

Manual | EN

TwinCAT 2

System Manager

TwinCAT 2 | I/O

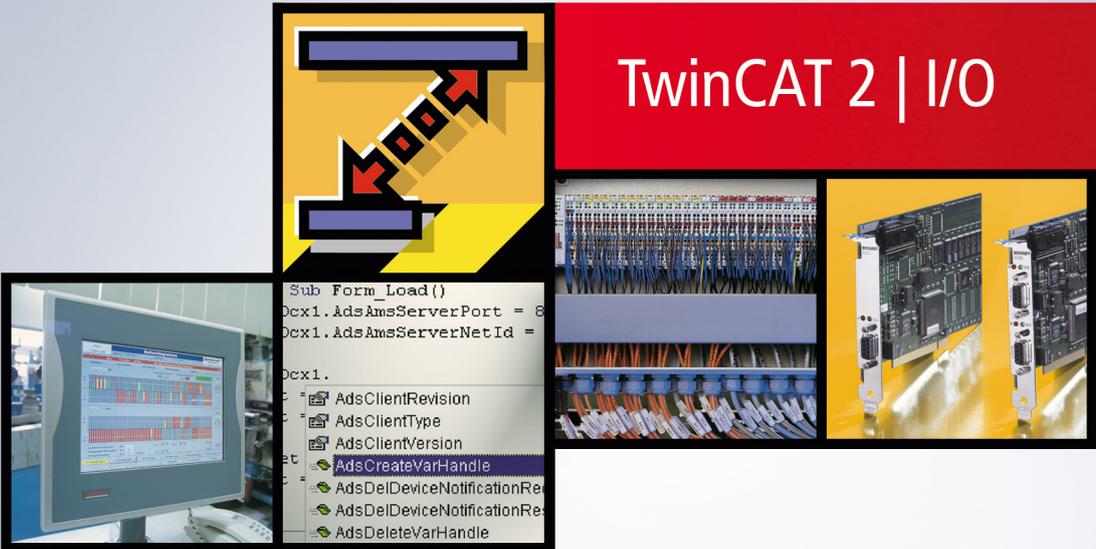


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1 Foreword

1.1 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.

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EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702
and similar applications and registrations in several other countries.

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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.

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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 Overview

The TwinCAT System Manager is the central configuration tool of the TwinCAT System. It is where the inputs and outputs of the software tasks and the physical inputs and outputs of the connected fieldbusses are managed. The individual software tasks (e.g. PLC tasks) each operate on their own private process image so that the addresses of the symbols mapped in the process image (variables) are relevant and valid only within that particular task.

The I/O information of the individual Software Tasks is read from and entered in the TwinCAT System Manager. From there, the installed fieldbusses and their connected modules/boxes are also described. The logical and physical inputs and outputs are assigned to one another by linking software task variables and fieldbus variables.

Task-task communication:

With the aid of the TwinCAT System Manager, the "in and outputs" of a task can be cyclically exchanged with the "out and inputs" of another task. The data consistency remains thereby intact.

Variable orientated:

The smallest addressable and linkable unit is a variable. Variables can be individual bits, bytes, 16 bit data words, 32 bit data words etc. Variables can also be structures or arrays (fields) consisting of other data types.

Process Images:

Variables are always precisely assigned to a process image, i.e. the address of the variable is indicated unambiguously in its process image - but only within that process image. Each software task and each fieldbus possesses precisely one process image (exception: PLC run time system tasks share a combined process image).

Assignments:

The TwinCAT System Manager produces individual assignments which contain the links created. Assignments are produced between software tasks and fieldbus devices and between software tasks if these have mutually linked variables. I.e. if a PLC task variable is linked to the variables of a fieldbus an assignment will be produced between these two. If the same PLC task has other variables linked with another fieldbus, a second assignment will be generated. The assignments contain the corresponding copying directives to enable the exchange of the corresponding variables at the run time.

Fieldbus independence :

When defining and programming the software tasks participating in the TwinCAT system it is not necessary to know the type and structure of these or the fieldbus used. Programming is carried out with the aid of logical variables which are defined locally within the software itself. The TwinCAT System Manager links these logical variables with other variables, which correspond either to physical inputs and outputs on the fieldbus or to logical variables of other tasks. The type and the special properties of each fieldbus do not need to be known or considered.

TwinCAT System Manager supports all standard commercial fieldbusses and some other PC standard interfaces:

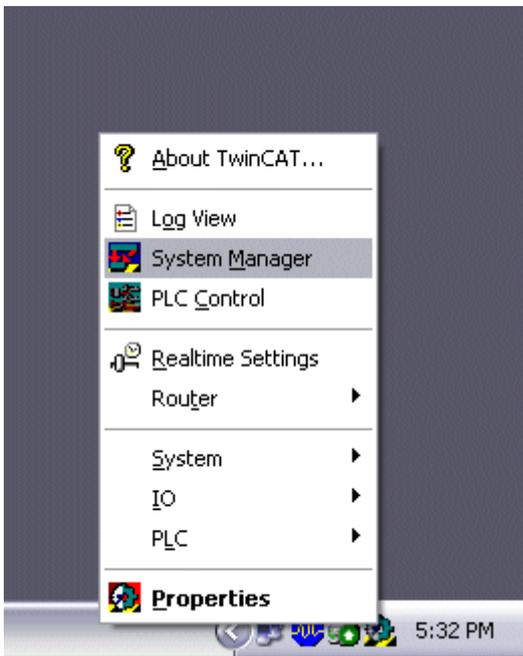
- Beckhoff Lightbus
- Profibus DP, MC (DP-V2)
- Interbus
- CANopen
- SERCOS
- DeviceNet
- Ethernet
- EtherCAT
- Beckhoff Real-Time Ethernet

- PC printer port (8 inputs and 8 outputs on TTL basis)
- Serial Bus Coupler BK8100 to COM
- USB Bus Coupler BK9500 and USB Control Panel interface (CPx8xx)
- Dual-ported memory interface (DPRAM) for PC cards
- NOVRAM (Non-Volatile RAM)
- System Management Bus (SMB) for monitoring of PC hardware like fans, temperatures, etc...

Detailed information on the various fieldbus cards and other supported I/O devices can be found in our [Reference Documentation](#) [► 133].

Starting TwinCAT System Manager:

To open the TwinCAT System Manager, move the mouse to the Windows 'start' menu and select 'start' -> 'Programs' -> 'TwinCAT System' -> 'TwinCAT System Manager' or start it from the Windows SysTray by clicking the TwinCAT icon and selecting 'System Manager' from the appearing Pop-up menu as shown below:



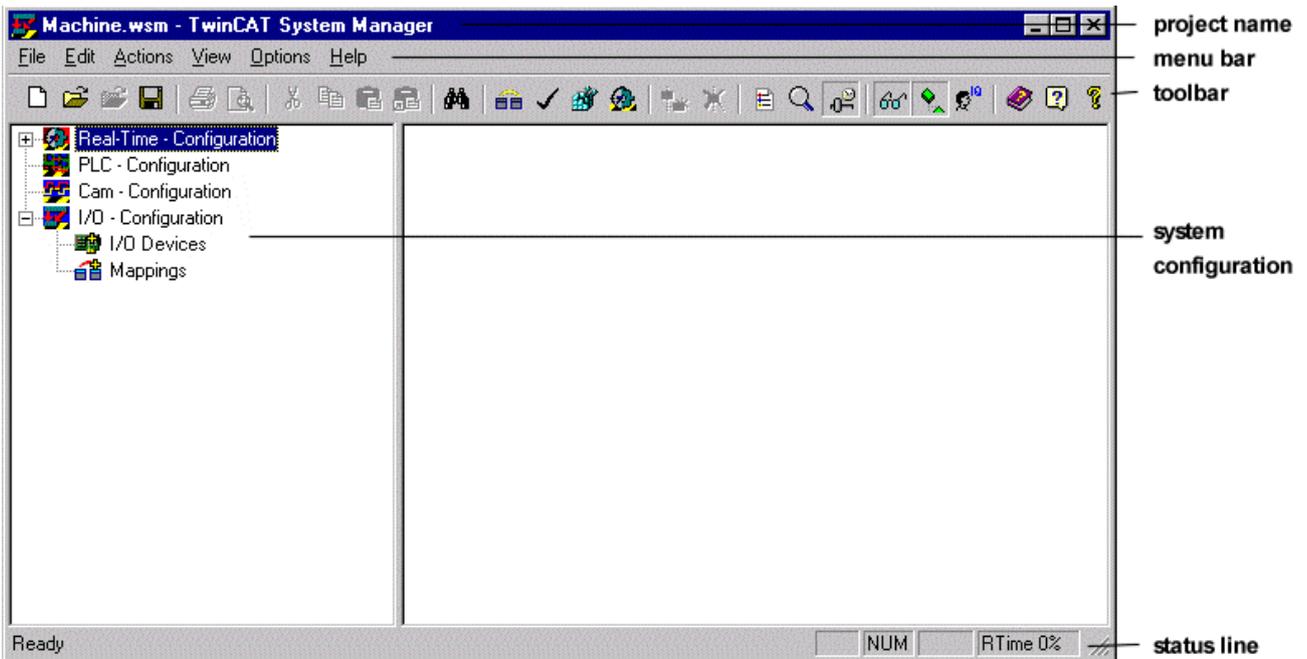
System Manager components :

The System Manager window is structured as shown in the image below (**up to TwinCAT version 2.8**):

The project name is written in the title bar (upper blue bar), in this case *Machine.wsm*. The menu bar and the toolbar (symbol bar) are below the title bar. These functions are described in the following chapter [Operation](#) [► 14].

In the large left-hand window a tree structure is displayed which contains all system configuration components.

At the bottom you can see the status line which provides information on the current system status. In the below case the system is running, this is indicated by the word "RTime".



For a description of the System Manager main window from TwinCAT version 2.9, please refer to: [TwinCAT System Manager -> Introduction. \[▶ 13\]](#)

System configuration model of the TwinCAT System Manager

The list below gives the various main components of the TwinCAT System Manager. The existence of the configuration components depends upon the Level of the Installed TwinCAT System.

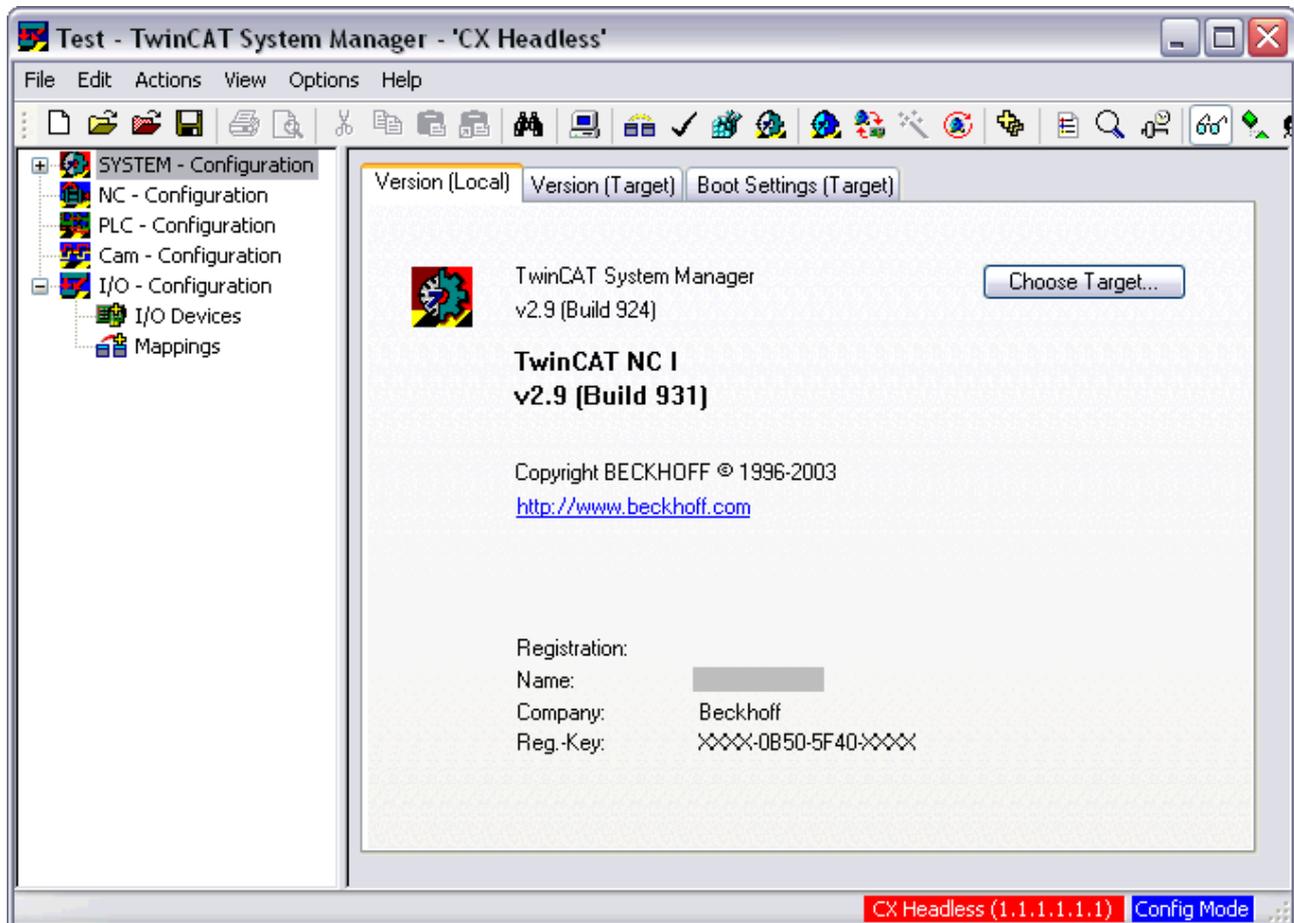
Configuration module	Description
Real Time - Configuration [▶ 53]	Basic system settings are carried out. The basis time for the system is specified. User-defined tasks can also be integrated.
PLC - Configuration [▶ 92]	Up to four PLC programs can be integrated into the maximum four run-time systems. Up to four tasks per run-time system can be carried out and the links between the individual task and the variables is configured.
Cam - Configuration [▶ 91]	The optional electronic camshaft controller is configured.
I/O - Configuration [▶ 97]	All devices and fieldbus components are listed and configured. These include: <ul style="list-style-type: none"> • all fieldbus cards, the boxes (beneath those fieldbus cards) and terminals connected to the boxes. • the uninterrupted power supply (serial or 24V) • serial and parallel interfaces • Motherboard diagnosis interfaces (SMB).

Further information on the use of the TwinCAT System Manager can be found in the TwinCAT [Quick Start](#) documentation.

3 Operation

On the picture below, the main window of the **TwinCAT System Manager** (v2.9) is shown.

Hyperlinks to the respective descriptions of the different elements of this main window are listed in the table underneath.



The field with the red background in the lower right part of the main window signals that the System Manager is currently logged into a remote system. The text in this field names the remote system (in the example this is a target with the TwinCAT Router name 'CX Headless' and the AmsNetId '1.1.1.1.1'). A double-click on this field opens the "Choose Target System [► 23]" dialog. Furthermore, the actual remote system name is displayed in the titlebar of the main window. If the field in the lower right corner is just grey as the rest of the window frame, it means that the System Manager is logged into a local target system.

The field with the blue background signals that the **remote system** is currently in "ConfigMode". It can also turn into green ("Running") or yellow (connection establishment / Timeout). Independently, the local system can always be in a different mode (see TwinCAT System Control icon color in *SysTray* of the local machine). In reference to the above picture, it could currently be in "Running" mode for example.

Informations about	Description
Menus and Buttons [▶ 14]	The main menus and Toolbar of the TwinCAT System Manager
SYSTEM - Configuration [▶ 53]	System configuration and Real-Time settings of the local resp. remote system
NC - Configuration [▶ 68]	Configuration of TwinCAT - NC / NCI (<i>minimum level "TwinCAT NC"</i>)
PLC - Configuration [▶ 92]	Configuration of TwinCAT System Manager relevant PLC settings (<i>minimum level "TwinCAT PLC"</i>)
Cam - Configuration [▶ 91]	Configuration of the (optional) TwinCAT Cam Server
I/O - Configuration [▶ 97]	Configurations for the I/O part on the local resp. remote target system
I/O [▶ 97] Devices [▶ 97]	At local or remote target system configured Input and Output devices (Fieldbus cards, NOVRAM, system interfaces,..) and their process images
Mappings [▶ 125]	Informations about mappings between the I/O devices and other TwinCAT devices, resp. their process images

3.1 Controls

3.1.1 Main Menus

The controls, more precisely the menu bar and the *toolbar* (symbol bar) of the TwinCAT System Manager are described below.

The menu bar comprises the following six options:

[File \[▶ 15\]](#), [Edit \[▶ 16\]](#), [Actions \[▶ 17\]](#), [View \[▶ 19\]](#), [Options \[▶ 20\]](#) and [?\(Help\) \[▶ 21\]](#).

Where present, the toolbar icons are displayed next to their corresponding menu entries.



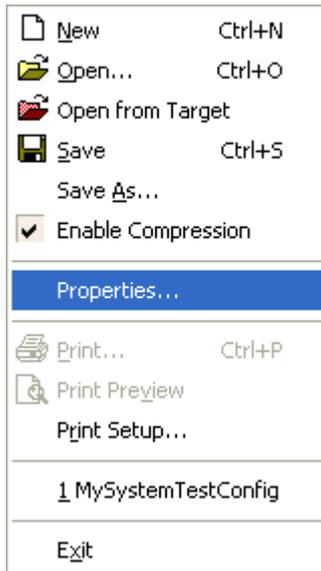
The title bar shows the name of the currently loaded TwinCAT System Manager project or "Unnamed" if a new project has not yet been saved under a name.

The standard Windows controls also appear in the right-hand corner of the title bar:

-  Moves the System Manager to the task bar without closing the project
-  /  Adjusts the System Manager view to small or full screen display (*Minimize / Maximize*).
-  Exits / closes the TwinCAT System Manager.

i Not all menu entries are active at all times

As the TwinCAT System Manager is context-sensitive, not all menu entries are active at all times!

"File" menu**New** 

Creates a new System Manager project (blank configuration).

Open 

Opens a dialogue for the selection of an existing saved System Manager project.

Open Currently Active 

Opens the project file whose configuration is currently active in the TwinCAT system.

Save 

Saves the current configuration in a TwinCAT System Manager *.wsm file (respectively *.tsm file under TwinCAT 2.9).

Save As

Saves the current configuration in a *.wsm file with user-defined name and location.

Hint:

At TwinCAT version 2.9, a new file format (*Structured Storage*) was implemented for saving of TwinCAT System Manager configurations. This new file format gets the file extension *.tsm. Alternatively, also under TwinCAT 2.9, configurations can be opened from WSM-files or saved into files with *.wsm extension. To achieve this, the appropriate extension is to be selected at "Save as type:" in the "Save As.." dialog.

● New file format

i From TwinCAT 2.9, a newly implemented format (Structured Storage) is used by default to save the system configuration. This new file format has the extension .tsm.

Alternatively, WSM files can still be read in under TwinCAT 2.9, or newly created configurations can be saved with the file extension *.wsm. To do this, simply select the appropriate file extension in the "Save as..." selection dialog.

Enable Compression

To be lenient with the limited resources on devices of the CX1000 and BXxxxx classes, an optional compression feature for saving of *.tsm configurations has been implemented at TwinCAT 2.9.

"Enable Compression" is activated by default and achieves, depending on the project, a space saving of 80% and more.

Properties

Under this new menu item at TwinCAT 2.9, [extended document information \[► 31\]](#) regarding the System Manager project can be found and edited.

Print

Opens Printing dialog if high-lighted. Printable section required.

Print Preview

Presents view of the selected window which is prepared for printing (depending upon selected area of the System Manager).

Printer Set-up

Opens the printer settings dialogue box.

Exit

Closes the TwinCAT System Manager.

"Edit" menu



Undo

Reverses the last action.

Cut

Copies selected object to the clipboard and removes it from the current configuration.

Copy

Copies selected object to the clipboard.

Paste

Inserts elements from the clipboard to the current position.

Insert with links

Inserts elements with present [link](#) [[▶ 39](#)] from the clipboard into the current position.

● All are not always available

i Not all of the above functions are available in every context.

"Actions" menu

	Generate Mappings	Ctrl+M
	Check Configuration	Ctrl+H
	Activate Configuration...	Ctrl+Shift-F4
	Set/Reset TwinCAT to Run Mode...	Ctrl+F4
	Set/Reset TwinCAT to Config Mode...	Shift-F4
	Reload Devices	F4
	Choose Target System...	F8
	Read Target Server Versions...	
	Update Bus Coupler/IP Link Firmware...	
	Access Bus Coupler/IP Link Register...	
	Export XML Description...	Ctrl+E
	Import XML Description...	Ctrl+I
	Check Variable Links	

Generate Mappings

Creates assignment between two [process images](#) [[▶ 46](#)].

Check Configuration

Checks the current configuration for plausibility.

Activates configuration

Saves and activates the current configuration. This function can be selected from the [Command line](#) [[▶ 34](#)] without opening the System Manager.

● New backup location for configuration data

i From version TwinCAT 2.8, the project-related configuration data is no longer saved in the Windows Registry, but in a newly introduced XML file with the name "CurrentConfig.xml". This file can be found in the subdirectory: \TwinCAT\Boot.

Starting/restarting TwinCAT in run mode

Starts or restarts the TwinCAT system with the currently saved configuration. From TwinCAT version 2.9, this button is also used to switch from CONFIG to RUN mode. In addition, a possibly configured PLC boot project is loaded and started if "Auto Boot" is activated (see also the description: [TwinCAT system -> User interface -> TwinCAT system control](#)). This function can be selected from the [Command line \[► 34\]](#) without opening the System Manager.

Target system

From TwinCAT 2.9, this button is used to start the TwinCAT target system selected via "Choose Target System" with the currently loaded configuration (by default, the target system is always the local PC). The ADS-AMSNetID and the name of the currently selected target system machine (TwinCAT PC, CX1000 or other TwinCAT target system) is displayed in the lower right corner of the System Manager. If the target system is the local PC, the name "Local" is displayed instead of the network name. If the currently selected target is a remote system, its name is also displayed in the title bar. The current mode is indicated in the lower right corner of the System Manager window, as well as additionally by means of a color change at the TwinCAT system control (in this case to the color green).

Start/restart TwinCAT in config mode

This remote configuration option (also called "remote configuration") is new with TwinCAT version 2.9. It switches the TwinCAT system into config mode. This functionality is required, among other things, in order to be able to configure devices of the Beckhoff [CX1000](#) class, for example, which do not have the TwinCAT System Manager locally (see also: "**Choose Target System**"). The current mode or status is displayed on the far right in the lower corner of the System Manager window, and, for a local target system, by means of a color change on the TwinCAT system control (in config mode, for example, this is the color blue).

Reload Devices

Rescans the I/O configuration at the selected target system and displays it in the System Manager tree view.

Choose Target System

With this item you can select the appropriate target system, where the configuration must be made for (see also: "[Set/Reset TwinCAT to Config Mode \[► 18\]](#)").

Read Target Server Versions

Reads the current TwinCAT server versions available on the prior selected target system.

Update Bus Coupler/IP Link Firmware

Updates the Firmware of Beckhoff Bus Couplers or Fieldbus Boxes through serial COM port.

Access Bus Coupler/IP Link Register

The user can access any available register at a Bus Coupler or Fieldbus Box module via COM port or TCP/IP address after entering the necessary information in the upcoming dialog.

Export XML Description

Saves the configuration data of the currently highlighted tree item as a XML Description file to disk.

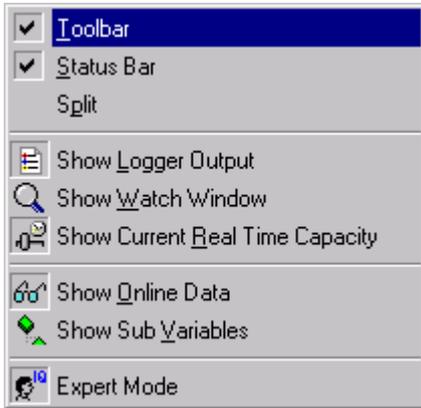
Import XML Description

Imports the configuration data of a previously saved XML Description file into the current System Manager configuration.

Check Variable Links

Validates the current mapping information.

"View" menu



Toolbar

Displays or hides the tool bar.

Status Bar

Displays or hides the status bar. The status bar is displayed at the lower edge of the main window.

Split

Activates a movement off a dividing line between the tree view and the dialogues in the System Manager main window.

Show Logger Output

Displays or removes the [Logger Window \[► 28\]](#) at the lower edge of the System Manager.

Show Watch Window

Displays/removes the [Watch Window \[► 26\]](#) within the System Manager.

Show Current Real Time Capacity

Displays/removes the real time load of the (starting) TwinCAT system in the lower right-hand corner of the main window.

Show Online Data

Displays/removes the online data of the configured variables. The current configuration for a display must be active, i.e. saved, in the *registry* and the TwinCAT system must be started.

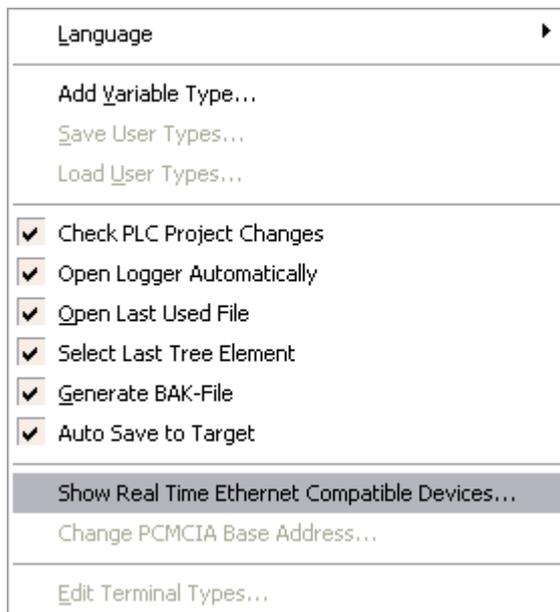
Show Sub Variables

Displays the sub-variables of variables.

Show Expert Mode

Displays or removes seldom used parameters for various settings dialogues in the System Manager.

"Options" menu



Language

Opens the selection menu to select one of the languages supported by the TwinCAT System Manager.

Languages

If the other languages are grayed out, the System Manager has found the corresponding DLLs, but they are not up-to-date.

Check PLC Project Changes

If this option is selected, a message box appears when saving configuration changes to PLC projects. This message box requests the [PLC Configuration \[► 92\]](#) to be *re-loaded* in.

Open Logger Automatically

Automatically opens the [Logger Window \[► 28\]](#) when System Manager is started and displays current TwinCAT events.

Open last Used File

Automatically opens the last saved *.wsm file when System Manager is started.

Select Last Tree Element

Automatically opens the last saved display of the configuration tree.

Generate BAK-File

When this option is selected a "Current Name".bak file is created as a backup file with each saving.

Auto Save to Target

When this option is selected, additionally to the local system the configuration is also saved to the target system (e.g. when configuring a CX1000 or BXxxxx). By default, the configuration is saved in a zipped version. See *a/so*: "[Enable Compression \[► 16\]](#)".

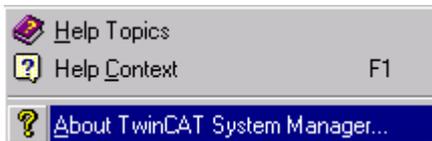
Show Real-Time Ethernet Compatible Devices

See: **Reference** | "[Ethernet Miniport \(Real-Time\) \[► 239\]](#)"

Change PCMCIA Base Address

Opens settings dialogue to change the PC Card base address. After making changes it is necessary to restart Windows.

"Help" menu (?)



Help Topics

Opens the TwinCAT System Manager Help files. Help is a part of the Beckhoff Information System. If you require an English version of Help, you need to install the English language Beckhoff Information System.

Help Context

When the Beckhoff Information System is installed, opens the Help page relating to the area selected in the System Manager.

About TwinCAT System Manager

Calls up information about the current installed version of the TwinCAT System Manager.

Other switching elements on the tool bar

Find

Opens device search dialog within the System Manager.

Device search

If you have selected the entry "**I/O Devices**" (below [I/O - Configuration \[► 97\]](#)) in the tree view on the left, a device search function can be triggered via the toolbar button shown here. The first step is to start searching for supported I/O devices and – if these are found – then continue with the search for connected devices ("boxes") and their terminal equipment, or IP link extension modules.



This functionality is only implemented universally from TwinCAT 2.9. To be able to run it, the target system must be in **config mode**. (The current mode is displayed in the lower right corner of the main window [► 13].)

Change free run status

After activating this button, with a target system in config mode, supported I/O devices can be set to free run mode. I/O variables of bus terminals can then also be written **without** configured and activated task (e.g. without PLC project).



If the target system was previously in **run mode**, the button "Reloading the I/O devices [► 18]" (reloading the configuration) in the toolbar must be pressed once to be able to set the I/O devices to free run mode.

Full expand tree below selected item

After pushing this button, the entry marked in the TreeView will be shown in the fully expanded view.

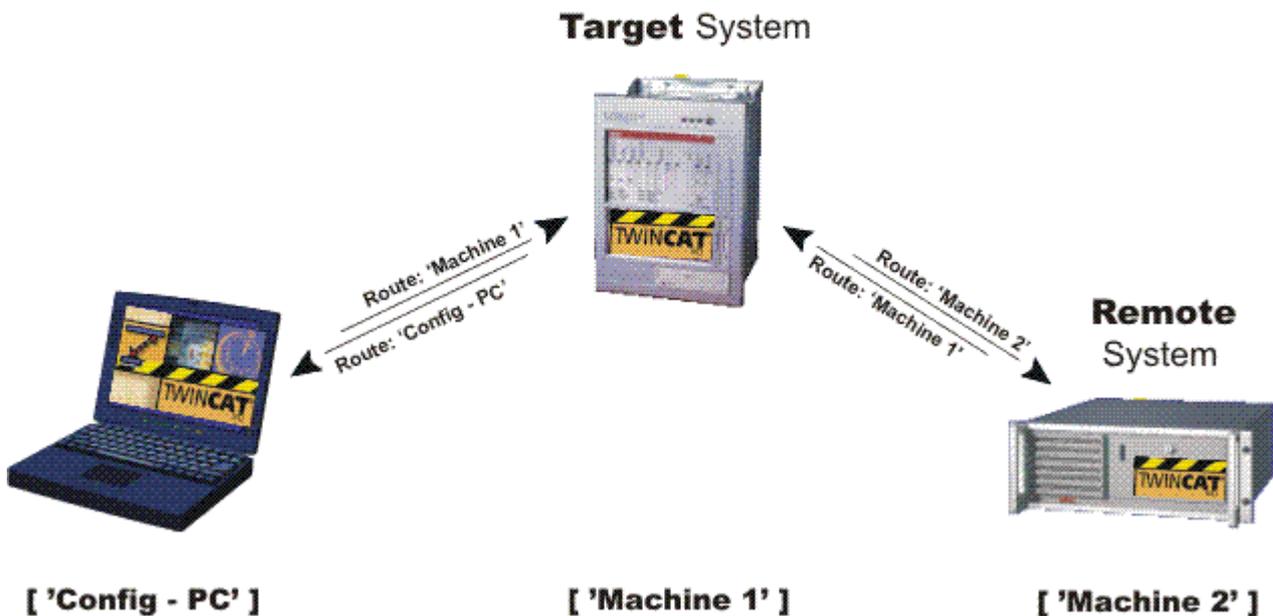
3.1.2 Definition Remote System resp. Target System

To be able to use the enlarged possibilities of the Selection of target systems [► 23] under **TwinCAT 2.9**, the terms "**target-system**" and "**remote-system**" must be defined. When you think of a remote configuration of TwinCAT systems (this could be both other TwinCAT-PCs and other devices of the CX1000 or BX family), a target system is the system, which is registered first at the configurations-PC as "static routes [► 65]". The target-system can be addressed directly. This means for instance, that the configurations-PC in any case has the rights to access the target system. These rights are already checked when the target system is added to the static routes. Moreover you can start a search from the target system to find TwinCAT systems which are released and accessible via TwinCat router. A system which is found and released for configuration is called "**remote-system**".

Rights on the Remote-System

The configurations-PC can configure the remote-system, even if it has no rights on it, but the target-system above which the remote-system has been routed, needs to have these rights.

Definition of TwinCAT Target vs. Remote Systems



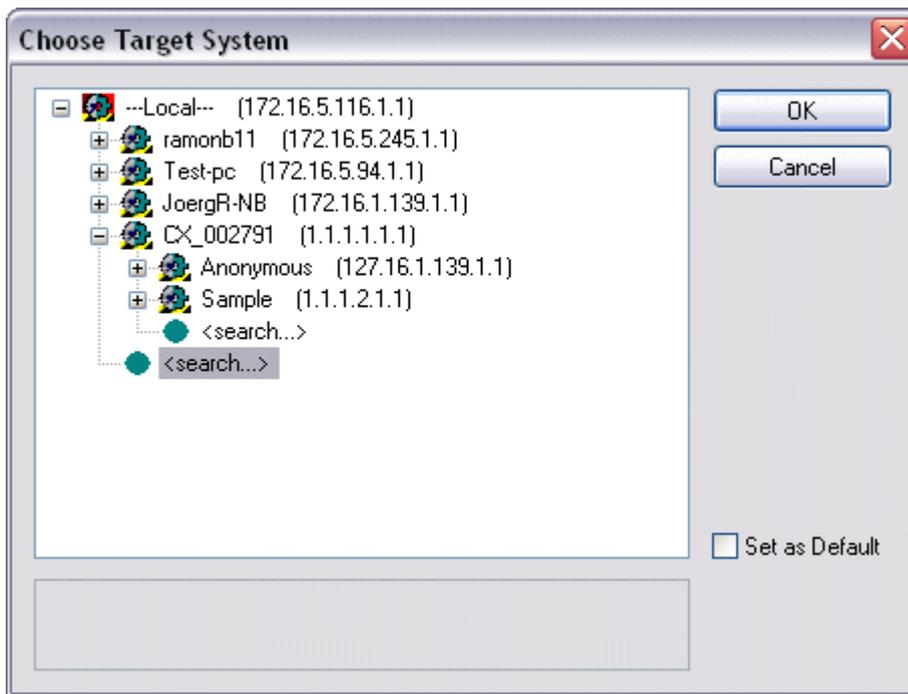
3.1.3 Selection of the Target system

You can select and further on configure [Target systems](#) [▶ 22] respectively [Remote-systems](#) [▶ 22] by the menu item *Selection of the Target system* which is new in TwinCAT 2.9. You can access the dialogue from the system manager's menu bar under the item "[Actions](#) [▶ 17]

Cause it is very important for the following to know the difference between "Target system" and "Remote system" here a definition: "[Definition of Remote- resp. Targetsystem](#) [▶ 22]

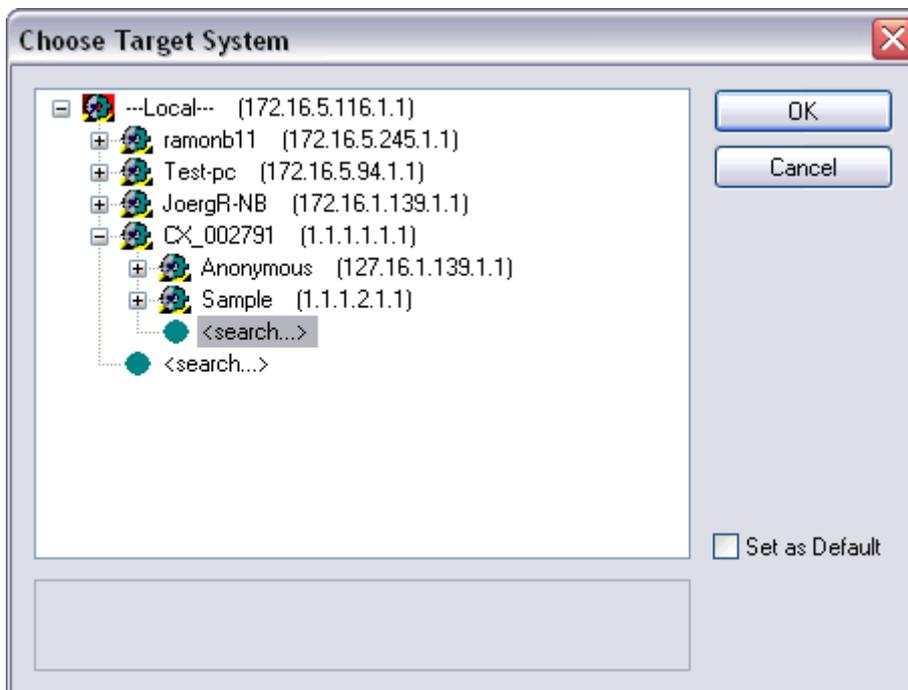
Dialogue "Select Target system"

After you have accessed the menu item "Select Target system" as described above, the dialogue "Select Target system" appears. Here you see a tree structure of all configuration targets registered at the local TwinCAT router. The first item is the local TwinCAT system with its *ADS-AmsNetId*. The configuration targets which are shown as child targets are called "[static routes](#) [▶ 65]". You find them in the system managers tree structure underneath "[SYSTEM - Configuration](#) [▶ 53]", child element "[Route Settings](#) [▶ 65]". If the required target system is available (Network is connected, TwinCAT is started resp. in [Config-Mode](#) [▶ 13]), you can choose it as target system. So you can connect to a CX1000, to configure it. This means, if you are local logged in on '172.16.5.116.1.1', a double click on 'CX_002F10' would create a connection to exact this target system.



If you want to access targets which aren't shown yet, you can click on the button "**Search...**" to look for further target systems accessible from "local". The "Add Route Dialogue" appears, and further TwinCAT target systems are added to the list of the actual routes.

If you want to look for further targets which are located behind one of the listed target systems, so called "Remote-systems [▶ 22]", click on the target system from which you want to route and click on "**Search...**". In this example we want to look for remote systems starting at 'CX_002F10'.



After a click on "**Search...**" the "Add Route Dialogue" appears. Now you can look for remote systems which are accessible and configurable from the router of the device 'CX_002F10'. These could be for instance profibus-members of the 'CX_002F10' with ADS-interface or an AX2xxx-B200 drive with Lightbus Interface.

Or you could for instance add another PC as Remote-PC cause the local configuration system has no rights for the [Remote-System \[▶ 22\]](#) but the [target system \[▶ 22\]](#) 'CX_002F10' has. So, it is quasi routed over the target system 'CX_002F10' to the Remote-PC.

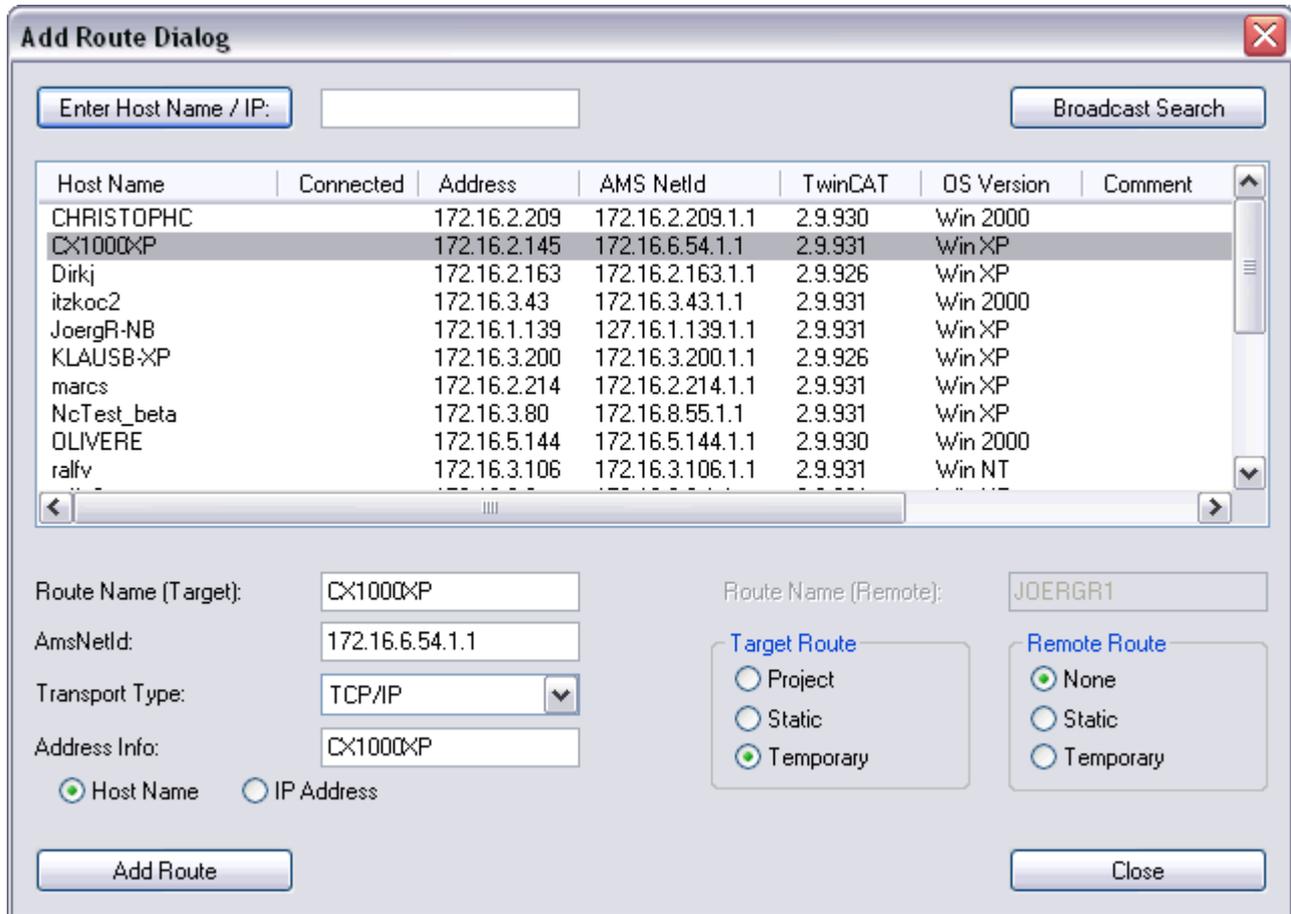
The "Add Route Dialogue"

Add Route Dialog

You can find a description of the dialogue starting with a click on "**Search...**"[here...](#) [[25](#)]

3.1.4 Add Route Dialog

The list of [target systems](#) [[22](#)] or [remote systems](#) [[22](#)] that can be reached can be extended with the aid of the following dialog:



Enter Host Name / IP

Executes the 'GetHostByName' command. The effect of this is that the name entered here is searched for in the network (*subnet*) as a possible TwinCAT target system or remote system.

Broadcast Search

Looks for all the TwinCAT systems connected to the current *subnet*. In order for the System Manager to find the targets, TwinCAT here must either be in [config mode](#) [[13](#)] or in [run mode](#) [[13](#)].

Host Name

The name of the remote or target system in the network.

Connected

Indicates the status of the connection.

Address

Specifies the address of the device concerned. The nature of the address depends on the transport protocol being used. If this is 'TCP/IP', it is therefore the TCP/IP address.

AMS NetId

The identification address of the device for the TwinCAT Router. See: [ADS-AmsNetId](#).

TwinCAT

Gives the versions and build numbers of the TwinCAT target system.

OS Version

Indicates the operating system installed at the target.

Route Name [Target], AmsNetId, Transport Type

Repeats this data in the relevant column when a target is chosen from the list.

Address Info

See **Host Name** and/or *IP Address*.

- Host Name

The **Address Info** is the name of the target.

- IP Address

The **Address Info** is the IP address of the target.

Add Route

Add the chosen target to the "routes".

Route Name (Remote)

...

The "Logon Information" dialog

It is necessary to have been assigned the required rights in order to be able to configure a remote or target system. If this has not been done, the following dialog appears:

If you have the password and user name for the required user group, they can be entered here, and the ability to configure the system is then granted.

● No password

A CX100x-xx1x, i.e. a device with the operating system MS Windows CE.NET does not need a password at the moment, therefore you can simply confirm the dialog with "OK" without having to enter anything in the two lines.

After confirming with "OK", an 'x' must appear below "Connected" for the added device in the "Add Route Dialog" described above. This completes the process and you can select the desired target as described in [Choose Target System \[► 23\]](#).

3.1.5 Watch Window

When the Watch Window display is selected, the following window appears at the lower edge of the System Manager (shown here with sample variables):

Variable	Online	Source
↕ iAnalogIN0	0x0000 (0)	iAnalogIN0 . Eingänge . Standard . test2
↕ bSwitch3	0	bSwitch3 . Eingänge . Standard . test2
↕ bSwitch2	1	bSwitch2 . Eingänge . Standard . test2
↕ bLamp1	0	bLamp1 . Ausgänge . Standard . test2
↕ iAnalogIN1	>0x0400 (1024)<	iAnalogIN1 . Eingänge . FastTask . test2
↕ iAnalogIN2	0x0000 (0)	iAnalogIN2 . Eingänge . FastTask . test2

Variable

Gives the name of the variable being viewed. The arrow symbol indicates whether the variable is linked or not.

Online

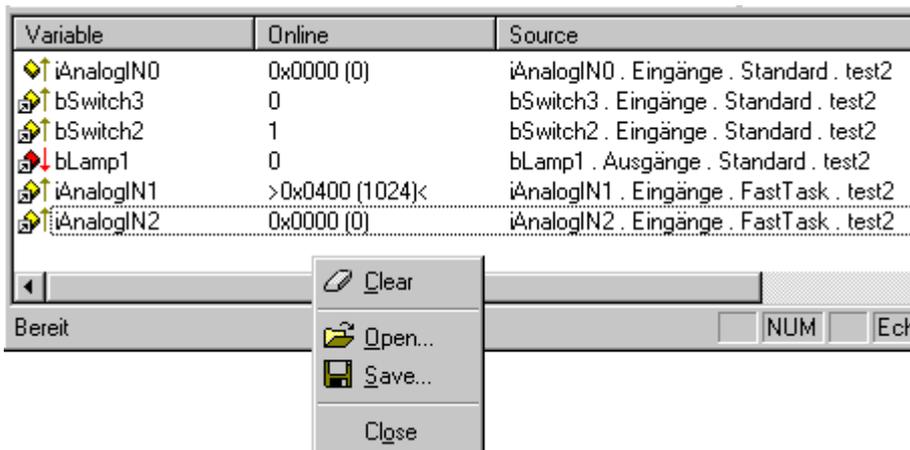
Shows the current value of the variable. For non-Boolean variables the value is displayed in hexadecimal and decimal format (in brackets). Forced variables are displayed with values also in straight bracket.

Source

Provides the source of the variable. The information is comprised of "Variable Name, In or Output, Task Name, PLC Project Name".

Watchlist Context Menu

A right-hand mouse click in an empty line of the Watch window will display the context menu.



Clear

Removes the variable from Watch window.

Open

Opens previously created and saved Watch window configurations.

Save

Calls up the dialogue to save the Watch window configuration to (file suffix: *.tcw).

Close

Removes the Watch window from the current System Manager view. The configuration is retained, however, and can be recalled at any time using the Menu: *View / Show Watch Window*.

3.1.6 Logger View

When the Logger View is activated, the following window appears in the lower section of the System Manager (shown here with some example messages):

Server (Port)	Timestamp	Message
 TCIO (300)	6/19/00 8:45:29 PM 130 ms	Gerät 2 (FC200x): Detected bus interruption immediately before receiver
 TCIO (300)	6/19/00 8:44:30 PM 381 ms	Gerät 1 (FC310x): Device has confirmed the last ADS-Service with an error, Er
 TCIO (300)	6/19/00 8:43:54 PM 539 ms	Gerät 1 (FC310x): Device has confirmed the last ADS-Service with an error, Er

Server

Gives the name and the port number of the server which generated the message. An icon is also shown indicating the severity of the error (e.g. System Stopped, etc..).

Timestamp

Gives the date and time of the current error message.

Message

Gives a brief description of the error which has occurred.

Logger View - Context Menu

A right-hand mouse click in the Logger window will display its context menu.

Server (Port)	Timestamp	Message
 TCNC (500)	11/7/00 10:19:42 PM 231 ms	AdsWrite 'function axis 1' (Invokeld: 116, IndexGroup: 0x00004201, IndexOf.
 TCNC (500)	11/7/00 10:19:42 PM 231 ms	'Axis 1' (Axis-ID: 1, Grp-ID: 1): Axis/Group has none enabled controller and, the.



Clear

Removes all messages from the Logger output

Filter

Currently in development.

Close

Removes the Logger window from the current System Manager view. The configuration is retained for the duration of the session and can be recalled at any time via the menu using *View.. / Show Logger Output*.

3.1.7 Status Display In/Outputs

When selecting the *inputs / outputs* entries in the tree view of the System Manager, a list view appears on the right-hand side of the input/output variables for that task (example shows inputs). If you have selected a [process image](#) [▶ 26] in the tree view, inputs and outputs appear in the list view.

Name		Online	Type	Size	>Address	In/Out	User ID	Linked to
Temp MB	X	0x0020 (32)	UINT16	2.0	0.0	Input	0	uiTempMB . SystemDiag_PC
Fan 0	X	0x0000 (0)	UINT16	2.0	2.0	Input	0	uiFan0 . SystemDiag_PC2 . I
Fan 1	X	0x12D5 (4821)	UINT16	2.0	4.0	Input	0	uiFan1 . SystemDiag_PC2 . I
Fan 2	X	0x0000 (0)	UINT16	2.0	6.0	Input	0	uiFan2 . SystemDiag_PC2 . I
Volt 2a	X	0x00CC (204)	UINT16	2.0	8.0	Input	0	uiVolt2a . SystemDiag_PC2 .
Volt 2b	X	0x0096 (150)	UINT16	2.0	10.0	Input	0	uiVolt2b . SystemDiag_PC2 .
Volt 3.3	X	0x0159 (345)	UINT16	2.0	12.0	Input	0	uiVolt3_3 . SystemDiag_PC2
Volt 5	X	0x01FC (508)	UINT16	2.0	14.0	Input	0	uiVolt5 . SystemDiag_PC2 . I
Volt 12	X	0x04B3 (1203)	UINT16	2.0	16.0	Input	0	uiVolt12 . SystemDiag_PC2 .
Volt -12	X	0x04B1 (1201)	UINT16	2.0	18.0	Input	0	uiVoltMinus12 . SystemDiag_
Volt -5	X	0x01F4 (500)	UINT16	2.0	20.0	Input	0	uiVoltMinus5 . SystemDiag_F
Temp 0	X	0x28 (40)	UINT8	1.0	22.0	Input	0	usiTemp0 . SystemDiag_PC2
Temp 1	X	0xD0 (208)	UINT8	1.0	23.0	Input	0	usiTemp1 . SystemDiag_PC2
Temp 2	X	0x00 (0)	UINT8	1.0	24.0	Input	0	usiTemp2 . SystemDiag_PC2
Temp 3	X	0x00 (0)	UINT8	1.0	25.0	Input	0	usiTemp3 . SystemDiag_PC2
Temp 4	X	0x00 (0)	UINT8	1.0	26.0	Input	0	usiTemp4 . SystemDiag_PC2
Temp 5	X	0x00 (0)	UINT8	1.0	27.0	Input	0	usiTemp5 . SystemDiag_PC2
Temp 6	X	0x00 (0)	UINT8	1.0	28.0	Input	0	usiTemp6 . SystemDiag_PC2
Temp 7	X	0x00 (0)	UINT8	1.0	29.0	Input	0	usiTemp7 . SystemDiag_PC2

Name

Gives the name of the physical I/O variables. A small arrow in the symbol indicates (exactly like the X in the following column) that the variable is [linked](#) [▶ 39]. By clicking on the column heading the variable list can be sorted alphabetically in ascending or descending order.

Online

Shows the current value of the variable. For non-Boolean variables the value is displayed in hexadecimal and decimal format (in brackets). Forced variables are displayed with values also in straight bracket (see [also Watch Window](#) [▶ 26]).

Type

Gives the [Data Type](#) [▶ 49] of the current variable. Click on the column header to sort the variables according to data type size.

Size

Gives the size of the variable in bytes.

Address

Shows the address at which the variable is located. The straight brackets before *Address* indicate whether the address of the physical I/O variable or the linked target variable (e.g. PLC task variable) is displayed. By clicking on the column heading the address list can be sorted in ascending or descending order. [Move Address](#) [▶ 45] in the context menu is used to alter addresses in the process image at a later point.

In / Out

Defines whether physical I/O variable is an input or an output variable.

User ID

Identification number defined by the user. Is provided for future System Manager functions.

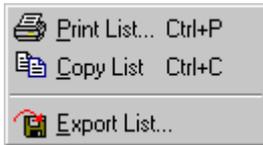
Linked to

Gives the target variable with the total hierarchy listing. By clicking on the column heading the target variable list can be sorted alphabetically in ascending or descending order.

Documentation of variable lists

Right click the mouse in a free line of the list view to display a context menu with a documentation function.

Context Menu



Print List

Opens a dialog to select an installed printer.

Copy List

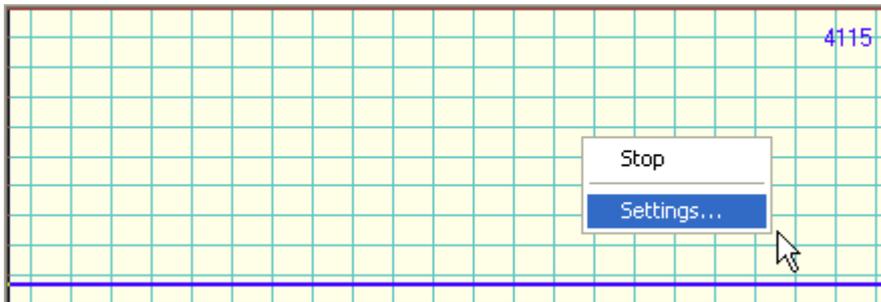
Copies the list to the clipboard

Export List

Exports the variable list to a *.csv file (comma separated values), for further processing, e.g. with a spreadsheet program.

3.1.8 Settings for History View

If an online view of a variable, task execution, etc... is displayed, a right mouse-click inside the graphical trace calls the below menu:



Stop

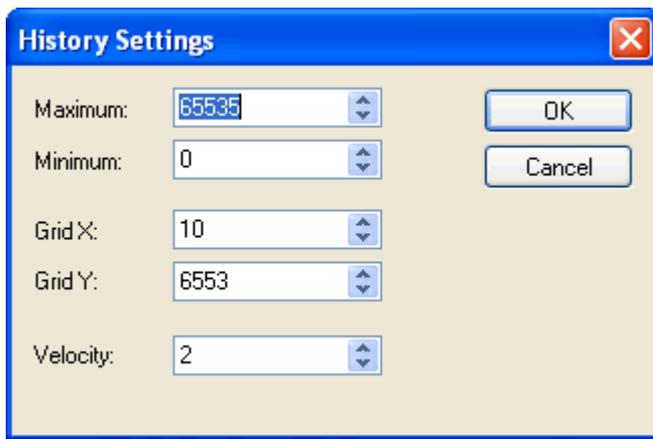
With activated *Stop* command (marked as checked in this case), this otherwise continuously running history view is stopped.

Settings

Opens the below described dialog for the settings related to the online history trace view.

"History Settings" dialog

After a click on *Settings...*, the following dialog appears:



Maximum

This, thru the right UpDown keys or direct input adjustable field, defines the maximum value for the history trace view. That means the value if the trace hits the upper edge of the grid.

Minimum

Defines the minimum value, means the value if the deflection touches the lower edge of the grid.

Grid X

Defines the grid scaling of the trace view in the horizontal range (time axis). The default value here is '10'.

Grid Y

Defines the grid scaling of the trace view in the vertical range as follows: $Maximum / Grid Y = \text{number of vertical fields}$.

Example: A *Maximum* value of '100000' and a *Grid Y* value of '20000' results in 5 displayed fields on the Y-axis.

Velocity

The feed forward velocity of the trace can be adjusted here. Default velocity is '2'.

OK

Accepts the made changes and closes the *History Settings* dialog.

Cancel

Disregards eventually made changes and closes the dialog.

3.1.9 Document Properties Dialog

Starting with TwinCAT v2.9, additional informations are saved together with the related System Manager project. These informations can be used to keep track of project and configuration variants, to detect the TwinCAT version used at the related machine later on, and for a basic version control.

After selection of the System Manager "*Properties...*" menu item - to be opened from the *File* menu - the following dialog appears:

Document Properties

Title: Project 0815

Author: xxx / Beckhoff

Revision: Machine revision 0.92

Comment: Space for useful information!

TwinCAT: SysMan v2.9 b908 (TwinCAT b905)

Licence: [blurred]

Created: Monday, October 28, 2002 14:49:45

OK Cancel

Title

A descriptive title should be added here.

Author

Name and company information of the person responsible for the configuration should be added here.

Revision

A revision number for the machine could be added here.

Comment

Usefull information about machine and/or project status should be edited here.

TwinCAT

The TwinCAT version (build number of the overall TwinCAT system in brackets) that was used to create the respective System Manager configuration is read out in advance and automatically entered at this point.



If the respective *.tsm file is subsequently passed on, the original information of the development system is retained here until the file is overwritten again by the current system.

Licence

Displays the TwinCAT Registration Key from that system, on which the configuration has been saved the last time.

Created

Displays the date on which the configuration has been saved the last time.

OK

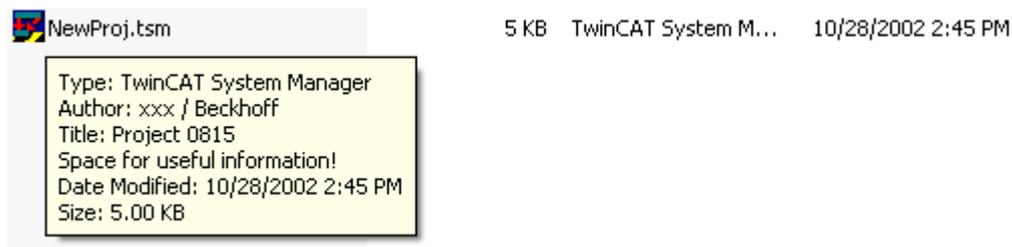
Accepts the changes made in the "Document Properties" dialog and closes the dialog.

Cancel

Closes the dialog without saving eventual modifications.

