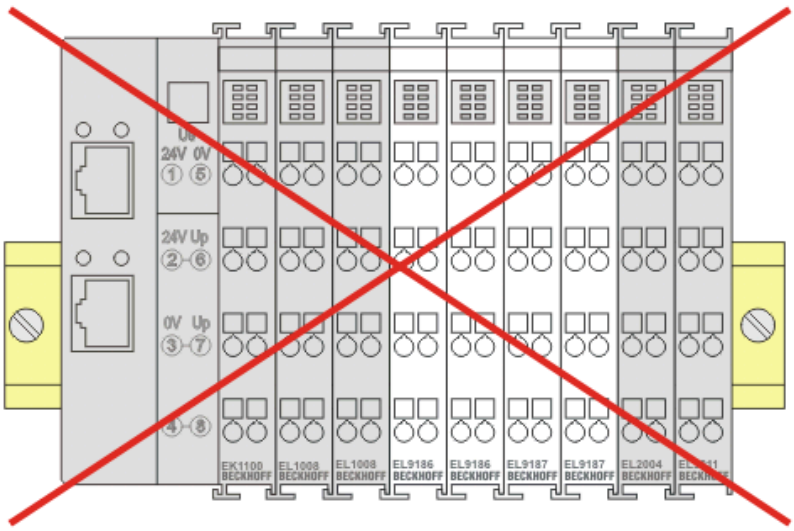


Fig. 32: Incorrect positioning

3.7 Note on shielding

NOTICE

Low-resistance shielding through external shield connection

The shielding of the EL66xx is capacitively connected to the mounting rail.

If low-resistance shielding is desired or required, the shield must be connected to an external shield support (e.g. with the clamp strap for shield connection ZB5800).

3.8 Installation positions

NOTICE

Constraints regarding installation position and operating temperature range

- Please refer to the technical data of the device to ascertain whether any restrictions regarding the installation position and/or the operating temperature range have been specified.
- When installing devices with increased heat dissipation, ensure that there is sufficient space above and below the devices during operation to guarantee adequate ventilation!

The installation positions and their names for mounting devices on mounting rails are specified below. The illustration of the devices in the following figures is an example.
The following applies to all installation positions: the reference direction “down” (see arrow) is the direction of the earth's gravitational force.

Horizontal installation (standard installation)

The mounting rail is mounted horizontally on a vertical mounting plate.
The connection level of the devices points to the front.

The devices are ventilated from below, which enables optimum cooling of the electronics through convection. This is therefore also the recommended installation position.

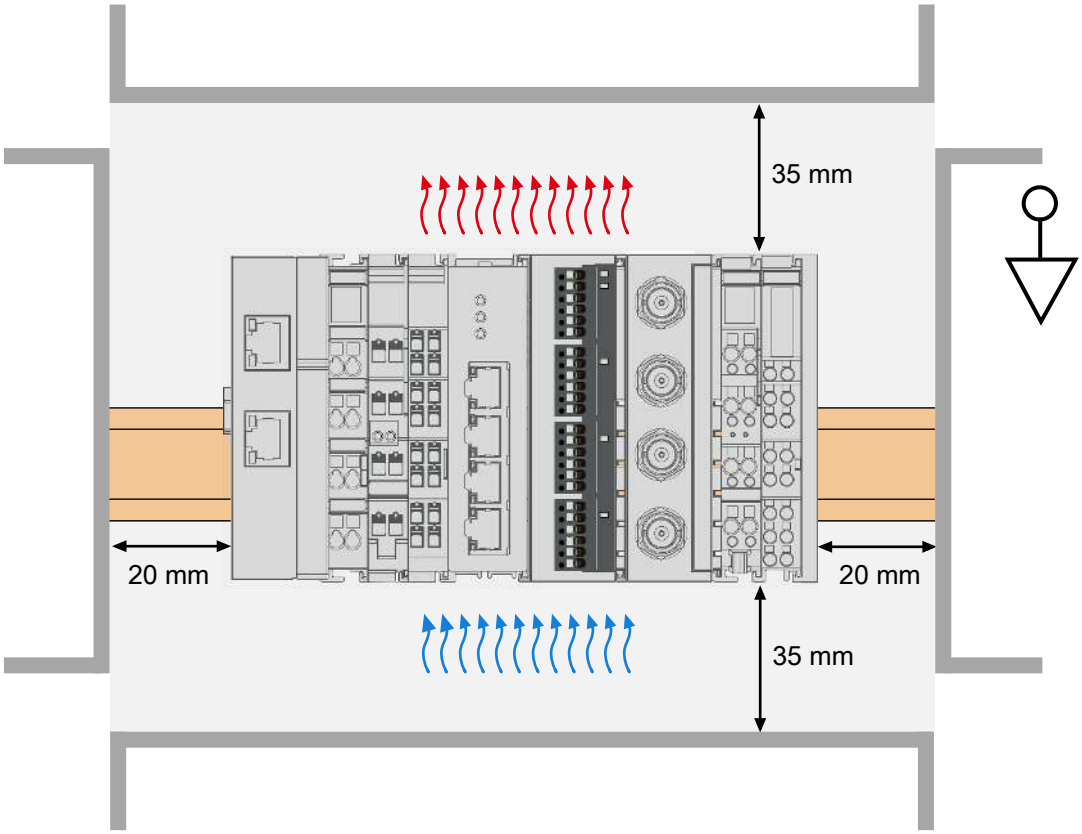


Fig. 33: Recommended minimum distances for standard installation position

NOTICE

Compliance with the minimum distances

Compliance with the minimum distances shown in the figure “Recommended minimum distances for standard installation position” is strongly recommended in all installation positions.

Vertical installation

The mounting rail is mounted vertically on a vertical mounting plate.
The connection level of the devices faces the front.
The devices can be arranged as follows:

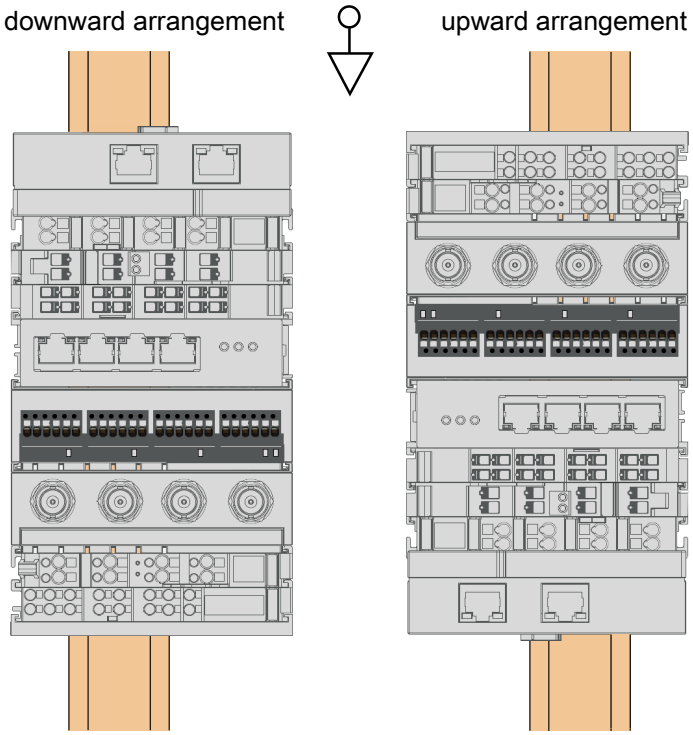


Fig. 34: Installation position: Vertical, downward arrangement (left)/upward arrangement (right)

Flat installation

The mounting rail is mounted on a horizontal mounting plate.
The connection level of the devices points upwards.

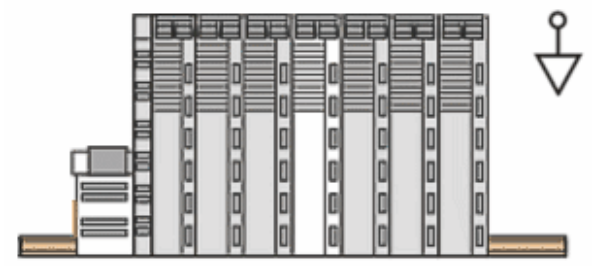


Fig. 35: Flat installation

NOTICE

Danger of sliding off the mounting rail

Particularly in the “vertical” installation position, but also in other installation positions under corresponding mechanical load, the terminal segment may move on the mounting rail. These can lead to undesirable malfunctions.

- If this risk exists, secure the terminal segment with appropriate locking devices, e.g. by clamping it to the mounting rail.

NOTICE

Compliance with the minimum distances

Compliance with the minimum distances shown in the figure “Recommended minimum distances for standard installation position” is strongly recommended in all installation positions.

Installation positions with ZB8610 fan cartridge

If the cooling should or must be increased for the intended application, the ZB8610 fan cartridge can be mounted on the underside of the device. In the horizontal installation position, the devices are ventilated from bottom to top by the fan cartridge. This optimum cooling is further enhanced by convection ventilation (see following figure).

The fan cartridge can be used in any installation position.

Further information on operation with and without a fan can be found in the technical data for the device (e.g. derating, information on installation positions, etc.).

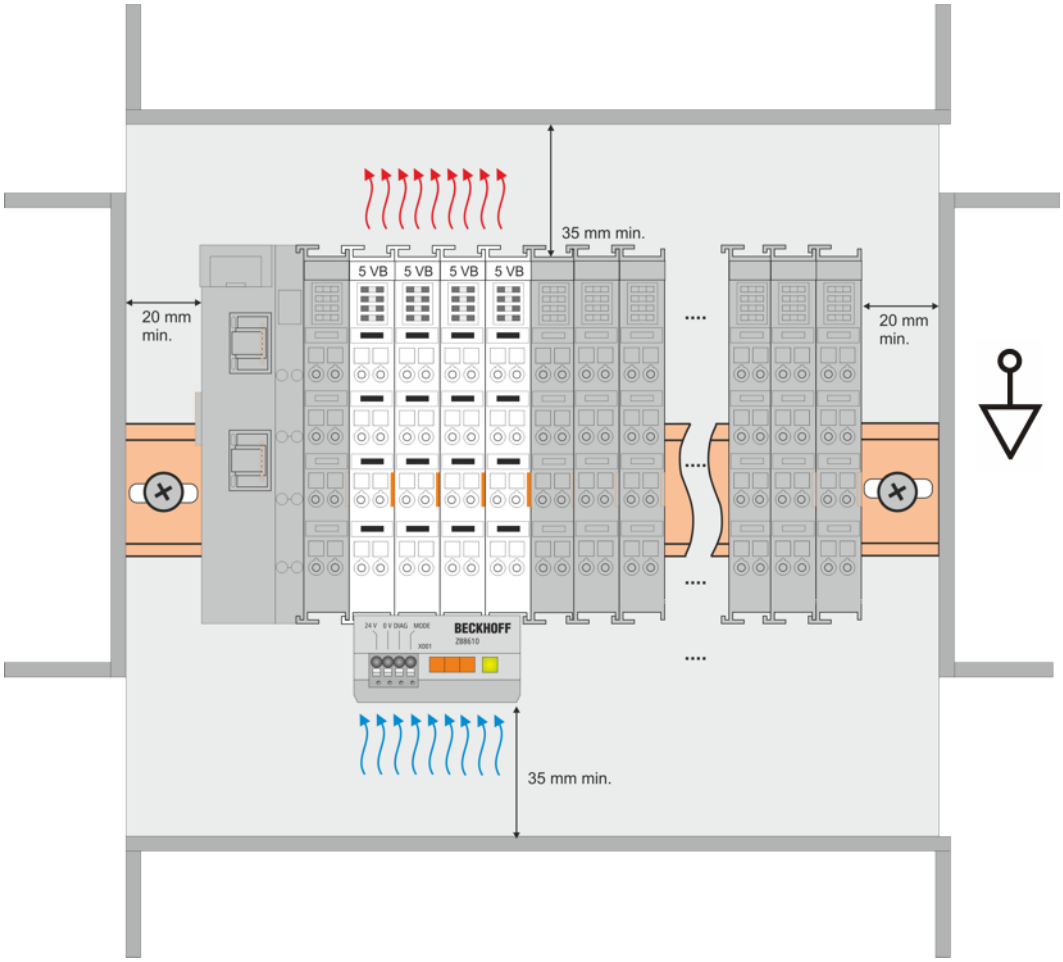


Fig. 36: Recommended minimum distances for operation with fan, using horizontal installation position as an example

NOTICE

Compliance with the minimum distances

Compliance with the minimum distances as shown in the figure “Recommended minimum distances for operation with fan” is strongly recommended.

3.9 Disposal



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

4 Commissioning

NOTICE



Further information

For information on commissioning with TwinCAT and EtherCAT basics, please refer to the "EtherCAT system manual".

4.1 Object description and parameterization

EtherCAT ESI Device Description (XML)

The presentation matches that of the CoE objects from the EtherCAT ESI Device Description (XML). It is recommended that you download the latest XML file from the download area on the Beckhoff website and install it according to the installation instructions.

Parameterization via the CoE list (CAN over EtherCAT)

The EtherCAT device is parameterized via the CoE Online tab (with a double click on the respective object) or via the Process Data tab (assignment of PDOs). Please note the following general CoE information when using/manipulating the CoE parameters:

- Keep a startup list if components have to be replaced.
- Differentiation between online/offline dictionary, existence of current XML description.
- "CoE Reload" for resetting the changes

Introduction

The CoE overview contains objects for different intended applications:

- Objects required for parameterization [▶ 49] during commissioning
- Objects intended for regular operation [▶ 50], e.g. through ADS access.
- Objects for indicating internal settings [▶ 50] (may be fixed)

The following section first describes the objects required for normal operation, followed by a complete overview of missing objects.

4.1.1 Objects for commissioning

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	0x19C93052 (432615506_{dec})
1018:03	Revision	Revision number of the EtherCAT slave; the low word (bit 0-15) indicates the special terminal number, the high word (bit 16-31) refers to the device description	UINT32	RO	0x00100000 (1048576_{dec})
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	0x00000000 (0_{dec})

Index F800 EL6601 Para

Index (hex)	Name	Meaning	Data type	Flags	Default
F800:0	EL6601 Para	Max. subindex	UINT8	RW	0x02 (2_{dec})
F800:01	General	0x0000: Standard operation 0x0001: VLAN TAGS are removed before filtering. 0x4000: EoE frames are blocked.	UINT16	RW	0x0000 (0_{dec})
F800:02	NetVars	This switch determines whether received subscriber data from frames with 0x88A4 in the header, that have not passed the subscriber filter, will be transported further via EoE/Mailbox to the EtherCAT Master. 0x0000: default, subscriber data are forwarded via EoE 0x0100: Subscriber data are being discarded	UINT16	RW	0x0000 (0_{dec})

4.1.2 Objects for regular operation

Index F100 Master Info

Index (hex)	Name	Meaning	Data type	Flags	Default
F100:0	Master Info	Max. subindex	UINT8	RO	0x02 (2_{dec})
F100:01	Status	Link Status of the Ethernet port 0: Link 1: No link	UINT16	RO	0x0000 (0_{dec})
F100:02	Control	reserved	UINT16	RO	0x0000 (0_{dec})

Index FA01 MAC Info

Index (hex)	Name	Meaning	Data type	Flags	Default
FA01:0	MAC Info	Max. subindex	UINT8	RW	0x03 (3_{dec})
FA01:01	RxPackets	Received Ethernet telegrams	UINT16	RW	0x0000 (0_{dec})
FA01:02	TxPackets	Sent Ethernet telegrams	UINT16	RW	0x0000 (0_{dec})
FA01:03	Reserved	Reserved	UINT16	RW	0x0000 (0_{dec})

4.1.3 Standard objects (0x1000-0x1FFF)

The standard objects have the same meaning for all EtherCAT slaves.

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: The Lo-Word contains the CoE profile used (5002).	UINT32	RO	0x0000138A (5002_{dec})

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	e.g. EL6601-0000-0017

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	00

Index 100A Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	00

Index 1600-16FE RxPDO-Map

Index (hex)	Name	Meaning	Data type	Flags	Default
1600+n:0	RxPDO-Map	PDO Mapping RxPDO (each module gets its own entry (Index 0x1600+n), 0 ≤ n < maximum number of modules	UINT8	RW	0x02 (2_{dec})
(1600+n):01	Output Mapping Area 001	1. PDO Mapping Entry (Object 7000+n*8:07)	UINT32	RW	0x7000+n*8:07, 16
(1600+n):02	Output Mapping Area 002	2. PDO Mapping Entry (Object 7000+n*8:0B)	UINT32	RW	0x7000+n*8:0B, 16

Index 1680 PDO control

Index (hex)	Name	Meaning	Data type	Flags	Default
1680:0	PDO control	Max. subindex	UINT8	RW	0x01 (1_{dec})
1680:01	PDO control	Entry Master Control	UINT32	RW	0xF100:02, 16

Index 1A00-1AFE TxPDO-Map

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00+n:0	TxPDO Map Ch.2	PDO Mapping TxPDO (each module gets its own entry (Index 0x1A00+n), 0 ≤ n < maximum number of modules	UINT8	RW	0x03 (3_{dec})
(1A00+n):01	Input Mapping Area 001	1. PDO Mapping Entry (Object 0x6000+n*8:03)	UINT32	RW	0x6000+n*8:03, 16
(1A00+n):02	Input Mapping Area 002	2. PDO Mapping Entry (Object 0x6000+n*8:04)	UINT32	RW	0x6000+n*8:04, 16
(1A00+n):03	Input Mapping Area 003	3. PDO Mapping Entry (Object 0x6000+n*8:05)	UINT32	RW	0x6000+n*8:05, 16

Index 1A80 PDO status

Index (hex)	Name	Meaning	Data type	Flags	Default
1680:0	PDO status	Max. subindex	UINT8	RW	0x01 (1_{dec})
1680:01	PDO status	Entry Master Status	UINT32	RW	0xF100:01, 16

Index 1C00 Sync manager type

Index (hex)	Name	Meaning	Data type	Flags	Default
1C00:0	Sync manager type	Using the sync managers	UINT8	RO	0x02 (2_{dec})
1C00:01	SubIndex 001	Sync-Manager Type Channel 1: Mailbox Write	UINT8	RO	0x01 (1_{dec})
1C00:02	SubIndex 002	Sync-Manager Type Channel 2: Mailbox Read	UINT8	RO	0x02 (2_{dec})
1C00:03	SubIndex 003	Sync-Manager Type Channel 3: Outputs	UINT8	RO	0x02 (2_{dec})
1C00:04	SubIndex 004	Sync-Manager Type Channel 4: Inputs	UINT8	RO	0x02 (2_{dec})

Index 1C12 RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	-
1C32:01	SubIndex 001	1. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT32	RW	0x1600 (5632_{dec})
...					
1C12:80	SubIndex 128	128. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT32	RW	0x167F (5759_{dec})
1C12:81	SubIndex 129	PDO Control	UINT32	RW	0x1680 (5760_{dec})

Index 1C13 TxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	-
1C13:01	SubIndex 001	1. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT32	RW	0x1A00 (6656_{dec})
...					
1C13:80	SubIndex 128	128. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT32	RW	0x1A7F (6783_{dec})
1C13:81	SubIndex 129	PDO status	UINT32	RW	0x1A80 (6784_{dec})

Index 1C32 SM output parameter (only with network variables)

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronization parameters for the outputs	UINT8	RW	0x0E (14_{dec})
1C32:01	Sync mode	Current synchronization mode: • 1: Synchronous with SM 2 event	UINT16	RW	0x0001 (1_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x00000000 (0_{dec})
1C32:03	Shift time	Time between SYNC0 event and output of the outputs (in ns, DC mode only)	UINT32	RW	0x00000000 (0_{dec})
1C32:04	Sync modes supported	Supported synchronization modes: • Bit 1 = 1: Synchron with SM 2 event is supported	UINT16	RW	0x0002 (2_{dec})

Index 1C33 SM input parameter (only with network variables)

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RW	0x0E (14_{dec})
1C33:01	Sync mode	Current synchronization mode: • 34: Synchron with SM 2 Event (outputs available)	UINT16	RW	0x0022 (34_{dec})
1C33:02	Cycle time	as 0x1C32:02 [▶ 52]	UINT32	RW	0x00000000 (0_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, only DC mode)	UINT32	RW	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 1: Synchronous with SM 2 Event is supported (outputs available)	UINT16	RW	0x0002 (2_{dec})

4.1.4 Profile-specific objects (0x6000-0xFFFF)

The profile-specific objects have the same meaning for all EtherCAT slaves that support the profile 5001.

Index 6000-67F8 Receiving Frame Data (Net Var Subscriber)

Index (hex)	Name	Meaning	Data type	Flags	Default
6000+n*8:0	Receiving Frame Data (Net Var Subscriber)	Max. subindex (each module gets its own entry (Index 0x6000+n*8), 0 ≤ n < maximum number of modules	UINT8	RW P	0x05 (5_{dec})
(6000+n*8): 01	Net Id	Source AMS Net Id	UINT48	RW P	-
(6000+n*8): 02	Var Id	Identification of network variables	UINT16	RW P	0x0001 (1_{dec})
(6000+n*8): 03	Quality	Period over which the variable was not updated (resolution 100 µs)	UINT16	RO P	0x0000 (0_{dec})
(6000+n*8): 04	Cycle Index	Entry is incremented with each Publisher cycle	UINT16	RO P	0x0000 (0_{dec})
(6000+n*8): 05	Data area 001	Data range	OCTED_STRING	RO P	00 00

Index 6001-67F9 Sending frame State (Frame status)

Index (hex)	Name	Meaning	Data type	Flags	Default
6001+n*8:0	Sending frame State (Frame status)	Max. subindex (each module gets its own entry (Index 0x6001+n*8), 0 ≤ n < maximum number of modules	UINT8	RW P	0x01 (1_{dec})
(6001+n*8): 01	Frame status	Status • Bit 0: Frame bypassed • Bit 1: Frame too large	UINT16	RW P	0x0000 (0_{dec})

Index 6002-67FA Receiving Frame Identification (Ignore Item Net Var Subscriber)

Index (hex)	Name	Meaning		Data type	Flags	Default
6002+n*8:0	Receiving Frame Identification (Ignore Item Net Var Subscriber)	Max. subindex (each module gets its own entry (Index 0x6002+n*8), 0 ≤ n < maximum number of modules		UINT8	RW P	0x05 (5_{dec})
(6002+n*8): 01	Net Id	"Net Id"	0: Entry is checked. If equality is detected, the associated data areas are transferred in the process data. 1: Entry is skipped. Associated data areas are not transferred in the process data.	UINT8	RW P	0x01 (1_{dec})
(6002+n*8): 02	Var Id	"Var Id"		UINT8	RW P	0x00 (0_{dec})
(6000+n*8): 03	Quality	"Quality"		UINT8	RW P	0x01 (1_{dec})
(6002+n*8): 04	Cycle Index	"Cycle Index"		UINT8	RW P	0x01 (1_{dec})
(6002+n*8): 05	Data area 001	"Data area 001"		UINT8	RW P	0x01 (1_{dec})

Index 6003-67FB Receiving Frame Length (Area Length Nat Var Subscriber)

Index (hex)	Name	Meaning	Data type	Flags	Default
6003+n*8:0	Receiving Frame Length (Area Length Nat Var Subscriber)	Max. subindex (each module gets its own entry (Index 0x6003+n*8), 0 ≤ n < maximum number of modules	UINT8	RW P	0x05 (5_{dec})
(6003+n*8): 01	Net Id	Length of the "Net Id" field	UINT16	RW P	0x0006 (6_{dec})
(6003+n*8): 02	Var Id	Length of the "Var Id" field	UINT16	RW P	0x0002 (2_{dec})
(6003+n*8): 03	Quality	Length of the "Quality" field	UINT16	RW P	0x0002 (2_{dec})
(6003+n*8): 04	Cycle Index	Length of the "Cycle Index" field	UINT16	RW P	0x0002 (2_{dec})
(6003+n*8): 05	Data area 001	Length of the "Data area" field	UINT16	RW P	0x0002 (2_{dec})

Index 7000-77F8 Sending Frame Data (Net Var Publisher)

Index (hex)	Name	Meaning	Data type	Flags	Default
7000+n*8:0	Sending Frame Data (Net Var Publisher)	Max. subindex (each module gets its own entry (Index 0x7000+n*8), 0 ≤ n < maximum number of modules	UINT8	RW P	-
(7000+n*8):01	Destination MAC address	MAC-Destination address Ethernet telegram	UINT48	RW P	-
(7000+n*8):02	Source MAC address	MAC-Source address Ethernet telegram	UINT48	RW P	-
(7000+n*8):03	Ethernet type	Beckhoff Ethertype	UINT16	RW P	0x88A4 (42120_{dec})
(7000+n*8):04	Header	Bit 0-10: Length of the following entries Bit 11: 0, Bit 12-15: 4, Network variable -type	UINT16	RW P	-
(7000+n*8):05	Net Id	Source AMS Net Id	UINT48	RW P	-
(7000+n*8):06	# of Vars	Number of variables	UINT16	RW P	-
(7000+n*8):07	Cycle Index	Entry is incremented with each Publisher cycle	UINT16	RO P	-
(7000+n*8):08	reserved	reserved	UINT16	RW P	-
(7000+n*8):09	Net Var 001 Id	Identification of network variables	UINT16	RW P	-
(7000+n*8):0A	Net Var 001 Header	Byte 0,1: Hash value Byte 2,3: Length of the data Byte 4,5: Quality	UINT48	RW P	-
(7000+n*8):0B	Net Var 001 Data	Data range	STRING	RO P	-
-					
(7000+n*8):(3*y+6)	Net Var y Id	Identification of network variables	UINT16	RW P	-
(7000+n*8):(3*y+7)	Net Var y Header	Byte 0,1: Hash value Byte 2,3: Length of the data Byte 4,5: Quality	UINT48	RW P	-
(7000+n*8):(3*y+8)	Net Var y Data	Data range	OCTED_STRING	RO P	-

Index 7001-77F9 Sending Frame Control (Frame control)

Index (hex)	Name	Meaning	Data type	Flags	Default
7001+n*8:0	Sending Frame Control (Frame control)	Max. subindex (each module gets its own entry (Index 0x7001+n*8), 0 ≤ n < maximum number of modules	UINT8	RW P	0x01 (1_{dec})
(7001+n*8):01	Frame Control	Frame Control • Bit 0 = 0: Send Frame • Bit 0 = 1: Skip Frame	UINT8	RW P	0x00 (0_{dec})

Index 7003-77FB Sending Frame Length (Area length Net Var Publisher)

Index (hex)	Name	Meaning	Data type	Flags	Default
7003+n*8:0	Sending Frame Length (Area length Net Var Publisher)	Max. subindex (each module gets its own entry (Index 0x7003+n*8), 0 ≤ n < maximum number of modules	UINT8	RW P	-
(7003+n*8): 01	Destination MAC address	MAC-Destination address Ethernet telegram	UINT48	RW P	-
(7003+n*8): 02	Source MAC address	MAC-Source address Ethernet telegram	UINT48	RW P	-
(7003+n*8): 03	Ethernet type	Beckhoff Ethertype	UINT16	RW P	0x88A4 (42120_{dec})
(7003+n*8): 04	Header	Bit 0-10: Length of the following entries Bit 11: 0, Bit 12-15: 4, Network variable -type	UINT16	RW P	-
(7003+n*8): 05	Net Id	Source AMS Net Id	UINT48	RW P	-
(7003+n*8): 06	# of Vars	Number of variables	UINT16	RW P	-
(7003+n*8): 07	Cycle Index	Entry is incremented with each Publisher cycle	UINT16	RW P	-
(7003+n*8): 08	reserved	reserved	UINT16	RW P	-
(7000+n*8): 09	Net Var 001 Id	Identification of network variables	UINT16	RW P	-
(7003+n*8): 0A	Net Var 001 Header	Byte 0,1: Hash value Byte 2,3: Length of the data Byte 4,5: Quality	UINT48	RW P	-
(7003+n*8): 0B	Net Var 001 Data	Data range	STRING	RW P	-
-					
(7003+n*8) :(3*y+6)	Net Var y Id	Identification of network variables	UINT16	RW P	-
(7003+n*8) :(3*y+7)	Net Var y Header	Byte 0,1: Hash value Byte 2,3: Length of the data Byte 4,5: Quality	UINT48	RW P	-
(7003+n*8) :(3*y+8)	Net Var y Data	Data range	OCTED_STRING	RW P	-

Index 8000-87F8 Frame Config

Index (hex)	Name	Meaning	Data type	Flags	Default
8000+n*8:0	Frame Config	Max. SubIndex	UINT8	RW	0x04 (4_{dec})
(8000+n*8): 04	Device type	3: Subscriber network variable, corresponding indexes 600x are being created. 4: Publisher network variable, corresponding indexes 0x700x are being created.	UINT16	RW	-

Index F000 Modular device profile

Index (hex)	Name	Meaning	Data type	Flags	Default
F000:0	Modular device profile	General information for the modular device profile	UINT8	RO	0x04 (4_{dec})
F000:01	Module index distance	Index distance of the objects of the individual channels	UINT16	RO	0x0008 (8_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x00FF (255_{dec})
F000:03	Standard Entries in Object 0x8yy0	Standard Entries in the Objects 0x8yy0	UINT32	RO	0x00000000 (0_{dec})
F000:04	Standard Entries in Object 0x9yy0	Standard Entries in the Objects 0x8yy0	UINT32	RO	0x00000000 (0_{dec})

4.2 Beckhoff network variables

4.2.1 Introduction

Network variables are any variables that are cyclically exchanged between PC/CX1000 via TwinCAT. Variables with any data types, including complex types, can be exchanged. The Publisher/Subscriber model is used. For highly deterministic communication, the real-time Ethernet driver for TwinCAT must be installed.

