

Manual | EN

TS6270

TwinCAT 2 PROFINET RT DEVICE

Supplement | Communication

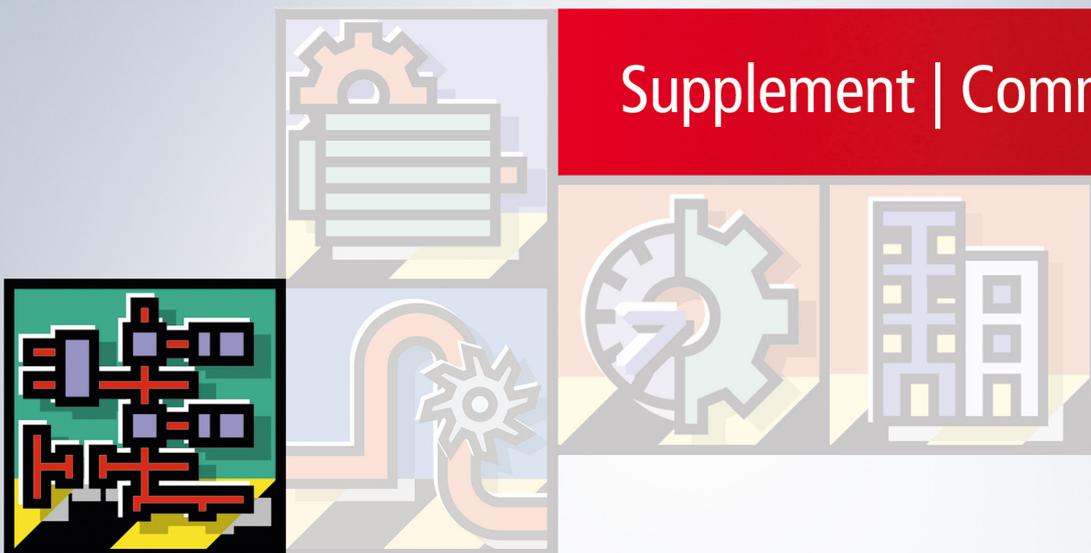


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1 Foreword

1.1 Documentation issue status

Version	Comment
2.0	Structure adoption, technical data added
1.1.0	Chapter "Shared Device" added, EC LED description corrected, changed the tree view
1.0.0	1st version

Firmware and hardware versions

The software version for the profinet device supplement is part of the TwinCAT build number.

The firmware and hardware version (delivery state) for the EL6631-0010 can be found in the serial number printed at the side of the terminal.

Syntax of the serial number

Structure of the serial number: KK YY FF HH

KK - week of production

(CW, calendar week)

YY - year of production

FF - firmware version HH - hardware version

Example with ser. no.: 12 06 3A 02:

12 - week of production 12

06 - year of production 2006

3A - firmware version 3A

02 - hardware version 02

1.2 Version identification of EtherCAT devices

Designation

A Beckhoff EtherCAT device has a 14-digit designation, made up of

- family key
- type
- version
- revision

Example	Family	Type	Version	Revision
EL3314-0000-0016	EL terminal (12 mm, non-pluggable connection level)	3314 (4-channel thermocouple terminal)	0000 (basic type)	0016
CU2008-0000-0000	CU device	2008 (8-port fast ethernet switch)	0000 (basic type)	0000
ES3602-0010-0017	ES terminal (12 mm, pluggable connection level)	3602 (2-channel voltage measurement)	0010 (high-precision version)	0017

Notes

- The **order identifier** is made up of
 - family key
 - type
 - version
- The **revision** indicates the technical progress and is managed by Beckhoff. In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise. Each revision usually has an associated XML description (ESI, EtherCAT Slave information), which is available for download from the Beckhoff webpage.
- Type, version and revision are read as decimal numbers.

Serial number

Beckhoff EtherCAT devices usually have an 8-digit serial number, which is printed on the device or attached to it on a sticker. This serial number indicates the construction condition on delivery.

Syntax of the serial number

Structure of the serial number: KK YY FF HH

KK - week of production (CW, calendar week)

YY - year of production

FF - firmware version

HH - hardware version

Example with ser. no.: 12 06 3A 02:

12 - week of production 12

06 - year of production 2006

3A - firmware version 3A

02 - hardware version 02

Examples of serial number data



Fig. 1: EL6688 EL Terminal



Fig. 2: CU2016 Switch



Fig. 3: EK1100 EtherCAT coupler

1.3 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.

For installation and commissioning of the components, it is absolutely necessary to observe the documentation and the following notes and explanations.

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 satisfies all 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 notice.

No claims to modify 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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Patents

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:

EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702

and similar applications and registrations in several other countries.

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1.4 For your safety

Safety regulations

Read the following explanations for your safety.

Always observe and follow product-specific safety instructions, which you may find at the appropriate places in this document.

Exclusion of liability

All the components are supplied in particular hardware and software configurations which are 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 technology 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.

1.5 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>.

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

2 TwinCAT Supplement

2.1 TwinCAT 2.10

2.1.1 PROFINET device integration under TwinCAT 2.10

i Installation

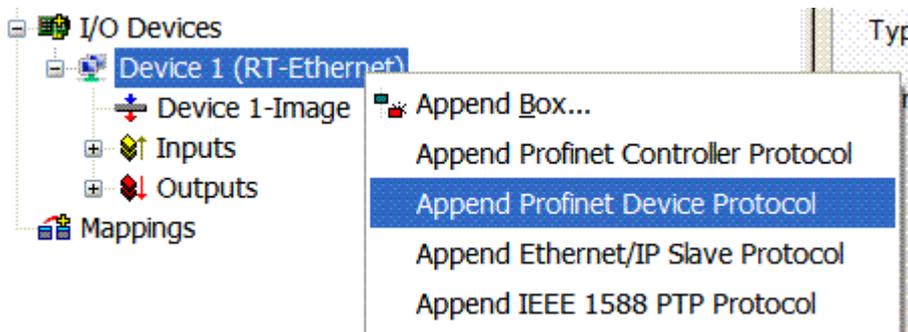
There is no installation version for the TwinCAT 2.10 version available. Please update to TwinCAT 2.11 or refer to the Beckhoff Support.

1. Integration of the PROFINET protocol

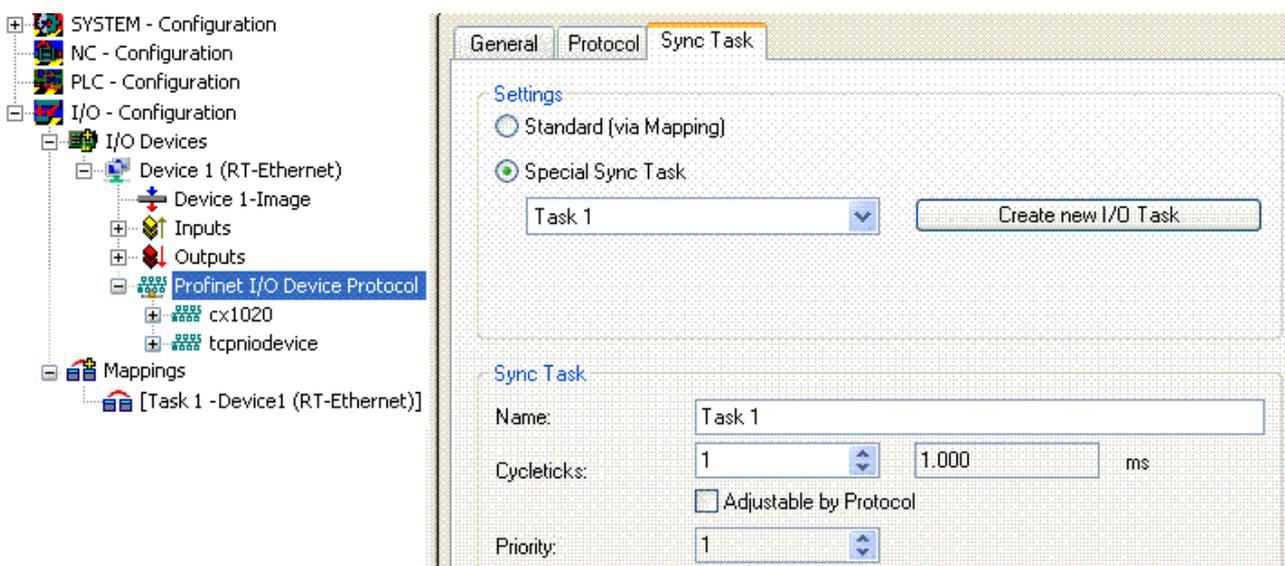
First, a real time Ethernet device must be added. This interface must be assigned to an adaptor class. This is composed of the MAC and IP address of the network card.

Hence, for example, if a CX9000 is to be parameterized, the target system must first be accessed remotely; the corresponding Ethernet port can subsequently be selected.

A PROFINET protocol is subsequently appended using the right mouse button. Precisely one TwinCAT device protocol can be appended!



The NetID used can be found under the "Protocol" tab. It is required for an ADS access, for example. Besides that, there is a possibility in the "Sync Task" tab to append a free-running task for PROFINET communication (this is recommended). Real time communication can hence run independent of a PLC task. For performance reasons, however (e.g. in the case of a CX9000), the Sync Tasks can be dispensed with and standard mapping takes place, i.e. a PLC task, for example, must be running in order for PROFINET communication to be possible.



Next, a box is integrated in the form of a GSDML (right click on "PROFINET I/O Device Protocol"). In TwinCAT it is also possible to configure several virtual PROFINET devices. Each device is again to be viewed as its own adaptor, i.e. each virtual device is assigned a default MAC address from a reserved range.

To avoid possible address conflicts, the MAC of virtual devices can also be changed. The name which the device was given in the strand (or in the "General" tab) is also taken as a PROFINET station name following a restart. On the basis of different MAC addresses and names, a PROFINET controller can now distinguish several devices in the strand. In turn, the individual virtual devices can then be linked with terminals from the E-bus, e.g. via a PLC task. As a result of this, for example, several EL6601 terminals in the E-bus can be configured as individual PROFINET devices!

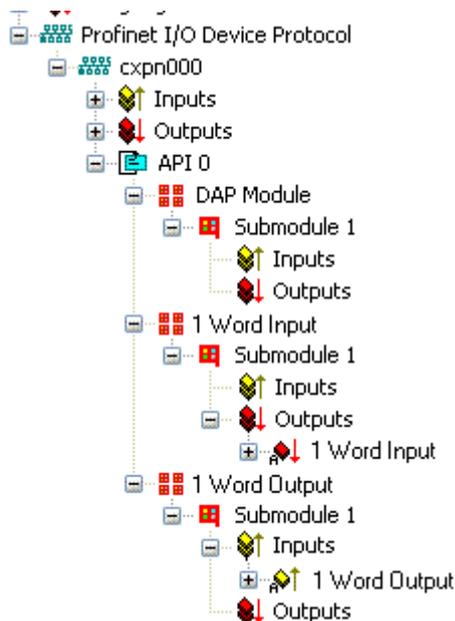
In PROFINET, different user profiles can be defined within a device (API - Application Process Instance). In Twin CAT, precisely one API is permitted / supported per device!

In accordance with PROFINET, the DAP (Device Access Point) is always defined on slot 0. Device-specific data is defined in it. In accordance with PROFINET, several DAPs can be defined; however, in TwinCAT there is currently precisely one!

2. Process data

The process data can be inserted from slot 1. This takes place by integrating the desired module in the API. Each module (slot) has at present precisely one sub-module (sub-slot). The configuration of the modules and hence the creation of the process data image on the PROFINET side takes place by means of specifying data types / data widths (e.g. byte, word, dword, float 32).

The designation of the inputs and outputs always takes place in TwinCAT from the TwinCAT point of view, i.e. the inputs are from the PROFINET point of view (from the controller) the outputs! Therefore the data of the PROFINET I/O devices is represented as follows:



This representation applies only to the TwinCAT PROFINET device, in the case of a TwinCAT PROFINET controller, the view will correlate again!

3. General Settings

In the "PROFINET Device" tab, the Instance ID and the PN Frame ID as well as the Client and Server UDP port can be changed. However, the default settings suffice for normal operation!

The screenshot shows the 'Device' configuration tab in TwinCAT. It is divided into two main sections: 'Adapter Properties' and 'Instance Properties'.
 Under 'Adapter Properties':
 - MAC Address: 00-02-B3-D7-7B-EC
 - VendorID: 0x0120
 - DeviceID: 0x0021
 - A checkbox labeled 'Generate Station Name from Control' is checked.
 Under 'Instance Properties':
 - ID: 0x0000
 - Server UDP Port: 0xC350
 - FrameID: 0xC000
 - Client UDP Port: 0xC351

There is a second possibility to assign the PROFINET station name. This is comparable with the DIP switches in the BK9103 and can be carried out via a PLC task. For activation, "Generate Station Name from Control" must be activated. For clarification, 000 will be appended to the previous tree names (default: "tcpniodvice").

● Tree name

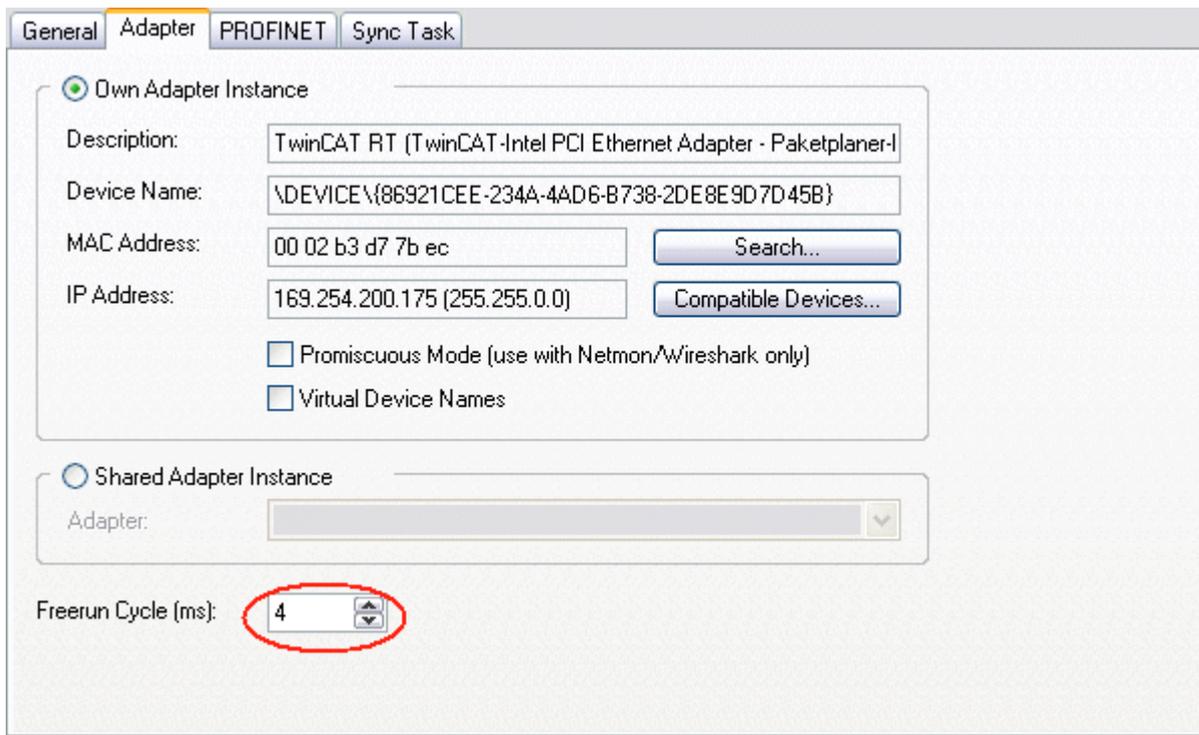
i This tree name no longer corresponds to the PROFINET station name! The Ctrl WORD of the PN protocol is used as an aid to assigning names, i.e. the number entered (value range 0 – 255) will be appended to the previous station name. In addition, the Ctrl WORD must be linked to a task. It is subsequently necessary to restart TwinCAT. If, for example, the task now specifies a value of 11 for the linked Ctrl WORD, its previous station name will change from, for example, "tcpniodvice" to "tcpniodvice011". The current tree name remains "tcpniodvice000".

The current station names and the IP configuration used can be checked via the "PROFINET diagnosis" tab.

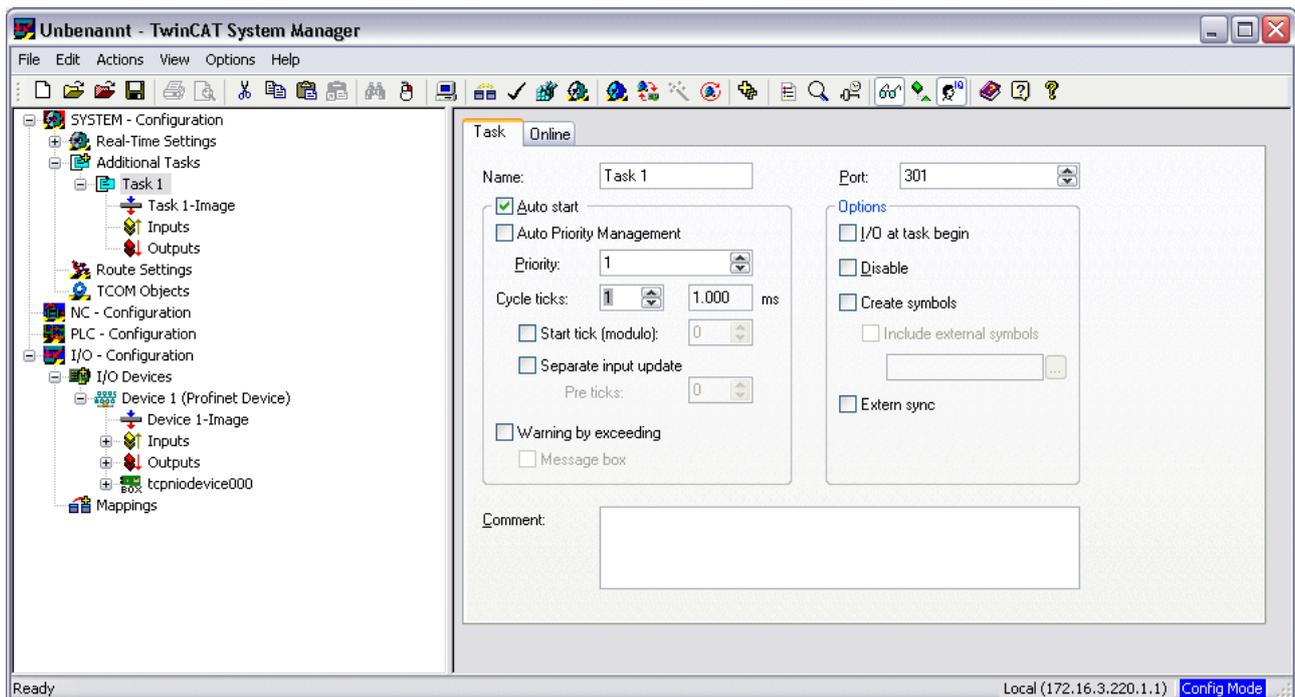
4. Cycle times

The device can be operated in the minimum cycle time of 1 ms defined by PROFINET!

If TwinCAT is operated in FREERUN mode, care must be taken that the freerun cycle set is not longer than the PROFINET cycle!



If TwinCAT is to be operated in RUN mode, a task must be created. In the simplest case, this is the aforementioned SyncTask. The call time for the task must not be longer than the PROFINET cycle time! If a second task is created, e.g. for the PLC, this can also run more slowly.



In the case of less powerful devices (e.g. CX1000, CX9000 with E-bus), the CPU load may reach its limits. However, the performance can be improved again by means of the following considerations/measures:

- Can I work with just one PLC task?
- Does the cycle time have to be 1 ms?
- If two tasks are used, can the PLC task time be shortened?
- Will several virtual PROFINET devices be required?

2.2 TwinCAT 2.11

2.2.1 Technical data - PROFINET RT

When using TwinCAT 2.11, all the target systems, for instance the CX Controllers, must have TwinCAT version 2.11 installed.