ToolTip display for System Manager files in Windows Explorer

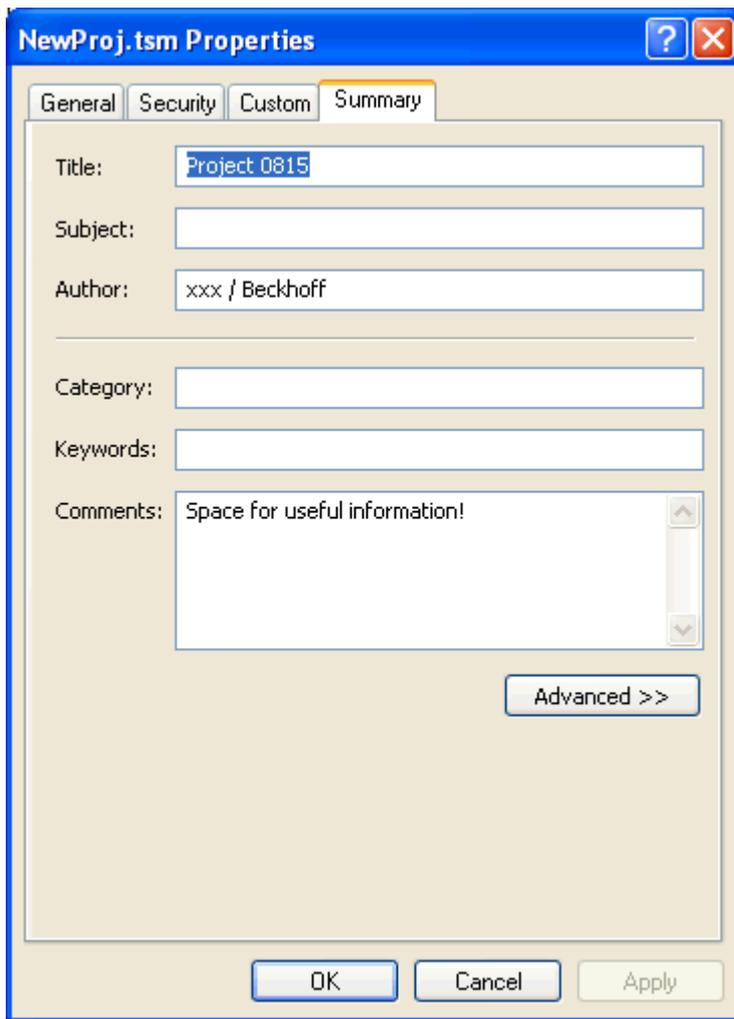
The "Document Properties" information at *.tsm files described above are conform to the *ToolTips* feature, established in MS Windows. Therefore, they are going to be displayed during a mouse-over movement on the file name inside the Windows Explorer. The example given below, shows the informations which are going to be displayed in that case:



"Summary" tab at Windows Explorer

Additionally, the above named informations can be called via Windows Explorer by right-klick on the file and selection of *Properties....*

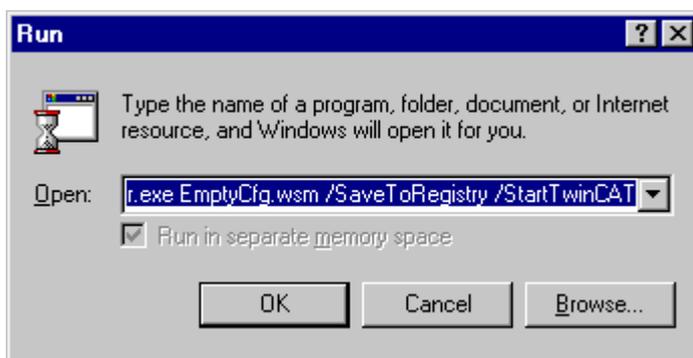
Due to the fact that *.tsm files are in *Structured Storage* format, you can see most of the "Document Properties" on the below shown "Summary" tab, even if TwinCAT is not installed on the system you are currently at.



3.1.10 Operating Options from the Command Lines

When automatically installing an application program including the application-specific TwinCAT files, it is also desirable to automatically activate the System Manager configuration and to automatically start the TwinCAT system.

Command Line Usage



Specify complete TwinCAT System Manager EXE path, the *.wsm file name and path plus the switches described below on the command line and it will execute the following functions:

Supported switches:

```
/SaveToRegistry
/StartTwinCAT
```

Further details about commands are given under [Control Elements - Main Menus \[► 14\]](#).

Syntax

```
TCatSysManager.exe [WSM Path [/SaveToRegistry [/StartTwinCAT]]]
```

Example 1:

```
F:\TwinCAT\IO\TCatSysManager.exe Test1.wsm /SaveToRegistry
```

The System Manager configuration *Test1* should be loaded via the command line.

Example 2:

```
F:\TwinCAT\IO\TCatSysManager.exe Test1.wsm /SaveToRegistry /StartTwinCAT
```

The System Manager configuration *Test1* should be loaded via the command line and the TwinCAT system started or respectively restarted.

3.2 Variables

3.2.1 Configuration of Variables

In and output variables can be added to process images. These can then be [linked \[► 39\]](#) with the various I/O devices or variables of other tasks. This section explains how to manipulate variables (HI / LO Swap, Force,..).

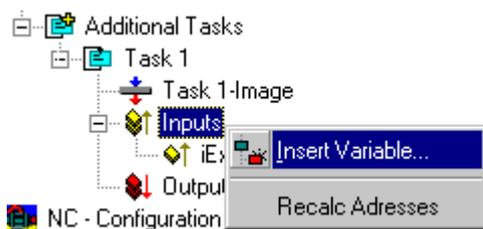
Add Variables

Variables assigned to the task process image can be added under the menu Inputs and Outputs sub-options.

Note: Variables for PLC tasks cannot be added inside the System Manager. These variables have to be declared within the PLC project using [TwinCAT PLC Control](#) (via defined PLC process image address or %Q* resp. %I*) and then added to the System Manager configuration using ReScan... PLC project command.

If you go to Tasks, *Inputs / Outputs* a right mouse click will display the following context menu:

Context menu:



Recalc Addresses

Recalculates the addresses of the variables in the process image.

Insert Variable

Displays the following dialogue:

Insert Variable

General

Name: Multiple:

Comment:

Start Address: Byte: Bit:

OK
Cancel

Variable Type

INT16	2.0
UINT8ARR2	2.0
BITARR16	2.0
UINT24	3.0
INT24	3.0
FLOAT	4.0
UINT32	4.0
INT32	4.0
UUINTOARR4	4.0

Sort by

Name
 Size
 Type

Name

Defines the name of the variable.

Comment

Defines an optional comment on the new variable.

Start Address

Specifies the address of the variable in the task's process image. This address must be the same as the address at which the task is waiting for the corresponding variable. The variable address can be subsequently changed using [Move Address](#) [► 45].

Multiple

Multiple variables of the same type can be created and added with sequential addresses.

Variable Type

Lists all currently recognised data types in TwinCAT System Manager from which the type of the new variable(s) can be selected.

Sort by

Allows the list of variable types to be sorted accordingly.



Adding new variables automatically adapts the size of the task process image.

Variable Information

The variable dialogue, flags and online dialogue are given under [Variable Information](#) [► 37].

3.2.2 Variable Information

When you select a variable in the tree view, you will see dialogues giving information and settings options and an online dialogue with a *Force* Option below a task or an I/O device (in the following image, a PLC variable on the BC), on the right-hand side.

"Variable" tab

Variable	Flags	Online
Name:	iExchangeVarToBC_1	
Type:	INT16	
Group:	Inputs	Size: 2.0
Address:	4 (0x4) [ext: 0]	User ID: 0
Linked to...	iExchangeVar1_r . Inputs . Standard . Additional Tasks	
Comment:		
ADS Info:	Port: 300, IGrp: 0x9002, IOffs: 0x4, Len: 2	

Name

Defines the name of the variable selected in the tree view.

Type

Gives the [Data Type \[► 49\]](#) of the current variable.

Group

Informs whether the variable is an input or an output.

Size

Gives the size of the variable in bytes.

Address

Displays the addresses of the variables in the process image. If, as in the example, another external address is given (e.g. for variables in the Bus Terminal controller), the value must be added after "ext:" on the offset of the data exchange variables (as defined in ["PLC" Dialogue \[► 112\]](#)).

User ID

A user-defined number for future System Manager functions.

Linked to

Indicates if applicable the variable linked with the selected variable. Actuate this button to display the [Selection Diagram](#) [► 43] for the variable link.

Comment

User-defined comments field.

ADS Info

Provides information required to access selected variable via ADS (e.g. TwinCAT Scope View, ...). The information comprises Port Number, Index Group, Index Offset and Variable Length in bytes.

"Flags" tab

Variable | **Flags** | Online

Swap LOBYTE and HIBYTE

Swap LOWORD and HIWORD

Swap LOBYTE and HIBYTE

Actuate this to exchange the values of the lower and higher *Byte* within the 16Bit variable. The result will be available for the process image (e.g. required for some 3rd party Profibus devices).

Swap LOWORD and HIWORD

Actuate this to exchange the values of the lower and higher *Word* within a 32Bit variable. The result will be available for the process image.

"Online" tab

Variable | Flags | **Online**

Value: 0x131B (4891)

New Value: Force... Release Write...

Comment: RPM

4891

Value

Shows the current value of the selected variable.

Force

Displays the dialogue for forcing the variable. The overwritten value is retained until the command is cancelled using *Remove* or the TwinCAT system restarts. A forced variable value is shown in red.

Release

Releases the variable to its regular process image value.

Write

Displays the dialogue for changing the variable value to a user-defined value. In this case the value is overwritten just once for one task cycle.

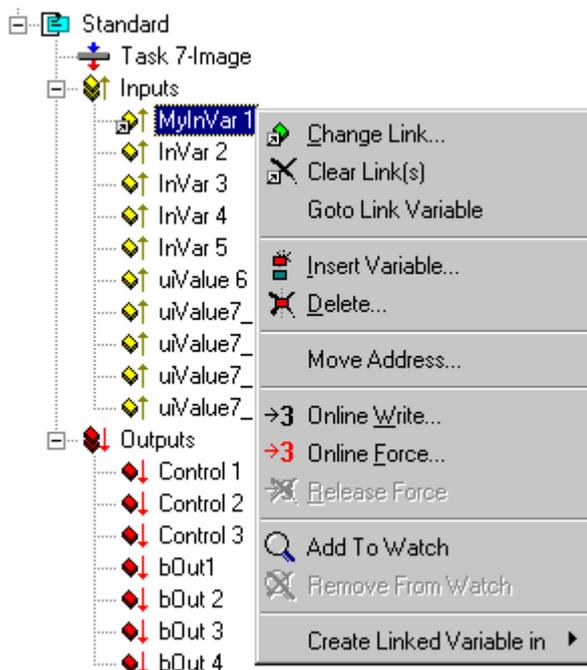
Additionally, the variable value is shown in a graphical trace view (continuously), the so-called *History View*. This display gives an impression about time-based value changes of a variable. Additional infos about the *History View* can be found under: [Settings for History View \[▶ 30\]](#).

3.2.3 Variable Links

The various task input or output variables can be linked when selected either with the context menu or the dialogue shown on the right-hand side, e.g. with the [I/O Configuration \[▶ 97\]](#).

Context Menu

Some of the selection options in the context menu are only available when the configuration is active, and the system is running or they have other dependencies. If that is the case, they aren't high-lighted.



Change Link

Opens the [Selection Dialog \[▶ 43\]](#) for determining the target variable to be linked.

Clear Link(s)

Removes a link (indicated with a small arrow to the left of the variable symbol) from a variable.

Goto Link Variable

Jumps to the linked target variable (e.g. Bus Terminal channel or in/output variable of another task) in the System Manager tree.

Insert Variable

Adds further variables to the task (do not use for PLC tasks as these variables should be specified within the PLC project).

Delete

Deletes corresponding variable from the list.

Move Address

Moves the address of the marked variable within the Process Image.

Online Write

Overwrites the current variable value with a user-defined value for one cycle.

Online Force

Overwrites the current variable value with a user-defined value until halted using Cancel Force.

Release Force

Cancels forced variable and restores the actual variable value.

Add to Watch

Adds the selected variable to the [Watch Window \[► 26\]](#). You can carry out a continuous observation of the current online variable values.

Remove from Watch

Deletes the selected variable from the Watch window

Create Linked Variable in

Adds linked variable to an existing PLC project.

3.2.4 Variable links from the System Manager

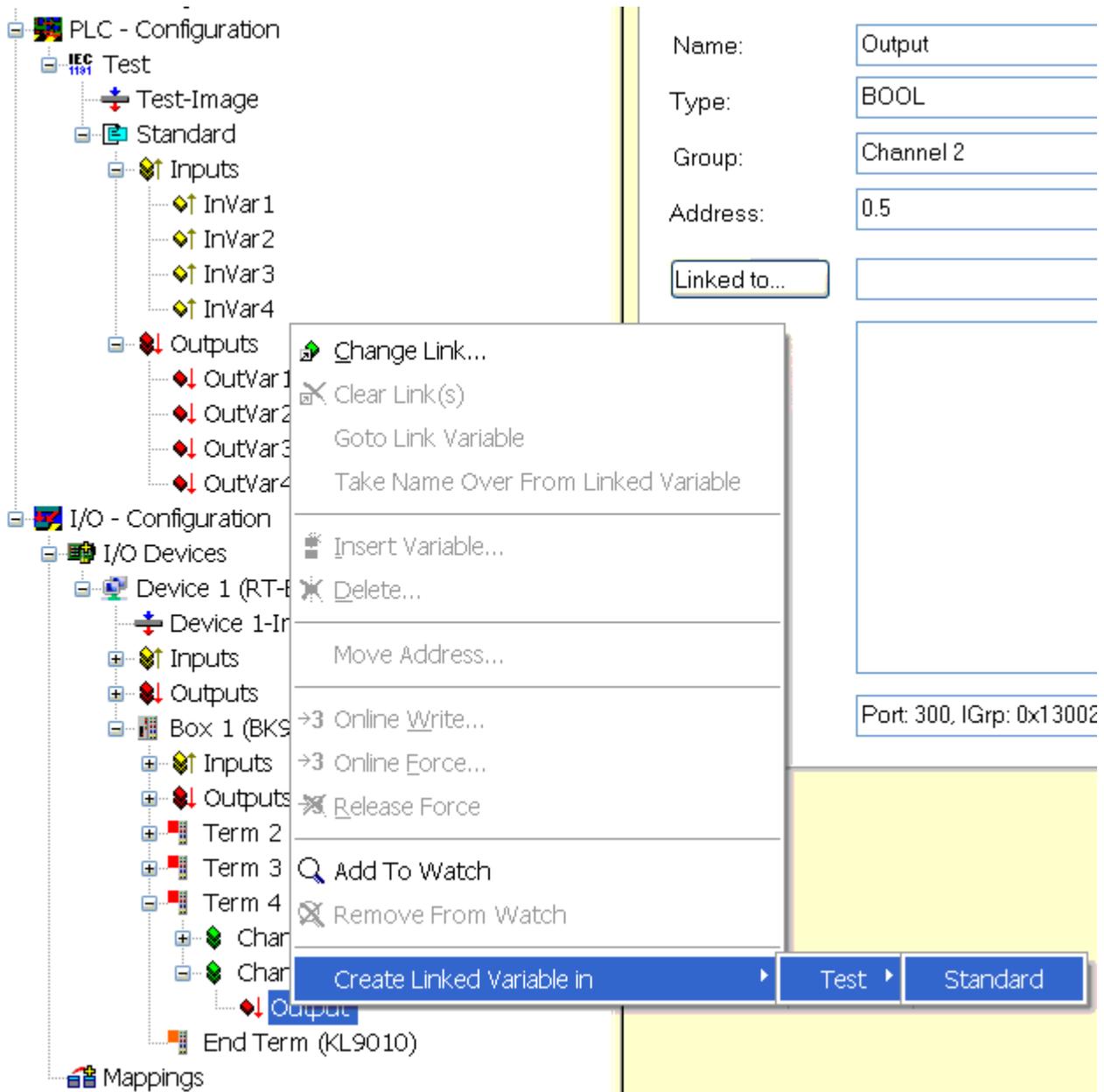
Normally, input and output variables between controller and hardware are created in one task – either in the PLC or in an additional task. These variables are then linked with the corresponding hardware variables in the System Manager.

However, in the Beckhoff TwinCAT software, another way is possible: scan the existing hardware (or configure it manually) and generate PLC variables on this basis (or have them generated). This way will be described below – "Create linked variable in".

Procedure

A hardware variable should now be linked to a task (PLC) from the hardware configuration, even though no corresponding variable has been defined there at all yet.

Create a hardware configuration in the System Manager manually or by scanning. Create a task that will administer the hardware. Fig. 1 shows the project "Test" with the task "Standard", the already existing inputs "InVar1" to "InVar4" and several outputs.



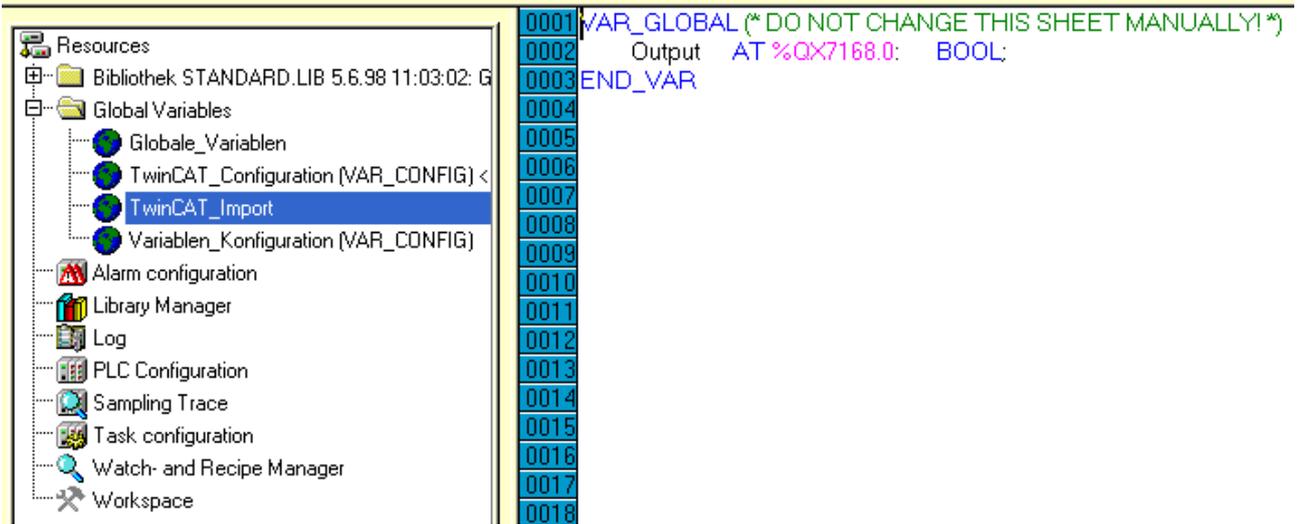
A right mouse-click on the desired hardware variable (here: output channel 2 of a KL2012) opens the dialog for creating a linked variable in a task. A new variable will be created in the selected task; see fig. 2.

Since this type of variable can be used in both directions (input/output), the symbol is blue and is given a double arrow. This type of variable is created in the normal process data area (here: IndexGroup 0xF03x) like all other output variables, input variables correspondingly in the input process image.

The PLC project must still be informed of this new variable; see fig. 3.

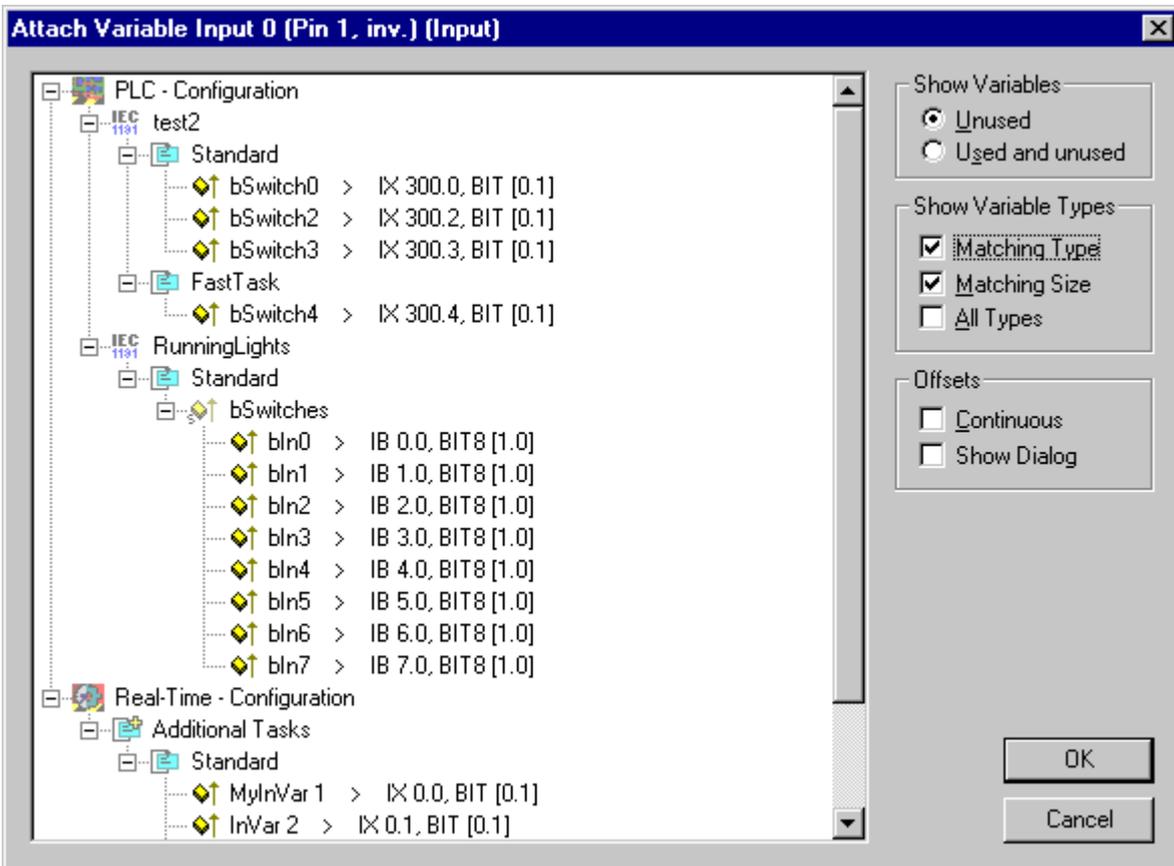
In fig. 3 the start address for PLC variables created in this manner is changeable, calculated with binary prefixes. In fig. 3 the start address is at 7 KB = 7186_{dec} bytes = E000_{hex} bytes.

Task variables created in this manner are adopted into the PLC project via "Save Export Variables". An import file appears in the PLC; see fig. 4:



3.2.5 Variable Selection Diagram

After selecting *Change Link..* or *Linked with..* the following Selection Diagram will appear:



All potentially linkable target variables will appear in the tree view of the Selection Diagram (depending on the selected variable type (input/output variable)).

Show Variables

Unused: If you select this option, only those variables which are not yet linked will be shown.

Used and Unused: With this option, all variables, including those already linked, are shown. This makes sense e.g. for outputs for which multiple links are to be defined.

Show Variable Types

Matching Type: Only matching variable types are displayed as options in the tree view.

Matching Size: Only variable types (e.g. includes structures) of a matching size are displayed.

All types: All available types of variables are displayed as options.

Offsets

Continuous: If Multi Link [▶ 45] is active, this option links variables in continuous order with regard to offset.

Open Dialogue: This option opens an Offset dialogue [▶ 44] where the user defines the bits of two variables to be mapped.

OK

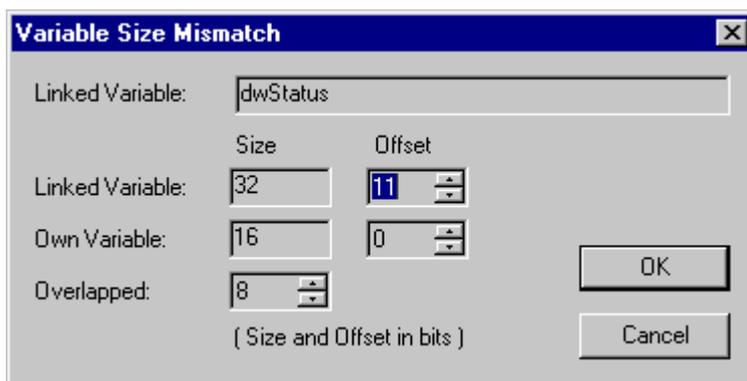
Confirms a variable link and closes the dialogue.

Cancel

Closes the dialogue without establishing a link.

3.2.6 Non-symmetrical Variable Link

If you select *Offline Dialogue* in the Variable Selection Diagram [▶ 43] and/or if two variables of different sizes are to be linked, the following dialogue is suggested:



In the example above the variable *dwStatus* is linked from its 11th bit to the first 8 bits of the selected target variable.

Linked Variable

Shows the names of the variables to be linked (selected variable in System Manager tree).

Size

Gives the size of the variables to be linked in bits.

Offset

Gives the bit offset, as starting bit of the link, within the variables. Use the scroll up/down arrow keys (spin buttons) to select the offset bit.

Own Variable

The target variable to be linked with the selected variable. *Size* and *offset* are also given. The offset itself can be adapted using the arrow keys.

Overlapped

States the number of bits to be linked together from the start offset.

Ok

Confirms a variable link and closes the dialogue.

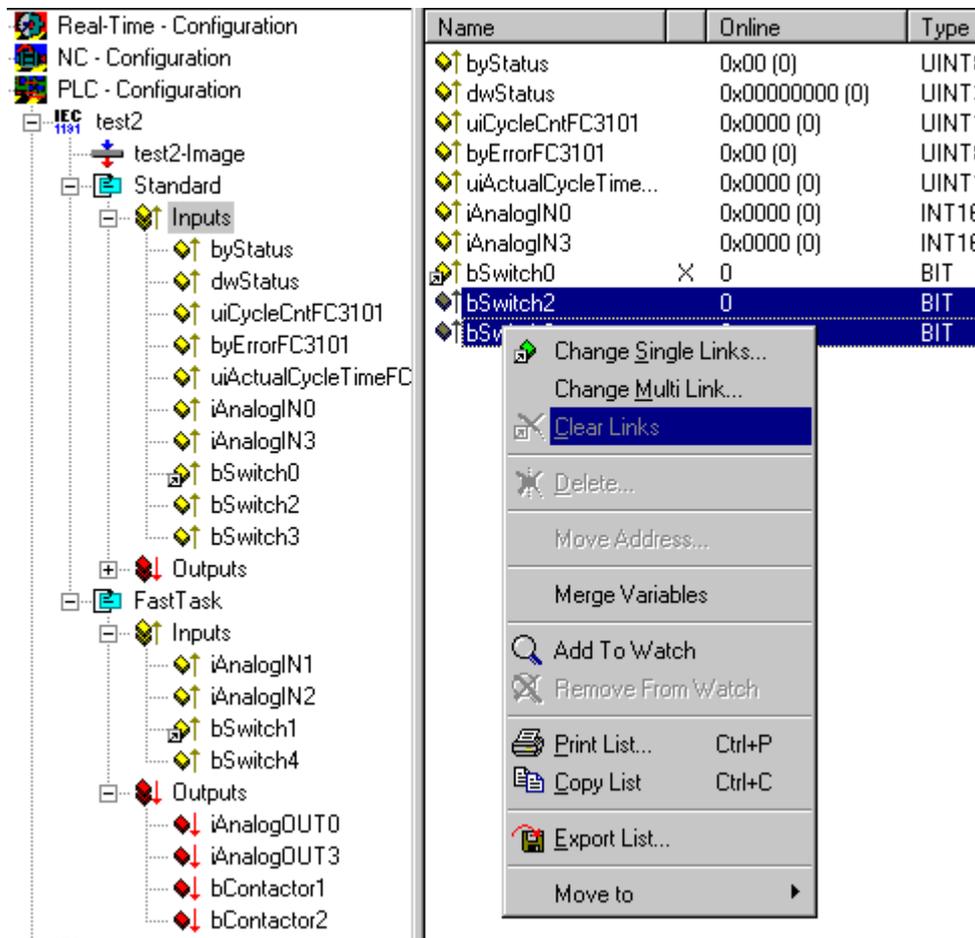
Cancel

Closes the dialogue without making a link.

3.2.7 Extended Link Options

When selecting the main rubric *Inputs/Outputs* in the tree view of the System Manager, the task in/output variables appear on the right-hand side in a list view. Click with the right mouse button on one or more chosen variables (Windows standard multiple selection) to display a special context menu with additional link options. Document functions can also be accessed from here.

Context menu



Change Single Links

Displays the [Selection Diagram \[▶ 43\]](#) for determining the target variable to be linked.

Change Multi Link

Displays the [Selection Diagram \[▶ 43\]](#) for multiple links of multiples continuous variables.

Clear Links

Removes the links of the marked variables.

Move Address

Displays the dialogue for changing the variable address in the [Process Image](#) [▶ 46].

Add to Watch

Adds the selected variable to the [Watch Window in the System Manager](#) [▶ 26]. You can carry out a continuous observation of the current online variable values.

Remove from Watch

Deletes the selected variable from the Watch window

Print List

Prints List. Further System Manager documentation functions are given under [I/O Configuration -Mappings](#). [▶ 125]

Copy List

Copies the list to the clipboard.

Export List

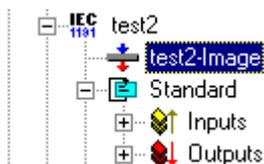
Exports the variable list in *.csv file format (comma separated values). This file can be edited further as required (e.g. using spreadsheets,...)

Move to

Marked variable(s) can be moved to other PLC Task, if available. Variable(s) will be refreshed with the appropriate cycle time, then.

3.2.8 Process Images

The tree view gives the process images for the tasks and/or devices below the various configurations.



If you select the process images shown in the example, on the right-hand side you will see the corresponding dialogue with more detailed information on the process image. The process image appears beneath, with a [list](#) [▶ 28] of all linked and unlinked I/O variables.

"General" Dialogue

The screenshot shows a dialog box with four tabs: 'General', 'Size / Offset', 'Input', and 'Output'. The 'General' tab is active. It features a 'Name' field with the text 'test2-Image', an 'Id' field with the value '6', and a 'Type' dropdown menu set to 'Master Image'. Below these is a large, empty text area for 'Comment'. At the bottom of the dialog, there are two checkboxes: 'Disabled' (unchecked) and 'Create symbols' (unchecked).

Name

Name of Process Image

Type

Defines whether process image functions as a master or a slave after linking (see also [Mapping Types](#) [▶ 127]).

Id

Gives the identification number of the process image.

Comment

User-defined comments field.

"Size / Offset" dialogue

The screenshot shows a dialog box with four tabs: 'General', 'Size / Offset', 'Input', and 'Output'. The 'Size / Offset' tab is active. It contains four input fields arranged in a 2x2 grid. The top row has 'Input Size' with the value '301' and 'Output Size' with the value '301'. The bottom row has 'Input Offset' with the value '0' and 'Output Offset' with the value '0'.

Input Size

Size of the *Input* area in the generated process image.

Input Offset

It is possible to enter a start offset for the input range (if applicable, depends upon the device).

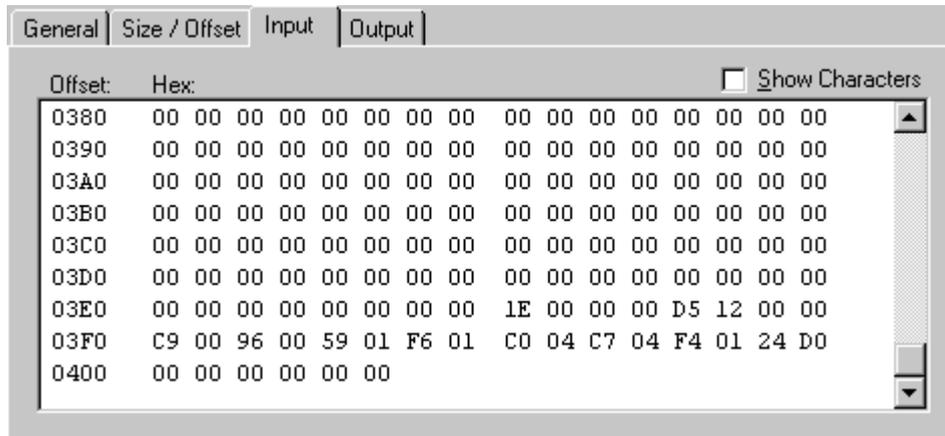
Output Size

Size of the *Output* area in the generated process image.

Output Offset

It is possible to enter a start offset for the output range (if applicable, depends upon the device).

"Input" / "Output" Dialogue



The process image area in byte-size, hexadecimal form is shown in the *Input / Output* dialogue (and as symbols in its own column, if the "Show Characters" option has been selected).

When displaying process images of devices with a mixed I/O area in the DPRAM (e.g. *Beckhoff C1220 Lightbus card*) output values are also shown reversed at the *input*.

Further information on process images and their links is given under [Mappings \[► 125\]](#).

3.2.9 Data Type Comparison

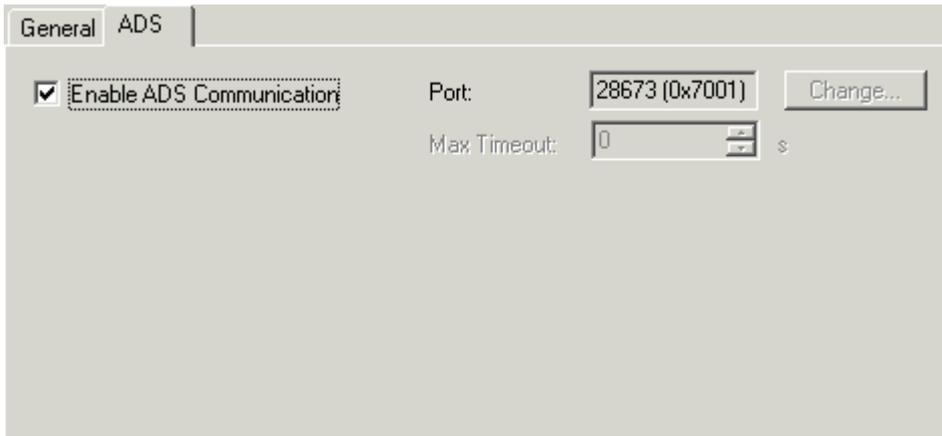
Requirements

System Manager	IEC61131-3	Correspondent .NET type	C# Keyword	Visual Basic Keyword	Remark
BIT	BOOL	System.Boolean	bool	Boolean	For info about specific PLC data type, see: TwinCAT PLC Control - Data Types
BIT8	BOOL	System.Boolean	bool	Boolean	
BITARR8	BYTE	System.Byte	byte	Byte	
BITARR16	WORD	System.UInt16	ushort	-	
BITARR32	DWORD	System.UInt32	uint	-	
INT8	SINT	System.SByte	sbyte	-	
INT16	INT	System.Int16	short	Short	
INT32	DINT	System.Int32	int	Integer	
INT64	LINT	System.Int64	long	Long	Integer type with size of 8 bytes. Currently not supported by TwinCAT PLC.
UINT8	USINT	System.Byte	byte	Byte	
UINT16	UINT	System.UInt16	ushort	-	
UINT32	UDINT	System.UInt32	uint	-	
UINT64	ULINT	System.UInt64	ulong	-	Unsigned integer type with size of 8 bytes. Currently not supported by TwinCAT PLC.
FLOAT	REAL	System.Single	float	Single	
DOUBLE	LREAL	System.Double	double	Double	

3.3 ADS Settings

3.3.1 ADS Settings at I/O Devices

Devices which can transport ADS-Services, but don't provide an own ADS-Server (e.g. the Virtual Ethernet or USB Interface), have the dialog described below.

"ADS" Tab**Enable ADS Communication**

Activates the communication with ADS capable devices. This box must be checked to allow ADS communication.

Port

Displays the ADS Port number of the device.

Change:

If this button is active, the ADS Port number can be changed here. Whether the change is possible or not, depends on the device type.

Max Timeout

Determines the allowed maximum response time for the ADS communication (in seconds).

3.3.2 ADS/AMS Settings at I/O-Devices

Devices with own ADS-AmsNetId (e.g. the Beckhoff AX2000 drive) have the following dialog for ADS/AMS settings.

At devices without own NetId or e.g. devices without Beckhoff Lightbus interface, only a part of the following items are present on the tab, but the existing ones have the same meaning.

"ADS/AMS" Tab

Allgemein	AX2000	ADS/AMS	Istwertkanal	Sollwertkanal	Online
<input checked="" type="checkbox"/>	Enable String Communication	Port:	28928 (0x7100)	Change...	
<input checked="" type="checkbox"/>	Enable Ams / Ads (with own NetId)	Max Timeout:	10	s	
	NetId:	172.16.3.23.2.2			
	Remote Name:	Gerät 1 (FC200x)_Box 1 (AX2000)			

Enable String Communication

Enables the asynchronous communication at devices with Beckhoff Lightbus interface .

Port

Displays the ADS Port number of the current device.

Change

Makes a change of the *Port number* possible.

Max Timeout

Determines the allowed maximum response time for the ADS communication (in seconds).

Enable AMS / ADS

At devices with own NetId, this box must be checked.

NetId

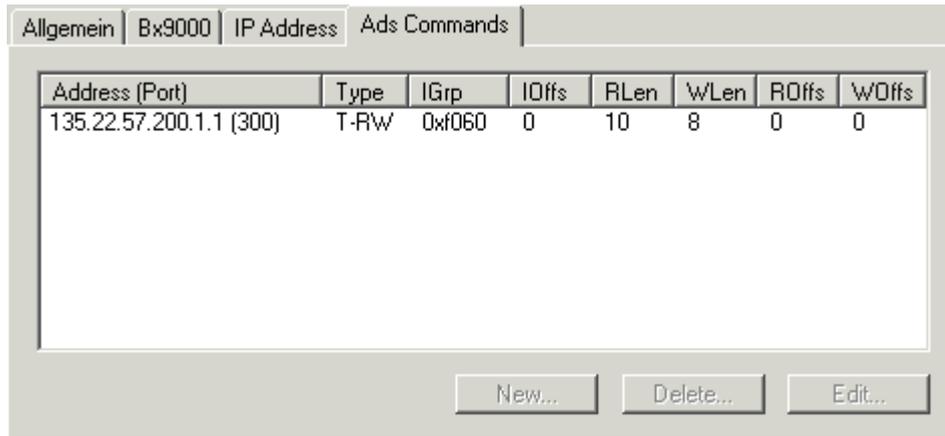
Displays the ADS-AmsNetId of this device.

Remote Name

Displays the name of this device as it appears in the list of possible -> "AMS Remote Connections". This field can be edited by user.

3.3.3 ADS Command Window

Subsequently, the manual ADS command control for accessing of ADS capable I/O devices (e.g. Beckhoff USB Bus Coupler BK9500 or Ethernet Bus Coupler BK9000) is described.

"ADS Commands" Tab

Address (Port): Addresses the AMS-Net ID and Port number (last one in brackets) for the destination of the ADS command.

Type: Telegram type of the ADS command (e.g. T-RW = Type Read/Write).

IGroup: Specifies the Index-Group of the wanted ADS command.

IOffs: Specifies the Index-Offset of the wanted ADS command.

RLen: Length of the data to read from the ADS device (in Byte).

WLen: Length of the data to write to the ADS device (in Byte).

ROffs: Offset of the data to read (in Byte).

WOffs: Offset of the data to write (in Byte).

New: Adds an ADS command to the list.

Delete: Removes the selected ADS command from the list.

Edit: Edits the values inside the different command fields.

4 SYSTEM Configuration

At the **SYSTEM - Configuration** tree-entry, project-specific TwinCAT System- and Real-Time Settings [▶ 54] can be made.

User-defined Tasks [▶ 59] can also be created, e.g. to output or read I/O device values from high-level language applications (Visual Basic-, Visual C++, C# .NET, Visual Basic.NET or Delphi).

SYSTEM - Configuration	Description
<u>Boot Settings</u> [▶ 65]	Boot / Auto-Logon settings for the local and for the target system
<u>Real-Time Settings</u> [▶ 54]	Configuration of TwinCAT Real-Time settings and display for Real-Time load
<u>Priorities</u> [▶ 58]	Display / manipulation (= <i>Advanced User</i>) of TwinCAT Task priorities
<u>User-defined Tasks</u> [▶ 59] ("Additional Tasks")	Configuration of possible additional user-defined tasks
<u>Task settings for "Additional Tasks"</u> [▶ 62] (if configured)	Dialog for settings of user-defined tasks
<u>Online Display Task Load</u> [▶ 64] (if additional user-defined tasks are configured)	Online view for the load of the user-defined task
<u>Task Process Images</u> [▶ 46] (if additional user-defined tasks are configured)	Mapping information about user-defined tasks
<u>Route Settings</u> [▶ 65]	Information about TwinCAT target system routing

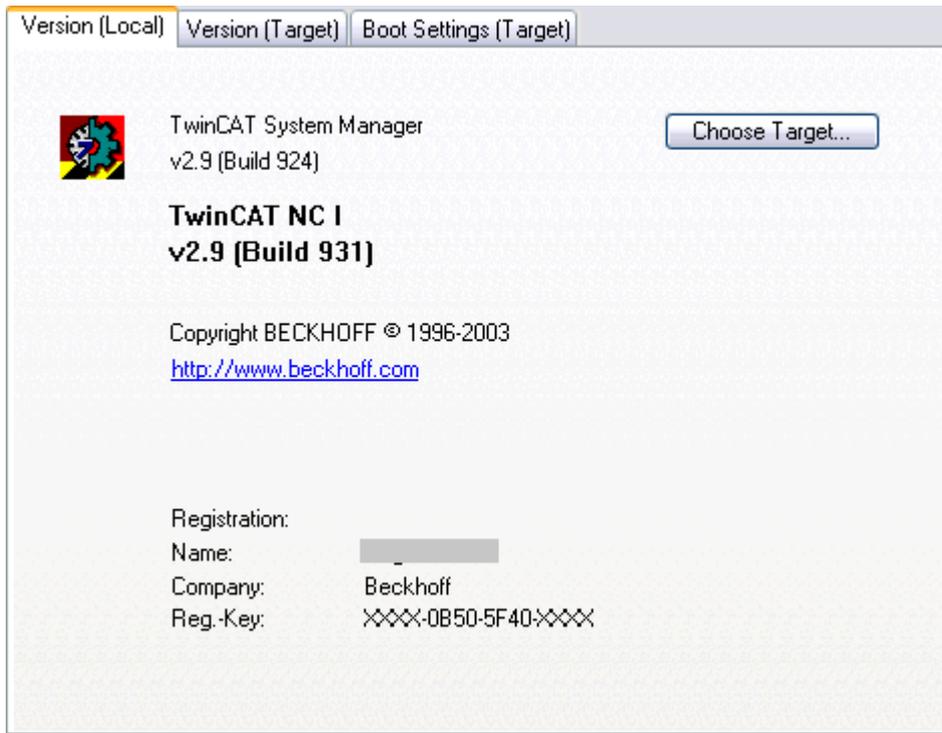
"General" Tab

This dialog only appears, if no Remote system is selected, means the System Manager accesses the local target system (see also "Choose Target System [▶ 23]").

Besides that, the following dialog "**Version [Local]**" is equivalent.

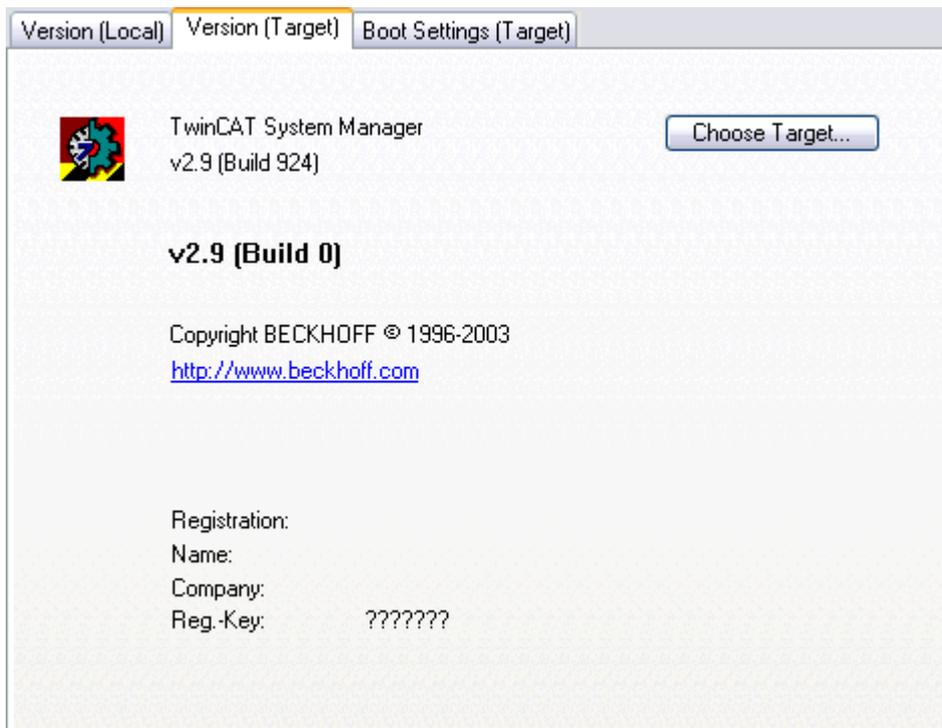
"Version [Local]" Tab

The following dialog shows the installed TwinCAT Level of the lokale system (at this example it is "*TwinCAT NC I*") and the version und "Build"- number of it (correspondingly the version 2.9 [Build 931]).



"Version (Target)" Tab

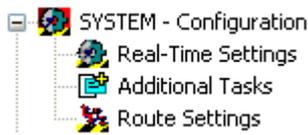
Besides the info about the locally installed TwinCAT version, another tab with corresponding info about the selected TwinCAT target system is available. The following dialog shows e.g. version 2.9 [Build 0].



Choose Target: Calls the selection dialog for TwinCAT target systems, accessible by TwinCAT Router. See also: Main Menu -> "Actions"

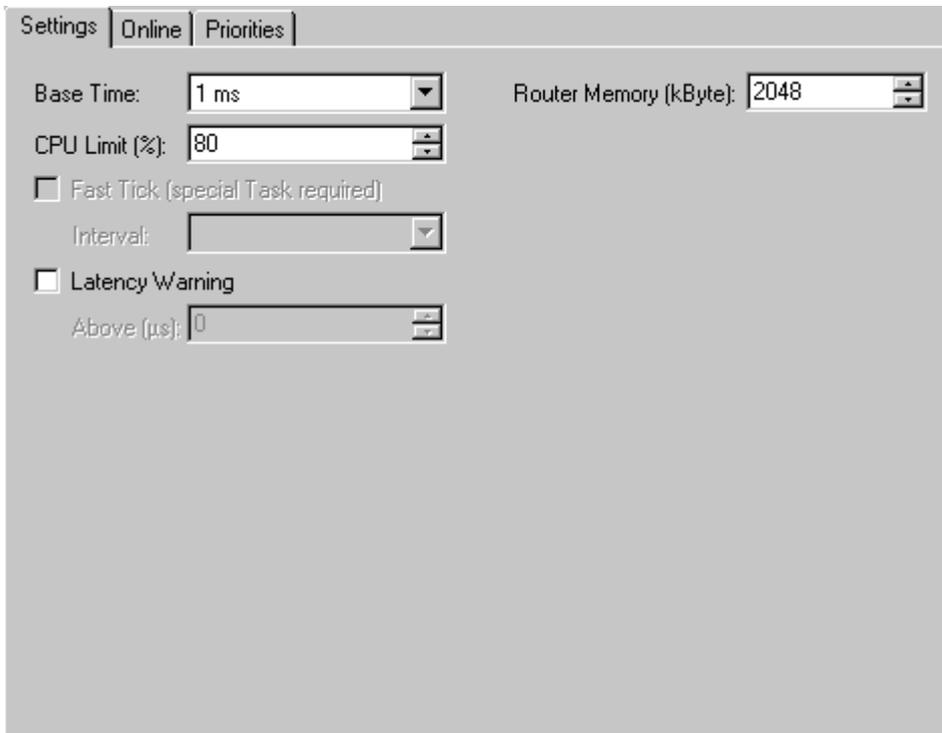
4.1 Real Time Settings

As a central configuration tool of the TwinCAT System, the TwinCAT System Manager contains below the rubric *SYSTEM - Configuration* [► 53] the entry *Real-Time Settings*. This is where the basic TwinCAT system parameters are specified or changed if necessary.



If this entry is selected, the **"Settings"** dialog (described below), the **"Online [▶_56]"** and the **"Priorities [▶_56]"** dialog (described later) appear on the right-hand side in the System Manager.

"Settings" tab



Base Time

The TwinCAT schedulers change on every tick from Windows to the TwinCAT real time. The planned and necessary task is then performed in TwinCAT real time. By the time the CPU limit (see below) has been reached, the system has changed back to Windows. The TwinCAT basis time is therefore the shortest possible task cycle time. The cycle time can also be a multiple of the basis time. The basis time should only be set to less than a millisecond if necessary and with correspondingly fast PC systems. The following are possible: (none), 1ms, 500µs, 333µs, 250µs, 200µs, 125µs, 100µs, 66µs and 50µs.

TwinCAT can be used without executed real-time by setting the Base Time value to none, realtime will not be executed. Implementations which don't need real-time, work as usual (AMS Router, TwinCAT Scope, ADS OCX, ...)

Restrictions:

Real-time tasks, like PLC tasks, software tasks and I/O tasks (Profibus, DeviceNet, Sercos or Lightbus) cannot be executed.

CPU Limit

Specify the CPU percentage proportion that completely fills the TwinCAT real time, the remainder is reserved for Windows (and for surface programs). The value can be set very high since it is automatically reset to Windows when the real time task has completed its cycle.

Fast Tick

Only for special TwinCAT extensions which require a rapid tick irrespective of basis time (e.g. camshaft controller).

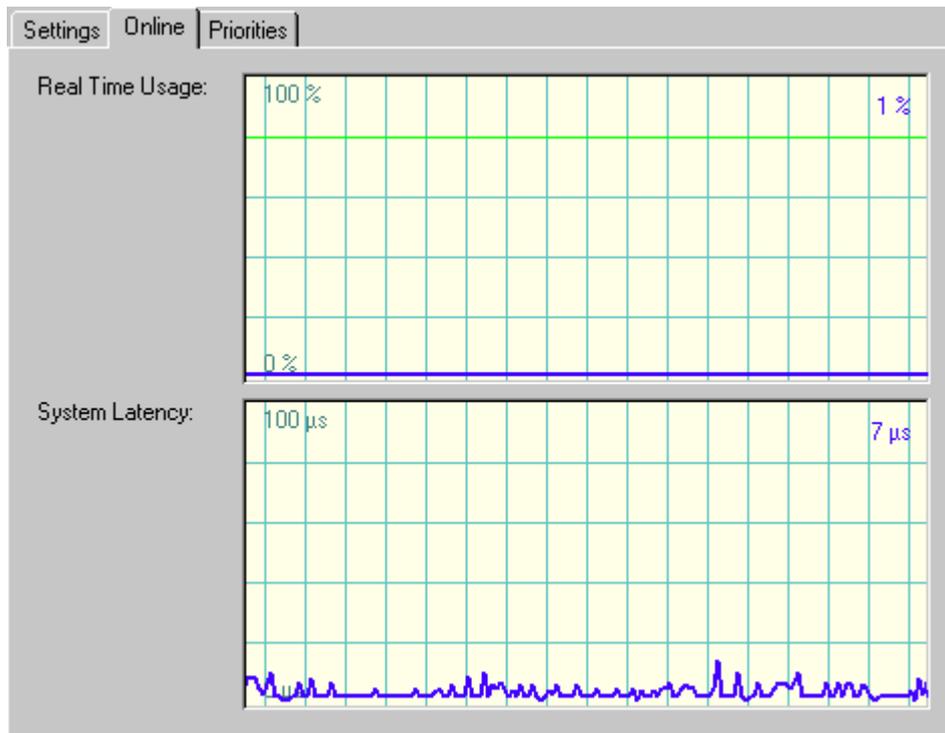
Latency Warning

The TwinCAT real time functions on practically all PC systems with extremely low fluctuations (Jitter). These jitters are measured continuously. If a pre-set limit is exceeded, the system can issue a warning.

Router Memory

The TwinCAT Router adminstrates the communcation of all participants. Changes of the memory size will be activ after a reboot.

"Online" tab



The online display gives information about the current CPU load. This is the amount of time required by the real time task. The bright green line indicates the pre-set *CPU Limit* value.

In addition, the current jitter (system latency time) is given in the bottom window.

Additional info about the *History View* can be found under: [Settings for History View \[▶ 30\]](#).

"Priorities" tab

Information about the different priorities in the TwinCAT System, see: [Priorities \[▶ 58\]](#).

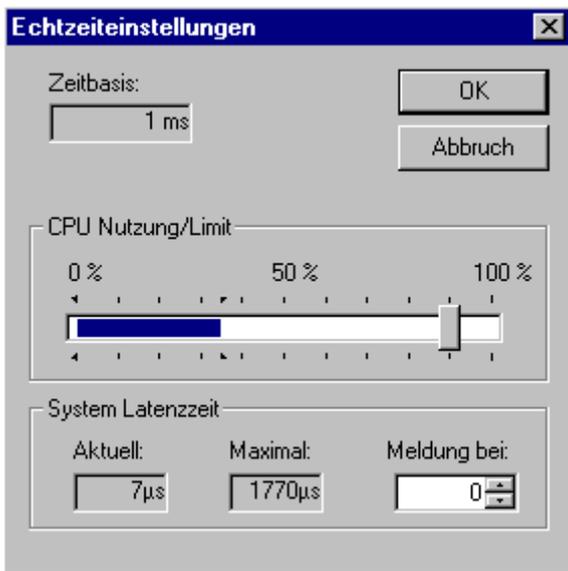
4.2 NT Resources and the Realtime-Settings

One of the NT Task Manager's functions is to provide the user with a list of the running processes and of the amount of CPU time that they are using. A different interpretation must be given to the display when TwinCAT is running:

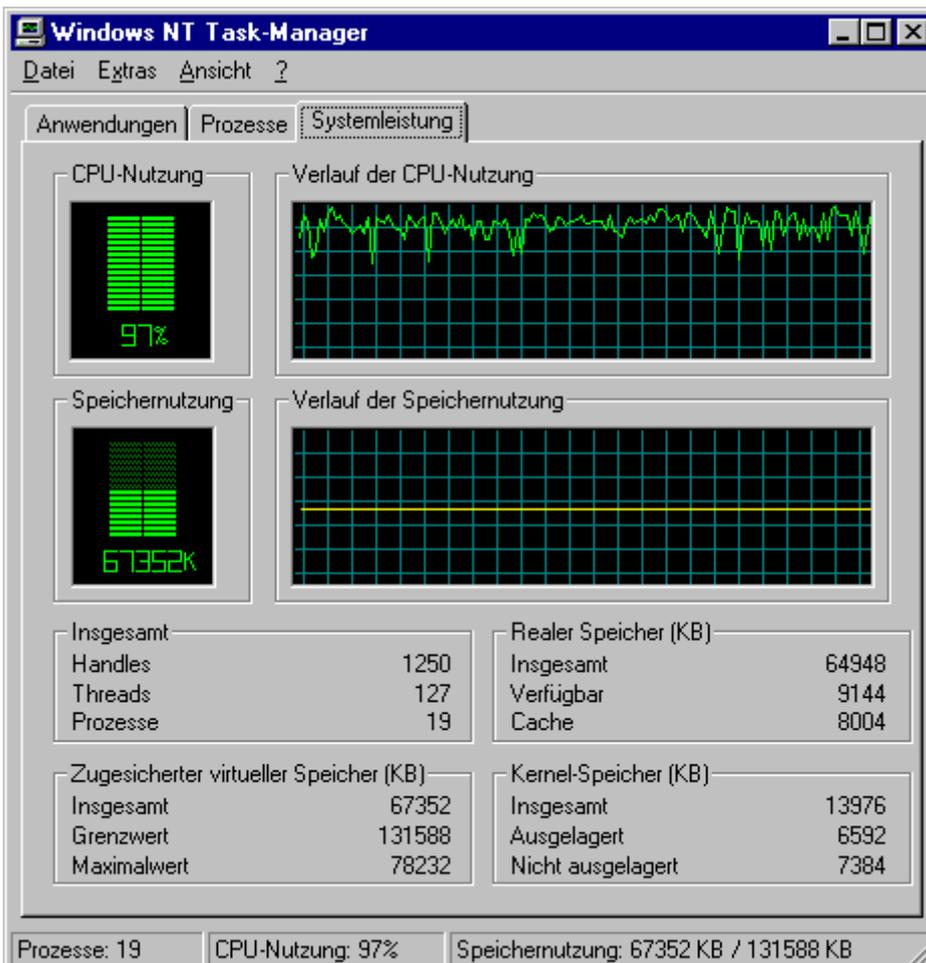
The TwinCAT real-time extension makes computing time available to the NT operating system. The NT operating system evaluates this portion as 100% CPU time. The display of the CPU time associated with processes in the NT task manager is thus not related to the CPU time itself, but to the remaining time still available to NT.

Example:

If TwinCAT requires a constant 35% of the CPU's capacity (see the "Realtime Settings"),



and an additional process is displayed in the NT Task Manager with 97% "CPU time",

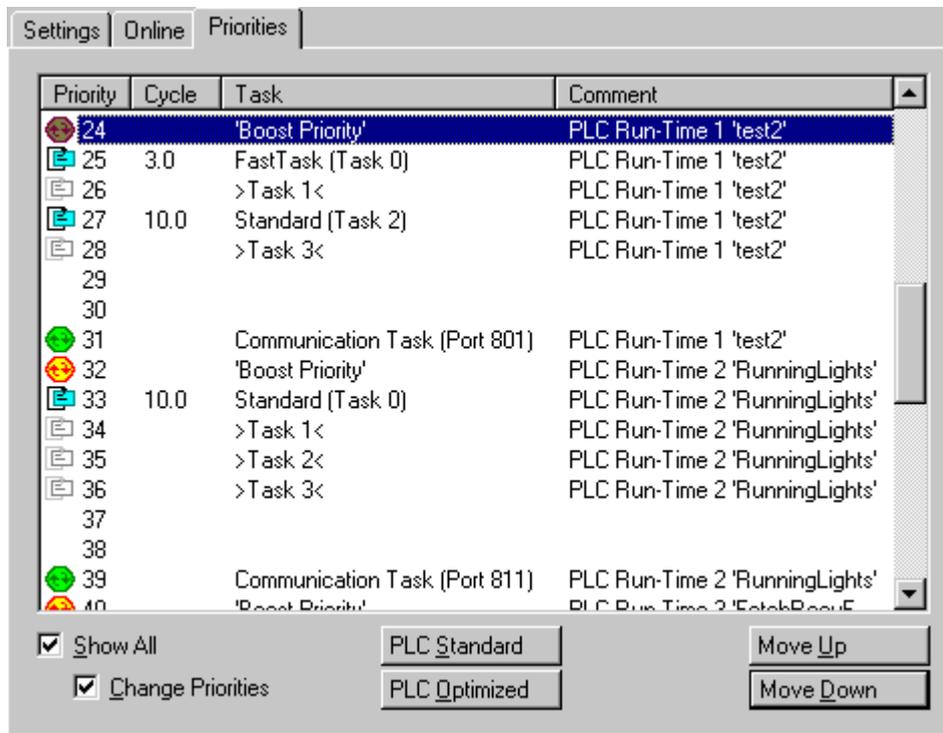


it means that this process is using 63,05% of the real CPU time.