Publisher/Subscriber model

In the Publisher/Subscriber model, the Publisher makes variables available. Subscribers can subscribe to a variable. The Publisher can make the variable available to a Subscriber, several Subscribers or all Subscribers. In Broadcast mode the variable is made available to all PCs, in Multicast mode to selected PCs and in Unicast mode only to one selected PC. A Subscriber can also be Publisher at the same time. In this way, a bidirectional data link can be provided.

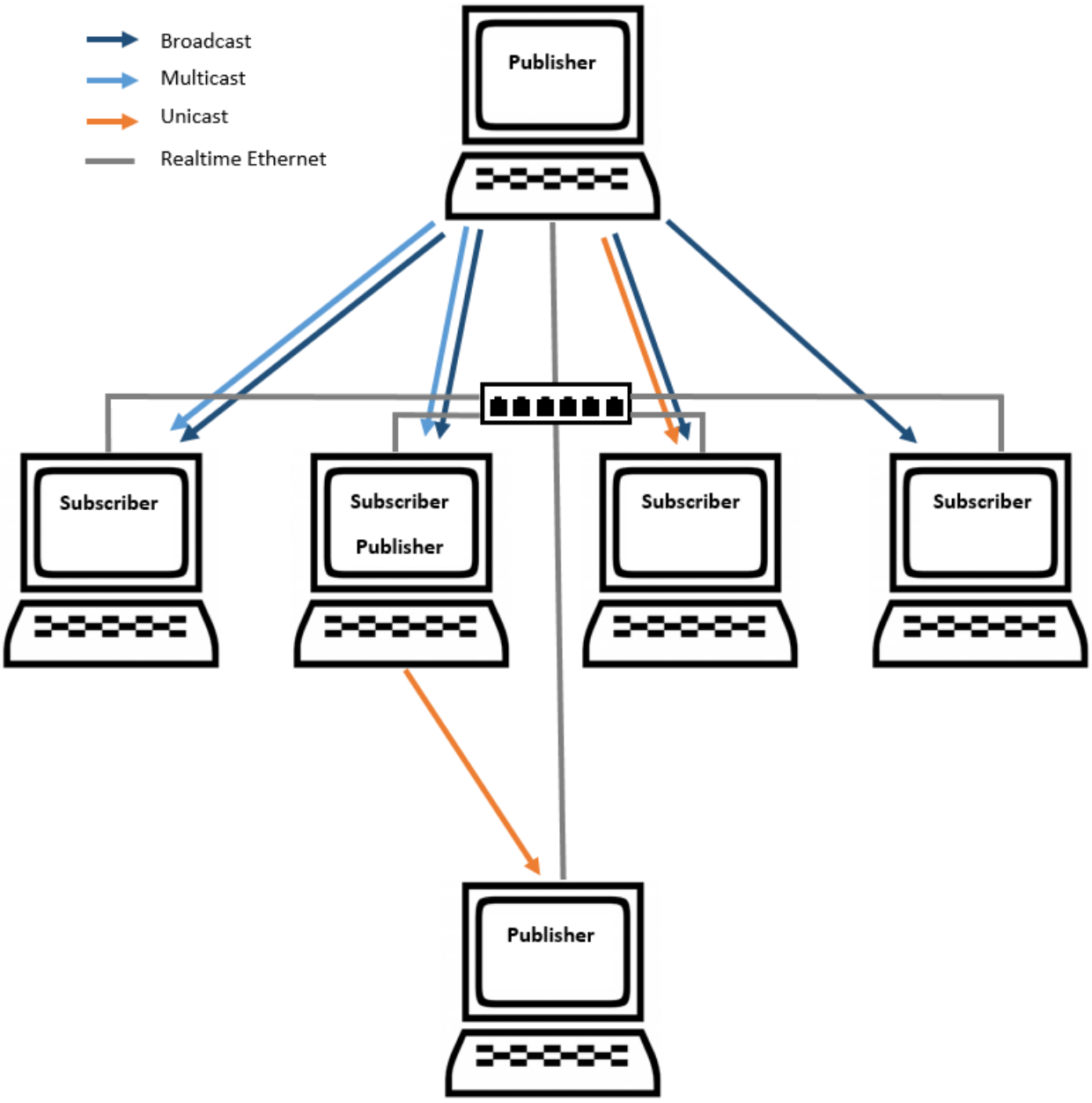


Fig. 37: Publisher/Subscriber model

Unicast

The Publisher makes the network variable available to a single selected PC.

Multicast

The Publisher makes the network variable available to selected PCs.

Broadcast

The Publisher makes the network variable available to all PCs.

4.2.2 Configuration of the Publisher

In the TwinCAT System Manager, a new box is added for the Publisher under the RT Ethernet device.

Insert a Publisher Box

A Publisher box must be added under the RT Ethernet device.

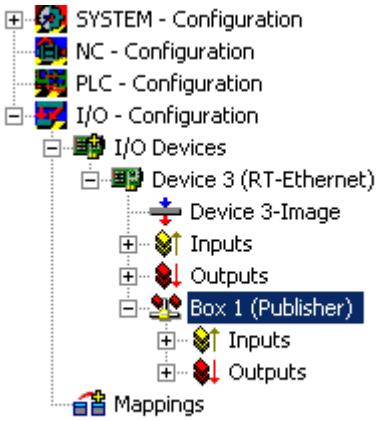


Fig. 38: Insertion of a Publisher Box in the TwinCAT configuration

Insert a Network Variable

The network variables are inserted underneath the box. Enter a name (nCounterPub in the sample) and a data type (UINT32 in the sample, corresponding to UDINT).

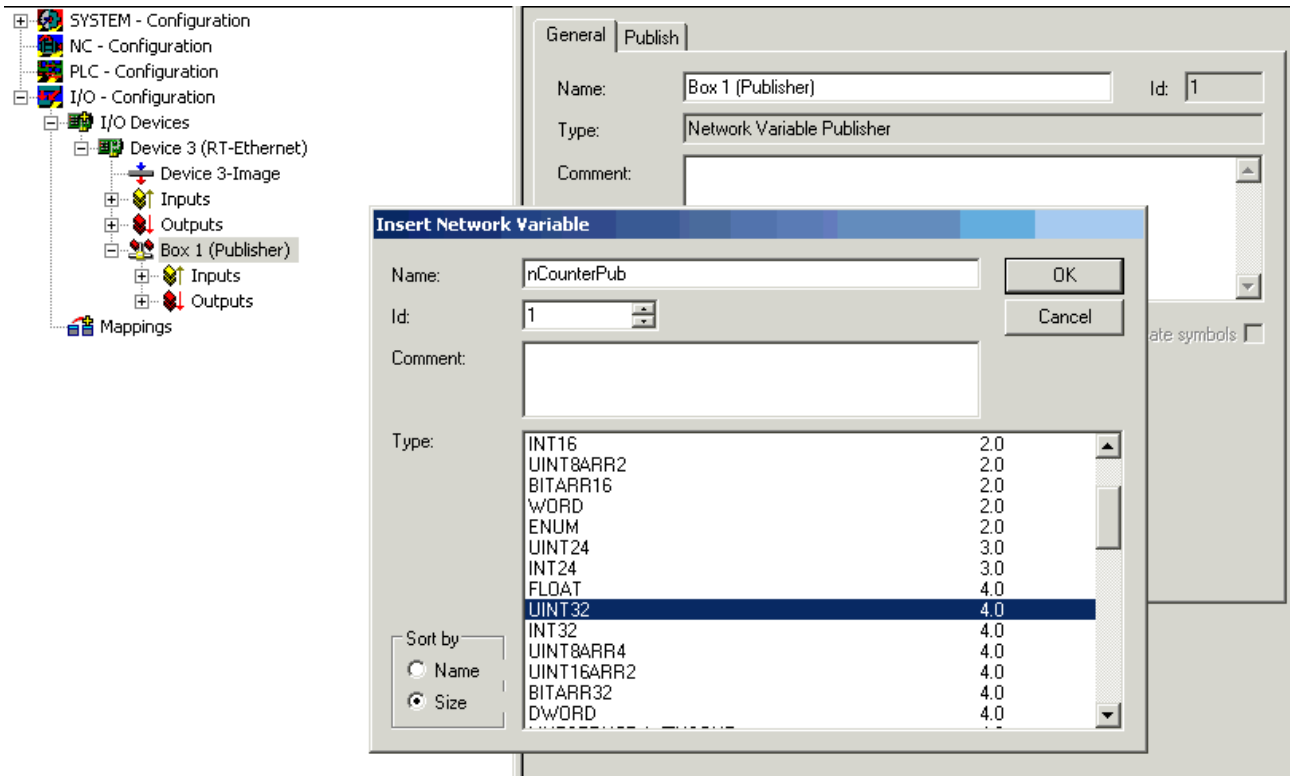


Fig. 39: Adding a network variable

Inputs and outputs are created underneath the added variables.

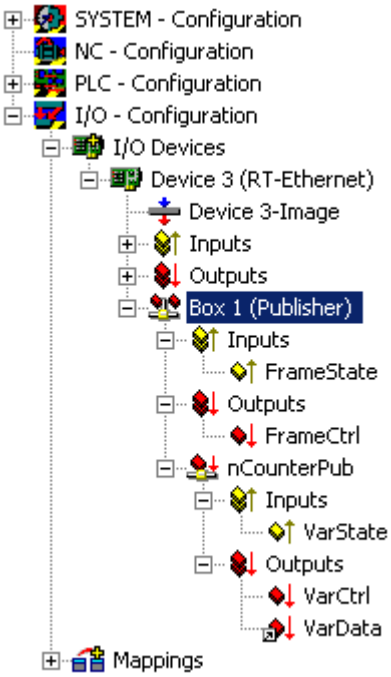


Fig. 40: Inputs/Outputs of the inserted variables

The FrameState input under the box indicates the current status of the sent Ethernet frames.

The following values are possible for the FrameState:

Short description	Value	Description
Not sent (frame skipped)	**0x0001**	
Error (frame oversized)	**0x0001**	The maximum size of an Ethernet frames was exceeded. The linked variable should be smaller.

A Control Word can be written in the FrameCtrl output under the box.

The following values are possible for FrameCtrl:

Short description	Value	Description
Disable sending	**0x0001**	Sending of a frame is interrupted. Sending of the frame does not restart until the value is 0 again.

The VarState input under the network variable indicates the current status of the network variable.
The following values are possible for VarState:

Short description	Value	Description
Not sent (variable skipped)	**0x0001**	

A Control Word can be written in the VarCtrl output under the network variable.

The following values are possible for FrameCtrl:

Short description	Value	Description
Disable publishing	**0x0001**	Sending of the network variable is interrupted. Sending of the network variable does not restart until the value is 0 again.

Mappings

The network variable of the Publisher can be mapped to any output variable with a suitable data type. In the sample, the network variable is linked to the output variable of a PLC.

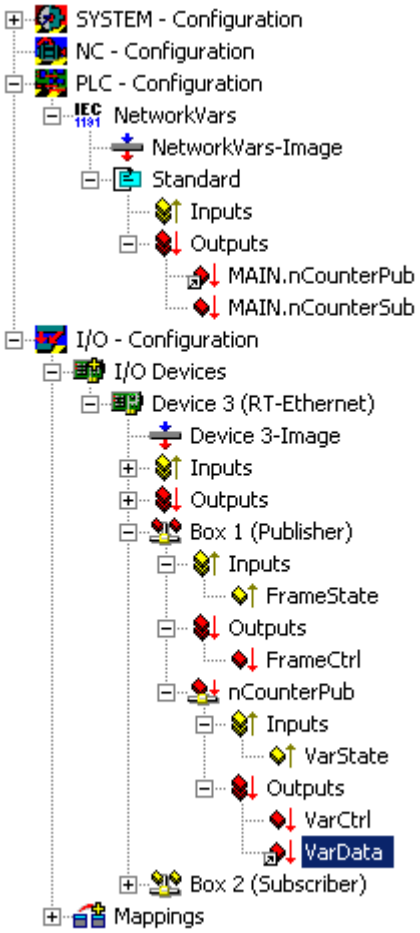


Fig. 41: Mapping of the network variable with an output variable of the PLC

4.2.3 Configuration of the Subscriber

In the TwinCAT System Manager, a new box is added for the Subscriber under the RT Ethernet device.

Adding a Subscriber box and linking the network variables

A Subscriber box must be added under the RT Ethernet device.

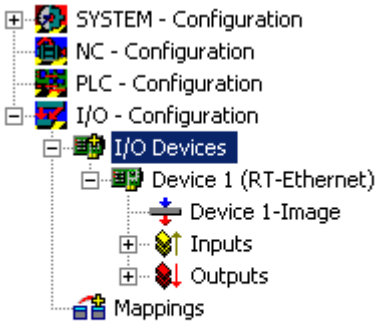


Fig. 42: Creation of an RT-Ethernet device

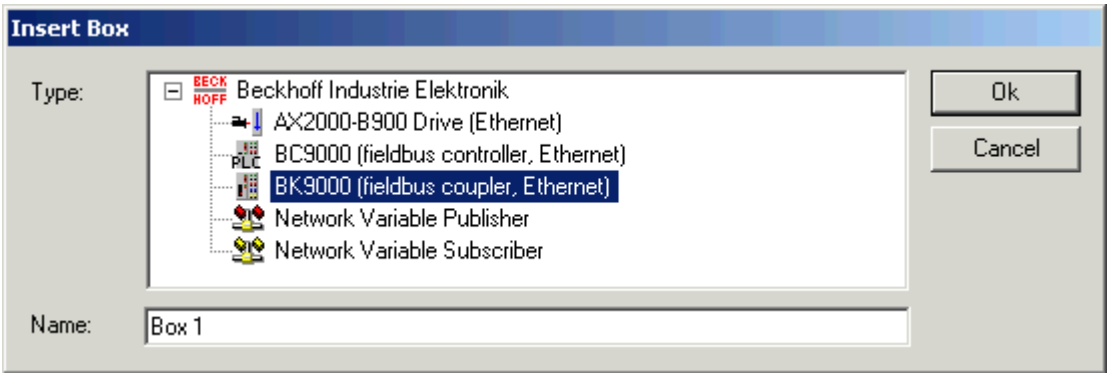


Fig. 43: Creation of a Subscriber Box (“Box 1”)

A network variable is then created under the Subscriber box.

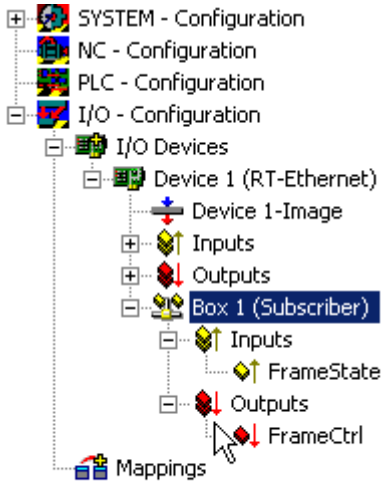


Fig. 44: TwinCAT tree with “Box 1” Subscriber Box

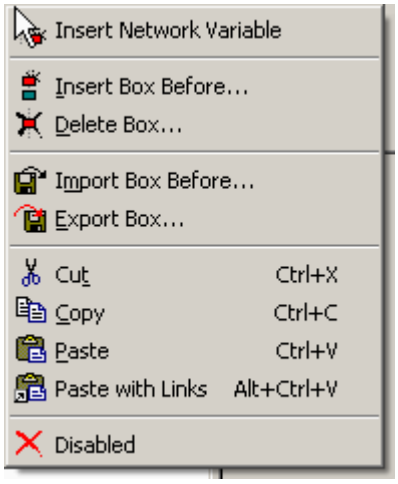


Fig. 45: Create network variable with right click

The link to a Publisher variable can be created automatically. First, you need to find the Publisher computer. All variables of this Publisher are then shown in a list.

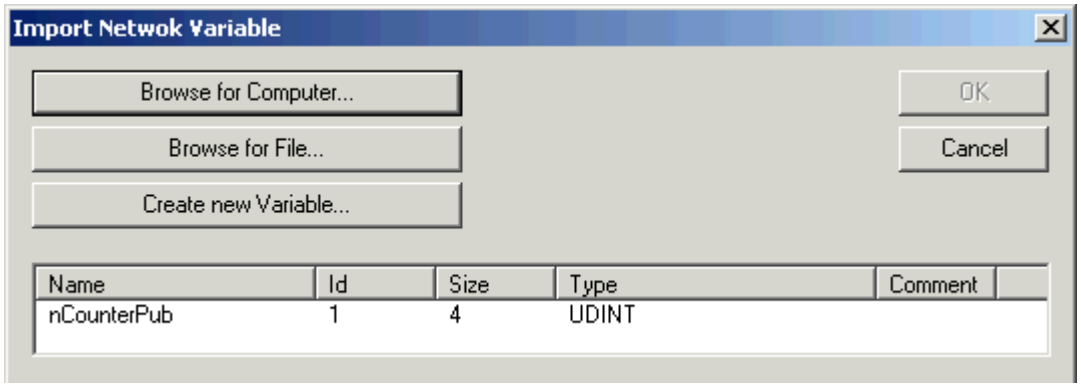


Fig. 46: Searching for Publisher computer

Inputs and outputs were created under the added variable.

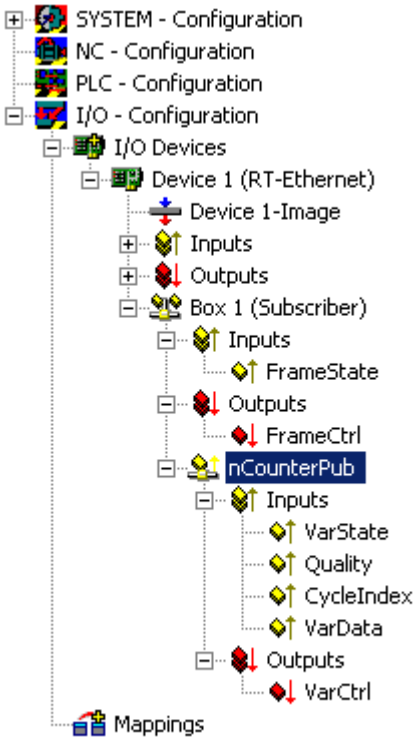


Fig. 47: Created in/outputs of the inserted variables

The FrameState input and the FrameCtrl output underneath the box give information about the current status or control of the received Ethernet Frames. FrameState and FrameCtrl are reserved and are currently not supported.

The VarState input and the VarCtrl output under the network variable indicate the current status (or control) of the received network variable. VarState and VarCtrl are reserved and are currently not supported.

Quality of the network variables

The quality of a network variable is assessed on the Subscriber side. Two input variables are available for this purpose under the network variable. The Quality variable provides a counter with a resolution of 100 µs. The counter value indicates the variable delay. The sample below shows the online value of Quality when the network connector is unplugged (counter increases) and reconnected (counter value 0).

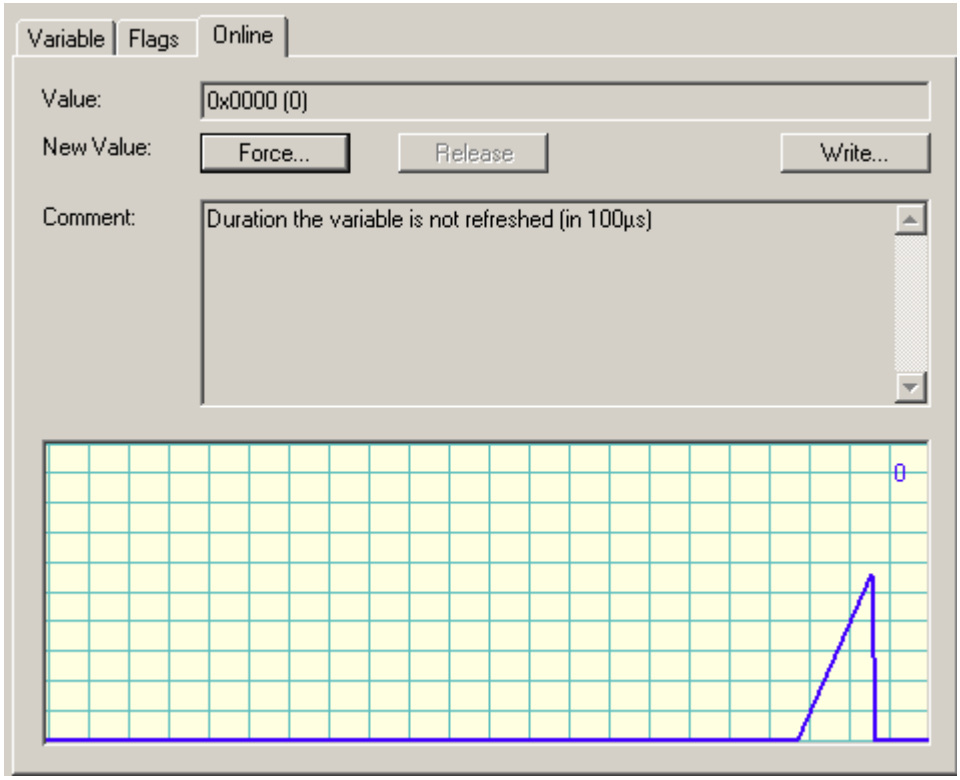


Fig. 48: Time diagram (Online value) of the Quality variables

In addition to the Quality variables, the CycleIndex variable is incremented in each Publisher cycle.