Technical data	Supplement
PROFINET version	RT Class 1 ConformanceClassB
Number of device interfaces) ¹	8
Topology	variable
Quantity of user data	per device, maximum one Ethernet frame length) ² 1500 bytes of user data, inc. IOPS and IOCS
Cycle time	≥ 1 ms

)¹ see the chapter on virtual PROFINET devices

)² Depending on the cycle time, the PROFINET cycle time, and the CPU being used

● Conditions required for operation



- Only Ethernet cards with Intel chipset are allowed.
- RealTime Ethernet driver must be installed.
- No other RealTime protocols must be connected through this interface.
- The real-time capability can only be guaranteed in the transmit direction; in the receive direction, the possibility of incorrect use means that it cannot be guaranteed. This might, for example, be the copying of large quantities of data through this interface.
It is recommended that the PROFINET network is separated from other networks.

2.2.2 PROFINET device integration under TwinCAT 2.11

This description applies to the PROFINET DEVICE Supplement.

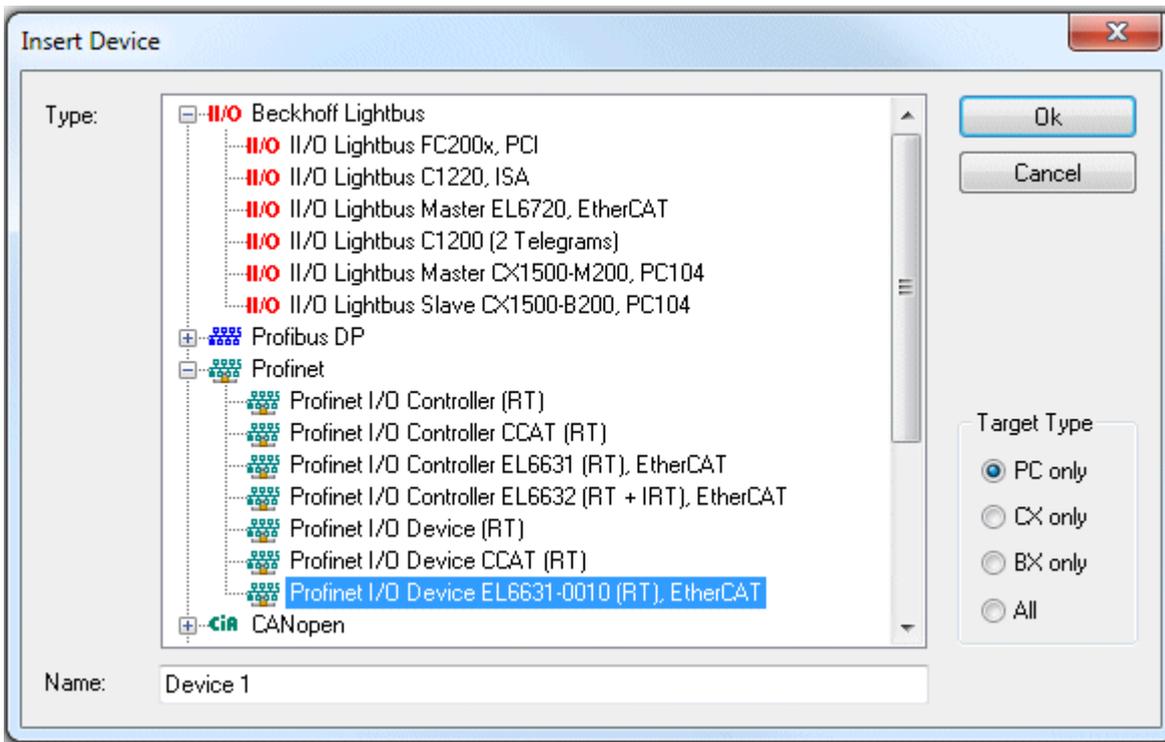
● Installation



For an accurate installation you have to install at least TwinCAT 2.11 Build 1546. If you use an older TwinCAT version, we recommend an update. If you need further assistance, please refer to the Beckhoff Support.

1. Integration of the PROFINET protocol

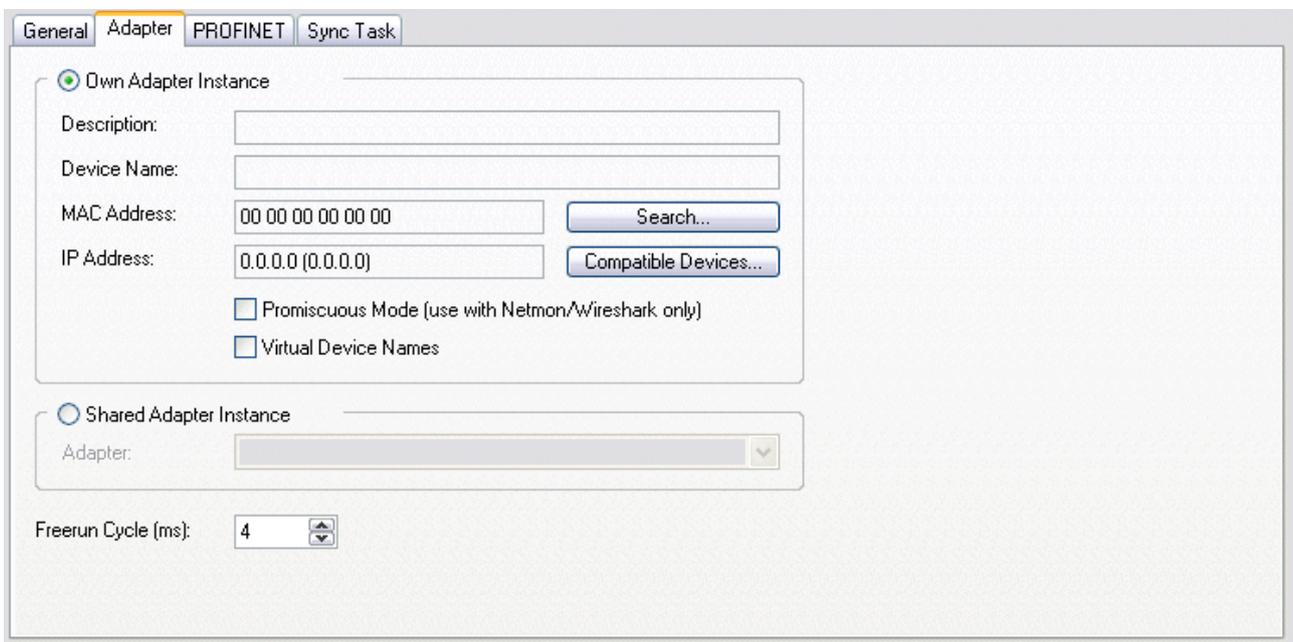
A PROFINET device must first be added.



i Network card

If no card is found, either the TwinCAT is not in Config mode, or the real-time Ethernet driver has not been installed properly.

This interface must be assigned to an adaptor class. This is composed of the MAC and IP address of the network card. Look for the corresponding network card by using "Search".



MAC address:
MAC address of the Ethernet card (read-only)

IP address:
IP address of the card (read-only). The IP address is read from the operating system, and has nothing to do with the PROFINET IP address that will be used later.

i IP address of the network card

Please note, that the IP address of the PROFINET Device and the IP address of the Ethernet card must not be the same! The PROFINET driver uses a virtual IP address, which must differ with the IP address of the OS!

Promiscuous Mode:

This is required in order to record Ethernet frames, and should normally be switched off.

Virtual Device Names:

A virtual name is used for the network card.

Shared Adapter Interface:

Is included for compatibility reasons, but can not be used with PROFINET..

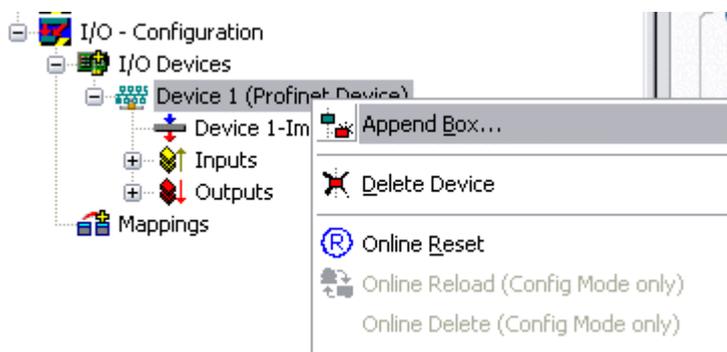
Free Cycle:

Cycle time in Config mode (no real-time). If TwinCAT is operated in FREERUN mode, care must be taken that the freerun cycle set is not longer than the PROFINET cycle!

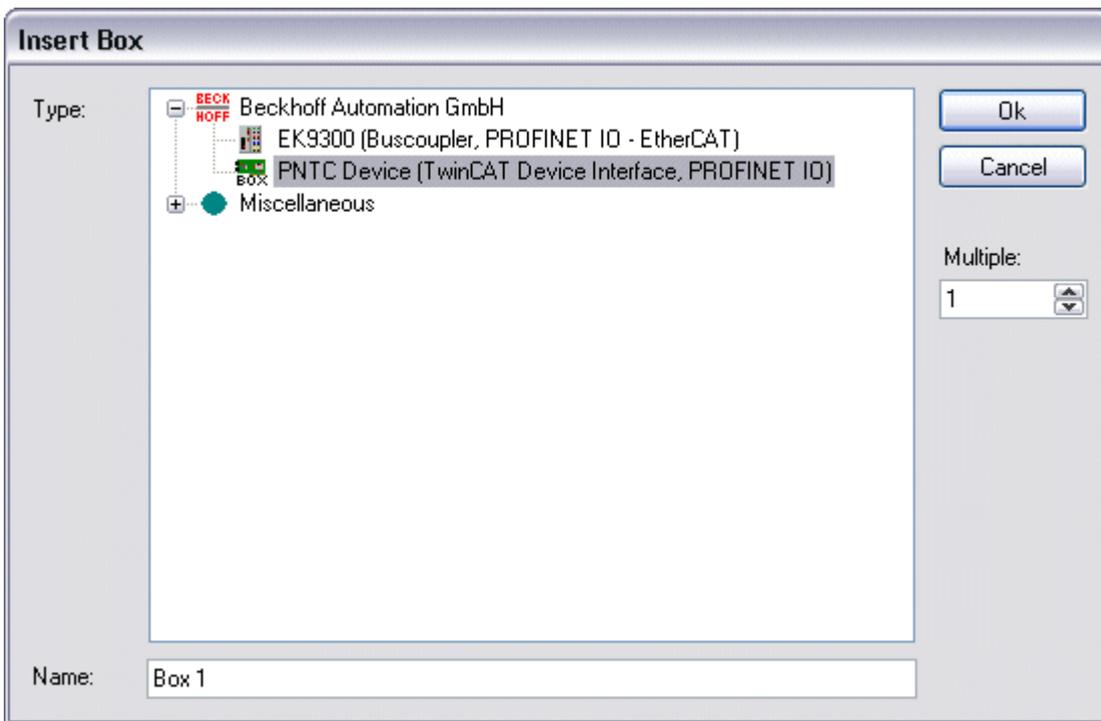
If, for example, a CX9000 is to be parameterized, the target system must first be accessed remotely; the corresponding Ethernet port can subsequently be selected.

The NetID used can be found under the "Protocol" tab. It is, for instance, necessary for an ADS access. Besides that, there is a possibility in the "Sync Task" tab to append a free-running task for PROFINET communication (this is recommended). This allows the RealTime communication to run independently of a PLC task. For performance reasons, however (e.g. in the case of a CX9000), the Sync Tasks can be dispensed with and standard mapping takes place, i.e. a PLC task, for example, must be running in order for PROFINET communication to be possible.

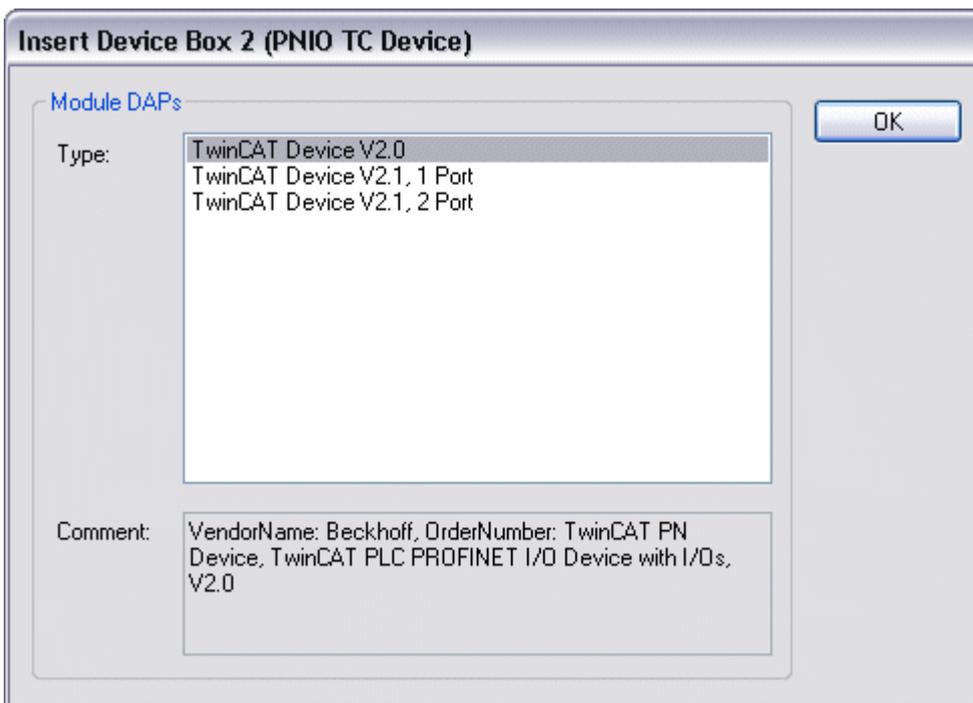
A PROFINET protocol is then added by means of the right mouse button. Precisely one TwinCAT device protocol can be appended!



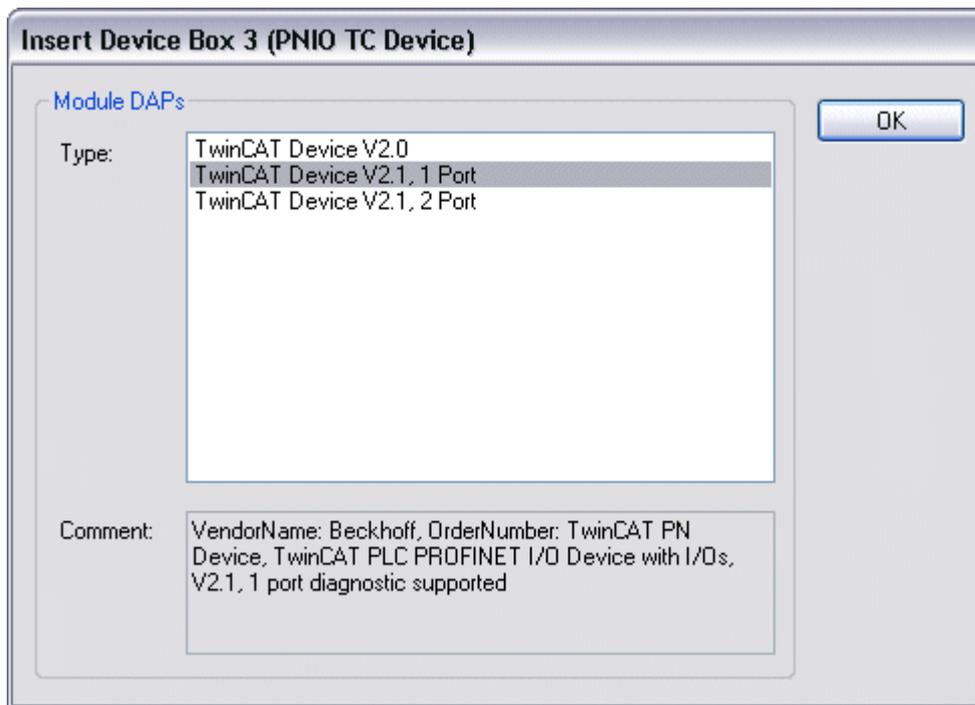
A Box in the form of a GSDML is then integrated (right mouse button on "PROFINET Device").



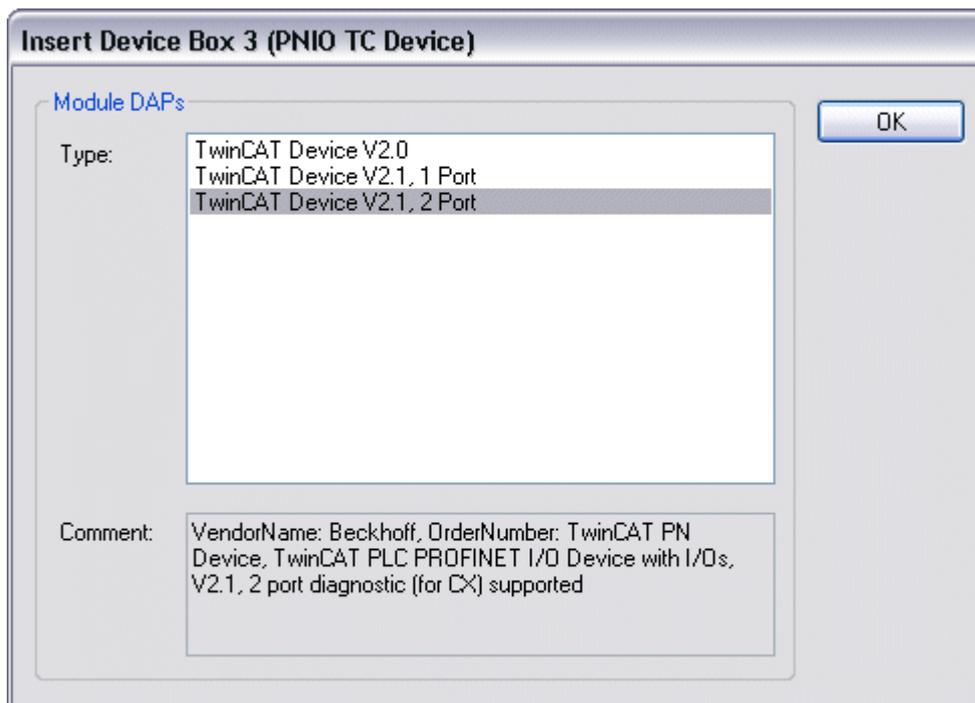
Integration with any Ethernet interface without port diagnosis according to Version 2.0 without LLDP.



Integration with a simple Ethernet interface (without switch, for example the CX1010 or FC90xx) with port diagnosis according to Version 2.1.



Integration with a switched Ethernet interface (the CX1020, for example) with port diagnosis according to Version 2.1.



Virtual PROFINET device

It is also possible in TwinCAT to configure several virtual PROFINET devices (a maximum of 7 in the Supplement, and 1 in the EL6631-0010). Each device is again to be viewed as its own adaptor, i.e. each virtual device is assigned a default MAC address from a reserved range. To avoid possible address conflicts, the last byte of the MAC address of virtual devices can also be changed. The name which the device was given in the strand (or in the "General" tab) is also taken as a PROFINET station name following a restart. On the basis of different MAC addresses and names, a PROFINET controller can now distinguish several devices in the strand.

It is therefore possible to use 8 devices per Ethernet interface in the PROFINET Device Supplement, and to communicate with 8 different PROFINET controllers.

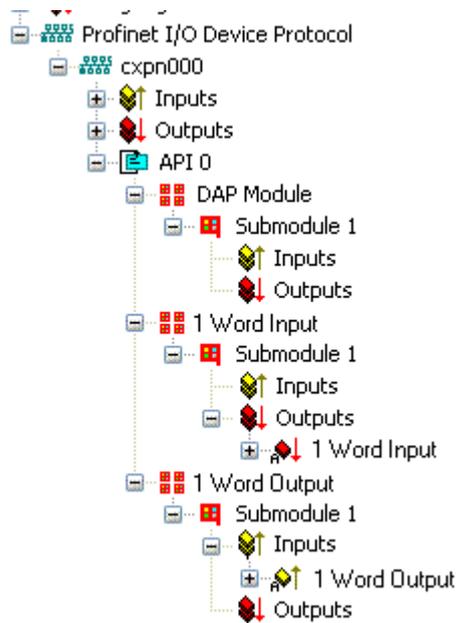
In PROFINET, different user profiles can be defined within a device (API - Application Process Instance). Precisely one API is permitted / supported for each device in TwinCAT.