4.3 Real Time Configuration - Priorities

In addition to the dialogues [Settings](#) [▶ 54] and [Online](#) [▶ 56], contains the Real Time - Configuration area of the TwinCAT System Manager a dialog named *Priorities*. The dialog displays the priorities of the different tasks inside the TwinCAT System. With enabling of the [Expert Mode](#) [▶ 20] it is even possible to change the priorities of the tasks, manually.

"Priorities" tab



Priority

Each TwinCAT Task has its own Priority in the system. The priority number is shown in this column. The lower the number, the higher the priority of the task. Additionally, each task type has a dedicated icon, shown in front of the number.

Cycle

Task cycle time in milliseconds.

Task

names the job of the task. At PLC tasks, it differs between

- **PLC communication Task:** This Task serves the ADS communication. To protect PLC data consistency, it should have the lowest priority level, referring to one PLC Run Time System.
- **PLC Boost Priority:** Priority of a PLC Task, as soon as it is in [Monitoring / Debug](#) mode. This Task should have the highest priority, referring to the Tasks of one PLC Run Time System.
- **Common TwinCAT Task** (light blue icon)
- **for currently unused PLC Tasks reserved Priority** (e.g. Task 1, 2 and 3 of a PLC Run Time System). The icon is grey (not active).

Comment

Describes the task origin (e.g. PLC Run Time System and project name).

Show All

Shows additionally the unused priorities of the available TwinCAT priorities.

Change Priorities

If **Show All** is activated, this checkbox enables the manipulation of the Task priorities inside the TwinCAT System.

Move Up

Moves the task priority up the list (and makes it therefore higher prior), if Expert Mode [► 20] is enabled.

Move Down

Moves the task priority down the list (and makes it therefore lower prior), if Expert Mode is enabled.

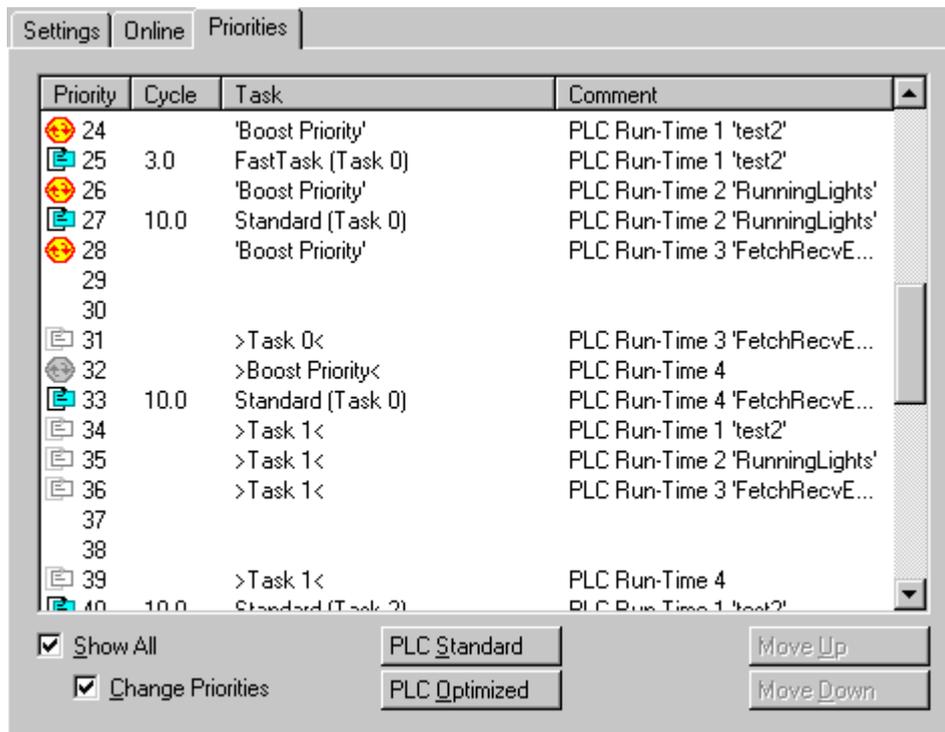
PLC Standard

Organizes the priorities of the PLC Tasks like they are staggered by default (all Tasks of the 1st RTS in front of the tasks of the 2nd RTS and so on).

PLC Optimized

Organizes the Task priorities within the TwinCAT Systems in an optimal order in terms of execution of high prior task of different Run Time Systems. Means, the highest priority task of RTS 1 is followed by the *Boost Priority* Task of RTS 2 and then by the highest priority task of this RTS and so on.

Following picture shows an example of the staggered order for *PLC Optimized*:



4.4 User-defined Tasks (Additional Tasks)

Overview

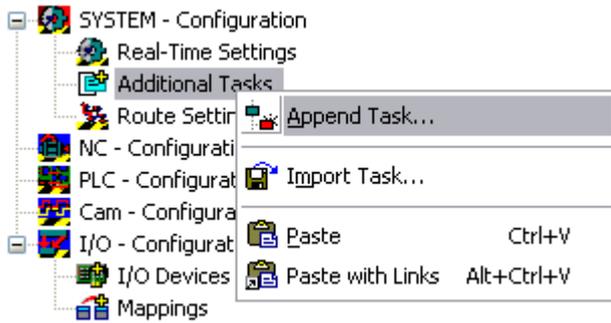
In addition to the four configurable tasks in the PLC runtime systems, the TwinCAT system also supports other (non-PLC) software tasks that can have I/O variables. These tasks are managed in the TwinCAT System Manager under the "Additional Tasks" option (below "SYSTEM Configuration [► 53]" in TwinCAT

v2.9). These tasks can be used if a PLC is not available. Variables of these tasks can be accessed directly from applications, such as the TwinCAT OPC Server, Visual Basic, Delphi, VB.NET, VC++, C#.NET, etc., via ADS-OCX, ADS-Dll, or TcADS-DLL.



Settings carried out under this option require more advanced knowledge of the TwinCAT system.

Context Menu



Append Task

Adds another task.

Import Task

Integrates previously created and exported task into the existing system.

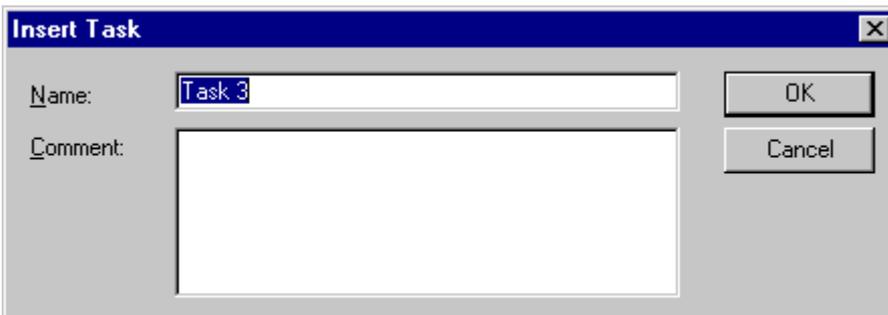
Paste

Inserts additional tasks from the clipboard.

Paste with Links

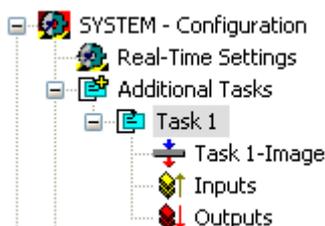
Inserts additional tasks with variable links from the clipboard.

The following dialogue appears after opting to *Add a task*:



The **Name** should be selected descriptively at this point. The nature of the user-defined task may also be outlined in a few sentences under **Comment**.

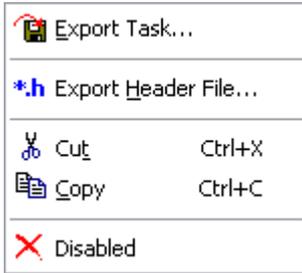
The new task then appears in the tree. This automatically contains the sub-menu options Process Image [▶ 46], *Inputs* and *Outputs*.



Further information about the inputs and outputs is given under: [Variable Configuration \[▶ 35\]](#).

Task Context Menu

A right mouse click on the selected task displays the following context menu:



Export Task

Exports the task configurations with sub-elements and links into a file with the suffix *.tce. It can be thereby imported, as described earlier, into other projects.

Export Header File

Exports the configured input and output variables of the task into a C/C++ header file, for further use in [TwinCAT Ring 3 I/O applications](#).

Cut

Copies the task to the clipboard and removes it from the current configuration.

Copy

Copies the task to the clipboard.

Disabled

Excludes the current task from calculation and editing by the TwinCAT system. Configurations and links are retained and are reactivated when this function is selected once more.

"Task" Dialog

There are different settings options for the tasks in the TwinCAT system. The effects and functions of these options are explained under [Task Settings \[▶ 62\]](#). The following option descriptions are for typical TwinCAT I/O applications.

The screenshot shows the 'Task' configuration dialog box with the 'Online' tab selected. The 'Name' field contains 'Task 1' and the 'Port' field contains '301'. Under the 'Auto-Start' section, the checkbox is checked. The 'Priority' is set to '1' and 'Cycle ticks' are set to '10' with a unit of 'ms'. The 'Warning by exceeding' checkbox is unchecked, and the 'Message box' checkbox is also unchecked. The 'Options' section includes 'I/O at task begin' (unchecked), 'Disable' (unchecked), 'Create symbols' (checked), and 'Extern Sync' (unchecked). A 'Comment' field is present at the bottom but is empty.

Port

The ADS Port number of the specific ADS device. At the first additional task this is usually ADS Port number **301**.

Auto-Start

Forces the TwinCAT System Manager to create the start command for this task. After start/restart of TwinCAT, this task is going to be started automatically with configured settings.

Cycle ticks

The interval time for this task (with its attached variables) is to be configured here. A [mapped I²C 125](#) Fieldbus (network) adaptor will be refreshed with this task interval then.

Create symbols

Should be activated to enable the symbol upload mechanism for this task **e.g.** for [TwinCAT OPC Server v4](#) or [TwinCAT Scope View](#). If this task has e.g. the port number 301, an application like **TwinCAT OPC Server v4** can upload the variables by name from this ADS Port number (with **AutoCfg option type = 5**).

"Online" Tab

For information about this dialog, see: [Online Display of Task Load I²C 64](#).

4.5 Task Settings

TwinCAT is a pre-emptive multitasking system. The settings options for this task are explained below. Not all options are available, however, for all tasks.

"Task" tab

The following settings options cannot be activated for every task.

The screenshot shows a configuration window for a task. At the top, there are two tabs: 'Task' and 'Online'. The 'Task' tab is active. The window contains several input fields and checkboxes. The 'Name' field is set to 'Task 1'. The 'Port' field is set to '301'. There are two checkboxes: 'Auto-Start' (checked) and 'Warning by exceeding' (checked). Below 'Auto-Start' is a 'Priority' field set to '1'. Below 'Warning by exceeding' is a 'Message box' checkbox (unchecked). There are two 'Cycle ticks' fields: one set to '10' and another set to '10.000' with 'ms' next to it. To the right, there is an 'Options' section with four checkboxes: 'I/O at task begin' (unchecked), 'Disable' (unchecked), 'Create symbols' (unchecked), and 'Extern Sync' (unchecked). At the bottom, there is a 'Comment' label followed by a large empty text area.

Name

Edits the internal name of the task

Port

Defines the AMS port number of the task. This value must be specified! For some tasks the value is already set (e.g. for PLC tasks).

Auto-Start

Causes the TwinCAT System Manager to create the start command for the task so that when restarting TwinCAT the task is automatically started with the specified data.

Priority

Defines the Priority of the Task [► 58] within TwinCAT (you should ensure that priorities are not duplicated). The priority is only relevant when Auto-Start is selected.

Cycle Ticks

Sets the cycle time in ticks (depends upon the pre-set TwinCAT Base Time [► 54]). of the task. The cycle time is only relevant when Auto-Start is selected.

Warning by exceeding

Causes the TwinCAT to issue a warning when the pre-set task cycle time is exceeded.

Message box

Outputs the warning (above) also as a message box.

I/O at task begin

An I/O cycle is carried out at the beginning of the task.

Disable

Allows occasional task-disablement, i.e. the task is ignored when generating the I/O information (e.g. during commissioning). The link information is, however, retained.

Create Symbols

Allows access to variables of the corresponding task via ADS (e.g. from TwinCAT Scope View). Further information is given under: [Variable Configuration](#) [▶ 35].

Extern Sync

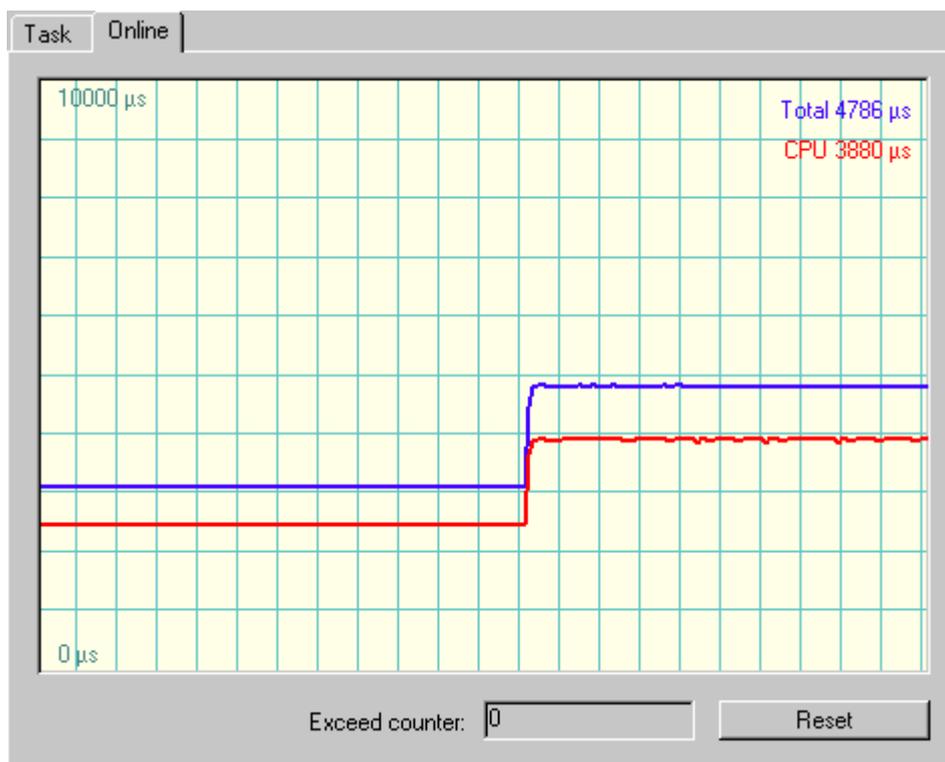
Is this option activated, this Task will be synchronized with a configured device with Master Sync Interrupt (e.g. a SERCOS card).

"Online" tab

Here you can find information on the [Online Display of Task Load](#) [▶ 64].

4.6 Online Display of Task Load

When the current configuration is loaded, the task load values can be graphically displayed under "Online".

"Online" tab**"CPU" display**

Shows the CPU time required for the last task execution.

"Total" display

Gives the time that has passed between the start and the end of the task execution. The difference between CPU and absolute (total) execution time can result, for example, from an interruption of the current task by a higher priority task or by Windows.

Exceed counter

Counts the number of cycle time limit exceeded.

Reset

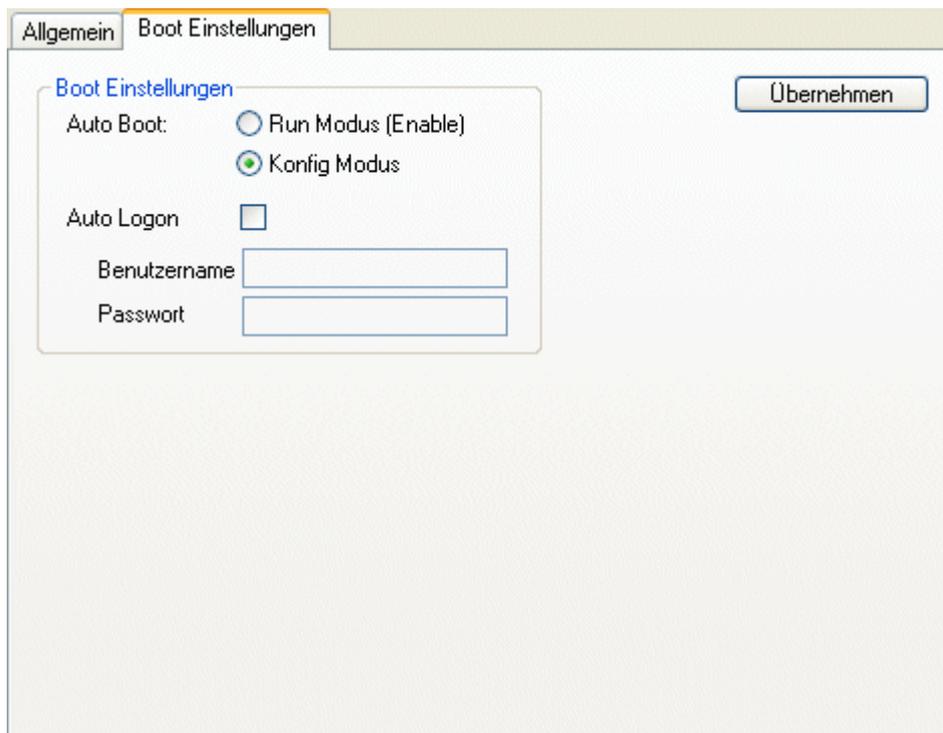
Resets the exceeded limit counter to 0.

Additional infos about the *History View* can be found under: [Settings for History View \[▶ 30\]](#).

4.7 Boot Settings

Under this tab you can define the boot- and autostart-settings for the local- or targetsystem.

If you want TwinCAT to execute one or several PLC-programs automatically at system start, you have to configure the number of runtime-systems first (see [PLC settings \[▶ 95\]](#)) and download the boot projects.

**Auto Boot:**

When you choose 'Run Modus (Enable)' under 'Auto-Boot' the system starts with a user logon.

Auto Logon:

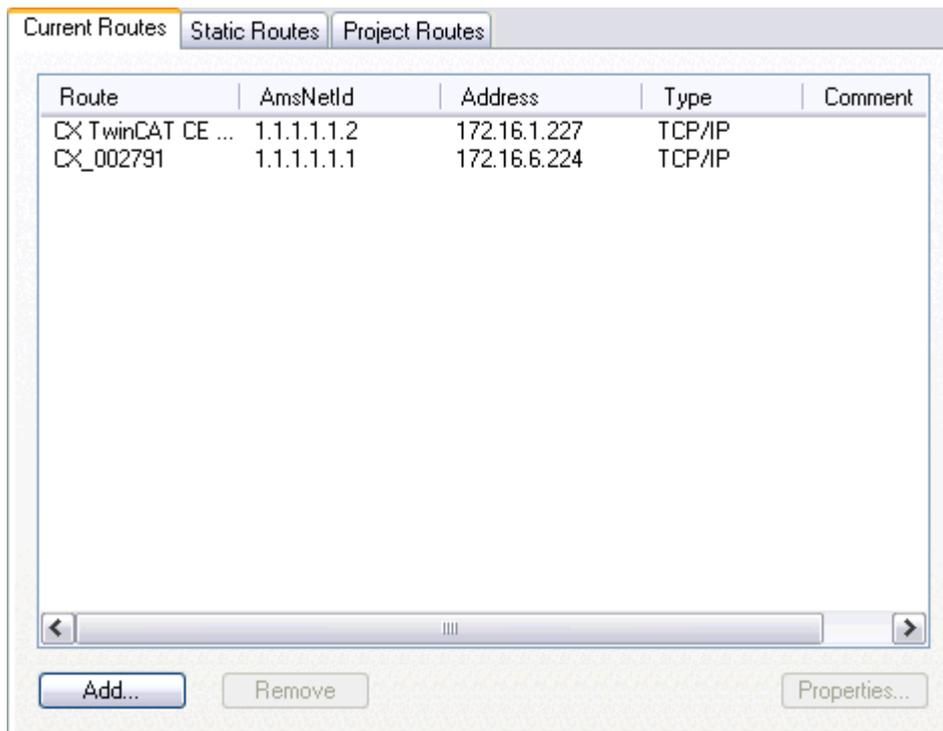
When you choose the option 'Auto Logon' additionally, TwinCAT starts in the runtime mode and executes autonomously the loaded and released boot projects.



If a CX device with Windows XP embedded is used via "Remote Desktop", the default setting must be complied with: Default User: Administrator, Default Password: 1.

4.8 Route Settings

Under TwinCAT 2.9 the routing possibilities have been enlarged considerably. For instance TwinCAT doesn't save the routes in the Windows registry, but reads out each addressed router of the desired TwinCAT target-system. Thereby the routes are classified in *actual*-, *static*- and *project routes*. After the connection has linked resp. the router has been read out, the located routes are collected in the category "*static routes*" and automatically also in the category "*actual routes*".

"Current Routes" tab**Route**

Shows the name of the TwinCAT target system currently listed at the local TwinCAT Router.

AmsNetID

Displays the ADS-AmsNetId of the listed target system.

Adresse

Shows the (*TCP/IP*) address of the listed target. The address depends on the used transport protokoll. Besides TCP/IP-addresses you also can use addresses of profibus-members etc.. These must support the ADS protocol, to be accessed as "target-system [▶ 22]" rsp. "remote-system [▶ 22]".

Type

Names the protocol used for this target.

Comment

If configured at the target system, the comment is shown here.

Add

Calls the configuration dialog for adding additional target systems to the local TwinCAT Router.

Remove

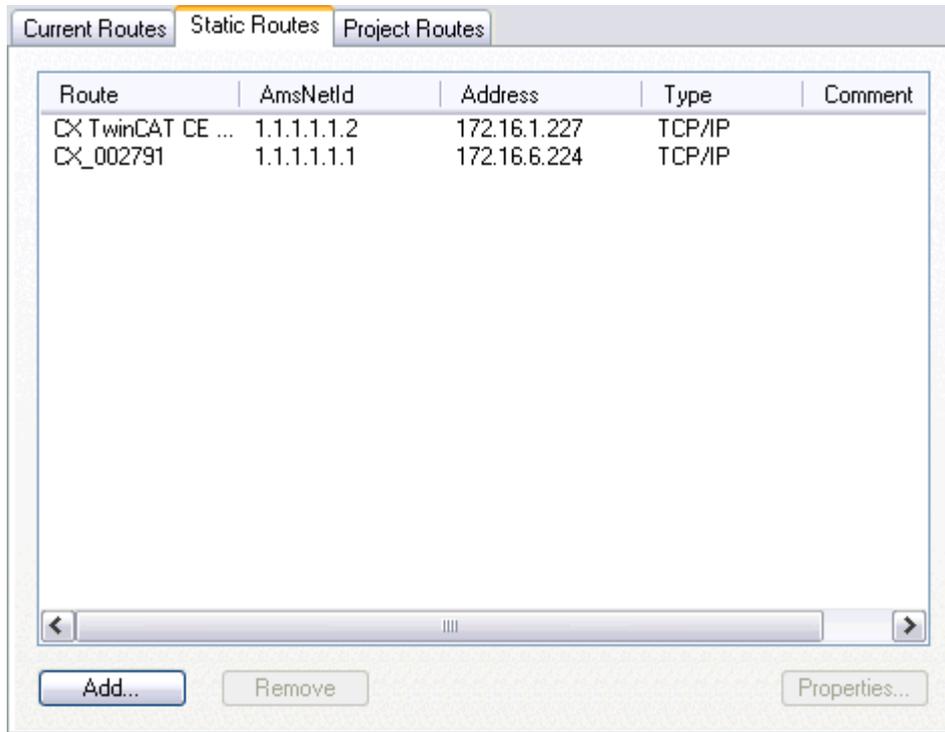
Deletes marked entries from the routing table of the local TwinCAT Router.

Properties

Calls the dialog for showing the "**Properties**" of the target system.

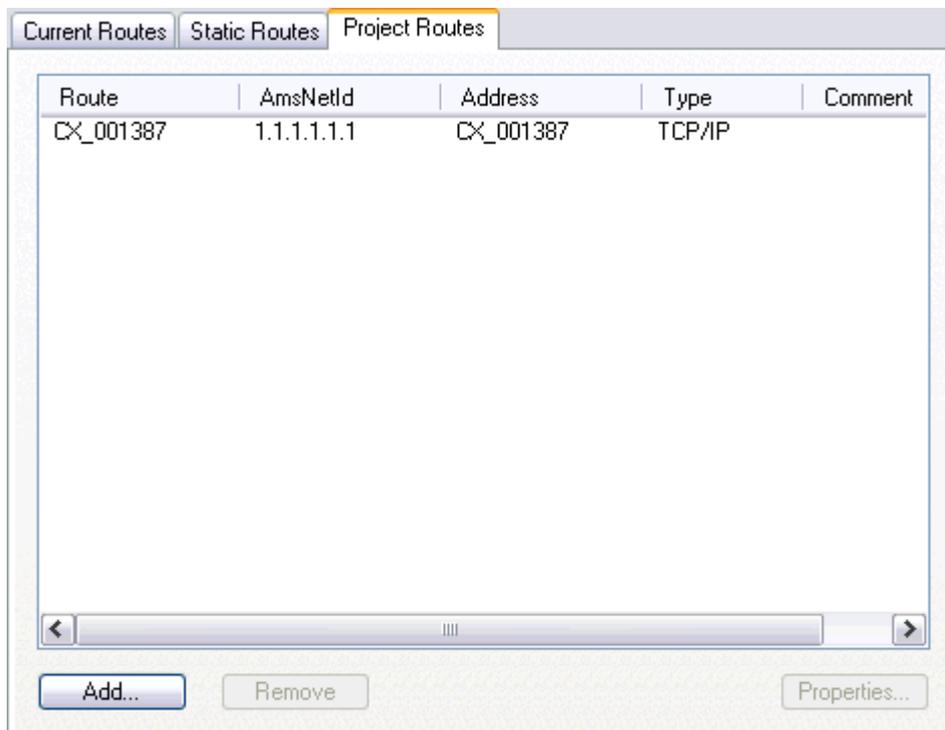
"Static Routes" tab

Static routes are those, which are already configured in the actual addressed router. While the target-system is addressed, the system manager reads out its routes and shows them as a list. When the TwinCAT system manager's projekt file is saved, these static routes are saved too. When you reload the *.tsm file you see them again. Apart from that the "static routes" quasi match the "AMS router" as usual.



For the description of the column headers and buttons, see **"Current Route"** tab.

"Project Routes" tab



For the description of the column headers and buttons, see **"Current Route"** tab.

5 NC Configuration

If TwinCAT is installed with NC function capability (minimum: TwinCAT Level NC PTP) you will see "NC Configuration" in the tree view of the System Manager. Here you can create the required axes and set their parameters. When TwinCAT is started, it's also possible to drive axes via corresponding online dialogues (**NC Manual Menu, Online Display of Axis Channel**) and carry out other NC axis functions like manual coupling etc..).

NC - Configuration	Description
Tasks [▶ 68]	NC task settings
Channel [▶ 71]	Information about axis channel
Axes [▶ 72]	Configuration of individual axes
TS1510 CAM Design Tool	Configuration of Cam plates with TwinCAT Cam Design Tool
TS1500 Valve Diagram Editor	Configuration of special characteristics for hydraulic valves with TwinCAT Valve Diagram Editor

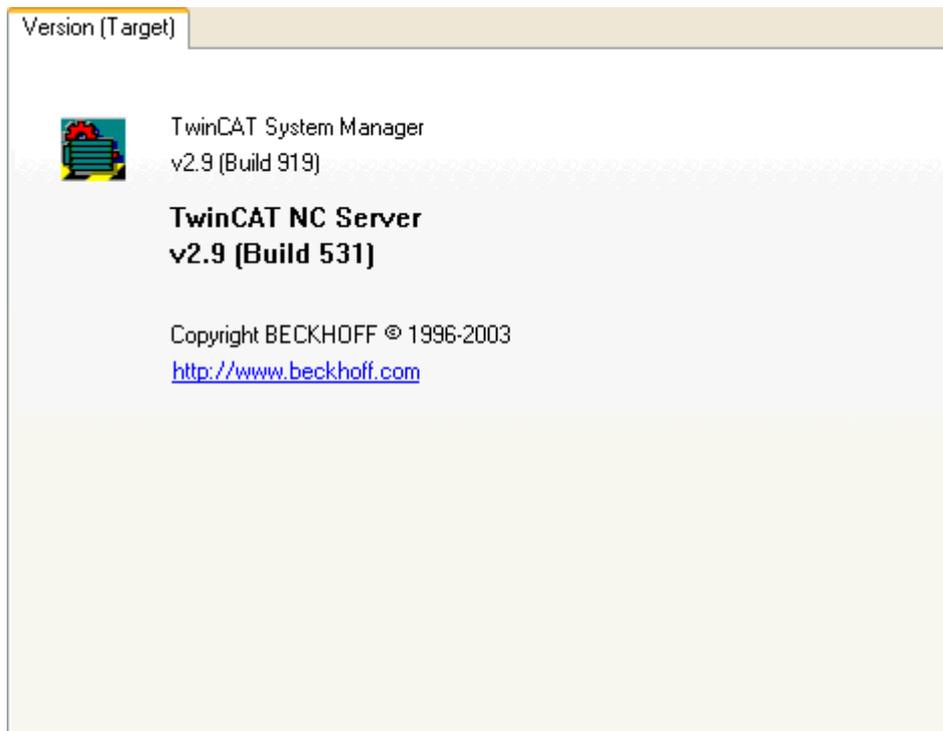
"General" Tab

This dialog only appears, if no Remote system is selected, means the System Manager accesses the local target system (see also "[Choose Target System \[▶ 231\]](#)").

Besides that, the following dialog "**Version [Target]**" is equivalent.

Dialog "Version [Target]"

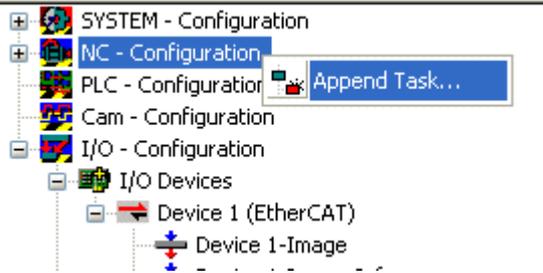
The following dialog describes the TwinCAT server of the target system, where this module is based on. In the shown dialog this is the - currently active - version 2.9 [Build 531] of the TwinCAT NC Server.



5.1 NC task

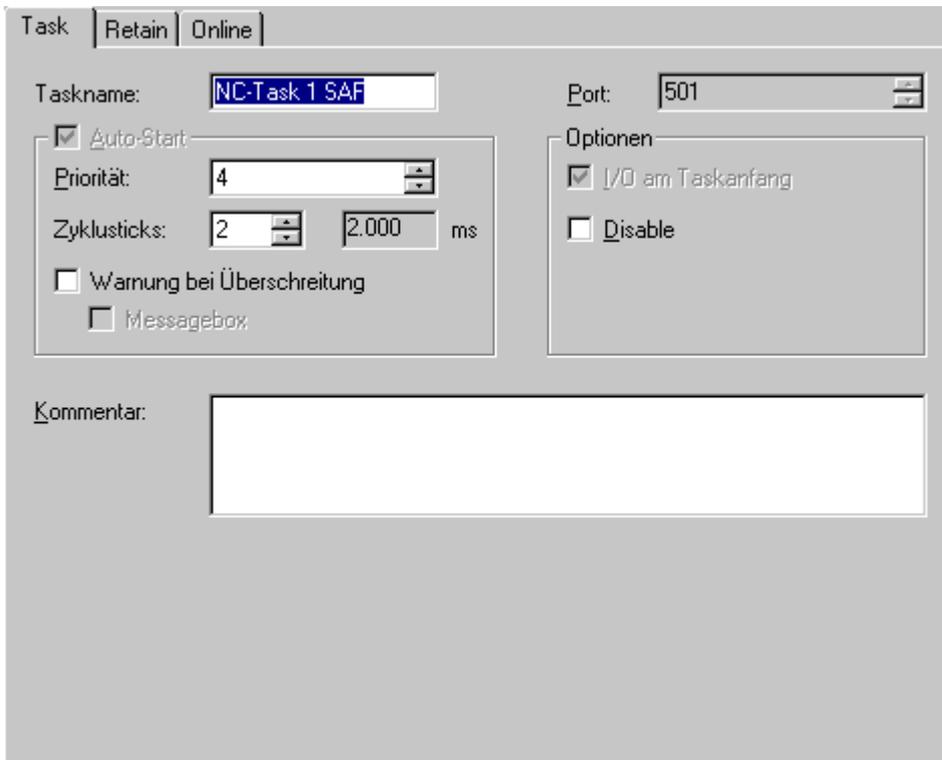
When selecting the entry *NC configuration*, the two NC tasks can be added by right mouse click, if this has not already been done...

Context menu



By inserting an NC task, an NC configuration is integrated into the current system configuration and the corresponding initialization commands for the NC server are generated. Implicitly, in addition to the NC-SEC task (**S**et **E**xecution task), an NC-SPP task (**S**et **P**reparation task) is also generated. The corresponding dialogs appear on the right side.

"Task" tab



More information about this tab can be found at: [Task Settings](#) [▶ 62].

"Retain" tab**None**

If selected accordingly, support of retain data (remanent data) is not required by this task.

Store only

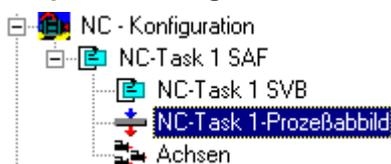
The retain data is saved when the system is shut down properly.

Load/Store

The retain data is saved at system shutdown and loaded at system startup.

"Online" tab

More information about this tab can be found at: ["Online" tab \[▶ 64\]](#).

NC process image

Below the SEC and SPP tasks there is the entry *NC-"Taskname" - Process image*. When you select it, the [process image \[▶ 46\]](#) dialogs are displayed on the right, as well as a [list \[▶ 28\]](#) of all linked and unlinked variables of the process image.

NC channel "Axes"

The entry *Axes* is also created automatically. When selected in the tree view, the general dialog for the object is displayed on the right side. In addition, an online [dialog "Axes" \[▶ 88\]](#) with the most important current setpoints and actual values of the axes configured under this channel can be selected here (the system must of course have been started with the current configuration for this).

5.2 NC channel

A TwinCAT NC configuration has at least one, but possibly also several channels. When selecting the *SAF Task* entry in the tree view, an axis channel can be added using the context menu described below.

Context menu:



Add channel

Adds another axis channel to the configuration. More detailed explanations can be found at [Add NC-channel \[► 90\]](#).

Delete

Removes the currently selected channel from the configuration.

Import channel

Imports a previously exported channel configuration (extension *.tce) into the current NC configuration.

"General" tab

With the entry "Axes" an axis channel is automatically created below the NC process image. If you select the corresponding option in the tree view, as shown in the following figure, the dialog "General" for the object is displayed on the right side. Furthermore, an [online dialog \[► 88\]](#) is available for the axis channel.



The screenshot shows a configuration window with two tabs: 'Allgemein' (selected) and 'Online'. The 'Allgemein' tab contains the following fields and controls:

- Name:** A text input field containing 'Achsen'.
- Id:** A text input field containing '1'.
- Typ:** A dropdown menu showing 'NC-Achsenliste'.
- Kommentar:** A large empty text area for comments.
- Disabled:** A checkbox that is currently unchecked.
- Symbole erzeugen:** A checkbox that is currently unchecked.

Name

Editable name of the axis channel.

Id

Identification number of the axis channel.

Type

Type of the axis channel.

Comment

Freely available edit box for comments. The EditBox only allows *Ctrl+Enter* (*Ctrl+Enter*) for a line break.

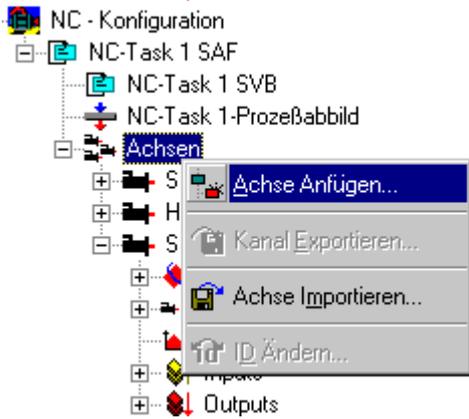
"Online" tab

For the axis channels, a special [online dialog \[► 88\]](#) with the most important current setpoint and actual values of the axes configured under this channel can be selected (the system must of course have been started with the current configuration for this).

5.3 NC axes

After selecting the axis channel in the tree view and pressing the right mouse button, the following appears

Context menu:



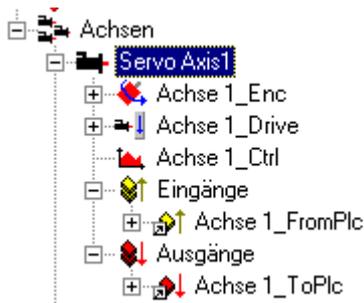
Append axis

Adds an axis to the configuration.

Import axis

Calls selection dialog for importing an already exported axis.

After opening an axis in the tree view, you will see the following picture:



On the right side, when you select an axis, several dialogs appear, including the

"General" tab

The screenshot shows a configuration window with the following elements:

- Tabbed interface: Allgemein (selected), Einstellungen, Global, Dynamik, Online, Funktionen, Kopplung.
- Name: Servo Axis1
- Id: 3
- Typ: Kontinuierliche Achse (inkl. SERCOS)
- Kommentar: (Large empty text area)
- Disabled: Disabled
- Symbole erzeugen: Symbole erzeugen

Name

Editable name of the axis.

Id

Identification number of the axis. Among other things, it is required when accessing the axis via function blocks of the PLC.

Type

Axis type. Here, a distinction is made between continuous, virtual, rapid/creep, and stepper motor axes, among others.

Comment

More freely available editing field for remarks about the axis. The *EditBox* allows only *Ctrl+Enter* (*Ctrl+Enter*) for a line break.

Create symbols

For symbolic access (by name) to the components of the axis via ADS (e.g. TwinCAT with ScopeView), the creation of symbols must be selected here.

5.4 Settings dialogs

5.4.1 Axes - Settings dialog

For a newly inserted axis, some basic settings are necessary in advance. Especially the specification of the axis type plays an important role for the further steps.

The screenshot shows the 'Global' tab of the Beckhoff NC Configuration dialog. At the top, there are tabs for 'Allgemein', 'Einstellungen', 'Global', 'Dynamik', 'Online', 'Funktionen', and 'Kopplung'. The 'Achstyp' dropdown menu is set to 'Standard (Verknüpfungen über Encoder und Antrieb)'. Below it is a 'Verknüpft m...' button and an empty text field. The 'Einheit' dropdown is set to 'mm'. To the right, the 'Anzeige' section contains three checkboxes: 'Position' (with a unit of μm), 'Modulo', and 'Geschwindigkeit' (with a unit of mm/min), all of which are currently unchecked. Below this, the 'Ergebnis' section displays four dropdown menus for 'Position' (mm), 'Geschwindigkeit' (mm/s), 'Beschleunigung' (mm/s²), and 'Ruck' (mm/s³). A 'Wizard...' button is located at the bottom right of the dialog.

Axis type

Here the correct connection type (depending on the [I/O configuration \[► 101\]](#)) of the axis must be defined. This refers to the type of setpoint / actual value transfer to or from the axis.

Linked to

Here, with some axis types (AX2000, SERCOS, Profidrive,...) an axis can be completely linked with the physical drive below the respective fieldbus card. For axes with analog interface, as set in the example above, the [links \[► 43\]](#) must be created at [NC encoder \[► 81\]](#) as well as [NC drive \[► 84\]](#).

Unit

Specifies in which unit the calculations and inputs for axis control are expected. The setting should actually always be *mm* or *degrees*.

Display

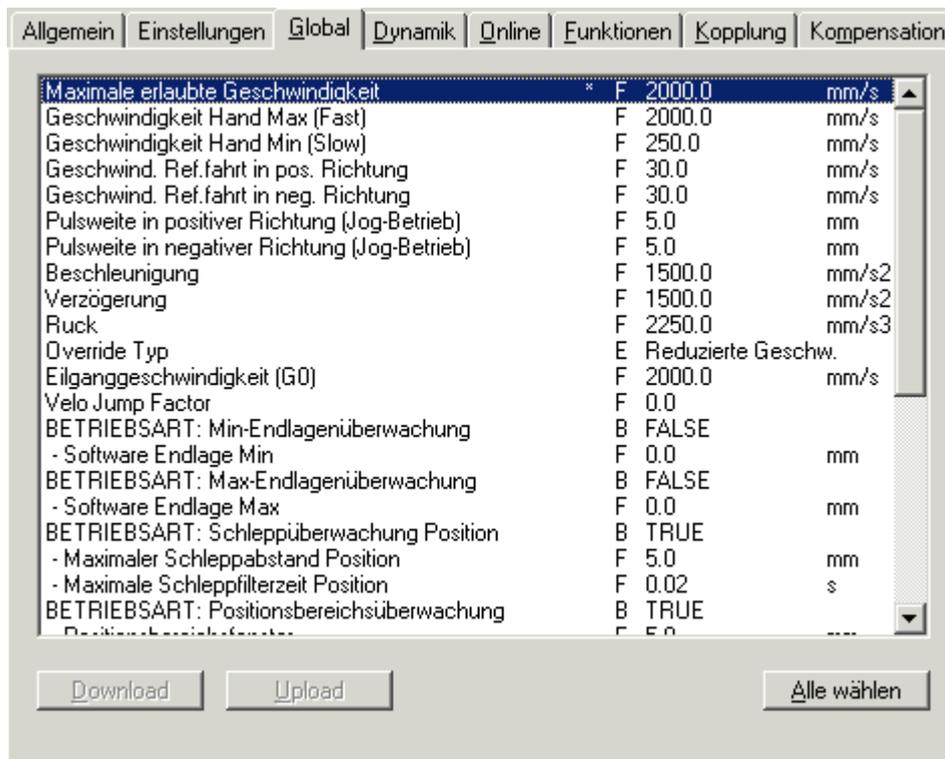
If a deviation from the standard display of some axis values is required, these can be activated here. This is possible for position and velocity.

Result

Here the currently set units of the axis are listed again.

5.4.2 Axes - Dialog: Global

Each axis has operation mode dependent setting parameters. These basic parameters are set here at "Global". The values must be accepted after changes with *Enter*. It is not possible to enter a comma, instead a point must be used for floating point numbers.



Max. allowed velocity

The value that, mechanically or functionally, limits the maximum permissible axis velocity.

Heading		
Value range:	Default:	Unit:

Rapid traverse velocity

The velocity value for the rapid traverse of the axis is specified here.

Value range:	Default:	Unit:
--------------	----------	-------

Velocity hand max

Specifies the maximum velocity in jogging mode (Fast).

Value range:	Default:	Unit:
--------------	----------	-------

Velocity hand min

Specifies the velocity in jogging mode (Slow).

Value range:	Default:	Unit:
--------------	----------	-------

Velocity ref. in pos. direction

Indicates the velocity during reference run in positive direction.

Value range:	Default:	Unit:
--------------	----------	-------

Velocity ref. in neg. direction

Specifies the velocity during reference run in negative direction.

Value range:	Default:	Unit:
--------------	----------	-------

OPERATION MODE: min. end position monitoring

Here the end position monitoring (often also called software limit switch) of the negative direction is switched on and the limit value is specified.

Value range:	Default:	Unit:
--------------	----------	-------

OPERATION MODE: max. end position monitoring

Here the end position monitoring of the positive direction is switched on and the limit value is specified.

Value range:	Default:	Unit:
--------------	----------	-------

OPERATION MODE: position lag monitoring

The position lag monitoring is activated here, as well as the limit value. Additionally, a filter time can be specified.

Value range:	Default:	Unit:
--------------	----------	-------

OPERATION MODE: target position monitoring

The monitoring and feedback of the NC axis "*Axis in target position*" is activated here as well as the target position window is specified. In addition, the monitoring period is specified.

Value range:	Default:	Unit:
--------------	----------	-------

OPERATION MODE: PEH time monitoring

If this option is activated, the axis must have reached the target position within the monitoring time, otherwise there will be an error message.

Value range:	Default:	Unit:
--------------	----------	-------

Download

Writes changed (*) and marked parameters down to the NC runtime system. For a permanent change, the configuration must additionally be written to the registry.

Upload

Reads marked parameters from the NC runtime system and displays them.

Select All

"Select all" makes a complete download or upload of the displayed parameters possible.

5.4.3 Axes - dialog: Dynamics

An easy-to-use setting option for the dynamics parameters is implemented in the TwinCAT System Manager. It is even possible to change the desired acceleration characteristic with a slider (when activated "*Indirect by Acceleration Time*"). Direct input of calculated values is also possible (option "*Direct*").

Maximum velocity (V max)

The maximum velocity of the axis set at [Global \[► 75\]](#) is displayed here.

Acceleration time

Axis acceleration time until V_{max} is reached.

Deceleration time

Time needed from V_{max} to velocity 0 mm/s.

Acceleration characteristic

Slider for indirect setting of acceleration and deceleration time.

Acceleration

Specifies the acceleration in mm/s^2 .

Deceleration

Specifies the deceleration in mm/s^2 .

Jerk

Specifies the jerk required for the targeted acceleration.

5.4.4 Axes - Dialog: Functions

Especially in the time of the initial commissioning of axes, one is dependent on aids from the software or hardware side. The advantage of e.g. a software controlled, direct raw value output to the drive, instead of using a battery box, is obvious.

The screenshot shows the 'Kopplung' (Coupling) tab of the Beckhoff NC Configuration software. At the top, there are navigation tabs: Allgemein, Einstellungen, Global, Dynamik, Online, Funktionen, and Kopplung. The main display area shows a large numerical field for the current position, '584.9176', and a smaller field for the 'Soll-Position: [mm]' (Target Position), also '584.9176'. Below this, there are several sections for configuring drive parameters:

- Erweiterter Achsstart (Extended axis start):** Includes a 'Starttyp:' dropdown set to 'Absolut', a 'Zielposition:' field with '33467.879 [mm]', a 'Geschwindigkeit:' field with '50.3 [mm/s]', and checkboxes for 'Beschleunigung:', 'Verzögerung:', and 'Ruck:' (checked), each with a corresponding numerical input field.
- Antriebs-Ausgabe (Drive output):** Includes an 'Ausgabearart:' dropdown set to 'Prozent' and an 'Ausgabewert:' field with '2 [%]'. Both sections have 'Start' and 'Stop' buttons.
- Ist-Position Setzen (Set current position):** Includes a dropdown set to 'Absolut' and a field with '0', with a 'Setzen' button.
- Ziel-Position setzen (Set target position):** Includes a dropdown set to 'Absolut' and a field with '0', with a 'Setzen' button.

Set position

In addition to the actual position (large display field), the current target position of the drive is also displayed.

Extended axis start

Start type: here, a distinction is made between relative, absolute, modulo, etc... start of the axis.

Target position: desired target position of the axis.

Velocity: desired positioning velocity after axis start-up.

Acceleration: if no automatically calculated acceleration is desired, the checkbox can be used to activate the acceptance of the value entered on the right.

Deceleration: the checkbox activates the acceptance of the deceleration value entered on the right, if its manual entry is desired.

Jerk: the checkbox activates the acceptance of the value entered on the right for the jerk (in the example no value is entered yet).

Start: starts the axis positioning with the entered or calculated values.

Stop: stops the execution of the axis positioning.

Drive output

Output type: only a percentage output (e.g. corresponding to 100% = 10V) to the drive can be selected here.

Output value: percentage setpoint of the maximum possible output value of the terminal or the Mxxx module.

Start: starts the output of the set value to the drive. Safety mechanisms, such as software end position monitoring etc.. are not considered.

Stop: stops the output of the set value to the drive.

Set actual position

Here you can manually set the actual position of the axis (as absolute, relative or modulo value).

Set target position

This function can be used to manually set the target position of the axis (as an absolute, relative or modulo value).

5.4.5 Axes - Dialog: Coupling

In order to be able to test the coupling of the axes manually, there is this special dialog in the TwinCAT System Manager.

Set position

In addition to the actual position (large display field), the current target position of the drive is also displayed.

Master/Slave coupling

Master axis: here the axis is selected which the currently edited axis is to follow as slave.

Coupling type: currently, linear coupling and the flying saw are implemented as coupling types.

Gearing factor: desired ratio between master and slave velocity as a real number.

Parameter 2-4: only valid when **Coupling type** "Flying saw" is selected.

Couple: activates the coupling of master and slave.

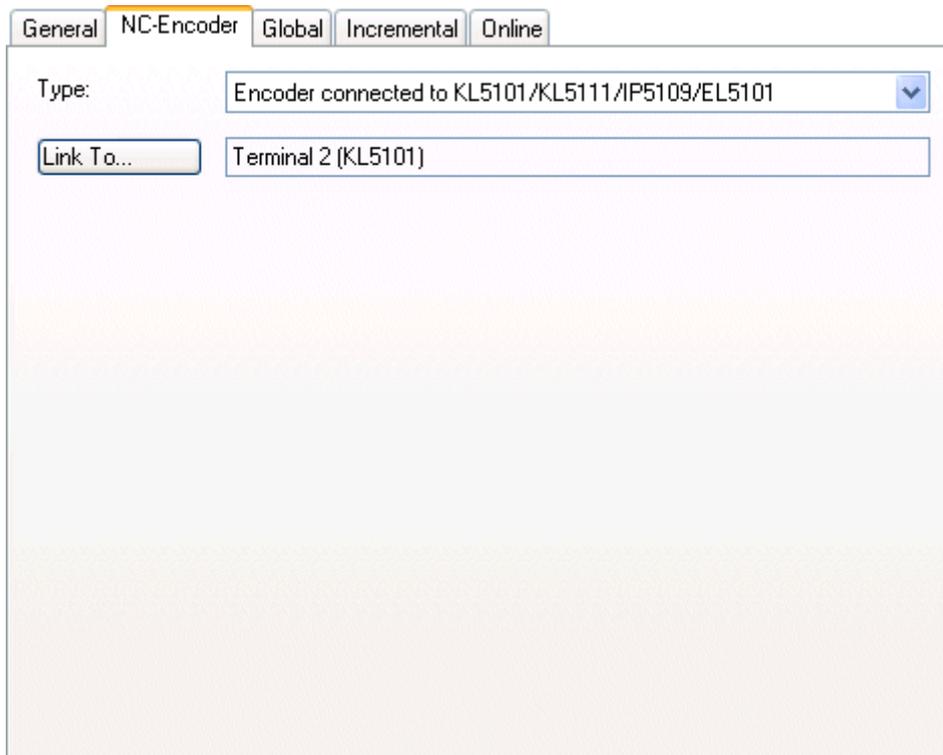
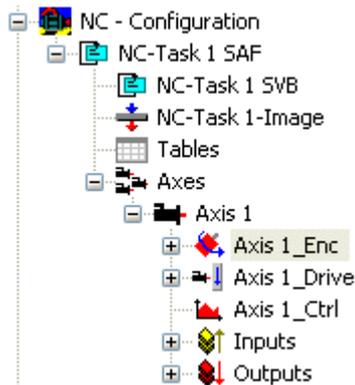
Decouple: returns both axes to the independent state.

Change factor: "On the Fly" change of the **gearing factor**.

Stop: refers to the stopping of the axis at the coupling type "Flying saw".

5.4.6 Encoder - dialog: NC encoder

Below the axes, in the tree view, there are some setting dialogs at *Axis_Enc* on the right side of the System Manager. One of them is the dialog "NC-Encoder", which is described below:



Type

Here you have to select the used interface type to which the encoder of the axis is connected. The following types are supported:

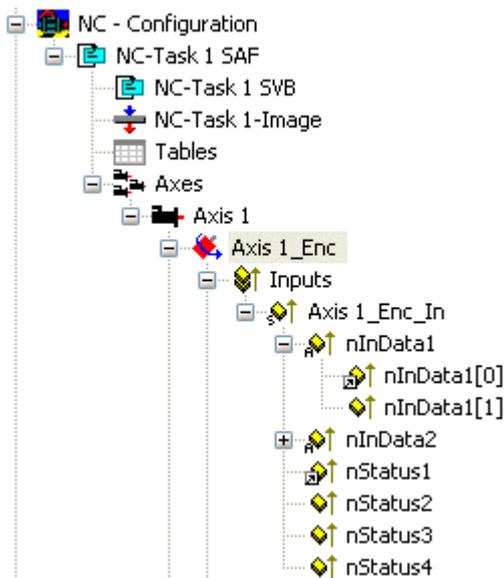
Supported types	Description
Simulation Encoder	For simulation purposes or as a virtual encoder, an internal, direct setpoint/actual value feedback can be switched on with this encoder type. This encoder type is set by default.
Encoder connected to M3000	The Beckhoff Lightbus M3000 absolute encoder is used as the encoder interface.
Encoder connected to M31x0 [► 306] / M3200	The Beckhoff Lightbus M31x0 or M3200 incremental encoder is used as the encoder interface.
Encoder connected to M2510	The Beckhoff Lightbus M2510 analog input/output module is used for position feedback with this encoder type.
Encoder connected to KL51x1	A KL5101 Incremental Encoder Interface is used for position feedback.
Encoder connected to KL5001	A KL5001 SSI encoder (absolute encoder) interface is used for position feedback.
Encoder connected to KL5051 / KL2502	The bidirectional KL5051 BI-SSI interface terminal is used here for position feedback. This should usually be the case with Digifas 7x00 drives from Seidel.
Encoder connected to KL30xx	One channel of the KL30xx analog input terminal is used here for position feedback.
Encoder connected to FOX-50 [► 307]	A FOX-50 module is used here as the interface for position feedback.
Encoder connected to SERCOS [► 340] (position)	Position feedback according to SERCOS specification.
Encoder to SERCOS (position+velocity)	Position and velocity feedback according to SERCOS specification.
Encoder connected to dig. input (binary)	
Hydraulic encoder	The force from P_a , P_b , A_a and A_b is fed in as feedback with this setting.
Encoder connected to AX2000	The resolver of the motor, or connected external encoders of the AX2000-B200 drive, provides the position feedback.
Encoder connected to ProfiDrive	Position feedback according to ProfiDrive specification.
Encoder connected to NC Backplane [► 251]	The Beckhoff NC Backplane transmits the positioning data here.
Encoder (universally applicable)	Universal applicable encoder
Encoder connected to CANopen	The position feedback is synchronous via the CANopen fieldbus interface (possible e.g. with the FC510x

Linked to

Here you have to select the terminal/module of the [I/O configuration \[► 101\]](#) which is electrically connected to the encoder of the axis. Only terminals or modules that match the set **type** are offered for linking.

Linking a universal encoder

The type *Encoder (universally applicable)* can be used for encoder systems that are not listed in the type list. In this case, the counter value of the encoder must be linked manually and the value range must be set. The link is made directly via the input variables of the axis encoder



The input/output variables of the encoder have the following meaning:

nInData1 - (16 or 32 bit) position value of the axis in increments

nInData2 - (16 or 32 bit) optional latch value for measuring probe function or referencing with zero pulse (reference mode: HARDWARE SYNC)

nStatus1 - status byte of the encoder

nStatus2..4 - further optional status bytes of the encoder

nCtrl1 - control byte of the encoder

nCtrl2...4 - further optional control bytes of the encoder

After linking the position count value with *nInData1* the maximum count value until overflow is still defined in the global encoder settings (*Encoder mask*).

In some cases, the word or double word of the counter still contains status information that can be hidden. For this purpose, the corresponding bits in the *Encoder Bit Rejection Filter Mask* are activated. In most cases, this mask remains zero.