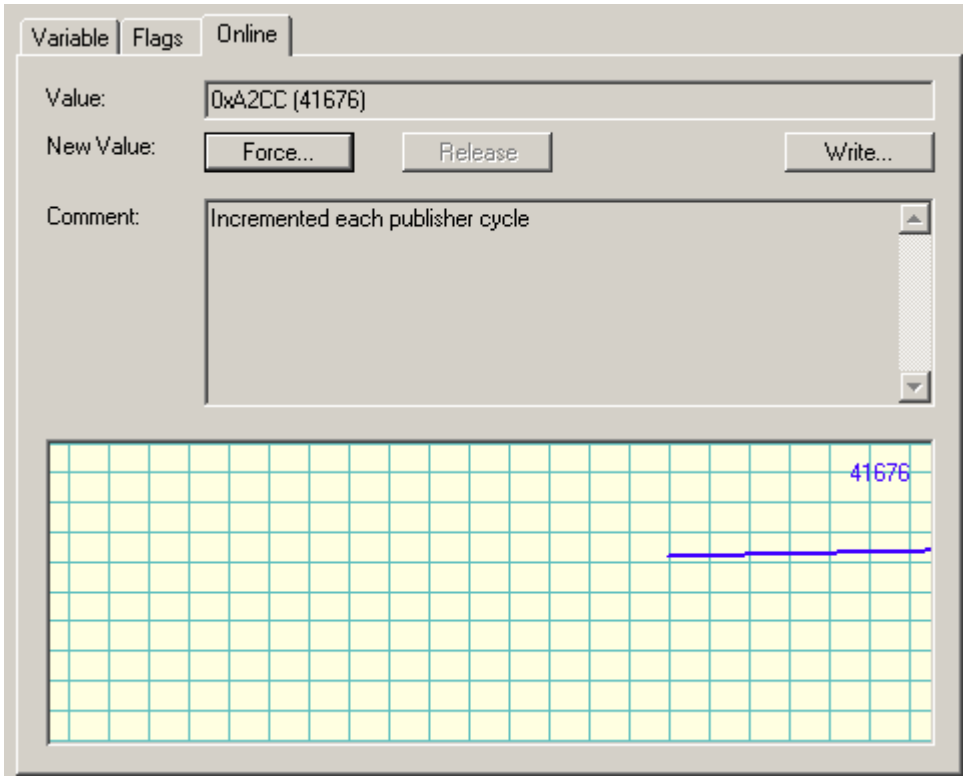


Fig. 49: Time diagram (Online value) of the CycleIndex variables

4.2.4 Beckhoff network variables - Settings

Beckhoff network variables (NWV) can be used for cyclic or acyclic sending of data between Windows-based PCs. In a device declared as a publisher (sender), such a network variable is received on the other side by a subscriber declared as the same type. As the name suggests, this data traffic is network-based, and the configuration is directly based on the protocols used.

A choice of two protocols is available:

- **MAC:** An ISO Layer 2 frame is sent with a sender and receiver MAC address, Ethertype 0x0806. An IP part with the destination IP address (e.g. 192.168.0.1) is not included. The telegram can therefore be further processed via a switch, but usually not via a router.
  MAC stands for media access control and in this case refers to the (unique) hardware address assigned to each Ethernet device during production. For sample, the Ethernet port of a Beckhoff PC might have the MAC ID 00:01:05:34:05.84, with "00:01:05" representing the Beckhoff ID and the rest assigned during production. The route of each Ethernet telegram between two Ethernet cable ends is determined by the source MAC and the destination MAC.
  The Ethernet telegram is identified as Beckhoff real-time Ethernet by the Ethertype 0x88A4. As a real-time Ethernet telegram (RT Ethernet) it bypasses the regular Windows TCP stack and is sent with higher priority, i.e. "immediately", via the specified Ethernet port of the PC.
  An option is available for configuring whether the sent telegram is received by all (broadcast), many (multicast) or a single subscriber (unicast).
- **UDP/IP**: The recipient is identified via an additional IP header in the Ethernet telegram. The UDP Ethernet frame can thus be further processed via a router.
  Once again, broadcast, multicast and unicast are available as options. The Ethernet telegram is identified as Beckhoff real-time Ethernet through the Ethertype 0x88A4 and treated as an RT protocol in the TwinCAT PC.
  In contrast to TCP, as a connection-less protocol UDP requires no acknowledgement of receipt for the message, i.e. the publisher does not know whether the subscriber has received the message. The ARP protocol [▶ 68] is therefore used for remote terminal monitoring in TwinCAT.

The telegram with the process data arrives at the recipient device (network port) via these addressing modes. In the Ethernet device/TwinCAT several transported process data are allocated via a variable ID

All network variables must be declared in the System Manager before they can be used.

The following intervention options are then available during operation:

- Sending of a configured network variable can be blocked dynamically
- The destination IP or destination MAC can be changed dynamically
- The variable ID "variable ID" can be changed dynamically
- The NWV content can be changed, but not the size (bit size)

Diagnostic variables on the publisher and subscriber side provide information about the connection quality.

If network variables are used, the temporal boundary conditions for the network topology used must be taken into account: in the case of IP addressing (routed) on a case-by-case basis several 100 ms communications cycle can be achieved, in the case of MAC addressing (switched) approximately 10 ms and less.

Diagnostic variable "quality"

If the processing tasks operate with different cycle times or the user changes the DataExchangeDivider, this must be taken into account in the analysis of the diagnostic variables. In conjunction with a fast Subscriber (e.g. 10 ms), a slow Publisher (e.g. 100 ms) leads to poor connection quality (as reported by the diagnostic variable "Quality").
Dynamic temporary blocking of sending a Publisher must also be taken into account. In this case the Subscriber registers poor quality.

Diagnostic variable "CycleIndex"

Please note the following information in order to decide whether you have to serve the variable CycleIndex.

Basic principles of Beckhoff network variables

- **Quality**:
  Time in [100 µs] by which arrival of the NWV at the Publisher was delayed.
  Relative arrival location:
  Input process image of the TwinCAT system
  Relative arrival time:
  Time at which the next cycle is loaded into the input image

  Note:
  The reason for determining the delay so precisely is that the NWVs are managed directly by the IO driver, independent of the cycle. Nevertheless, the data of an NWV that is delayed by a few percent of the cycle time will not be taken into account until the input process image is read during the next task cycle.

  Note EL6601/EL6614:
  Even with the EL66xx the NWV arrival time is defined as the time when the data are available in the input process image of the RT device, not the time of arrival at the EL66xx or in the input image of the EtherCAT device.

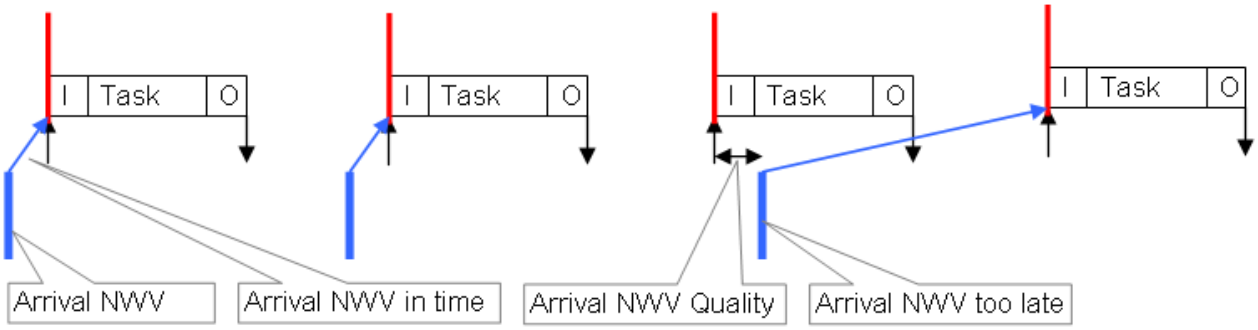


Fig. 50: Interrelationship between quality and delayed network variable

- **Variable ID**
  The variable ID (16 bit) is used for global identification of the individual process data. Therefore, an ID in the Publisher or Subscriber group may only be used once within a TwinCAT device, see Fig. *Sample for communication via network variables*: Publishers 1 and 2 on PC1 must have different IDs (10 and 8), although the same ID (8) may be used in Publisher 2 and Subscriber 1.

Selecting the variable ID

In order to achieve unambiguous allocation we recommend using different IDs for each data communication between connected PCs. Reason: In Fig. *Sample for communication via network variables,* PC2/Subscriber2 not only receives the designed ID=8-variable from PC1/Publisher2, but, since it is sent as a broadcast (!), it also receives the NWV from PC3/Publisher1. Differentiation is then no longer possible in PC2.

- Cycle Index
  The 16-bit cycle index is a counter sent by the Publisher together with the data. It is generally incremented with each transmission and can therefore be used as an indicator for flawless transfer. It can be read on the subscriber side as *CycleIndex*. Its appearance depends on the Publisher platform:
  - Publisher on a PC: The variable *CycleIndex* is not visible and is automatically and cyclically incremented by the System Manager
  - Publisher on an EL66xx: The variable *CycleIndex* is visible and must be incremented/served by the user such that it is not equal 0 on the subscriber side.

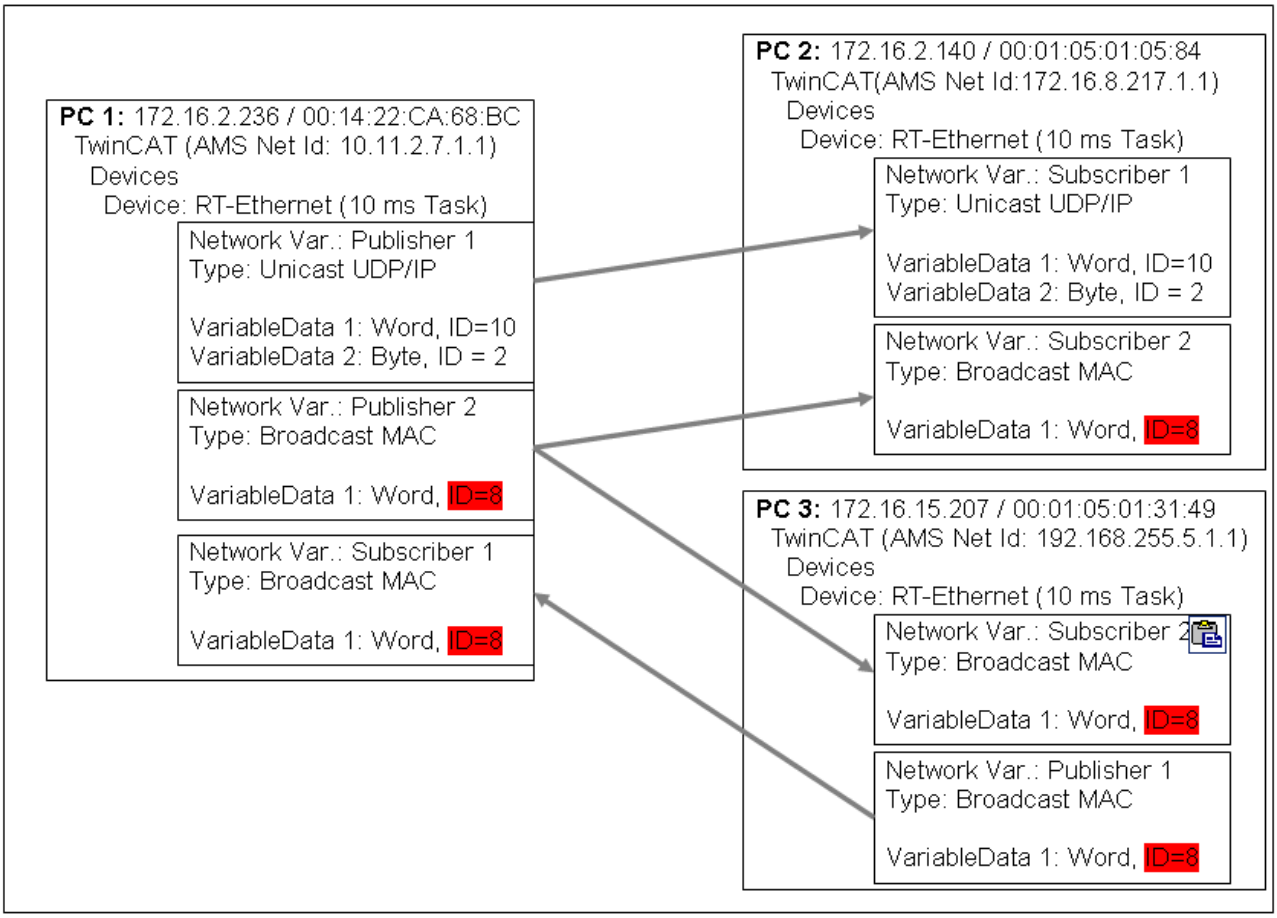


Fig. 51: Sample for communication via network variables

Data representation on different platforms

Please note that simple and complex data (WORD, ARRAYs, REAL, STRING, user-defined structures) are represented internally in a different manner on different platforms!

x86 platforms use byte-alignment, others (ARM) 2-byte or 4-byte alignment.
This means that if a complex structure is created in an x86/PC PLC project and an ARM PLC project, they can each have a different effective size and a different internal structure. (see Fig. *"Data representation e.g. x86 Systems vs. ARM Systems")*

In the sample, the structure in the CX (and hence the network variable to be created there) is larger than in the PC; also the word and real variables do not match each other because a variable can begin at any byte position in the PC, but only at every even-numbered one in the CX.

Consequences

Recommendation for structures that are identical on both end devices
- firstly, all 4-byte variables (must lie at an address that is divisible by 4)

- then all 2-byte variables (must lie at an address that is divisible by 2)

- then all 1-byte variables

Further recommendations

- if STRING(x) is used, the "EndOfString" zero is also interpreted as a character, otherwise x+1 must be divisible by 4

- the above rules also apply to sub-structures.

Please refer to the notes in the Structure section of the Infosys.

Consequences

Use of Bus Terminal Controllers (BICxxxx, BXxxxx)

Since the representation of floating point numbers (REAL) on Bus Terminal Controllers (BCxxxx, BXxxxx) differs from that in the x86, these cannot be transmitted. "SINT", for sample, can be used for signed values.

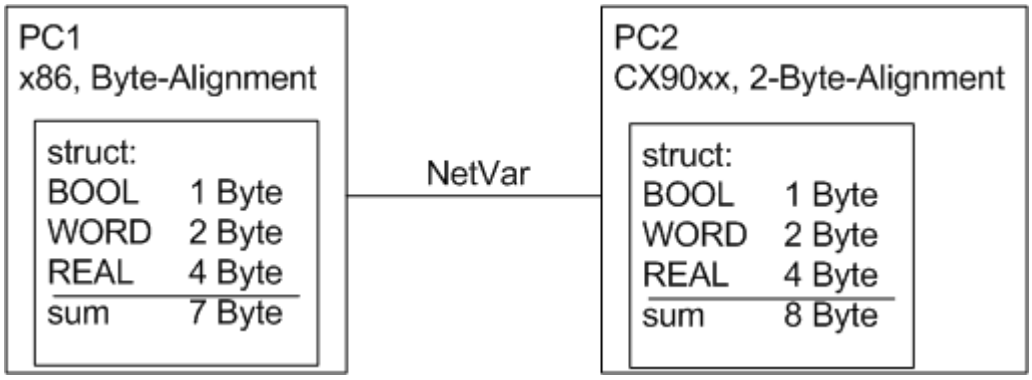


Fig. 52: Data representation e.g. x86 Systems vs. ARM Systems

Settings in the System Manager

Appearance of the variables

Depending on the platform used (PC or EL66xx), the publisher/subscriber will appear differently. A publisher/subscriber can be created

- On a PC network interface, see Fig. *Publisher settings - RT Ethernet*
- on an EL66xx, see Beckhoff network variables - Settings [▶ 64]

The following settings options are available in the Beckhoff System Manager TwinCAT 2.10 build 1328:

Publisher, Box

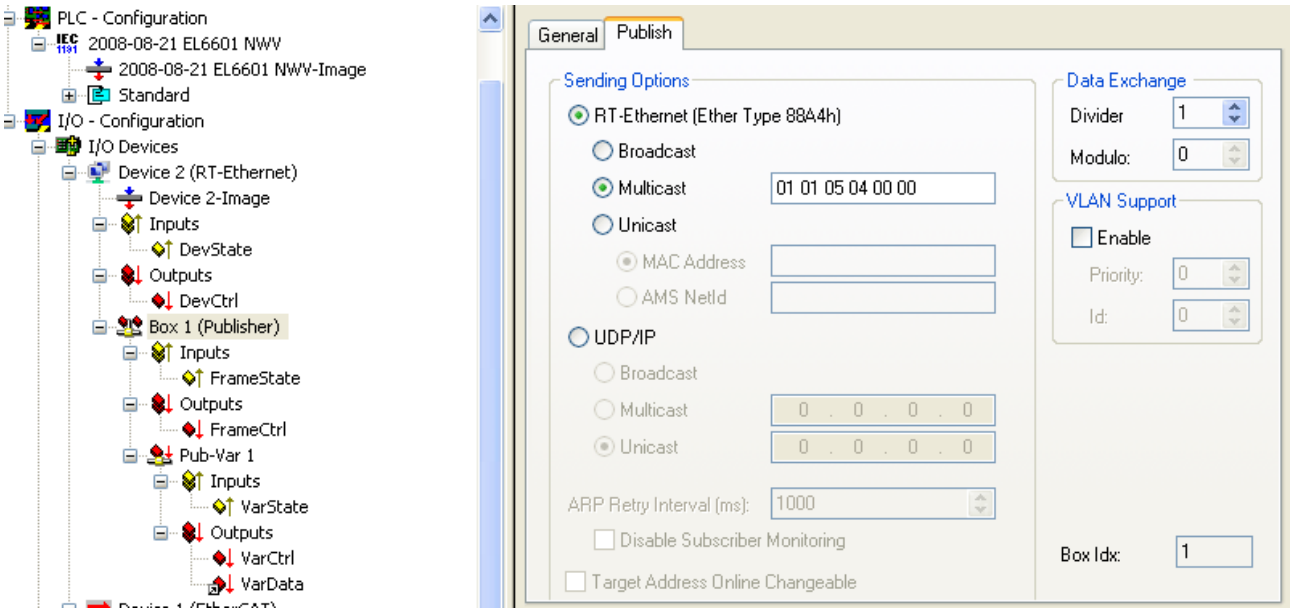


Fig. 53: Publisher RT Ethernet settings

RT Ethernet settings:

- **MAC-Broadcast:** Sent to all network devices, destination MAC FF:FF:FF:FF:FF:FF.
- **Multicast**: A destination MAC address becomes a multicast address if the first bit in the first byte of the MAC (the so-called group bit) is set. With the Beckhoff ID "00 01 05" the default target address "01 01 05 04 00 00" is formed, as shown in Fig. *Publisher RT Ethernet settings*.
  The MAC range 01:00:5E:00:00:00 to 01:00:5E:FF:FF:FF is intended for general multicast application, with the first 3 bytes specified by the IEEE and the last 3 bytes derived from the lower part of the IP address of the destination PC. The resulting destination MAC therefore never physically exists in the network. Instead, the destination network card detects Ethernet frames formed in this way as multicast frames sent to it, although the Ethernet port itself can have another, unique MAC address. Please refer to the relevant literature for further rules relating to the formation of multicast MAC/IP addresses.
- **Unicast**: Either direct entry of the destination MAC or via the AMS Net ID of the destination device, e.g. 123.456.123.456.1.1, in which case this route must be entered in the local AMS router (right-click on the TwinCAT icon in the taskbar --> Properties --> AMS router)

Use of broadcast and multicast

Network variables sent as broadcast or multicast at MAC or IP level can generate high network load (depending on the cycle time), since they are multiplied into the whole connected network. This may cause simple network devices such as printers to crash. With short cycle times all network traffic may become blocked. We strongly recommend using unicast addressing, taking into account variable identification, as described above.

Advanced Settings:

- Data exchange: The task cycle time * divider is the rhythm at which this network variable is sent. (not for EL66xx).
- VLAN support: In conjunction with manageable switches the Ethernet frame parameterized here can be assigned a fixed route via VLAN tagging (Virtual Local Area Network).

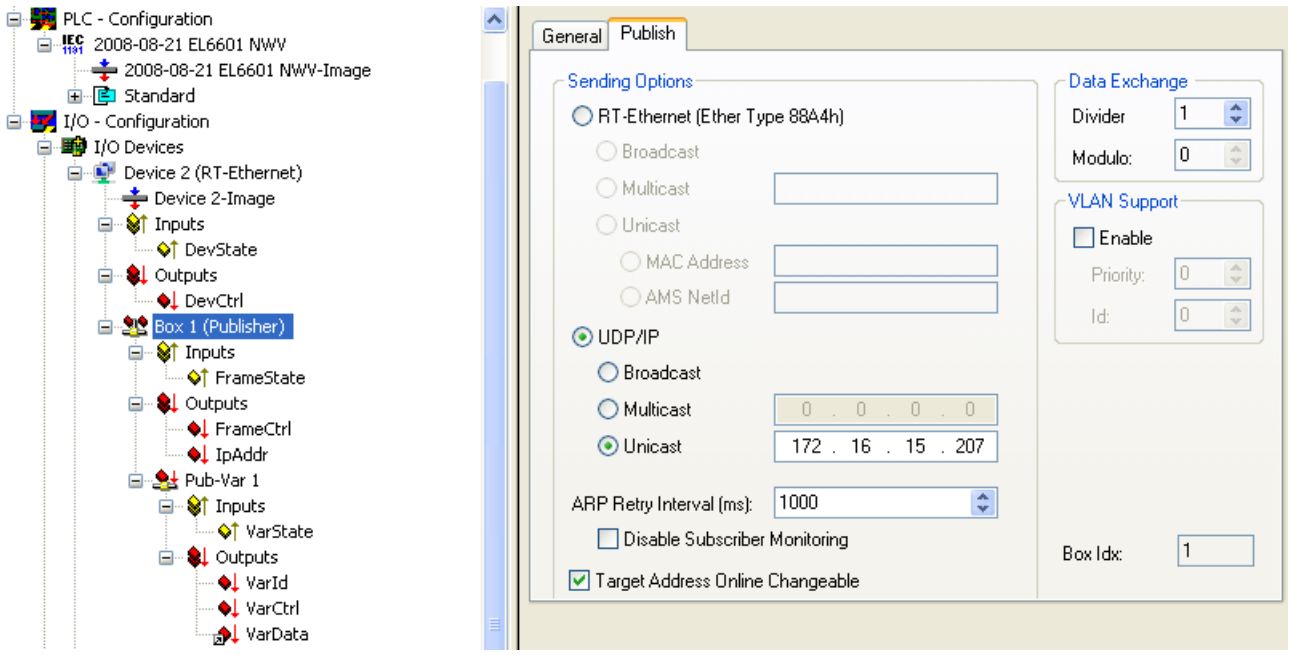


Fig. 54: Publisher settings - UDP/IP

UDP/IP settings - the addressing technique of the IP network layer with IP addresses is used. UDP is a connection-less protocol without feedback.

- Broadcast: Sent to all device with destination IP (v4) 255.255.255.255
- Multicast: The destination IP must be specified, see notes on MAC multicast
- Unicast: Specify the target device (e.g.: 192.168.0.1), making sure that it can be reached through the subnet mask

Use of broadcast and multicast

Network variables sent as broadcast or multicast at MAC or IP level can generate high network load (depending on the cycle time), since they are multiplied into the whole connected network. This may cause simple network devices such as printers to crash. With short cycle times all network traffic may become blocked. We strongly recommend using unicast addressing, taking into account variable identification, as described above.

Advanced Settings:

- "ARP Retry Interval": In order to ascertain the presence of the recipient, the publisher sends an ARP request to the target device at these intervals. If the network administration of the recipient is operational, it sends an ARP reply. This is only meaningful with unicast.
  In the event of an error bit 3 is set (0x0004) in the diagnostic FrameState variable.
  Note: ARP handling (ARP = Address Resolution Protocol: allocation of hardware/MAC addresses to network addresses [IP]) is managed by the operating system (Windows).
- "Disable Subscriber Monitoring": deactivates the procedure described above.
- "Target Address changeable": In this case the destination IP can be changed dynamically.

Publisher, Variable

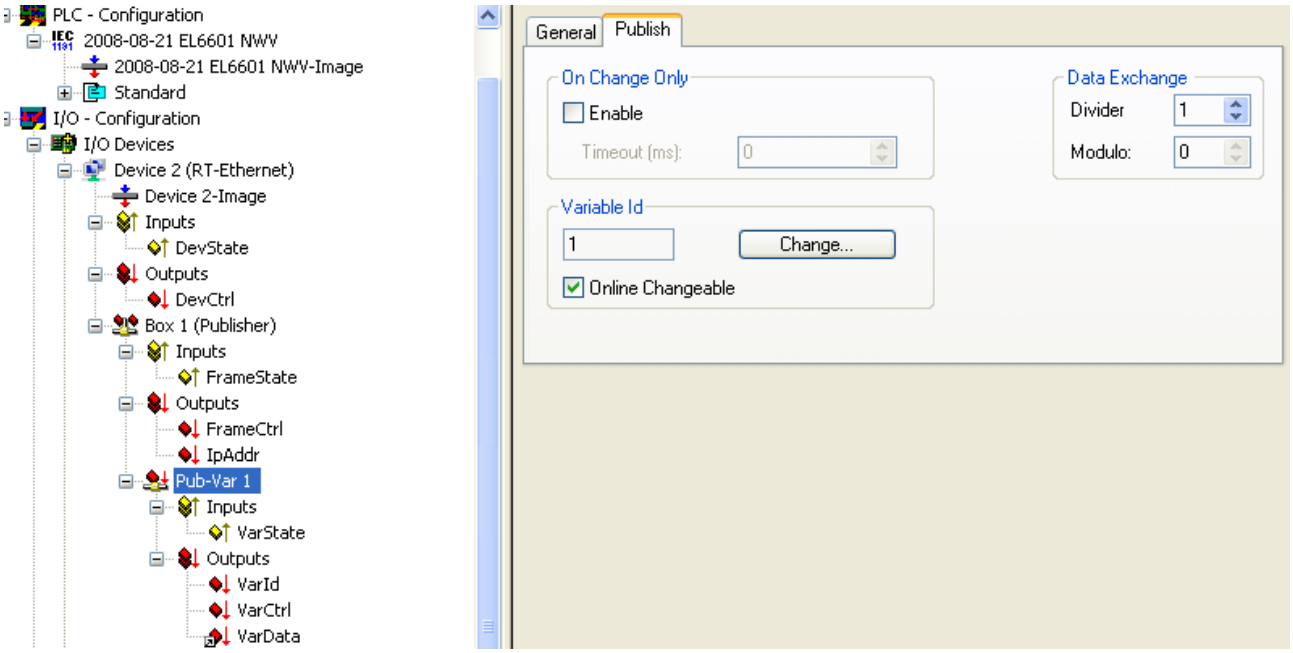


Fig. 55: Publisher variable settings

Settings:

- "Variable ID": Identification number with which the variable is sent. Can be changed online via PLC where appropriate.
- "Data exchange": see above (not for EL66xx).
- "On change only": NWV is only sent if the value changes (not for EL66xx).