In accordance with PROFINET, the DAP (Device Access Point) is always defined on slot 0. Device-specific data is defined in it. In accordance with PROFINET, several DAPs can be defined; however, in TwinCAT there is currently precisely one!

2. Process data

The process data can be inserted from slot 1. This takes place by integrating the desired module in the API. Each module (slot) has at present precisely one sub-module (sub-slot). The configuration of the modules and hence the creation of the process data image on the PROFINET side takes place by means of specifying data types / data widths (e.g. byte, word, dword, float 32).

The designation of the inputs and outputs always takes place in TwinCAT from the TwinCAT point of view, i.e. the inputs are from the PROFINET point of view (from the controller) the outputs! Therefore the data of the PROFINET I/O devices is represented as follows:



This representation applies only to the TwinCAT PROFINET device, in the case of a TwinCAT PROFINET controller, the view will correlate again!

3. General settings

The instance ID can be changed on the "PROFINET Devices" tab. However, the default settings suffice for normal operation!

The screenshot shows the 'Device' configuration window with the following settings:

- Adapter Properties:**
 - MAC Address: 00-02-B3-D7-7B-EC
 - VendorID: 0x0120
 - DeviceID: 0x0021
 - Generate Station Name from Control
- Instance Properties:**
 - ID: 0x0000
 - Server UDP Port: 0xC350
 - FrameID: 0xC000
 - Client UDP Port: 0xC351

There is one further way of assigning the PROFINET station name. This is comparable with the DIP switches in the BK9103 and can be carried out via a PLC task. For activation, "Generate Station Name from Control" must be activated. For clarification, 000 will be appended to the previous tree name (default: "tcpnodevice").

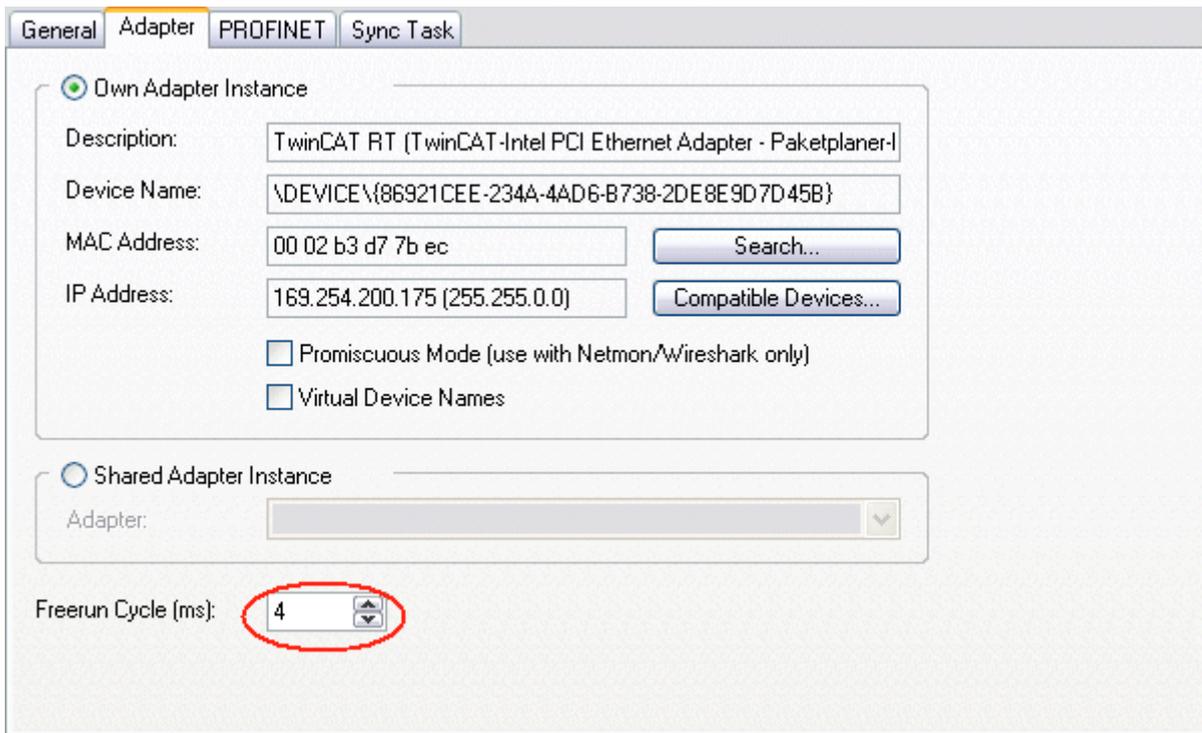
● Tree name

i This tree name no longer corresponds to the PROFINET station name! The Ctrl WORD of the PROFINET protocol is used to help assign a name. This means that the number that is entered (range of values 0 - 255) is appended to the existing station name. In addition, the Ctrl WORD must be linked to a task. It is subsequently necessary to restart TwinCAT. If, for example, the task now specifies a value of 11 for the linked Ctrl WORD, its previous station name will change from, for example, "tcpnodevice" to "tcpnodevice011". The current tree name remains "tcpnodevice000".

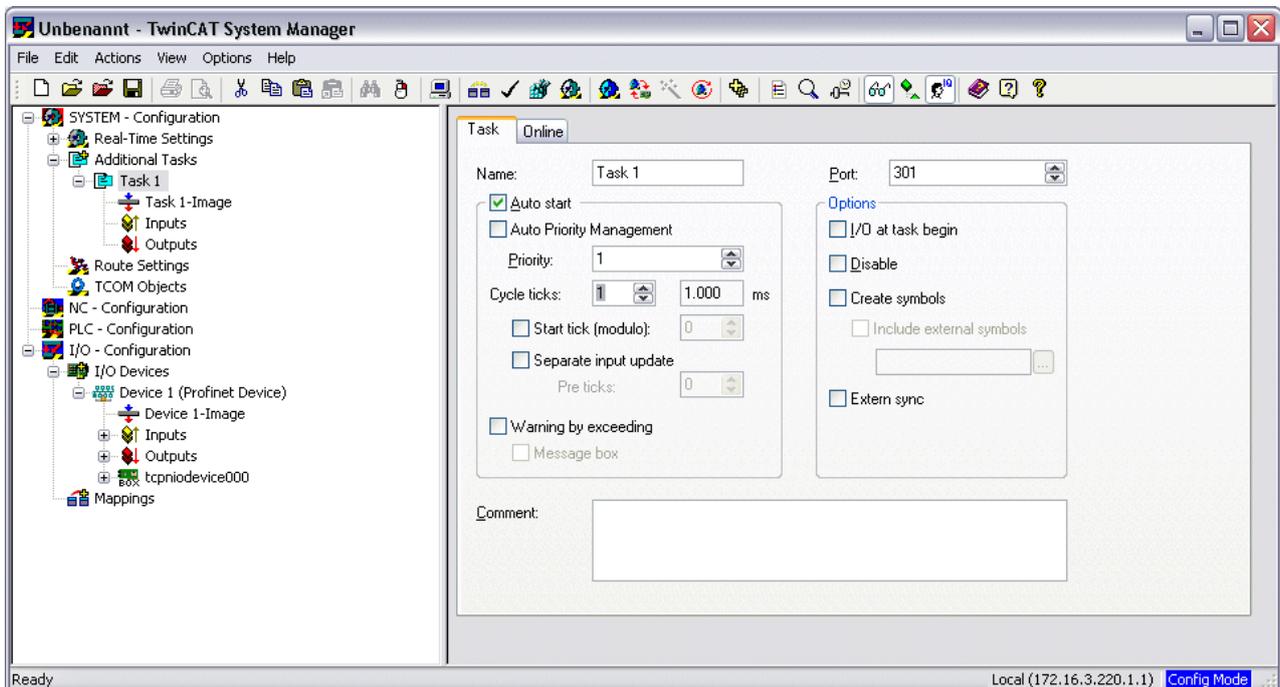
The current station names and the IP configuration used can be checked via the "PROFINET diagnosis" tab.

4. Cycle times

The device can be operated in the minimum cycle time of 1 ms defined by PROFINET!



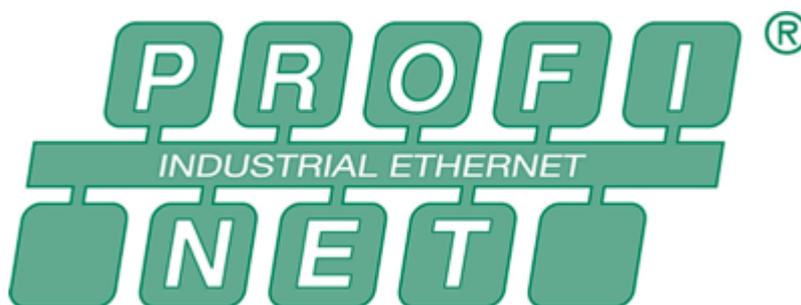
If TwinCAT is to be operated in RUN mode, a task must be created. In the simplest case, this is the aforementioned SyncTask. The call time for the task must not be longer than the PROFINET cycle time! If a second task is created, e.g. for the PLC, this can also run more slowly.



In the case of less powerful devices (e.g. CX1000, CX9000 with E-bus), the CPU load may reach its limits. However, the performance can be improved again by means of the following considerations/measures:

- Is it possible to work with just one PLC task?
- Does the cycle time have to be 1 ms?
- If two tasks are used, can the PLC task time be shortened?
- Will several virtual PROFINET devices be required?

3 PROFINET EL6631-0010



The EL6631-0010 PROFINET IO Device (Slave) Terminal enables simple exchange of data between EtherCAT and PROFINET IO. It is a device in the EtherCAT strand, which can consist of up to 65,535 devices. The EL6631-0010 has a 3-port switch. Two ports are fed to the outside on RJ-45 sockets. This allows the I/O stations to be structured as a line topology, as a result of which the wiring is simplified. The maximum distance between two devices is 100 m.

Protocols such as LLDP or SNMP can be used for network diagnostics.

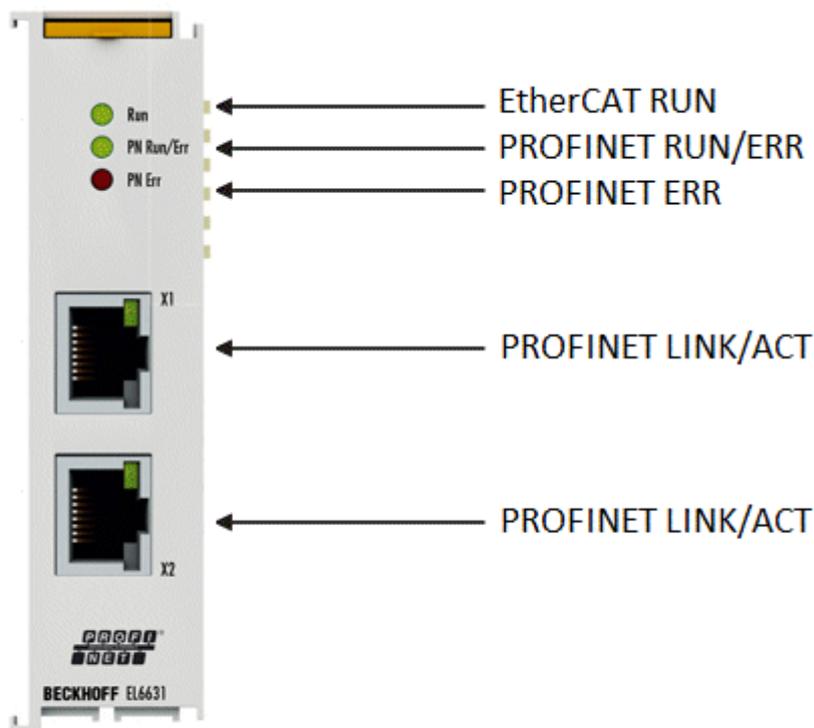
3.1 EL6631-0010 - Technical data

Requirements

Technical data	EL6631-0010
Bus system	PROFINET RT Device
Number of Ethernet ports/channels	2
Ethernet interface	10BASE-T/100BASE-TX Ethernet with 2 x RJ45
Cable length	up to 100 m twisted pair
Transfer rate	10/100 Mbit/s, IEEE 802.3u Auto negotiation, half- or full duplex at 10 and 100 Mbit/s possible, settings automatically
Diagnosis	Status LEDs
Power supply	via E-Bus
Current consumption E-bus	typ. 400 mA
Electrical isolation	500 V _{eff} (E-Bus/Ethernet)
Bit width in the process image	variable (max. 2 kByte for inputs and outputs)
Configuration	via TwinCAT System Manager
Weight	approx. 75 g

Technical data	EL6631-0010
Operating temperature	0°C ... + 55°C (aligned in horizontal installation position) 0°C ... + 45°C (for all other installation positions, see advice [► 28])
Storage temperature	-25°C ... + 85°C
Relative humidity	95 %, no condensation
Dimensions (W x H x D)	approx. 26 mm x 100 mm x 52 mm (width aligned: 23 mm)
Mounting [► 25]	on 35 mm mounting rail according to EN 50022
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC immunity/emission	according to EN 61000-6-2 / EN 61000-6-4
Protect. class	IP 20
Installation position	see advice [► 28]
Approval	CE Ex [► 31] UL [► 51]

3.2 EL6631-0010 - LEDs



LEDs for EtherCAT diagnosis

LED	Display	Description
RUN	green	off
		State of the EtherCAT State Machine: INIT = Initialization of the terminal BOOTSTRAP = Function for firmware updates of the terminal

LED	Display	Description
	flashing 200 ms	State of the EtherCAT State Machine: PREOP = Setting for mailbox communication and variant standard settings
	off (1 s) on (200 ms)	State of the EtherCAT State Machine: SAFEOP = Channel checking of the Sync Manager and the Distributed Clocks. Outputs stay in safe operation mode.
	on	State of the EtherCAT State Machine: OP = Normal operation mode, mailbox- and process data communication possible

LED diagnosis PROFINET RUN/Err

Colour green	Colour red	Meaning
on	off	EL terminal is parameterized
off (1 s) on (200 ms)	off	EL6631-0010 does not have an IP address
flashing 200 ms	off	EL6631-0010 still has not received a PROFINET name
off	flashing 200 ms	Terminal starts

LED diagnosis PROFINET Err

Colour green	Colour red	Meaning
on	off	EL terminal is exchanging data
flashing 200 ms	off	EL terminal is exchanging data, but the provider status is stopped
off (1 s) on (200 ms)	off	EL terminal is exchanging data, but the modules are different
off	flashing 500 ms	No AR established, establishment of connection has not been initialized
flashing 500 ms	flashing 500 ms	Identify EL terminal through PROFINET "flashing"

LEDs starting up

Run	PN Run/ Err	PN Err	Meaning
off	off	off	No electrical voltage connected to E-bus. The EL6631-0010 must be exchanged if EtherCAT terminals behind it need to function.
off	off	red on	EL terminal is starting up; after approx. 10 seconds, the LED should go out. If this does not happen, the EL6631-0010 module must be exchanged.

3.3 Mounting and wiring

3.3.1 Recommended mounting rails

Terminal Modules und EtherCAT Modules of KMxxxx and EMxxxx series, same as the terminals of the EL66xx and EL67xx series can be snapped onto the following recommended mounting rails:

- DIN Rail TH 35-7.5 with 1 mm material thickness (according to EN 60715)
- DIN Rail TH 35-15 with 1,5 mm material thickness

i Pay attention to the material thickness of the DIN Rail

Terminal Modules und EtherCAT Modules of KMxxxx and EMxxxx series, same as the terminals of the EL66xx and EL67xx series does not fit to the DIN Rail TH 35-15 with 2,2 to 2,5 mm material thickness (according to EN 60715)!

3.3.2 Mounting and demounting

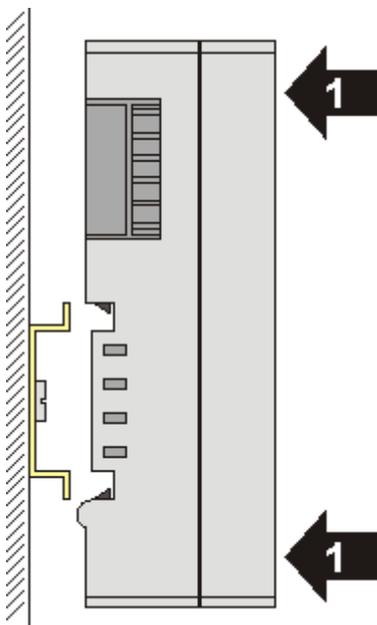
The terminal modules are fastened to the assembly surface with the aid of a 35 mm mounting rail (e.g. DIN rail TH 35-7.5 according to EN 60715a).

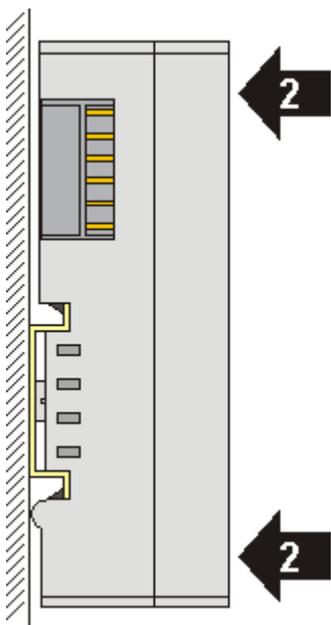
⚠ WARNING**Risk of electric shock and damage of device!**

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.



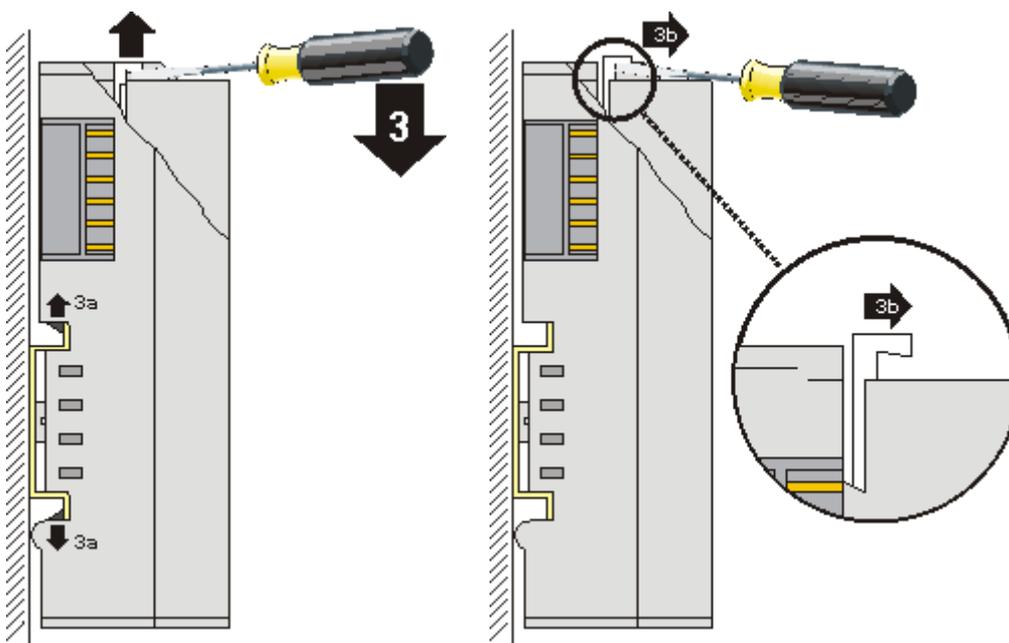


and press (1) the terminal module against the mounting rail until it latches in place on the mounting rail (2).

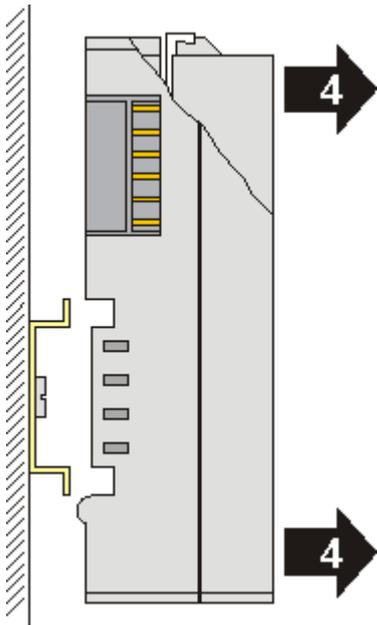
- Attach the cables.