General **NC-Encoder** Global Incremental Online

ENCODER-Mode	E	'POSVELO'	
Invert Encoder Counting Direction	B	FALSE	
Scaling Factor	F	0.0001	mm/INC
Position Bias	F	0.0	mm
Modulo Factor (e.g. 360.0°)	F	360.0	mm
- Tolerance Window for Modulo Start	F	0.0	mm
ENABLE: Min Soft Position Limit	B	FALSE	
- Software Position Limit Min	F	0.0	mm
ENABLE: Max Soft Position Limit	B	FALSE	
- Software Position Limit Max	F	0.0	mm
Filter Time for Actual Position (P-T1)	F	0.0	s
Filter Time for Actual Velocity (P-T1)	F	0.01	s
Filter Time for Actual Acceleration (P-T1)	F	0.1	s
Encoder Mask (Maximal Value)	r D	0x0000FFFF	
Encoder Bit Rejection Filter Mask	D	0x00000000	
ENABLE: Actual Position Correction	B	FALSE	
Filter Time Actual Position Correction (P-T1)	F	0.0	s
Evaluation Direction	E	'POS+NEG'	
Reference System	E	'INC'	

Download Upload **Select All**

5.4.7 Drive - dialog: NC Drive

Below the axes, in the tree view, there are some setting dialogs at xxx_Drive on the right side of the System Manager. One of them is the dialog "NC Drive", which is described below:

General **NC-Drive** Global Analog

Type: Drive connected to KL4xxx/KL2502-30K/KL2521/IP2512/EL4xxx

Link To... Term 3 (KL4032) # Channel 1

Type

The type of setpoint output used to the drive is selected here. The following types are supported:

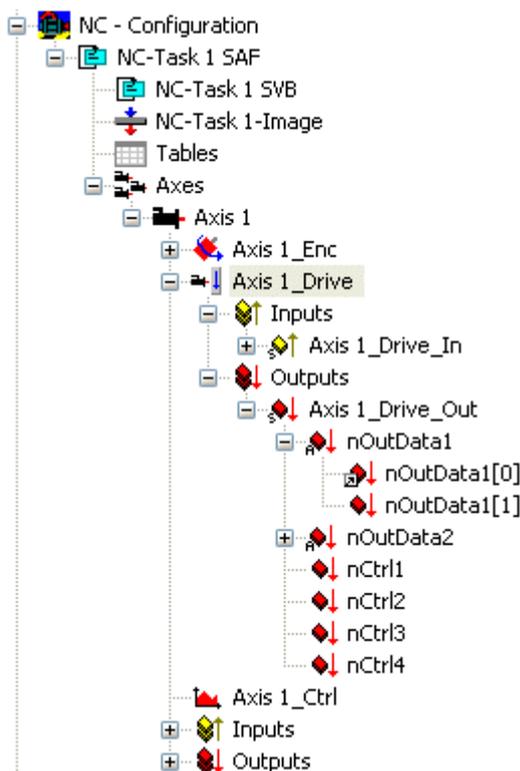
Supported types	Description
Drive connected to M2400 [► 301] DAC <i>n</i>	The Beckhoff Lightbus M2400 input/output module is used for setpoint output to the drive.
Drive connected to KL4XXX / KL2502	The drive receives its setpoint from a KL4xxx analog output terminal or from a KL2502 PWM terminal
High/low speed drives	The drive can be controlled with this setting option with a digital output terminal with 2 speeds (e.g. Dahlander motor, frequency converter,...).
Stepper motor drive	The setpoint specification of this so-called "low cost" stepper motor axis is done via digital output terminals
DAC of the NC Backplane [► 251]	A digital/analog converter of the Beckhoff NC Backplane outputs the setpoint to the drive.
Drive (universally applicable)	Universally applicable drive interface.
Drive connected to CANopen	The drive receives its setpoint synchronously via the CANopen fieldbus interface (e.g. possible with the FC510x

Linked to

Here, the terminal (incl. the correct channel of the terminal) or the *Mxxxx* module of the [I/O configuration \[► 101\]](#) must be selected, which is electrically connected to the setpoint input of the drive. Only terminals/modules matching the set **type** are offered for linking.

Linking a universal drive

The type *Drive (universally applicable)* can be used for output systems that are not listed in the type list. In this case, the output value of the axis must be linked and scaled manually. The link is made directly via the output variables of the axis drive.



The input/output variables of the drive have the following meaning:

nOutData1 - (16 or 32 bit) position value of the axis in increments

nOutData2 - (16 or 32 bit) optional velocity value of the axis in increments

nStatus1 - status byte of the drive

nStatus2..4 - further optional status bytes of the drive

nCtrl1 - control byte of the drive

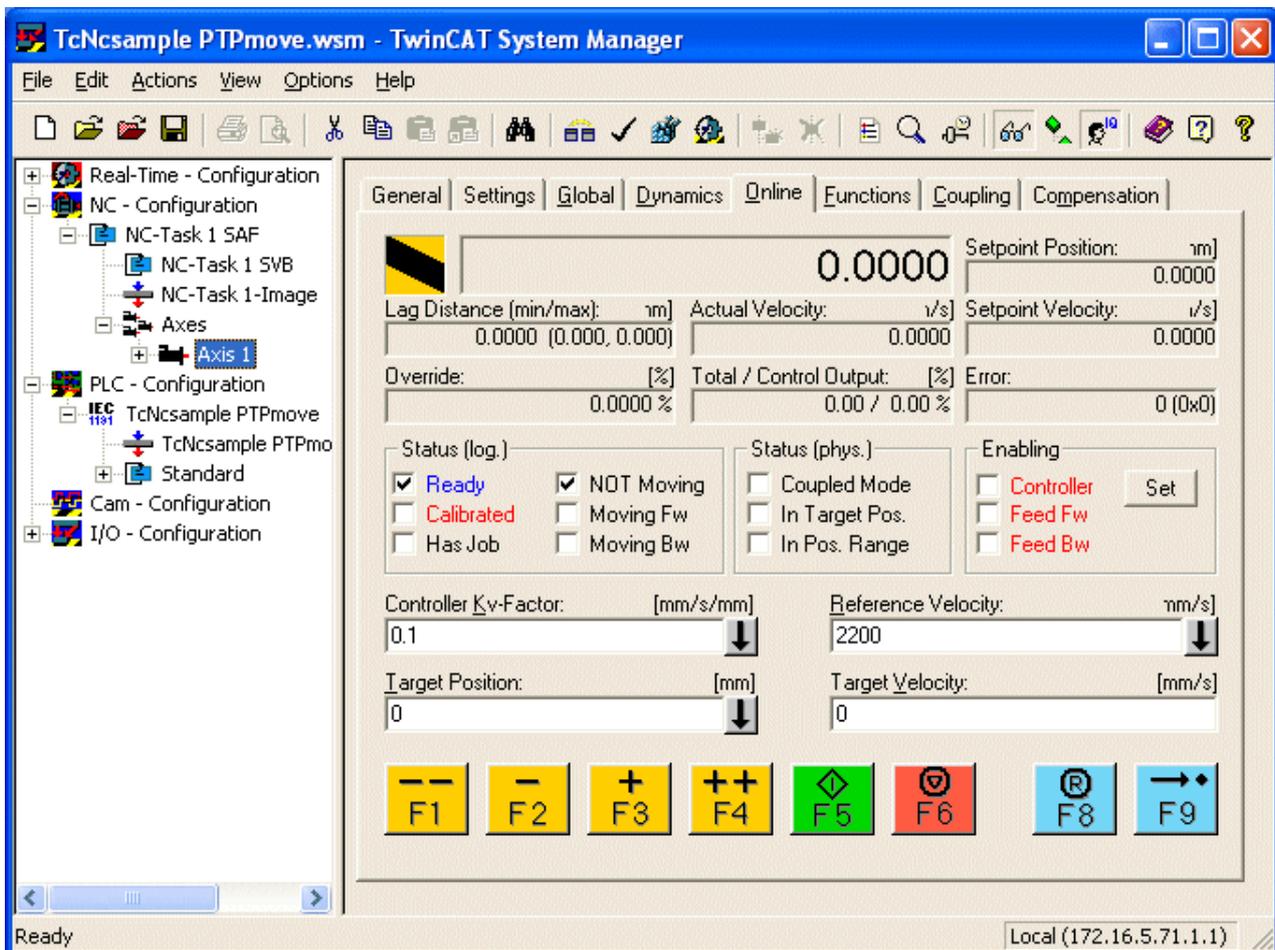
nCtrl2..4 - further optional control bytes of the drive

5.5 NC operation

5.5.1 NC manual mode

Overview

The online menu is the main menu for online axis operation. Here, after setting the releases, the corresponding axis can be moved manually. In addition, the most important axis states are displayed by means of checkmarks when the configuration is active.



The menu is divided into **displays, input fields and function keys**.

Displays

- Actual position and setpoint position,
- lag error with minimum and maximum value since last reset,
- actual velocity and target velocity,
- override in %, total and controller output in %, error code,
- axis status:
- ready for operation, referenced. In standstill (logical),

- Has order, Moves larger, Moves smaller, Coupled, In target position (i.e. in the set target window for a preset time), In position range (i.e. in the preset position range).
- Enables for controller, feed+, feed-.

Input fields

Partly with download by mouse click on the rectangular button. After pressing this arrow symbol, the value of the input field is transferred to the NC server.

Enable	Data type	Value	Unit	Description
Kv-factor	FLOAT	>=0	[mm/s]/mm	P controller Kv-factor.
Reference velocity	FLOAT	>0	mm/s	Reference velocity at maximum output size (e.g. at 10 V).
Target position	FLOAT		mm	Target position where the download calls the "New target position" function.
Travel velocity	FLOAT	>0	mm/s	Global set velocity. If the distance is too short to reach this velocity, a smaller suitable target velocity is automatically calculated and activated.

Function keys

Key	Function
F1	Reverse at velocity <i>Hand Max</i>
F2	Reverse at velocity <i>Hand Min</i>
F3	Move forward at velocity <i>Hand Min</i>
F4	Move forward at velocity <i>Hand Max</i>
F5	Start with the values set in the input fields and the values set in the "Dynamics" menu
F6	Stop
F8	Reset
F9	Calibrate with the values set in the "Global" menu. Notice The signal of a referencing cam must be mapped into the axis data structure (Axis.PlcToNc.ControlDword.5) by the PLC so that the sequence initiated with F9 can react to the cam.

"Set" window

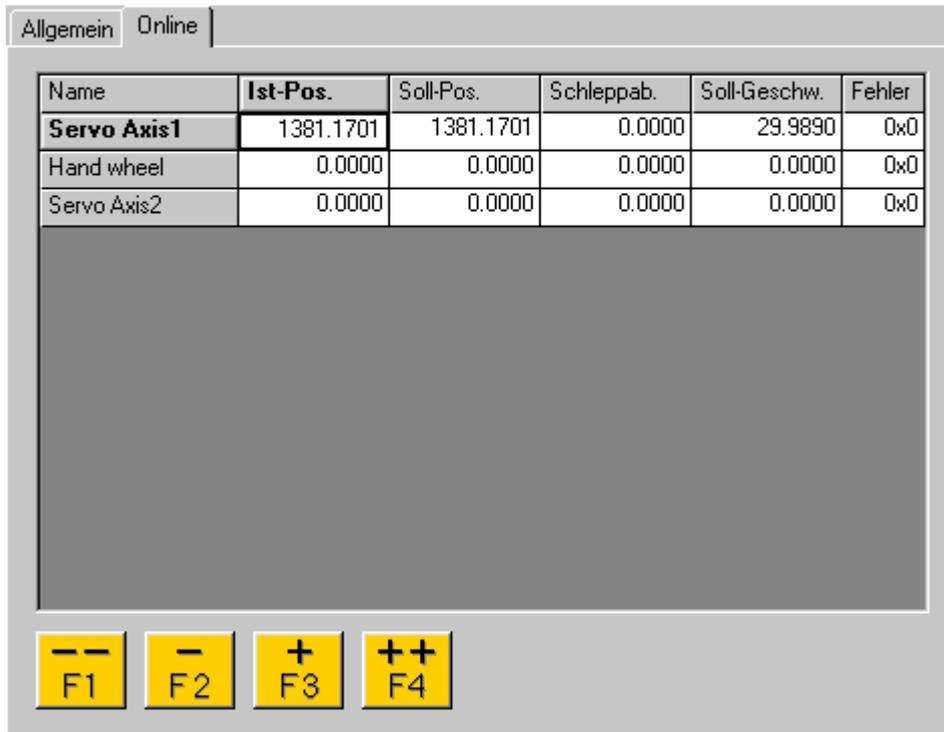
This window allows - without PLC - to set certain enables and values. If a PLC is active, the set values are generally overwritten periodically and do not take effect.

Enable	Data type	Value	Unit	Description
<i>Controller</i>	BOOL			Without controller enable, the controller is not active and 0 V are output.
Feed+	BOOL			The axis cannot be started in the positive direction without an enable Feed+. If the axis moves in positive direction and the enable Feed+ is removed, then the axis is stopped (the axis does not start again if later the enable is set again).
Feed-	BOOL			The axis cannot be started in the negative direction without an enable Feed-. If the axis moves in negative direction and the enable Feed- is removed, then the axis is stopped (the axis does not start again if later the enable is set again).
Override	FLOAT	>0	%	Velocity override in % in the range [0.0,100.0] related to the target velocity.

5.5.2 Online display axis channel

When the TwinCAT system is started and the current configuration is loaded, the setpoint and actual values of the axis channel selected in the tree view can be displayed in list view under "Online".

"Online" tab



Name

Shows the axis name.

Actual position

Indicates the current position of the respective axis.

Set position

Displays the position that the axis should actually have at the current time.

Lag error

Difference between the set position and actual position.

Error

If an NC error occurs on one or more axes, it is displayed here.

-- F1

This button can be used to move the axis quickly in negative direction in jogging mode.

- F2

This button can be used to move the axis slowly in negative direction in jogging mode.

+ F3

This button can be used to move the axis slowly in positive direction in jogging mode.

++ F4

This button can be used to move the axis quickly in positive direction in jogging mode.

5.5.3 Add NC channel

After calling [Add channel](#) [▶ 71] the following dialog appears:

Name

Here you edit a suitable name for the additional channel.

Type

One can choose between a channel for interpolation (TwinCAT Level NC-I) or FiFo axes.

Comment

Editable comment box. A line break is initiated here with 'Ctrl'+Enter'.

Okay

Inserts new NC channel into the tree structure and thus NC configuration.

Cancel

Exits the dialog without inserting a new channel.

"Override" tab

After adding an additional channel, an "Override" dialog appears on the right side, unlike the standard axis channel, for both possible types. In this dialog you can set the channel axis override as shown below. The channel spindle override is currently not yet supported.

Full override can additionally be set via "Set to 100%" key.

6 CAM Configuration

If the TwinCAT Digital Cam Server is also installed, you can see the configuration page.

The configuration parameters for the digital cam server are described in the "[TS5800 | TwinCAT 2 Digital Cam Server](#)" manual

7 PLC Configuration

If TwinCAT is installed with PLC function capability (minimum TwinCAT Level PLC) you will see "PLC - Configuration [▶ 92]" in the tree view of the System Manager. PLC projects can be added here and their settings (number of run-time systems, port no., cycle times, ...) checked. The path settings for the PLC project can also be adjusted accordingly.

PLC - Configuration	Description
PLC Settings [▶ 95]	Settings according to the PLC environment (Number of Run-Time systems, handling of persistent data, etc..)
PLC Project Settings [▶ 92] ("IEC1131")	Project pathes and other informations about the associated PLC project(s)
Prozess Images [▶ 46]	Overview about the mappings between PLC variables and other process images (I/O devices, NC variables,...)
Task [▶ 62]	Informations about the tasks contained in the associated PLC project(s)

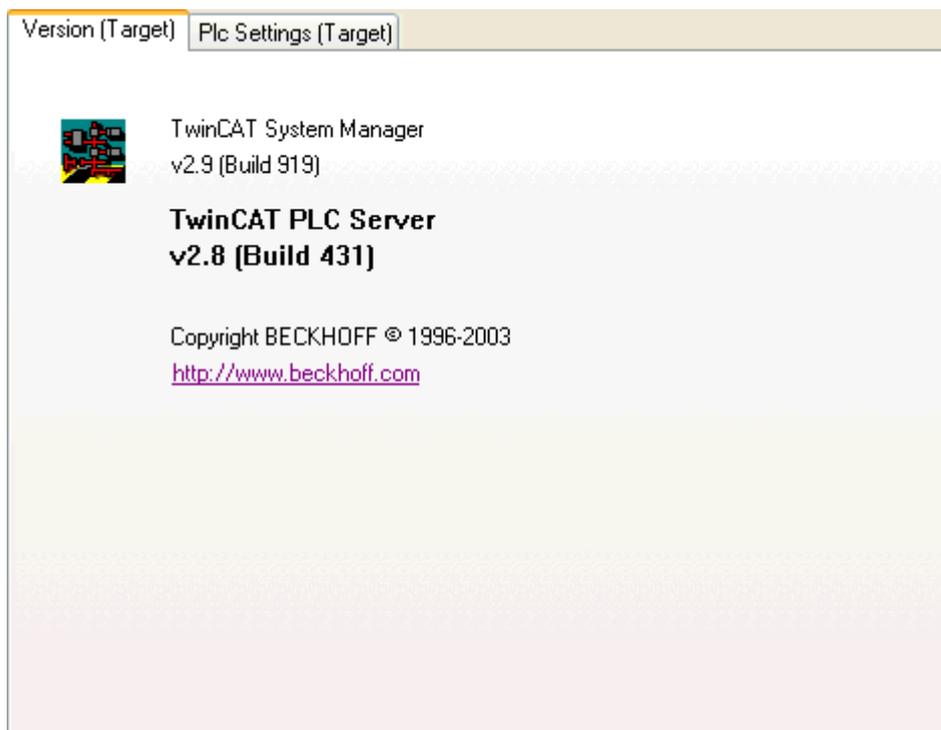
"General" Tab

This dialog only appears, if no Remote system is selected, means the System Manager accesses the local target system (see also "[Choose Target System \[▶ 231\]](#)").

Besides that, the following dialog "**Version [Target]**" is equivalent.

"Version [Target]" Tab

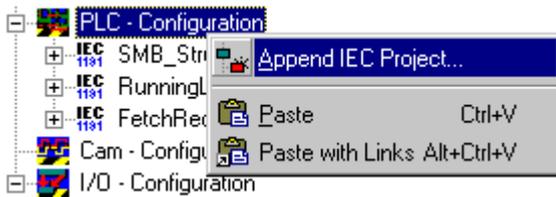
The following dialog describes the TwinCAT server of the target system, where this module is based on. In the shown dialog this is the - currently active - version 2.9 [Build 431] of the TwinCAT PLC Server.



7.1 Generating a PLC Configuration

Select *PLC Configuration* in the tree view of the System Manager and then right click on the mouse to open the corresponding context menu.

Context menu:



Append IEC Project

Opens a dialog to select and add a PLC project to the configuration.

Paste

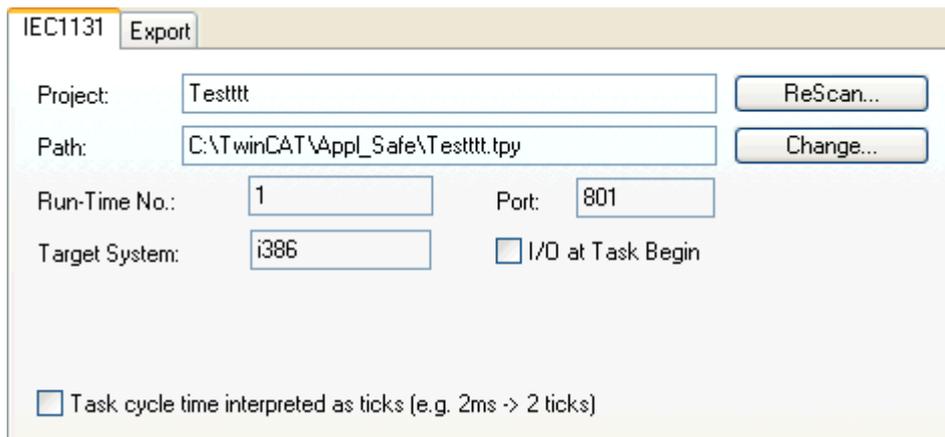
Adds the PLC project which is currently on the clipboard to the configuration.

Paste with Links

Command does the same like *Paste*, but tries to restore available variable links.

"IEC61131" tab

When a project was generated with TwinCAT PLC Control without errors and then saved, a PLC configuration can be added to the current system configuration and the I/O variables with address locations are read in. When you select the added PLC project in the tree the associated dialogue IEC1131 appears on the right-hand side.



Project

Shows the name of the currently selected PLC project.

Path

Defines the path of the current PLC project. This path indicates the PLC project currently being edited.

The path points to a *.tpy file. File names with the extension *.tpy are XML files that contain information about the variables present in the PLC project which are bound to addresses and their underlying data types, as well as general project information.

The XML based *.tpa files, which hold the finally resolved addresses from possible variable configurations or global_variables-lists with accordingly localized variables (%I* and/or %Q*), and which are uniquely available for each project, are new. The assigned addresses are displayed in the Resources area | "TwinCAT_Configuration (VAR_CONFIG)" in TwinCAT PLC Control.

Runtime no.

Indicates the runtime system that the selected PLC project is configured for. Settings changes can be carried out under

Online settings in the TwinCAT PLC Control.

Port

Defines the AMS Port Number of the run-time system. The number shown depends on the *Run-time Number* described above.

Target System

Defines the target system for which the respective PLC code was generated. If the PLC is running on the PC, code i386 is generated.

I/O at Task Begin

An I/O cycle is carried out at the task start. This means a jitter-free cycle of the I/O independent of the run-time of the task (normally not activated for PLC configurations).

Task cycle time interpreted as ticks

This checkbox is deactivated by default. It is only in use, when the TwinCAT [Base Time \[► 54\]](#) differs from its default value of 1ms. This is e.g. the case, when a PLC Task interval less than 1ms is wanted.

ReScan

Re-loads the current PLC configuration into the system. Changed configurations (e.g. new I/O variables) will then appear in the System Manager configuration.

Change

This command enables the path for the PLC project to be adjusted. This is necessary if the project location has changed or if you want to activate another PLC project.

PLC Configuration - Process Image

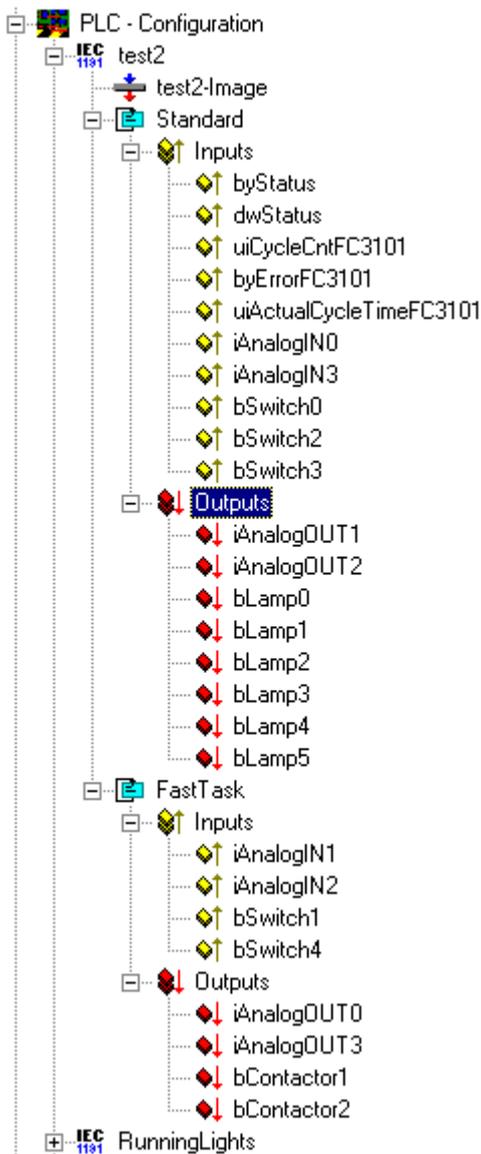
Below the PLC project name appears an input '*Project Name*' - *Process Image* (as shown below). Further information is given under: [Process Images \[► 46\]](#).

PLC Configuration - Task Information

If the tree below the process image is opened as shown below you will see the name of the task configured in the PLC project. The corresponding dialogue appears on the right-hand side in the System Manager, see [Task Settings \[► 62\]](#).



As a PLC project can comprise up to 4 tasks, several task names will appear in the corresponding multitasking projects in the tree. This is shown in the diagram below for both 'Standard' and 'FastTask' tasks.



The input and output variables are always assigned to the first task after loading the PLC project, but can also be assigned to other tasks, e.g. via Drag&Drop. This means that the values of the variables can be refreshed according to the current pre-set task cycle times.

If you select an input or output variable, this can be linked either with the context menu or the dialogue which appears on the right-hand side, via a [Variable Link \[▶ 39\]](#).

[Extended Link Options \[▶ 45\]](#)

Further link and documentation functions for variable lists are described here.

7.2 PLC Settings

You can configure the settings of the PLC environment in the system manager's menu 'PLC-configuration' under the tab 'PLC settings'.

Number of runtime systems:

Here you can determine the number of available runtime systems and configure which runtime system shall contain which boot project.

Boot Project

For every runtime system you can separately activate the loading of a boot project. You activate or deactivate the runtime system's boot project with a click on the corresponding line. For creating a boot project start the TwinCAT PLC Control, in the online-menu you find the button "Creating a boot project".

Loading / Saving of the Retain Data

If you have addressed a boot project for a runtime system, you can load or write remanent data for it. Select or deselect this option via the checkbox.

8 IO Configuration

The *I/O - Configuration* [▶ 97] is an important component of the TwinCAT System Manager. The lowest level of TwinCAT is *TwinCAT Level I/O*, means an I/O Configuration entry in the TwinCAT System Manager tree- view is always present. After the various *Configurations* [▶ 10] have been executed for the different tasks and the System Manager has been acquainted with all relevant variables, the hardware (usually a fieldbus with I/O modules) is configured under this rubric. It is also possible to configure the I/O section first and the other tasks (e.g. PLC tasks) later on, of course.

I/O - Configuration	Description
I/O Devices [▶ 97]	At target system (local or remote) configured Input and Output devices (Fieldbus cards, NOVRAM, system interfaces,..) and their process images
Mappings [▶ 125]	Informations about mappings between the I/O devices and other TwinCAT devices, resp. their process images

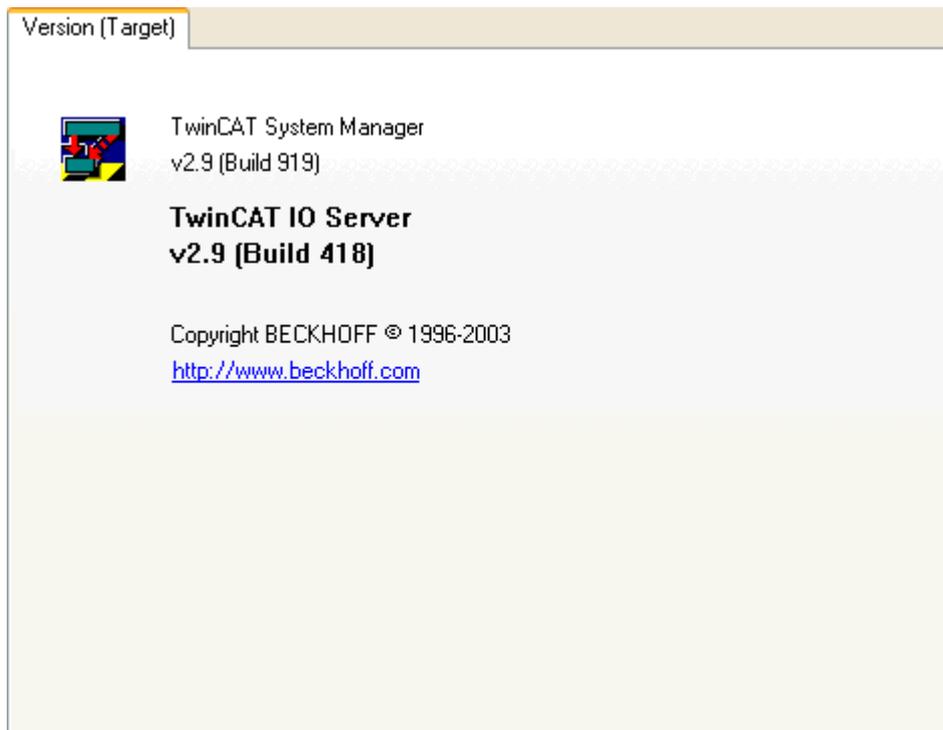
"General" Tab

This dialog only appears, if no Remote system is selected, means the System Manager accesses the local target system (see also "[Choose Target System](#) [▶ 231]").

Besides that, the following dialog "**Version [Target]**" is equivalent.

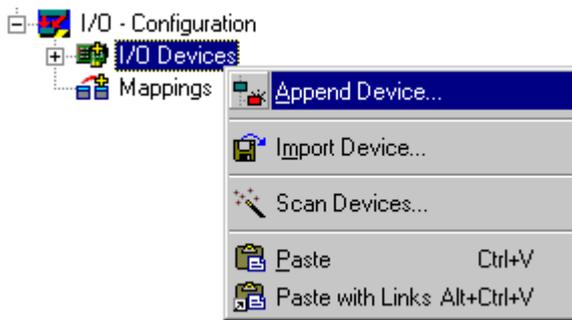
"Version [Target]" Tab

The following dialog describes the TwinCAT server of the target system, where this module is based on. In the shown dialog this is the - currently active - version 2.9 [Build 418] of the TwinCAT IO Server.



8.1 Adding an I/O Device

Click on the right-hand mouse button on *I/O Devices* to display the following context menu:



Append Device

Opens the Selection Dialog [▶ 99] for the supported fieldbus cards [▶ 133] and other hardware devices (e.g. common PC interfaces, etc..).

Import Device

Integrates previously created and exported I/O configurations [▶ 100] into the current System Manager project.

Scan Devices

Scans the PC for supported I/O devices. Found devices are listed afterwards under I/O Devices in the treeview.

From TwinCAT 2.9 on, the target system must be in Config Mode [▶ 13] for this function.

Paste

Adds another device to the current position (before marked device) in the configuration.

Paste with Links

Does the same as *Paste*, but adopts previously created variable links from the imported file.

After installing a device the property pages dialog appears on the right hand side in the System Manager view.

Further information about dialog "General": Dialog "General" [▶ 132].

Further information about I/O devices: Reference | I/O Devices [▶ 133]

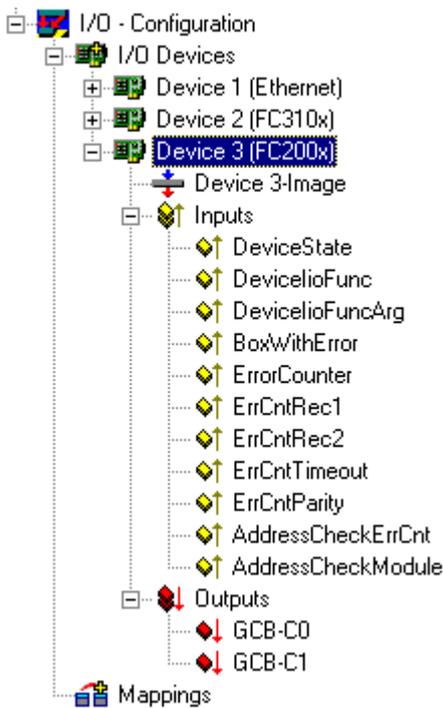
The current values in the dual port memory can be viewed online via the DPRAM (Online) [▶ 267].

I/O Devices - Process Image

Below the device name appears an input box '*Device Name*'-*Process Image*. Further information is given under: Process Images [▶ 46].

I/O Devices - Status and Control Information

After opening the tree below the I/O device, you will find the status and control information on the selected device.



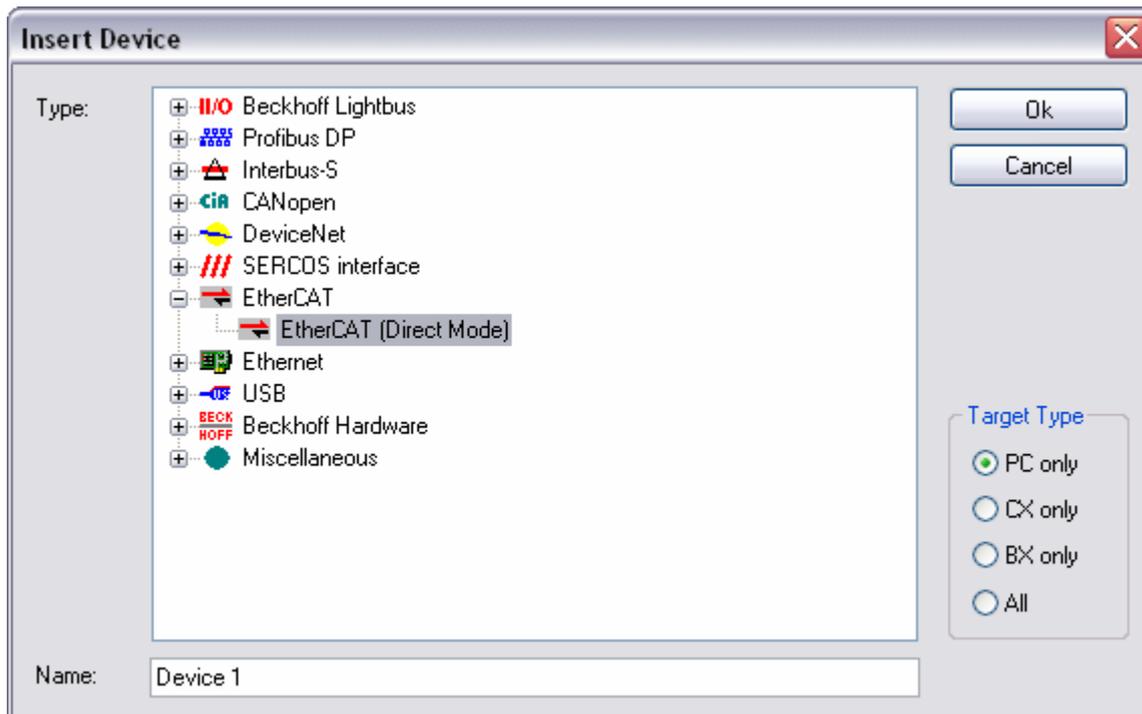
These are input and output variables which can be linked as standard, e.g. with matching PLC variables, and which can therefore indicate the status of the device to the PLC run-time system. Further information about the topic of links can be found under: [Variable Links \[▶ 39\]](#).

Adding In/Output Modules

The selection and configuration of the various I/O modules (boxes) is described under: "[Adding Input/Output Modules \(boxes\) \[▶ 100\]](#)".

8.2 Select I/O Device

After executing *Append Device...*, the following dialog appears to choose the specific I/O device (several Fieldbus cards, Beckhoff-specific Hardware, common PC interfaces,...):



In the tree-view of this selection dialog, you'll find all available I/O devices (see also "Target Type", in above example e.g. a Beckhoff EtherCAT-capable port. See: [I/O Devices \[▶ 133\]](#) in the **Reference** chapter for details on supported Fieldbus adapters.

Type

Offers all supported I/O devices for the respective Fieldbus protocol.

Name

The description of the device can be edited here.

Target Type

Provides a filter for limiting the shown devices to the respective Beckhoff platform to be configured in this session.

Ok

Confirms the selection of the device and closes the dialog. Alternatively, a selection of the I/O device with double-click is possible to close this dialog automatically.

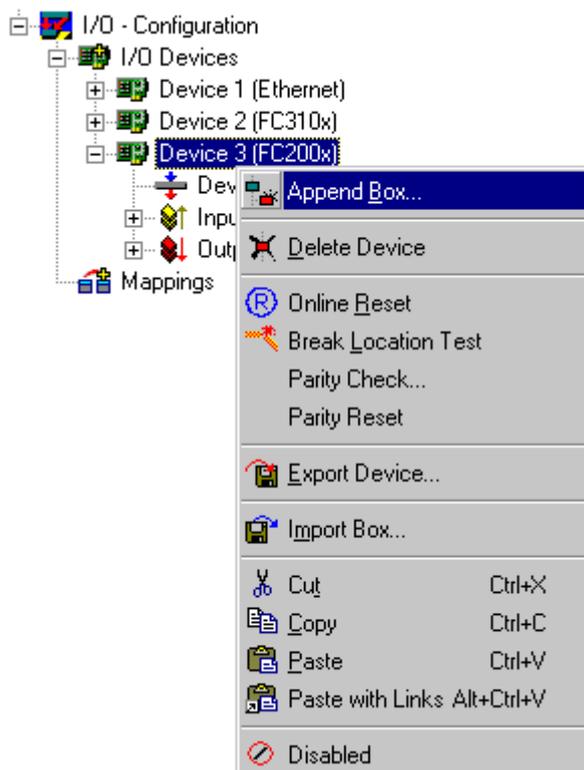
Cancel

Closes the dialog without adding a device to the current configuration.

8.3 Adding Input/Output Modules (boxes)

The various input and output modules (*boxes*) are now added and configured and/or linked with the variables of the PLC projects or other run-time systems (e.g. of an [Additional Task \[▶ 59\]](#)) below the configured fieldbus cards.

A right mouse click on the [Configured \[▶ 97\]](#) I/O Device [\[▶ 97\]](#) (the example shows a *Beckhoff FC200x Lightbus PCI card*) displays a context menu. As the name says, this menu is context-dependant, i.e. different fieldbus cards often have different context menus. In the following description, therefore, only the general menu entries are discussed. You can obtain detailed device information from the Technical Reference.



Append Box

Calls up, depending on the configured fieldbus system, the [Selection Diagram \[► 101\]](#) for the supported I/O module.

Delete Device

Deletes the I/O device from the tree view and thereby from the configuration.

Online Reset

Actuates an I/O reset on the card. This is only possible, of course, for active configurations and when the system is running.

Export Device

Saves the entire configuration (with all added boxes) for the selected device into an export file.

Import Box

Integrates a previously configured and exported fieldbus station into the current system.

Cut

Copies the current I/O device to the clipboard and removes it from the I/O configuration.

Copy

Copies the current I/O device to the clipboard.

Paste

Inserts another device from the clipboard into the current position (before marked device) in the configuration.

Paste with Links

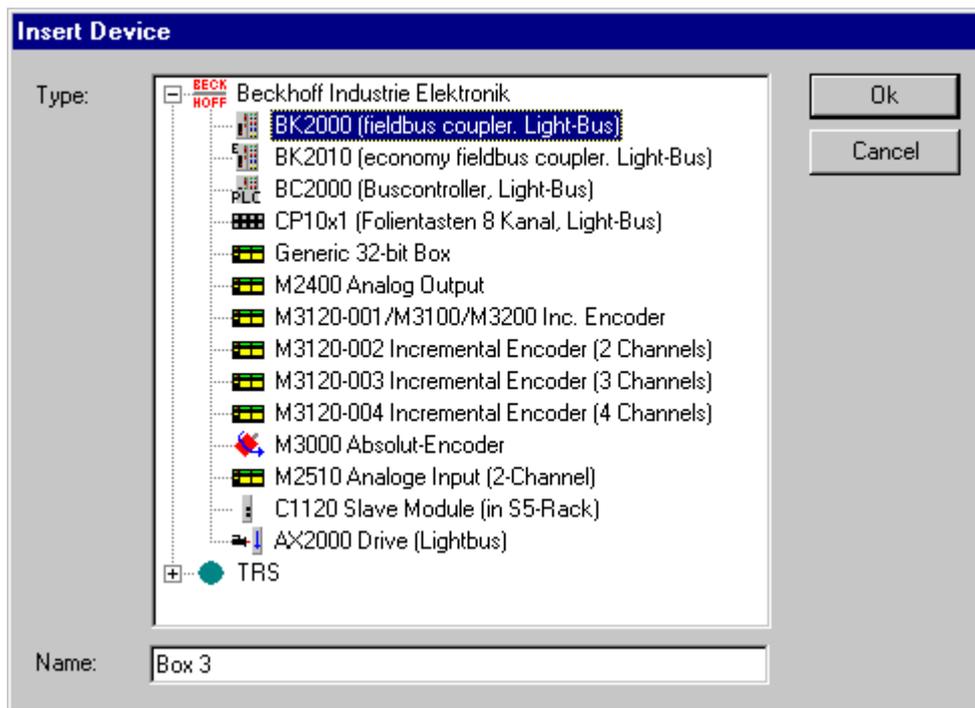
Does the same as *Paste*, but adopts previously created [Variable Links \[► 39\]](#) if possible.

Disabled

Excludes the marked box for calculation. Box configuration and possibly linked variables are still conserved and available for future restoration.

8.4 Select Box

After selecting *Add Box...*, a Selection Diagram for the specified I/O module appears, according to the selected fieldbus system (*in this case Beckhoff Lightbus*).



The tree view of the Selection Diagram displays all possible I/O modules (see also [Technical Reference](#) [|> 133](#)). These are sometimes listed in order of manufacturer to simplify viewing.

The *Profibus* and *DeviceNet* fieldbus systems support I/O configuration with description/configuration files supplied with the systems (or by each manufacturer). Adding these types of GSD/GSE and/or EDS boxes is described under [Adding GSE and EDS Boxes](#) [|> 102](#).

Type

Shows the possible I/O modules. These can be compact or modular I/O devices, and drives with digital interface (like the AX2000 drive shown in the example).

Name

The identifier for the selected module can be edited here.

Ok

Confirms a module selection and closes the dialogue. Alternatively, double click to achieve the same result.

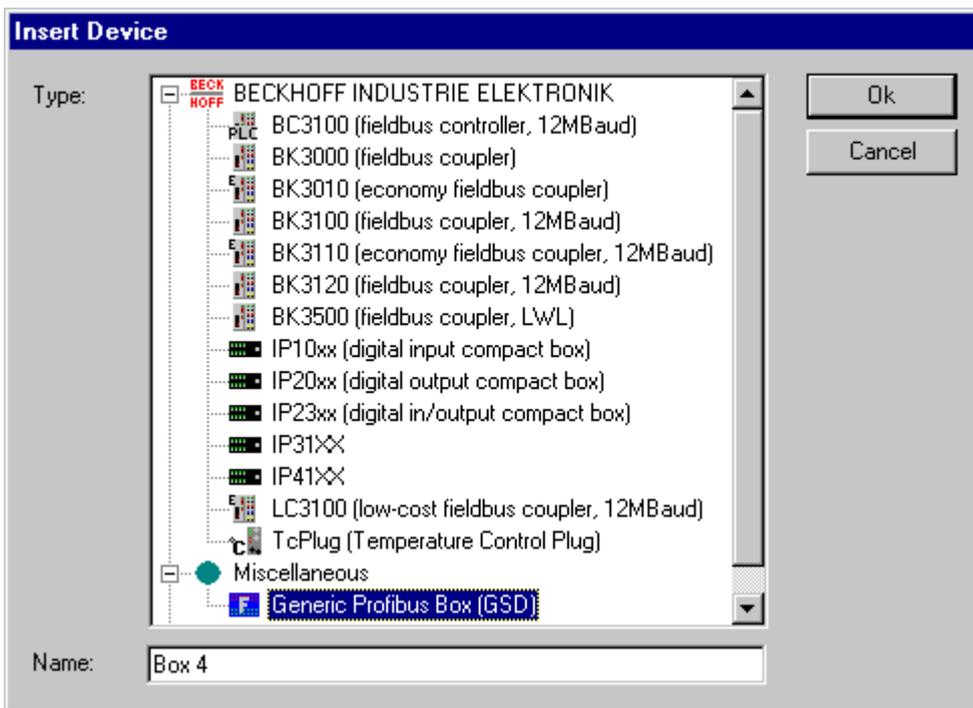
Cancel

Closes the dialogue without adding a module to the configuration.

8.5 Adding GSD and EDS Boxes

The *Profibus* and *DeviceNet* fieldbus systems contain device-specific configuration files which are provided by the hardware manufacturers. These serve to integrate these external devices into any control system that supports that fieldbus. The files are described under *Profibus* as GSD and under *DeviceNet* as EDS (*Electronic Data Sheet*) files.

After selecting *Append Box...*, depending upon the selected fieldbus system (in this case *Profibus*), a 'Generic *Profibus* Box (GSD)' item is shown under *Miscellaneous*.



In the case of *DeviceNet* you would see '*General DeviceNet Box (EDS)*'.

With double-click or press on *Ok*, a Windows file-selection dialog shows available *.gsd files stored in the \TwinCAT\IO\GSD directory.



Press the *Open* button to integrate the device into the System Manager configuration.

Notice:

The device manufacturers are responsible for the GSD and/or ESD files, i.e. **Beckhoff Automation GmbH does not provide GSD/GSE (GSE = GSD files in English) or EDS files for 3rd party devices**, nor does it offer any guarantee of their function.

Device description

The specific structure of the GSD/GSE and/or ESD files (specified by the corresponding user organisations (PNO and ODVA respectively) allows the TwinCAT System Manager to read and display device information (manufacturer, device type etc.). This is shown in the right-hand *General* dialogue for the device selected in the tree.

The screenshot shows a software dialog box with two tabs: 'General' and 'Profibus'. The 'Profibus' tab is active. It contains the following fields and controls:

- Name:** A text input field containing 'Box 3 (GSD Box) [MOVITRAC 31+FFP31]'.
- Id:** A small text input field containing the number '3'.
- Type:** A dropdown menu showing 'Generic Profibus Box (GSD)'.
- Comment:** A multi-line text area containing 'Vendor: SEW-EURODRIVE' and 'Revision: 1.0'.
- Disabled:** A checkbox that is currently unchecked.
- Create symbols:** A checkbox that is currently unchecked.

The dialogue contains the device name, type, manufacturer and GSD/GSE and/or EDS file revision number. The latter can be of particular importance if there is any confusion over currently valid versions.

There is also a "Checkbox" for disabling the device, i.e. if selected, the device will be excluded on the driver side from the current combination of the fieldbus telegram, but can be retained on the hardware side unless the address is assigned to another device.

Compact and Modular Devices

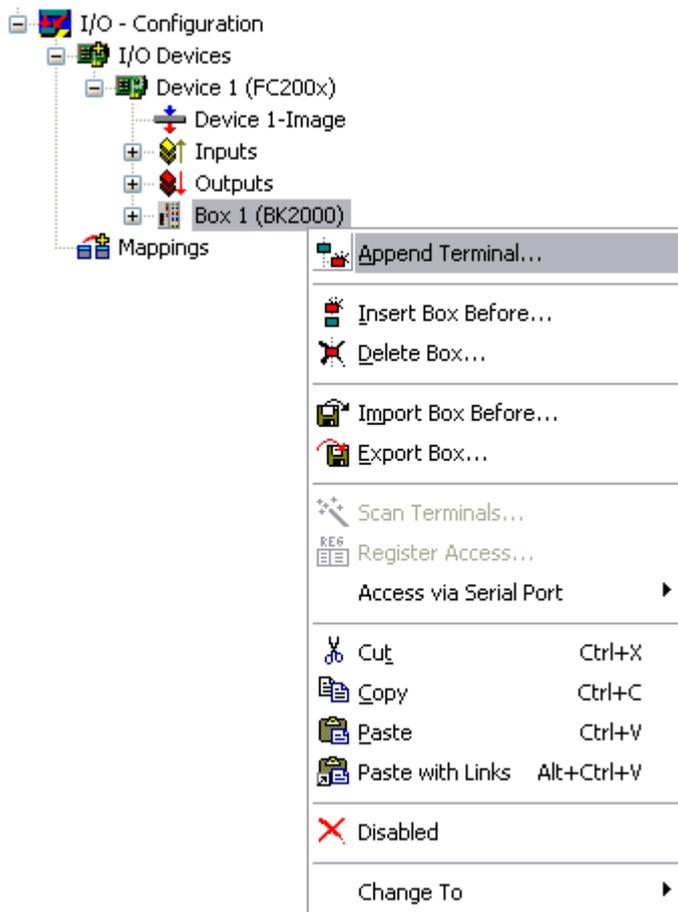
The integrated external devices may be compact or modular. In the case of a compact device, the length of the input and output data transferred by the fieldbus can be pre-set. In the case of a modular device the number of the input and output data bytes of the device can be configured. Further details are given in the Technical Reference (see [Modular Profibus Devices \[▶ 312\]](#)), along with details about the specific settings for the *Profibus* tab seen above (see [GSD Device \[▶ 312\]](#)). [\[▶ 312\]](#) You will find information about the *DeviceNet* fieldbus system under [DeviceNetNode \[▶ 336\]](#).

8.6 Adding Bus Terminals (KLxxx)

The various input and output terminals are added, and the channels are linked with task variables beneath the configured Bus Coupler.

A right mouse clicks on the [Configured Box \[▶ 97\]](#) (the example shows a *Beckhoff BK2000 Bus Coupler*) opens the following context menu:

Context menu



Append Terminal

Calls up the [Selection Diagram \[► 106\]](#) for the various Beckhoff Bus Terminals.

Insert Box Before

Adds a box in front of the box currently selected in the tree (in this case, box 1).

Delete Box

Deletes the box from the tree view and thereby from the configuration.

Import Box Before

Integrates a previously configured and exported fieldbus station into the current system.

Export Box

Saves the selected fieldbus station to an export file (*.tce).

Cut

Copies the currently selected fieldbus station to the clipboard and removes it from the I/O configuration.

Copy

Copies the current fieldbus station to the clipboard.

Paste

Inserts another box from the clipboard into the current position (before the marked device) in the configuration.

Paste with Links

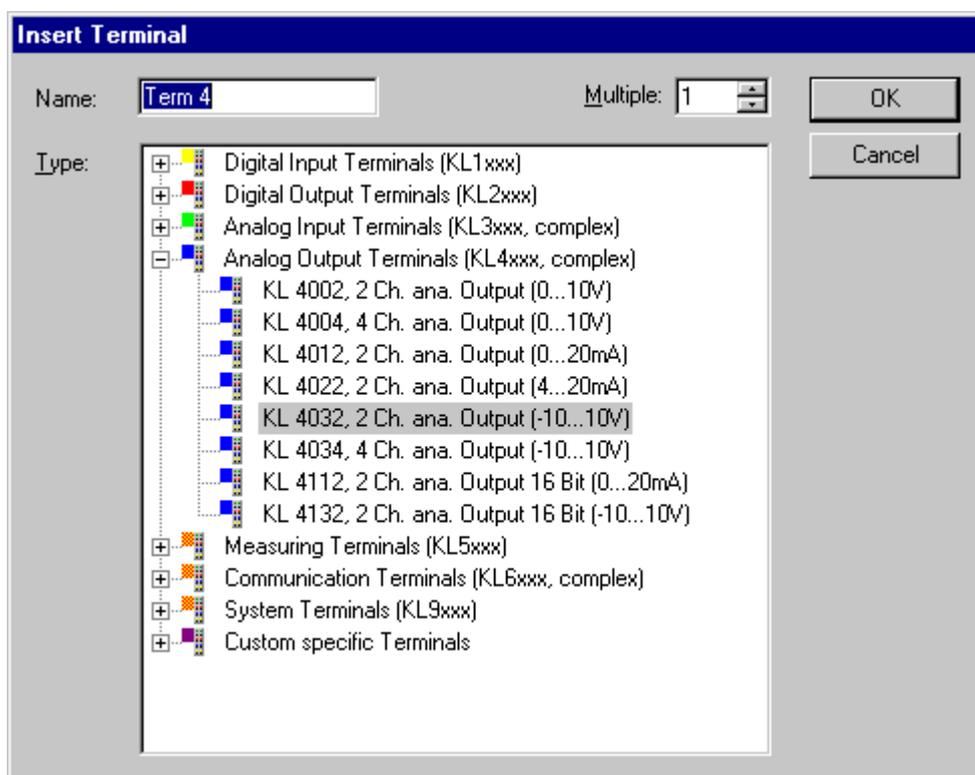
Does the same as Paste, but reconnects previously created [variable links](#) [► 39] if possible.

Disabled

Removes the box from the current system configuration (excludes it from calculation) without deleting it. The box can be reactivated at any time.

8.7 Terminal Selection Diagram

After selecting *Add Terminal...*, you will see a Selection Diagram for the various terminals. Bus Terminal Controller (BC) terminals are described under [Terminal selection for Bus Terminal Controllers](#) [► 111].



Details about the various Beckhoff Bus Terminals are described under [Terminals - Technical Reference](#) [► 378].

Type

The list shows the different Beckhoff Bus Terminals sorted by their main groups.

Name

Here you can edit the identifier for the selected terminal, which should appear in the tree view.

Multiple

Inserts n terminals of the selected type continuously into the configuration.

OK

Integrates the selected terminals into the configuration.

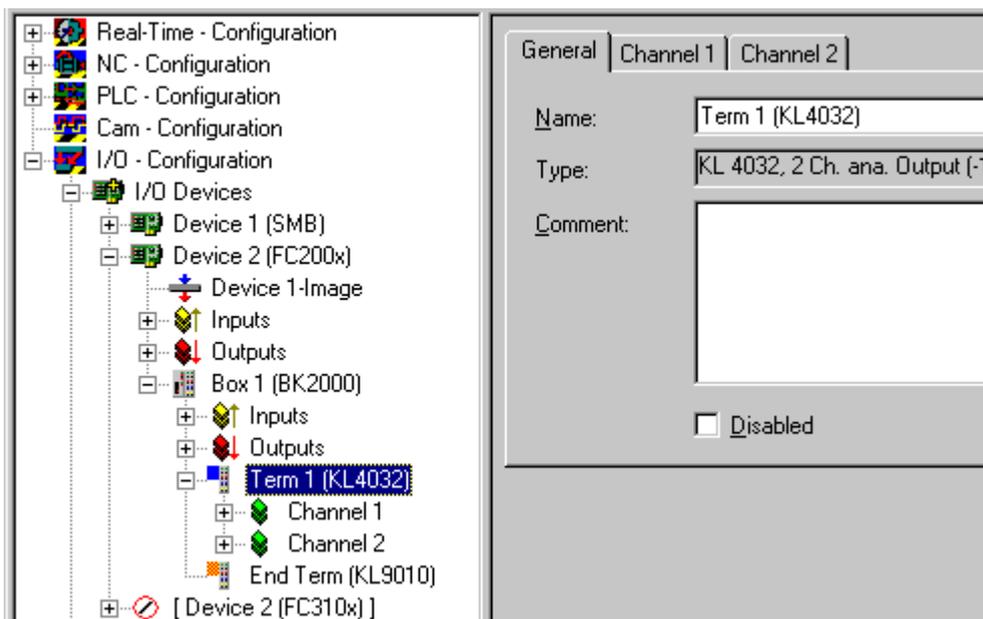
Cancel

Closes the dialogue without adding a terminal to the configuration.

You can find further information about the configuration of the terminals in the System Manager under: [Terminal Configuration](#). [► 107]

8.8 Terminal Configuration

Once a terminal has been added it will appear in the System Manager tree view. On the right hand side, you will see the general and terminal-specific dialogues:

**Name**

In this view you can edit the identifier for the selected terminal, which will then appear in the tree view and in the [Exporting Variables Information](#) [► 35].

Type

Names the selected terminal type and its function.

Comment

User-defined comment on the terminal to be used (e.g. specific, user-defined settings in the terminal registers). The comment given here is also displayed when performing configurations under [Bus Terminal Controller - Configurations](#) [► 110], the subsequent [Exporting Variables Information](#) [► 35] and in the [Global BC Variable List](#) [► 113]. This information also appears when importing I/O variables into the [TwinCAT OPC Server](#).

Disabled

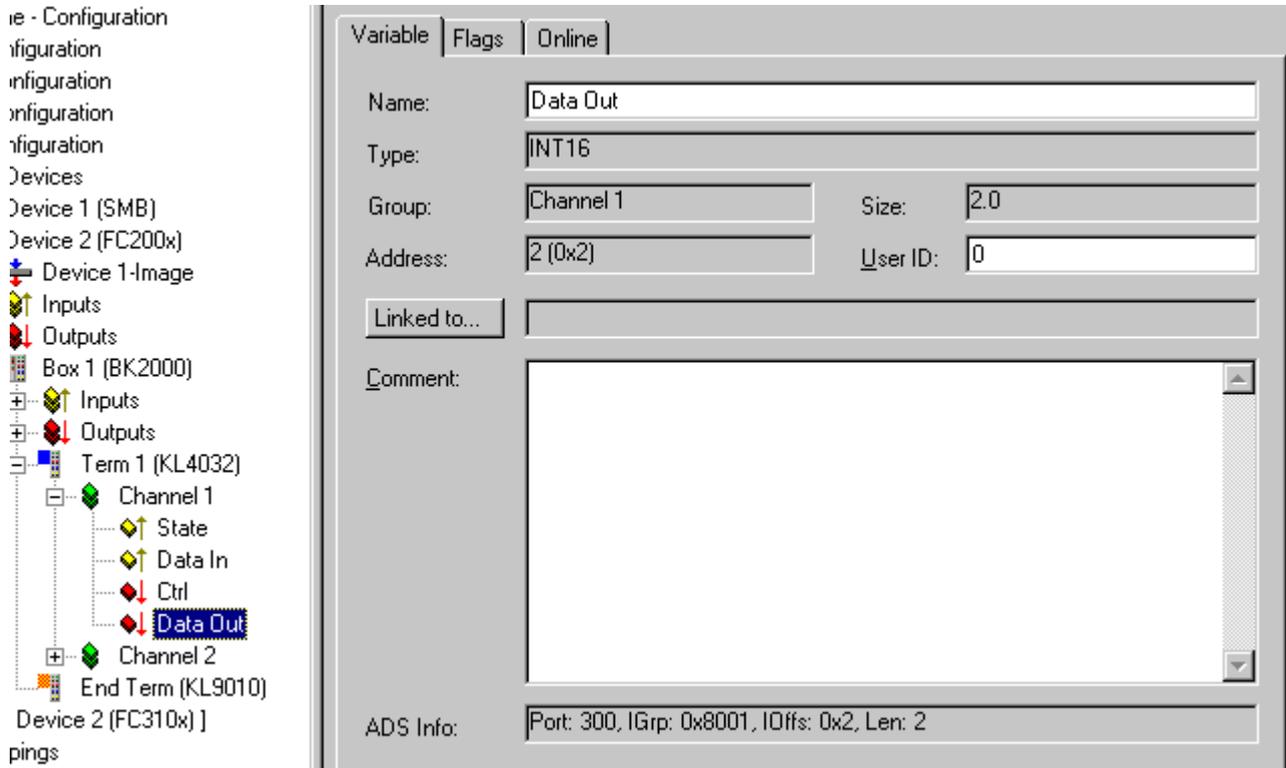
Disables the terminal input for the current configuration (transparent), i.e. the terminal is excluded from the configuration and calculation.

Variable Links - Terminal Channel Dialogues

This area is context-dependant, i.e. the dialogue type can depend on the selected terminal. There are two options for linking terminal variables with task variables (e.g. in/outputs for a PLC task).

1st option

Open the terminal within the tree view to the lowest level and select the physical I/O variable you wish to link (the example shows 'Data Out', the process data output for this terminal).



Name

Identifier of the selected physical I/O variable.

Type

Data type of the selected physical I/O variable.

Group

The channel to which the selected physical I/O variable belongs.

Size

Number of data bytes of this physical I/O variable.

Address

Parameter offset in the local process image of the coupler.

User ID

User-defined identification number for this variable (for future System Manager functionality).

Linked to

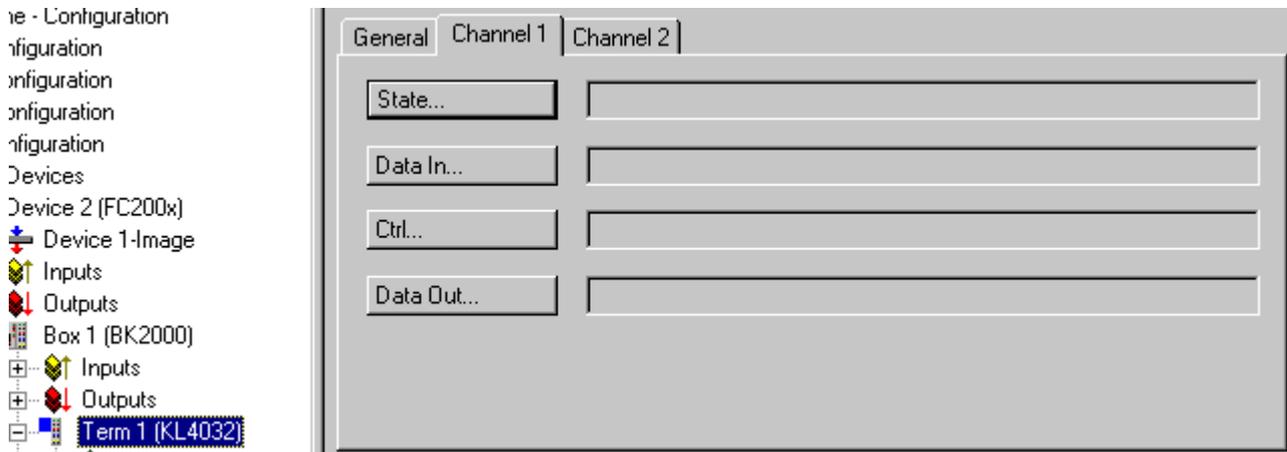
Calls up the variable link [Selection Diagram](#) [► 43].