Subscriber, Box

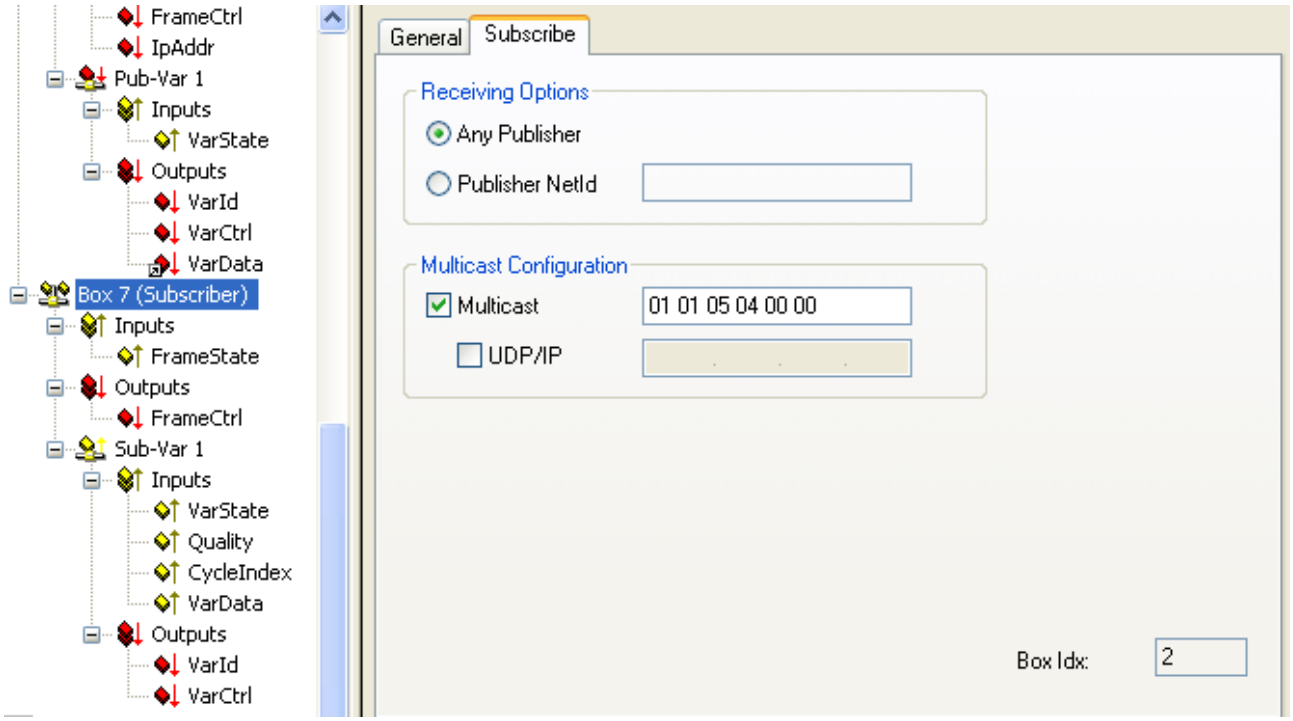


Fig. 56: Subscriber settings

Settings:

- "Receiving Options": Only permits NWVs from a certain publisher for this subscriber

- "Multicast Configuration": ditto.

Process data:

- "VarId": If activated, the variable ID can be modified online

Subscriber, variable

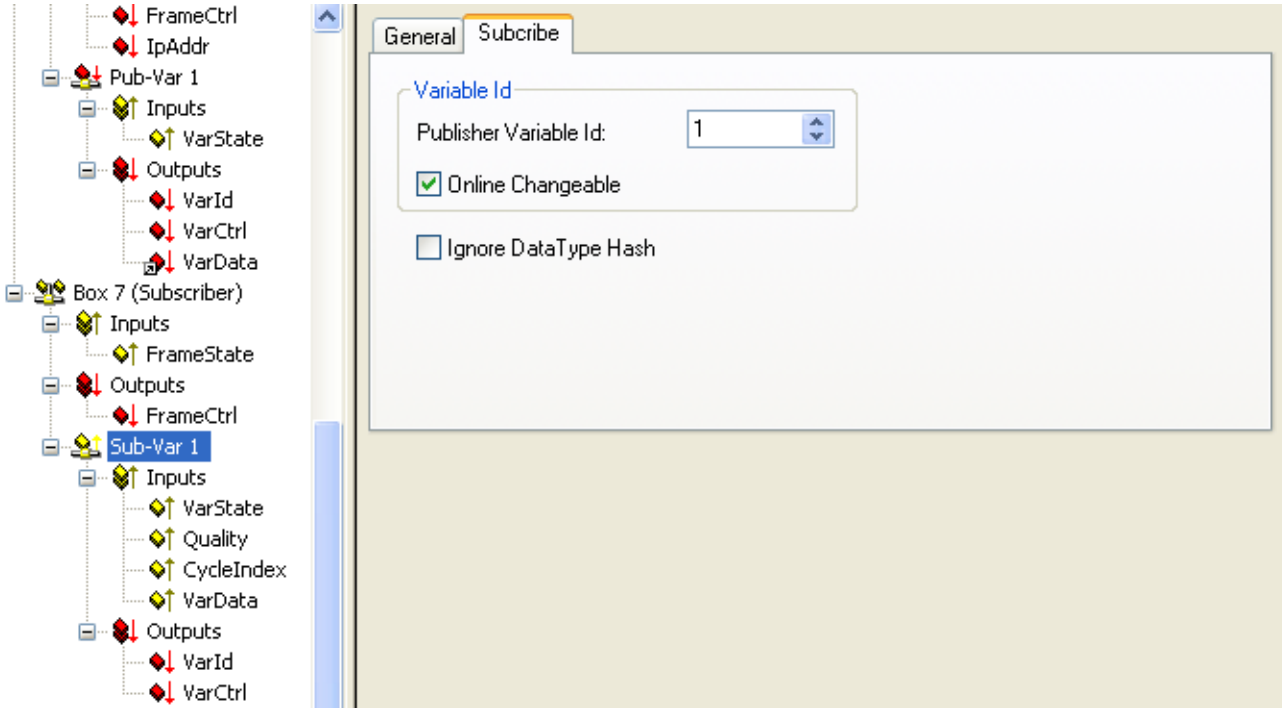


Fig. 57: Subscriber variable settings

Settings:

- "Variable ID": Only permits NWVs with a certain ID for this subscriber. Can be changed dynamically via PLC where appropriate.
- "Ignore Data Type Hash": Hash calculation is currently not supported

Process data:

- "Quality": See explanatory notes above.
- "CycleIndex": This index is incremented with each successful transfer, IF this is done by the opposite side, i.e. the publisher. If the publisher is an EL66x, the user must increment *CycleIdx* there.
- "VarData": Transferred data.

5 Application samples

5.1 Sample programs

Using the sample programs

This document contains sample applications of our products for certain areas of application. The application notices provided here are based on typical features of our products and only serve as samples. The notices contained in this document explicitly do not refer to specific applications. The customer is therefore responsible for assessing and deciding whether the product is suitable for a particular application. We accept no responsibility for the completeness and correctness of the source code contained in this document. We reserve the right to modify the content of this document at any time and accept no responsibility for errors and missing information.

Sample 1: Determine Publisher/Subscriber data throughput

Sample program (https://infosys.beckhoff.com/content/1033/el6601_el6614/Resources/17350688139.zip)

With appropriate EtherCAT cycle time and depending on the scale and number of the publishers/subscribers configured in the EL66xx, real-time cycle times down to 500 µs or below are possible.

Typical throughput values for EL6601, FW08, Rev. EL6601-0000-0018 are

- 1 publisher with 1000 bytes, 1 subscriber with 1000 bytes, simultaneous bidirectional operation: 2 ms
- 1 publisher with 100 bytes, 1 subscriber with 100 bytes, simultaneous bidirectional operation: 300 µs

Both characteristic values were determined with this sample program (https://infosys.beckhoff.com/content/1033/el6601_el6614/Resources/17350688139.zip). TwinCAT from version 2.11 is required for the *.tsm System Manager file.

The EL6601 is used as a sample to explain configuration as publisher or subscriber for network variables. The dialogs under TwinCAT 2.10 and TwinCAT 2.11 here are slightly different.

Sample 2: Online diagnostics

Sample program (https://infosys.beckhoff.com/content/1033/el6601_el6614/Resources/2349552907.zip)

The following objects are available for initial diagnostic in the CoE directory:

- 0xFA01, subindex 01: Frame Counter Rx (incoming to RJ45 socket)
- 0xFA01, subindex 02: Frame Counter Tx (outgoing from RJ45 socket)

The values can be read from the controller using PLC function blocks (FB_EcCoeSdoRead in TcEtherCAT.lib).

This and further diagnostic information from the CoE of the EL66xx are accessible via https://infosys.beckhoff.com/content/1033/el6601_el6614/Resources/2349552907.zip.

5.2 Application sample - network printer

The application samples have been tested with a test configuration and are described accordingly. Certain deviations when setting up actual applications are possible.

The following hardware was used for the test configuration:

- TwinCAT master PC with Windows XP Professional SP 2, TwinCAT version 2.10 (Build 1305) and INTEL PRO/100 VE Ethernet adapter
- Beckhoff Ethernet coupler terminal EK1100, terminals EL1012, EL6601 and EL9010
- Printer HP LaserJet 4200tn

A network printer is connected to the EL6601 within the terminal network via the Control Panel of the control system IPC:

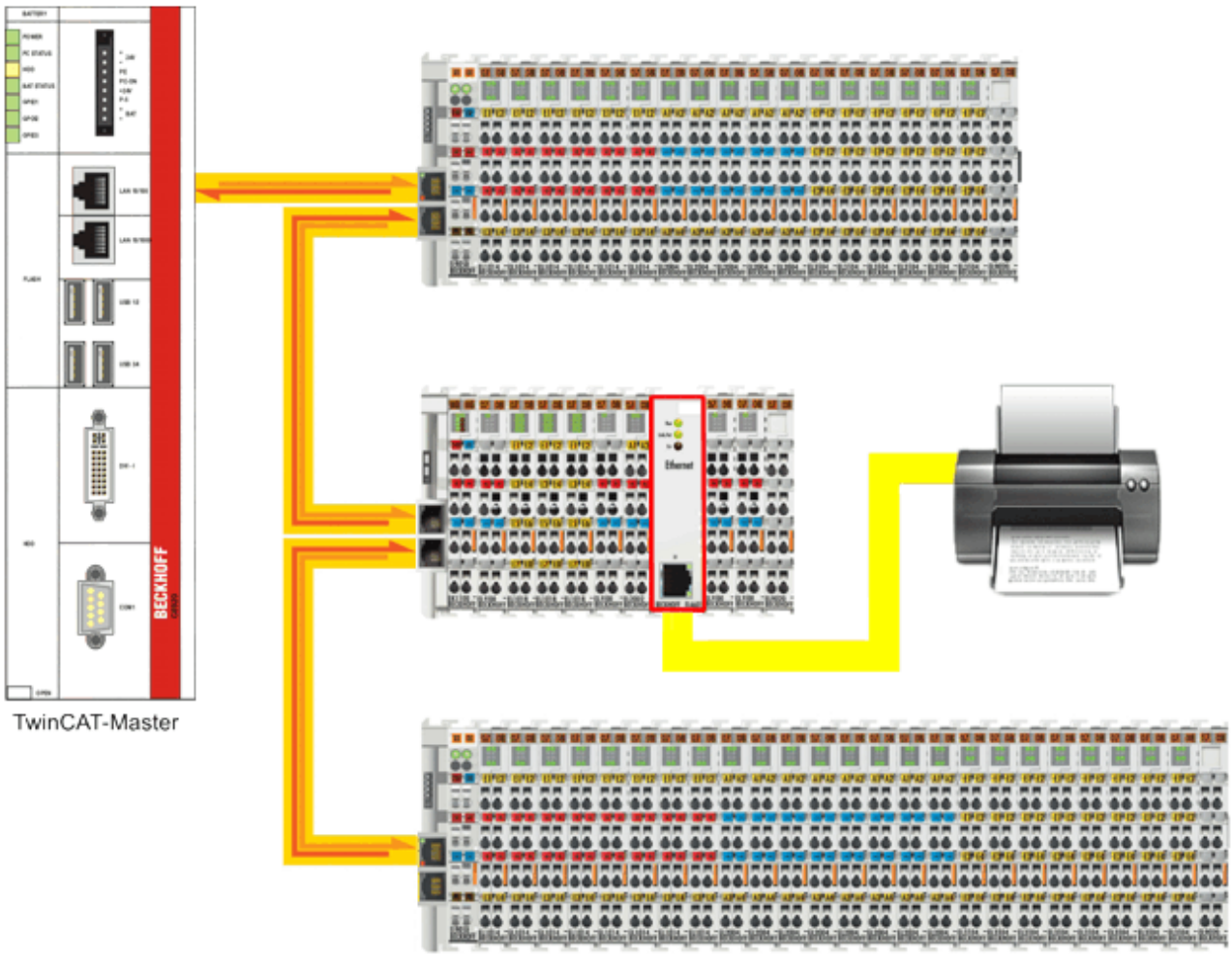


Fig. 58: Connection of a network printer

Legend:

EtherCAT connection

Ethernet connection

Checking the network address of the TwinCAT master PC

- Start the TwinCAT System Manager in Config mode, read the Bus Terminal configuration, and activate free-run mode

- The EL6601 should appear in the system configuration being in OP mode (see Online tab EtherCAT Status Machine)

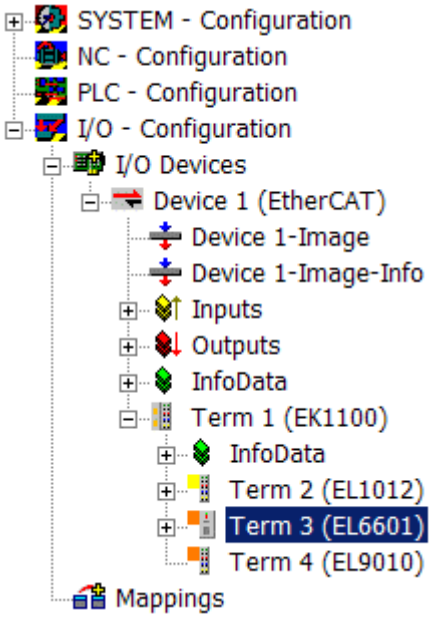


Fig. 59: EL6601 in the configuration

- Connect the network printer with the EL6601 via a CAT-5 (1:1) cable
- In the Control Panel of the controller IPC, check the network adapter via which the EtherCAT system is operated:
  Network Connections [Properties] -> *Local Area Connection* (TwinCAT LAN adapter), [Properties]-> *Internet Protocol* (TCP/IP) [Properties]

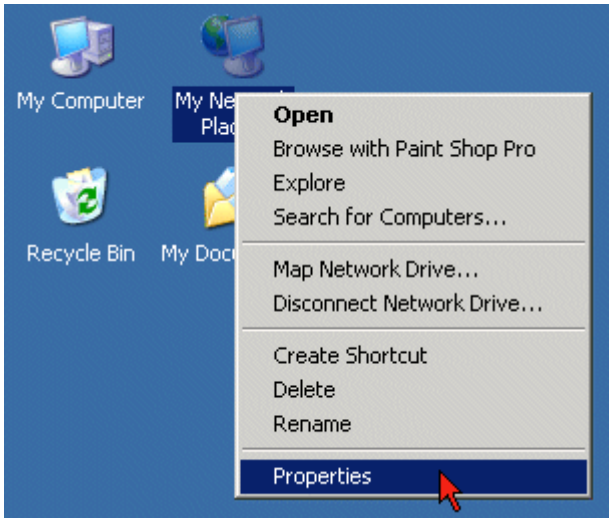


Fig. 60: Context Menu Network Environment -> “Properties”

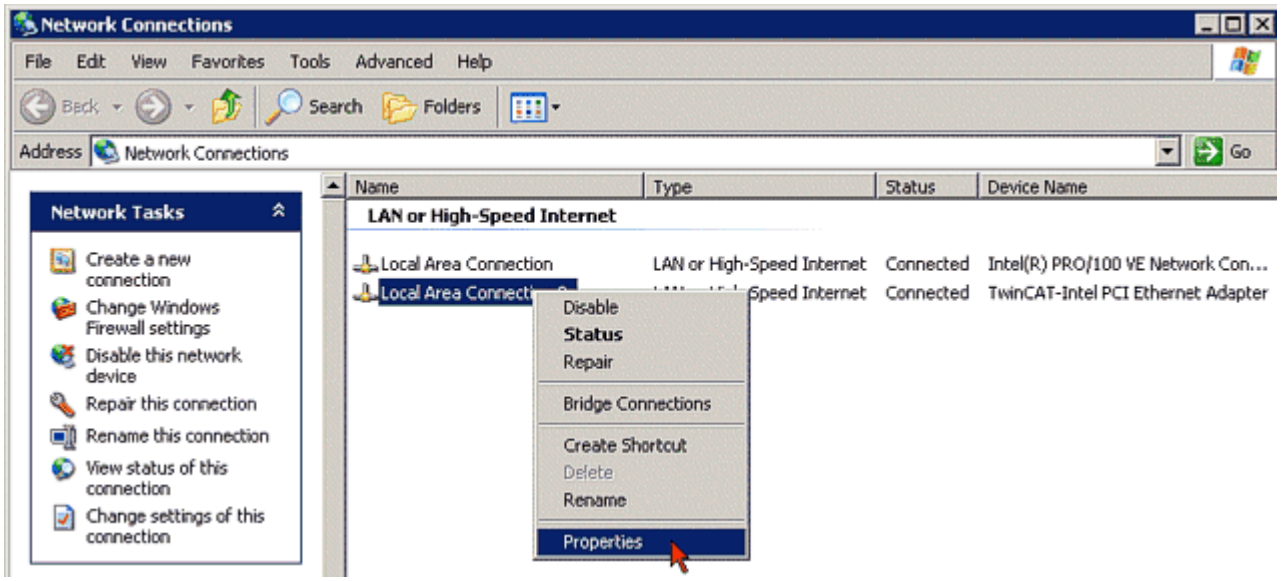


Fig. 61: Context Menu “LAN Connection (TwinCAT-LAN-Adapter),” -> “Properties”

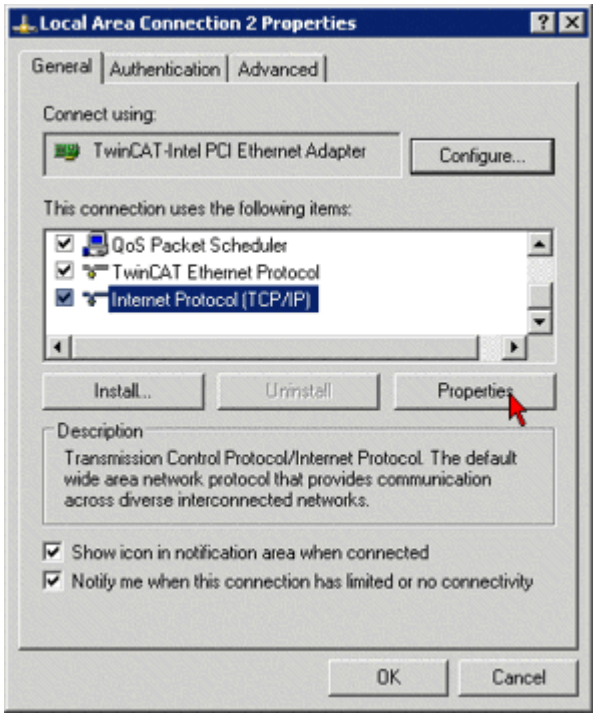


Fig. 62: Properties Internet Protocol (TCP/IP)

- Enter an IP address for the subnet of the network printer (e.g. 192.168.0.1/255.255.255.0) and confirm with *OK*

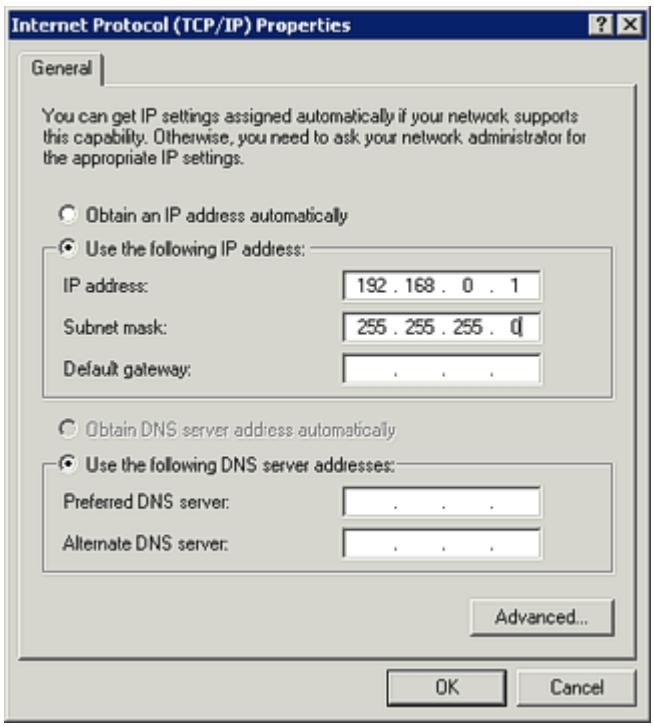


Fig. 63: Entry of the IP address of the subnetwork of the network printer

Network address

The network address in the sample is only used for the purpose of illustrating the configuration. Please note that in your application the IP address of network printer must match the IP number range/subnet mask of the master PC.

- Configure the network printer (in the configuration menu of the printer) and allocate the printer an IP address from the IP number range of the subnet defined above (Follow the user guide of your printer), e.g.: 192.168.0.37
- Configure the network printer via the Control Panel: *Printers & Faxes -> Add a printer* , in the Add Printer Wizard select *Local printer*, and in the following pull-down menu *Create a new port*. .. select *Standard TCP/IP Port*

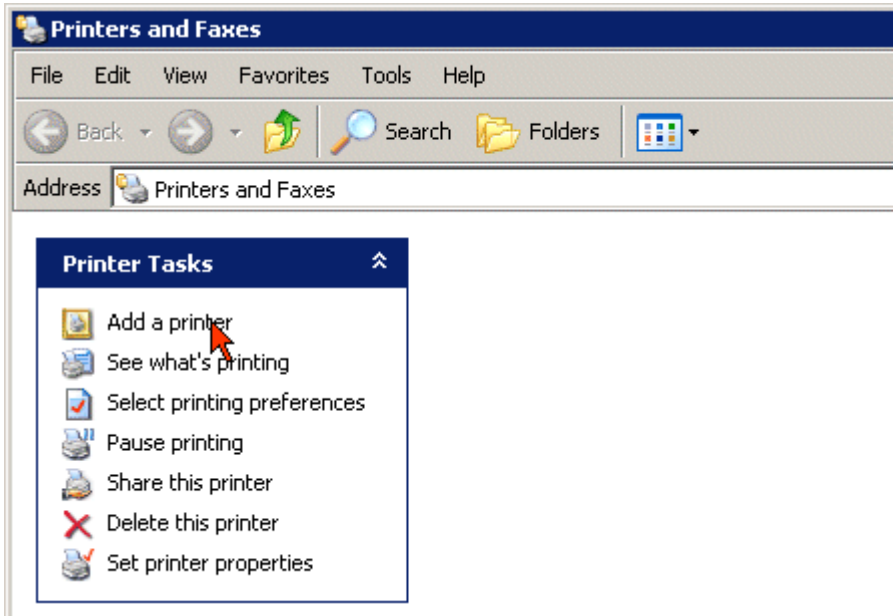


Fig. 64: Control Panel “Add a Printer” under “Printers and Faxes”

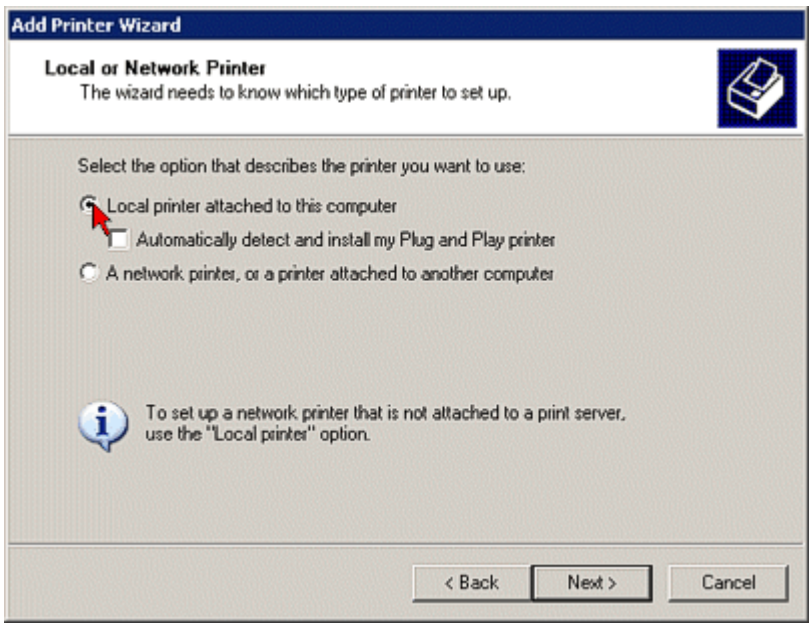


Fig. 65: Select “Local Printer” radio button

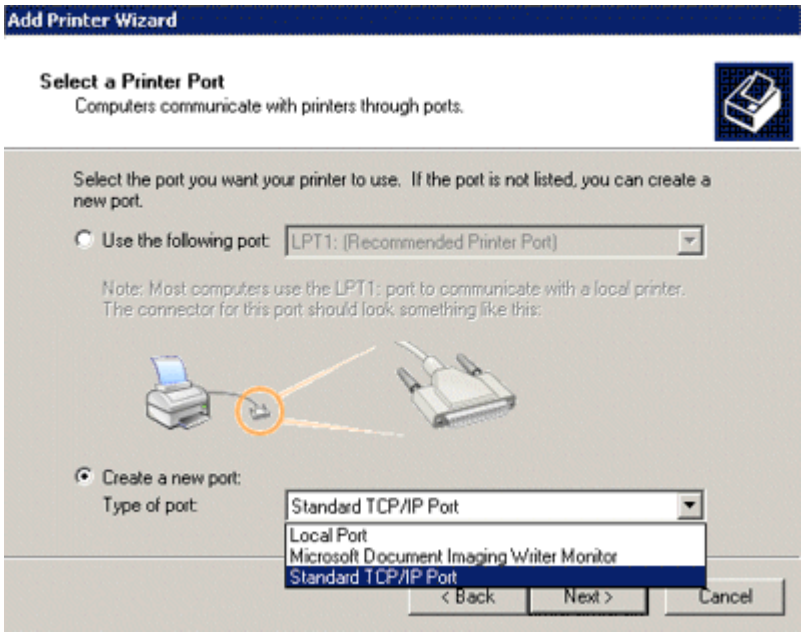


Fig. 66: Select Connection Type

- In the following menu under Printer Name or IP Address enter the IP address of the printer defined in the configuration menu (in the sample 192.168.0.37)

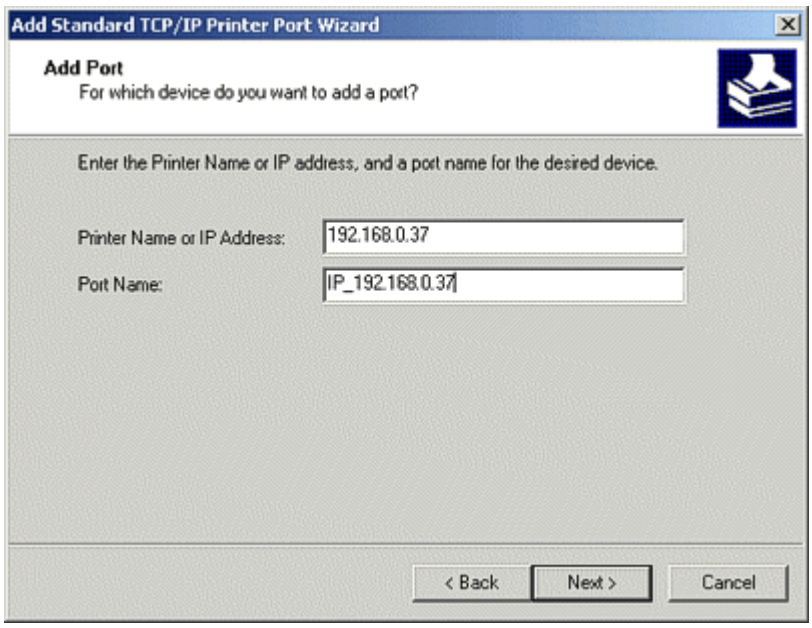


Fig. 67: Entry of the IP address and printer name

- Confirm the port properties and exit the wizard
- In the Add Printer Wizard install the drivers from your printer manufacturer

5.3 Application sample - Service interface with remote desktop

The application samples have been tested with a test configuration and are described accordingly. Certain deviations when setting up actual applications are possible.