Demounting

- Remove all the cables. Thanks to the KM/EM connector, it is not necessary to remove all the cables separately for this, but for each KM/EM connector simply undo 2 screws so that you can pull them off (fixed wiring)!
- Lever the unlatching hook on the left-hand side of the terminal module upwards with a screwdriver (3). As you do this
 - an internal mechanism pulls the two latching lugs (3a) from the top hat rail back into the terminal module,
 - the unlatching hook moves forwards (3b) and engages



- In the case 32 and 64 channel terminal modules (KMxxx4 and KMxxx8 or EMxxx4 and EMxxx8) you now lever the second unlatching hook on the right-hand side of the terminal module upwards in the same way.
- Pull (5) the terminal module away from the mounting surface.



3.3.3 Mounting and demounting

The terminal modules are fastened to the assembly surface with the aid of a 35 mm mounting rail (e.g. DIN rail TH 35-7.5 according to EN 60715a).

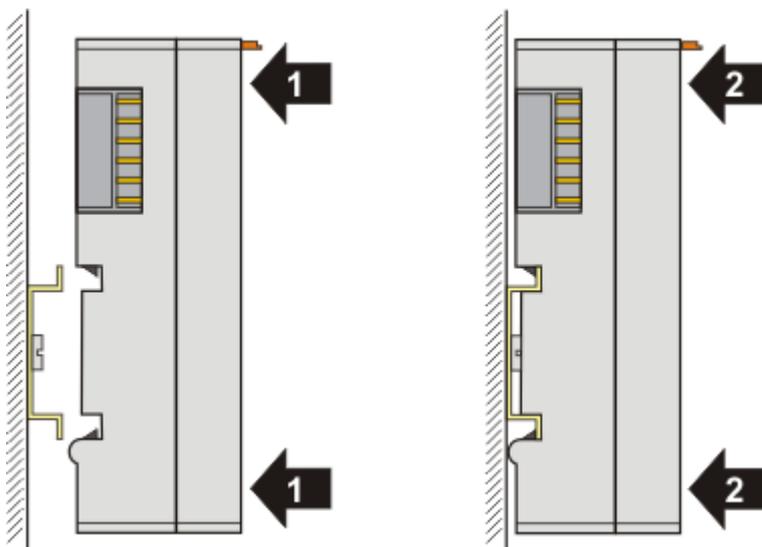
⚠ WARNING

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.



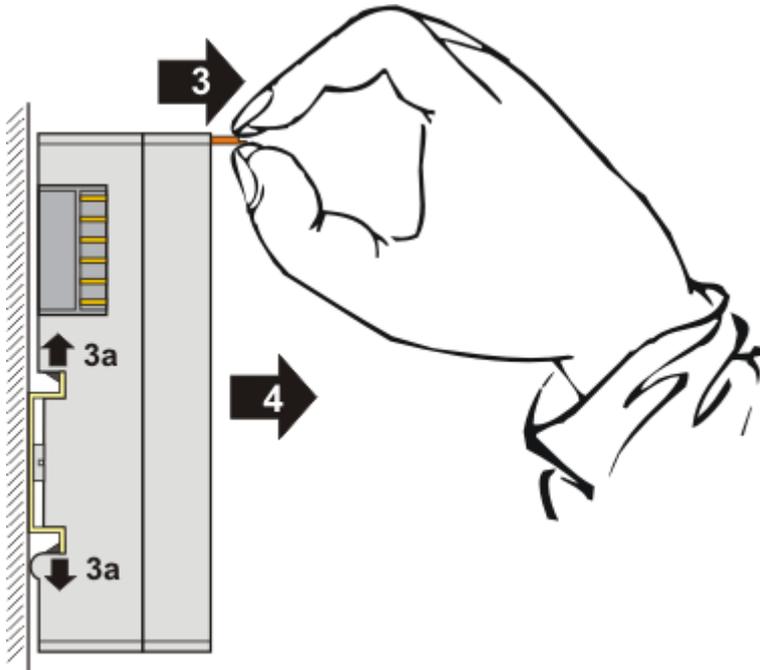
and press (1) the terminal module against the mounting rail until it latches in place on the mounting rail (2).

- 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.

3.3.4 Installation positions

NOTICE

Constraints regarding installation position and operating temperature range

Please refer to the technical data for a terminal to ascertain whether any restrictions regarding the installation position and/or the operating temperature range have been specified. When installing high power dissipation terminals ensure that an adequate spacing is maintained between other components above and below the terminal in order to guarantee adequate ventilation!

Optimum installation position (standard)

The optimum installation position requires the mounting rail to be installed horizontally and the connection surfaces of the EL/KL terminals to face forward (see Fig. 1). The terminals are ventilated from below, which enables optimum cooling of the electronics through convection. "From below" is relative to the acceleration of gravity.

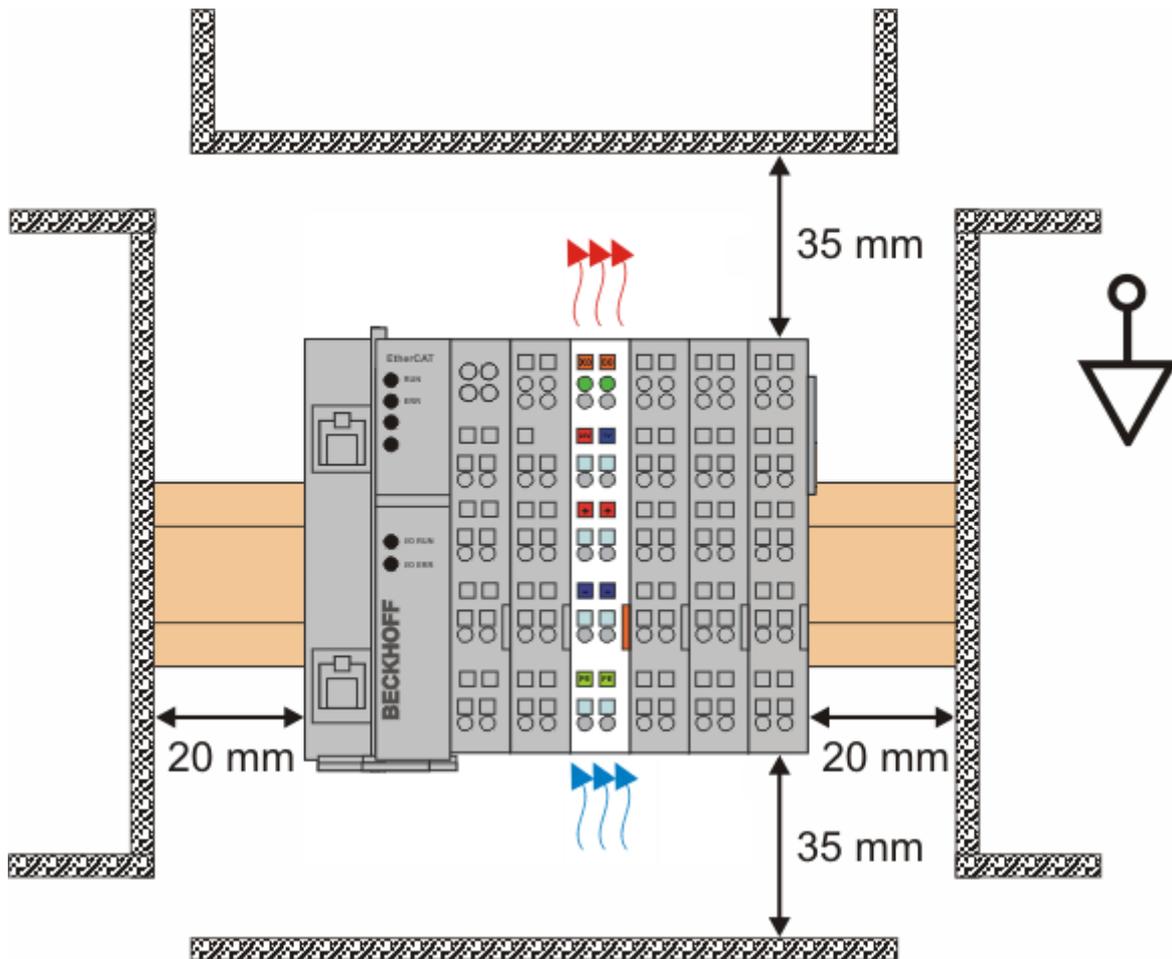


Fig. 1: Recommended distances for standard installation position

Compliance with the distances shown in Fig. 1 is recommended.

Other installation positions

All other installation positions are characterized by different spatial arrangement of the mounting rail - see Fig 2.

The minimum distances to ambient specified above also apply to these installation positions.

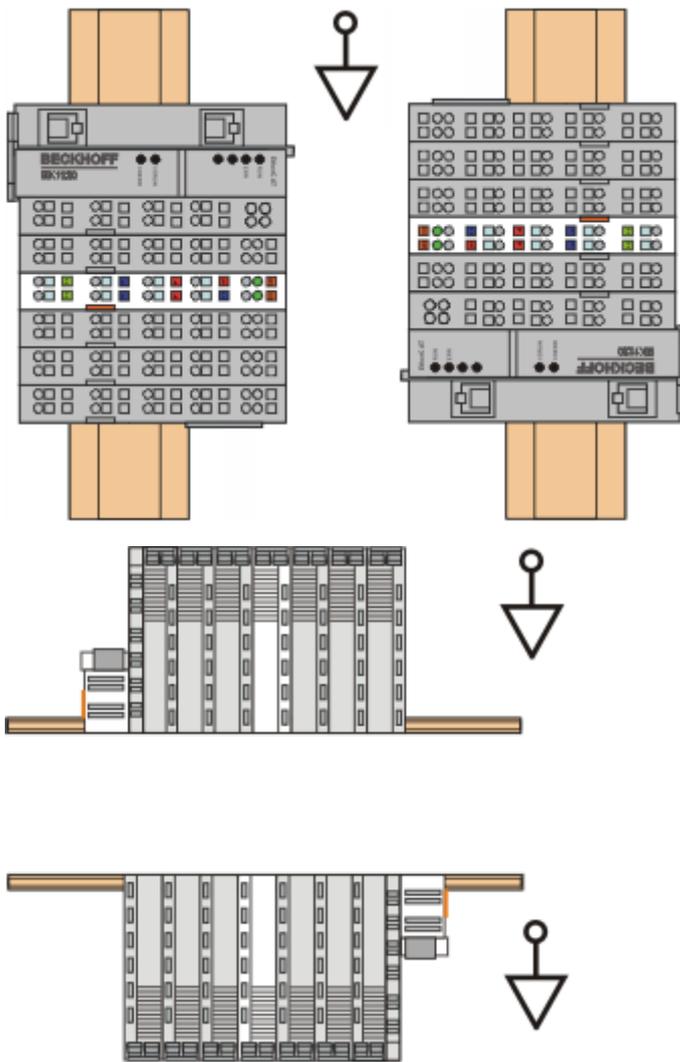


Fig. 2: Other installation positions

3.3.5 ATEX - Special conditions

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas (directive 94/9/EU)!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60529! The environmental conditions during use are thereby to be considered!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines, or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of 0 - 55°C for the use of Beckhoff fieldbus components 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 power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

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

- EN 60079-0: 2006
- EN 60079-15: 2005

Marking

The Beckhoff fieldbus components certified for potentially explosive areas bear one of the following markings:



II 3 G Ex nA II T4 KEMA 10ATEX0075 X Ta: 0 - 55°C

or



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

Serial number

The Beckhoff fieldbus components bear a serial number that is structured as follows:

WW YY FF HH

WW - week of production (CW, calendar week)
 YY - year of production
 FF - firmware version
 HH - hardware version

Example with ser. no.: 35 04 1B 01:

35 - week of production 35
 04 - year of production 2004
 1B - firmware version 1B
 01 - hardware version 01

3.4 Commissioning

3.4.1 Technical data - PROFINET RT

Technical data	EL6631-0010
PROFINET version	RT Class 1 ConformanceClassB
Number of device interfaces) ¹	2
Topology	variable
Quantity of user data	1 kbyte in/out
Cycle time	≥ 1 ms

)¹ see the chapter on virtual PROFINET devices



Switch functionality

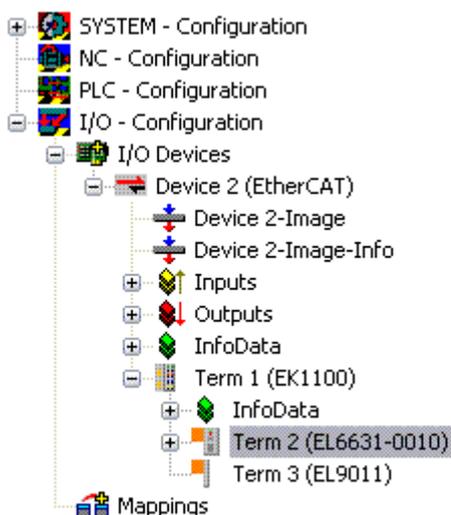
The internal Switch is deactivated, if you set the terminal into the Bootstrap mode and you can't use the switch, if you do a firmware update.

3.4.2 PROFINET device (EL6631-0010) integration under TwinCAT 2.11

This description applies to the PROFINET DEVICE EL6631-0010.

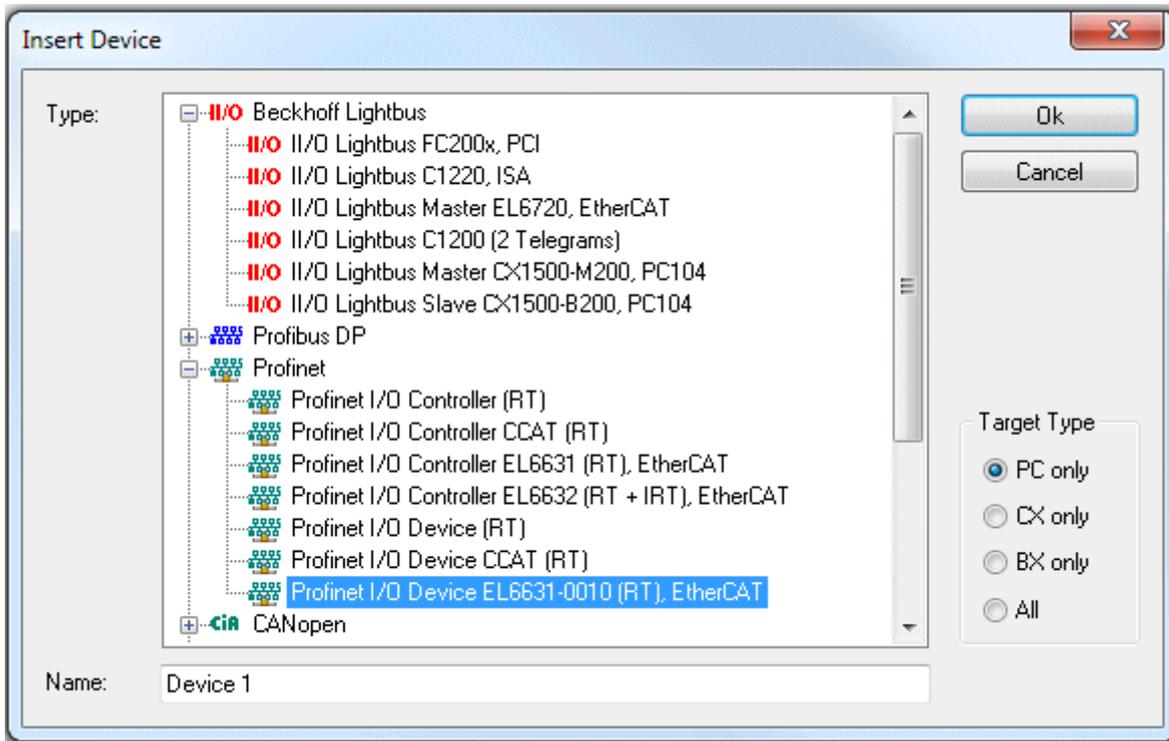
1. Integration of the EL6631-0010 into the EtherCAT network

Insert the EL6631-0010 into your TwinCAT project.

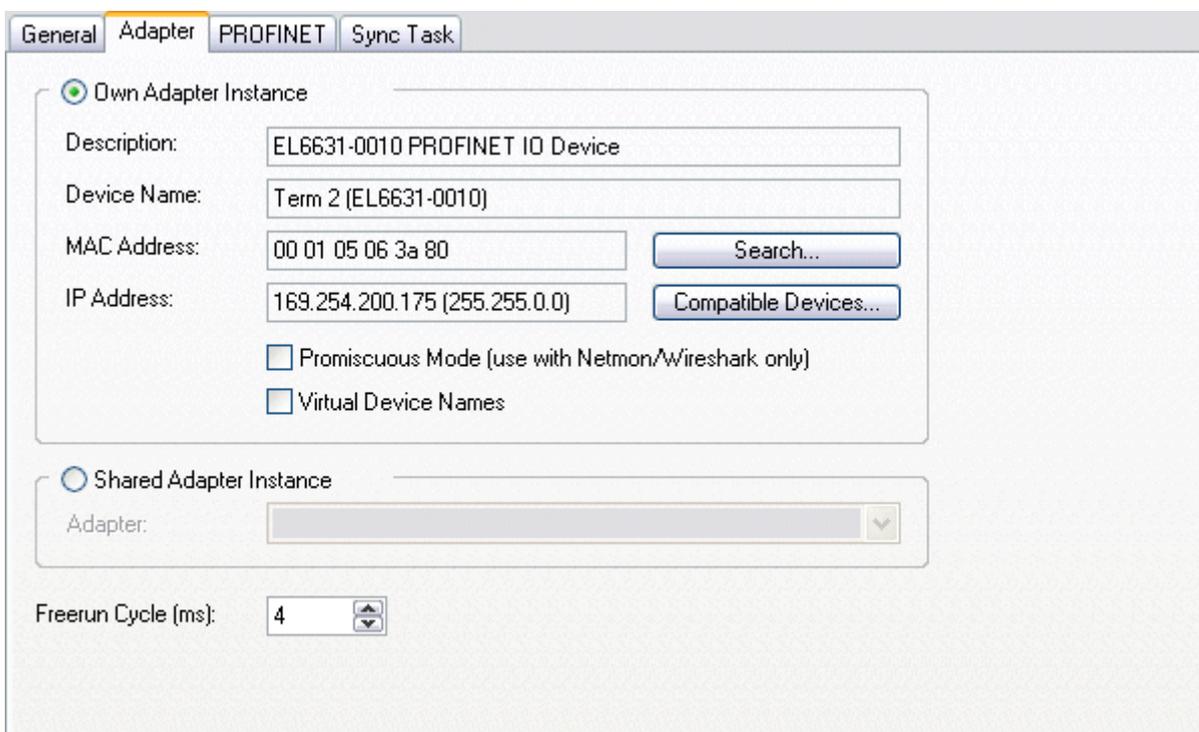


2. Integration of the PROFINET protocol

A PROFINET device must first be added - EL6631-0010.



This interface must be assigned to an adaptor class. This is composed of the MAC and IP address of the network card. Use "Search" to look for the corresponding EtherCAT terminal. If there is only one terminal in the system, it will be configured automatically.



MAC address:
MAC address of the Ethernet card (read-only)

IP address:

IP address of the card (read-only). The IP address is read from the operating system, and has nothing to do with the PROFINET IP address that will be used later.

Promiscuous Mode:

Is not supported by the EL6631-0010

Virtual Device Names:

Is not supported by the EL6631-0010

Shared Adapter Interface:

Is not supported by the EL6631-0010

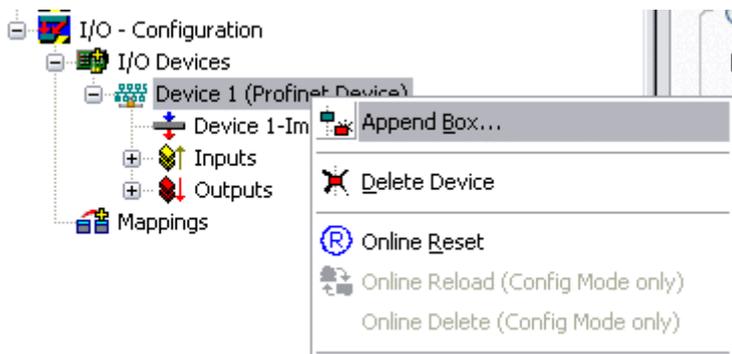
Free Cycle:

Cycle time in Config mode (no real-time). If TwinCAT is operated in FREERUN mode, care must be taken that the freerun cycle set is not longer than the PROFINET cycle!