Comment

User-defined comment on the physical I/O variable.

2nd option

Select the terminal in the tree view and then go to the channel required in the dialogue on the right-hand side. In the dialogue, all physical I/O variables are listed. Here you can link the process data in/outputs and possible terminal Control/Status information with task variables ([Selection Diagram](#) [[▶ 43](#)]).



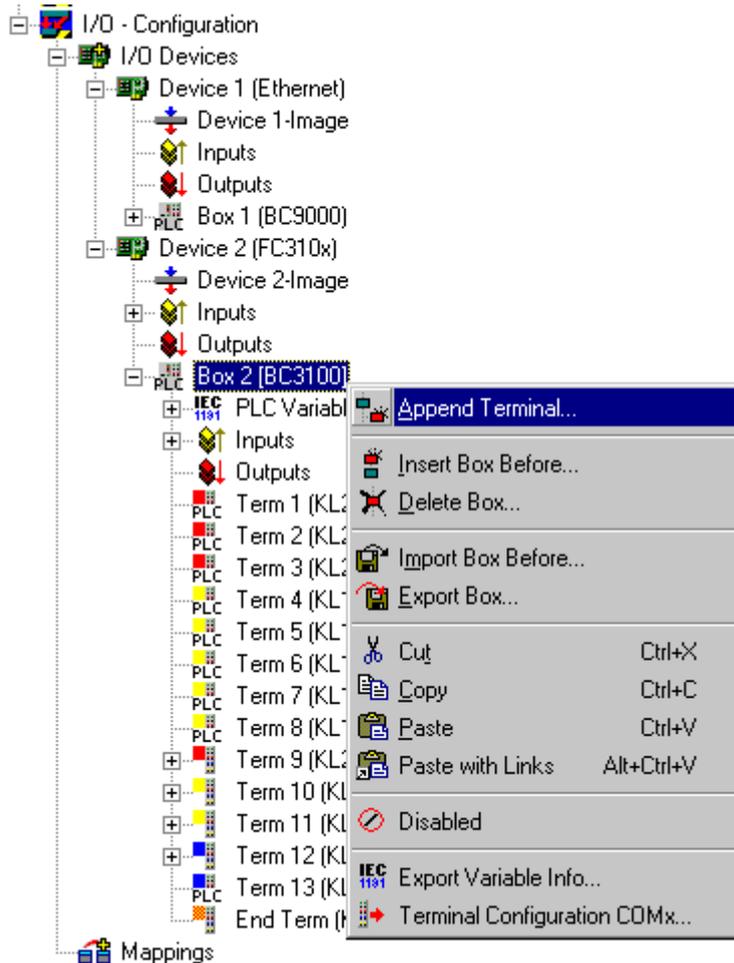
Details about the various Beckhoff Bus Terminals are described under [Terminals - Technical Reference](#) [[▶ 378](#)].

9 Bus Terminal Controller

At some fieldbus cards (e.g. Ethernet, Profibus, Interbus and Lightbus) you can add programmable Bus Terminal Controllers (BC) as well as the standard in/output modules (*boxes*). These controllers are bus couplers with PLC functionality. This device type requires additional settings which are described under [Bus Terminal Controller Configuration](#) [▶ 110].

9.1 Context Menu, Bus Terminal Controller

Right mouse click below I/O Devices [▶ 97] on Added Box [▶ 100] (the example shows a *Beckhoff BC3100 Profibus BC*) to open a context menu with the following inputs:



Append Terminal

Calls up the [Selection Diagram](#) [▶ 111] specific for the various Bus Terminal controllers.

Export Variables Info

Can display a dialogue for exporting a terminal configuration and enable subsequent importing of the variable list into TwinCAT PLC Control. This process allows you to specify I/O variables, address offsets and comments on the configured terminals and [Data Exchange Variables](#) [▶ 112] in the [Global Variable List of the BC](#) [▶ 113] after an import. This applies equally to importing the existing file to the [TwinCAT OPC Server](#).

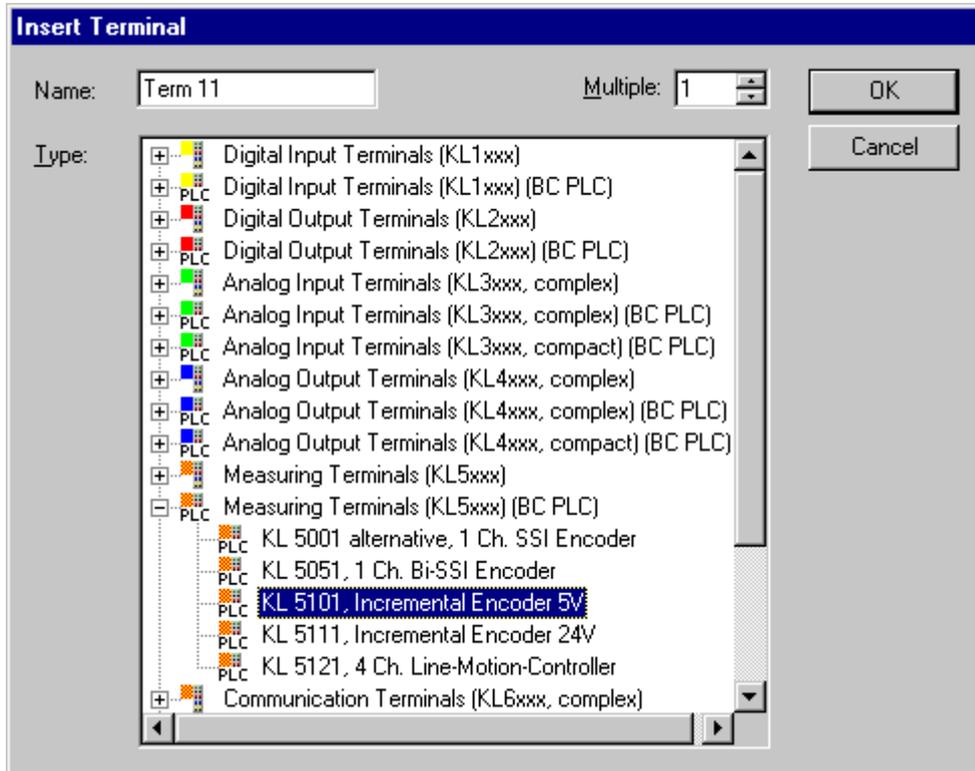
Terminal Configuration via COMx

Displays the [Selection Diagram](#) for loading a terminal configuration into the BC (via the serial interface).

Here not mentioned context menu items are described under [Adding Bus Terminals](#) [▶ 104].

9.2 Terminal Selection Diagram for Bus Terminal Controllers

After selecting *Add Terminal...* you will see a Selection Diagram beneath a Bus Terminal Controller (e.g. BC3100, BC2000 or BC9000) for the various digital, analogue and non-standard terminals. It is important to note here, as shown in the image below, that all terminals are represented, as is usually the case for Bus Couplers and for the BC PLC, as non-linking and thereby locally used terminals.



Details about the various Beckhoff Bus Terminals are described under [Terminals - Technical Reference \[▶ 378\]](#).

Type

The list shows the different Beckhoff Bus Terminals sorted by their main groups. Analogue and special terminals are provided and listed according to fieldbus system

- *Compact*: Only the terminal's data bytes are integrated into the System Manager device configuration [Process Image \[▶ 46\]](#) on the PC.
- *Complex*: The terminal's data and control/status bytes are integrated into the device configuration process image on the PC.
- *PLC - compact*: The terminal's data bytes provided only, and only for the local BC process image
- *PLC - complex*: The terminal's data and control/status bytes, for the local BC process image.

Name

The identifier for the selected terminal can be edited here. The revised name is used for e.g. [Exporting Variable Info \[▶ 110\]](#).

Multiple

Inserts n terminals of the selected type continuously into the configuration.

OK

Integrates the selected terminals into the configuration.

Cancel

Closes the dialogue without adding a terminal to the configuration.

You can find further information about the configuration of the terminals in the System Manager under: [Terminal-specific Dialogues \[► 107\]](#).

9.3 Data Exchange PC/Bus Terminal Controller

For Bus Terminal controllers you can define below *PLC variables* data exchange variables (see example in the tree view below) for the fieldbus-based PC to PC communication.

If you select a BC in the tree view of the TwinCAT System Manager, the following *BC Mini PLC* dialogue (amongst others) will appear on the right-hand side:

"PLC" Dialogue
PLC Cycle Time

The reserved Mini PLC cycle time. During this period, no data will be sent by the BC to the fieldbus.

Background Time

Time for the processing of the communication via the fieldbus (includes program download, debugging,...).

PLC Var. Offs IN

Start offset of the data exchange variables in the input area of the [BC Process Image \[► 113\]](#).

PLC Var. Offs OUT

Start offset of the data exchange variables in the output area of the [BC Process Image \[► 113\]](#).

AMS Response during download

Can be disabled for compatibility reasons in old Bus Terminal controllers (BC3100 and BC2000). Newer bus controller firmware versions acknowledge the receipt of individual download sequences. This checkbox must therefore be activated (in all cases for BC9000).

Start with Configuration Error

Even if the configured BC9000 is not connected to the network, it is possible to start the TwinCAT system if this checkbox is enabled.

Retain Data

Store Retain Data: Activates the support of residual data in the Bus Terminal controller.

Size: Size of the retain data area within the Bus Terminal controller (%Mx0 .. %Mxy).

KBus Update

Double Cycle: Activates the execution of BC station I/O cycles (KBus Update) within before and after each PLC cycle.

Before PLC: A KBus update will be carried out before executing the PLC cycle.

After PLC: A KBus update will be carried out after executing the PLC cycle.

Firmware Update (via COMx)

This function is used to update a BC firmware version.

”Variable” Dialogue

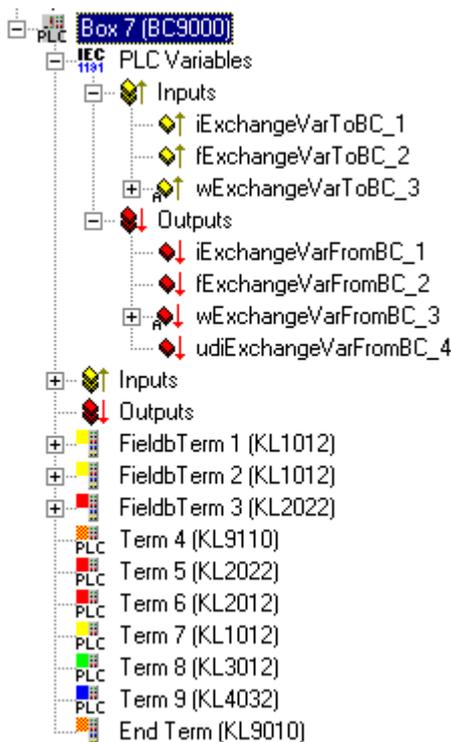
After selecting [Adding Variables \[▶ 35\]](#) you will see the dialogue for the selected variable on the right-hand side under the tree input *PLC Variables*, as described in the [Variables Information \[▶ 37\]](#) rubric.

You should, of course, use intelligent names for the data exchange variables as these are used when [Exporting Variable Information \[▶ 35\]](#) as variable names in the local [BC Process Image \[▶ 110\]](#).

You may now [Link \[▶ 39\]](#) the data exchange variables with existing tasks.

Sample BC configuration

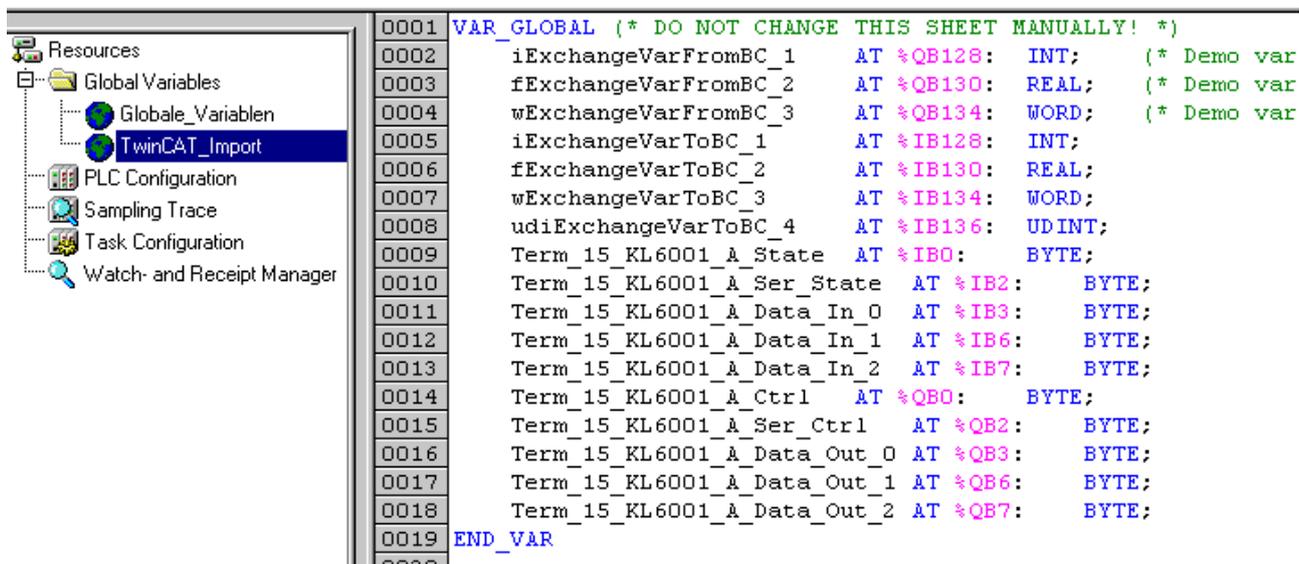
The image below shows both data exchange variables and fieldbus variables. The BC manages terminals 4 - 9 locally.



9.4 Example: Global Variable Lists

TwinCAT PLC Control

After importing an exported file using [Export Variables Info \[▶ 110\]](#)... in the TwinCAT System Manager, you will see a variable list named *TwinCAT_Import* under *Resources* in the *Global_Variables* folder.



The variables are composed of the [Names \[► 107\]](#) configured in the System Manager and the type of terminal, along with the channel number and the definition of the terminal variable. The address in the local BC process image (IEC61131-3 notation) and the data type of the variables are given.

The variables in lines 2 to 8 are [Exchange Variables \(PLC Variables\) \[► 112\]](#) to be transferred via the fieldbus. They serve to exchange data between the BC PLC program and the superordinate control system. They can, for instance, be processed further with TwinCAT PLC, TwinCAT OPC or via ADS on the application level. For example, the declared output variables for the outputs process image (lines 2, 3 and 4) are inputs in the superordinate control system. The variables of lines 5 - 8 are correspondingly outputs of the superordinate control system.

The exchange variables in the local BC process image start from offset 128 (as shown in the example). Nevertheless, this offset can also be [set \[► 112\]](#) in a System Manager dialogue if necessary.

Details on the different Beckhoff Bus Terminal types (e.g. definition of descriptors *Ctrl* and *State* and *Data_x*) are described under [Terminals - Technical Reference \[► 378\]](#).

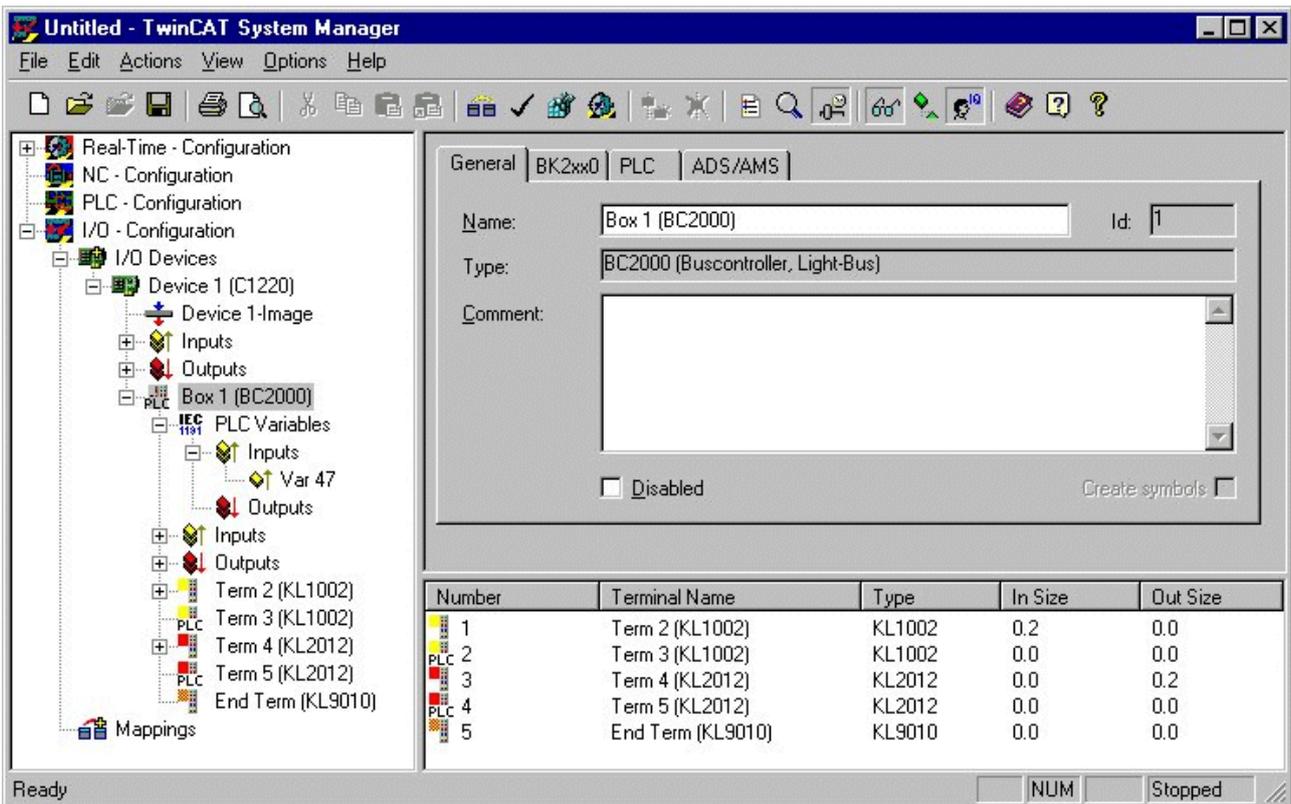
9.5 Merging the BC2000 in the TwinCAT system manager

basic properties:

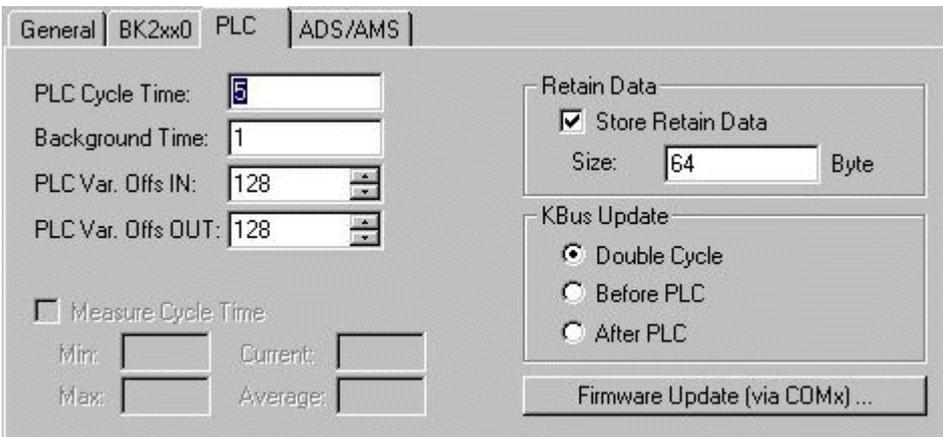
The basic properties of the bus terminal controller are handled in the system manager. The terminals of the bus terminal controller can be assigned directly to the Lightbus master or to the BC2000. Terminals that are assigned directly to the BC2000 are displayed in the system manger with "PLC", and are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

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

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



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



PLC Cycle Time

The PLC cycle time determines the program's repetition frequency. This time is not deterministic. This means that when the program in the bus terminal controller needs more time, the PLC cycle time rises. If the program needs less than the cycle time, it is repeated at intervals of the set cycle time. The processing of the Lightbus and the serial interfaces is executed in the background time. This should be set to approx. 20 % of the PLC cycle time.



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



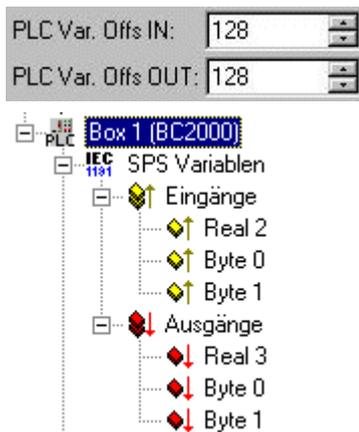
PLC cycle time = mean cycle time + 20% = 10 ms + 20% = 12 ms
 Background time = PLC cycle time * 0,2 = 12 ms * 0,2 = 2,4 ms " 2 ms

Mean cycle time

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

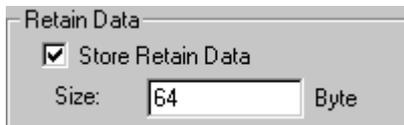
PLC Variables

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



Remanent Variables

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



Terminal Bus (K-Bus) Update

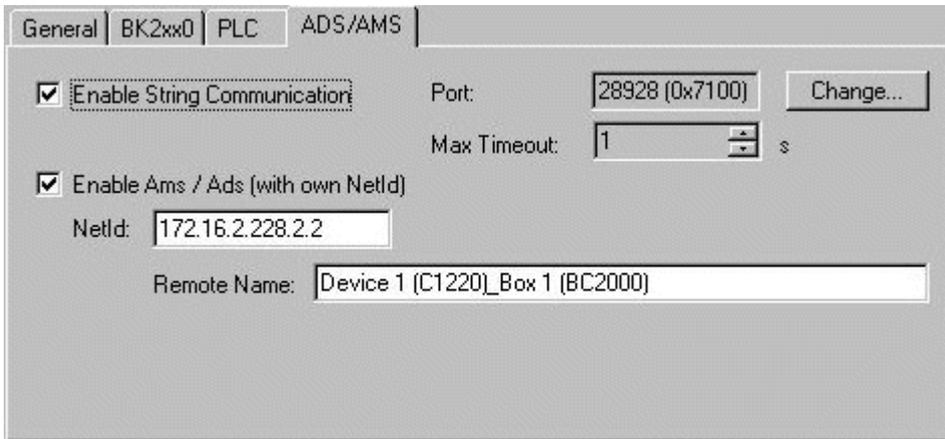
Double Cycle: Terminal bus inputs before the PLC cycle Terminal bus outputs after the PLC cycle

Before PLC: Terminal bus inputs and outputs before the PLC cycle

After PLC: Terminal bus inputs and outputs after the PLC cycle

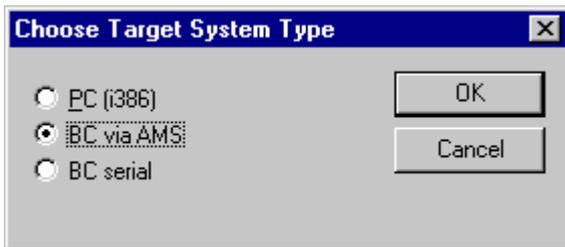
Program download via the fibre optic ring

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



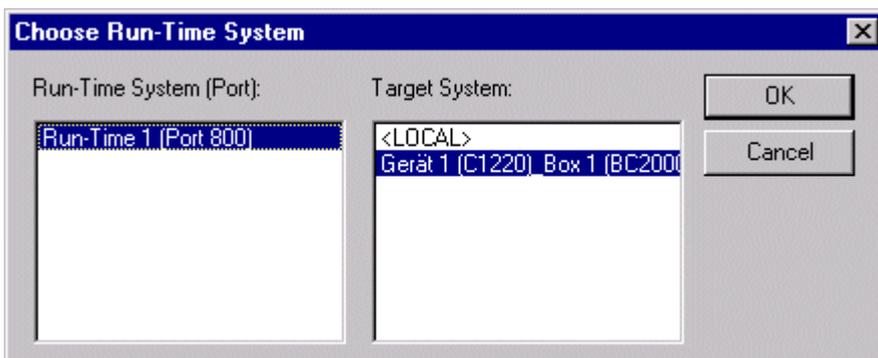
Selection of the target platform

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



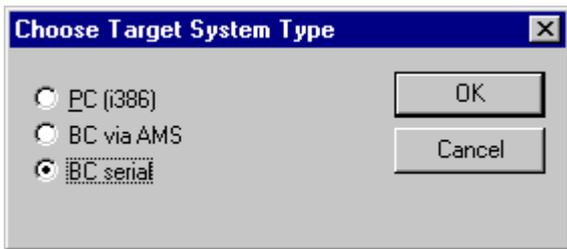
Selection of the target system

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



Program download via the RS232 interface

Every bus terminal controller offers the possibility of being programmed via the PC's RS232 interface. This can be implemented with the aid of a special cable. For this purpose, the serial interface is selected in PLC Control.



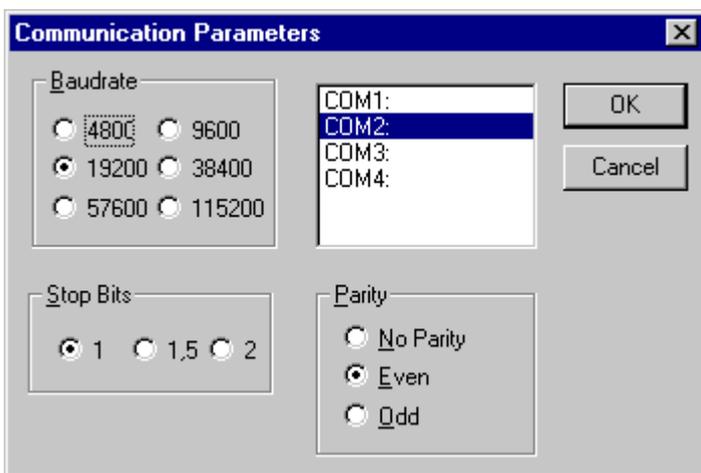
Communication parameters

The settings for the serial interface, port number, baud rate etc. are found under Online/Communication parameters in PLC Control. The bus terminal controller requires the following setting:

Baud rate: 19200

Stop bits: 1

Parity: even



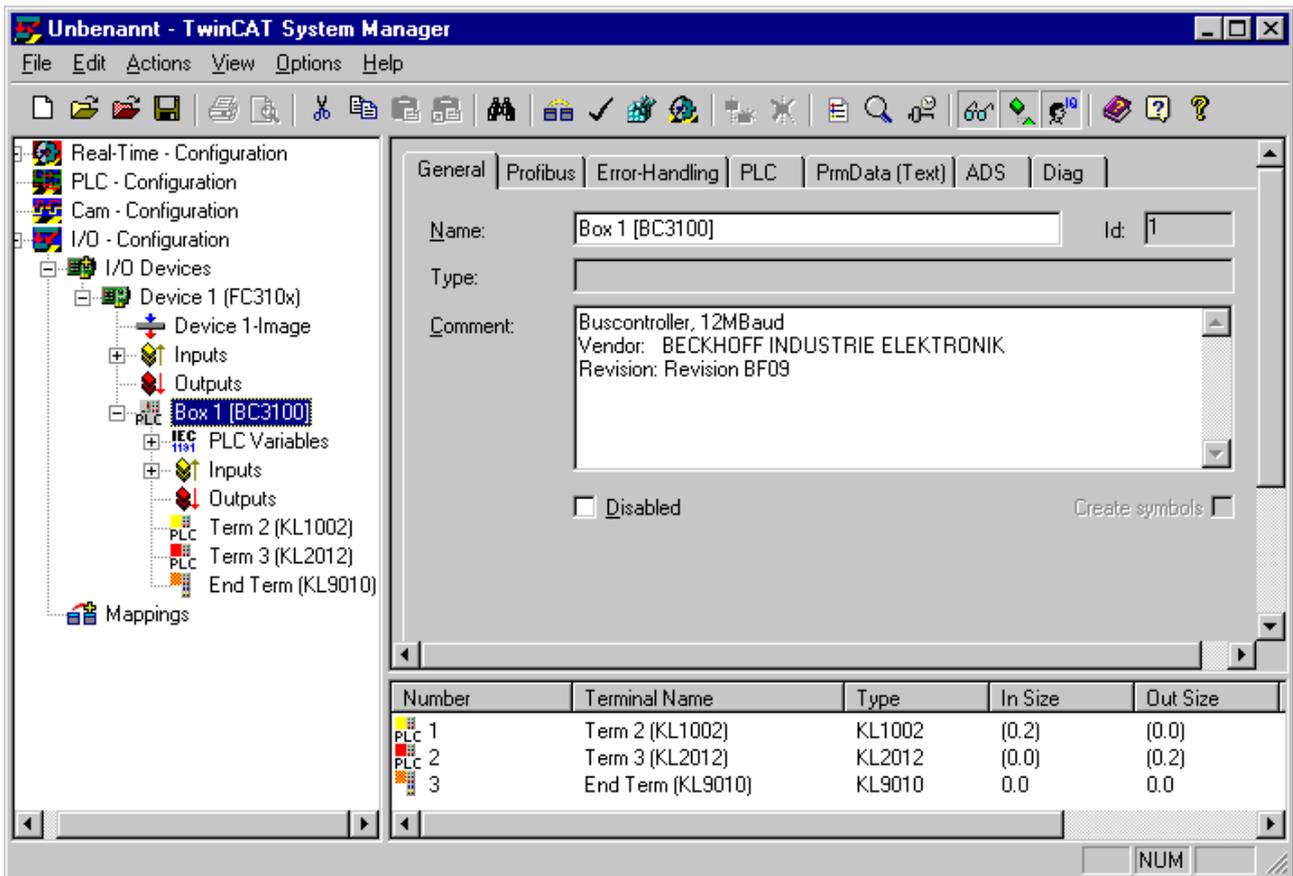
9.6 Merging the BC3100 in the TwinCAT System Manager

basic properties:

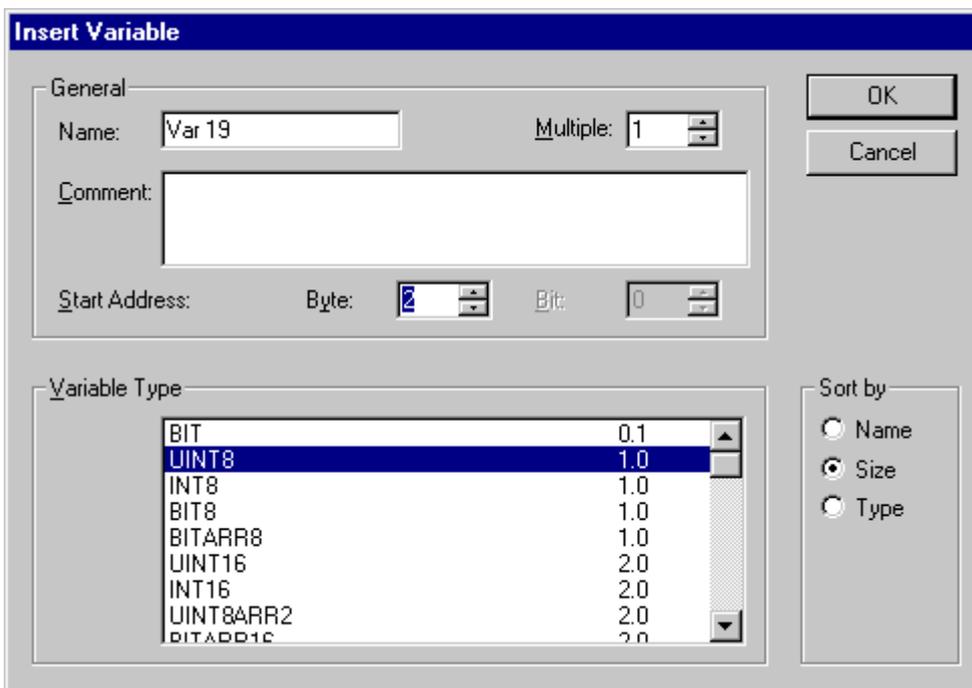
The basic properties of the bus terminal controller are handled in the system manager. The terminals of the bus terminal controller can be assigned directly to the Lightbus master or to the BC3100. Terminals that are assigned directly to the BC3100 are displayed in the system manger with "PLC", and are not visible to the master. A further distinction between "Complex" and "Compact" is also made in the analogue terminals.

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

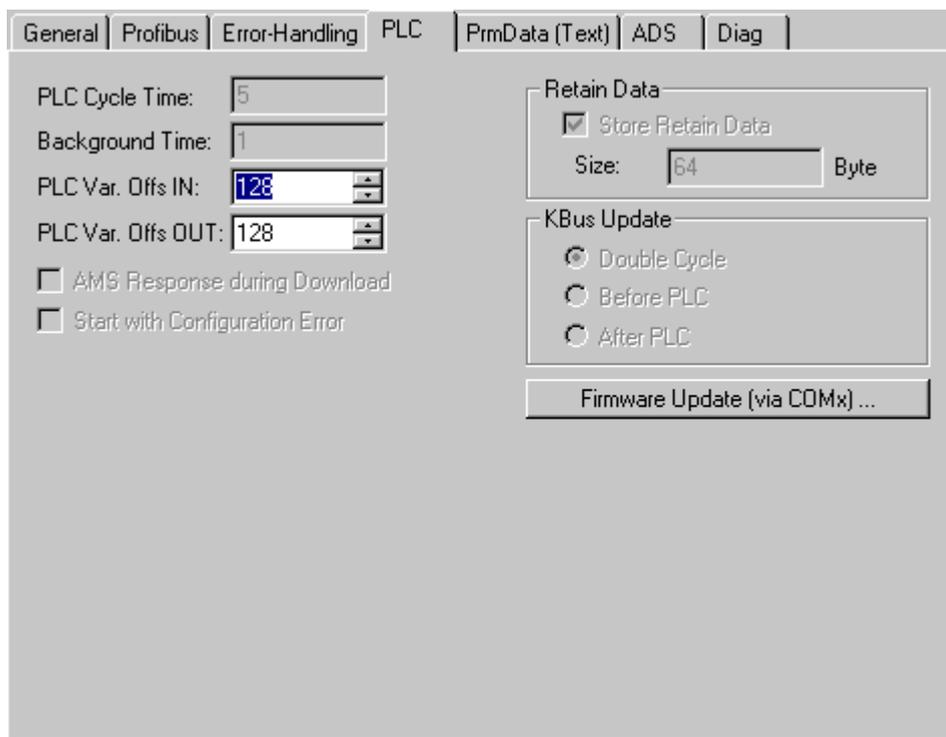
The terminals that are assigned to the master are invisible to the bus terminal controller. If it is desired to make a terminal visible to both systems, the terminal must first be assigned to the BC3100, and then the data from the terminal are transmitted to the master via the PLC variables.



If you merge the PLC variables, the following dialog opens. It determines the start address.



The settings for the PLC in the bus terminal controller are found under the "PLC" tab. All the basic settings that control the properties of the PLC in the BC3100 are handled there.



PLC Cycle Time

The PLC cycle time determines the program's repetition frequency. This time is not deterministic. This means that when the program in the bus terminal controller needs more time, the PLC cycle time rises. If the program needs less than the cycle time, it is repeated at intervals of the set cycle time. The processing of the Lightbus and the serial interfaces is executed in the background time. This should be set to approx. 20 % of the PLC cycle time.



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



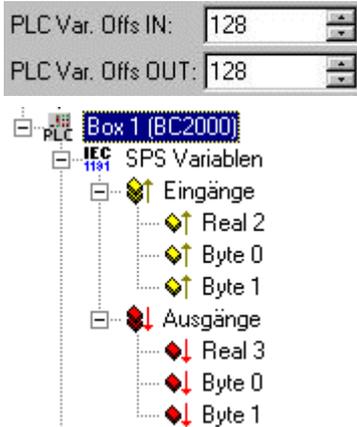
PLC cycle time = mean cycle time + 20% = 10 ms + 20% = 12 ms
 Background time = PLC cycle time * 0,2 = 12 ms * 0,2 = 2,4 ms " 2 ms

Mean cycle time

The measured cycle time also includes that required for the terminal bus update. This results in a connection between the number of terminals that are inserted and the cycle time. Before initiating the program, the bus terminal controller executes a terminal bus update, to interrogate the inputs. After the program has been executed, the BC3100 carries out another terminal bus update, to write the current outputs. The background time follows this. The cycle time can also be shortened if the terminal bus update is carried out simultaneously for inputs and outputs (see Terminal Bus Update).

PLC Variables

PLC variables are variables that are situated in the BC3100 from addresses %IB128 and %QB128. This offset can be shifted. These addresses are not assigned to any terminal, so that signals or data can be transmitted to or received from the master via the PLC variables.



Remanent Variables

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



Terminal Bus (K-Bus) Update

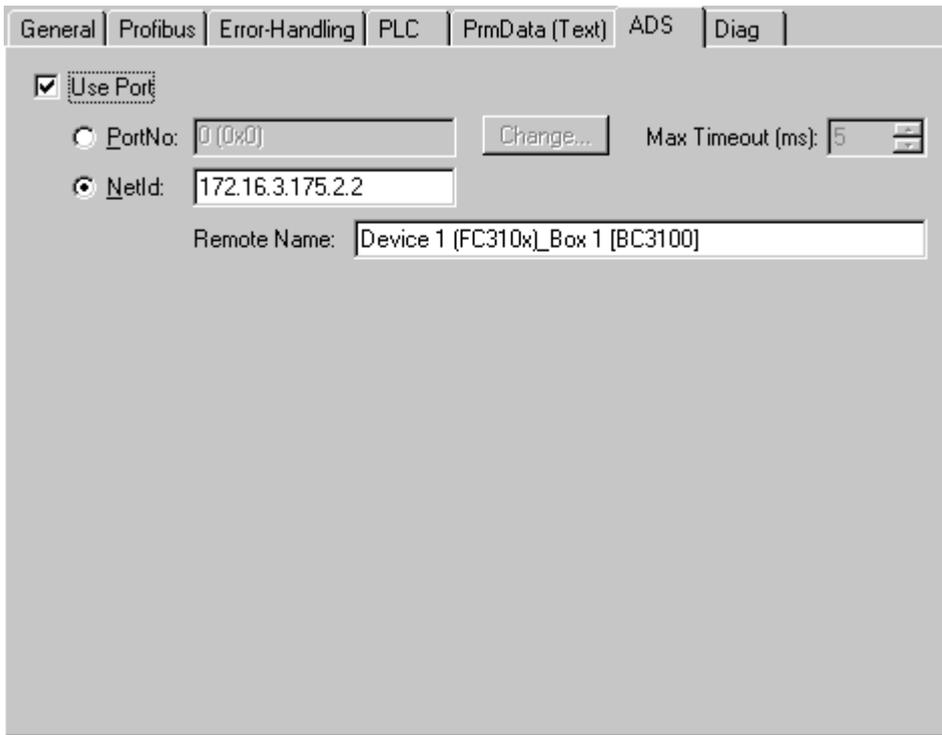
Double Cycle: Terminal bus inputs before the PLC cycle Terminal bus outputs after the PLC cycle

Before PLC: Terminal bus inputs and outputs before the PLC cycle

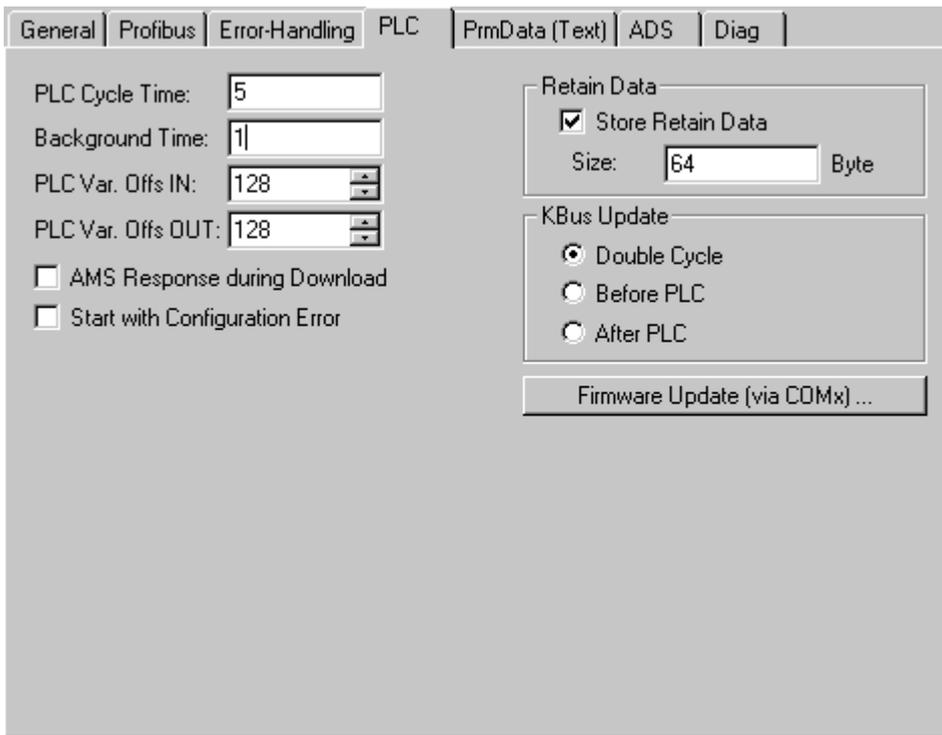
After PLC: Terminal bus inputs and outputs after the PLC cycle

Program download via the fibre optic ring

TwinCAT offers a facility for transferring the program to the BC3100 over the optical fibre ring. To do this, string communication and the Ams/Ads must be activated in the system manager under the ADS/AMS tab. The TwinCAT system is started after the configuration has been saved. Now the BC3100 target system can be selected in PLC Control.



Thus the PLC tab changes as follows:



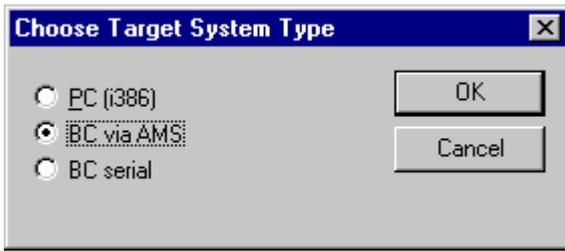
If the program is larger, AMS Response during download must be selected.

After saving the configuration you can start the TwinCAT System. In the PLC Control it's now possible to select the target system of the BC3100.

Selection of the target platform

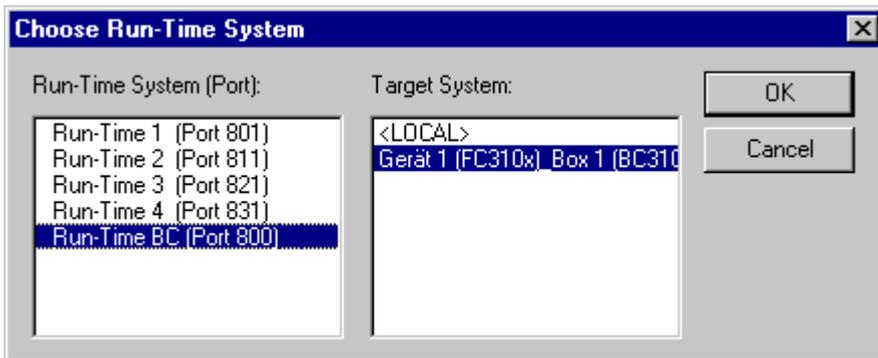
When TwinCAT PLC Control is restarted, the program asks for the target platform, i.e. the device on which the user will want his program to run. TwinCAT offers two target platforms, the PC as a controller and the BC3100 coupler. For the program transfer with the bus terminal controller there are again two possibilities.

"AMS" is for communication over the fieldbus, while the "serial" communication takes place via the PC's serial interface and the BC3100 programming interface. (Zu öffnen unter dem Karteireiter Ressourcen -> Steuerungskonfiguration)



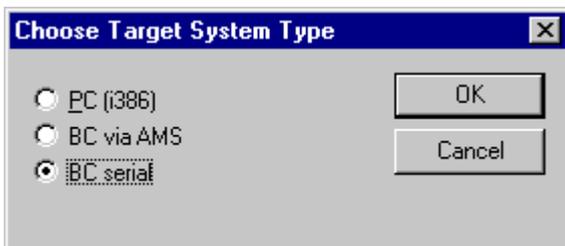
Selection of the target system

Once the program has been written, the target system is selected under the "Online" symbol bar. In this example, the FC310x with the Box1 and the Run-Time1 of the bus terminal controller.



Program download via the RS232 interface

Every bus terminal controller offers the possibility of being programmed via the PC's RS232 interface. This can be implemented with the aid of a special cable. For this purpose, the serial interface is selected in PLC Control



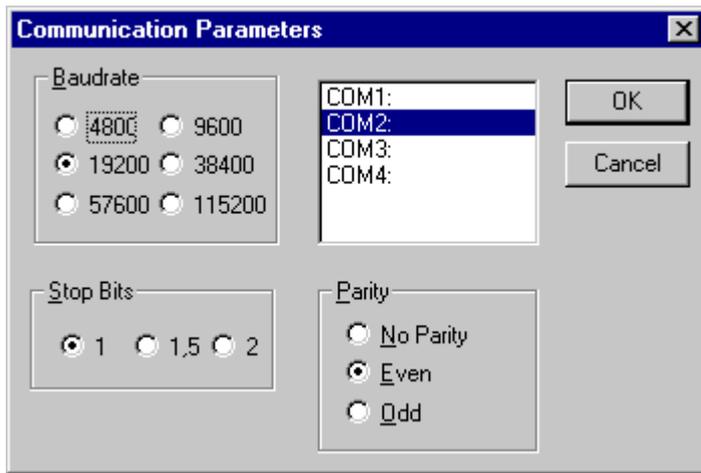
Communication parameters

The settings for the serial interface, port number, baud rate etc. are found under Online/Communication parameters in PLC Control. The bus terminal controller requires the following setting:

Baud rate: 19200

Stop bits: 1

Parity: even

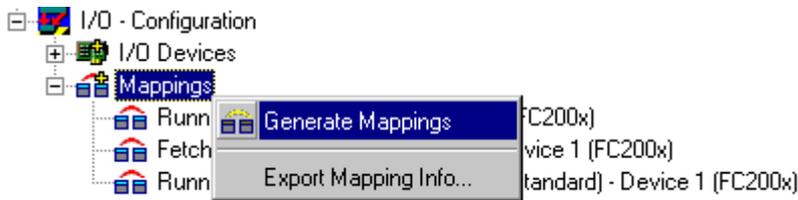


10 Mappings

The [Variable Links](#) [▶ 39] created for the various [Process Images](#) [▶ 46] can be controlled afterwards in a graphical display. See the rubric *Assignments* beneath *I/O Configurations*.

Context Menu

Right click on *Mappings* to display its context menu. If you select the "Generate Mappings" entry, the copy actions between the configured tasks and devices will be recalculated.



Generate Mappings

On the right-hand side the corresponding dialogue for the generated mappings will appear as shown below. Select a device mapping to view its cross-reference lists.

Cross Links

NC-Task 1 SAF - RunningSystemFor2Axes_Tc27new (Standard) RunningSystemFor2Axes_Tc27new (Standard) - Device 1 (FC200x) RunningLights (Standard) - Device 1 (FC200x) FetchRecvExmpRTS4 (Standard) - Device 1 (FC200x)	<input type="checkbox"/> Address A <input type="checkbox"/> B <input checked="" type="checkbox"/> Type(s) <input type="checkbox"/> Size(s) <input type="checkbox"/> Offsets <input type="checkbox"/> Swap Images <input checked="" type="checkbox"/> Auto Column Width <input type="checkbox"/> Long Names
--	--

RunningSystemFor2Axes_Tc27new	Address	Device 1 (FC200x)	Type
> AX2000_DriveError	1000.0	DatIn	UINT32 / UINT16ARR2
> bMomSwitchStartCalibrAxis1	0.5	Input	BIT
> bMomSwitchStartCalibrAxis2	0.6	Input	BIT
> bSoftClick_StartAxis1	0.0	Input	BIT
> bSoftClick_StartAxis2	0.2	State . State[4]	BIT
> bSoftClick_StopAxis1	0.1	State . State[1]	BIT
> bSoftClick_StopAxis2	0.3	State . State[3]	BIT
< bLampAxis1Calibrated	1.0	Output	BIT
< bLampAxis2Calibrated	1.1	Output	BIT

Settings options in the cross-referencing dialogue

Address A

Shows the addresses of the linked variables of the process image A. In the case of PLC tasks (as in the example of the *RunningSystem* PLC project task standard) these are the addresses at which the variables were located at %I... / %Q... Select this option to display the *Address* column in the list. Click on the column header to display the variables sorted by their addresses (ascending or descending order).

Address B

Shows the addresses within process image B. Process image B can be a task for physical I/Os (the example shows a task for updating a *C1220* card) or another linked task within the system configuration.

Type(s)

Displays/removes the [Data Type \[▶ 49\]](#) information column.

Size(s)

Displays/removes the byte size information column for the current data type.

Swap Images

Swaps process image A and B in the list.

Auto Column Width

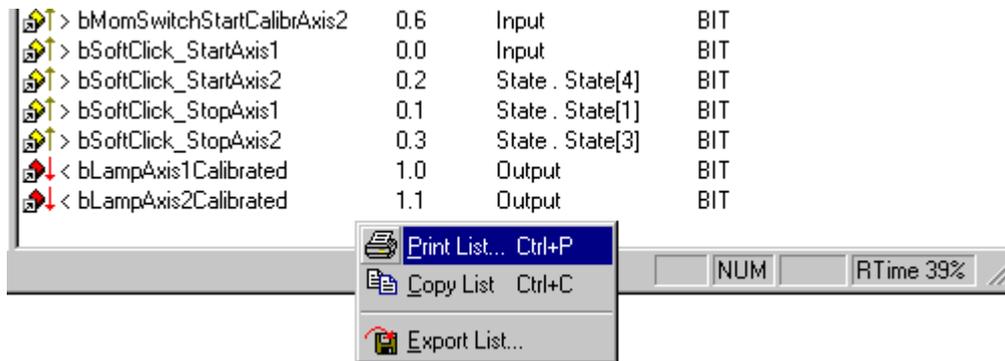
Adapts column width automatically to accommodate long variable names.

Long Names

Shows the linked target variable in its own column with detailed information (coupler name, terminal name..).

Context Menu

Right click the mouse in the list window to display the context menu for the documentation functions.

**Print List**

Outputs the list with all displayed information to the installed printer. For further documentation functions see: [Extended Link Options. \[▶ 45\]](#)

Copy List

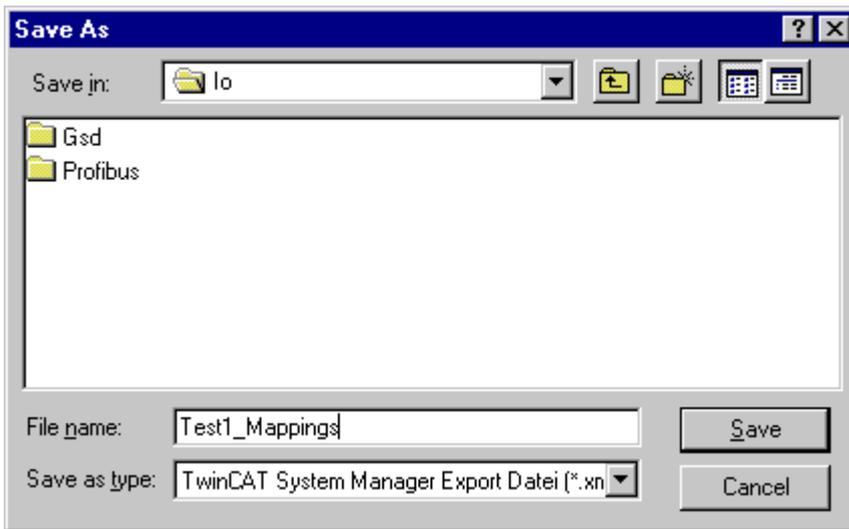
Copies the list to the clipboard.

Export List

Exports the variable list in *.csv file format (comma separated values), for further processing (e.g. with a spreadsheet program, etc.).

Export Mapping Info

This *Mappings* context menu entry calls up a file selection box which is used to save link information for the current System Manager project (XML text file).



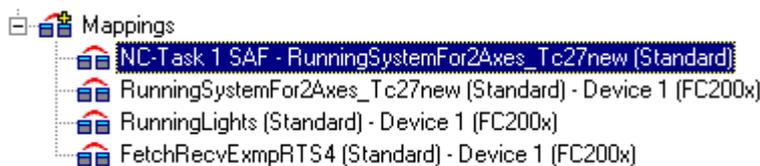
You can import this file later to restore the previous links in the event of configuration changes or loss of mapping information. Variable names do not need to be changed in this case.

If you wish to save the link information of a selected mapping, select the corresponding assignment on the left in the tree view.

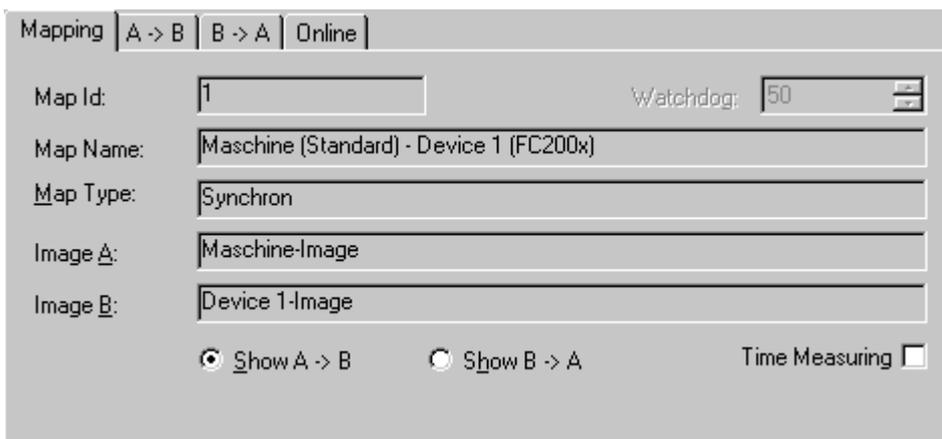
For further information on task/device assignments see: [Process Images \[▶ 127\]](#). Describes, amongst other things, the graphical display of links.

10.1 Mapping Types and Graphical Display

A list of all process image links is given under [Mappings \[▶ 125\]](#).



On the right-hand side the corresponding dialogue for the selected assignments will appear as shown below.



Map ID

Identification number for internal management of the various [Mappings \[▶ 125\]](#).

Map Name

Names both linked process images.

Map Type

- **Synchronous** : A process image is master, second slave. The master actuates the outputs for writing (e.g. to fieldbus card C1220, ..) and checks that the other side has completed its I/O cycle in order to read the current inputs. The other side has no independent cycle time in this case (Engl. timekeeper).
- **Asynchronous** Is set, e.g. in the event of links from two tasks, or with devices operating on their own cycle times (e.g. COM port) and independently regulates and thereby the refreshes inputs and outputs. The exchange of information between two Process Images [▶ 46] thereby takes place in the case of asynchronous mapping based on the three-buffer principle.

For some device types (e.g. the multitasking Profibus card *FC310x*) a mix of synchronous and asynchronous assignment (mappings) is used. In relation to the device the higher Priority [▶ 62] task behaves in a synchronous manner while the lower priority task is asynchronous.

Watchdog

In the case of asynchronous mapping (*see Map Type*) a task could fail to conclude correctly (endless loop), the other task is, however, processed as normal and therefore continues to read old values from the buffers. A maximum lifecycle value is specified to prevent this occurring. Once the value is reached, all buffer values are reset to '0'.

Timing

Activates the timing of a synchronous assignment (*see Map Type*).

Process Image A

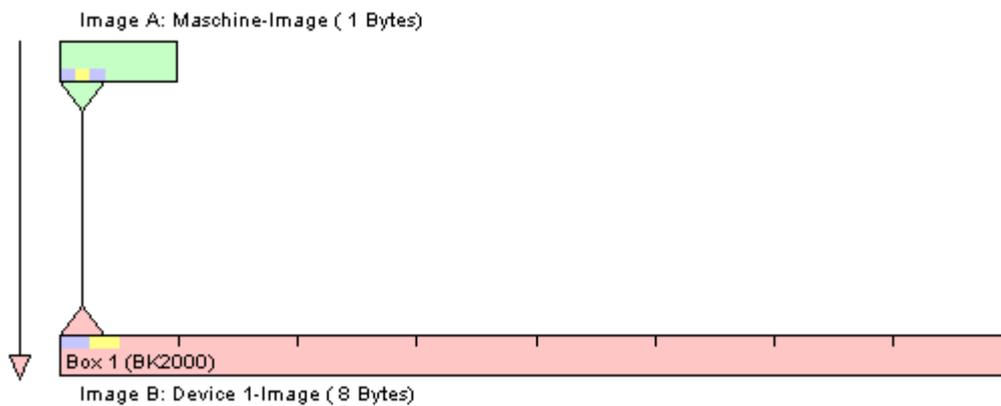
Shows the task name assigned to process image A.

Process image B

Shows the task name assigned to process image B.

Show A -> B and/or B -> A

Exchanges the direction of both process images in the displayed view.

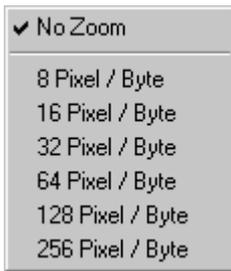


The colors green and pink represent process images A and B. The colors yellow and blue are in/outputs of the process image. Click with the mouse on the in/outputs to display a tool tip with the variable terminal names.