The following hardware was used for the test configuration:

- TwinCAT master PC with Windows XP Professional SP 2, TwinCAT version 2.10 (Build 1305) and INTEL PRO/100 VE Ethernet adapter
- Beckhoff Ethernet coupler terminal EK1100, terminals EL1012, EL6601 and EL9010
- Notebook (service PC) for remote desktop connection with Windows XP Professional SP 2 and standard Ethernet interface

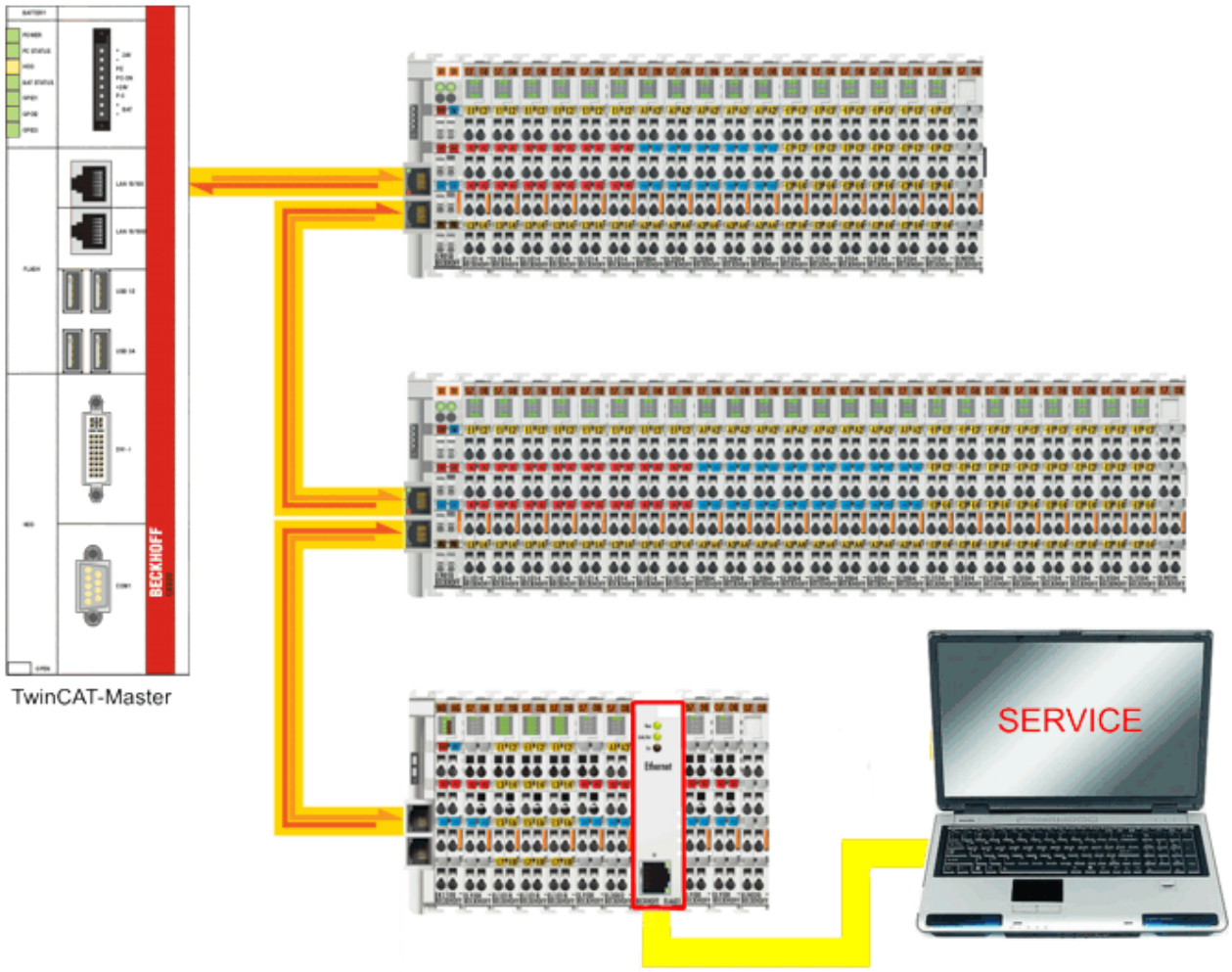


Fig. 68: Integration of a Service interface with remote desktop-PC

Configuration at the TwinCAT master PC

- Start the TwinCAT System Manager in Config mode, read the Bus Terminal configuration, and activate free-run mode
- The EL6601 should appear in the system configuration being in OP mode (see Online tab EtherCAT Status Machine)

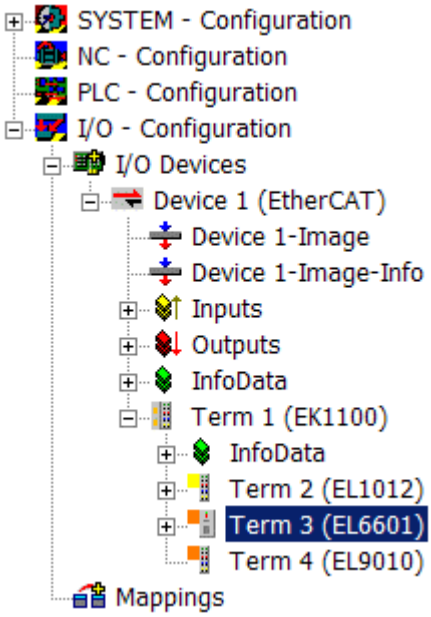


Fig. 69: EL6601 in the configuration

- In analogy to the configuration of a network printer the IP number of the EtherCAT network port of the TwinCAT Master-PC in the subnet is e.g. 192.168.0.1
- Open the Control Panel of the TwinCAT master PC and click on *Security Center -> Windows Firewall*

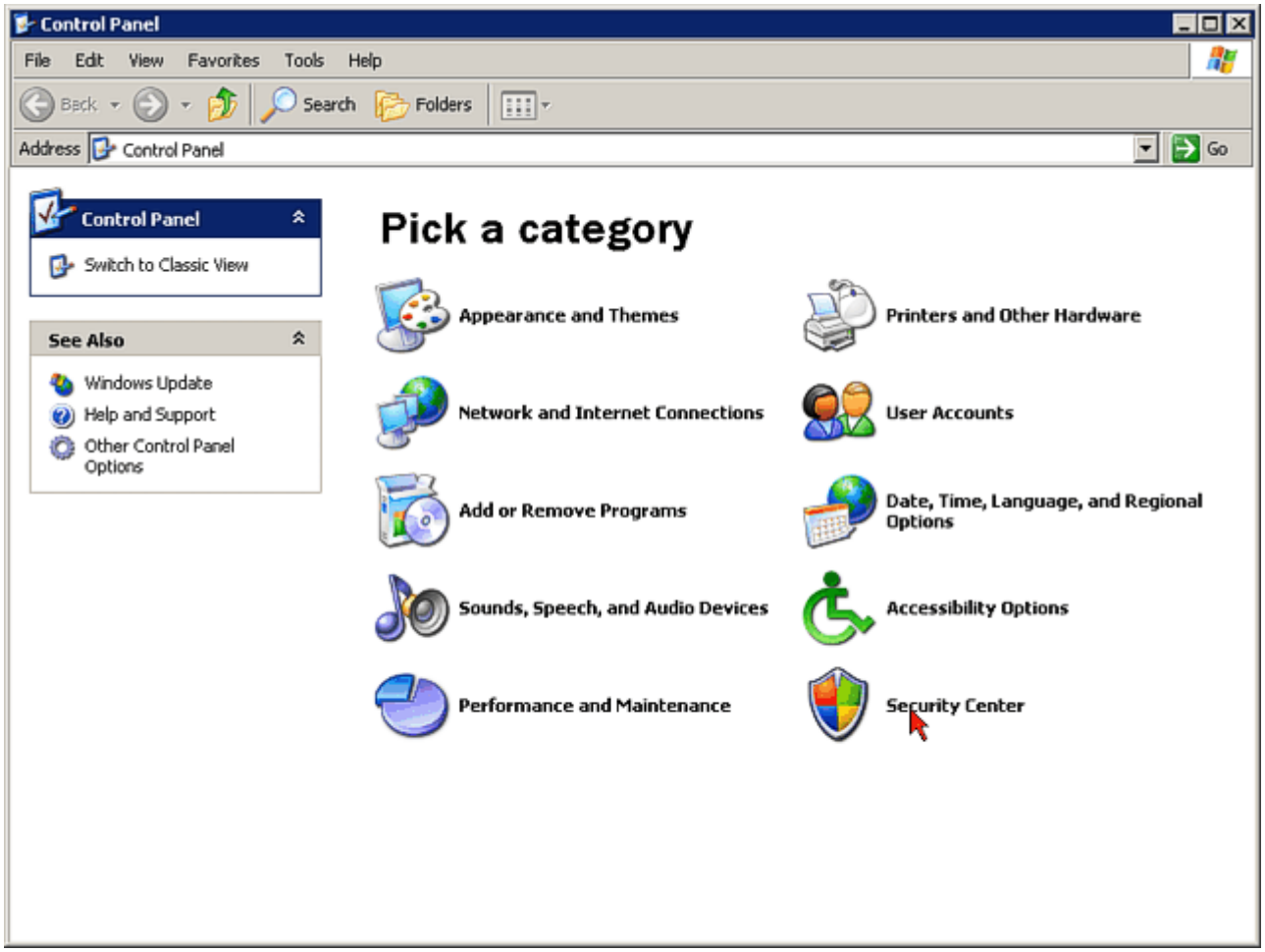


Fig. 70: Selection of “Security Center” in the View Control Panel Category



Fig. 71: Choose security settings for Windows Firewall

- If the Windows firewall is activated click on tab *Exceptions*
- Select *Remote Desktop* and confirm with *OK*

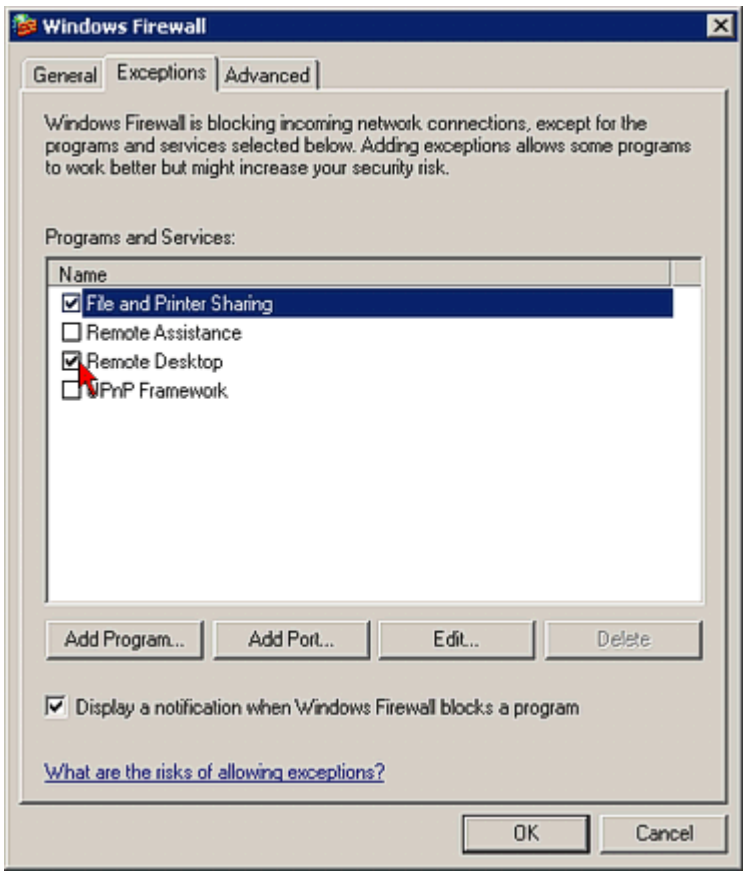


Fig. 72: At the “Exceptions” Tab activate the “Remote desktop” service

- Return to the Control Panel of TwinCAT master PC and select *Performance and Maintenance -> System*

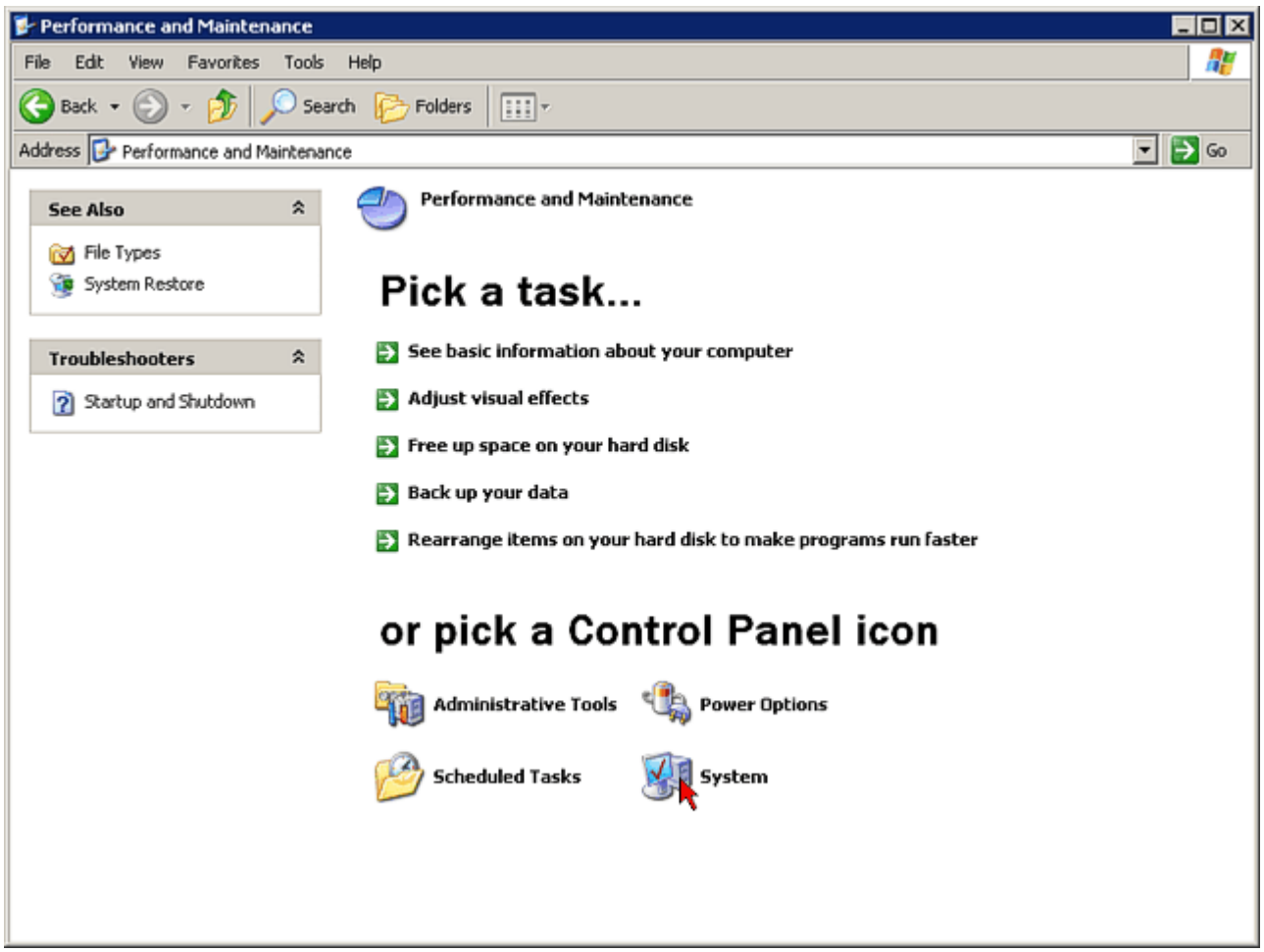


Fig. 73: Select “Service and Maintenance” from “System” in the View Control Panel

- Click on the *Remote* tab, and in the Remote Desktop category select the option *Allow users to establish a remote desktop connection*

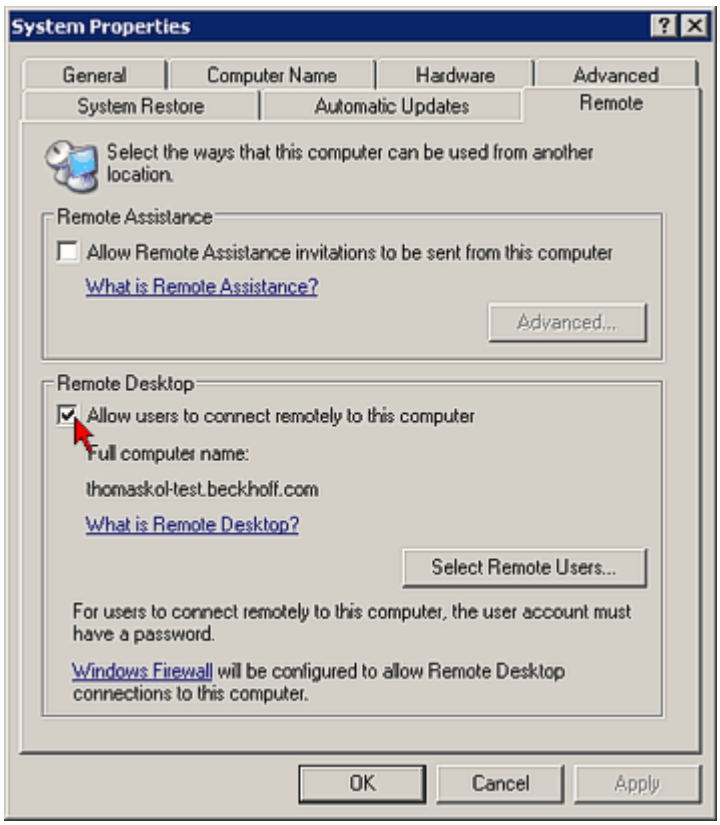


Fig. 74: Check “Allow users to establish a remote desktop connection”

- Open the list of remote desktop users via the button *Select remote users...* and add additional users if required
- Confirm with *OK*.

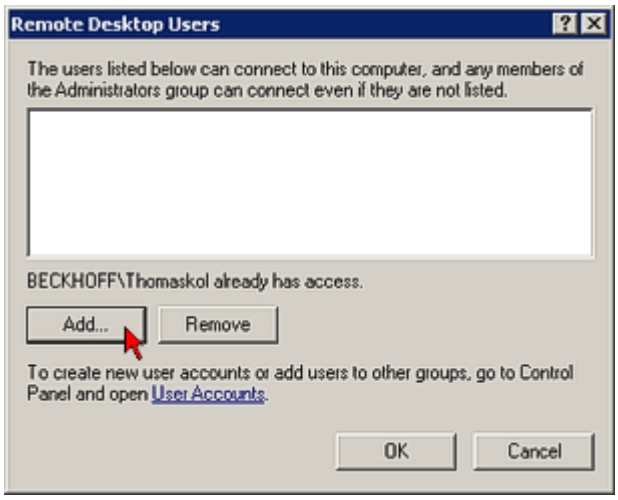


Fig. 75: Adding remote desktop users

Configuration at the service PC

For a remote desktop connection with the TwinCAT master PC via the EL6601 the network address of the service PC has to be set according to the IP number range of the TwinCAT master PC subnet.