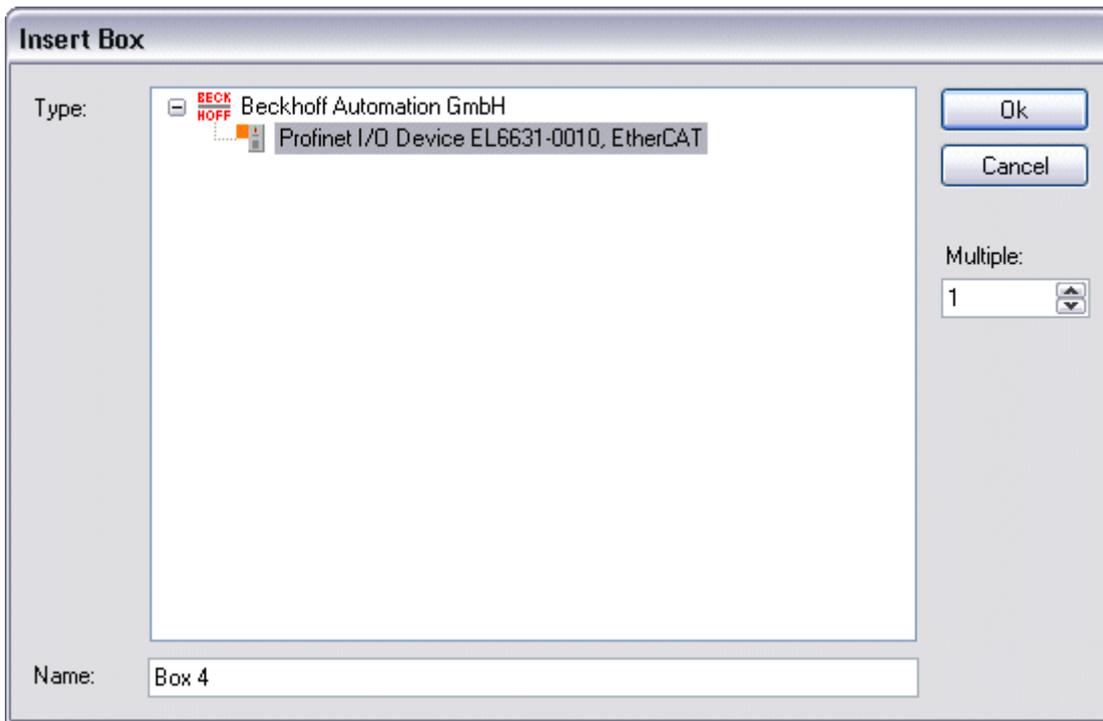
If, for example, a CX9000 is to be parameterized, the target system must first be accessed remotely; the corresponding Ethernet port can subsequently be selected.

The NetID used can be found under the "Protocol" tab. It is, for instance, necessary for an ADS access. Besides that, there is a possibility in the "Sync Task" tab to append a free-running task for PROFINET communication (this is recommended). This allows the RealTime communication to run independently of a PLC task. For performance reasons, however (e.g. in the case of a CX9000), the Sync Tasks can be dispensed with and standard mapping takes place, i.e. a PLC task, for example, must be running in order for PROFINET communication to be possible.

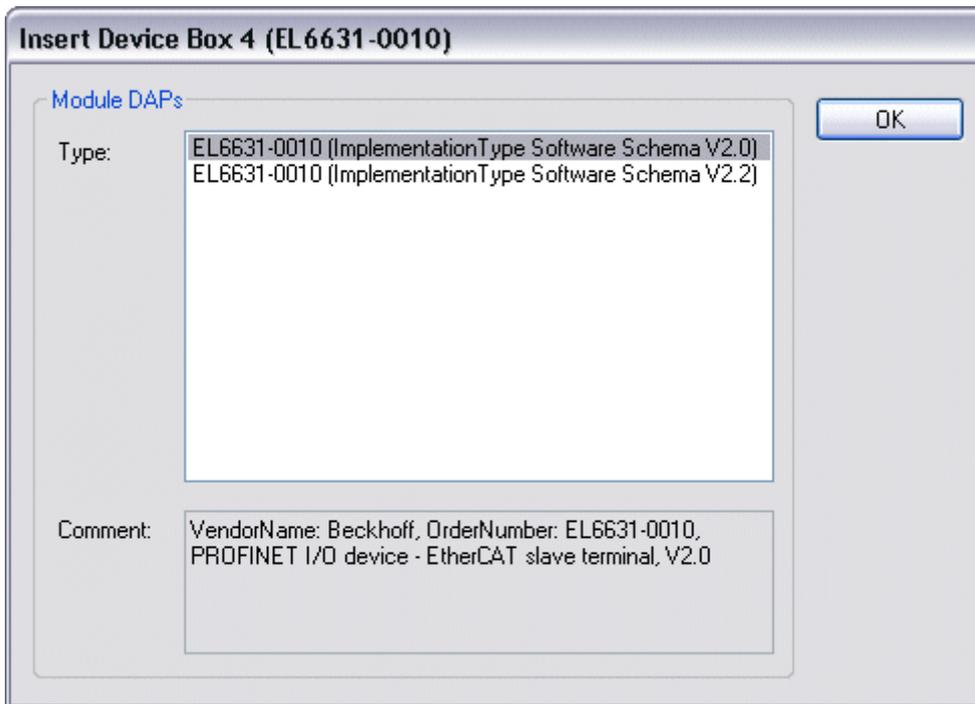
A PROFINET protocol is then added by means of the right mouse button. Precisely one TwinCAT device protocol can be appended!



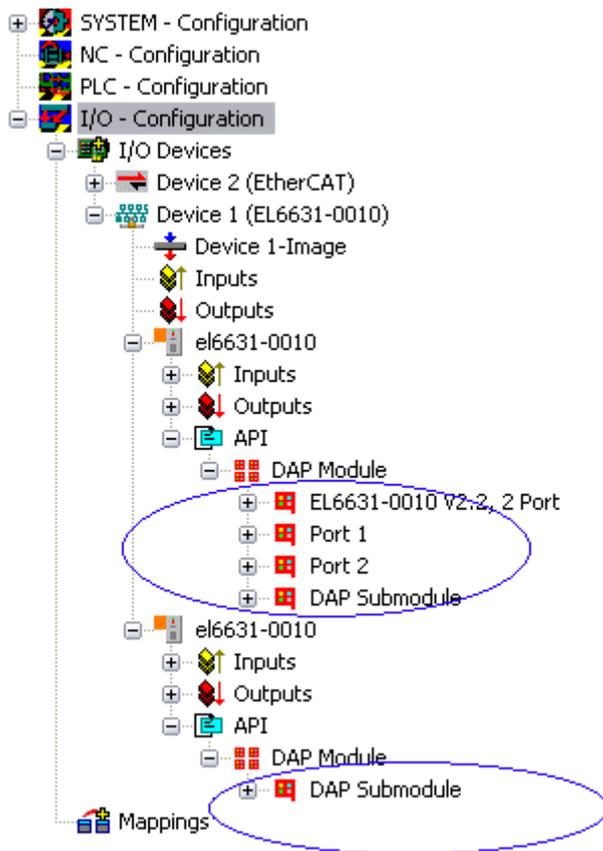
A Box in the form of a GSDML is then integrated (right mouse button on "PROFINET Device").



Now select the version to be used to integrate your EL6631-0010. The main difference between V2.0 and V2.2 lies in the support for sub-modules.



In the first EL6631-0010 (according to V2.2) the ports, and therefore the port diagnosis, can be seen in the DAP. The following EL6631-0010 is integrated according to V2.0. No port diagnosis is possible here. The same version must be used in the master. Older PROFINET controllers can not yet support Version 2.2, in which case you should use Version 2.0.



Virtual PROFINET device

It is also possible in TwinCAT to configure a number of virtual PROFINET devices (a maximum of 7 in the PROFINET Device Supplement, and one additional device in the EL6631-0010). Each device is again to be viewed as its own adaptor, i.e. each virtual device is assigned a default MAC address from a reserved range. To avoid possible address conflicts, the MAC address of virtual devices can also be changed. The name which the device was given in the strand (or in the "General" tab) is also taken as a PROFINET station name following a restart. On the basis of different MAC addresses and names, a PROFINET controller can now distinguish several devices in the strand.

It is therefore possible to use 8 devices per Ethernet interface in the PROFINET Device Supplement, and therefore to communicate with 8 different PROFINET controllers. In the case of the EL6631-0010 it is 2 devices.

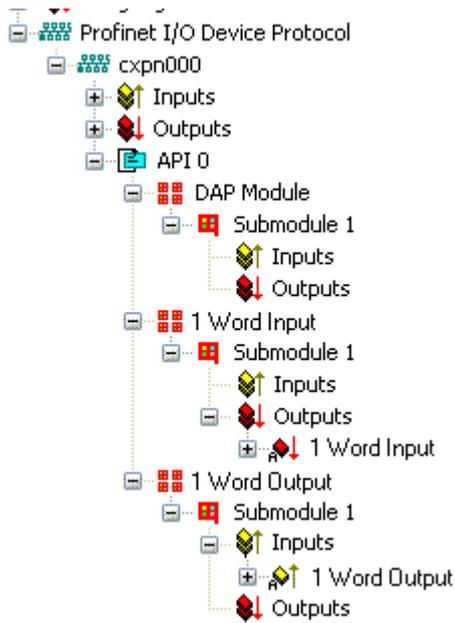
In PROFINET, different user profiles can be defined within a device (API - Application Process Instance). Precisely one API is permitted / supported for each device in TwinCAT.

In accordance with PROFINET, the DAP (Device Access Point) is always defined on slot 0. Device-specific data is defined in it. In accordance with PROFINET, several DAPs can be defined; however, in TwinCAT there is currently precisely one!

3. Process data

The process data can be inserted from slot 1. This takes place by integrating the desired module in the API. Each module (slot) has at present precisely one sub-module (sub-slot). The configuration of the modules and hence the creation of the process data image on the PROFINET side takes place by means of specifying data types / data widths (e.g. byte, word, dword, float 32).

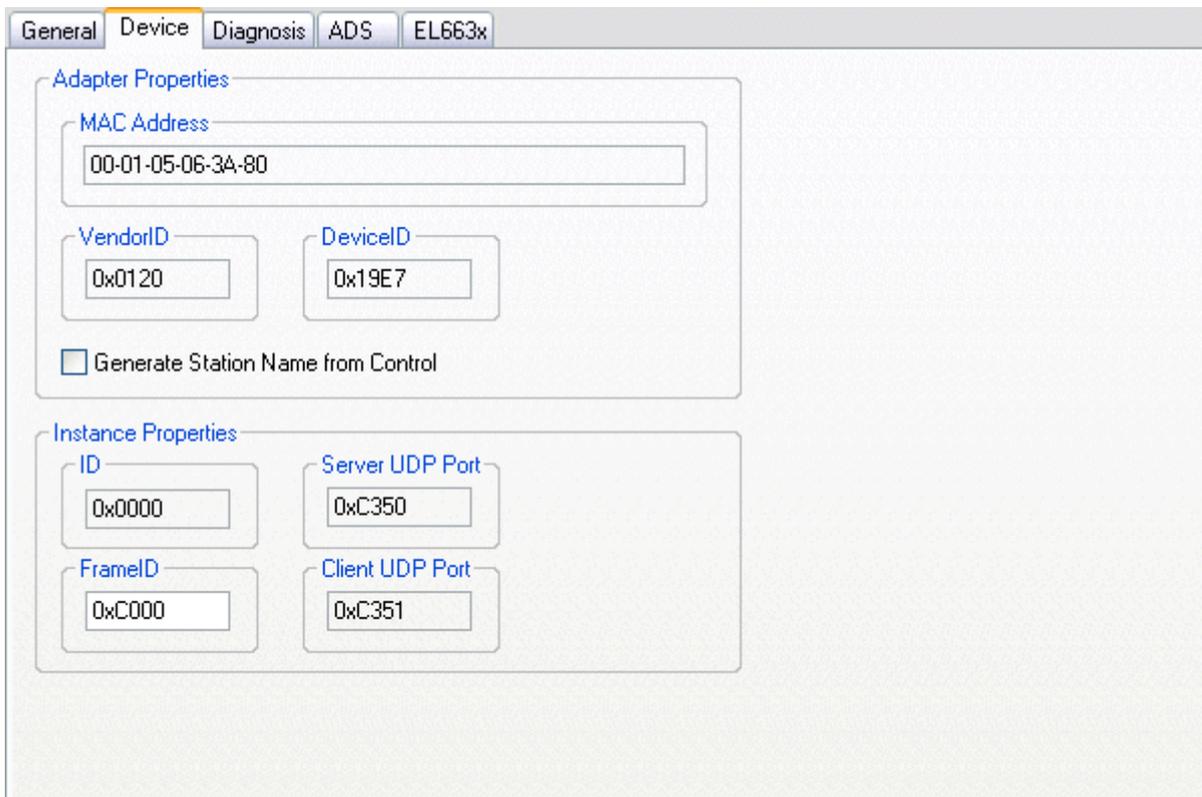
The designation of the inputs and outputs always takes place in TwinCAT from the TwinCAT point of view, i.e. the inputs are from the PROFINET point of view (from the controller) the outputs! Therefore the data of the PROFINET I/O devices is represented as follows:



This representation applies only to the TwinCAT PROFINET device, in the case of a TwinCAT PROFINET controller, the view will correlate again!

4. General settings

The FrameID can be changed on the "PROFINET Devices" tab. However, the default settings suffice for normal operation!



4.1 PROFINET name assignment

When the EL6631-0010 is shipped it does not have a PROFINET name. It returns an empty string when the devices are searched.

There are several ways to assign a name to an EL6631-0010:

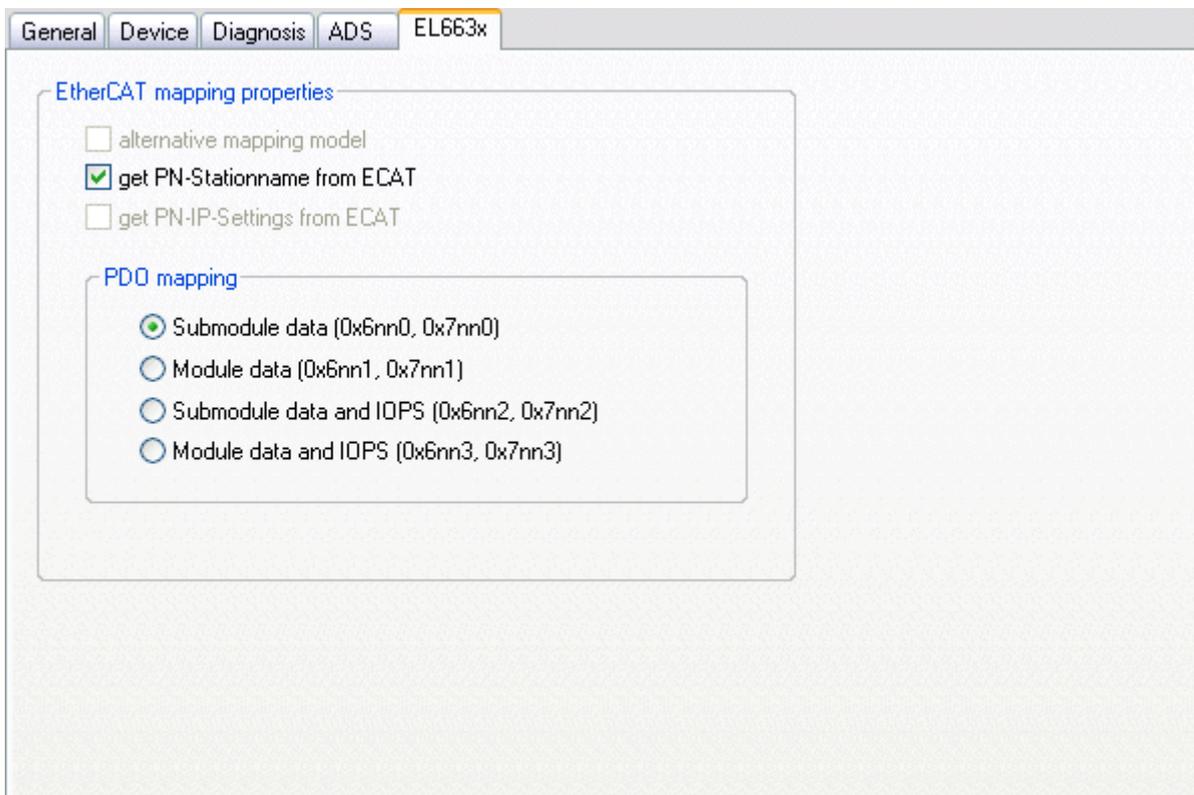
1. Assignment through the PROFINET controller
2. Assignment through the EtherCAT Master (assignment through the controller is then no longer possible)
3. Assignment through a link to the PLC program (assignment through the controller is then no longer possible)
4. Automatic device startup through topology specification is supported
You can obtain more information from your PROFINET controller

4.1.1 Assignment through the PROFINET controller

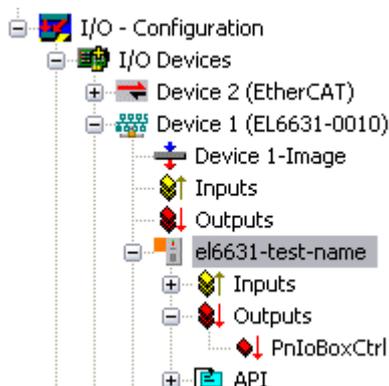
In this case, the PROFINET controller assigns the name of the device. You can learn about this from the manufacturer of your PROFINET controller.

4.1.2 Assignment by the EtherCAT Master

Tick the "get PN station name from ECAT" to activate this.

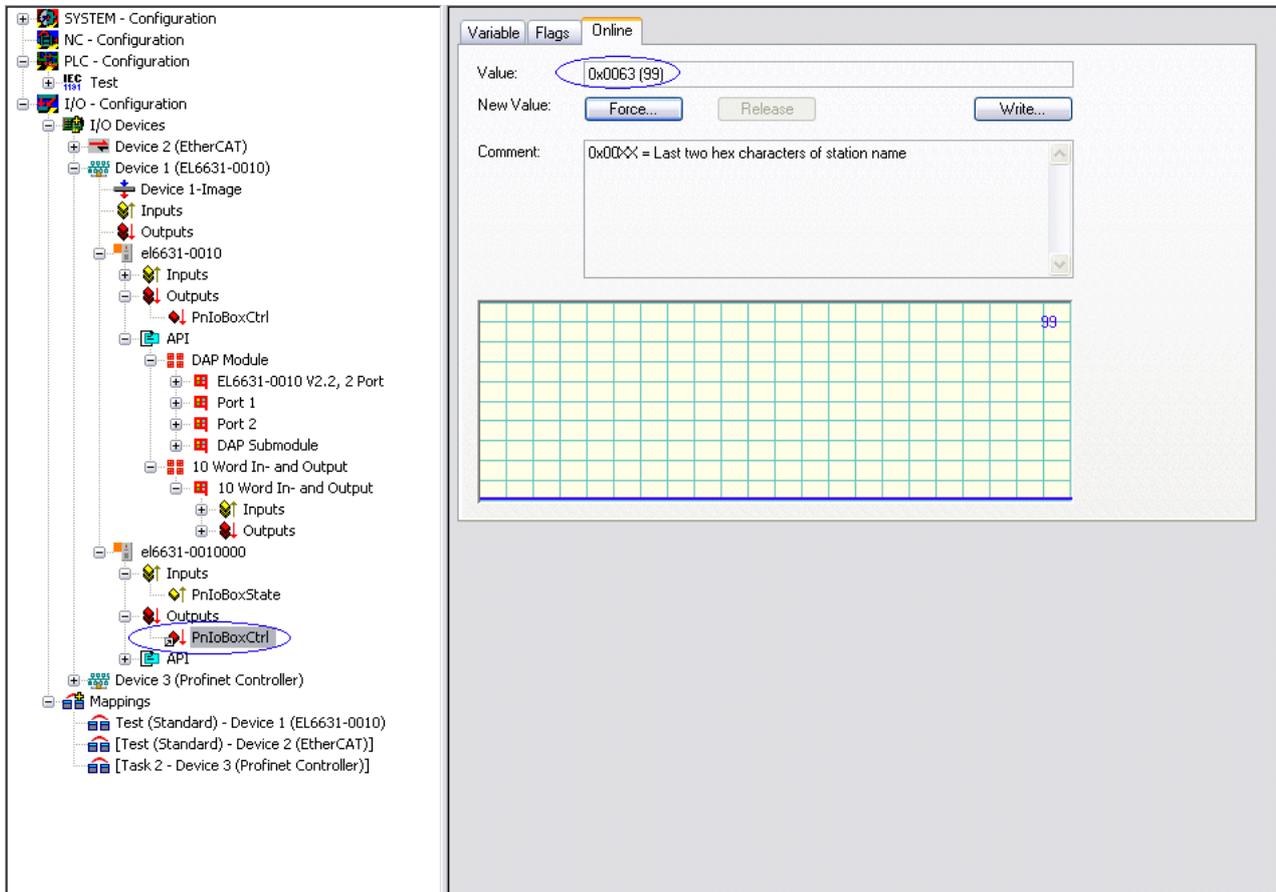


The name used in the System Manager tree is then used. In this case, for example, "el6631-test-name".