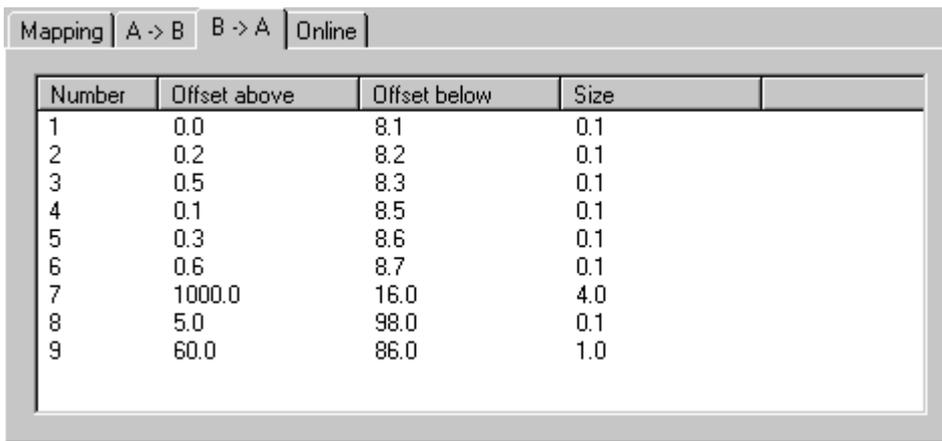


Context Menu

A right mouse click displays the context menu via which you can set the zoom resolution of the mapping's graphics. The higher the pixel value per byte, the easier it is to assess the links for individual variables.



Dialogues "A -> B" and/or "B -> A"



Number

Current Copy Action Number.

Offset A

Gives the offset within process image A, from which the copy action is actuated.

Offset B

Gives the offset within process image A, from which the copy action is actuated.

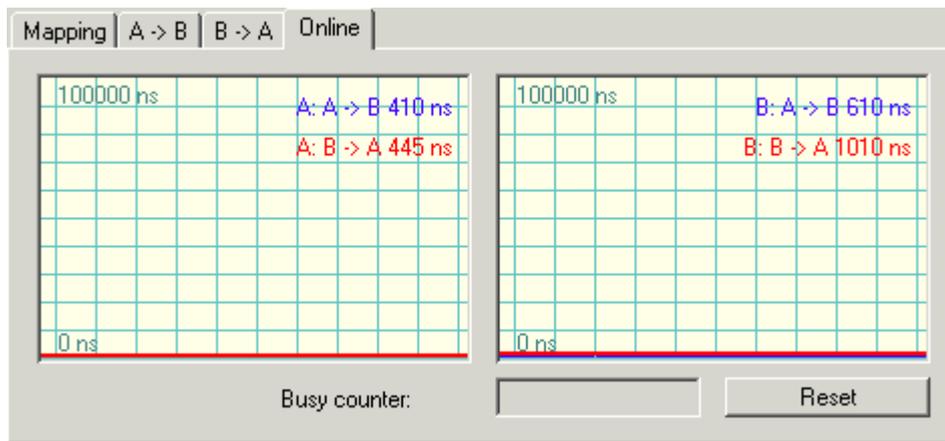
Size

Length of the values to be copied from each offset (e.g. 0.1 means that one bit is copied).

"Online" tab

With an active configuration and the system started, you will find a graphic illustration of the time (in nanoseconds) that is currently required for copying process image A to B or B to A here. This dialog has existed since TwinCAT 2.8 with synchronous *and* asynchronous assignments (cf. "Assignment types" above).

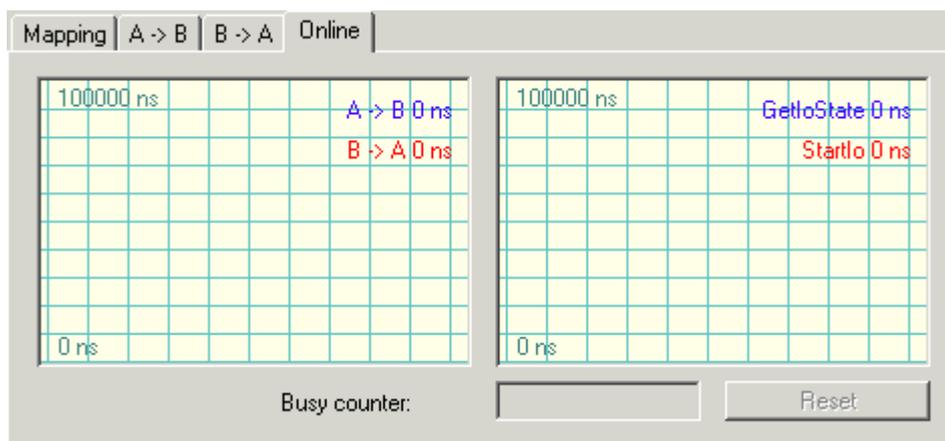
Asynchronous assignments:



The time shown along with

- *A: A->B* refers to the copying of all the data of this assignment for process image A into the buffer for B.
- *A: B->A* refers to the copying of all the data of this assignment for process image A out of the buffer for B.
- *B: A->B* refers to the copying of all the data of this assignment for process image B out of the buffer for A.
- *B: B->A* refers to the copying of all the data of this assignment for process image B into the buffer for A.

Synchronous assignments:



The time shown along with

- **A->B** refers to the copying of all the data of this assignment for process image A to B.
- *B->A* refers to the copying of all the data of this assignment for process image A from B.
- *GetIoState* refers to the duration of the testing function `GetIoState()`, whose complexity varies depending on the fieldbus card employed.
- *StartIo* refers to the duration of the function `StartIo()`, which starts the bus and whose complexity varies depending on the fieldbus card employed.



All times are measured as the difference in the time between the beginning and end of the respective action and can therefore strongly fluctuate in the event of interruptions.

Details of the continuously running graphic display of the current online value can be found under: [History display settings](#) [► 30].

Busy counter

At synchronous mappings of process images, the master process image checks whether the slave has completed its I/O cycle and offers new inputs for transmission. If transmission does not take place, the *Busy Counter* is incremented by the master. At asynchronous mappings, the "*Busy counter*" field is disabled.

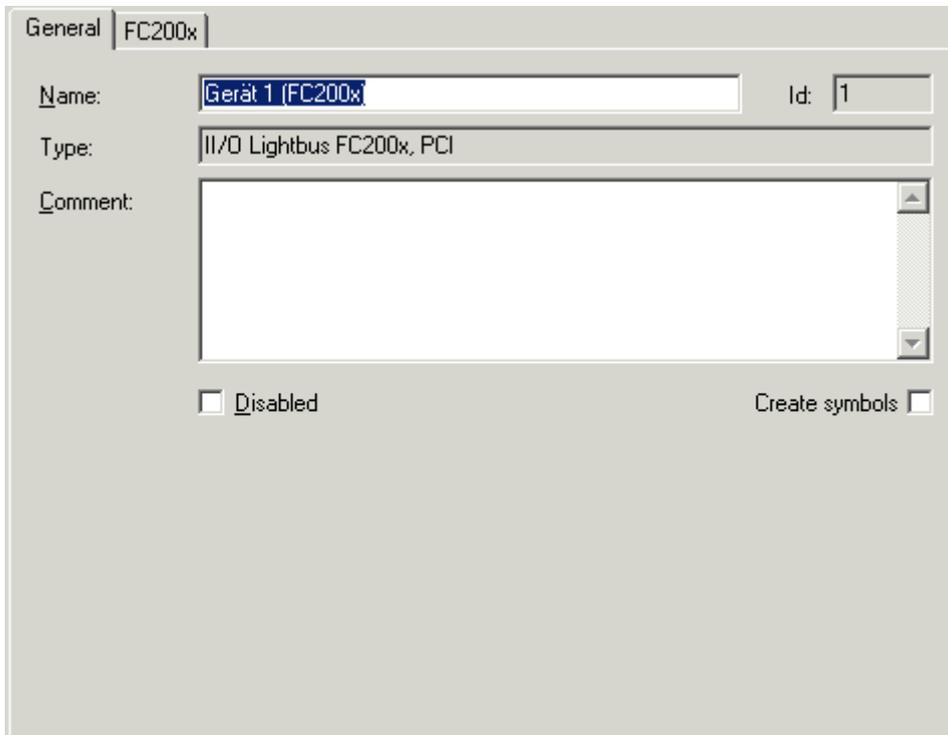
Reset

Resets the *Busy counter* to '0'.

11 Reference

11.1 Dialog "General"

After installing a device (the example shows a FC2001 card) the following dialogue appears on the right hand side in the System Manager view:



The screenshot shows a dialog box titled "General" for an "FC200x" device. The "Name" field contains "Gerät 1 (FC200x)" and the "Id" field contains "1". The "Type" field is set to "I/O Lightbus FC200x, PCI". The "Comment" field is empty. At the bottom, there are two checkboxes: "Disabled" and "Create symbols", both of which are unchecked.

Name

Displays the user-defined name of the device, selected on the left-hand side in the tree.

Id

Identification number for internal management within the System Manager.

Type

Gives the type of the particular I/O device (fieldbus type, etc..).

Comment

User-defined comment giving additional information about the device.

Disabled

Provides the option of driving the configurations without connected hardware for test purposes. Default: Not selected.

Create symbols

Provides the option of creating symbols for the I/O task process data. Default: Not selected.

11.2 I/O Devices

The TwinCAT I/O system resp. System Manager supports with **TwinCAT 2.9** the following I/O devices:

Beckhoff Lightbus

Beckhoff [FC2001](#) [[▶ 135](#)] PCI card, Master

Beckhoff [FC2002](#) [[▶ 135](#)] PCI card, Master (2 channels)

Beckhoff [C1220](#) [[▶ 135](#)] ISA card, Master

Beckhoff C1200 ISA card, Master (max. 2 telegrams)

Beckhoff [CX1500-M200](#) [[▶ 135](#)] PC104, Master

Profibus DP / MC

Beckhoff [FC3101](#) PCI card, Master

Beckhoff [FC3102](#) PCI card, Master (2 channels)

Beckhoff [CX1500-M310](#) PC104, Master

Beckhoff [FC310x](#) PCI card, Slave interface

Beckhoff **CX1500-B310** PC104, Slave interface

Beckhoff **BX3100** Slave interface

Siemens [CP5412A2](#) [[▶ 141](#)] ISA card, Master (FC3100)

Hilscher [CIF30-DPM](#) [[▶ 140](#)] ISA card, Master (FC3000)

Hilscher [CIF30-PB](#) [[▶ 140](#)] ISA card, Master, 8k DPRAM (FC3015)

Hilscher [CIF50-PB](#) [[▶ 140](#)] PCI card, Master, 8k DPRAM (FC3020)

Hilscher [CIF60-PB](#) [[▶ 140](#)] PCMCIA card, Master, 8k DPRAM (FC3060)

Hilscher [CIF104-DPM](#) [[▶ 140](#)] PC104 card, Master (2k DPRAM)

Hilscher [CIF104-PB](#) [[▶ 140](#)] PC104 card, Master (8k DPRAM)

Beckhoff [AH2000](#) [[▶ 254](#)] Profibus MC Slave

Siemens [IM182](#) [[▶ 145](#)] ISA card, Slave (SPC3)

Beckhoff [FC310x](#) Profibus Monitor, PCI

Interbus

Phoenix [IBS ISA SC/I-T](#) [[▶ 150](#)] ISA card, Master

Phoenix [IBS PCI SC/I-T](#) [[▶ 150](#)] PCI card, Master

Phoenix [IBS ISA SC/RI/RT-LK](#) [[▶ 150](#)] ISA card, Master

Phoenix [IBS PCI SC/RI/I-T/RI-LK](#) [[▶ 150](#)] PCI card, Master

Hilscher [CIF30-IBM](#) [[▶ 146](#)] ISA card, Master (2k DPRAM)

Hilscher [CIF50-IBM](#) [[▶ 146](#)] PCI card, Master (2k DPRAM)

Hilscher [CIF60-IBM](#) [[▶ 146](#)] PCMCIA card, Master (8k DPRAM)

Hilscher [CIF104-IBM](#) [[▶ 146](#)] PC104 card, Master (2k DPRAM)

Hilscher [CIF40-IBSM](#) [[▶ 148](#)] ISA card, Master, 2k DPRAM (FC4000)

Hilscher [CIF50-IBS](#) [[▶ 157](#)] PCI Interbus-S slave card (8k DPRAM)

CANopen

Beckhoff [FC5101](#) [[▶ 169](#)] PCI card, Master

Beckhoff [FC5102](#) [[▶ 169](#)] PCI card, Master (2 channels)

Beckhoff [CX1500-M510](#) [[▶ 169](#)] PC104, Master

Beckhoff **CX1500-B510** PC104, Slave

Beckhoff **BX-SSB** Master

Hilscher [CIF30-CAN](#) [[▶ 179](#)] ISA card, Master (8k DPRAM)

Hilscher [CIF50-CAN](#) [[▶ 179](#)] PCI card, Master (8k DPRAM)

Hilscher [CIF60-CAN](#) [[▶ 179](#)] PCMCIA card, Master (8k DPRAM)

Hilscher [CIF104-CAN](#) [[▶ 179](#)] PC104 card, Master (8k DPRAM)

Beckhoff [FC510x](#) CANopen Monitor, PCI

DeviceNet

Beckhoff [FC5201](#) [[▶ 184](#)] PCI card, Master

Beckhoff [FC5202](#) [[▶ 184](#)] PCI card, Master (2 channels)

Beckhoff [CX1500-M520](#) [[▶ 184](#)] PC104 card, Master

Beckhoff [FC520x](#) [[▶ 184](#)] PCI card, Slave

Beckhoff **CX1500-B520** PC104 card, Slave

Hilscher [CIF30-DNM](#) [[▶ 187](#)] ISA card, Master, 8k DPRAM (FC5200)

Hilscher [CIF50-DNM](#) [[▶ 187](#)] PCI card, Master, 8k DPRAM (FC5250)

Hilscher [CIF60-DNM](#) [[▶ 187](#)] PCMCIA card, Master, 8k DPRAM (FC5260)

Hilscher [CIF104-DNM](#) [[▶ 187](#)] PC104 card, Master (8k DPRAM)

Beckhoff [FC520x](#) DeviceNet Monitor, PCI

SERCOS

Beckhoff [FC7501](#) [[▶ 191](#)] PCI card, Master/Slave

Beckhoff [FC7502](#) [[▶ 191](#)] PCI card, Master/Slave (2 channels)

Beckhoff [CX1500-M750](#) [[▶ 191](#)] PC104, Master/Slave

Indramat [SERCANS PCI SCS-P](#) [[▶ 196](#)] PCI card, Master (FC7550)

Indramat [SERCANS ISA SCS-P](#) [[▶ 196](#)] ISA card, Master (FC7500)

Ethernet

[Ethernet Miniport \(Real Time\)](#) [[▶ 239](#)]

Virtual [Ethernet Interface](#) [[▶ 241](#)]

USB

Virtual [USB Interface](#) [[▶ 242](#)]

Beckhoff Hardware

Beckhoff [CP9030](#) [[▶ 244](#)] ISA card for CP-Link (Connection for Beckhoff Control Panel, incl. UPS support)

Beckhoff [CP9035](#) [[▶ 246](#)] PCI card for CP-Link (Connection for Beckhoff Control Panel, incl. UPS support)

Beckhoff [CP9040](#) [[▶ 248](#)] for CP-PC (Control Panel-PC CP71xx)

Beckhoff [C1230S](#) [[▶ 250](#)] ISA card for special keys (S-keys) and UPS support in Beckhoff IPC's

Beckhoff [NC Backplane](#) [[▶ 251](#)]

Beckhoff [AH2000](#) [[▶ 254](#)] Backplane

Beckhoff [CX1100-BK](#) [[▶ 257](#)] Power Supply / Bus Terminal Connection

Beckhoff **BX KBus**-Interface

Miscellaneous

The [Serial COM port](#) [[▶ 259](#)] device (for UPS, BK8xxx or KL6001 emulation mode use)

PC [LPT Port](#) [[▶ 263](#)] (Printer port) for use as a small I/O device

Generic [NOV](#) [[▶ 264](#)] / [DP-RAM](#) [[▶ 263](#)] support for Beckhoff Fieldbus cards with optional NOVDRAM extension or DP-RAM support for any PC card.

System Management Bus ([SMB](#) [[▶ 267](#)]) motherboard bus for temperature and fan speed diagnosis

11.2.1 Beckhoff Lightbus

11.2.1.1 Beckhoff C1220/FC200x/CX1500-M200

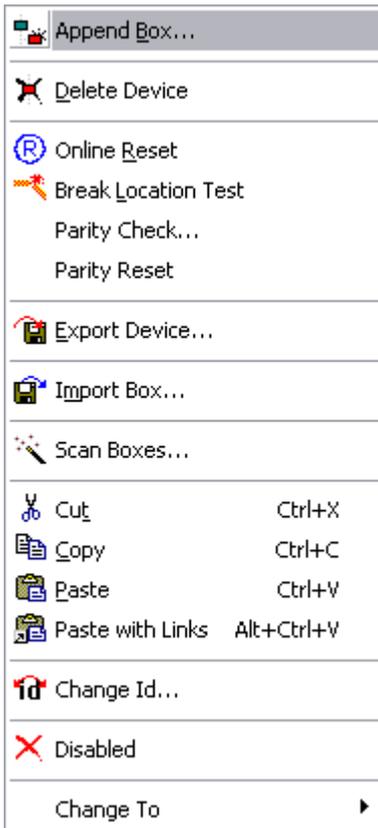
The C1220 is an active ISA master card for the Beckhoff Lightbus. Up to 254 Lightbus nodes ("Boxes") can be connected into a ring circuit. Individual boxes and sometimes separate I/O data boxes can be updated selectively and on a priority basis (Beckhoff CDL concept).

The DPRAM of the C1220 is 4 kBytes. There are no interrupts used.

The [FC2001](#) and [FC2002](#) are PCI bus cards which are otherwise no different from the C1220. The FC2002 supports two independent Lightbus rings (works like two independent C1220/FC2001 cards).

The CX1500-M200 is a Beckhoff Lightbus Master interface for the CX1000 Embedded-PC series. Again, from the functional standpoint a CX1500-M200 doesn't differ from a C1220 card.

Context menu



Append Box... <Insert>

Adds Beckhoff Lightbus boxes to the configuration. The order must correspond with the physical order inside the fiber-optic ring! For a list of all currently supported Beckhoff Lightbus devices, see "[Lightbus - Overview](#) [p. 299]" page.

Delete Device...

Removes the C1220 fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the fiber optic ring.

Break Location Test

Initiates a ring break test on the fiber optic ring. This Lightbus-specific feature brings up the "Box" position, the fiber-optical ring is currently interrupted.

Export Device

Exports all device settings made at this Lightbus device into a file (*.tce), including eventually available mapping information with **Diagnosis Inputs**.

Import Box

Imports formerly saved node ("Box") configurations, including attached Bus Terminals and available variable links, if wanted.

Scan Boxes

Scans the ring for deployed Lightbus nodes (including attached Bus Terminals).

"C1220", "FC200x", "CX1500-M200" tab

Address: (C1220) The DPRAM address of the card can/must be set here. This address is jumper-defined on the card and can assume the following values (jumper settings J1 – J6):

- 0xC8000 00 1000
- 0xD0000 01 0100 (standard)
- 0xD8000 10 0010
- 0xE0000 11 0001

i Address automatically assigned

With CX1500-M200, the address is assigned automatically or preset ex factory.

PCI Slot/Ring: (FC2001/FC2002) indicates the logical PCI slot and, for FC2002, whether ring A or ring B is in use.

Search: Searches for existing C1220 or FC2001/FC2002 connections in the computer or CX1500-M200 connections on the CX1000 and sets the address or slot number accordingly.

Upload: Scans the Lightbus ring for connected devices and their inputs/outputs (see also *.Scan boxes...*).

Check number of boxes: If you tick this checkbox, when the card is initialized the number of boxes which are physically present is compared with the number entered under this card in the System Manager. If the numbers do not comply an error is triggered.

System start despite fiber-optic error: A warning is only issued, instead of aborting the TwinCAT start.

K-Bus update with broadcast telegram (0x80): Decides whether K-bus update should take place individually for each bus coupler or for all bus couplers simultaneously via broadcast telegram when bus couplers are connected.

Reserved CDLs: The Lightbus master cards have eight priority channels (CDLs), which are normally also used freely by the System Manager. If individual CDLs are unused in non-standard applications, these must be indicated here.

Firmware: Indicates the firmware revision of a found card (for older C1220s, only "Found" is displayed).

Load (%): Estimates bus load based on the sum of the load of all required CDLs. This value can be used to decide, for example, whether another ring should be opened or whether the triggering cycle time should be increased.

”(Online) DPRAM” Tab

See [”Online Display of DPRAM \[▶ 267\]”](#)

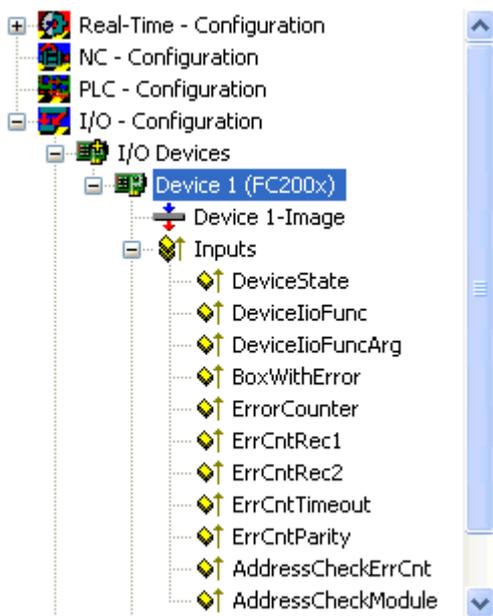
”CDL” Tab

See [”CDL Configuration”](#) .

Diagnosis Inputs

Diagnosis Inputs

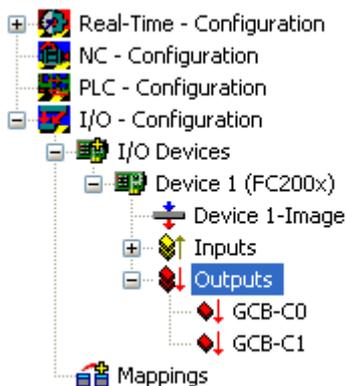
The C1220 as well as the FC2001, FC2002 and CX1500-M200 show up in the System Manager with below described diagnosis and control outputs for the status of the fiber optical ring and the Lightbus interface card itself.



Variable	Description
DeviceState	General status, assumes values 0 (o.k.) and 1 (error) only
DevicelioFunc	Number of function at which error occurred (see C1220 manual also)
DevicelioFuncArg	Function argument (see C1220 manual also)
BoxWithError	Number of box at which error has occurred
ErrorCounter	General Error Counter (DPRAM offset 0xEE0) The Lightbus interface card has several error counters implemented for detection of I/O problems. These counters are accessible from DPRAM starting at offset 0xEE0 as 16-bit values. There is no overflow handling or reset of these counters implemented by the C1220/FC200x firmware. The counter, who reflects the errors detected by the internal address check (0xEEA) doesn't increment the <i>ErrorCounter</i> .
ErrCntRec1	Error detected by Receiver 1 Received address and/or control bytes unequal the corresponding sent bytes. Receiver 1 alternates with Receiver 2 to compensate the execution time spend for the handling of the interrupt service routines (ISR). <i>ErrCntRec1</i> and <i>ErrCntRec2</i> both increment the sum <i>ErrorCounter</i> (see above)
ErrCntRec2	Error detected by Receiver 2 Received address and/or control bytes unequal the corresponding sent bytes. Receiver 2 alternates with Receiver 1 to compensate the execution time spend for the handling of the interrupt service routines (ISR). <i>ErrCntRec1</i> and <i>ErrCntRec2</i> both increment the sum <i>ErrorCounter</i> (see above)
ErrCntTimeout	Timeout during telegram receiving
ErrCntParity	Telegram received with CRC error
AddressCheckErrCnt	Error at internal address check (DPRAM offset 0xEEA). If this counter increments, an address check and count telegram with logically wrong content has been received (AD <> D3)
AddressCheckModule	If inside the C1220/FC200x error mask bit 1 is set, this cell contains the module address of the box which caused the error.

Control Outputs

Via the General Control Block (GCB), the supervision of the finalization of the different process images is handled. The control bits related to the error detection are described below.



Variable	Description
GCB-C0	If this bit is set (default), the address check is active. For detection of parity errors, this bit must be active
GCB-C1	If this bit is set, the address check is even active at LWL errors (problems related to the fiber-optical conductor)

11.2.2 Profibus DP

11.2.2.1 Hilscher CIFx0-DPM and -PB

The **CIF30-DPM** is a Profibus ISA master card (2kByte DPRAM).

The **CIF104-DPM** is a Profibus PC104 master card (2kByte DPRAM).

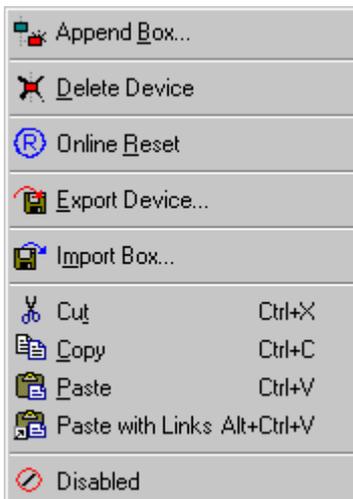
The **CIF30-PB** is a Profibus ISA master card (8kByte DPRAM).

The **CIF50-PB** is a Profibus PCI master card (8kByte DPRAM).

The **CIF60-PB** is a Profibus PCMCIA master card (8kByte DPRAM)..

The **CIF104-PB** is a Profibus PC104 master card (8kByte DPRAM).

Context menu



Append Box... <Insert>

Adds Profibus slaves (boxes). As the addressing in the Profibus takes place via fixed station numbers, the sequence of the added boxes is irrelevant.

Currently supports the following boxes (further details on the boxes given later):

Supported boxes	Description
BK3000 [▶ 277]	Bus Coupler (max. 1.5 MBaud)
BK3100 [▶ 277]	Bus Coupler (max. 12 MBaud)
BK3010 [▶ 277]	Economy Bus Coupler (max. 1.5 MBaud)
BK3110 [▶ 277]	Economy Bus Coupler (max. 12 MBaud)
BK3500 [▶ 277]	Bus Coupler (fibreoptic, max. 1.5 MBaud)
LC3100 [▶ 277]	Low-cost Bus Coupler (max. 12 MBaud)
BC3100 [▶ 277]	Bus controller with integrated PLC (max. 12 MBaud)
GSD Device [▶ 312]	General Profibus device (GSD files required from the manufacturer)

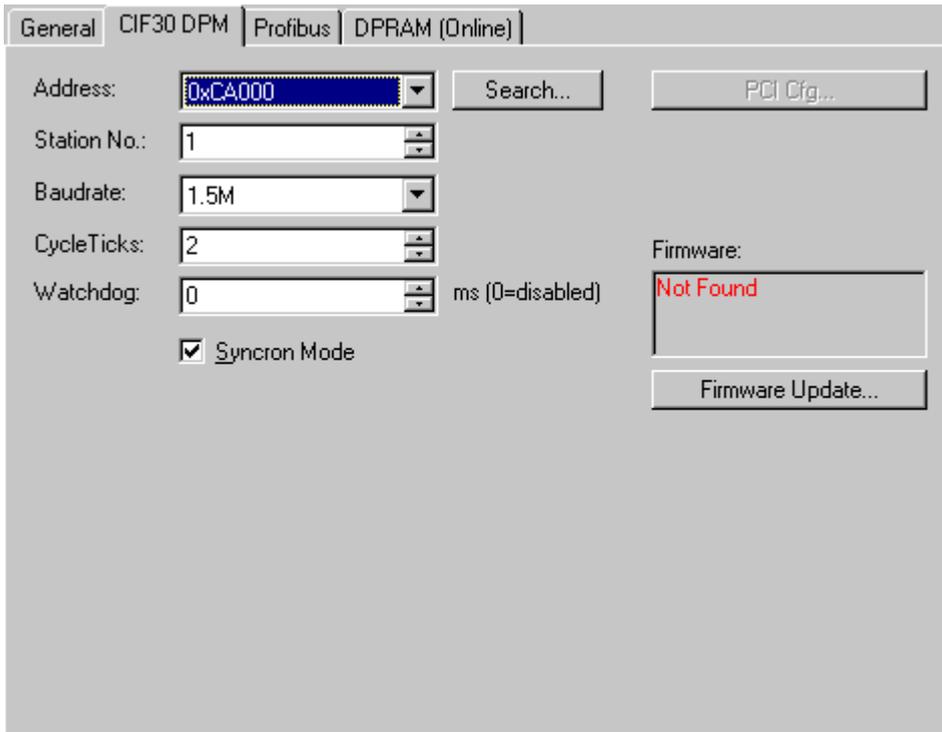
Delete Device...

Removes the CP5412A2 fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the Profibus.

"CIF x0 DPM / PB" tab



Address: Enter the DPRAM card address here. This address is jumped on the card and can assume the following values: from 0xC8000 to 0xEF800 in steps of 0x800 (and 0x2000 at CIF 30-PB)

Search: Searches the computer for available CIF-30 cards (only when TwinCAT is active)

Stations No.: Each Profibus device requires a unique station number - including the master.

Baudrate: Set the Profibus baudrate. Automatically tests whether the connected slave also supports this baudrate.

Cycle Ticks: The smallest possible cycle time for the currently specified slave is set here. It can be manually increased (in ms)

Synchronous Mode: The highest priority task linked with the corresponding device controls the fieldbus cycle and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

"Profibus" tab

See "[Siemens CP5412A2 \[▶ 141\]](#)"

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)"

11.2.2.2 Siemens CP5412 A2

The DPRAM of the CP5412A2 is 16 or 64 Kbytes. There are no interrupts used. There are no functional differences between the 16k and 64k settings. In general therefore the 16k setting is recommended.

Context menu



Append Box... <Insert>

Adds Profibus slaves (boxes). As the addressing in the Profibus takes place via fixed station numbers, the sequence of the added boxes is irrelevant.

Currently supports the following boxes (further details on the boxes given later):

Supported boxes	Description
BK3000 [▶ 277]	Bus Coupler (max. 1.5 MBaud)
BK3100 [▶ 277]	Bus Coupler (max. 12 MBaud)
BK3010 [▶ 277]	Economy Bus Coupler (max. 1.5 MBaud)
BK3110 [▶ 277]	Economy Bus Coupler (max. 12 MBaud)
BK3500 [▶ 277]	Bus Coupler (fibreoptic, max. 1.5 MBaud)
LC3100 [▶ 277]	Low-cost Bus Coupler (max. 12 MBaud)
BC3100 [▶ 277]	Bus controller with integrated PLC (max. 12 MBaud)
GSD Device [▶ 312]	General Profibus device (GSD files required from the manufacturer)

**Delete Device... **

Removes the CP5412A2 fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the Profibus.

"CP 5412" tab

The screenshot shows the configuration window for the CP 5412 card. The 'Profibus' sub-tab is selected. The configuration parameters are as follows:

- Port: 0x240
- Address: 0xD0000
- Station No.: 1
- Baudrate: 1.5M
- CycleTicks: 0
- Estimated PB-Cycle (µs): 0
- Options: Synchron Mode, Slave Synchron, Auto Reset, Optimized Input Update

Address: The DPRAM address of the card is set here. The software sets this address when the card is initialized

Reserve DPRAM area

i For newer motherboards/BIOS, the DPRAM area which the card will use in the computer BIOS may need to be reserved. The corresponding setting is generally carried out in PNP-BIOS and is described as ISA Memblock.

16 / 64kByte: Here you set whether the card should use 16 or 64 kByte DPRAM. There are no functional differences between the 16k and 64k settings. Therefore, the 16k setting is recommended in general.

Port: Used to set the port address for the card, which is set on the card via the DIL switch. When the card is initialized, the DPRAM address specified above is set via the port. Available ports (in hex) (with the corresponding DIL switches 1-4) are:

- 240-243 0000 (standard)
- 244-247 0001
- 248-24B 0010
- 24C-24F 0011
- 280-283 0100
- 284-287 0101
- 288-28B 0110
- 28C-28F 0111
- 300-303 1000
- 304-307 1001
- 308-30B 1010
- 30C-30F 1011
- 390-393 1100
- 394-397 1101
- 398-39B 1110
- 39C-39F 1111

Station No.: Each PROFIBUS device requires a unique station number – including the master

Baud rate: The PROFIBUS baud rate is set here. Automatically tests whether the connected slave also supports this baud rate

Cycle ticks: The smallest possible cycle time for the currently specified slave is set here automatically. It can be manually increased (in ms)

Synchron mode.: The highest priority task linked with the corresponding device controls the fieldbus cycle and is thus synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

"Profibus" tab

General	CP 5412	Profibus	DPRAM (Online)	Debug Box
Slot-Time [tbit]:	<input type="text" value="300"/>	Quiet-Time [tbit]:	<input type="text" value="0"/>	
min. T sdr [tbit]:	<input type="text" value="11"/>	Setup-Time [tbit]:	<input type="text" value="1"/>	
max. T sdr [tbit]:	<input type="text" value="150"/>	Target-Rot.-T. [tbit]:	<input type="text" value="11920"/>	
Gap-Factor:	<input type="text" value="100"/>	HSA:	<input type="text" value="126"/>	
Max. Retry-Limit:	<input type="text" value="1"/>	Min-Slave-Int. [ms]:	<input type="text" value="0"/>	
Poll-Timeout [ms]:	<input type="text" value="8"/>	Data-Ctrl.-Time [ms]:	<input type="text" value="100"/>	
<input checked="" type="checkbox"/> GAP-Update (Multi-Master)		<input type="checkbox"/> Bp-Flag (Auto-Clear)		
PROFIBUS-Mode <input checked="" type="radio"/> Master <input type="radio"/> Master/Slave <input type="radio"/> Slave <input type="radio"/> Multi-Slave				

The parameters set here are described in the PROFIBUS standard (DIN 19245 part 3 - PROFIBUS-DP), Chapter 7 and should only be changed by expert users.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)".

Input Diagnosis

The Siemens CP5412A2 automatically provides two input bytes, which describe the status of the card and the Profibus:



DeviceState: General status, which only assumes values 0=OK and 1=error

DeviceDpState: DeviceDpState is a flag byte, the individual bits have the following definitions:

0x00 = No error

0x01 = Transmitter fault

0x02 = Master address fault

0x04 = HSA fault

0x08 = Baud rate fault

0x80 = Temp fault



If the CP5412A2 is implemented in a Beckhoff IPC with 24 V UPS and/or with special keys, the port address must be changed from 0x240 to another value as 0x240 is configured by the IPC.

11.2.2.3 Siemens IM182 - Profibus Slave

The TwinCAT system can be used as a slave in a Profibus with the aid of the Profibus DP - slave fieldbus card.

The DPRAM is 1536 (0x600) bytes. There are no interrupts used.

Context menu



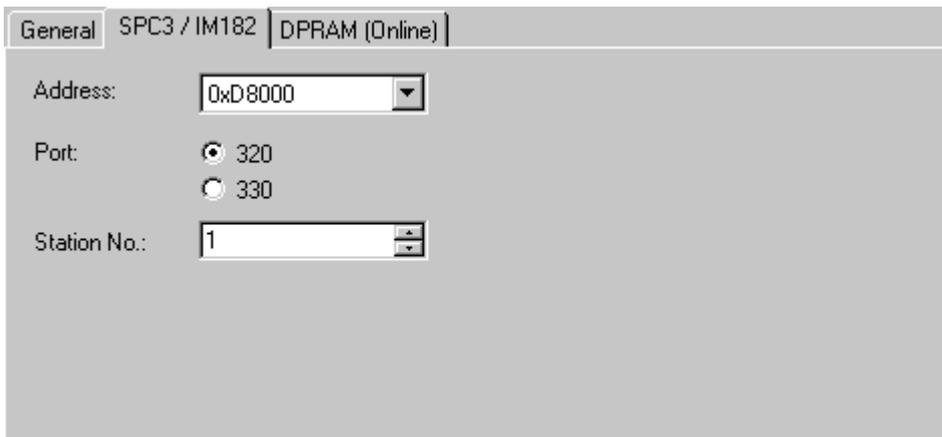
Delete Device...

Removes the IM182 fieldbus card from the I/O configuration.

Online Reset

Initiates an online reset on the Profibus.

"SPC3 / IM182" tab



Address: Enter the DPRAM card address here. This address is jumped on the card

Port: The card uses one of the ports 0x320 or 0x330

Stations No.: Each Profibus device requires a unique station number.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)"

Input Diagnosis

The Siemens SPC3/IM182 automatically provides one input byte which describes the status of the card and the Profibus:

Flags: The individual bits have the following definitions:

- 0x01 = NEW_OUTPUTS
- 0x02 = CLEAR_MODE
- 0x04 = NO_DATA_EXCH
- 0x08 = BAUD_SEARCHING
- 0x10 = SYNC_MODE
- 0x20 = FREEZE_MODE

Variables can be defined under the inputs and outputs for data exchange with a Profibus master. These variables are exchanged with the Profibus master and can be linked within TwinCAT.

Variables are added as described in "Additional Tasks" under "Adding Variables"

11.2.3 Interbus-S

11.2.3.1 Hilscher CIFxx-IBM

The CIF30-IBM is an Interbus ISA master card.

The CIF50-IBM is an Interbus PCI master card.

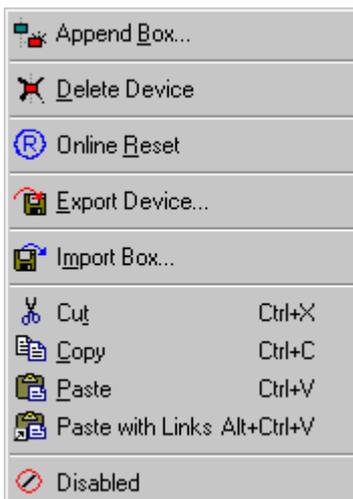
The CIF60-IBM is an Interbus PCMIA master card.

The C104-IBM is an Interbus PC104 master card.

The CIFx0-IBM DPRAM is 2 Kbytes (CIF60-IBM 8 Kbytes). There are no interrupts used.

The following description relates to the CIF30-IBM. The other cards vary from the point of view of TwinCAT in form only.

Context menu



Append Box... <Insert>

Adds InterBus nodes ("boxes"). For an [Overview \[▶ 315\]](#) of all currently supported Interbus devices, *please see [▶ 315]*...

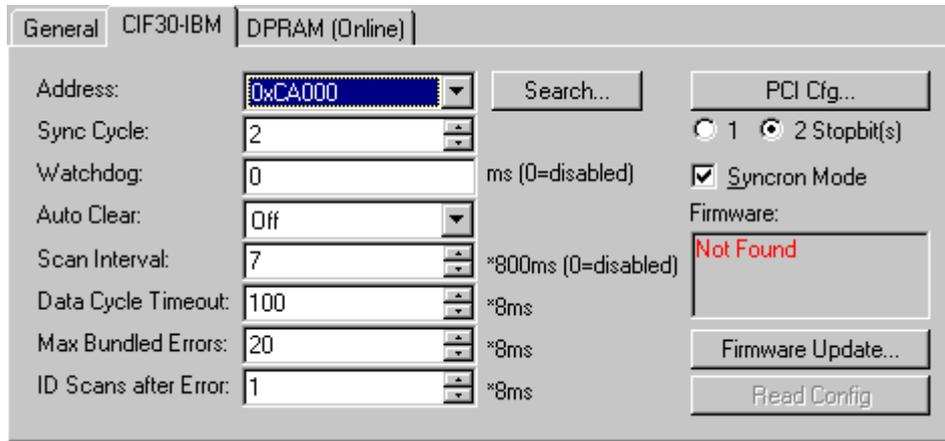
**Delete Device... **

Removes the CIF40-IBSM fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the InterBus-S.

"CIF-x0 IBM" tab



Address: Enter the DPRAM card address here. This address is jumped on the card and can assume the following values: from 0xC8000 to 0xEF800 in steps of 0x800

Search: Searches the computer for available CIF-40 cards (only when TwinCAT is active)

Cycle Ticks: Used to set the cycle time with which the InterBus-S should be served (in ms)

Synchronous Mode: The highest priority task linked with the corresponding device controls the fieldbus cycle and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

Read Config: Activates loading of current Interbus device configuration, provided that a TwinCAT configuration is started in which no devices have been configured under the Interbus master card!

- **Up to TwinCAT 2.9 Build <= 1000:** After TwinCAT-Start the "Read Bus Configuration" button is enabled.
- **Since TwinCAT 2.9 Build > 1000:** Start TwinCAT system in config mode. Select "Reload I/O Devices" and "Scan Sub Devices".

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)"

Input Diagnosis

The CIF-40 automatically provides two input bytes which describe the status of the card and the Interbus:

GlobalFlags: The individual bits have the following definitions:

- 0x01 = Ctrl: Parameterisation error
- 0x02 = W1Err: At least one faulty W1 interface
- 0x04 = W2Err: At least one faulty W2 interface
- 0x08 = SysErr: System error occurred
- 0x10 = Mod: At least one slave registering module error
- 0x20 = Rec: At least one slave requires reconfiguration

EventError: This value is dependent upon the GlobalFlags:

In the case of W1Err, W2Err, Mod or Rec the number of the affected slaves is displayed. The following conditions apply otherwise:

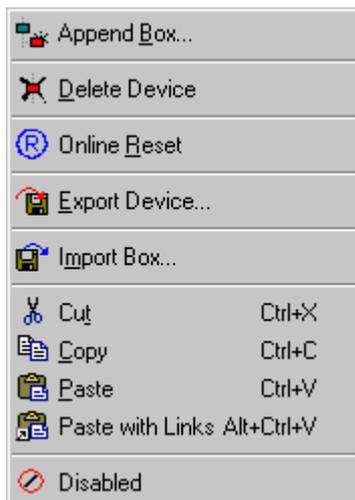
- = 101, SysErr difference between configuration list and structure present
- = 103, SysErr network change during bus operation
- = 104, SysErr multiple data cycle error
- = 105, SysErr time monitoring error
- = 106, SysErr un-locatable network error
- = 108, SysErr no network connection
- = 170, Ctrl communication was not initialised
- = 171, Ctrl too many modules (> 112) parameterised
- = 172, Ctrl more modules connected than parameterised
- = 173, Ctrl fewer modules connected than parameterised
- = 174, Ctrl unsupported length code
- = 175, Ctrl incorrectly parameterised length code
- = 176, Ctrl incorrectly parameterised identity code
- = 177, Ctrl incorrectly parameterised installation depth
- = 178, SysErr user program-served watchdog out of configured time
- = 180, Ctrl unknown operating mode
- = 181, SysErr user program did not acknowledge data cycle

11.2.3.2 Hilscher CIF40-IBSM

The CIF40-IBM is an InterBus-S master card.

The DPRAM of the CIF40-IBSM is 2 Kbytes. There are no interrupts used.

Context menu



Append Box... <Insert>

Adds InterBus nodes ("boxes"). For an [Overview \[▶ 315\]](#) of all currently supported Interbus devices, *please see [▶ 315]*...

Delete Device...

Removes the CIF40-IBSM fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the InterBus-S.

"CIF-40 IBSM" tab

Address: Enter the DPRAM card address here. This address is jumped on the card and can assume the following values: from 0xC8000 to 0xEF800 in steps of 0x800

Search: Searches the computer for available CIF-40 cards (only when TwinCAT is active)

Cycle Ticks: Used to set the cycle time with which the InterBus-S should be served (in ms)

Synchronous Mode: The highest priority task linked with the corresponding device controls the fieldbus cycle and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)"

Input Diagnosis

The CIF-40 automatically provides two input bytes which describe the status of the card and the Interbus:

GlobalFlags: The individual bits have the following definitions:

- 0x01 = Ctrl: Parameterization error
- 0x02 = W1Err: At least one faulty W1 interface
- 0x04 = W2Err: At least one faulty W2 interface
- 0x08 = SysErr: System error occurred
- 0x10 = Mod: At least one slave registering module error
- 0x20 = Rec: At least one slave requires reconfiguration

EventError: This value is dependent upon the GlobalFlags:

In the case of W1Err, W2Err, Mod or Rec the number of the affected slaves is displayed. The following conditions apply otherwise:

- = 101, SysErr difference between configuration list and structure present
- = 103, SysErr network change during bus operation
- = 104, SysErr multiple data cycle error
- = 105, SysErr time monitoring error
- = 106, SysErr un-locatable network error
- = 108, SysErr no network connection
- = 170, Ctrl communication was not initialised
- = 171, Ctrl too many modules (> 112) parameterised
- = 172, Ctrl more modules connected than parameterised
- = 173, Ctrl fewer modules connected than parameterised
- = 174, Ctrl unsupported length code
- = 175, Ctrl incorrectly parameterised length code
- = 176, Ctrl incorrectly parameterised identity code
- = 177, Ctrl incorrectly parameterised installation depth

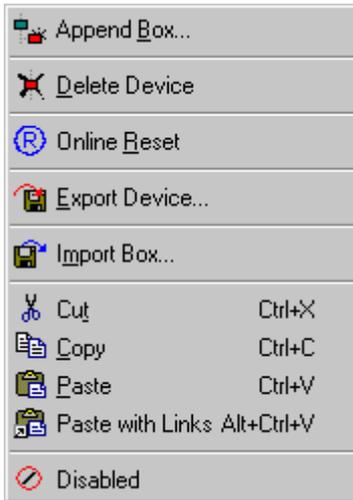
= 178, SysErr user program-served watchdog out of configured time
 = 180, Ctrl unknown operating mode
 = 181, SysErr user program did not acknowledge data cycle

11.2.3.3 Phoenix IBS SC-I-T and IBS SC/RI/RT-LK

The IBS ISA SC-I/T is an InterBus-S master card.

The IBS ISA SC-I/T DPRAM (MPM) is 4 Kbytes. There are no interrupts used.

Context menu



Append Box... <Insert>

Adds InterBus nodes ("boxes"). For an [Overview \[▶ 315\]](#) of all currently supported Interbus devices, *please* see [\[▶ 315\]](#)...

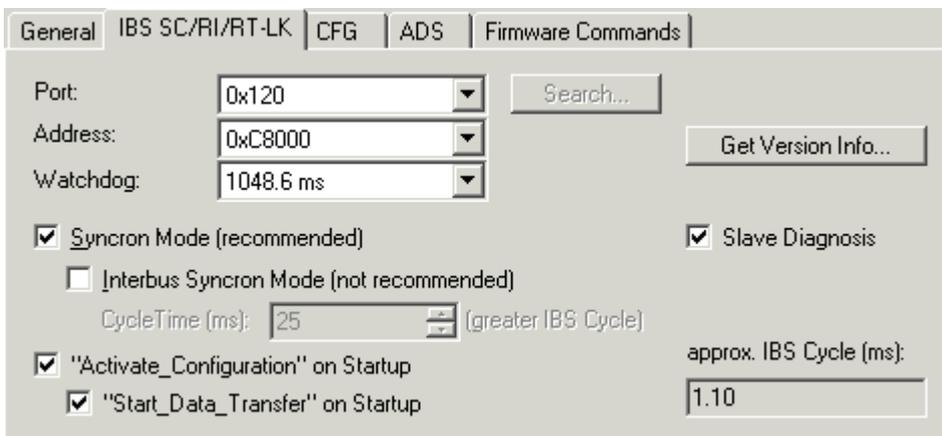
Delete Device...

Removes the IBS ISA SC-I/T fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the InterBus-S. The card is then set to *RUN* mode (see [Bus Controller \[▶ 153\]](#)).

"IBS ISA SC-I/T "and "IBS ISA SC/RI/RT-LK" tab



Address: Enter the DPRAM card address here. This address can assume the following values: from 0xC8000 to 0xEF000 in steps of 0x1000

Port: Enter the card port address here. This address is jumped on the card and can assume the following values: from 0x100 to 0x3F8 in steps of 0x8

IBS cycle: The run-time of the Interbus is calculated approximately based on the configured devices and displayed.

Synchronous Mode: The highest priority task linked with the corresponding device controls the fieldbus cycle and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

"Activate_Configuration" at StartUp: Activates the loaded configuration during the TwinCAT StartUp phase (standard setting). Can be disabled if other firmware services are to be accessed before StartUp (see [System Start with Incomplete Configuration](#) [▶ 155]).

"Start_Data_Transfer" at StartUp: Starts cyclical data transfer in the Interbus at the TwinCAT system start.

Read Bus Configuration: Activates loading of current Interbus device configuration, provided that a TwinCAT configuration is started in which no devices have been configured under the Interbus master card!

- **Up to TwinCAT 2.9 Build <= 1000:** TwinCAT system reports an error message (0 boxes configured and x boxes awaited). The "Read Bus Configuration" button is then enabled. This will display the previously recognised configuration in the tree.
- **Since TwinCAT 2.9 Build > 1000:** Start TwinCAT system in config mode. Select "Reload I/O Devices" and "Scan Sub Devices".

Slave Diagnosis: Option available for system coupler only (Masters with slave interface). If selected, the process data provides additional two input words: SlaveDiag and SlaveDiagPara.

Read Firmware Version: Reads the firmware version of the card via firmware service "Get_Version_Info" (see card's user manual).

i For newer motherboards/BIOS, it may be necessary to reserve the DPRAM area which the card will use in the computer BIOS. The corresponding setting is generally carried out in PNP-BIOS and is described as ISA Memblock.

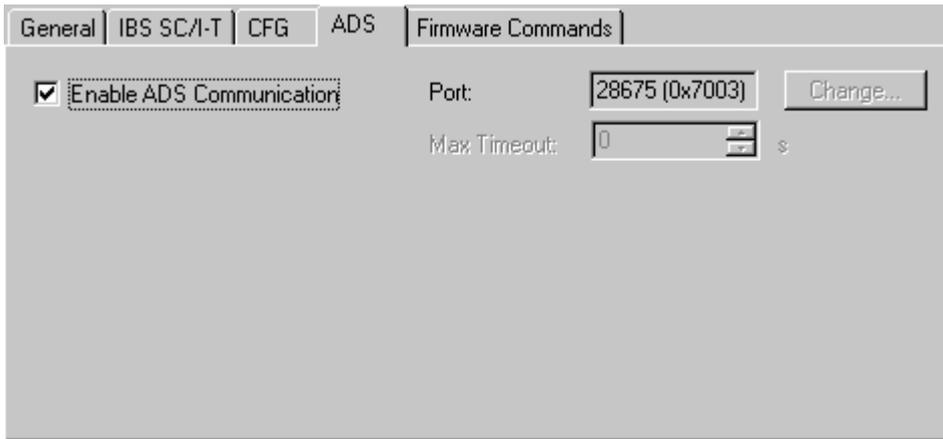
"CFG" tab

No.	Name	DevNo	Length	ID-Code	Level	GroupNo	CAC
1	Box 1 (BK4000)	1.0	0	0	0	---	---
2	Box 2 (BK4010)	2.0	0	0	0	---	---
3	Box 3 (IBS Box)	3.0	0	3	0	---	---

Lists the configuration framework produced based on the configured devices and which is loaded into the card at the system StartUp. Serves as an overview, particularly when the configuration is to be influenced at the run-time via ADS.

Firmware services

Nearly all SC/I-T firmware services can be accessed via ADS by each TwinCAT program. For this purpose, you need to assign an AMS port to the SC/I-T. This port is activated on the "ADS" tab. The port number is specified as 0x7000 + the ID of the SC/I-T. Otherwise a PLC library is offered which gives the essential Firmware Services for [Bus Control](#) [▶ 153] in a simple user form.

"ADS" tab

Use AdsReadWriteReq (see ADS documentation) to display the services in the following form:

IndexGroup = 0x00010001

IndexOffset = firmware service code (e.g. 0x00000713 for Control_Active_Configuration)

The number of parameters is determined automatically using Write data. The Write data are not converted by the TwinCAT into Motorola format. The user must do this if required.

The result (confirmation) of the firmware service is returned in Read data.

Example: Switching off a device while bus is in operation

Interbus Box Tab "CAC/CDF [▶ 318]"

The device with the logical device number 3.1 should be switched off while the bus is in operation:

IndexGroup: 0x00010001

IndexOffset: 0x00000713 (Control_Active_Configuration)

Write Data:

Word 0 0x0200 (device_Off in Motorola Format)

Word 1 0x0100 (entry in Motorola Format)

Word 2 0x0103 (3.1 in Motorola Format)

The Write length is 6 bytes so that the firmware of the Parameter_Count 3 (words) is provided.

Confirmation:

Positive confirmation is as follows:

Read Data:

Word 0 0x0000

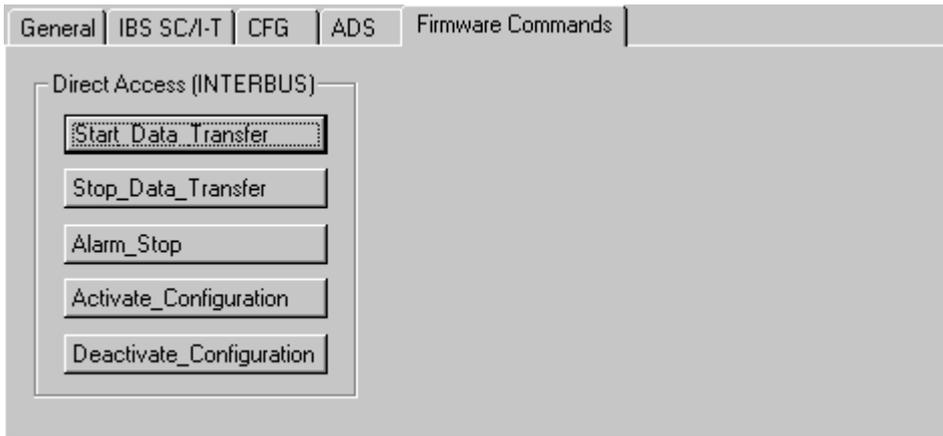
Negative confirmation is as follows:

Read Data:

Word 0 0xFFFF (result in Motorola Format)

Word 1 0xFFFF (Add_Err_Info Motorola Format)

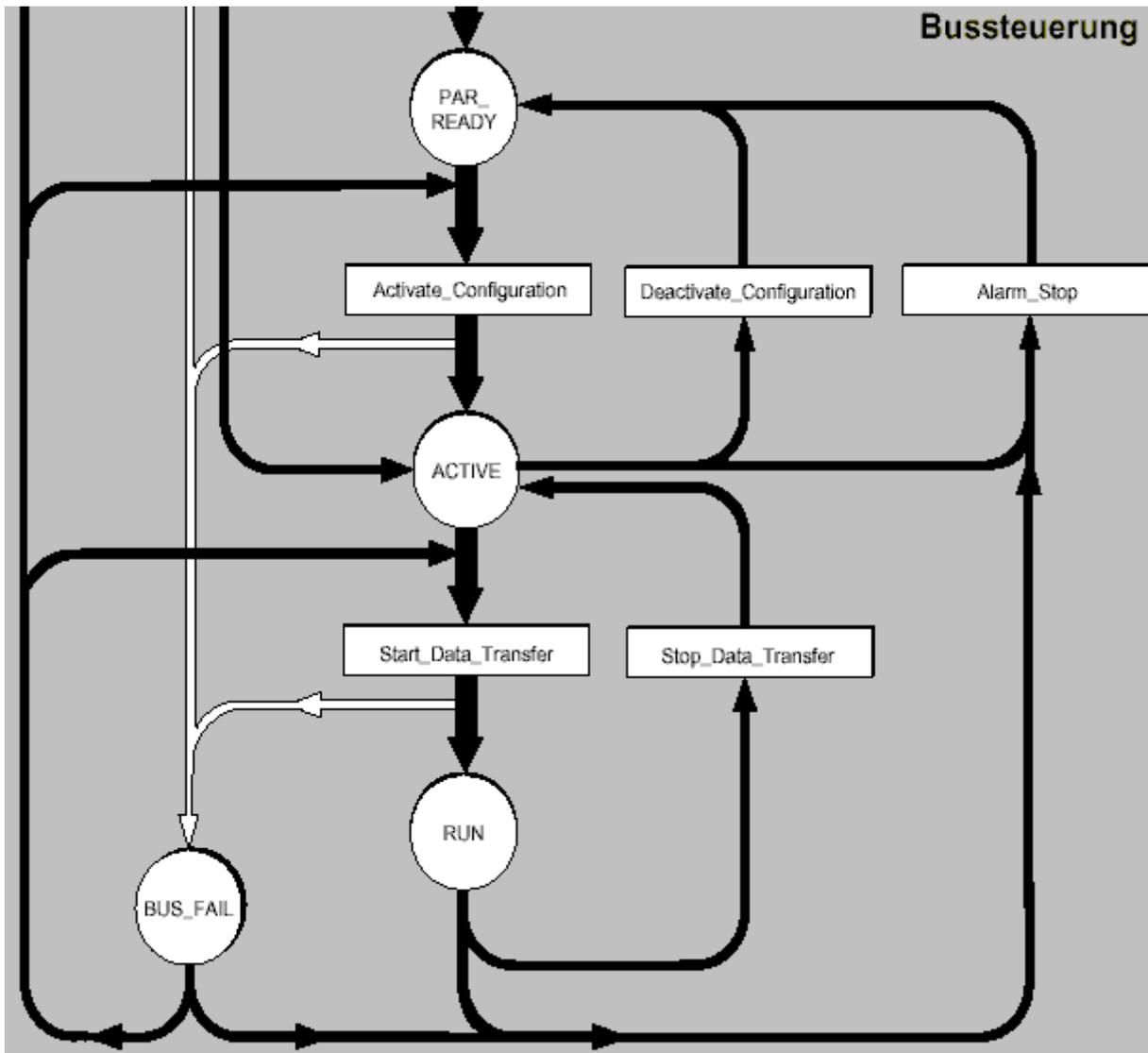
"Firmware Commands" tab



Allows typical firmware bus control commands to be triggered via ADS (providing that an ADS port has been selected).

Bus Control

The bus controller can be influenced with the above firmware services as illustrated below:



Status [\[► 154\]](#) indicates the current card status.