- Connect the Ethernet port of the service PC with the EL6601 via a CAT-5 (1:1) cable
- In the Control Panel of the Service-PC check the Ethernet network adapter, via which the EtherCAT system is operated:
  Network Connections [Properties] -> *Local Area Connection* (Ethernet LAN adapter), [Properties]-> *Internet Protocol* (TCP/IP) [Properties]

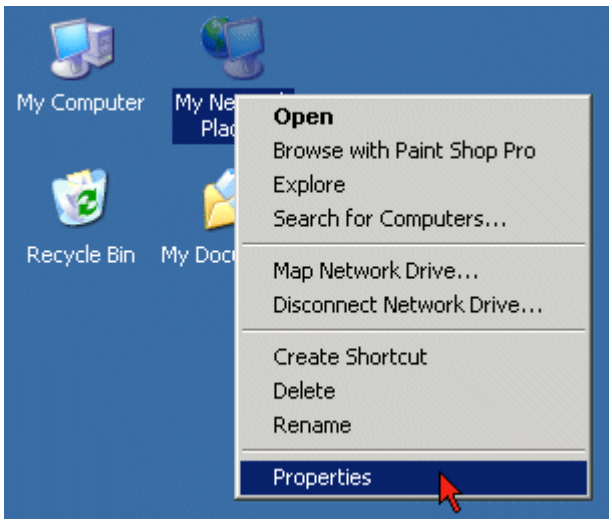


Fig. 76: Context Menu Network Environment -> “Properties”

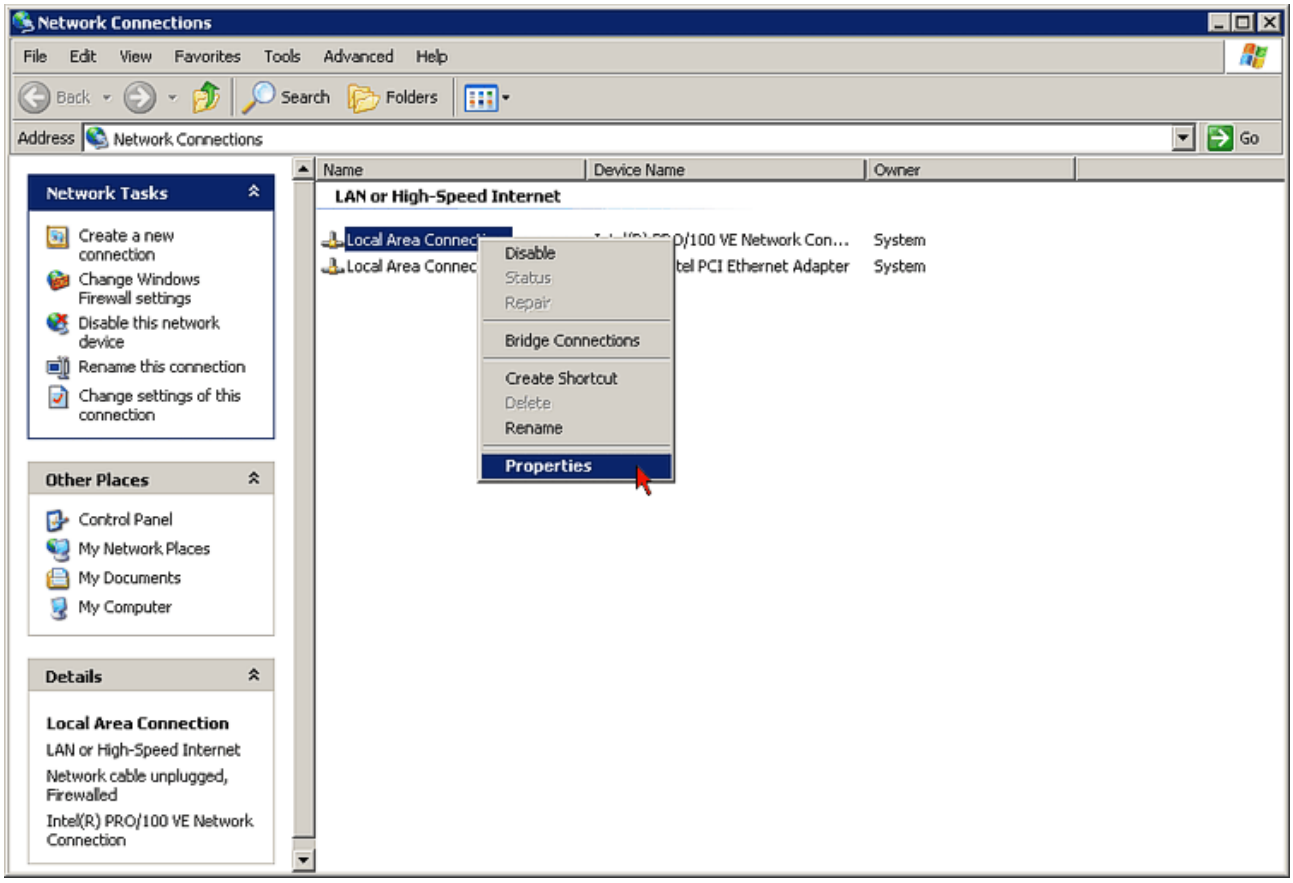


Fig. 77: Context Menu “LAN Connection (Ethernet-LAN-Adapter),” -> “Properties”

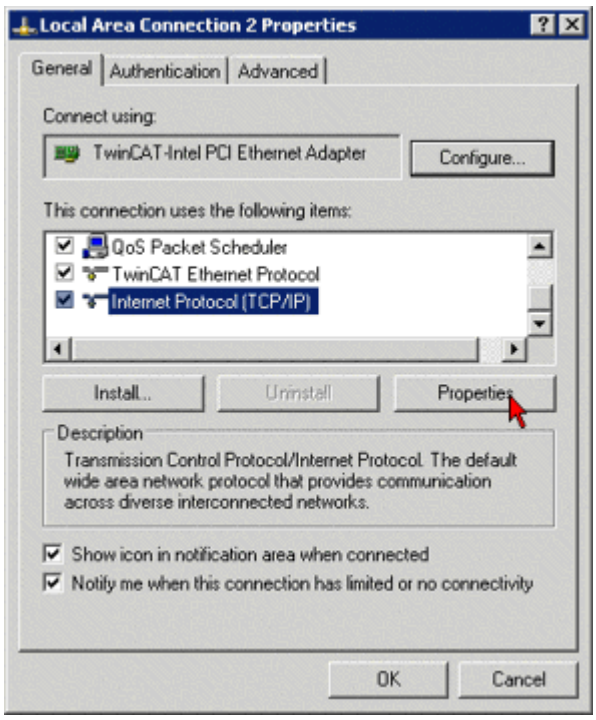


Fig. 78: Properties Internet Protocol (TCP/IP)

- Enter an IP address for the subnet of the network printer (e.g. 192.168.0.38/255.255.255.0) and confirm with *OK*

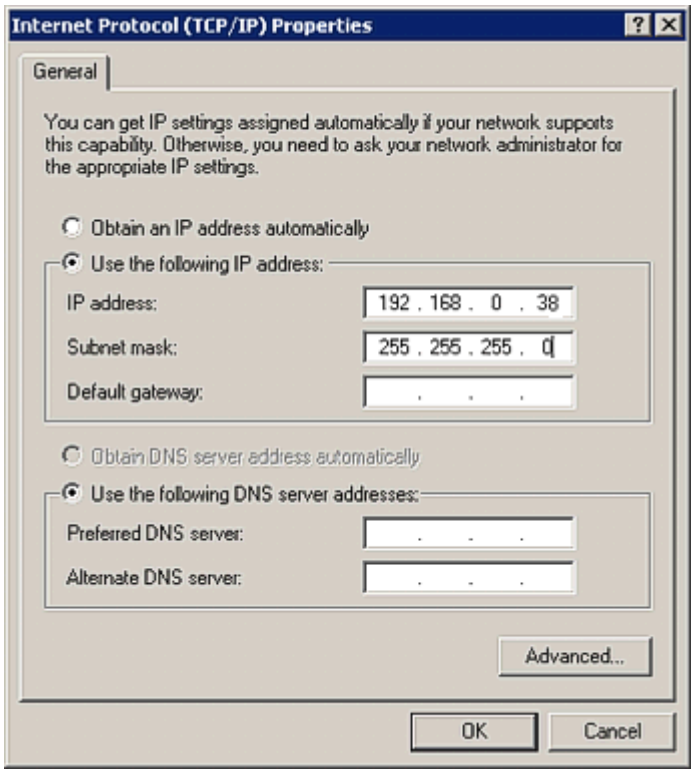


Fig. 79: Entry of the IP address of the subnetwork of the Service-PC

- The Ethernet connection to the TwinCAT master PC is now tunneled via the EL6601 through the EtherCAT terminal network and can be established via the remote desktop.

Establishing the remote desktop connection

- On the service PC start the remote desktop connection via *Start -> Programs -> Accessories -> Communication -> Remote desktop connection*

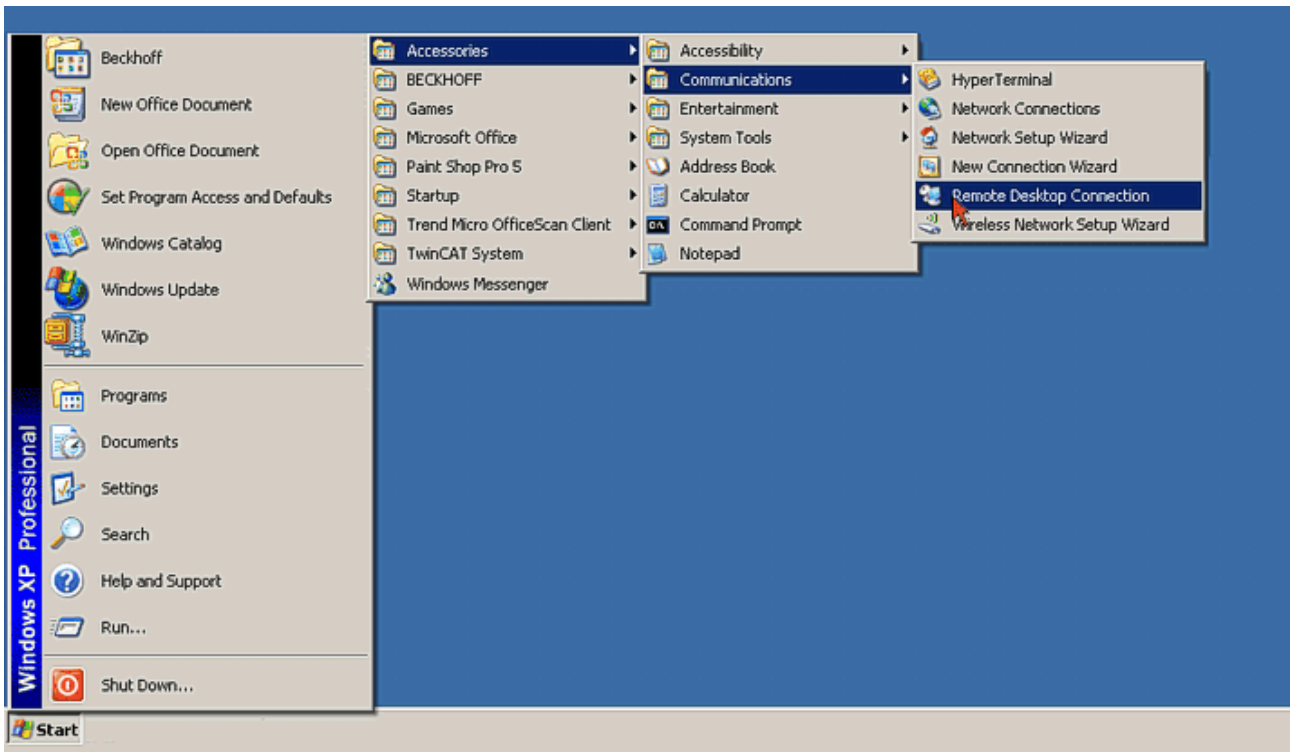


Fig. 80: Start remote desktop connection

- Enter the IP address of the TwinCAT master PC (e.g. 192.168.0.1) and click *Connect*

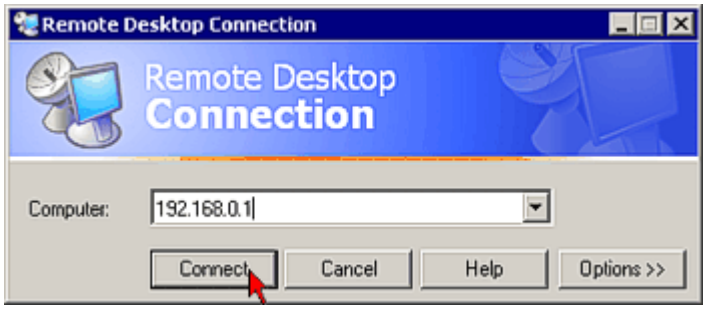


Fig. 81: Entry of the IP address of the Remote-PC

- The login window of the TwinCAT master PC appears on the desktop of the service PC
- Enter your user name and password for the TwinCAT master PC and confirm with *OK*
  The IP address of the TwinCAT master PC is shown above the remote desktop

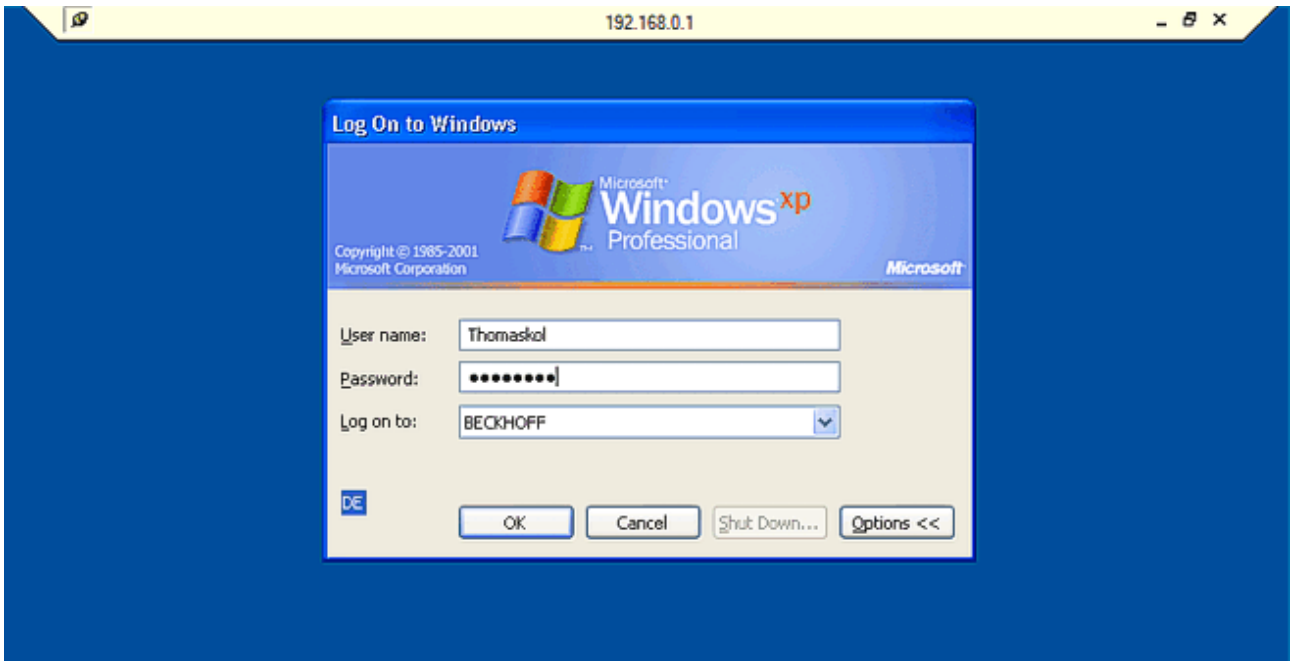


Fig. 82: Login window of the remote PC via the remote desktop connection

Login via remote desktop

Users can only log in via a remote desktop if a user name and password have been set up in the TwinCAT master PC!

- The TwinCAT system can now be remotely controlled via the service PC.
  To log out close the remote desktop window.

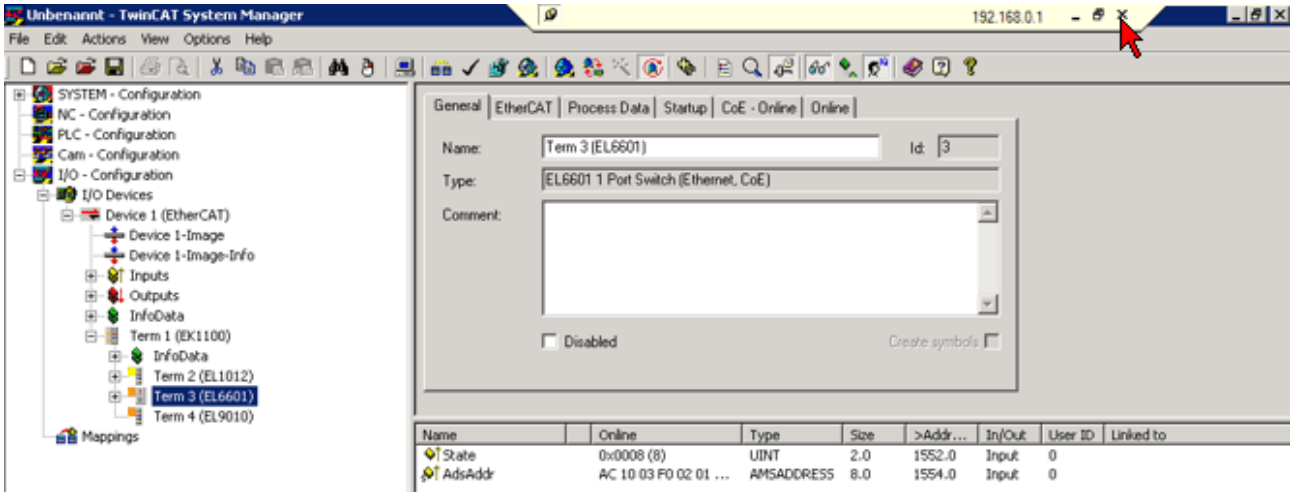


Fig. 83: Closing the remote desktop connection

Access to the remote system

When controlling the TwinCAT master PC via a remote desktop TwinCAT must be executed in Run mode or Config mode (free run). If the task is interrupted the service PC can no longer access the remote system!

5.4 Application sample - Lower-level control system

The application samples have been tested with a test configuration and are described accordingly. Certain deviations when setting up actual applications are possible.

The following hardware was used for the test configuration:

- TwinCAT master PC with Windows XP Professional SP 2, TwinCAT version 2.10 (Build 1305) and INTEL PRO/100 VE Ethernet adapter
- Beckhoff Ethernet coupler terminal EK1100, terminals EL1012, EL6601 and EL9010
- Beckhoff Embedded PC CX9000 (subordinate control unit) with Windows CE v5.00, HW 1.4, terminals EL2032, EL9010

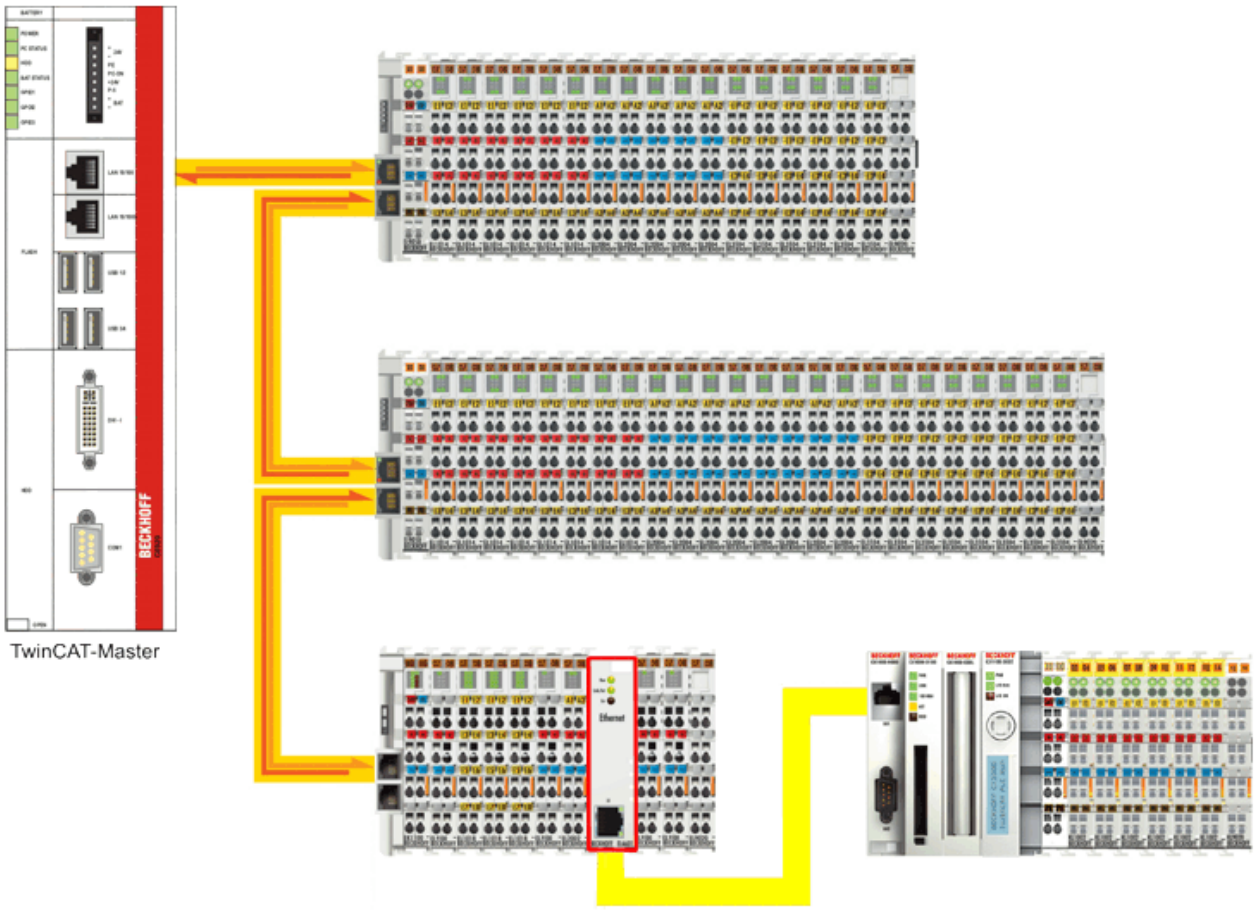


Fig. 84: Integration of a lower-level control system

Configuration of the subordinate control system

For a connection with the TwinCAT master PC via the EL6601 the network address of the subordinate control system has to be set according to the IP number range of the TwinCAT master PC subnet.

- From the desktop of the lower-level control system (Windows CE) choose *Start -> Settings -> Network and Dial-up Connections* to start the configuration of the network settings
  (Notes on setting the network address of a lower-level controller can also be found in the EtherCAT system documentation and the TwinCAT documentation)

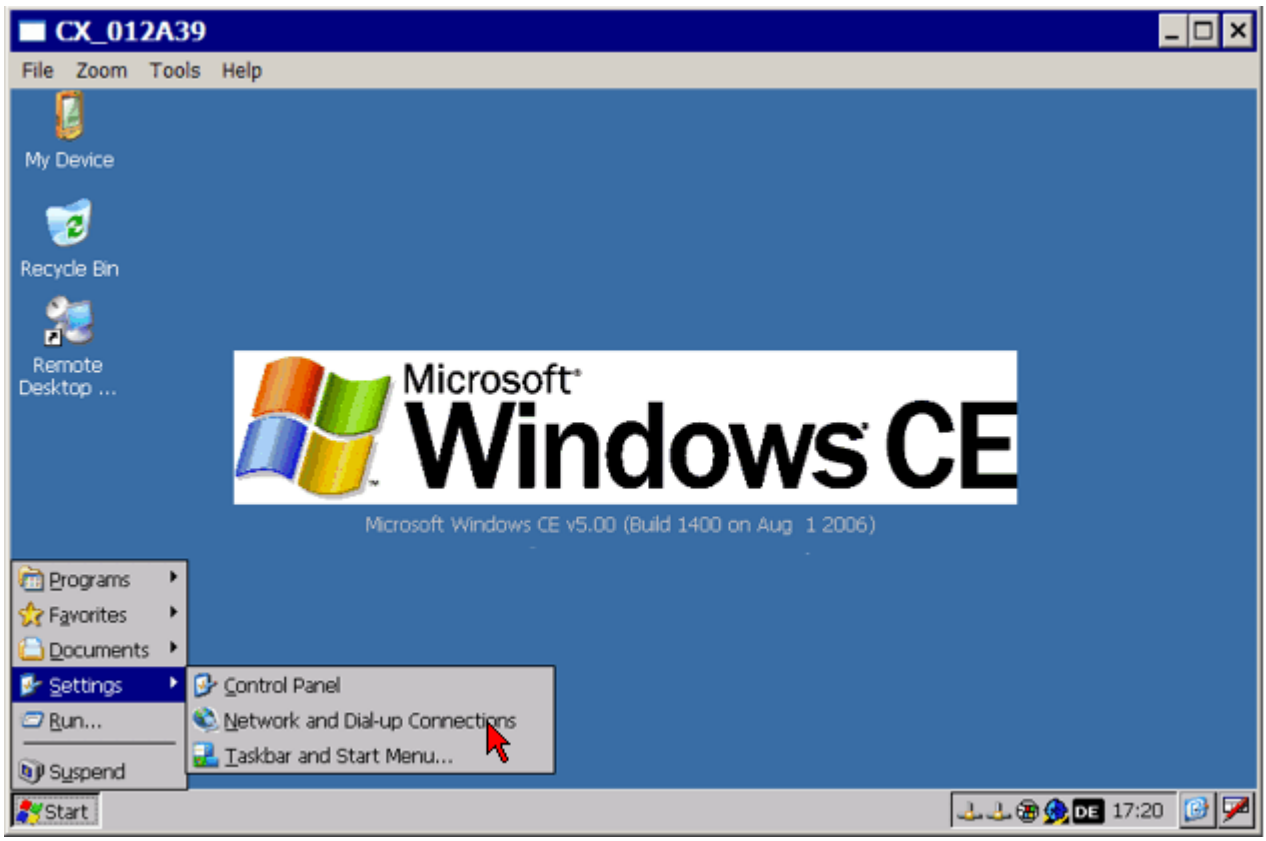


Fig. 85: Select Configuration of network connections

- Open the network settings for this connection by double-clicking on the *TCIXPNPE1* connection (Ethernet port)

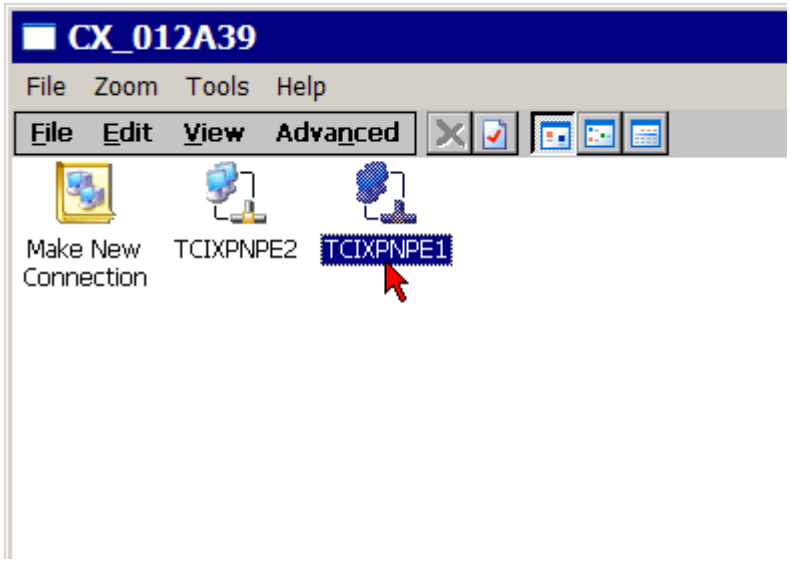


Fig. 86: Select network settings for Ethernet port

- Enter an IP number from the IP number range of the subnet (e.g. 192.168.0.39/255.255.255.0) for the TwinCAT master PC and confirm with *OK*.