4.1.3 Assignment through a link to the PLC program

This is comparable with the DIP switches in the BK9103 and can be carried out via a PLC task. For activation, "Generate Station Name from Control" must be activated. For clarification, 000 will be appended to the previous tree name (default: "tcpniodevice").



i **Tree name**

This tree name no longer corresponds to the PROFINET station name! The Ctrl WORD of the PROFINET protocol is used to help assign a name. This means that the number that is entered (range of values 0 - 255) is appended to the existing station name. In addition, the Ctrl WORD must be linked to a task. It is subsequently necessary to restart TwinCAT. If, for example, the task now specifies a value of 11 for the linked Ctrl WORD, its previous station name will change from, for example, "tcpniodevice" to "tcpniodevice011". The current tree name remains "tcpniodevice000".

The current station names and the IP configuration used can be checked via the "PROFINET diagnosis" tab.

4.2 Diagnostics

The actual PROFINET name is displayed on the Diagnostics tab. The IP configuration is specified when the master boots up, and has the values that are assigned by the master. The "Module Difference" field is displayed if the specified configuration is not the same as the actual configuration. The field should be empty if there is no error.

Stationname: el6631-0010099

IP configuration:

IP address: 192 . 168 . 1 . 9

Subnet: 255 . 255 . 255 . 0

Gateway: 0 . 0 . 0 . 0

Refresh

Module Difference

SlotNumber	ModuleInfo	ModuleState	SubSlotNu...	SubModt
2	No Module	No Module	0	0x0

5. Cycle times

The device can be operated in the minimum cycle time of 1 ms defined by PROFINET!

General Adapter PROFINET Sync Task

Own Adapter Instance

Description: TwinCAT RT (TwinCAT-Intel PCI Ethernet Adapter - Paketplaner-I)

Device Name: \DEVICE\{86921CEE-234A-4AD6-B738-2DE8E9D45B}

MAC Address: 00 02 b3 d7 7b ec Search...

IP Address: 169.254.200.175 (255.255.0.0) Compatible Devices...

Promiscuous Mode (use with Netmon/Wireshark only)

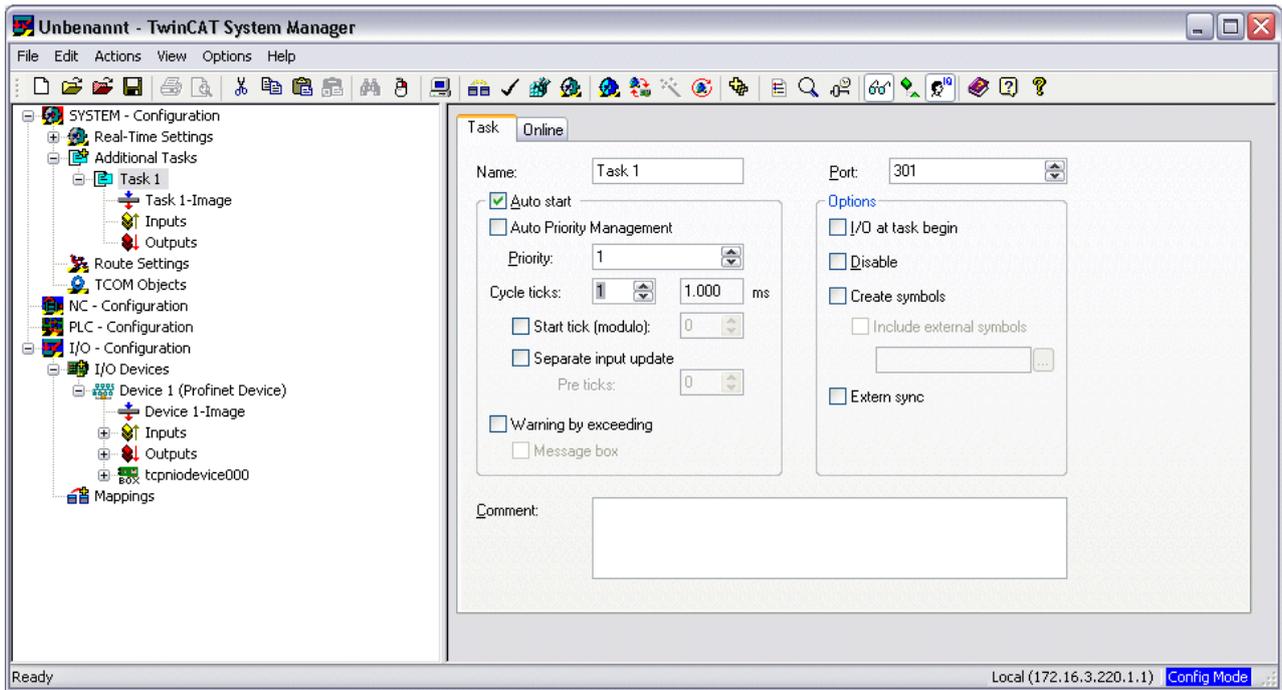
Virtual Device Names

Shared Adapter Instance

Adapter: [Dropdown]

Freerun Cycle (ms): 4

If TwinCAT is to be operated in RUN mode, a task must be created. In the simplest case, this is the aforementioned SyncTask. The call time for the task must not be longer than the PROFINET cycle time! If a second task is created, e.g. for the PLC, this can also run more slowly.

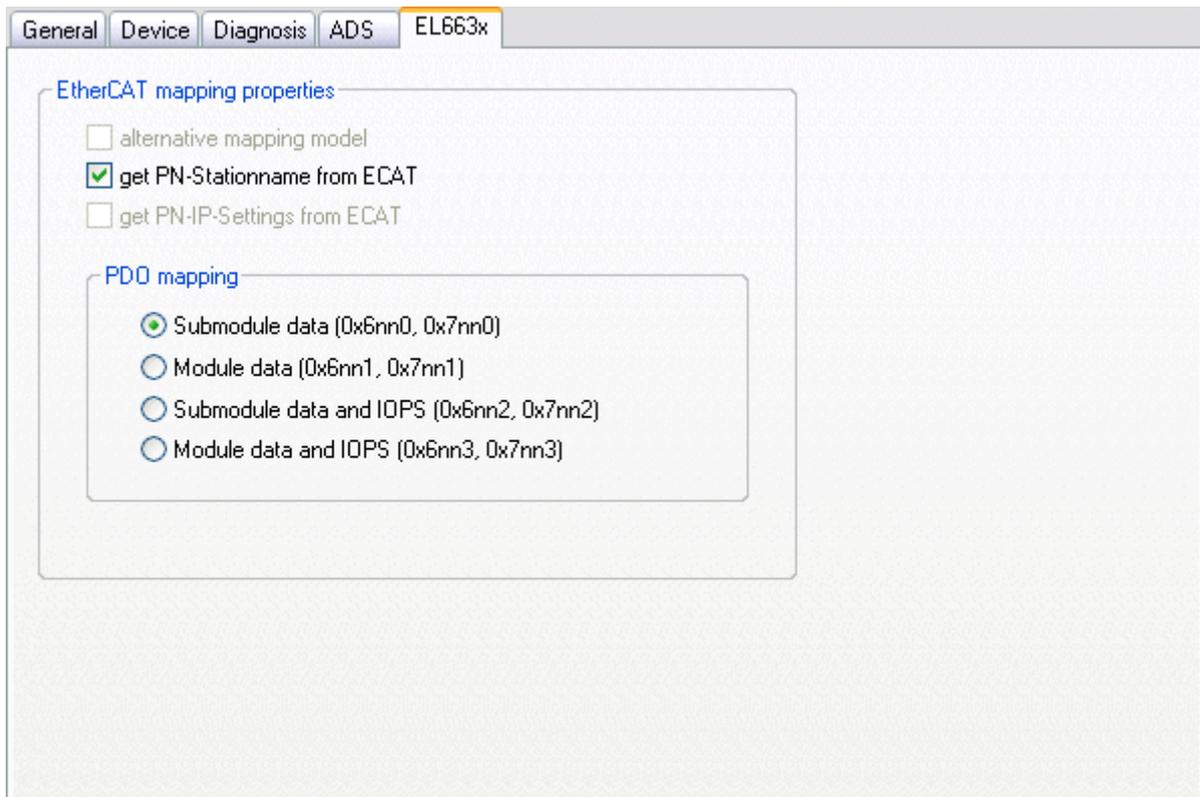


In the case of less powerful devices (e.g. CX1000, CX9000 with E-bus), the CPU load may reach its limits. However, the performance can be improved again by means of the following considerations/measures:

- Is it possible to work with just one PLC task?
- Does the cycle time have to be 1 ms?
- If two tasks are used, can the PLC task time be shortened?
- Will several virtual PROFINET devices be required?

6.0 PDO Mapping

The PDO mapping describes how the PROFINET data is to be represented in the EtherCAT. The "Submodule data" setting should be used if TwinCAT is used.



4 Profinet Features

4.1 PROFINET alarm

PROFINET alarms can also be transmitted through the ADS interface.

An ADS WRITE block is to be used for this.

ADS WRITE	Comment
AMSNETID	AMS Net ID of the PROFINET device
PORT	0xFFFF (if a virtual PROFINET device is used, the port number is formed from 0x1000 + the device ID)
Index group	High word - alarm type (see PROFINET specification), low word - 0xF807
Index offset	High word - slot number, low word - sub slot number

No further data is transmitted.

PROFINET alarm (examples)

ALARMS	Comment
0x0000	reserved
0x0001	Diagnosis appears
0x0002	Process
0x0003	Pull
0x0004	Plug
0x0005	Status
...	Further diagnostic messages (see PROFINET specification)

4.2 PROFINET record data

PROFINET record data can also be received directly by means of the PLC. An "indication" is set in the PLC for this purpose. A READINDICATION for reading and a WRITEINDICATION for writing. The RECORD data structure has the following description:

```

WORD      RW;
  #define  PN_READ      0
  #define  PN_WRITE    1
WORD      NrOfAR;
DWORD     API;
WORD      Slot;
WORD      SubSlot;
PNIO_RECORD RecordData;
    
```

Record Data

```

WORD      Index;
WORD      Length;           //to 0 to read
WORD      TransferSequence;
WORD      LengthOfAligned;
    
```

Table of PROFINET record data represented on ADS

PROFINET	Length in bytes	Comment	ADS
-	String	AMS NET ID of the PROFINET device	AMSNETID
-	2	0xFFFF When the virtual interface is used, the port number is to be taken from the System Manager.	Port
Read/Write	2	0 - Read 1 - Write	Read - ReadIndication Write - WriteIndication
Number of AR	2	0x0000	-
API Application Process Identifier	4	0x00000000	-
Slot	2	Slot Nummer 0x0000-0x7FFF	IndexOffset High Word
SubSlot	2	SubSlot number 0x0000-0x8FFF	IndexOffset Low Word
Record Data Index	2	0x0000-0x1FFF	IndexGroup Low Word
-	2	0x8000	IndexGroup High Word
Record Data Length	2	to "0" to read	LENGTH
Record Data Transfer Sequence	2	consecutive number	-
Record Data Length of Aligned	2	can be zero	-

Example for reading data; the PROFINET controller wants to read data from a Beckhoff device via the record data. In this example, all the ReclIndex values are accepted, and will return the same data - 10 bytes that are located in the "Data" data array.

```

CASE i OF
0:  ADSREADIND (
      CLEAR:=FALSE ,
      VALID=> ,
      NETID=> ,
      PORT=> ,
      INVOKEID=> ,
      IDXGRP=> ,
      IDXOFFS=> ,
      LENGTH=> );
  IF ADSREADIND.VALID THEN
    IdxGroup:=ADSREADIND.IDXGRP;
    IdxOffset:=ADSREADIND.IDXOFFS;
    i:=10;
  END_IF

10: ADSREADRES (
      NETID:=ADSREADIND.NETID,
      PORT:=ADSREADIND.PORT,
      INVOKEID:=ADSREADIND.INVOKEID ,
      RESULT:=0 ,
      LEN:=10 ,
      DATAADDR:=ADR (Data) ,
      RESPOND:=TRUE );
  i:=20;
  ADSREADIND (CLEAR:=TRUE);

20: i:=0;
  ADSREADRES (RESPOND:=FALSE);
END_CASE

```

4.3 Shared Device

The ProfiNET feature "Shared Device" is supported by the EL6631-0010, by the TwinCAT Supplement from version TC211 22.xx (= TC2 R3).

Shared Device features a function that allows two controllers to simultaneously access one device and, if applicable, the same process data image.

The difference to the use of the virtual device lies in the fact that, when creating a virtual device, a completely new device is generated (with its own name, MAC, IP, etc.). i.e. as a result the controller sees two separate devices and can establish two completely separate connections.

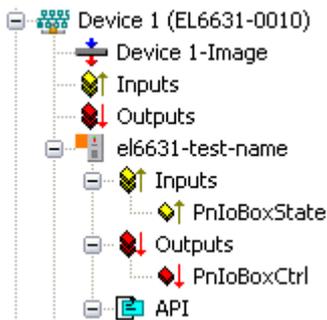
In the case of Shared Device, conversely, there is only ever one device. On the device side nothing needs to be engineered for this; the complete functionality is handled in the ProfiNET stack. A common example for this would be the use of the safety functionality. A "normal CONTROLLER" is assigned the "normal" inputs and outputs, while the F-CPU is assigned the safe I/Os. If the requested process image should overlap in both controllers, then the first AR (primary) that is established is given full read and write access to the submodule. The second AR (secondary) receives a corresponding ModuleDiff block at the submodules that are already occupied. If the primary AR is released, then the secondary AR receives an alarm now indicating that the requested submodule is free. The second controller now has the possibility, if it supports this, to re-parameterize the submodules and to adopt them into its AR.

4.4 Diagnosis

4.4.1 State- and Ctrl flags

PROFINET Status

The status of the PROFINET communication can be monitored by means of PnIoBoxState.



PnIoBoxState	Comment	Meaning
0x0001 (Bit 0)	Device is in I/O exchange	PROFINET device is exchanging data
0x0002 (Bit 1)	Device is blinking	PROFINET device is being searched for by identification
0x0004 (Bit 2)	Provider State 0=STOP, 1=RUN	The PROFINET controller is stopped
0x0008 (Bit 3)	Problem Indicator 0=OK, 1=Error	The PROFINET device has encountered problems

In the absence of an error, the value of PnIoBoxState is "5" - in other words, bits 0 and 2 are set.

PROFINET Control

PnIoBoxCtrl can be used for assigning names; only the low byte is to be used for this. The high byte must be 0x00.

4.4.2 Port diagnosis

Port Diagnosis

Port diagnostics can be used to identify the neighboring PROFINET devices. The device's own port can also be identified.

The screenshot displays three data panels in a software interface:

- Local Port Data:** A table with columns 'Name' and 'Value'.

Name	Value
Port Number	1
Port ID	port-001
Port Description	Ethernet Port 1, Slot 0 PortSubmodule 1, 10...
- Remote Port Data:** A table with columns 'Name' and 'Value'.

Name	Value
Port ID	port-001
Port Description	bk9103 - port-001
System Name	bk9103
System Description	Beckhoff bk9103 - HW: V2.00, SW: V6.00
Chassis ID	bk9103-8
- Port Statistik:** A table with columns 'Name' and 'Value'.

Name	Value
Speed	100 MBit/sec
Phys MAC	0x00 0x01 0x05 0x00 0x00 0x01
Operating status	up
Rx octets	540727375
Rx LLC packets	509745493

Each panel has a corresponding 'Get' button to the right: 'Get local port data', 'Get remote port data', and 'Get port statistik'.

4.4.3 Further diagnosis through the ADS interface

Additional diagnostic facilities are available through the ADS interface.

Read out the PROFINET name and the IP settings

An ADS READ block is to be used for this.

ADS WRITE	Comment
AMSNETID	AMS Net ID of the PROFINET device
PORT	0xFFFF (if a virtual PROFINET device is used, the port number is formed from 0x1000 + the device ID)
Index group	High word - 0x0000, low word - 0xF804
Index offset	0x0000
Length	257

Data byte off-set	Value	Comment
0..3	reserved	reserved
4..7	ARRAY4 of Byte	IP address
8..11	ARRAY4 of Byte	Sub Net Mask
12..15	ARRAY4 of Byte	Default Gateway
16...x	STRING (max. length 240)	PROFINET name

Reading out the module difference

An ADS READ block is to be used for this.

ADS WRITE	Comment
AMSNETID	AMS Net ID of the PROFINET device
PORT	0xFFFF (if a virtual PROFINET device is used, the port number is formed from 0x1000 + the device ID)
Index group	High word - 0x0000, low word - 0xF826
Index offset	0x0000
Length	20882

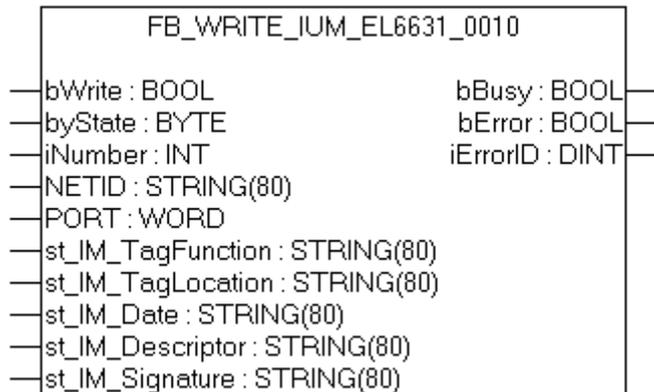
The modules are identical if the length null is returned. The length can differ, depending on the type (see the ModuleDiffBlock PROFINET specification)

Example of how the data can be constructed:

Data byte offset	Value	Comment
0..3	UINT32	API
4..5	UINT16	Number of Modules
6..7	UINT16	Slot
8..11	UINT32	Module Ident (see GSDML File)
12..13	UINT16	Module State (0-noModul, 1- WrongModule, 2- ProperModule, 3- Substitute)
14..15	UINT16	NumberOfSubModules
16..17	UINT16	SubSlot

5 TwinCAT library and programming

5.1 FB_Write_IuM_EL6631_0010



This function block writes I&M1, I&M2, I&M3 and I&M4 (Identification & Maintenance) data according to ProfiNET specification over EtherCAT as a string to the ProfiNET device on the ProfiNET device.

VAR_INPUT

```
VAR_INPUT
  bWrite      : BOOL;
  NETID      : STRING;      (* AMS NET ID EtherCAT Master *)
  PORT       : WORD;        (* EtherCAT Slave address *)
  byState    : BYTE;        (* Bit 0 -> I&M1 || Bit 1 -> I&M2 || Bit 2 -> I&M3 || Bit 3 -
> I&M4*)
  iNumber    : INT:=0;      (* "0"=EL6631-0010 or "1"=virtual EL6631-0010*)
  st_IM_TagFunction : STRING; (* I&M1 byState.0=TRUE*)
  st_IM_TagLocation : STRING; (* I&M1 byState.0=TRUE*)
  st_IM_Date   : STRING;    (* I&M2 byState.1=TRUE*)
  st_IM_Descriptor : STRING; (* I&M3 byState.2=TRUE*)
  st_IM_Signature : STRING;  (* I&M4 byState.3=TRUE*)END_VAR
```

bWrite: A rising edge on this input activates the function block and the I&M data is written to the ProfiNET device.