- State & 0x00E0 == 0x0080 -> *PAR_READY*
- State & 0x00E0 == 0x00C0 -> *ACTIVE*
- State & 0x00E0 == 0x00E0 -> *RUN*

Input Diagnosis



The IBS ISA SC-I/T automatically provides two input words whose bits describe the status of the card and the Interbus:

State: 0x0001 = user error

0x0002 = periphery error

0x0004 = bus error

0x0008 = hardware error(interface module)

0x0010 = diagnostic routine active

0x0020 = data transfer active

0x0040 = selected configuration is ready to operate

0x0080 = interface module is ready to operate

0x0100 = bus segment is switched off

0x0200 = disable command output

0x0400 = standard function negative

0x0800 = synchronisation error occurred

0x1000 = data cycle malfunction

0x2000 = pre-set waiting period exceeded

0x4000 = pre-set error density exceeded

0x8000 = signal to controller present

DiagPara: The content depends upon the contents of State.

- If 0x0001 or 0x0008 bit is set, the error code is shown in DiagPara.

- If 0x0002 or 0x0004 bit is set, the segment address of the error location is shown in DiagPara.

See firmware Reference Manual IBS SYS FW G4 LIB UM (item no.: 27 45 13 0) under function GetIBSDiagnostic.

Available only for Masters with slave interface (System coupler).

SlaveState:

0x0001 = Slave data transfer. The slave is in data exchange mode.

0x0002 = Fail. Slave reports modul error.

0x0004 = Slave initialized.

0x0008 = Power on. The external voltage is ok.

0x0010 = Ready. Slave is in READY state.

SlaveDiagPara: The content depends upon the contents of SlaveState.

System StartUp with Incomplete Configuration

System StartUp with Incomplete Configuration

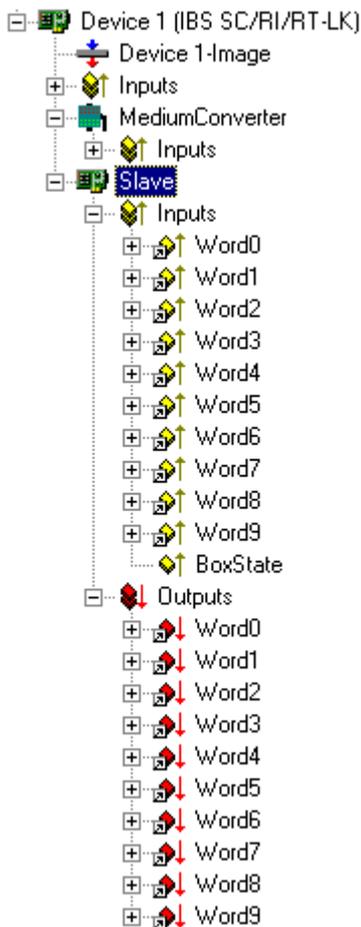
If you wish the system to start with incomplete configuration you have several options:

1. **Alternative Definition:** If the potentially unavailable devices are assigned an alternative, they will be disabled when the system is started (this can only take place if deliberately activated using *Control_Active_Configuration* (see. "[InterBus-S \[► 318\]](#)" tab for that device)).
2. **Special Device Settings:** A *Control_Active_Configuration* command can be defined for individual devices. This will be executed before activating the configuration (see "InterBus-S Tab" for that device). Note that a *Control_Active_Configuration* command will affect subsidiary devices!
3. **Special configuration during system StartUp by the PLC:** You can tell the card to switch on in *PAR_READY* mode at the system StartUp and have further configuration and bus control carried out by the PLC. In this case proceed as follows:
 4. Deselect automatic "[Active Configuration \[► 150\]](#)". This will leave the card in *PAR_READY* state
 5. After the system start, you can individually deselect those devices which you do not require or use a [Group Definition \[► 318\]](#) (*Control_Active_Configuration*), so that only remaining (present) devices are activated. De-selection (switching off selected devices) is generally carried out from the PLC via ADS. You can link in the PLC library "PlclbsScit.lib" to view the necessary ADS commands in the form of options.
 6. Actuate "Active_Configuration" via ADS
 7. Actuate "Start_Data_Transfer" via ADS

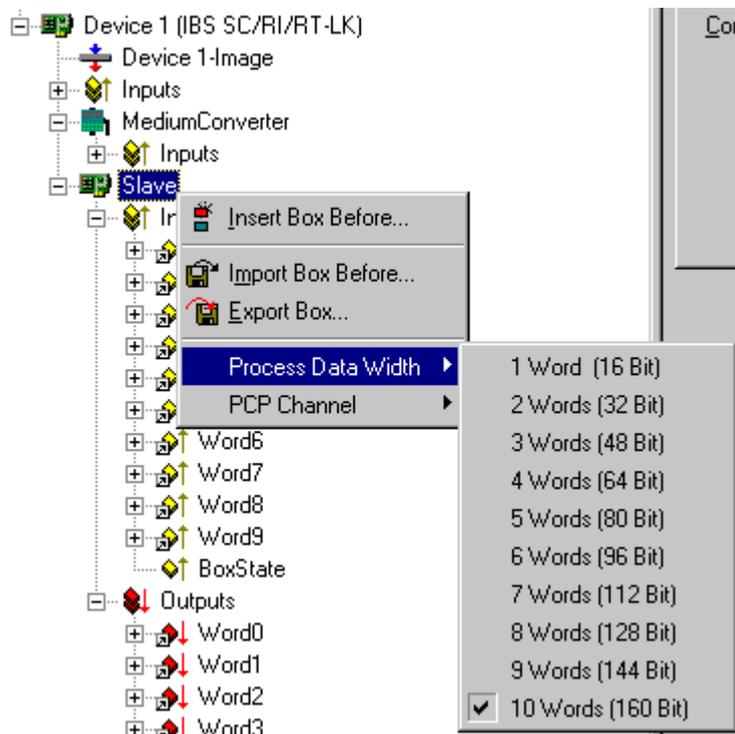
If you later wish to reactivate the inactive devices, use also "Control_Active_Configuration" via ADS when the system is in *RUN* mode.

ISA IBS SC/RI/RT-LK Slave Interface (System Coupler)

The slave interface is configured by the higher level INTERBUS system. The process data length of the slave interface can be configured and has a maximum length of 10 words. When the IBS SC/RI/RT-LK is added to the I/O configuration, the process data length of the system coupler is set to 10 words, and the parameter channel data length to 0 bits (no PCP). The INTERBUS interfaces of the IBS SC/RI/RT-LK are translated by a medium converter from copper to optical fibre transmission. The medium converter has ID code 0x08 and length code 0x0. It is added automatically by the System Manager to the card's I/O configuration. Do not initiate operation of the higher level INTERBUS system until the system coupler has the final configuration, since configuration changes will put the higher level system into an error state.

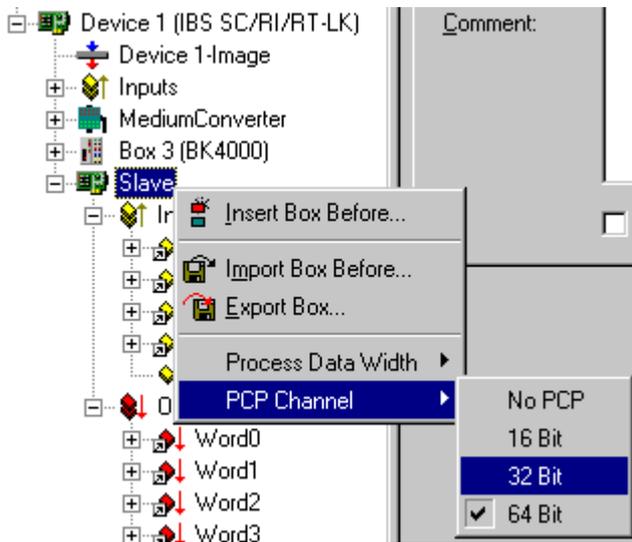


The process data length and parameter channel length of the system coupler can be configured via the slave's context menu commands. The slave's context menu can be opened by clicking with the right mouse button on the slave in the tree of I/O devices.



The maximum possible length for the process data channel depends on the length chosen for the parameter channel. The process data length of 10 words can only be configured after the parameter channel has been deactivated. The system coupler's ID code is generated from the chosen length of the parameter channel, and can adopt the following values:

- ID code 3: no PCP, maximum process data length 10 words.
- ID code 235: parameter channel length 1 word, maximum process data length 9 words.
- ID code 232: parameter channel length 2 words, maximum process data length 8 words.
- ID code 233: parameter channel length 4 words, maximum process data length 6 words.



The system coupler can be supplied with an external voltage so that data can still continue to be exchanged in the higher-level system even if the lower level master fails. The slave's configuration cannot be permanently saved on the IBS SC/RI/RT-LK card and is reset to default values whenever the PC boots again. The card's configuration memory is cleared, and the higher-level system reports a peripheral error. In the default configuration, the system coupler has ID code 233 and length code 0x4 (4 words). The parameter channel is 64 bits long.

Configuration of the IBS SC/RI/RT-LK Slave Interfaces in the Higher-level INTERBUS System

The system coupler in the higher-level system is preceded by a bus terminal with ID code 0x0C and length code 0x0. The system coupler's ID code and length code are specified by the configuration of the system coupler in the lower-level system.

11.2.3.4 Hilscher CIF50-IBS

11.2.3.4.1 Hilscher CIF50-IBS

System requirements:

- TwinCAT 2.9 build > 1000 and higher.

The CIF50-IBS is an Interbus-S slave PCI card with 8 kB DPRAM. Supported baud rates: 500kBit and 2MBit. The baud rate can be configured via a DIP switch on the card. The new baud rate will only apply after a system restart (power OFF). The slave card is offered in two versions, i.e. with copper or optical fibre fieldbus interface. TwinCAT configuration is identical in both cases.

"General" tab

See ["General" tab](#) [▶ 132]

"CIF50-IBS" tab

Preserve Database: If this option is selected, the static (FLASH) configuration is not cleared when TwinCAT is started. Default: Not selected.

PCI Bus/Slot: Indicates in which logical PCI slot the card was found.

Search: This option enables any CIF50-IBS cards installed in the computer to be identified.

Firmware Update: Enables a firmware update to be carried out.

Watchdog: Watchdog time in ms. Default: 0 ms (deactivated).

Generation of the module error at the Interbus master can be configured via the following options:

Cause Error on Watchdog: The watchdog monitoring should send a module error to the master. The watchdog time must be set to a value $\neq 0$. After a TwinCAT stop, a module error is sent to the master once the watchdog time has elapsed. Default: Selected.

Cause Error on NOT READY: A module error is sent to the master if the slave is in NOT READY state. During a TwinCAT stop, the slave is set to NOT READY state. Default: Selected.

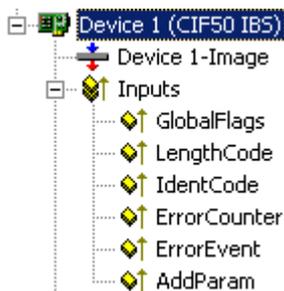
Cause Error on Init Error: A module error is sent to the master if an error occurs during initialisation. Default: Selected.

Cause Error on Init Command: A module error is sent to the master after an initialization command. Default: Selected.

The module error enables the master to detect the state of the slave card.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)"

CIF50-IBS diagnostic inputs

The CIF50-IBS automatically has 8 input bytes describing the state of card and the Interbus:

GlobalFlags: The individual bits have the following definitions:

- 0x01 = Bus Active (0 = Bus not active)

- 0x02 = Data Exchange Active (0 = No data exchange)
- 0x04 = PCP Communication Established (0 = No PCP communication)
- 0x08 = Initialization Error Detected (0 = No initialization fault)
- 0x10 = Runtime Error Detected (0 = No runtime error)
- 0x20 = Application is in 'NotReady' State (0 = System running)

Via these flags the slave application can detect the state of the InterBus (master). During data exchange with the master, the bits *Bus Active* and *Data Exchange Active* are set. If the master is not configured, the bit *Application is in 'NotReady' State* may be set.

LengthCode: Shows the current length code of the slave module. Default: 21 (= 10 words input and output process data length).

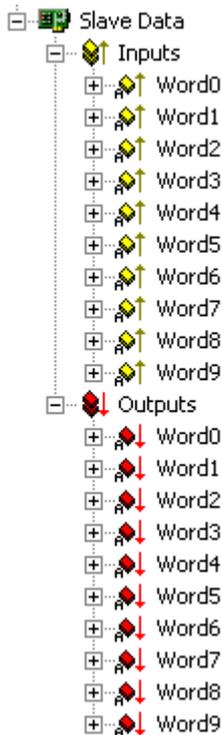
IdentCode: Shows the current ID code of the slave module. Default: Digital I/O slave (ID code = 0x03).

ErrorCounter: Number of errors detected since the module was switched on.

EventError: Error code of the last detected error. See [CIF50-IBS error codes](#) [▶ 161].

AddParam: Additional error code parameters (optional). See [CIF50-IBS error codes](#) [▶ 161].

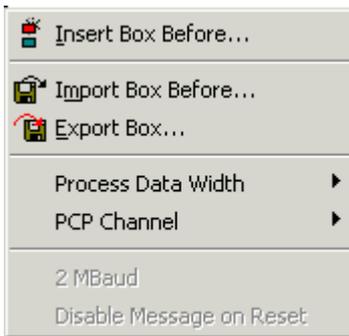
CIF50-IBS slave data (slave process data)



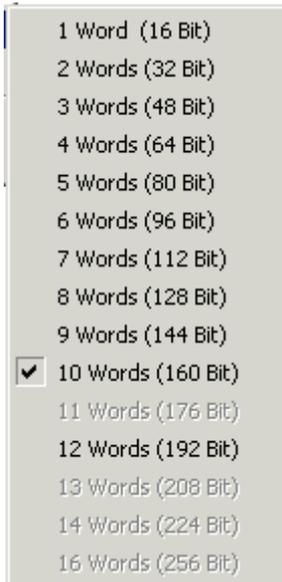
The length of the process data can be configured via the "Slave Data" context menu.

"Slave Data" context menu

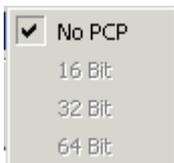
Right-clicking on "Slave Data" in the configuration tree brings up the following menu:



Process Data Width: Can be used to configure the length of the slave process data.



PCP Channel: PCP communication is currently not supported.



The following process data lengths can be configured:

Slave length code	Real data width of the Slave in Bytes (Words)
1	2 (1)
2	4 (2)
3	6 (3)
4	8 (4)
5	10 (5)
6	16 (8)
7	18 (9)
14	12 (6)
15	14 (7)
21	20 (10)
22	24 (12)

System behavior of the CIF50-IBS within a TwinCAT system

In order to be able to operate the card as an Interbus-S slave with an Interbus master, it has to be configured (initialized) first. The card configuration can be stored in a static flash or a non-static memory. If present, the static configuration has a higher priority and is loaded first when the power supply is switched on. In order to be able to load a non-static configuration, the existing static configuration has to be deleted first.

NOTICE

The static (flash) configuration can only be loaded with the SyCon configuration software. With TwinCAT System Manager, only the non-static configuration can be loaded. The TwinCAT software will delete any existing static configuration. The slave card only retains the non-static configuration until it is de-energized (e.g. PC switched off and external power supply OFF).

The slave card can also be supplied from an external 24V supply. The external power supply can only be used if the additional COP 50-EPS module is connected with the card. The external power supply ensures that the slave card retains its non-static configuration if the PC is switched off. In the event that this power supply is also interrupted and no static configuration is loaded, the card has to be re-configured. A non-configured slave card will report an initialization error to the master. The master configuration cannot be activated and data exchange cannot be started (the non-initialized slave segment can initially be switched off in the master configuration and subsequently (once initialized) be switched on).

11.2.3.4.2 CIF50-IBS error codes

The following error description should help to solve problems quickly.

VFD = Virtual Field Device

CRL = Communication Reference List

CR = Communication Reference

OD = Object Description

ID Code = Identification Code

PDU = Process Data Unit

Initialization Errors

Error number	Description
0	No Error / Success No error detected (default value)
50	No User Task The user task could not be found (internal error). Additional Code: 0 (not used)
51	No Global Data The global data area could not be accessed (internal error). Additional Code: 0 (not used)
52	No PLC Task The PLC task could not be found (internal error). Additional Code: 0 (not used)
53	Unknown Mode The detected data exchange mode is not supported. Additional Code: 0 (not used)
54	Invalid Data Length The detected data length is undefined / reserved. Additional Code: 0 (not used)
55	Length Code Out of Range The detected data length code exceeds the max. defined value. Additional Code: Detected length code
56	Invalid ID Code The detected ID code is none of the defined ID codes. Additional Code: Detected ID Code
57	Initialization Of the CRL Failed The internal loading procedure for CRL has failed. Additional Code: 0 (not used)
58	No CRL Header Found The CRL header could not been found. Additional Code: 0 (not used)
59	CRL Not Found The CRL could not been found. Additional Code: 0 (not used)
60	CRL Termination Failed The CRL could not been terminated. Additional Code: 0 (not used)
61	Invalid CRL Header An error detected during scanning the CRL header (global error). Additional Code: 0 (not used)
62	Invalid Communication Reference (® CRL Header) The detected communication reference is invalid and has set to 0 for CRL header. Additional Code: Detected CR
63	Invalid Size (® CRL Header) The entry for the 'size' field within the CRL exceed the max. defined value for this entry. Additional Code: Found CRL size entry
64	Acyclic Control Interval (ACI) Out of Range (® CRL Header) The value for the ACI exceed the max. value specified for this entry. Additional Code: 0 (not used)
65	Symbol Length Out of Range (® CRL Header) The value for the symbol length exceeds the max. specified value for this entry (here: 11). Additional Code: Found symbol length entry
66	VFD Pointer Error (® CRL Header) The VFD pointer is not supported. This value within the CRL header has to be set to 0 (= FALSE). Additional Code: 0 (not used)
67	Invalid CRL (® CRL) Error detected during scanning the CRL (global error). Additional Code: 0 (not used)
68	CRL Entries Does Not Match (® CRL) The count of CRLs found does not match the 'size' field of CRL Header. Additional Code: CR of deficient entry

Error number	Description
69	Missing CRL Entry (® CRL) CRL entry could not been found. Additional Code: CR of deficient entry
70	Double Communication Reference Found (® CRL) At least one communication reference is already in use. Additional Code: CR of deficient entry
71	Communication Reference Out of Range (® CRL) The detected communication reference exceeds the specified value for this entry (here: max. 3). Additional Code: CR of deficient entry
72	Invalid Remote Address Found (® CRL) The detected remote address exceeds the specified value for this entry (here: max. 62). Additional Code: CR of deficient entry
73	Double Remote Address Found (® CRL) The detected remote address is already in use. Additional Code: CR of deficient entry
74	Invalid Connection Type Found (® CRL) The detected connection type is unsupported; only MMAZ is possible. Additional Code: CR of deficient entry
75	Invalid LLI SAP Found (® CRL) The detected LLI SAP is not supported. Additional Code: CR of deficient entry
76	Invalid Connection Attribute (® CRL) The detected connection attribute is unsupported; only CONN_ATTR_D is defined. Additional Code: CR of deficient entry
77	Send/Receive - Conf./Ack. Counter Out of Range (® CRL) One of the max. values for Send_Conf, Recveive_Conf, Send_Ack, or Receive_Ack counters is out of range. Additional Code: CR of deficient entry
78	PDU Length Out Of Range (® CRL) One of the values of the PDU for Req_Len_High, Req_Len_Low, Ind_Len_High, Ind_Len_Low is out of range. Additional Code: CR of deficient entry
79	Unsupported Service Detected (® CRL) At least one unsupprted service was detected (client and/or server). Additional Code: CR of deficient entry
80	Symbol Length Out Of Range (® CRL) The value for the symbol length exceeds the max. specified value for this entry (here: 11). Additional Code: CR of deficient entry
81	Max. Allowed Object Entry Reached (® OD) The detected count of objects exceeds the max. defined value. Additional Code: 0 (not used)
82	Invalid Object Description (® OD) Error detected during scanning OD (global error). Additional Code: 0 (not used)
83	Unknown Object Code (® OD) The detected object code is not one of SIMPLE_VAR or ARRAY Object Code. Additional Code: Object index of deficient entry
84	Object Index Out of Range (® OD) The value for the object index exceeds the max. specified value for this entry. Additional Code: Object index of deficient entry
85	Double Object Index Detected (® OD) At least one object index is already in use. Additional Code: Object index of deficient entry
86	Undefined Data Type (® OD) The detected object data type is unsupported / undefined. Additional Code: Object index of deficient entry

Error number	Description
87	Number Of Elements Out of Range (® OD) The number of elements does not correspond to the related object Code: for SIMPLE_VAR Object: Nof_Elements = 1, for ARRAY Object: 1 < Nof_Elements < 256 Additional Code: Object index of deficient entry
88	Object Length Out of Range (® OD) The object length exceeds the max. value specified for data types VISIBLE_STRING and OCTET_STRING, respectively does not correspond to the data types of the other objects. Additional Code: Object index of deficient entry
89	OD Inconsistent
90 .. 99	RFU Reserved for further use

Runtime Errors

Error number	Description
110	<p>Watchdog Failure</p> <p>A watchdog failure has occurred. Additional Code: Data exchange mode</p>
111	<p>No Data Acknowledge</p> <p>The user has failed to acknowledge the data cycle (in data exchange mode 0). Additional Code: Data exchange mode</p>
112	<p>Bus Not Active</p> <p>The InterBus is NOT_ACTIVE state. Additional Code: 0 (not used)</p>
113	<p>Bus Reset</p> <p>The InterBus is in RESET state. Additional Code: 0 (not used)</p>
114	<p>Application</p> <p>An application (USER) error has been detected by the ALI task. Additional Code: One of the error numbers marked with *.</p>
115 *	<p>No Bus Communication</p> <p>The state of the VFD object is not 'Ready for Communication', or the communication state of the InterBus is not 'Active' (i.g., the board is not connected).</p>
116	<p>Negative Read.Confirmation Received</p> <p>A negative Read.Confirmation has been received from a communication partner. Additional Code: CR of deficient confirmation</p>
117	<p>Negative Write.Confirmation Received</p> <p>A negative Write.Confirmation has been received from a communication partner. Additional Code: CR of deficient confirmation</p>
118 *	<p>Object Non Existent</p> <p>The task could not find the requested object.</p>
119 *	<p>Client Not Ready</p> <p>The state of the PCP client is NOT_READY; a request is still active.</p>
119	<p>Client Not Ready</p> <p>The state of the PCP client is NOT_READY; a request is still active. Additional Code: CR of active request</p>
120	<p>Negative Initiate.Confirmation Received</p> <p>A negative Initiate.Confirmation is received. Additional Code: CR of deficient confirmation</p>
121 *	<p>Invalid Communication Reference</p> <p>The task could not find the requested communication reference.</p>
122 *	<p>Request Still Active</p> <p>A request is queued internally; the request is still active.</p>
123 *	<p>Communication Reference Not Open</p> <p>The requested communication reference is not open.</p>
124	<p>Nothing to Process</p> <p>There is no request to process. Additional Code: CR of deficient confirmation</p>
125	<p>Object Attribute Inconsistent</p> <p>The task has detected an invalid object index for a Read / Write Request or an invalid data length. Additional Code: Object index of the deficient request</p>
126	<p>Type Conflict</p> <p>The task has detected an invalid data type for BOOLEAN, respectively for VISIBLE_STRING within a Write Indication. Additional Code: Object index of the deficient request</p>
127	<p>Invalid PDU Size</p> <p>The task has detected an invalid PDU size for a Read Request. Additional Code: Object index of the deficient request</p>

Error number	Description
128	Abort.Indication Received The task has received an Abort.Indication from a communication partner. Additional Code: CR of connection
129	Reject.Indication Received The task has received an Reject Indication from a communication partner. Additional Code: HighByte = PduType, LowByte = RejectCode
130	Negative Initiate.Response The task has received an Initiate Indication from outside world, but it has sent a negative response to the requester. Additional Code: CR of deficient response
131	Invalid Invoke ID The task has detected an invalid invoke ID. Additional Code: Received invoke ID (from the application) or object index of the deficient indication
132	PNM7 Event.Indication The task received a PNM7_Event.Indication. Additional Code: HighByte = ReasonCode, LowByte = AddDetail
133	Unknown Table The detected download table is unknown
134	Invalid Download Function The detected download function is unknown
135	Invalid Table Length The detected table length is invalid
136	Requested ComRef not Closed The requested Communication Reference number is not closed.
137	Invalid Device Model
138 .. 149	RFU Reserved for further use.

Other Errors

Error number	Description
152	Unknown Command The detected command is unknown. Additional Code: 0 (not used)
167	Function Error Error in msg.bFunction detected. Additional Code: 0 (not used)
202	Segment Failure The task could not get a message segment. Additional Code: 0 (not used)
210	Database Not Found The task could not find the internal database. Additional Code: 0 (not used)
212	Database Error The task has detected an error during reading the database. Additional Code: 0 (not used)
217	System Failure A general system failure has been detected by the device. Additional Code: 0 (not used)

11.2.4 CANopen

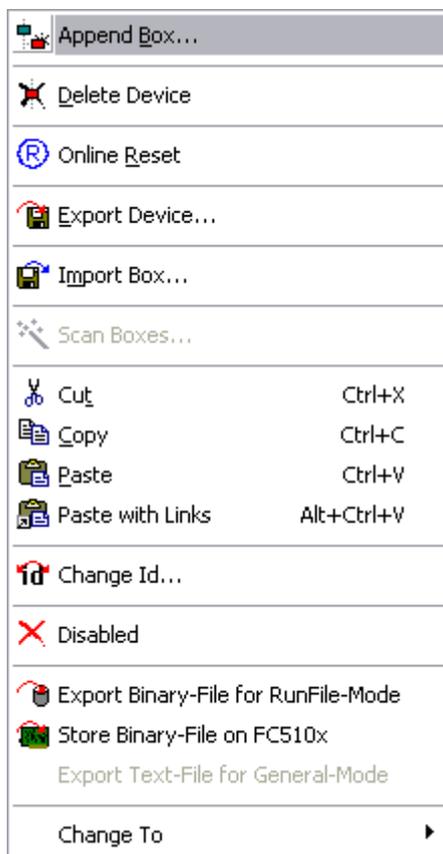
11.2.4.1 Beckhoff FC510x

The **FC510x** is a [CANopen \[▶ 380\]](#) master card with one [\(FC5101\)](#) or two [\(FC5102\)](#) channels. It supports all CANopen [Communication Modes \[▶ 381\]](#) and complies with the CANopen specification DS301V4.01. The card can synchronize the related PLC or NC task using CANopen [SYNC \[▶ 384\]](#). It is a good idea to control drives via the bus in "master" synchronization mode as the SYNC objects are averagely transmitted with quartz precision and the process data exchange is synchronized throughout with the application.

The CANopen master card provides numerous [diagnosis possibilities \[▶ 177\]](#). [Emergency objects \[▶ 178\]](#) are stored and can be read via ADS.

The two-channel card FC5102 has two independent microprocessor systems. Therefore, the two channels do not interfere with each other. The CAN interfaces are galvanically isolated (-> [hardware description \[▶ 175\]](#)).

Context menu



Append Box... <Insert>

Adds CANopen slaves (boxes). For an [Overview \[▶ 320\]](#) of all currently supported CANopen devices, *please* see [\[▶ 320\]](#)...

Delete Device...

Removes the FC510x fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the CANopen bus.

"FC510x" tab

General	FC 510x	ADS	General Diag	Box States
PCI Bus/Slot:	not found			Search...
Master-Node-ID:	127			Hardware Configuration...
Baudrate:	500 k			Upload Configuration
Synchronization Mode:	Slave			Verify Configuration
Shift-Time (µs):	850			Firmware:
PLL Sync Time (µs):	0			
Cycle Time (µs):	1000			Firmware Update...
Watchdog Time (ms):	0			Calculate Equi-Times
Sync-Cycle Multiplier:	2			Sync Master
Sync-Cycle-Time (in µs):	2000			<input checked="" type="radio"/> PC-Task
Sync-Tx-PDO Delay (in %):	40			<input type="radio"/> Balanced PC-Task
				<input type="radio"/> Hardware-Link

PCI Slot/Irq:

Shows in which logical PCI slot the card was detected and which IRQ is assigned to it. The IRQ is unused.

Master Node Id:

Node address for the FC510x. Value range: 1...127. Determines the identifier of the master heartbeat telegram. Ensure that it is not the same as a slave node address.

Baud rate:

Set the [Baud rate](#) [► 392] here. Automatically tests whether the connected slave also supports this baud rate.

Synchronization Mode:

The synchronization mode determines the accuracy of the [CANopen SYNC](#) [► 384] telegram generation.

The highest priority task linked with the FC510x device controls the CANopen card and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers. For all operating modes you can individually set the communication type for each process data object (PDO) - event driven or synchronized (in each PDO tab). If one of the PDOs has been configured for synchronous operating mode, a SYNC telegram is sent at the start of the cycle, which the slaves use to synchronize their actions with the master cycle.

Depending on the sync accuracy requirements of the application several modes can be selected. Please note, that due to CAN technology a single SYNC telegram may jitter for one entire frame length if the bus is busy at the time of sync generation. The SYNC accuracy therefore refers to the long-time stability. Bus nodes that use a phase locked loop (PLL) mechanism to synchronize themselves require a maximum long-time stability or accuracy of the SYNC.

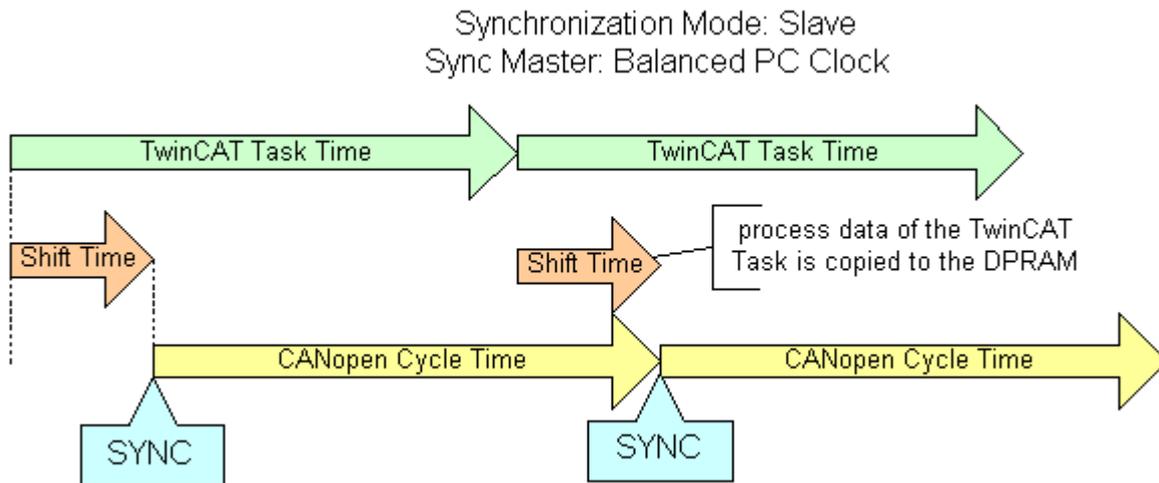
The screenshot shows the configuration window for an FC 510x card. The 'General' tab is selected. The 'Synchronization Mode' is set to 'Slave'. The 'Sync Master' section is set to 'PC-Task'. A red circle highlights the 'Synchronization Mode' dropdown and the 'Sync Master' radio buttons.

Parameter	Value
PCI Bus/Slot:	not found
Master-Node-ID:	127
Baudrate:	500 k
Synchronization Mode:	Slave
Shift-Time (µs):	850
PLL Sync Time (µs):	0
Cycle Time (µs):	1000
Watchdog Time (ms):	0
Sync-Cycle Multiplier:	2
Sync-Cycle-Time (in µs):	2000
Sync-Tx-PDO Delay (in %):	40
Sync Master:	<input checked="" type="radio"/> PC-Task <input type="radio"/> Balanced PC-Task <input type="radio"/> Hardware-Link

Slave

In slave synchronization mode the card receives its time basis from a sync master. The sync master is selected at the corresponding field.

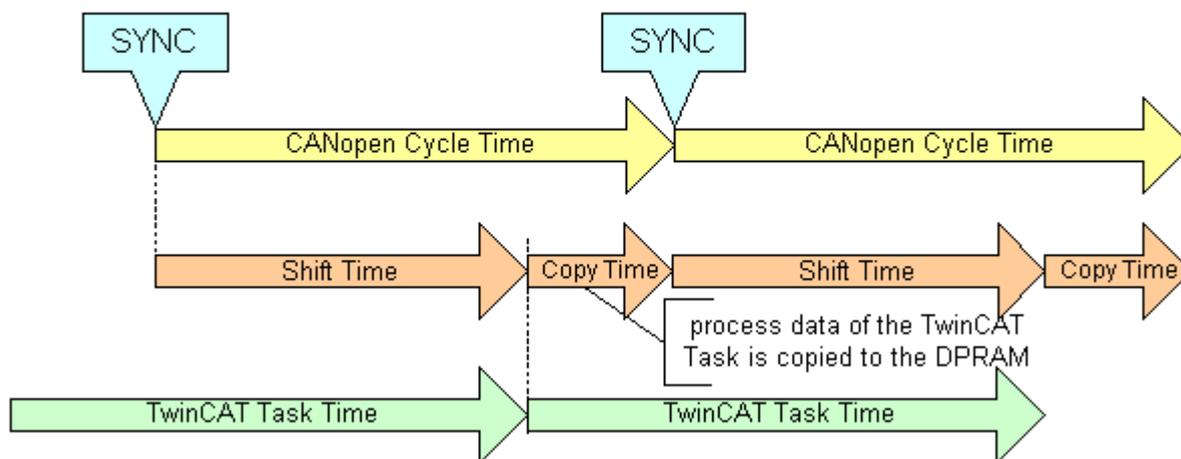
- **Sync Master: PC-Task.** This is the default setting. The PC provides the time basis using the TwinCAT Real Time. Depending on the settings the Task start (Default with TwinCAT NC) or the Task end (Default at TwinCAT PLC) triggers the SYNC telegram.
- **Sync Master: Balanced PC Task.** This operating mode as well generated the CANopen Sync cycle with the long term accuracy of the PC time basis. However, the short term accuracy (interval between two SYNC telegrams) is better that with Sync Master "PC-Task":
 - Run time differences (e.g. caused by case dependent program calls) are leveled out,
 - the FC510x delays pending transmit telegrams until the SYNC telegram was sent,
 - the SYNC intervals are determined by the quartz timer of the FC510x card.
 - The card timer is adjusted in small steps to the PC-timer if the difference is larger that the value of the "PLL Sync Time".
 - In this mode the SYNC telegram is delayed for the **Shift Time** after the end of the TwinCAT task cycle. Here the shift time should be set to a value as small as possible
 - but large enough to allow the process data access by the TwinCAT task. The function "Calculate Equi-Times" helps to configure the optimal shift time. It is started by selecting the corresponding button.



Master

In master synchronization mode the card generates its time basis locally. The SYNC is generated with long time quartz accuracy. The start of the TwinCAT task is triggered by the card, delayed by the Shift Time. In this mode the shift time value should be as large as possible. The function "Calculate Equi-Times" helps to configure the optimal shift time. It is started by selecting the corresponding button.

Synchronisation Mode: Master



Cycle Time:

Displays the cycle time of the corresponding highest priority task. The value is updated when the TwinCAT mapping is generated.

Sync-Cycle Multiplier:

$\text{CANopen SYNC Cycle Time} = (\text{Task}) \text{ Cycle Time} \times \text{Sync-Cycle Multiplier}$. Event driven PDO communications and cyclic synchronized PDO communication are frequently combined when used in conjunction with CANopen. To be able to respond rapidly to an event, the TwinCAT task cycle time has to be less than the CANopen SYNC cycle time.

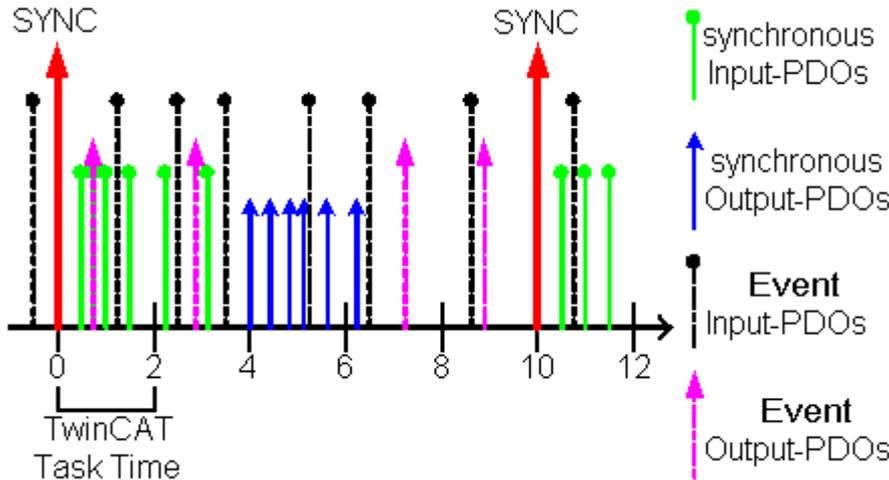
Sync-Cycle time

Shows the cycle time of the CANopen SYNC telegram. This cycle time is derived from the highest priority task which has process data linked to the card, and the Sync Cycle Multiplier.

Sync-Tx-PDO Delay:

Directly after the SYNC telegram, the synchronized slaves send their input data/actual values. The FC510x can delay the sending of the output data / set value (TxPDOs from the perspective of the card) to minimize the telegram, burst directly after the SYNC. The Sync-Tx-PDO delay parameter is used to set this delay in percent of the Sync Cycle Time.

Example:



Task Cycle Time = 2000µs, Sync Cycle Multiplier = 5, Sync Tx-PDO Delay =40[%]. Event driven PDOs can be processed by the PLC task every 2 ms. The CANopen sync cycle is 10 ms, the FC510x sends its synchronized PDOs 4ms (=40% of 10ms) after SYNC.

Search...:

Searches for all connected FC510x channels. Select those required. In the case of an FC5102 both channels A and B appear. These behave in logical terms like two FC5101 cards.

Hardware Configuration ...:

In which the address of the FC510x is set in the lower memory area (below 1 MB) of the PC.

Upload Configuration:

Scans the CANopen network and adds all detected equipment to the device (FC510x) (only available when no box has been configured). In the case of Beckhoff boxes, reads the configuration precisely. In the case of external devices, the PDO configuration and the identity object are read and evaluated.

Verify Configuration:

Allows one to compare the expected (configured) network configuration with the actual (physically present) configuration. The data from the CANopen Identity object is read and compared. In the case of Beckhoff Boxes the connected Bus Terminals or Extension Modules are identified and compared. In preparation.

Firmware:

Shows the current firmware version of the FC510x.

Firmware update...:

The FC510x card firmware version is updated here.



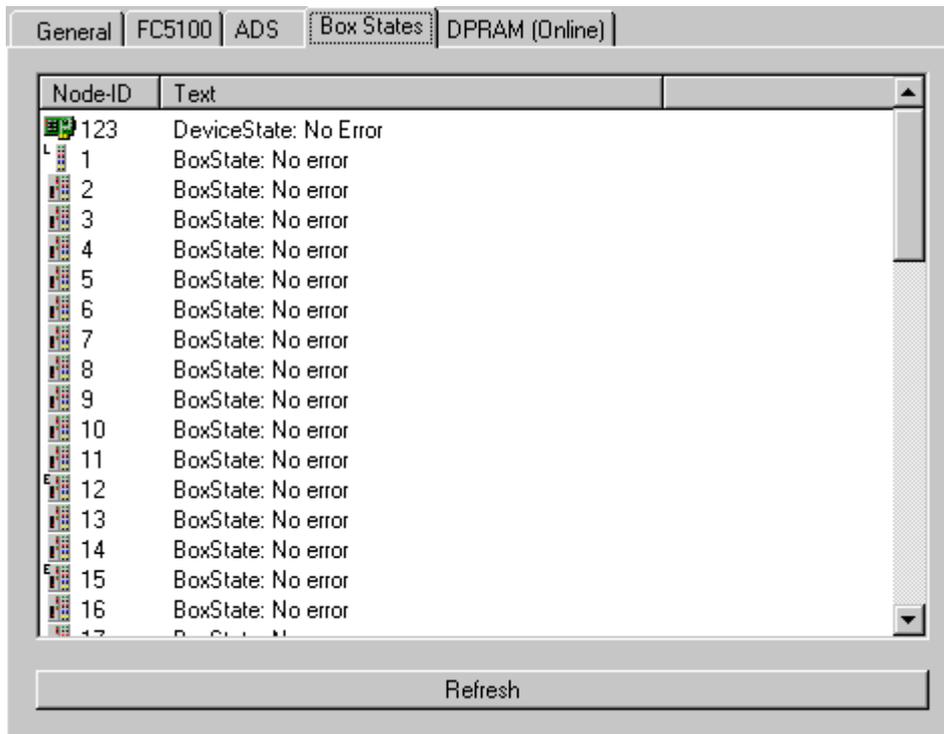
Stop TwinCAT

The TwinCAT system must be stopped for this function.

"ADS" tab

The FC510x is an ADS device with its own net ID, which can be changed here. All ADS services (diagnosis, non-cyclical communication) going to the FC510x must address this net ID.

"Box States" tab



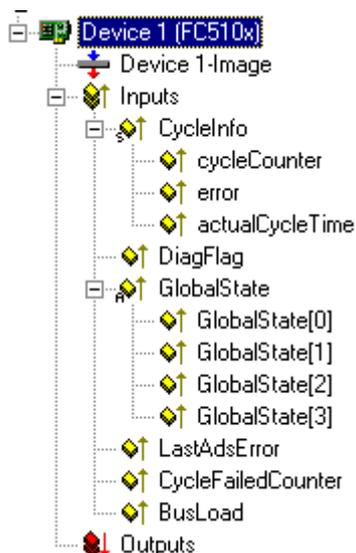
Displays an overview of all current box statuses.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[► 267\]](#)".

Diagnostic inputs

The FC510x automatically provides various diagnostic variables which describe the status of the card and the CANopen network:



cycleCounter: Is incremented at the end of each firmware cycle so that this variable can indicate whether the last cycle was completed before the task was started.

error: Shows the number of slaves whose BoxState is not equal to zero. The BoxState of the slaves must only be checked if this value is not 0.

actualCycleTime: Shows the actual cycle time in 4/25 μ s. This variable is only updated when all slaves are involved in the data exchange (and when error is 0).

DiagFlag: Shows whether the diagnostics information on the card has changed. This can be read off using ADS-Read. To this end, specify the net ID of the FC510x, the port number 200, and the IndexGroup 0xF100. The IndexOffset and the length are then based on the diagnostic data. **The BoxStates are also directly available as box variables.**

Offset 1–127: BusStatus List, one byte for each station address from 1–127 which contains the station status (see BoxState for CANopen boxes)

Global State: Various diagnostic and status displays for the FC510x. The byte in GlobalState(0) indicates the status of the card in relation to the TwinCAT system: the potential statuses are RUN, RESET, OFFLINE, and STOP. GlobalState(2) gives information on the state of the CAN controller: "CAN warning limit reached" and "Bus off" are displayed. "Warning limit reached" means that the send/receive error counter on the CAN controller has exceeded the value 96. BusOff means that the CAN controller can no longer participate in bus communication due to too many CAN errors (Error frames). In this case, there is a serious physical error in the CAN network. (e.g. too few or too many termination resistors, at least one device with incorrect baud rate, short circuit, etc.) The "bus off" state can only be exited through a card reset. Details on further global state data, see comments in "Online" tab.

LastAdsError: Shows the error code of the last ADS access error, e.g. if an attempt has been made to read the diagnostic data for a deactivated node.

CycleFailedCounter: Counts the number of firmware cycles which could not be completed before the associated task wanted to re-read/re-write the process image. If this counter is incremented, the task cycle time has been set too low for the actual network configuration.

BusLoad: Shows the current bus load in %. The [Bus Load \[► 389\]](#) is an important design criterion for CAN networks. The value shown is an average value over 100 ms.

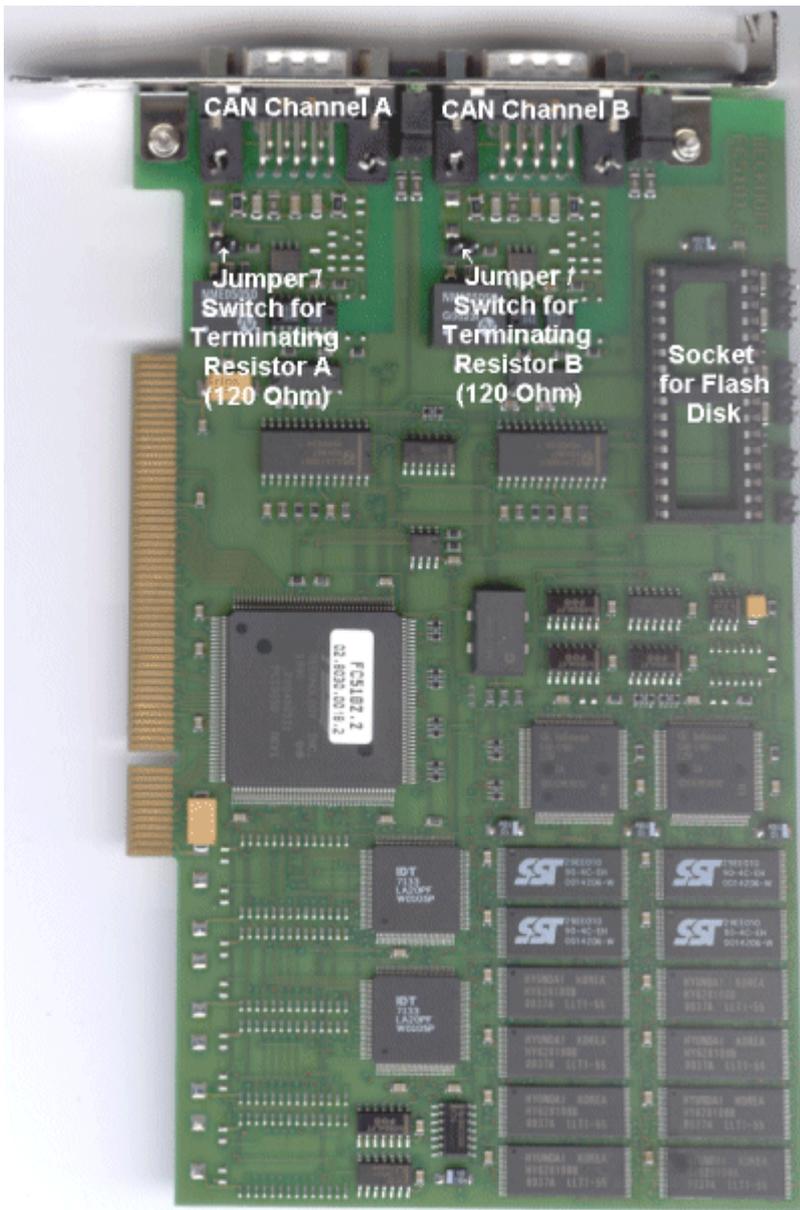
11.2.4.2 Beckhoff FC510x Hardware Description

The **FC510x** is a [CANopen \[► 380\]](#) Master card with one (FC5101) or two channels (FC5102). The CAN transceivers are galvanically isolated.

CAN Terminating Resistor

On the card there are CAN terminating resistors (120 Ohms). These can be activated with a jumper (up to hardware version 3) or with a switch (from hardware version 4) close to the CAN connectors.

The Flash Disk Socket is currently not in use.



Pin assignment

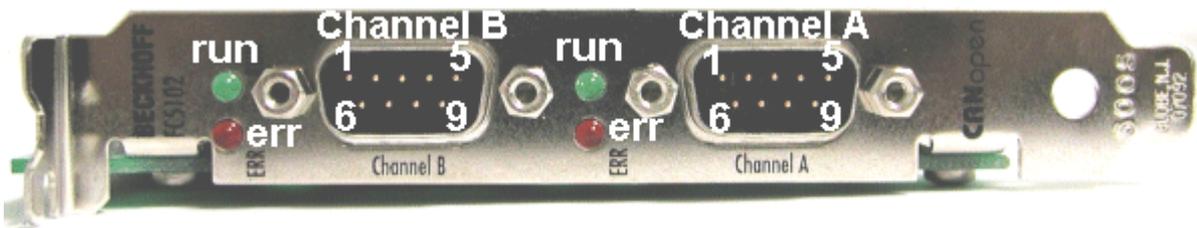
The CAN bus line is connected via 9-pin D-Sub sockets with the following pin assignment.

Pin	Assignment
2	CAN low (CAN-)
3	CAN Ground (internally connected to pin 6)
5	Shield
6	CAN Ground (internally connected to pin 3)
7	CAN high (CAN+)

The unlisted pins are not connected.

i Auxiliary voltage

An auxiliary voltage of up to 30 VDC may be connected to pin 9. Some CAN devices use this to supply the transceiver.



LED Behavior

The red ERROR LED and the green RUN help to quickly diagnose the status of the card:

Error LED (red)	Run LED (green)	Description
off	off	TwinCAT has been stopped
off	on	All configured bus nodes are error free (Box State=0), TwinCAT Task or Process is running.
off	blinking with 2 Hz	The Task, whose process data is linked to the card, is not running. All configured bus nodes have been found and are error free (Box State=0)
blinking with 2Hz	on	At least one box state is unequal zero (e.g. node not found, wrong configuration, node in error), TwinCAT Task is running
blinking with 2 Hz	off	At least one box state is unequal zero (e.g. node not found, wrong configuration, node in error), TwinCAT Task is not running
on	off	TwinCAT is running, CAN Controller is "Bus OFF". Physical CAN problem. Possible reasons: e.g. terminating resistor missing, bus too long, wrong baud rate, node address configured twice, short circuit, wiring error. Restart is necessary
blinking with 20Hz	blinking with 20Hz	Configuration Upload is under way
blinking with 20Hz	off	card is in STOP mode

11.2.4.3 FC510x: Box Diagnosis

The CANopen fieldbus card FC510x has a comprehensive range of diagnostic options for connected network nodes.



For each CANopen fieldbus node there is a node state input variable, which signals the status of the current slave during the running time and can be linked, for example with the PLC.

Node State

Variable	Flags	Online
Name:	NodeState	
Type:	UINT8	
Group:	Inputs	Size: 1.0
Address:	3585 (0xE01)	User ID: 0
Linked to...		
Comment:	0 = No error 1 = Station deactivated 2 = Station not exists 3 = Master lock 4 = Invalid slave response 5 = Parameter fault 6 = Not supported 7 = Config fault 8 = Station not ready 9 = Static diagnosis 10 = Diagnosis overflow 11 = Physical fault	
ADS Info:	Port: 300, IGrp: 0x9004, IOffs: 0xE01, Len: 1	

DiagFlag:

Shows whether the box diagnostic information has changed.

CANopen Emergency Messages

CANopen emergencies and other diagnostic data can be read out via ADS read (new data present as soon as you see the DiagFlag). You need to enter the FC510x ADS net ID. Other ADS parameters:

Port: 200

IndexGroup: Lo-Word = 0xF180, Hi-Word = Node-Number.

IndexOffset: See below

Length: See below

If more than 26 bytes of diagnostic data have been read out the emergency memory is reset.

The diagnostic data have the following definitions:

Offset 0,1:	Bit 1:	Boot up message not received or incorrect
	Bit 2:	Emergency-Overflow
	Bit 0, Bit 3-15:	reserved
Offset 2,3:	Bits 0-14:	TX-PDO (i+1) received
	Bit 15:	All TX PDOs 16-n received
Offset 4,5:	Bits 0-4:	1: Incorrect TX PDO length
		2: Synchronous TX PDO absent
		3: Node signalling PRE-OPERATIONAL
		4: Event timer timed out for TX PDO
		5: No response and guarding is activated
		6: Toggling missed several times and guarding activated
	Bits 5-15:	Associated COB ID
Offset 6:	Bits 0-7:	1: Incorrect value during SDO upload
		2: Incorrect length during SDO upload
		3: Abort during SDO up/download
		4: Incorrect date during a boot-up message
		5: Timeout while waiting for a boot-up message
Offset 7:	Bits 0-7:	2: Incorrect SDO command specifier
		3: SDO toggle bit has not changed
		4: SDO length too great
		5: SDO-Abort
		6: SDO-Timeout
Offset 8,9	Bits 0-7:	SDO up/download index
Offset 10:	Bits 0-7:	SDO up/download sub-index
Offset 11:	Bits 0-7:	reserved
Offset 12:	Bits 0-7:	Abort errorClass
Offset 13:	Bits 0-7:	Abort errorCode
Offset 14,15:	Bits 0-15:	Abort additionalCode
Offset 16-19:		Read value (if offset 6 = 1)
Offset 20-23:		Expected value (if offset 6 = 1)
Offset 24-25:		Number of consecutive emergencies
Offset 26 - n:		Emergencies (8 bytes each)

11.2.4.4 Hilscher CIfxx-CAN

The CIf30-CAN is an CANopen ISA master card.

The CIf50-CAN is an CANopen PCI master card.

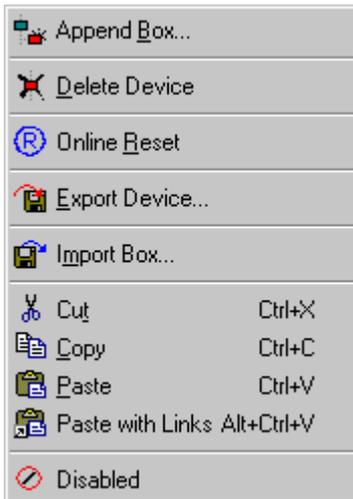
The CIf60-CAN is an CANopen PCMCIA master card.

The C104-CAN is an CANopen PC104 master card.

The DPRAM of the CIfx0-CAN is 8 Kbytes. There are no interrupts used.

The following description relates to the CIf30-CAN. The other cards vary from the point of view of TwinCAT in form only.

Context menu



Append Box... <Insert>

Adds CANopen boxes.

Currently supports the following boxes (further details on the boxes given later):

Supported boxes	Description
BK5100 [▶ 280]	Bus Coupler
BK5110 [▶ 280]	Economy Bus Couplers
BK5120 [▶ 280]	Bus Coupler
LC5100 [▶ 280]	Low-Cost Bus Couplers
CANopen Node [▶ 320]	General CANopen device.

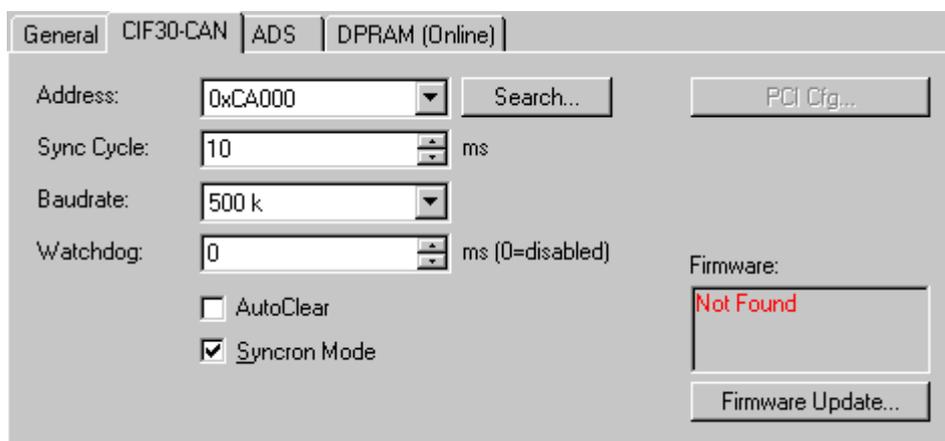
Delete Device...

Removes the CIF30-CAN fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the CAN bus.

"CIF-30 CAN" tab



Address: Enter the DPRAM card address here (CIF30-CAN and C104-CAN). This address is jumped/ configured on the card and can assume the following values: from 0xC8000 to 0xEE000 in steps of 0x2000

PCI Slot/Ring: (CIF50-CAN) Indicates the logical PCI slot into which the card is inserted.

Search: Searches the computer for available CIF-30 cards (only when TwinCAT is active)

Synch Cycle: Enter the cycle time for the synch telegram send.

Baudrate: Used to set the baud rate used for CAN bus operation.

Watchdog: Watchdog, used by the CANopen card to monitor TwinCAT.

AutoClear: If you select this box, a node failure will halt the whole network. Otherwise, the system attempts to re-incorporate the node and continues operating.

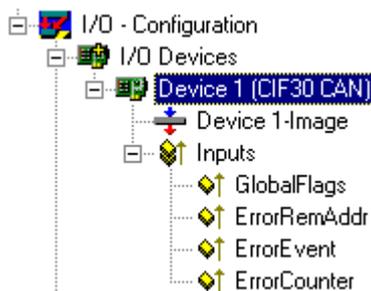
Synchronous Mode: The highest priority task linked with a corresponding device controls the fieldbus cycle and is thereby synchronized with the fieldbus I/O update (but not with CANopen SYNC; this is an independent card function). All other tasks are served asynchronously via corresponding buffers.

Firmware Update... Update the CIF-30 CAN firmware version here. The currently loaded firmware version is shown in the window - in red if the TwinCAT recognizes and is awaiting a more recent version.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM \[▶ 267\]](#)"

Input Diagnosis



The CIF-30 automatically provides four input bytes which describe the status of the card and the CAN bus:

GlobalFlags: The individual bits have the following definitions:

- 0x01 = Ctrl: Parameterization error
- 0x02 = ACtrl: Device stopped communication because of a guarding error at a node.
- 0x04 = NData: At least one node failing to communicate or has a configuration error
- 0x08 = Fatal: Serious bus error occurred
- 0x10 = Event: Communication error recognized
- 0x20 = NRdy: Host is not ready

ErrorRemAddr: Address of the node sending the signal, address 255 is the master card itself

EventError:

If ErrorRemAddr is other than 255 the following applies:

- =30: Guarding malfunction
- =31: Node has changed status
- =32: Sequence error in guarding protocol
- =33: No answer from remote frame PDO
- =34: No answer during a node configuration
- =35: Incompatible node profile number
- =36: Incompatible node device type number
- =37: Unknown SDO response received
- =38: SDO syntax error
- =39: Node in STOP mode

If ErrorRemAddr 255 appears the following applies:

- =52 unknown Handshake Mode has been configured
- =56 baud rate not defined
- =60 node address has been duplicated
- =220 host watchdog error
- =210 no database
- =212 database error

ErrorCounter: Number of errors to have occurred

11.2.4.5 CIFx0-CAN: Box Diagnosis

The CANopen fieldbus card CIFx0-CAN has a comprehensive range of diagnostic options for connected network nodes.



For each CANopen fieldbus node there is a box state input variable, which signals the status of the current slave during the running time and can be linked, for example with the PLC.