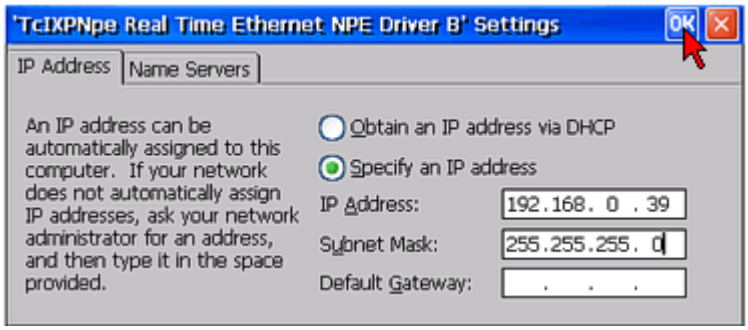


Fig. 87: Enter IP address

Configuration at the TwinCAT master PC and establishing a connection

- Start the TwinCAT System Manager in Config mode, read the Bus Terminal configuration, and activate free-run mode
- The EL6601 should appear in the system configuration being in OP mode (see Online tab EtherCAT Status Machine)

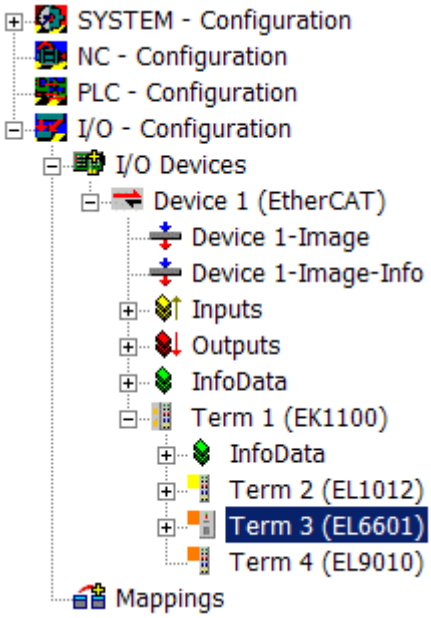


Fig. 88: EL6601 in the configuration

- In analogy to the configuration of a network printer, the IP number of the TwinCAT master PC in the subnet might be 192.168.0.1, for sample
- Connect the subordinate control unit (target system) with the EL6601 via a CAT-5 (1:1) cable
- Start another system manager session in Config mode and click on *Select Target System...-> Search (Ethernet)*

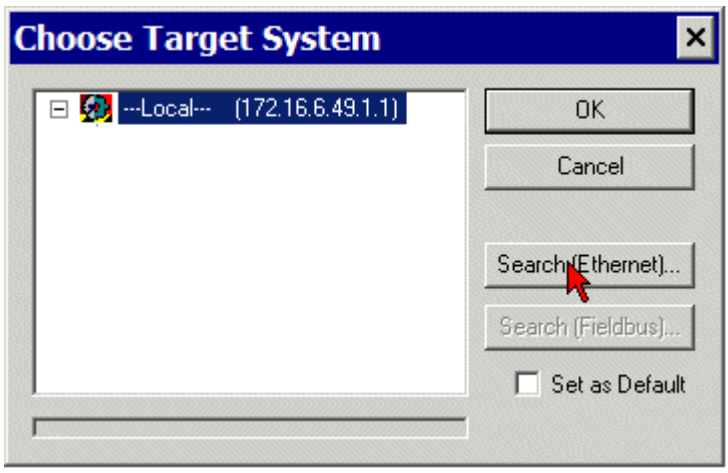


Fig. 89: Select target system

- Enter the IP address of the subordinate control system in the field next to *Enter Host Name / IP:*
- After confirming the button *Enter Host Name / IP:* the name of the target system appears in the selection box

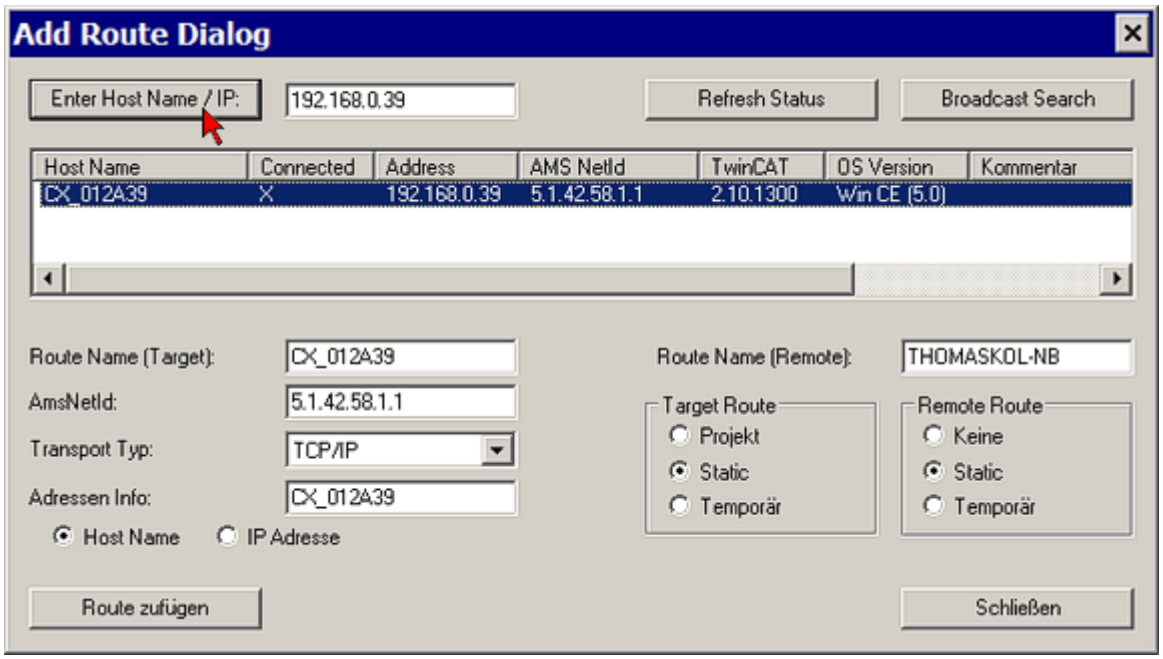


Fig. 90: In the “Route Dialog” add the route of the target system

- Click on *Add Route* and enter the access data for the target system as required
- After closing the dialog box the name of the target system appears in the selection menu
- Make your selection and confirm with *OK*

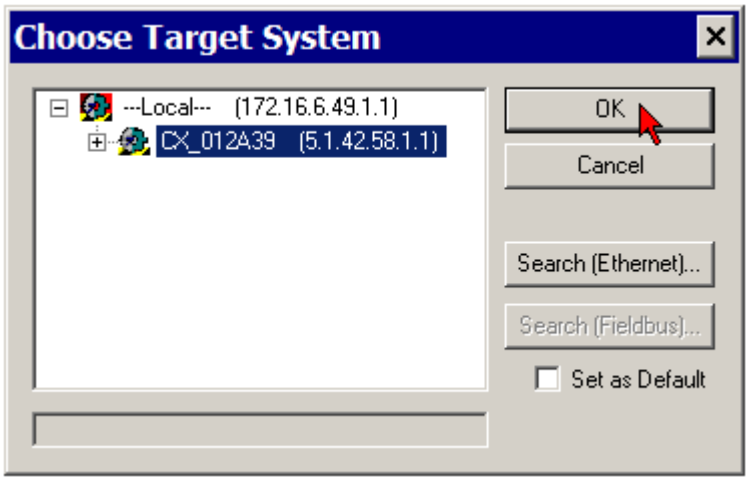


Fig. 91: Confirm selection

- Activate free-run mode for reading the Bus Terminal configuration of the subordinate control system

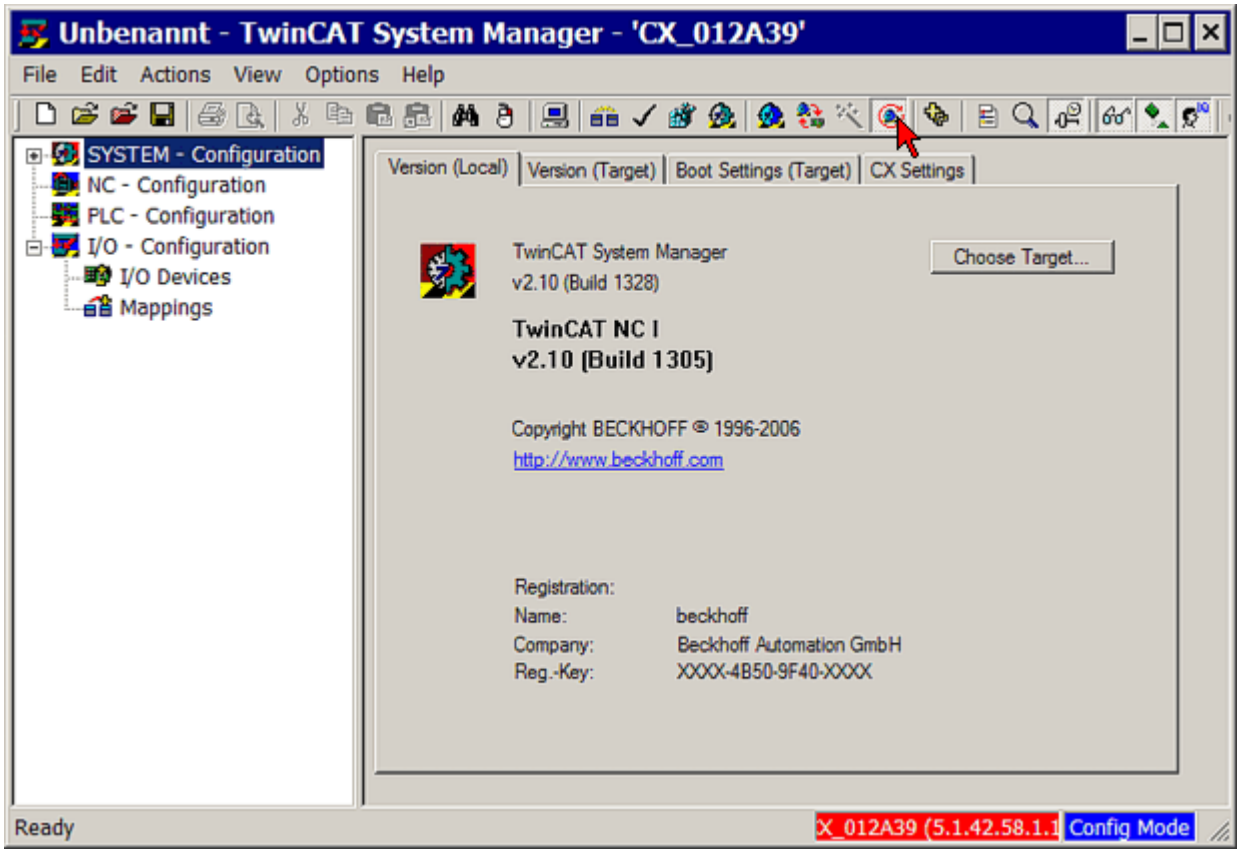


Fig. 92: Enable FreeRun

5.5 Application sample – setting up an EtherCAT Master PC as a network bridge

The application samples have been tested with a test configuration and are described accordingly.
Certain deviations when setting up actual applications are possible.
In this sample, transmission is intended to take place from a subordinate PC via the EL6601 and EtherCAT and a Master PC into a superordinate network.

The following hardware was used:

- Computers A and B: Windows XP SP2
- Computer C: Windows XP Embedded

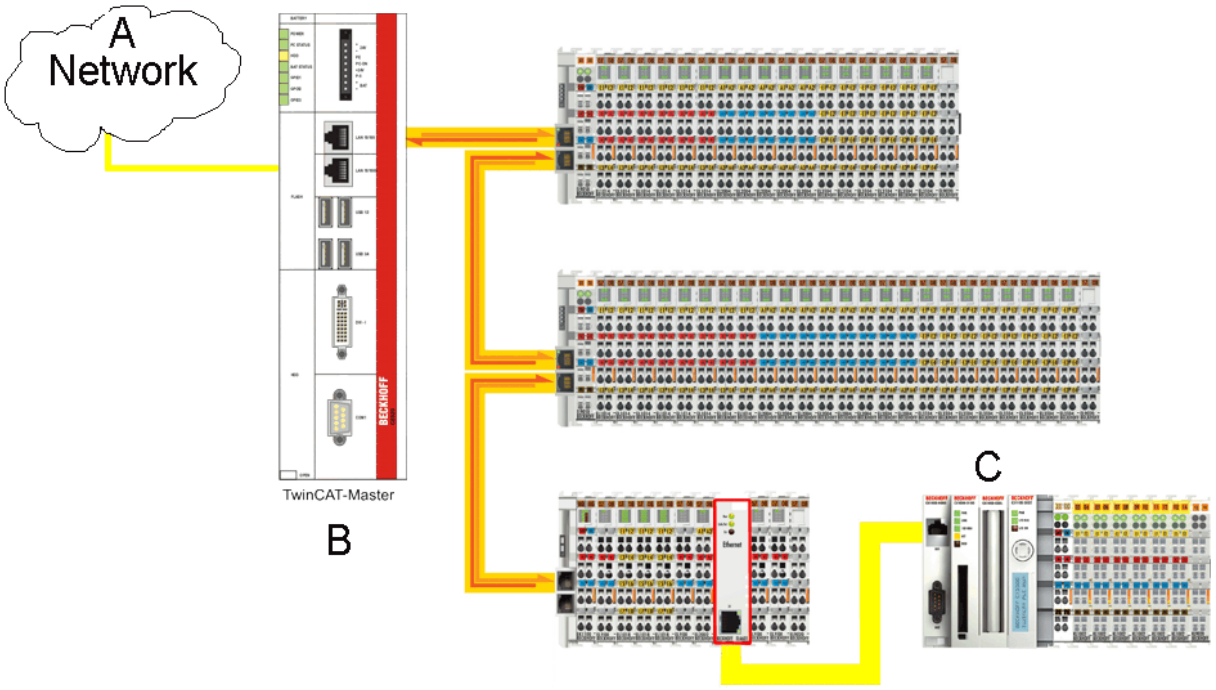


Fig. 93: Setting up an EtherCAT-Master-PC as Network Bridge

To do this, the Master PC "TwinCAT Master" (B) must be setup as a TCP/IP bridge in order to route TCP/IP telegrams through to the subordinate CX1020 (C) or to relay them in the opposite direction. The partner device is a PC (A).
Distinction must be made between two cases here: static addresses [▶ 94] and DHCP address assignment [▶ 98] (network).

The following explanations assume the preceding samples as basic knowledge.

Computers (A), (B) and (C) have a static IP address

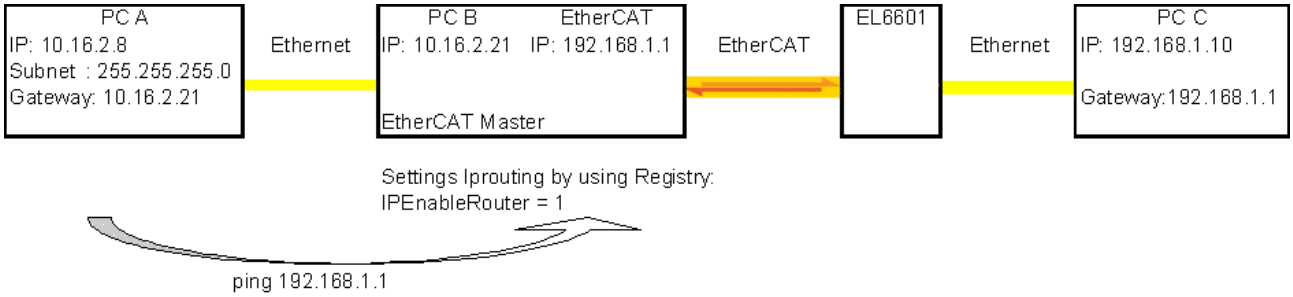


Fig. 94: Configuration of the network PC

- Configure the three PCs as shown in the diagram. The dialogs for the properties of the Internet protocol were explained in the preceding samples.

- Using the registry editor (Start --> Run --> regedit), set the entry "IPEnableRouter" in the "bridge" PC B to the value 1. The entry is usually located under HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Services\TCPIP\Parameters or also under HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\TCPIP\Parameters.
- Following a restart, routing for IP telegrams is active for this PC. The connection can then be checked by means of a ping (Start --> Run --> cmd --> ping 192.168.1.1) to the EtherCAT port 192.168.1.1.
- If the EtherCAT master is in a normal and error-free state (TwinCAT in "Config"/"FreeRun" or "Run" mode), the connected Ethernet device with the IP address 192.168.1.10 can be reached via the EL6601.
- Explanation of the entry *Gateway*, using PC A as an sample: PC A has the IP address 10.16.2.8 with a subnet mask 255.255.255.0. This means that it can reach all IP telegrams within a range from 10.16.2.0 to 10.16.2.255. If it is required to send an IP telegram to a different address range (e.g. to 192.168.1.1), this must run via the defined gateway, in this case 10.16.2.21, which in turn can relay the telegram to 192.168.1.10 via the configured IP routing.
- Windows offers the useful command line command *ipconfig* for checking the configuration. If PC A is configured correctly, the command Start Run cmd ipconfig/all displays the following screen:

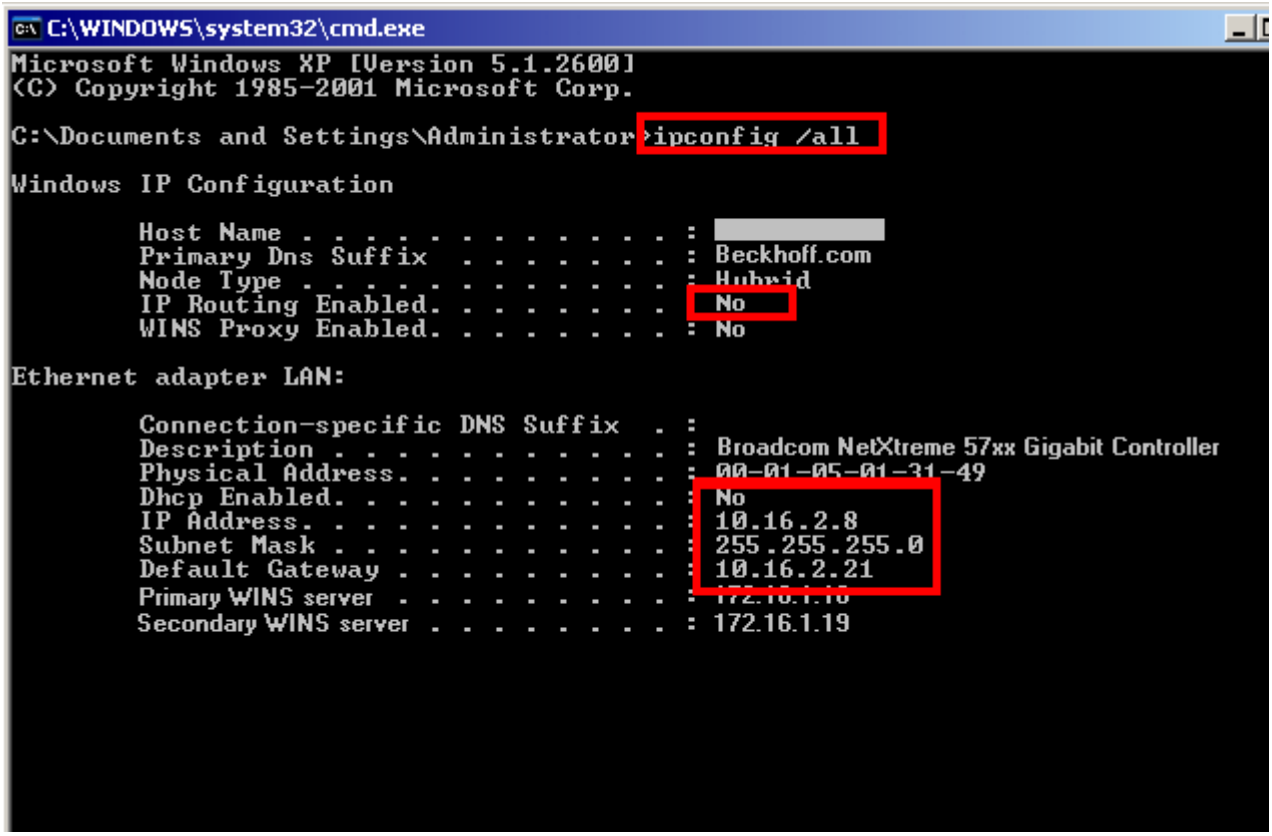


Fig. 95: Checking the configuration with command line command “ipconfig /all”

- IP routing is disabled (default) and the IP address of the selected adaptor (here called *LAN*) is assigned fixedly. Since DHCP was set beforehand, WINS entries are still present.
- The same command on PC C displays:

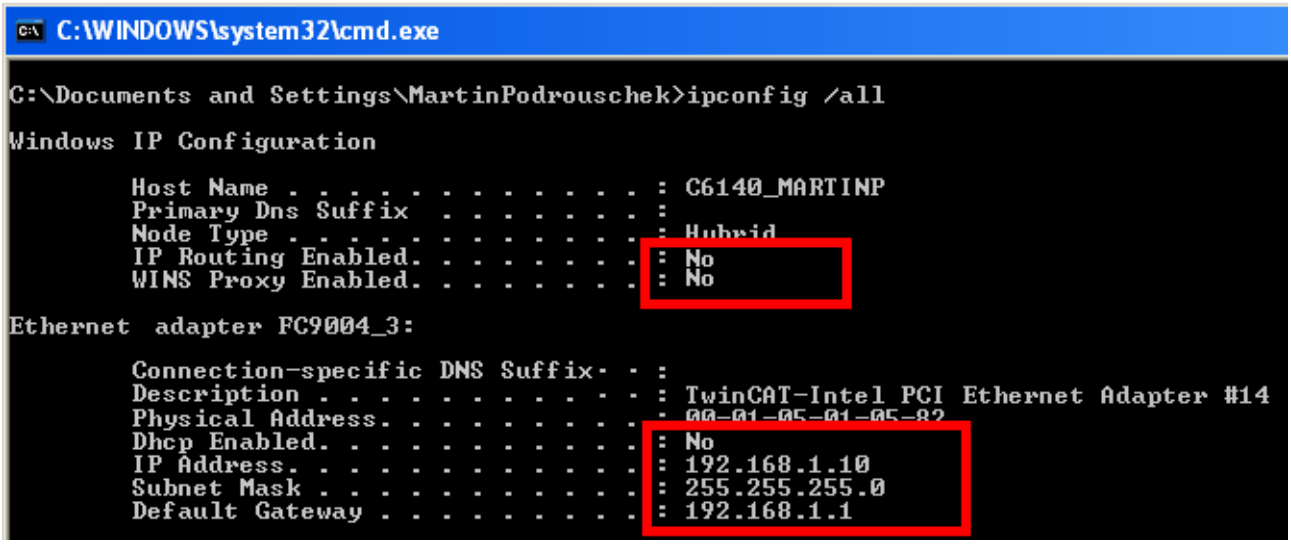


Fig. 96: Checking the configuration PC C

- This was entered under XP in the dialog

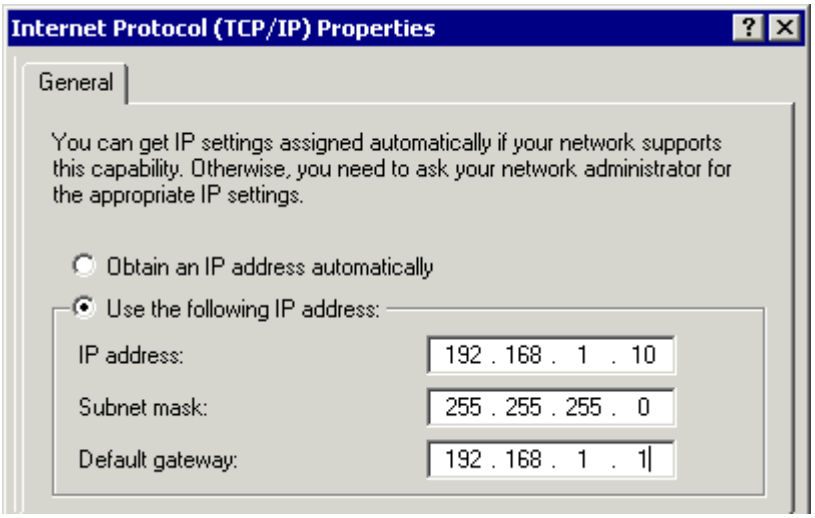


Fig. 97: Entry of network parameters

- Accordingly, the command on the bridge PC B displays:

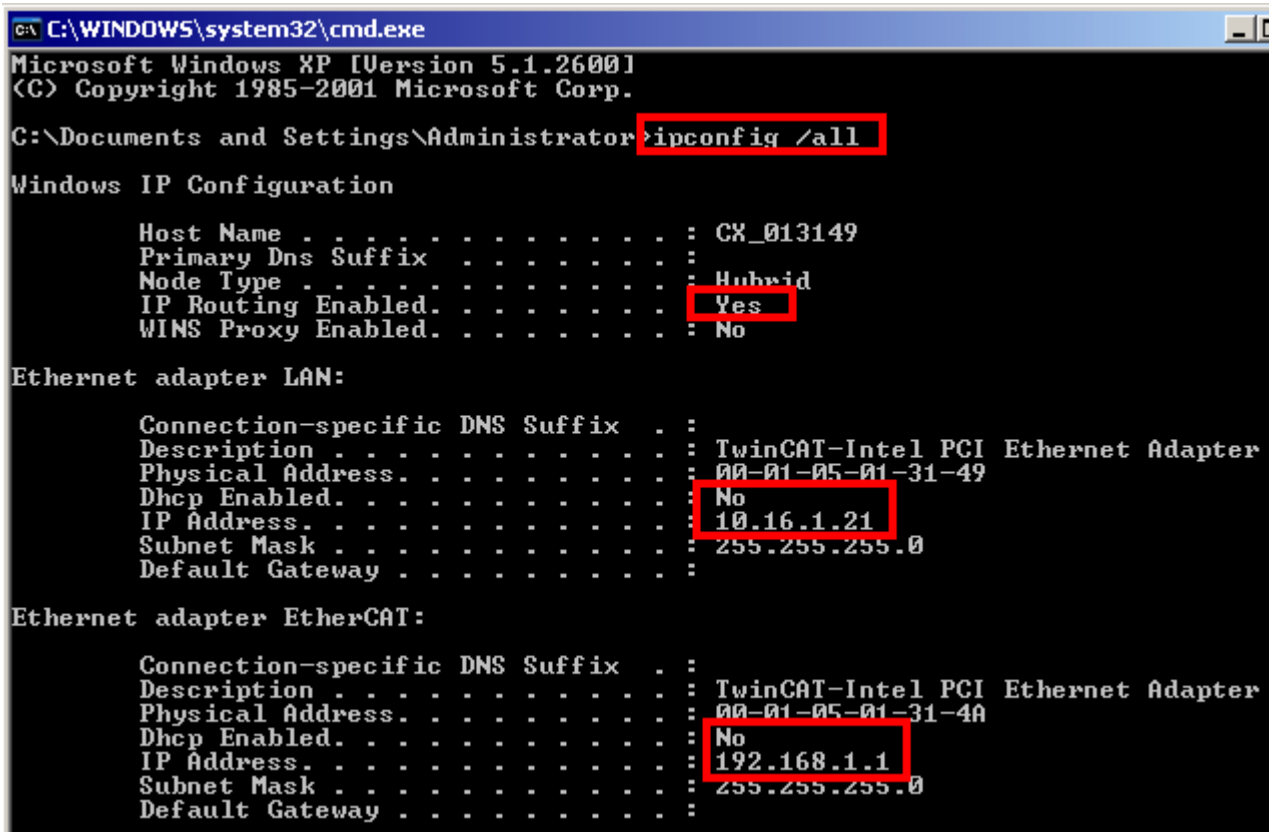


Fig. 98: Checking the Configuration Bridge PC B

"ipconfig" switches

Using the switches /release and /renew, the command ipconfig can be used to re-establish IP connections.