NETID: AMS Net ID of the controller

PORT: Port via which the controller communicates with the device (port = Device ID + 1000_{hex})

byState: This byte can be used to select which I&M data is to be written.

iNumber: Two ProfiNET devices can be mapped with one terminal. *iNumber* ("0" or "1") is used to select the device for which the I&M data is to be written.

st_IM_TagFunction: Label for the function of the device is written to the device.

st_IM_Taglocation: Label for the installation site of the device is written to the device.

st_IM_Date: Date of the installation of the device is written to the device.

st_IM_Descriptor: Description of the manufacturer is written to the device.

st_IM_Signature: Signature of the manufacturer is written to the device.

VAR_OUTPUT

```
VAR_OUTPUT
  bBusy      : BOOL;
  bError     : BOOL;
  iErrorID   : DINT;
END_VAR
```

bBusy : When the function block is activated this output is set. It remains set until a feedback is received. While Busy = TRUE, no new command will be accepted at the inputs.

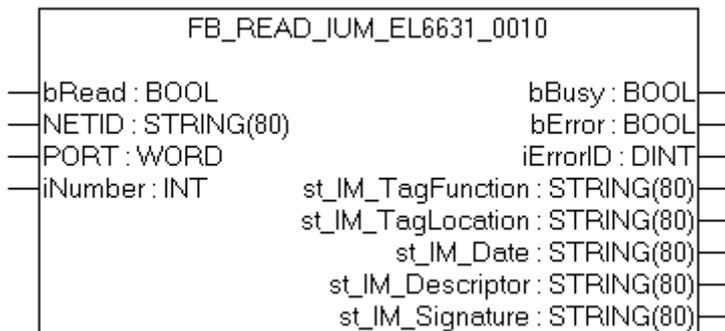
bError : If an error should occur during the transmission of the command, this output is set after the *bBusy* output has been reset.

iErrorID : Supplies an ADS error number when the output *bError* is set.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v2.11.0 R3	PC or CX (x86, ARM)	TcProfinetDiag.Lib

5.2 FB_Read_IuM_EL6631_0010



This function block reads I&M1, I&M2, I&M3 and I&M4 (Identification & Maintenance) data over EtherCAT as a string from a ProfiNET device. The reading of the I&M0 data takes place in the case of a ProfiNET device with EtherCAT over CoE (CAN over EtherCAT).

VAR_INPUT

```
VAR_INPUT
  bRead      : BOOL;
  NETID      : STRING; (* AMS NET ID EtherCAT Master *)
  PORT       : WORD;   (* EtherCAT Slave address *)
  iNumber    : INT;    (* "0"=EL6631-0010 or "1"=vitual EL6631-0010*)
END_VAR
```

bRead : A rising edge on this input activates the function block and the I&M data is read from the ProfiNET device.

NETID : AMS Net ID of the controller

PORT : Port via which the controller communicates with the device (port = Device ID + 1000_{hex})

iNumber : Two ProfiNET devices can be mapped with one terminal. *iNumber* ("0" or "1") is used to select the device for which the I&M data is to be read out.

VAR_OUTPUT

```
VAR_OUTPUT
  bBusy      : BOOL;
  bError     : BOOL;
  iErrorID   : DINT;
  st_IM_TagFunction : STRING; (* I&M1 *)
```

```

    st_IM_TagLocation : STRING; (* I&M1 *)
    st_IM_Date        : STRING; (* I&M2 *)
    st_IM_Descriptor  : STRING; (* I&M3 *)
    st_IM_Signature   : STRING; (* I&M4 *)
END_VAR

```

bBusy : When the function block is activated this output is set. It remains set until a feedback is received. While Busy = TRUE, no new command will be accepted at the inputs.

bError : If an error should occur during the transmission of the command, this output is set after the *bBusy* output has been reset.

iErrorID: Supplies an ADS error number when the output *bError* is set.

st_IM_TagFunction: Read label for the function of the device.

st_IM_Taglocation: Read label for the installation site of the device.

st_IM_Date: Supplies the date of installation of the device in the format.

st_IM_Descriptor: Returns the manufacturer description stored for the device.

st_IM_Signature: Returns the manufacturer signature stored for the device.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v2.11.0 R3	PC or CX (x86, ARM)	TcProfinetDiag.Lib

6 Appendix

6.1 UL notice



Application

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

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).

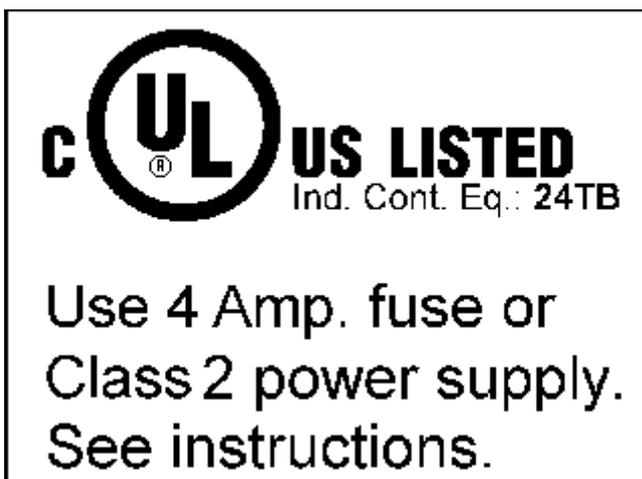
For devices with Ethernet connectors

Not for connection to telecommunication circuits.

Basic principles

Two UL certificates are met in the Beckhoff EtherCAT product range, depending upon the components:

- UL certification according to UL508 with limited power consumption
The current consumed by the device is limited to a max. possible current consumption of 4 A. Devices with this kind of certification are marked by this sign:



Almost all current EtherCAT products (as at 2010/05) are UL certified without restrictions.

Application

If terminals certified *with restrictions* are used, then the current consumption at 24 V_{DC} must be limited accordingly by means of supply

- from an isolated source protected by a fuse of max. 4A (according to UL248) or

- from a voltage supply complying with *NEC class 2*.
A voltage source complying with *NEC class 2* may not be connected in series or parallel with another *NEC class 2* compliant voltage supply!

These requirements apply to the supply of all EtherCAT bus couplers, power adaptor terminals, Bus Terminals and their power contacts.

6.2 Firmware compatibility

Beckhoff EtherCAT devices will be equipped with the last available firmware on delivery. There are certain dependencies between firmware and hardware, not all combinations are compatible. The overview below shows which firmware is compatible to a certain hardware status.

- It is strictly recommended to apply the last available firmware on the hardware.
- There is no customer right to get a firmware update at no charge for already delivered products by the Beckhoff company.

NOTICE

Damage of devices possible!

Please note the details concerning the firmware update on the special page. If you run a device in BOOTSTRAP mode to initiate a firmware update, it is possible that there is no checking of compatibility of the firmware. A damage of the device is possible! Please always make sure, that the firmware is suitable for the hardware status of the device!

EL6631-0010

Hardware (HW)	Firmware	Revision No.	Date of release
03 - 04*	01*	EL6631-0010-0016	2011/05

*) At the time of creation of this documentation this is the current compatible hardware status. Please check the Beckhoff website for the latest [documentation](#).

6.3 Firmware EL/ES/EM/EPxxxx

This section describes the device update for Beckhoff EtherCAT slaves from the EL/ES, EM, EK and EP series. A firmware update should only be carried out after consultation with Beckhoff support.

Table of contents

- Storage locations
- [Device description ESI file/XML](#) [► 53]
- [Firmware version definition](#) [► 55]
- [Updating Controller firmware *.efw](#) [► 56]
- [FPGA firmware update *.rbf](#) [► 57] [Multiple update](#) [► 60]

Storage locations

An EtherCAT slave stores operating data in up to 3 locations:

- Depending on functionality and performance EtherCAT slaves have one or several local controllers for processing I/O data. The corresponding program is the so-called **firmware** in *.efw format.
- In some EtherCAT slaves the EtherCAT communication may also be integrated in these controllers. In this case the controller is usually a so-called **FPGA** chip with *.rbf firmware.
- In addition each EtherCAT slave has a memory chip for storing its own device description, a so-called **EEPROM**. On power-up this description is loaded and the EtherCAT communication is set up accordingly. The device description is available from the download area of the Beckhoff website at (<http://www.beckhoff.de>). All ESI files (**E**therCAT **S**lave **I**nformation) are available in ZIP format.

Customers can access the data via the EtherCAT fieldbus and its communication mechanisms. Acyclic mailbox communication or register access to the ESC is used for updating or reading of these data.

The TwinCAT System Manager offers mechanisms for programming all 3 parts with new data, if the slave is set up for this purpose. Generally the slave does not check whether the new data are suitable, i.e. it may no longer be able to operate if the data are unsuitable.

NOTICE

Risk of damage to the device!

- Firmware downloads to an EtherCAT device must not be interrupted.
- Flawless EtherCAT communication must be ensured. CRC errors or LostFrames must be avoided.
- The power supply must adequately dimensioned. The signal level must meet the specification.

Device description ESI file/XML

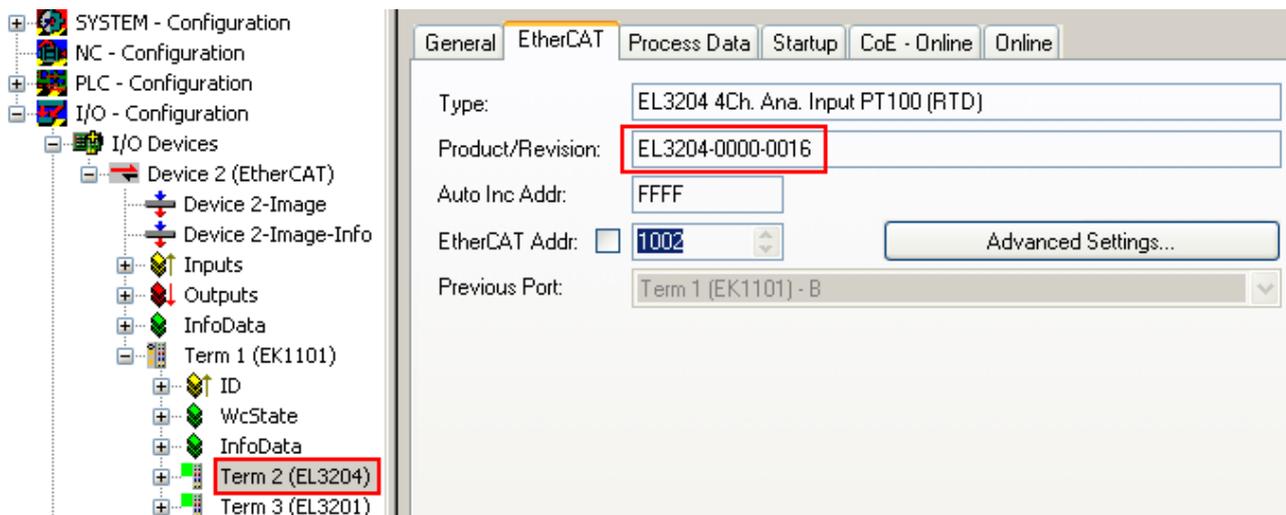
NOTICE

Update of the ESI description/EEPROM

Some slaves have stored calibration and configuration data from the production in the EEPROM. These are irretrievably overwritten during an update.

The ESI device description is stored locally on the slave and loaded on start-up. Each device description has a unique identifier consisting of slave name (9 digits) and a revision number (4 digits). Each slave configured in the System Manager shows its identifier in the EtherCAT tab (device identifier from name EL3204-0000 and revision -0016

):



The configured identifier must be compatible with the actual device description used as hardware, i.e. the description which the slave has loaded on start-up (in this case EL3204). Normally the configured revision must be the same or lower than that actually present in the terminal network.

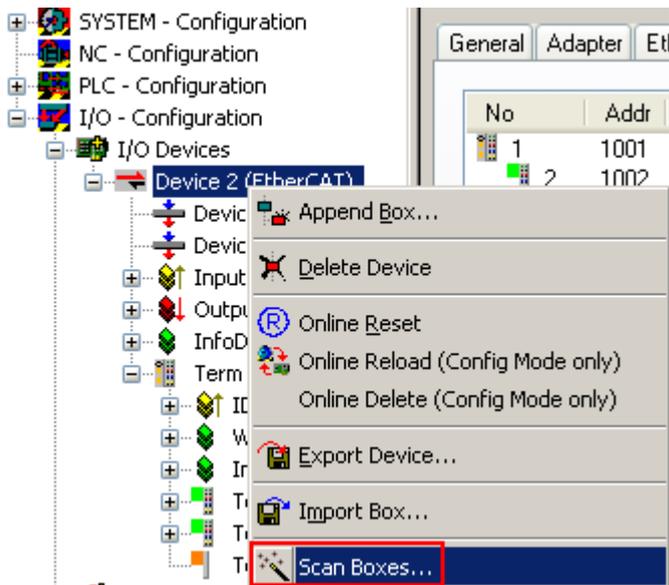
For further information on this, please refer to the [EtherCAT system documentation](#).

Update of XML/ESI description

The device revision is closely linked to the firmware and hardware used. Incompatible combinations lead to malfunctions or even final shutdown of the device. Corresponding updates should only be carried out in consultation with Beckhoff support.

Display of ESI slave identifier

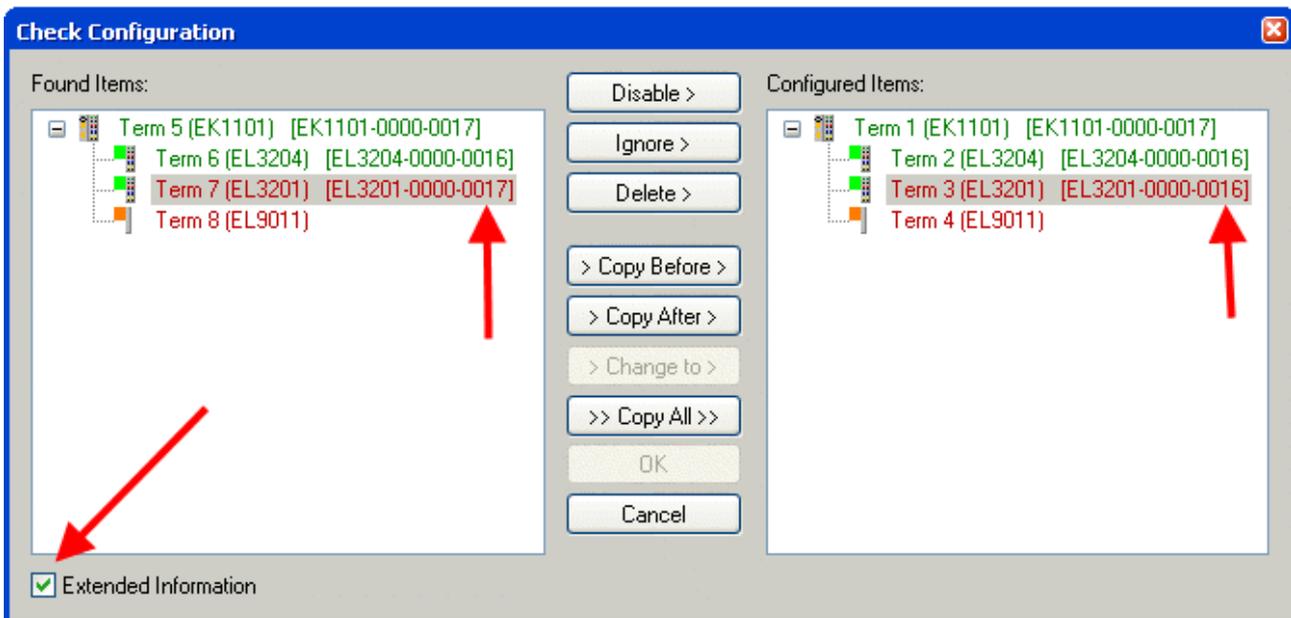
The simplest way to ascertain compliance of configured and actual device description is to scan the EtherCAT Boxes in TwinCAT mode Config/FreeRun. Scan the subordinate field by right-clicking on the EtherCAT device in Config/FreeRun mode:



If the found field matches the configured field, the display shows: Configuration is identical



otherwise a change dialog for entering the actual data in the configuration.



In this example, an EL3201-0000-0017 was found while an EL3201-0000-0016 was configured. In this case the configuration can be adapted with the *Copy Before* button. The *Extended Information* checkbox must be set in order to display the revision.

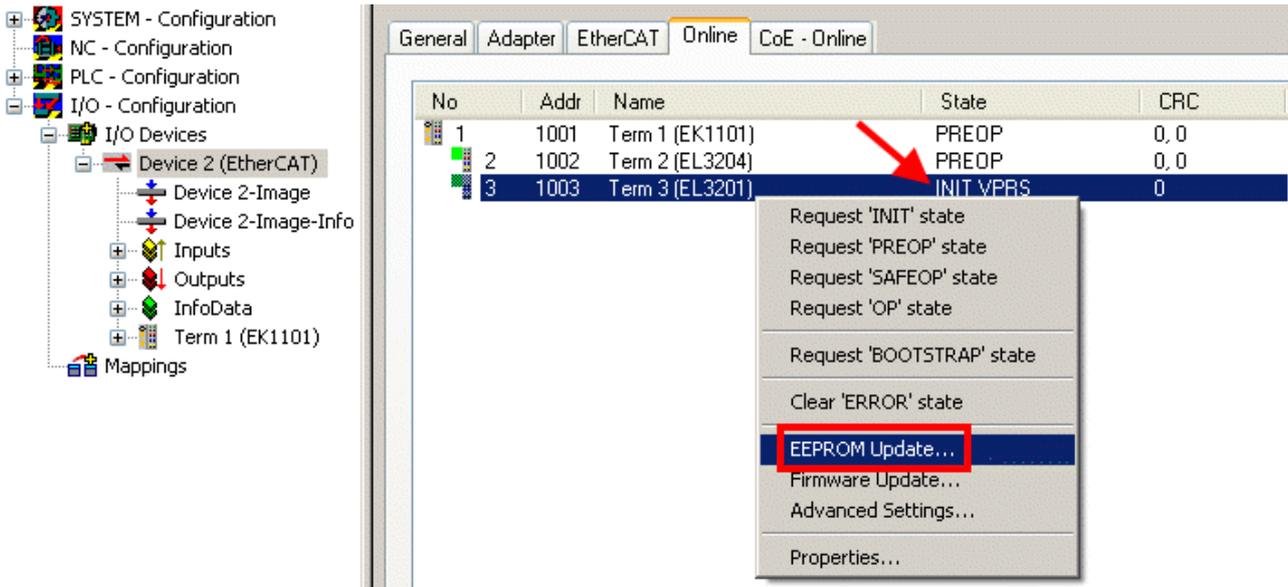
Changing the ESI slave identifier

Changing the ESI slave identifier

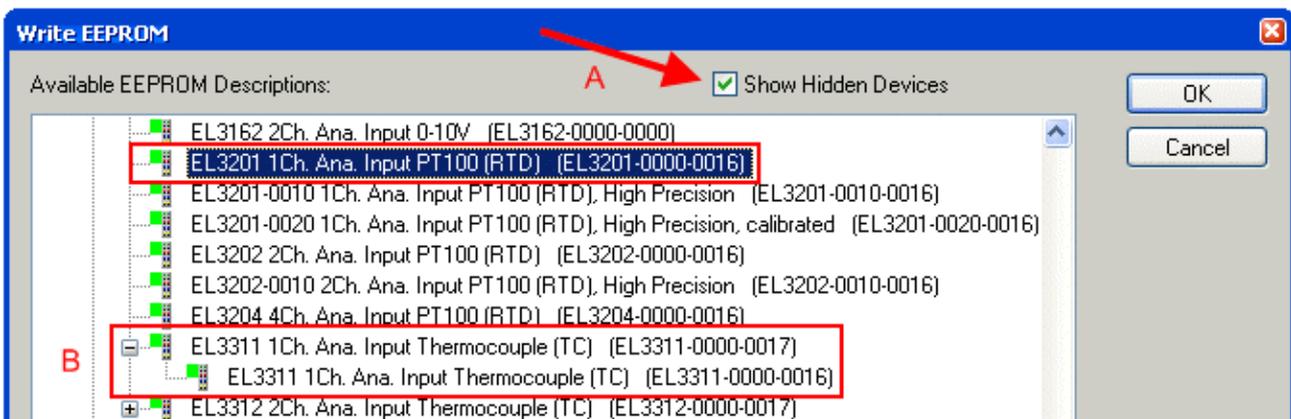
The ESI/EEPROM identifier can be updated as follows under TwinCAT:

- The EtherCAT communication with the slave must be flawless.

- The state of the slave is irrelevant.
- Right-click on the slave in the Online tab leads to the dialog *EEPROM Update*:



In the following dialog the new ESI description is selected. The checkbox *Show Hidden Devices* shows also older, normally hidden outputs of a slave:



A progress bar in the System Manager shows the progress - first writing, then verifying.

i The change only takes effect after a restart.

Most EtherCAT devices read a modified ESI description immediately or after startup from the INIT. Some communication settings such as distributed clocks are only read during power-on. The EtherCAT slave therefore has to be switched off briefly in order for the change to take effect.

Determining the firmware version

Determining the version on laser inscription

Beckhoff EtherCAT slaves feature serial numbers applied by laser. The serial number has the following structure: **KK YY FF HH**

- KK - week of production (CW, calendar week)
- YY - year of production
- FF - firmware version
- HH - hardware version

Example with ser. no.: 12 10 03 02:

12 - week of production 12
 10 - year of production 2010
 03 - firmware version 03
 02 - hardware version 02

Determining the version via the System Manager

The TwinCAT System Manager shows the version of the controller firmware if the master can access the slave online. Click on the E-bus terminal whose controller firmware you want to check (in the example terminal 2 (EL3204)) and select the tab *CoE Online* (CAN over EtherCAT).

i CoE Online and Offline CoE

- **online:** it is offered in the EtherCAT slave by the controller if the EtherCAT slave supports this. This CoE directory can only be displayed if the slave is connected and ready for operation.
- **offline:** in the EtherCAT slave information ESI/XML the default content of the CoE may be contained. This CoE directory can only be displayed if it is contained in the ESI (e.g. "Beckhoff EL5xxx.xml").

In the following dialog the FW state of the marked EL3204 is displayed in CoE entry x100A with 03:

The screenshot shows the TwinCAT System Manager interface. On the left, a tree view shows the configuration hierarchy, with 'Term 2 (EL3204)' highlighted. The main window displays the 'CoE - Online' tab. At the top, there are buttons for 'Update List', 'Advanced...', and 'Add to Startup...'. Below these are checkboxes for 'Auto Update', 'Single Update', and 'Show Offline Data'. A table lists CoE entries with columns for Index, Name, Flags, and Value. The entry '100A Software version' is highlighted with a red box. Below the table is an 'Advanced Settings' section with a 'Dictionary' panel. In the Dictionary panel, 'All Objects' is selected, and 'Online - via SDO Information' is chosen. A red box highlights the 'All Objects' selection.

Index	Name	Flags	Value
1000	Device type	RO	0x01401389 (20976521)
1008	Device name	RO	EL3204-0000
1009	Hardware version	RO	00
100A	Software version	RO	03
1011:0	Restore default parameters	HU	> 1 <

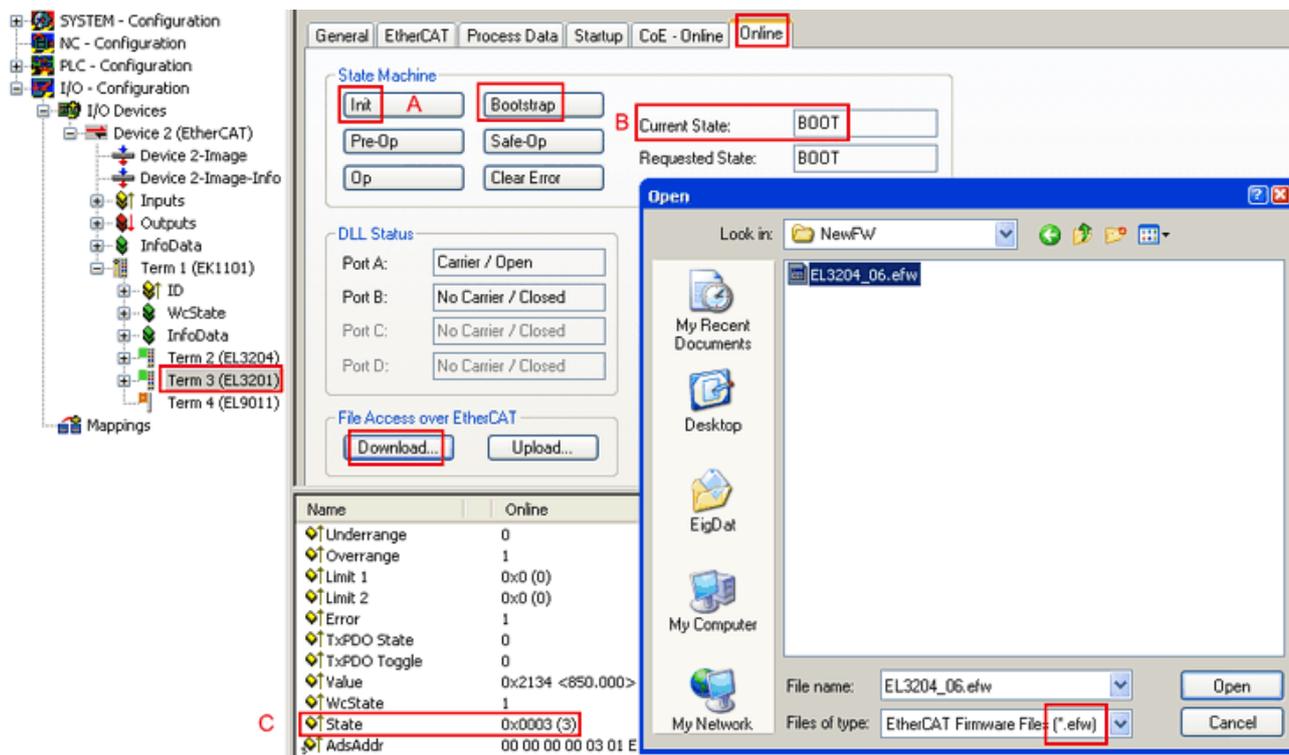
In (A) TwinCAT 2.11 shows that the Online CoE directory is currently displayed. If this is not the case, the online directory can be loaded through the Advanced Settings (B) by *Online* and double-clicking *All Objects*.

Updating controller firmware *.efw

i CoE directory

The online CoE directory is managed by the controller and stored in its own EEPROM. It is generally not changed by a FW update.

To update the controller firmware of a slave, go to the *Online* tab:



Proceed as follows, unless instructed otherwise by Beckhoff support.

- Switch slave to INIT (A)
- Switch slave to BOOTSTRAP
- Check the current status (B, C)
- Download the new *.efw file
- After the download switch to INIT, then OP
- Switch off the slave briefly

FPGA firmware *.rbf

If an FPGA chip deals with the EtherCAT communication an update may be accomplished via an *.rbf file.

- [Controller firmware \[► 56\]](#) for processing I/O signals
- [FPGA firmware \[► 57\]](#) for EtherCAT communication (only for terminals with FPGA)

The firmware version number included in the terminal serial number contains both firmware components. If one of these firmware components is modified this version number is updated.

Determining the version via the System Manager

The TwinCAT System Manager indicates the FPGA firmware version. Click on the Ethernet card of your EtherCAT segment (Device 2 in the example) and select the *Online* tab.

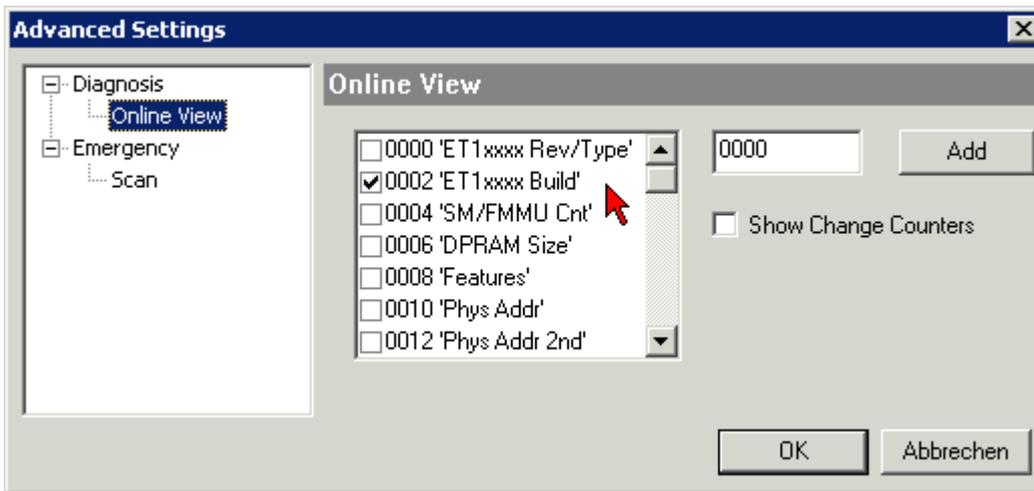
The *Reg:0002* column indicates the firmware version of the individual EtherCAT devices in hexadecimal and decimal representation.

No	Addr	Name	State	CRC	Reg:0002
1	1001	Term 1 (EK1100)	OP	0	0x0002 (11)
2	1002	Term 2 (EL1012)	OP	0	0x0002 (10)
3	1003	Term 3 (EL2004)	OP	0	0x0002 (11)
4	1004	Term 4 (EL3102)	OP	0	0x0002 (10)
5	1005	Term 5 (EL4102)	OP	0	0x000B (11)
6	1006	Term 6 (EL5001)	OP	0	0x0002 (11)
7	1007	Term 7 (EL6751)	OP	0	0x000C (12)

Number	Box Name	Address	Type	In Size	O
1	Term 1 (EK1100)	1001	EK1100	0.0	0
2	Term 2 (EL2004)	1002	EL2004	0.0	0
3	Term 3 (EL2004)	1003	EL2004	0.0	0
4	Term 4 (EL5001)	1004	EL5001	5.0	0

If the Reg:0002 column is not displayed, right-click the table header and select *Properties* in the context menu.

The *Advanced Settings* dialog appears where the columns to be displayed can be selected. Under *Diagnose/Online View* select the '0002 ETxxxx Build' checkbox in order to activate the FPGA firmware version display.



Update

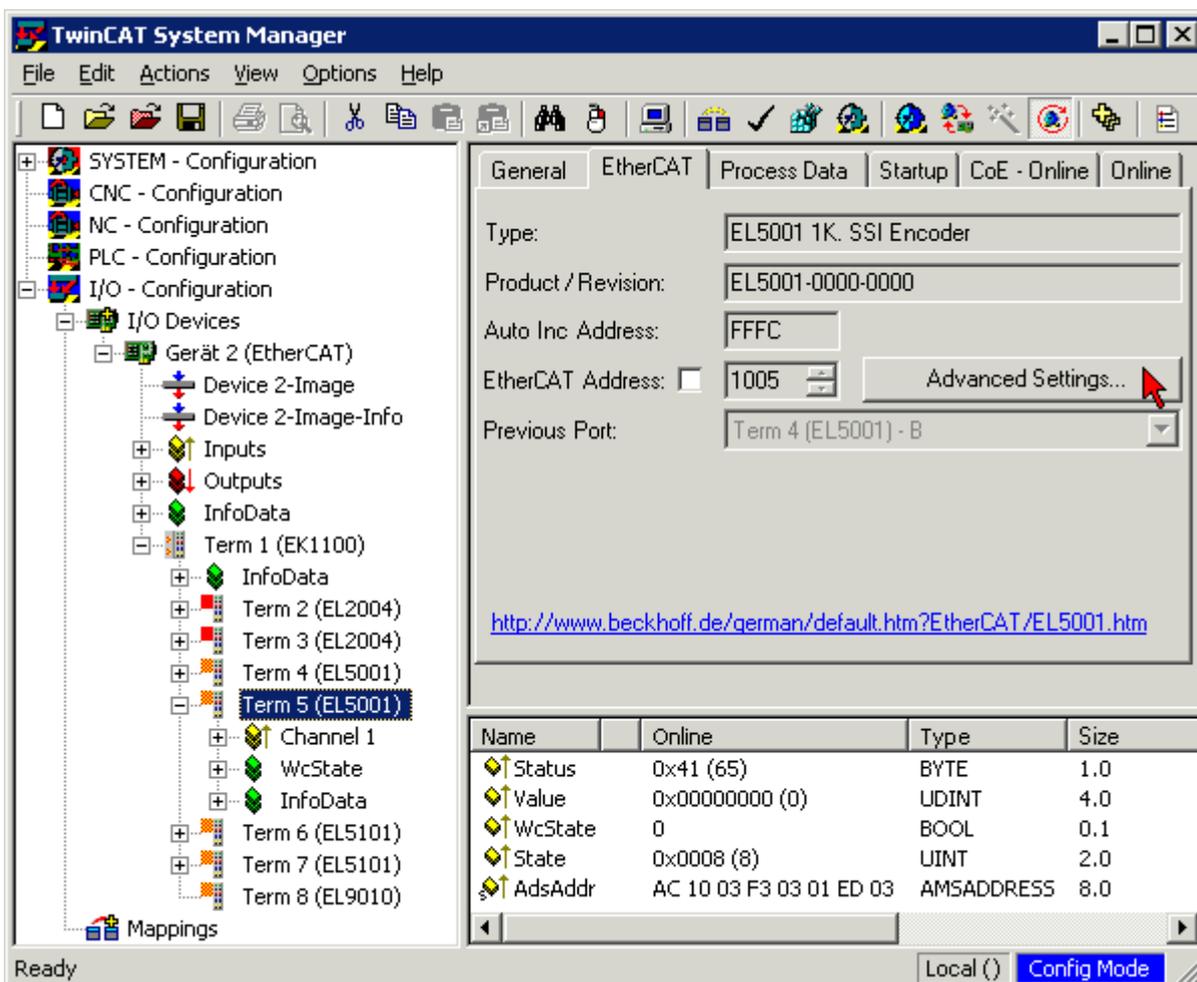
For updating the FPGA firmware

- of an EtherCAT coupler the coupler must have FPGA firmware version 11 or higher;
- of an E-Bus Terminal the terminal must have FPGA firmware version 10 or higher.

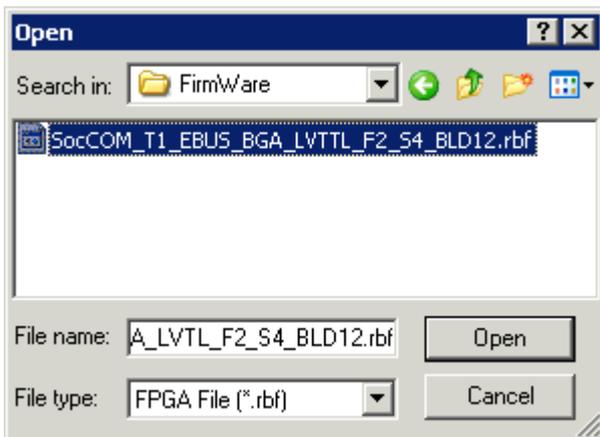
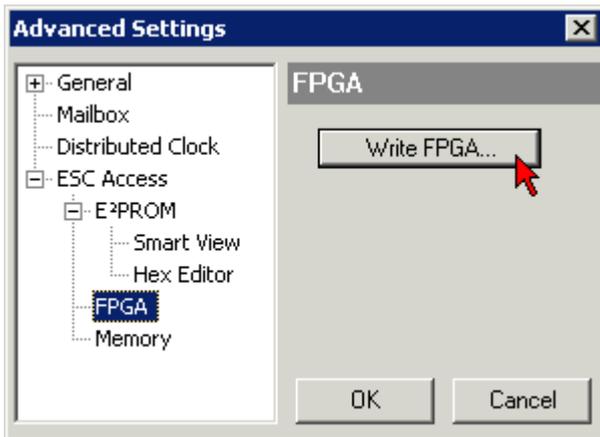
Older firmware versions can only be updated by the manufacturer!

Updating an EtherCAT device

In the TwinCAT System Manager select the terminal for which the FPGA firmware is to be updated (in the example: Terminal 5: EL5001) and click the *Advanced Settings* button in the *EtherCAT* tab.



The *Advanced Settings* dialog appears. Under *ESC Access/E²PROM/FPGA* click on *Write FPGA* button.



Select the file (*.rbf) with the new FPGA firmware, and transfer it to the EtherCAT device.

NOTICE

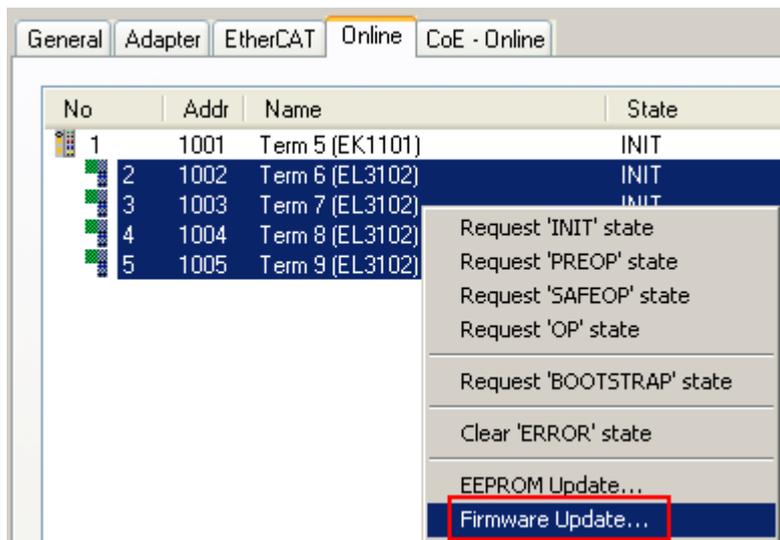
Risk of damage to the device!

A firmware download to an EtherCAT device must never be interrupted! If this process is canceled, the supply voltage switched off or the Ethernet connection interrupted, the EtherCAT device can only be recommissioned by the manufacturer!

In order to activate the new FPGA firmware a restart (switching the power supply off and on again) of the EtherCAT device is required.

Simultaneous updating of several EtherCAT devices

The firmware of several devices can be updated simultaneously, as well as the ESI description. The prerequisite for this is that the same firmware file/ESI applies to these devices.



Select the required slaves and carry out the firmware update in BOOTSTRAP mode as described above.

6.4 ATEX Documentation

i Notes about operation of the Bus Terminal System in potentially explosive areas (ATEX)

Pay also attention to the continuative documentation Notes about operation of the Bus Terminal System in potentially explosive areas (ATEX) that is available in the download area of the Beckhoff homepage <http://www.beckhoff.com>!

6.5 Master device file GSDML

The GSDML file describes a PROFINET device. This file is necessary for the PROFINET Controller, and must be integrated in the corresponding configuration software. You can find the required GSDML files in the TwinCAT\IO\PROFINET folder, or on the website at www.beckhoff.com under Download -> Configuration files.

- [GSDML for PROFINET | Device Supplement TS/TF6270](#)
- [EL6631-0010 | EtherCAT PROFINET Device](#)

Comment	GSDML File Name*	PROFINET Device
Supplement Profinet Device	GSDML-V2.1-beckhoff-TCPNDevice-20091009	PROFINET device for FC9xxx cards with Intel chipset or Ethernet interfaces with Intel chipset, for OS with XP, XPemb
Supplement Profinet Device CE	GSDML-V2.1-beckhoff-TCPNDevice-20091009	PROFINET device for FC9xxx cards with Intel chipset or Ethernet interfaces with Intel chipset, for OS CE
EL6631-0010	GSDML-V2.2-beckhoff-EL6631-20100309.xml	EL6631-0010

* The file name may change as new features or versions are introduced.

6.6 Support and Service

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

Download finder

Our download finder contains all the files that we offer you for downloading. You will find application reports, technical documentation, technical drawings, configuration files and much more.

The downloads are available in various formats.

Beckhoff's branch offices and representatives

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

The addresses of Beckhoff's branch offices and representatives round the world can be found on our internet page: www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

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

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

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

Beckhoff Service

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

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

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e-mail: service@beckhoff.com

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