Checklist for connection settings:

- Bridge PC configured for "IP routing" by means of registry entry
- Fixed IP addresses in correlating ranges for all 4 Ethernet ports involved
- Firewalls disabled if need be (unnecessary in the case of the default setting)
- EtherCAT/TwinCAT in "Freerun" or "Run" mode
- Link display on all ports involved
- "Ping" works

Observation of network traffic

Experienced users can observe and evaluate the network traffic using a network sniffer, such as Wireshark.

Notice on Operating system Windows CE/embedded

Under Windows CE IP Routing must be set in the CX Configuration Dialog (see Fig. “*Setting IP Routing in Windows CE*”)
The entry “TCP/IP Settings” -> “IP Routing” sets the Registry-Key “IPEnableRouter”= 1 under [HKEY_LOCAL_MACHINE\Comm\Tcpip\Parms]
Restart required.
See also Microsoft Developer Network: Routing for IPv4 - Explanation on Routing.
Ordinarily the Routing table is automatically maintained, if necessary routes will still have to be added with “Route Add” command, see also Windows XP/7 etc.
Windows CE does not support some Routing protocols such as RIP or OSPF.

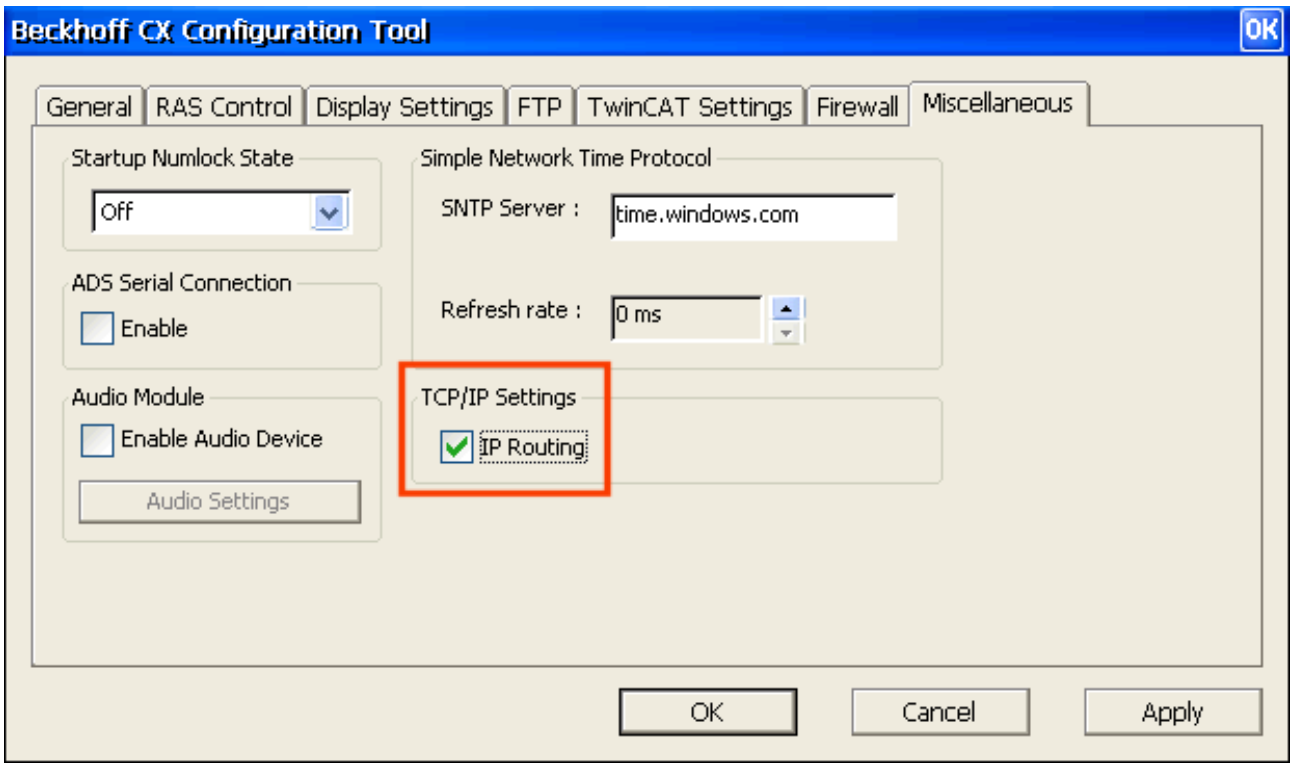


Fig. 99: Setting “IP Routing” in Windows CE

Network with DHCP address assignment

A connection between the PCs C and A (or the network) is not possible.

Explanation: Computers (A) and (B) receive their IP addresses from the DHCP server if the Ethernet ports are configured accordingly. One possible sequence is as follows (see RFC1541 and RFC2131):

- A newly connected PC sends a DHCPDISCOVER message with its MAC address via MAC Broadcast to all other network devices
- The DHCP server offers the requesting device one or more IP addresses in the DHCPOFFER message
- The requesting PC selects an IP address and answers via MAC Broadcast with a DHCPREQUEST message to the DHCP server
- The DHCP server confirms the selection with a DHCPACK message.

This works for computers (A) and (B). The DHCPDISCOVER messages from computer (C) are accepted by the EL6601 and relayed in computer (B) to Windows via the EtherCAT port, but Windows (B) does not route these messages (and all other DHCP telegrams) through to the relaying Ethernet port – this function, known as DHCP Relay Agent, is only available in the server version of Windows.

This is the normal operating case when Windows PCs configured as DHCP devices are linked with each other.

Remedy:

- Install a local DHCP server on computer (B), taking care that no conflict arises with the superordinate network DHCP server
- It is possible that two Windows PCs, which are configured as DHCP devices and connected to each other, will only establish their addresses after a short time (several minutes)

5.6 Application sample - Flexible Ethernet Port

The application samples have been tested with a test configuration and are described accordingly. Certain deviations when setting up actual applications are possible.

This sample illustrates the principle of remote access from a subordinate PC to the central EtherCAT controller via a flexibly connected EL6601 and EtherCAT.

The following elements were used:

- IPC with Windows XP SP2
- TwinCAT 2.11 b1534
- EL6601, SN xxxx0605

The approach

The task is to commission an extensive system with EtherCAT topology. To this end frequent access to the TwinCAT System Manager on the central PC is required. In practice the technician will primarily be at the local terminals/EtherCAT slaves during commissioning. The central System Manager as the TwinCAT target system should therefore be accessed from the respective coupler location via a remote PC and Ethernet.

Two mechanisms are used for this purpose:

- EtherCAT tunnels standard IP telegrams through dedicated slaves, e.g. EL6601, via the acyclic mailbox procedure
- Via the HotConnect functionality a coupler station (coupler + terminals) can be classified as freely pluggable in the configuration (.tsm). Special couplers must be used for this purpose.

A freely pluggable combination of EK1101 and EL6601 (HotConnect group) can now be used as a flexible Ethernet interface.

Possible configuration

A possible configuration is described below:

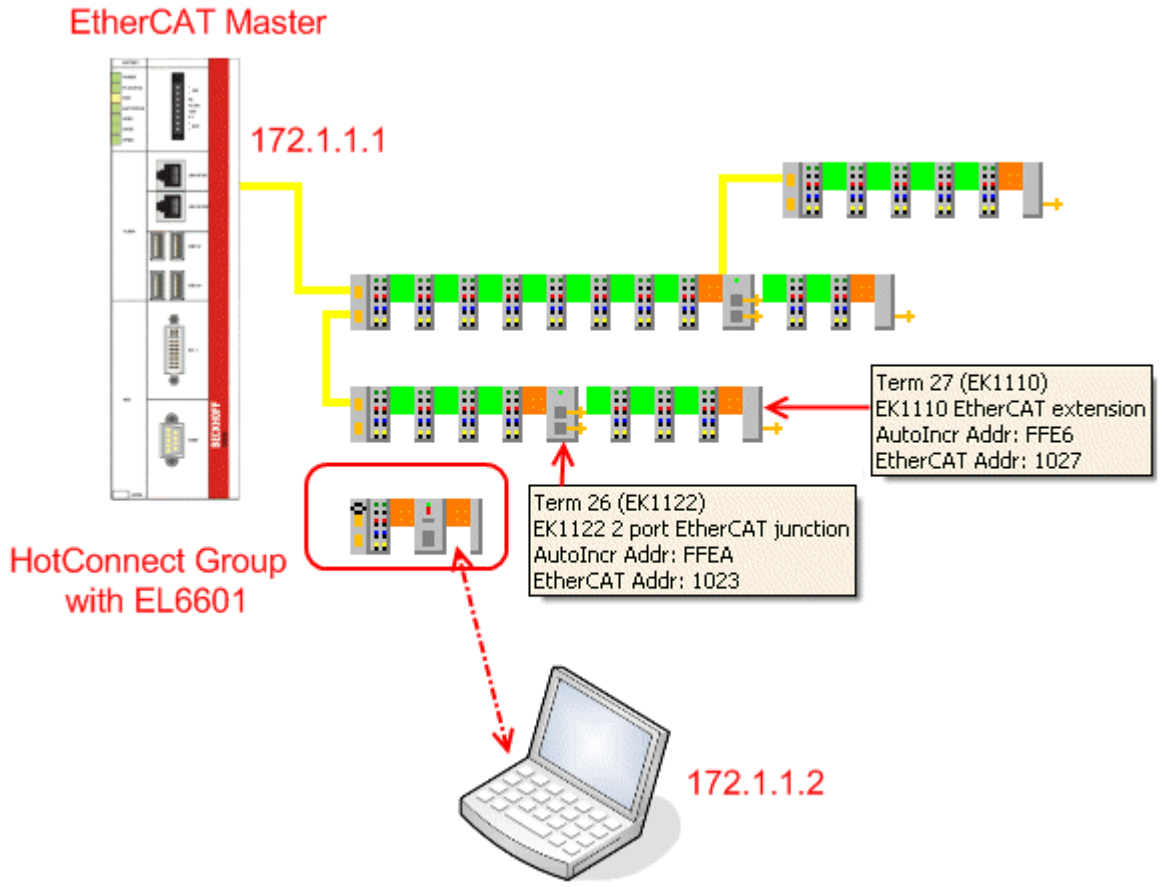


Fig. 100: Structure HotConnect Group

The system offers EK1110 (end couplers), EK1122 (junction terminals) and free EK1100 ports for connecting the HotConnect group. The IP addresses should be regarded as samples, the notes from the previous samples must be taken into account.

No further settings are required at the TwinCAT/EtherCAT master. EoE is automatically forwarded in TwinCAT 2.11.

Remote access operability and EtherCAT state

The process of Ethernet pass-through described here only works as long as the EtherCAT master and the EL66xx are at least in state PREOP. Otherwise no mailbox traffic and therefore no Ethernet transport takes place. However, if the network structure is already functional, this does not represent an insurmountable obstacle for general commissioning.

Change of location and EtherCAT state

Once the HotConnect group is reconnected with the EtherCAT network it may take several seconds for the group to participate in the data traffic again, the EL66xx to be in OP state again and the link (see link LED) to be restored.

Sample configuration

A small EtherCAT system is commissioned, the offline topology view in the System Manager shows two coupler stations and one non-localized station with an EK1101.

- In offline state the System Manager does not know where the EK1101 station with its ID was connected.

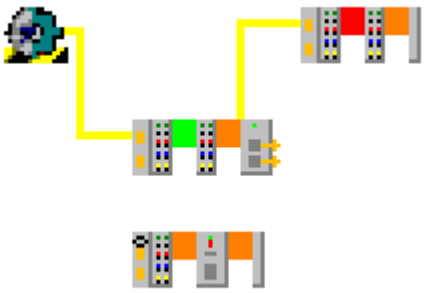


Fig. 101: EK1101 localized with EL6601

- The current assignment is visible online, the EK1101 with the EL6601 is connected to the second port of the EK1100.

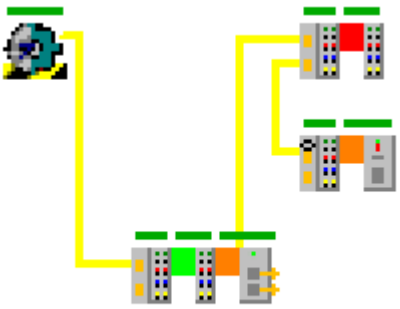


Fig. 102: EK1101 localized with EL6601

- All slaves are in OP state, so that this system can now be accessed as target system from the remote PC.
- In the remote system an empty System Manager is opened and the EtherCAT computer with the IP 172.1.1.1 (in this sample) is located as the target system via IP
  (Tab Actions -> Choose Target System -> "Search (Ethernet)" -> [enter IP 172.1.1.1] -> "Enter Host Name / IP")

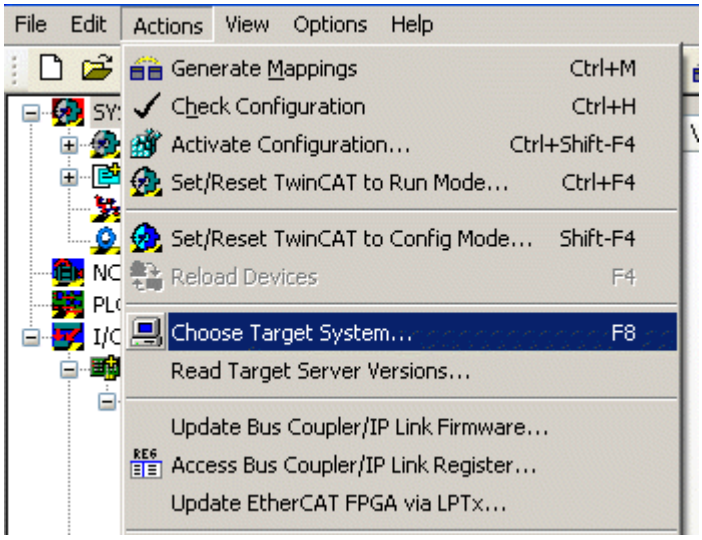


Fig. 103: Selection of the target system

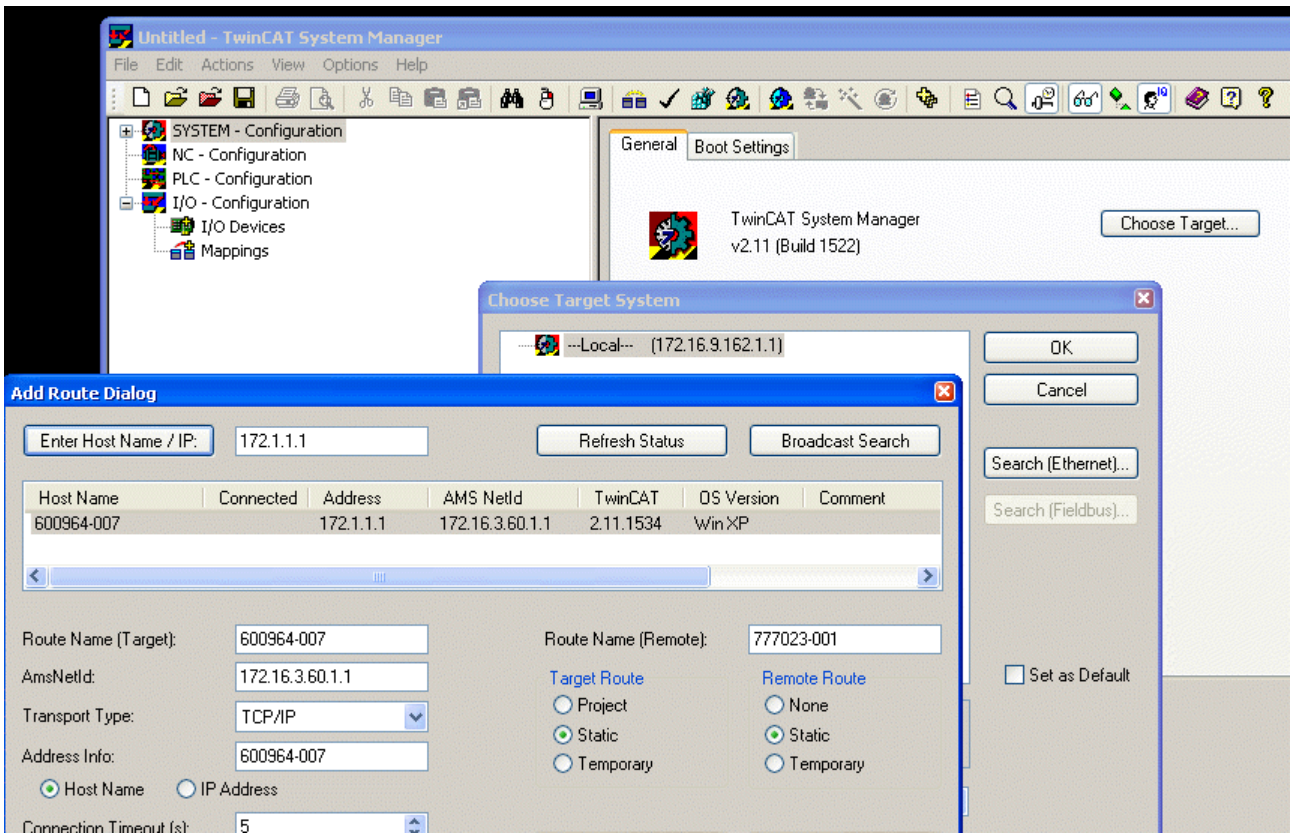


Fig. 104: Enter target system 172.1.1.1

- After double-clicking on the line showing the found target system the user can log into the target system:

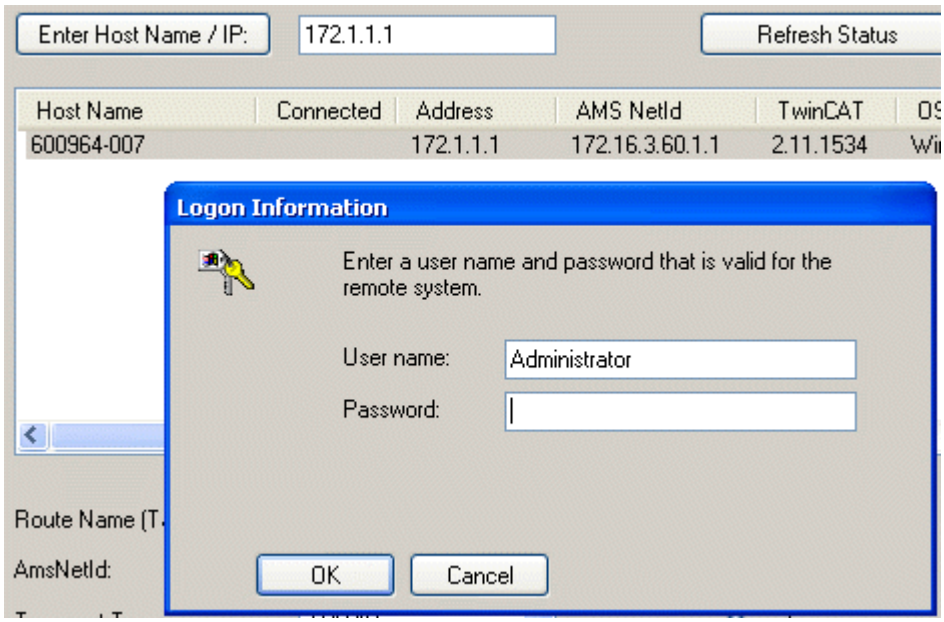


Fig. 105: Entry of logon information on target system

- After successful connection the configuration can be loaded by the target system through "Open from target system".

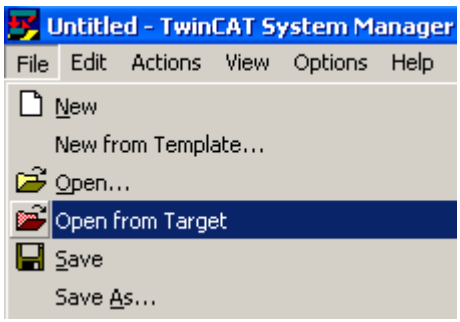


Fig. 106: Opening of target system and loading of configuration

Checklist

The following checklist can be used for a successful configuration up to remote access:

1. Successful EtherCAT configuration
   - no LostFrames
   - EtherCAT master and all slaves in OP state
   - all WorkingCounters = 0; if necessary, set up special SyncUnits for deliberately inactive slaves
2. Set a different IP address for the EtherCAT port and the port used at the laptop, but within the same subnet section.
   (here: 172.1.1.1 and 172.1.1.2)
3. Check the connection from both sides through ping commands
4. Establish connection as target system

Ethernet connection

It is advisable to use credible addresses in the Properties dialog of the network interface, IP protocol (Windows XP SP2) Default gateway and DNS server, although they are not actually required. Settings of the remote PC from the sample:

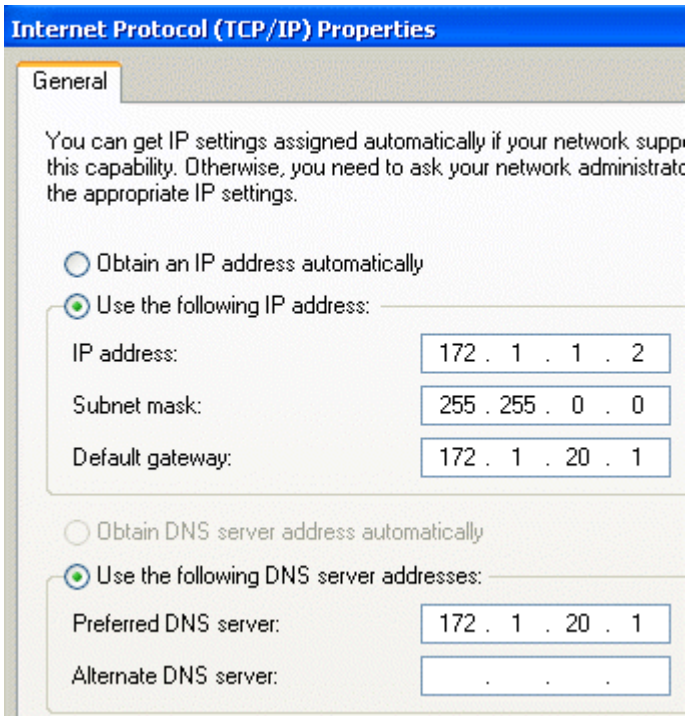


Fig. 107: Entry of network addresses in the remote system

6 Appendix

6.1 Firmware compatibility

Beckhoff EtherCAT devices are delivered with the latest available firmware version. Firmware and hardware must be compatible; not every combination ensures compatibility. The overview below shows the hardware versions on which a firmware can be operated.

Note

- The newest possible firmware for the respective hardware should be implemented
- Beckhoff is not under any obligation to provide customers with free firmware updates for delivered products.

NOTICE

Risk of damage to the device!

Observe the notes on the firmware update in the EtherCAT System Manual in chapter “Firmware Update”.
If a device is set to BOOTSTRAP mode for firmware update, it may not check whether the new firmware is suitable during download.
This may result in damage to the device! Therefore, always make sure that the firmware is suitable for the hardware version!

EL6601			
Hardware (HW)	**Firmware (FW)**	**Revision no.**	**Date of release**
05 - 14	06		2009/07
	07	EL6601-0000-0017	2009/09
	08		2009/11
	09		2010/07
		EL6601-0000-0018	2010/09
	10		2011/09
		EL6601-0000-0019	2012/10
	11		2013/04
	12	EL6601-0000-0020	2014/07
15 – 21	13	EL6601-0000-0021	2014/12
	14		2015/07
	15		2017/02
	16		2023/06
	17		2023/09
25*	20*	EL6601-0000-0025	2026/06

EL6614			
Hardware (HW)	**Firmware (FW)**	**Revision no.**	**Date of release**
00 - 09*	01	EL6614-0000-0017	2008/05
	02		2008/12
	03		2009/08
	04		2009/11
	05		2010/07
		EL6614-0000-0018	2010/09
	06		2011/09
		EL6614-0000-0019	2012/10
	07		2013/04
	08	EL6614-0000-0020	2014/07
10 – 17*	09	EL6614-0000-0021	2014/12
	10		2015/07
	11		2017/02
	12		2023/06
	13*		2023/09

*) This is the current compatible firmware/hardware version at the time of the preparing this documentation. Check on the Beckhoff website whether more up-to-date documentation is available.

6.2 Support and Service

Beckhoff Support and Service provides assistance with questions regarding Beckhoff products and system solutions, as well as with their planning, commissioning, and operation.

Beckhoff subsidiaries and representative offices

Please contact your Beckhoff subsidiary or your representative office for local support and service for Beckhoff products. You can find the addresses of Beckhoff subsidiaries and representative offices at: www.beckhoff.com/worldwide.

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✉ Email:	support@beckhoff.com, Support form
Web page:	www.beckhoff.com/support

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Our service specialists are here to assist you with any questions you may have regarding after-sales service processes, such as replacement parts, repairs, etc.

☎ Hotline:	+49 5246 963-460
✉ Email:	service@beckhoff.com, Service form
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The Download finder serves as a central source for downloadable documents and files related to Beckhoff products, such as application reports, technical documentation, drawings, and configuration files.

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