Node State

Variable	Flags	Online
Name:	BoxState	
Type:	UINT8	
Group:	Inputs	Size: 1.0
Address:	3583 (0xDFF)	User ID: 0
Linked to...		
Comment:	0 = No error 2 = Node not responding 5 = Config fault 9 = Node deactivated 13 = Node is pre-operational 14 = Node is prepared	
ADS Info:	Port: 300, IGp: 0x9003, IOfs: 0xDFF, Len: 1	

DataExchange

This bit indicates whether the node is currently exchanging data. Nodes can only be monitored if their guarding protocol has been activated.

CANopen Emergency Object

Some CANopen status data and up to 5 emergency objects received from a node can be read from any TwinCAT program via ADS and/or signaled to any TwinCAT program. In this case, set ADS parameters as follows:

Port: 300

IndexGroup: 0x5000 + Device-ID

IndexOffset: Hi-Word: Node-ID, Lo-Word: 0x100

Length: 8 - 48

The diagnostic data is structured as follows:

Offset: 0: Nodestatus bits

Bit 7: Node is deactivated

Bit 3: Guarding protocol is active

Bit 2: parameterisation error

Bit 1: Emergency buffer overflow

Bit 0: Mode does not respond

Offset: 1,2: Node type (Index 0x1000)

Offset: 3,4: Profile Number

Offset: 5: Node State

1: Disconnecting

2: Connecting

3: Preparing

4: Prepared

5: Operational

127: Pre-Operational

Offset: 6: Current Error

30: Guarding malfunction

31: Node has changed status

32: Sequence error in guarding protocol

33: No answer from remote frame PDO

34: No answer during a node configuration

35: Incompatible node profile number

36: Incompatible node device type number

37: Unknown SDO response received

38: SDO syntax error

39: Node in STOP mode

Offset: 7: Number of Emergency Messages

Offset: 8-47: Emergency buffer (-> node description)

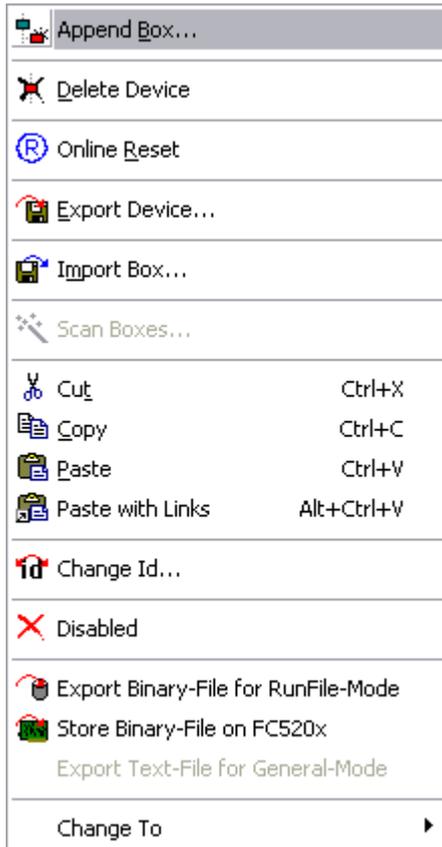
The data contain the status. The emergency buffer contains the last emergency messages received. The node status bits are collated in the box state diagnostic input.

11.2.5 DeviceNet

11.2.5.1 Beckhoff FC520x

The **FC520x** is a DeviceNet compliant Fieldbus card with one (FC5201) or two independent channels (FC5202). It can be driven as both a DeviceNet master and/or a DeviceNet slave. In master operating mode, it can exchange data with up to 63 slaves. All IO operating modes defined by DeviceNet are available as options for the exchange of IO data. Support of the Offline Connection Set provides access to a high-performance diagnostic interface. The "Auto-Device-Replacement" function makes it easy to replace faulty nodes.

Context menu



Append Box... <Insert>

Adds DeviceNet slaves (boxes). For an Overview [[▶ 336](#)] of all currently supported DeviceNet devices, please see [[▶ 336](#)]...

Delete Device...

Removes the FC520x fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the DeviceNet Master.

"FC5200" tab

The screenshot shows the configuration window for the FC5200 card. The 'General' tab is selected, and the 'FC 5200' sub-tab is active. The parameters are as follows:

- PCI Slot/Irq: 9-A/9 (0xF1003000)
- Mac-Id: 0
- Baudrate: 500 k
- Operation Mode: TASKSYNCHRON
- Shift Time (µs): 200
- PLL Sync Time (µs): 20
- Safety Time (µs): 20
- Cycle Time (µs): 1000
- Estimated Cycle: (empty)
- IO-Cycle Time (ms): 100
- Heartbeat Time (s): 0
- Firmware: 0.1
- DeviceNet Mode: Master (selected)

PCI Slot/Irq: Shows in which logical PCI slot the card was detected and which IRQ is assigned to it. The IRQ is unused.

Search...: Searches for all connected FC520x channels. Select those required. In the case of an FC5202 both channels A and B appear. These behave in logical terms like two FC5201 cards.

PCI Configuration ...: In which the address of the FC520x is set in the lower memory area (below 1 MB) of the PC.

Upload Configuration ...: Scans the DeviceNet network and adds all found devices (boxes cannot be added). In the case of Beckhoff boxes, reads the configuration precisely. Searches external devices to find the corresponding EDS file.

Firmware: Shows the current firmware version of the FC520x.

Firmware Update...: Update the FC520x card firmware version here.

Stations No.: Each DeviceNetdevice requires a unique station number (MAC-ID)- including the master.

Baudrate: Set the DeviceNet Baudrate here. Select one of the following: 125kBaud, 250 kBaud and 500 kBaud

Operating Mode: Set the CDLSYSNCHRON operating mode, the highest priority task linked with the corresponding device controls the DeviceNet cycle and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

Shift-Time: The DeviceNet cycle is started by a real time timer, but only if at the time of the timer overflow, the PC application has already sent the output data (transfer of output data). This means that the real time timer on the card and the highest priority TwinCAT task are using the same cycle time but are shifted together by a predetermined time difference, whereby the shift time must be greater than the maximum TwinCAT jitter plus the maximum mapping time (see Equi Diag tab).

PLL-Sync-Time: As the card's real time timer and the highest priority TwinCAT task gradually diverge, the card's real time timer must be readjusted. The PLL Sync time gives thresholds at which, once exceeded, the card's real time timer is readjusted. A small PLL Sync time exerts a strong shift on the cycle time of the card's real time timer, producing a significant jitter on the fieldbus.

Safety-Time: Idle time on the bus before the start of the next cycle.

Cycle Time: Displays the cycle time of the corresponding highest priority task.

Estimated Cycle: Displays the expected DeviceNet cycle time.

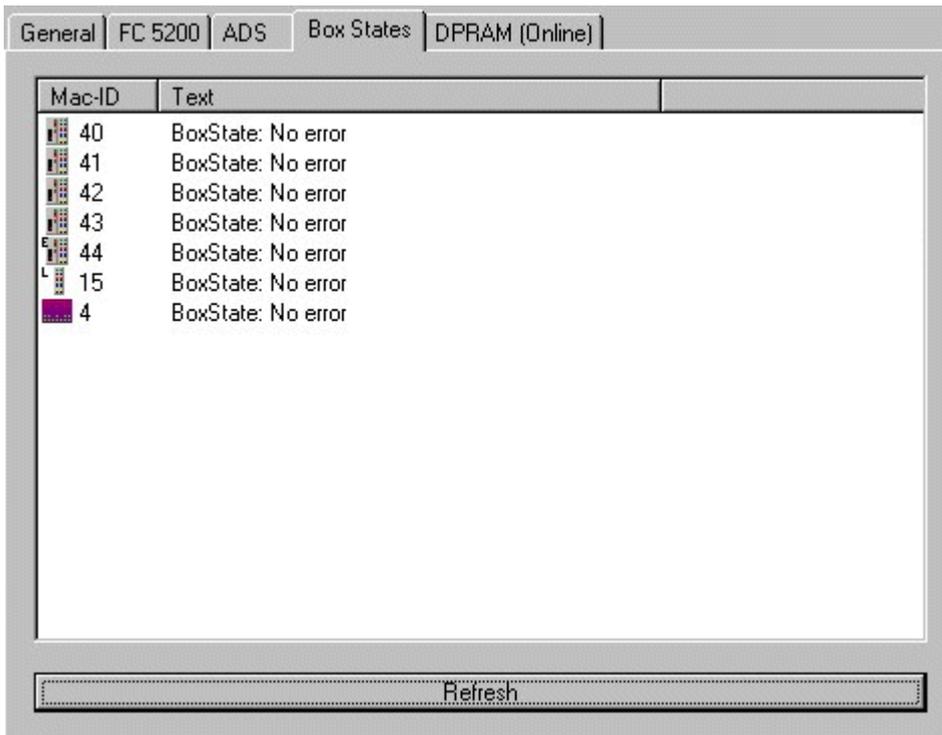
IO-Cycle Time: Sets the cycle time for the IO connections. This value is used as the default value for newly added boxes.

Heartbeat Time : Cycle Time for DeviceNet Heartbeat Messages. Heartbeat messages allow monitoring of the nodes within the network.

”ADS” tab

The FC520x is an ADS device with its own net ID, which can be changed here. All ADS services (diagnosis, non-cyclical communication) going to the FC520x must address this net ID.

”Box States (Diag)” tab



Displays an overview of all current box statuses.

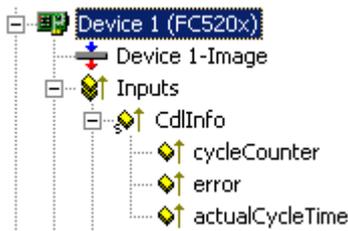
Tab ”(Online) DPRAM”

See [”Online Display of DPRAM \[► 267\]”](#) .

Input Diagnosis

The FC520x automatically provides several diagnostic variables which describe the status of the card and the DeviceNet network:





CdlInfo:

CdlInfo.error: Shows the number of slaves with which data exchange cannot be carried out. The box status of the slaves must only be checked if this value is not equal to 0.

CdlInfo.cycleCounter: Is incremented at the end of each DeviceNet cycle. This variable allows you to determine whether the last cycle was completed before the task was begun

CdlInfo.actualCycleTime: Shows the current cycle time in 4/25 µs. This variable is updated only when all slaves are involved in the data exchange (also when CdlInfo.error is 0)

DiagFlag: Shows whether the diagnostics information on the card has changed. This can be read off using ADS Read. For that purpose, specify the net ID of the FC520x, the port number 200 and the IndexGroup 0xF100. The IndexOffset and the length then relate to the diagnostic data.

11.2.5.2 Hilscher CIFxx-DNM

The CIF30-DNM is a DeviceNet ISA master card.

The CIF50-DNM is a DeviceNet PCI master card.

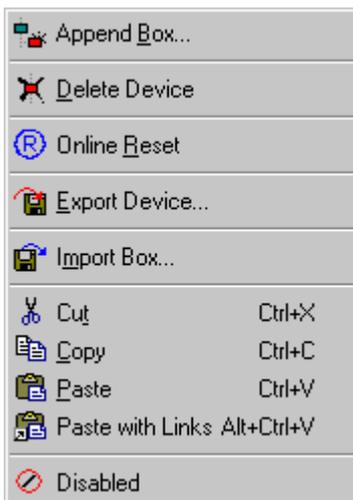
The CIF60-DNM is a DeviceNet PCMCIA master card.

The C104-DNM is a DeviceNet PC104 master card.

The DPRAM of the CIFx0-CNM is 8 Kbytes. There are no interrupts used.

The following description relates to the CIF30-DNM. The other cards vary from the point of view of TwinCAT in form only.

Context menu



Append Box... <Insert>

Adds DeviceNet boxes.

Currently supports the following boxes (further details on the boxes given later):

Supported boxes	Description
BK5200 [▶ 282]	Bus Coupler
BK5210 [▶ 282]	Economy Bus Couplers
LC5200 [▶ 282]	Low-Cost Bus Couplers
DeviceNet Node [▶ 336]	General DeviceNet device

Delete Device...

Removes the CIF30-DNM fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the DeviceNet.

"CIF-30 DNM" tab

Address: Enter the DPRAM card address here (CIF30-DNM and C104-DNM). This address is jumped/ configured on the card and can assume the following values: from 0xC8000 to 0xEE000 in steps of 0x2000

PCI Slot/Ring: (CIF50-DNM) Indicates the logical PCI slot into which the card is inserted.

Search: Searches the computer for available CIFxx-CAN cards

MAC ID: Enter the master node (scanner) card address here. These must not be duplicated within the network.

Heartbeat: Set the rate with which the DeviceNet card sends heartbeat messages (not supported at the present time).

Baudrate: Used to set the baudrate used for DeviceNet operation.

Watchdog: Watchdog, used by the DeviceNet card to monitor TwinCAT.

VendorID: Gives the vendor ID with which the scanner card is identified in the network (e.g. in the Duplicate MAC ID Detection protocol)

AutoClear: If you select this box, a node failure will halt the whole network. Otherwise, the system attempts to re-incorporate the node and continues operating.

Synchronous Mode: The highest priority task linked with the corresponding device controls the fieldbus cycle and is thereby synchronized with the fieldbus. All other tasks are served asynchronously via corresponding buffers.

Firmware Update... Update the CIFxx-DNM firmware version here. The currently loaded firmware version is shown in the window - in red if the TwinCAT recognises and is awaiting a more recent version.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM](#) [[▶ 267](#)]"

Diagnostic

Table 1: Global Flags

Error Code	Description	Troubleshooting
0x00	No error	
0x01	Ctrl: Parameter error	Check Master Parameter
0x02	AClr: Device stops the transmission to all nodes	Check cabling, Reconfigure Master
0x04	NExc: at least one node has not reached the data exchange state	Check ErrorRemAddr and ErrorEvent. inspect the field device indicated by ErrorRemAddr.
0x08	Fatal error because of heavy buserror	Check cabling, inspect the field devices, may one node makes trouble on the bus, Check DeviceNet Voltage
0x10	Event: transmission errors were detected	Check cabling, inspect the field devices, may one node makes trouble on the bus, Check Baudrate and MAC Id
0x20	NRdy: HOST is not ready	Check TwinCAT System for general errors
0x40	Duplicate MacId detected	Check Masters MacId
0x80	Duplicate MacId Test active	Check Baudrate and cabling, Master is may not able to set up his Duplicate Mac Id messages

Table 2: Error Rem Addr

Error Code	Description	Troubleshooting
Station Number	Number of faulted slave device	Inspect the field device with the indicated MAC id, Check ErrorEvent Diagnoses
255	Error inside Device	Check Master Parameter, Check ErrorEvent Diagnoses

Table 3: ErrorEvent (for ErrorRemAddr = 255, Error inside device)

Error Code	Description	Troubleshooting
57	Duplicate MAC Id detected	Check the addresses of the field devices, change Masters MAC Id
58	Master Config Error, download error of Master parameter	Contact technical support
212	Failure in reading masters data base	Contact technical support

Table 4: ErrorEvent (for ErrorRemAddr = Station Number, MacId)

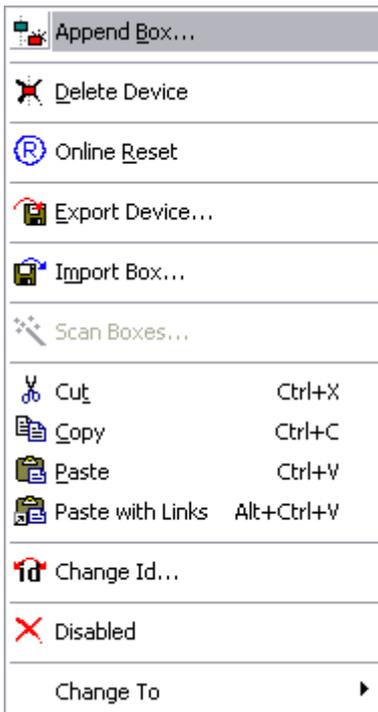
Error Code	Description	Troubleshooting
30	device access timeout, device stopped communicating	Inspect the field device, verify connections, check cabling
32	Device rejects access with unknown error code	Check IO features of the device, check explicit access to device, check object class, instance, and attribute id
35	Device responses in allocation process with connection error	Check IO features of the device, check explicit access to device, check object class, instance, and attribute id
36	Produced connection length is different to the configured one	Check number of Bytes to be produced by the device, check devices IO configuration
37	Consumed connection length is different to the configured one	Check number of Bytes to be consumed by the device, check devices IO configuration
38	Device service response telegram unknown	Contact technical support of the device manufacturer
39	Connection already in Request	Check cabling, inspect device, Master is not able to set up a connection to the device
40	Number of CAN-message data bytes in read produced or consumed size response not matches expected one	Contact technical support of the device manufacturer
41	Predefined Master- / Slave Connection Set already exists	Check number of Masters connected to the network, device may already be in use by another master
42	Polling IO data length is different to the configured one	Check number of Bytes to be produced by the field device, check field devices IO configuration, contact technical support of the device manufacturer
43	Sequence Error in fragmented polling IO transmission	Inspect device, contact technical support of the device manufacturer
44	Fragment Error in fragmented polling IO transmission	Inspect device, contact technical support of the device manufacturer
45	Sequence Error in fragmented polling IO transmission	Inspect device, contact technical support of the device manufacturer
46	Polling IO data length is different to the configured one	Check number of Bytes to be produced by the device, check devices IO configuration, contact technical support of the device manufacturer
47	Sequence Error in fragmented Change of State / Cyclic IO transmission	Inspect device, contact technical support of the device manufacturer
48	Sequence Error in fragmented Change of State / Cyclic IO transmission	Inspect device, contact technical support of the device manufacturer
49	Sequence Error in fragmented Change of State IO transmission	Inspect device, contact technical support of the device manufacturer
50	Change of State / Cyclic IO data length is different to the configured one	Check number of Bytes to be produced by the device, check devices IO configuration, contact technical support of the device manufacturer

11.2.6 SERCOS

11.2.6.1 Beckhoff FC7501/FC7502

The FC7501 respectively FC7502 are single-channel and double-channel SERCOS cards (SERCOS = **SEriell Realtime Communication System**) with PCI interfaces. They can be operated as SERCOS masters and/or as SERCOS slaves. The SERCON816 ASIC is used for these cards. It supports not only 2 and 4 Mbaud, but also 8 and 16 Mbaud. Now, neither the transmitter nor the receiver being used are specified for 16 Mbaud, which means that this property cannot yet be guaranteed.

Context menu



Append Box... <Insert>

Adds Sercos slaves (boxes). For an [Overview \[▶ 339\]](#) of all currently supported SERCOS devices, *please see [▶ 339]*...

Delete Device...

Removes the FC750x fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset of the Sercos master, so that the phase will switch to phase 0 and will then return to what had previously been the current phase.

"FC7500" tab

PCI Slot/Irq: Shows in which logical PCI slot the card was detected and which IRQ is assigned to it. The IRQ is unused.

Search...: Searches for all connected FC750x channels. Select those required. In the case of an FC7502 both channels A and B appear. These behave in logical terms like two FC7501 cards.

PCI-Cfg...: In which the address of the FC750x is set in the lower memory area (below 1 MB) of the PC.

Scan the bus...: The Sercos ring is scanned here, and all devices found are added to the device. The configuration of Beckhoff boxes is read precisely.

Data rate: The Sercos baud rate is set here. 2 Mbaud, 4 Mbaud, 8 Mbaud or 16 Mbaud can be selected.

Transmitter power: The power of the transmitter is set here, depending on the length of optical fibre being used.

Operating mode: The FC750x can be operated as a Sercos master and as a Sercos slave. In either of these operating modes, the card can be operated as the synchronous master (the PC and other synchronous devices receive their clock from the sync master) or as a sync slave (the card, or the card channel, receive the synchronisation signal from the other channel or from another card over the ribbon cable). There can only be one synchronous master within one PC. If both the channels of a FC7502 are used, then only the A-channel (the channel closest to the motherboard) can be used as the sync master.

Start-up to Phase 4: If selected, then every time TwinCAT starts an attempt will be made to bring the Sercos bus into phase 4, and thus to perform cyclical data exchange. If this option is not selected, the card will remain in phase 2. It will then have to be placed into phase 4 at a later stage by ADS from, for example, the PLC.

Check Timing: If selected, then in each cycle the exact real-time behaviour of access to the card is monitored. If not maintained (actual values are read too early, or set values are written too late) then a corresponding counter located in the process data is incremented. This monitoring has only a very small impact on the performance, so that there is no disadvantage to using it in normal applications. In applications with very short cycle times and where performance margins are very tight, however, it can be switched off.

Watchdog: The SERCON816 Sercos ASIC used has a hardware watchdog that monitors regular PC access, activating phase 0 if the accesses cease. The number of cycles that the watchdog will tolerate is given here. The watchdog is deactivated if the figure supplied is 0.

NC Access Time: A figure is given here for the time required by the NC in each cycle for reading the actual values and writing the set values. This value is only used by the internal time slot calculation, so that possible time slot problems can be seen in advance (cf. Check Timing Errors).

NC Shift Time: The NC shift time can be used to delay the time at which the NC begins to read the actual values. The value gives the number of μs after the last AT. The default value of $50\mu\text{s}$ ensures in normal cases that even if there is a small amount of jitter in the real-time system, the ATs, and therefore the actual values, have safely arrived at the master before the NC acts. If more than one Sercos ring is in use, it may be necessary to adjust this value, since the NC accesses all the rings at the same time, but the connected devices in particular rings mean that the last ATs arrive at different times. Since the Sercos rings on the bus are synchronized in hardware, the following rule applies: The NC shift time should be set on the various rings in such a way that the resulting t_{NCAccess} time (see timing) is about the same on all the rings. In addition to this, the NC shift time should not be much less than about $20\mu\text{s}$ on any ring.

Cycle-Time(3-4): The cycle time of the highest priority associated task is indicated here. This is used in phases 3 and 4.

Cycle-Time(0-2): The cycle time in phases 0 to 2 is given here. This is used for the bus start-up.

The following values make it possible to influence the internal time slot calculation, to make modifications of a few μs in the event of communication problems or loading difficulties. However, this should not be done without the appropriate Sercos expertise, so that the effects can be estimated.

JT1 User: The value set here alters the jitter JT1 used in the internal time slot calculation.

JT2 User: The value set here alters the jitter JT2 used in the internal time slot calculation.

JTSCyc User: The value set here alters the jitter JTSCyc used in the internal time slot calculation.

T3 User: The value set here alters the time T3 used in the internal time slot calculation.

T4 User: The value set here alters the time T4 used in the internal time slot calculation.

"Timing (Online/Offline)" tab

tSCYC	t2	t3	t4	MdtLen	dMST	dMDT	tNC	dNC
2000	1737	1964	1493	40	28	215	1054	200

Addr	SLKN	MdtPos	t1	dAT	t1min	t5	tATMT	tATAT
1	0101	1	19	61	12	500	2	2
2	0202	9	96	61	12	500	2	2
3	0303	17	173	61	12	500	2	2
4	0404	25	250	61	12	500	2	2
5	0505	33	327	61	12	500	2	2

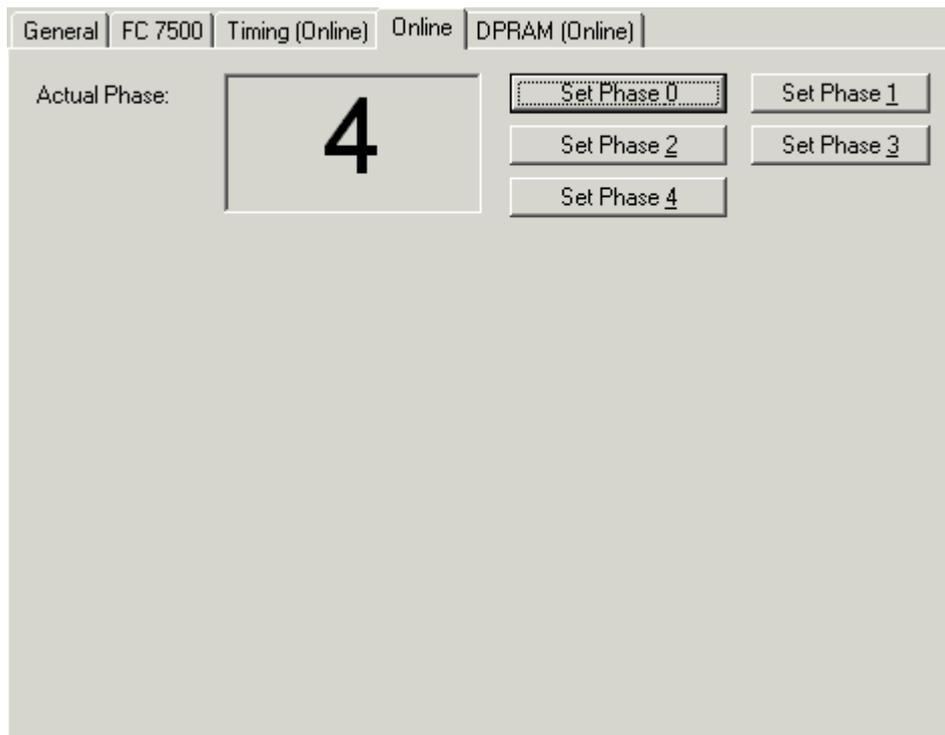
The Timing tab provides internal details of the time slot calculation. A distinction is made between and online and an offline mode since parameters are also read from the devices and included in the calculation of the time slot. In offline mode (TwinCAT is stopped) default values are used for the timing values that are normally read from the devices, so that the result of this calculation can differ slightly from that obtained with

the true values. The offline calculation does however as a rule provide a very good estimate of the bus timing. In online mode (TwinCAT is running and the Sercos Bus is in phase 3 or 4) the exact values are displayed and provide the expert user with very precise information about the timing on the bus.

The diagram in the lower section provides a good summary of the bus loading being generated, and over the capacity still available. A Sercos cycle is displayed between the two red master control telegrams (MST). After the MST the devices first send their drive telegrams (green), and after the NC shift time the NC access time (dotted region) starts, in which the NC accepts the actual values and transmits new set values. The subsequent clear region leading up to the Master Data Telegram (MDT, blue) indicates bus capacity that is still free, and can be used for other devices or for additional data associated with the existing devices.

Not long after the MDT the master sends another MST, so starting the next cycle. Times T3 and T4 indicate when the devices should all simultaneously accept the set values or acquire the actual values.

"Online" tab



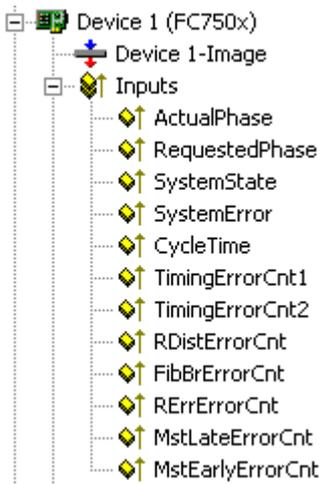
The Online tab makes it possible to find the current phase of the Sercos ring and to change it. Three red dashes "---" for the phase indicate a ring that is not closed. A phase indication like "2->3" indicates that a change of phase is currently in progress, and that it is possible that this may take some time.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM](#) [▶ 267]" . The registers in the ASIC can be seen starting at address 0x1000 following the DPRAM of the SERCON816 without a break.

Input Diagnosis

The FC750x has a variety of diagnostic variables available automatically. They describe the state of the card and of the Sercos ring:



ActualPhase: The current phase of the Sercos ring is displayed.

RequestedPhase: The phase currently being requested (e.g. by the PLC) is displayed. The card or driver is presently attempting to activate this phase.

SystemState: Gives more precise information about the current phase:

0xE001 = Phase 0
 0xE002 = Phase 1
 0xE003 = Phase 2
 0xE004 = Phase 3
 0xE005 = Phase 4
 0xE008 = Break
 0xE011 = Phase switch 0 -> 1
 0xE012 = Phase switch 1 -> 2
 0xE013 = Phase switch 2 -> 3
 0xE014 = Phase switch 3 -> 4

SystemError: Indicates the current error state:

0x0000 = No error
 0x8005 = Drive addresses are incorrect
 0x8006 = HS-timeout (service channel)
 0x8007 = Double AT-failure
 & 0x8009 = LWL-bus is interrupted
 0xD002 = Switch from 2->3 failure (S-0-0127)
 0xD003 = Switch from 3->4 failure (S-0-0128)
 0xD004 = Invalid Command
 0xF001 = Configuration error (actual/nominal channel)
 0xF002 = Error in the time slot calculation
 0xF003 = Incorrect phase setting by the NC
 0xF004 = Internal error
 0xF005 = Error lifecounter
 0xF008 = Double MDT-failure
 0xF009 = Double MST-failure
 0xF00A = Sync-In signal failure

TTimingErrorCnt1/b>: A counter that is incremented if the NC supplies new set values too late ("Check timing" must have been selected).

TimingErrorCnt2/b>: A counter that is incremented if the NC accesses the actual values too early ("Check timing" must have been selected).

RDistErrorCnt/b>: An error counter that counts telegrams received in a damaged state (cf. RDIST in the SERCON816 Reference Manual). The cause can be an incorrect baud rate.

FibBrErrorCnt: An error counter that counts telegrams received in a damaged state (cf. FIBBR in the SERCON816 Reference Manual). The cause can be an incorrect baud rate.

RErrErrorCnt: An error counter that counts telegrams that have been lost or that are received at the wrong time (cf. RERR in the SERCON816 Reference Manual).

MstLateErrorCnt: An error counter that counts MSTs that are received too late (cf. MSTLATE in the SERCON816 Reference Manual).

MstEarlyErrorCnt: An error counter that counts MSTs that are received too early (cf. MSTEARLY in the SERCON816 Reference Manual).

11.2.6.2 Indramat SERCANS SCS-P

The SERCANS SCS-P is a SERCOS master card for up to eight axes. It is supported as both an ISA and a PCI type.

The DPRAM of the SERCANS SCS-P is 4 Kbytes. An interrupt is used, which actuates the card and is also used for synchronising functions in the TwinCAT system.

Context menu

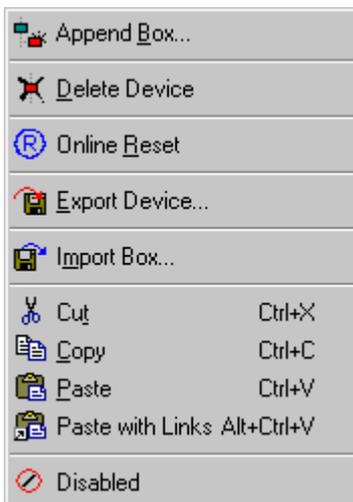


Table 5: Append Box... <Insert>

Supported boxes	Description
SERCOS Axis [▶ 340]	Sercos axis
BK7500 [▶ 286]	Bus Coupler

Delete Device...

Removes the SERCANS SCS-P fieldbus card and all subsidiary elements from the I/O configuration.

"Sercans SCS-P" tab

Address: ISA: Enter the DPRAM card address here. This address is jumped on the card and can assume the following values: from 0xC0000 to 0xEF000 in steps of 0x1000
 PCI: Shows the PCI slot number, the PCI interrupt and the DPRAM address.

Search: Used to search the computer for SERCANS cards of the corresponding type (ISA / PCI).

Cyclic IRQ: Enter the cyclical interrupt used. It must coincide with the card setting (jumper, ISA only). The non-cyclical card interrupt is not required and may not be jumped on the card (ISA only).

Sync Master: See "Synchronizing Several SERCANS Cards".

Phase 4: Used to specify whether the card should StartUp in phase 4 at the TwinCAT system StartUp. It will otherwise remain in phase 2 and can be switched to phase 4 at a later point via ADS.

Tab "(Online) DPRAM"

See "[Online Display of DPRAM](#) [▶ 267]"

Synchronising Several SERCANS Cards

If you require more than eight axes, you will need to use 2 or more SERCANS cards. These cards must be synchronized with one another since only one card can control the TwinCAT system. The card which synchronizes the TwinCAT system is described a "Sync Master" and the corresponding check box for this card should be ticked (none of the others). The synchronizing process is different depending on whether you are using ISA or PCI cards. You cannot mix ISA and PCI cards in one installation!

Synchronizing ISA cards

In the case of the "slave" cards, you should set the same cyclical interrupt as for the "master" card. Otherwise, break the J100 connection on the back of the card (including the track)! J100 is to be found on the back, next to the inserted interrupt jumpers. If the card is to be used as a master at a later point, re-solder J100.

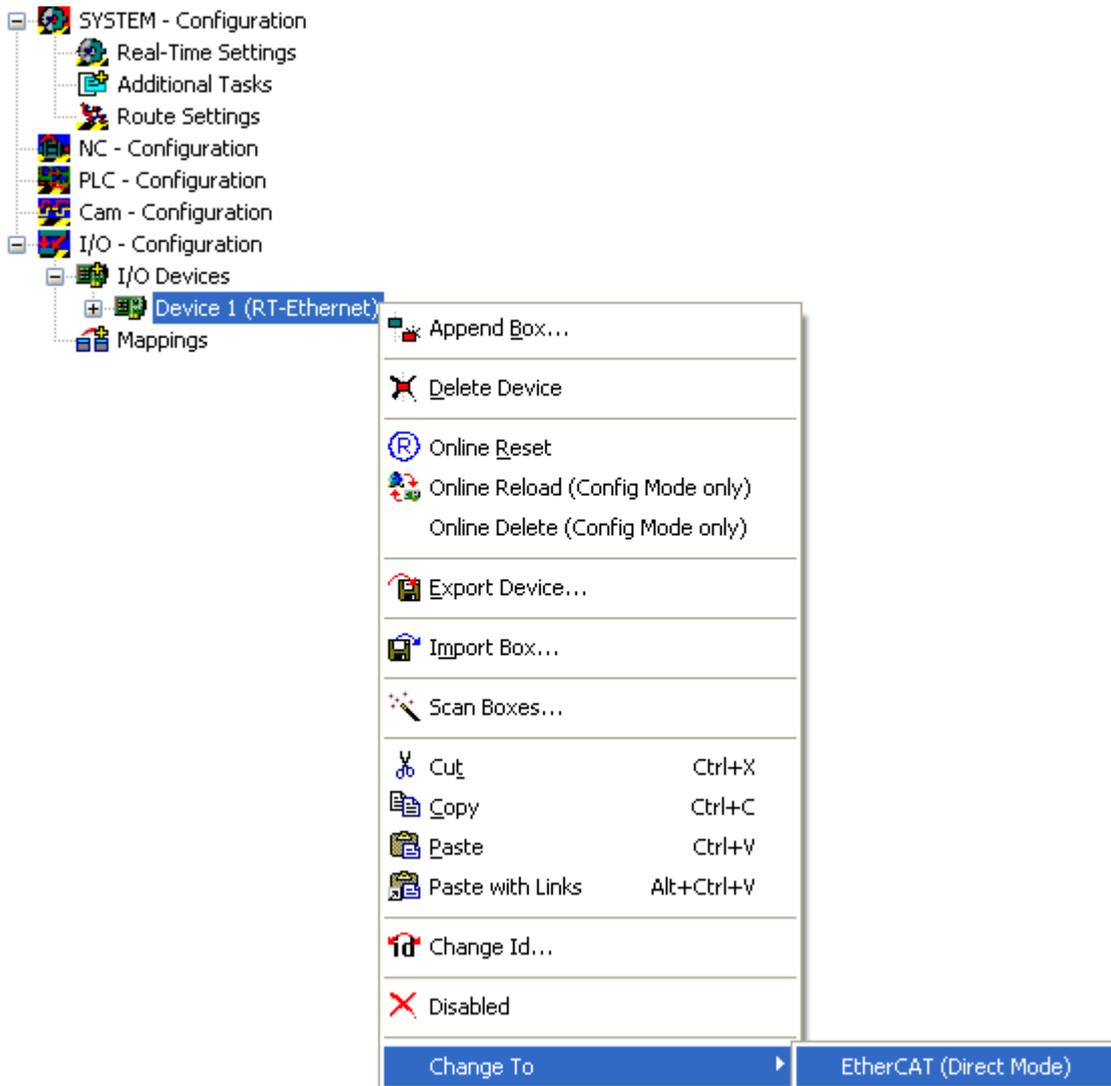
Synchronizing PCI cards

In the case of PCI cards, synchronisation is carried out via a 10-pin ribbon cable (angled ribbon cable socket on the top), which is used to connect all SERCANS cards in parallel. On the "master" card you also need to connect a jumper on J108 between PIN 1 PIN 2. This jumper is not required on the "slave" cards.

11.2.7 EtherCAT(Direct Mode)

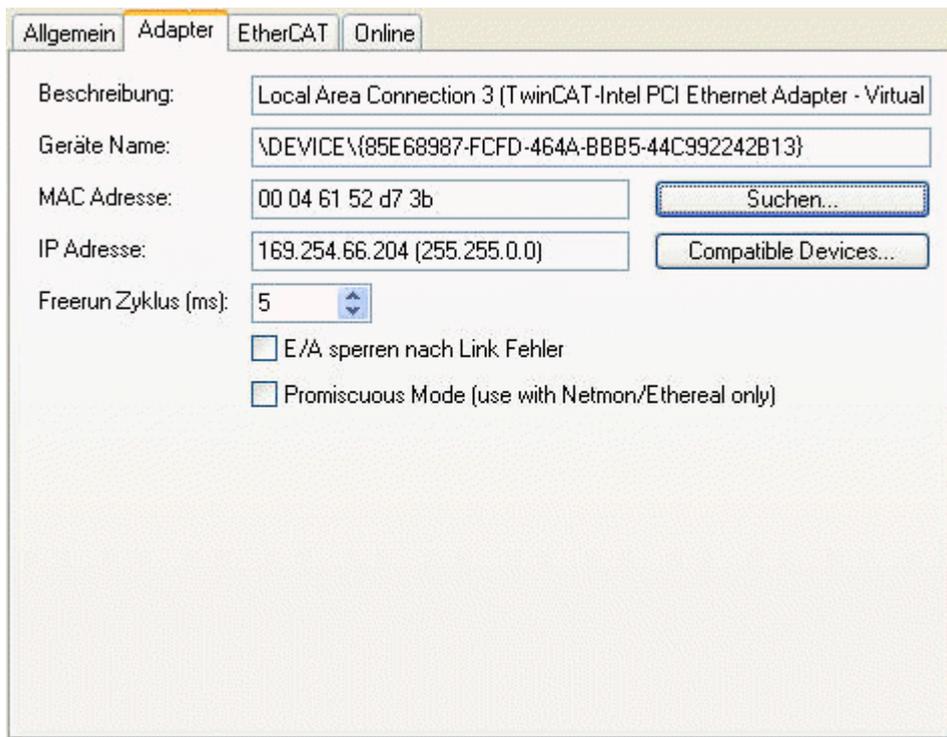
11.2.7.1 EtherCAT(Direct Mode) "Online" tab:

The EtherCAT(Direct Mode) is a Real Time Ethernet Device that only supports the EtherCAT protocol. Internally it uses the same network drivers as the standard Real-Time Ethernet device (see [Ethernet Miniport \(Real-Time\) \[► 239\]](#)). Install instructions for the network drivers can be viewed under [Appendix C \[► 413\]](#). The EtherCAT (Direct Mode) device should be used, if only EtherCAT slave devices are connected to the network adapter. It offers additional features not available in the standard Real-time Ethernet device. If you scan for the device, at least one EtherCAT slave device should be connected to the device, otherwise the Rt-Ethernet device is selected. To change the device type from Real-Time Ethernet device to EtherCAT(Direct Mode), you have to open the context menu of the device in the System Manager tree view. Then you have to select the menu entry "Change To/ EtherCAT(Direct Mode)":



EtherCAT(Direct Mode) "Adapter" tab

After adding an EtherCAT(Direct Mode) to the [I/O configuration \[► 97\]](#), the following "Adapter" tab is available on the right:



The Ethernet adapter currently selected is shown on this "Adapter" tab.

Search...: Looks for [TwinCAT Real-Time Ethernet compatible devices \[► 239\]](#) and displays them.

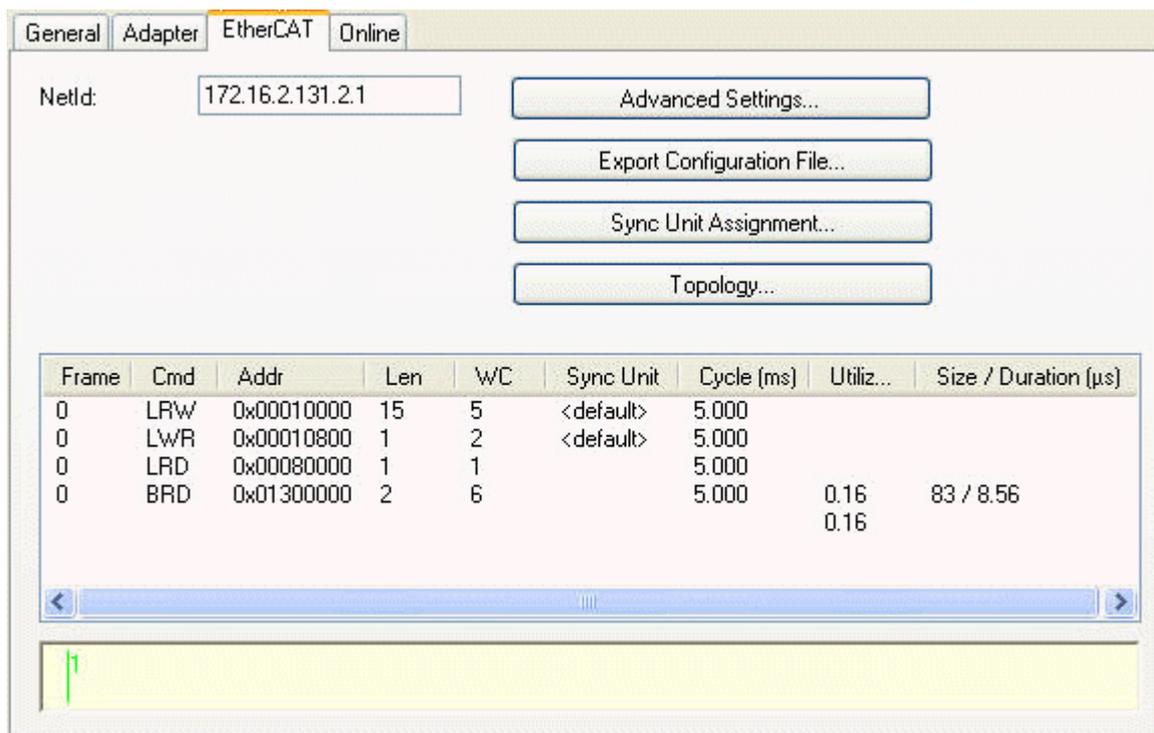
MAC Address: MAC Address of this Ethernet controller

IP Address: Settings taken from Windows Registry. These can be changed under "Control Panel | Network Connections" in the TCP/IP '*Properties..*' section.. If Real-Time Ethernet and "normal" Ethernet are both used on the same system with two different network adapters, the subnet addresses of these adapters (NICs) must differ! Nevertheless, the Real-Time Ethernet belonging devices have to be configured with the same subnet address (first two quadruples) as the Ethernet Miniport adapter and vice-versa, of course.

Freerun Cycle: The cycle time used if [Free-Run \[► 22\]](#) is active ([Config Mode \[► 13\]](#) only), can be set here. The cycle time in Run mode results automatically in reference to the task with the highest priority linked to the variables of the adapter or one of its nodes.

Lock I/O after Link Error: If this box is checked, the process data exchange doesn't resume automatically after a resolved link problem (e.g. when the network cable has been unplugged). In such a situation, an I/O Reset is necessary afterwards, instead.

Promiscuous Mode(use with Netmon/Ethereal only): This check box should only be enabled, if one wants to capture the network traffic with tools like Ethereal or the Microsoft Network monitor. If this box is checked, the Real-Time Ethernet miniport device copies all frames to the NDIS protocol layer of windows. This allows protocol drivers to capture the frames.

EtherCAT(Direct Mode) "EtherCAT" tab:

NetId: This is the NetId of the EtherCAT master device. The NetId is a parameter necessary for communicating with the EtherCAT master device via ADS. The ADS port of the EtherCAT master is always 0xFFFF(65535) and the Ads Port of an EtherCAT slave device is equal to the fixed address (see [EtherCAT Addr \[► 357\]](#)) of the slave.

Advanced Settings...: Opens the [Advanced Settings \[► 223\]](#) Dialog. This dialog contains additional settings for the EtherCAT master device.

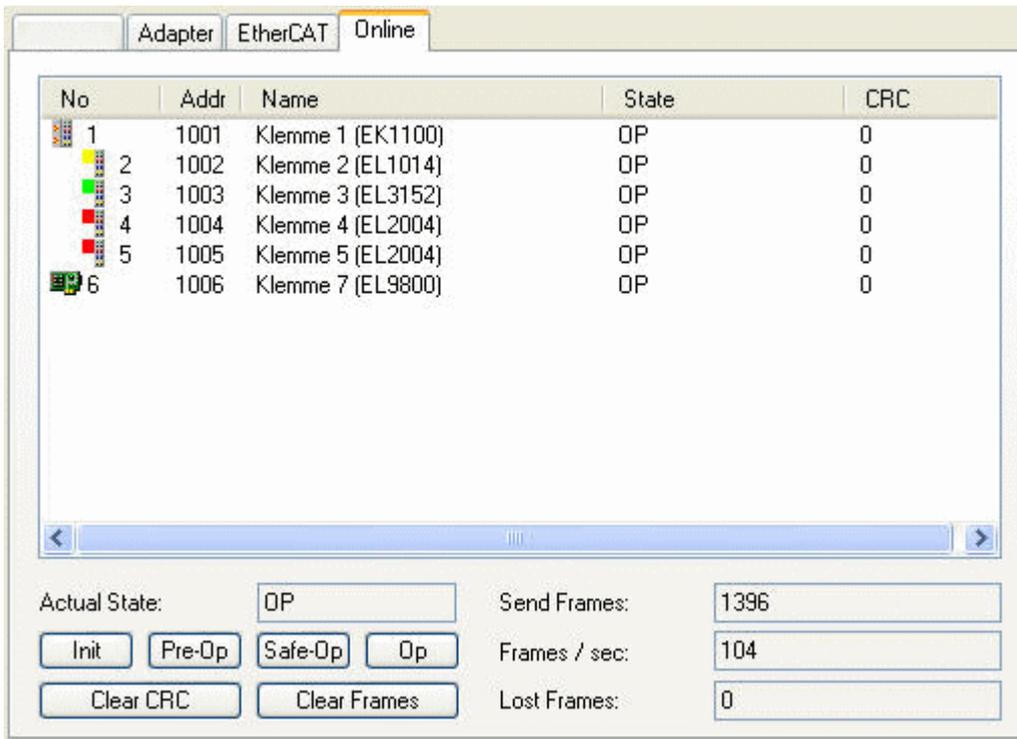
Export Configuration File...: Creates the XML Master Configuration file. This file describes the process data and the frames sent during the EtherCAT state transitions.

Sync Unit Assignment...: Opens the "Sync Unit Assignment" dialog. This dialog can be used to group EtherCAT slave devices into separate sync units.

Topology...: Opens the "Topology" dialog. This dialog displays the topology of the configured EtherCAT slave devices.

The list view at the bottom displays all cyclic EtherCAT commands sent by the EtherCAT master:

Column	Description
Frame	The cyclic frame the EtherCAT command is contained in. One EtherCAT frame can contain one or more EtherCAT commands.
Cmd	The type of the command.
Addr	Address of the data section of the EtherCAT slave devices this command addresses. If the EtherCAT command uses logical addressing (LRW, LW or LR) "Addr" specifies the logical address. Otherwise the upper 16 Bit always specifies the physical memory address and the lower 16 Bits either the fixes address of the device (see EtherCAT Addr) or the auto increment address of the device (see Auto Inc Addr dependent on the type of the command.)
Len	Length of the data section.
WC	Expected working counter. Each EtherCAT slave that is addressed by an EtherCAT command increments the working counter. If it is a Logical Read Write(LRW) command each EtherCAT slave device data is written to increases the working counter by 2 and each EtherCAT slave data is read from increases the working counter by 1.
Sync Unit	Sync Unit the EtherCAT command belongs to.
Cycle Time(ms)	Cycle time with which the frame is sent.



Actual State: Shows the current state of the EtherCAT master device.

Send Frames: Shows the number of frames sent by the EtherCAT master device.

Frames: Shows the number of sent frames per second.

Init: Requests the 'Init' state from the master.

Pre-Op: Requests the 'Pre-Op' state from the master.

Safe-Op: Requests the 'Safe-Op' state from the master.

Op: Requests the 'Op' state from the master.

Clear CRC: Clears the CRC counters of the EtherCAT slave devices.

ClearFrames: Resets the counter displayed in the "Send Frames" edit box to 0.

The list view shows all the EtherCAT slave devices and their corresponding states and CRC counters:

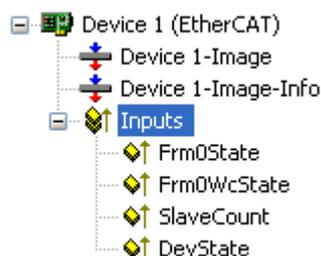
Column	Description
No	Physical position of the device in the communication ring
Addr	Fixed address (see EtherCAT Addr) of the slave device.
Name	Name of the EtherCAT device
State	State of the EtherCAT slave device. The state can be either INIT, PRE-OP, SAFE-OP or OP. If the device cannot be found by the master or the slave is unable to change the state, ERR + the last known valid state is displayed.
CRC	CRC counter of the EtherCAT slave device. If an individual slave device is selected in the list, the CRC counters of the ports A,B and C(if in use) are listed in brackets.

To request a specific state from an individual EtherCAT slave device one must right click on the slave device in the list view. This opens following context menu:

Request 'INIT' state
Request 'PREOP' state
Request 'SAFEOP' state
Request 'OP' state
Request 'BOOTSTRAP' state
Clear 'ERROR' state
EEPROM Update...
Firmware Update...

Now one can select one of the "Request 'xxx' state" menu items to set the device into a different state.

11.2.7.2 Additional Diagnostic information



FrmXState: Variable of type WORD (or UINT), that shows the state of the frame X. For each EtherCAT command in the frame, a bit is reserved in FrmXState:

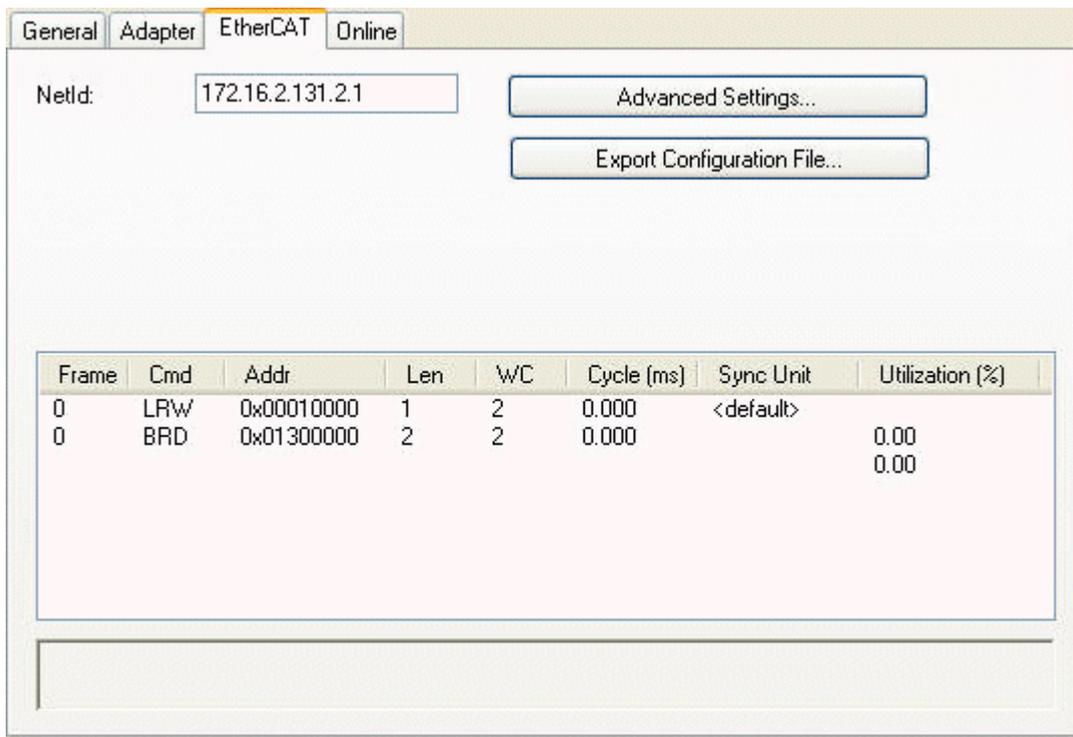
Bit	Description
0 (0x0001)	1. EtherCAT command not sent (NOP requested)
1 (0x0002)	2. EtherCAT command not sent (NOP requested)
2 (0x0004)	3. EtherCAT command not sent (NOP requested)
...	
14 (0x4000)	15. EtherCAT command not sent (NOP requested)
15 (0x8000)	complete frame not sent

FrmXWcState: Variable of type WORD (or UINT), that shows the working counter states of the individual EtherCAT commands of the cyclic frame X. For each EtherCAT command in the frame, a bit is reserved in FrmXWcState:

Bit	Description
0 (0x0001)	wrong working counter of 1. EtherCAT command received
1 (0x0002)	wrong working counter of 2. EtherCAT command received
2 (0x0004)	wrong working counter of 3. EtherCAT command received
...	
14 (0x4000)	wrong working counter of 15. EtherCAT command received
15 (0x8000)	complete frame missing

An EtherCAT frame can consist of one or more EtherCAT commands. Each of these commands has an expected working counter value. In other words, the master knows, how many slave devices are addressed by an individual command and can calculate the expected working counter. If the master receives a wrong working counter this indicates that one or more slaves have a problem. In this case the corresponding bit in FrmXWcState is set.

In the Example above only one frame (Frame0) is sent cyclically during process data communication. In the "EtherCAT" tab of the EtherCAT device one can see the individual cyclic frames and the EtherCAT commands contained in them:



The first command is a Logical Read Write command and the second is a broadcast read command. The LRW command is responsible for reading the inputs and writing to the outputs of one or more slave devices. The BRD(Broad Cast Read) command reads out the combined states of all slaves.

Slave Count: Number of slave devices connected to the EtherCAT master.

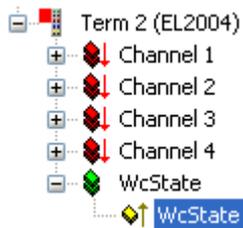
DevState: Device status information as WORD (or UINT) variable, assumes the following values:

Bit	Description:
0 (0x0001)	Link error detected.
1 (0x0002)	I/O locked after link error (I/O reset required)
2 (0x0004)	Link error (redundancy adapter)
3 (0x0008)	Missing one frame (redundancy mode)
4 (0x0010)	Out of send resources (I/O reset required)
5 (0x0020)	Watchdog triggered
6 (0x0040)	Ethernet driver (miniport) not found
7 (0x0080)	I/O reset active
8 (0x0100)	At least one device in 'INIT' state
9 (0x0200)	At least one device in 'PRE-OP' state
10 (0x0400)	At least one device in 'SAFE-OP' state
11 (0x0800)	At least one device indicates an error state
12 (0x1000)	DC not in sync

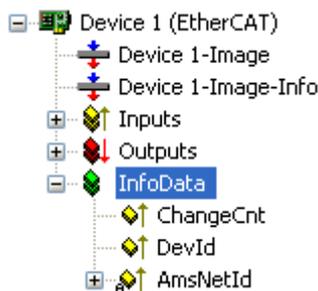
The bits 8-11 of the device state variable indicate if one or more Slave devices are in a specific state. During process data communication the slaves are in the state Operational. In this case bits 8-11 are set to 0. If one slave device is in the Init state instead of Operational, the bit 8 would be set (DevState = 0x0100).

EtherCAT Slave Device

Additionally, to diagnostics inputs of the EtherCAT device, each slave device as a optional diagnostic input variable called WcState:



WcState: Variable of type BOOL, that shows the working counter state of the EtherCAT slave device. A value of 0 indicates a valid working counter and a value of 1 an invalid working counter. If the working counter is invalid, this indicates that the EtherCAT command, that is responsible for updating the inputs and outputs for this device, has an incorrect working counter. Because this command can address more than 1 slave device, the variable WcState of all involved devices will be set to invalid and one cannot determine the device that causes the problem with the help of this variable. To determine if an individual slave device has a problem, one can read out the state of the device with the help of the InfoData.State variable.



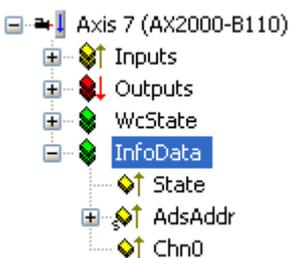
If 'Info Data' is enabled (see [Master Settings](#) |> 2231), the 'Info' device image is added to the EtherCAT device. Additionally, an entry 'InfoData' is added to the EtherCAT device and to the connected EtherCAT slave devices. 'InfoData' contains input variables, that supply information about the EtherCAT device, that normally do not change very often. Variables mapped to the 'Info' images are not updated cyclically but only if the image has changed.

ChangeCnt: The ChangeCnt shows how often the contents of the image has changed.

DevId(optional): This is the device id of the EtherCAT device.

AmsNetId(optional): The AmsNetId is a parameter necessary for communicating with the EtherCAT master device via ADS. The ADS port of the EtherCAT master is always 0xFFFF(65535) and the Ads Port of an EtherCAT slave device is equal to the fixed address (see **EtherCAT Addr**) of the slave.

EtherCAT Slave Device



State: The 'State' variable holds the current EtherCAT state and link status of the EtherCAT slave device.

Value	Description
0x__1	Slave in 'INIT' state
0x__2	Slave in 'PREOP' state
0x__3	Slave in 'BOOT' state
0x__4	Slave in 'SAFEOP' state
0x__8	Slave in 'OP' state
0x0010	Slave signals error
0x0020	Invalid vendorId, productCode... read
0x0100	Slave not present
0x0200	Slave signals link error
0x0400	Slave signals missing link
0x0800	Slave signals unexpected link
0x1000	Communication port A
0x2000	Communication port B
0x4000	Communication port C
0x8000	Communication port D

AdsAddr(optional): The variable 'AdsAddr' holds the Ams netId and Ams port of the slave device. These are necessary parameters for communicating with the EtherCAT slave device via ADS. The variable 'AdsAddr' is added by default if the slave supports a mailbox.

Chn0(optional for drives only): Drive channel.

Additional non cyclic diagnostic information can be found on the [Online \[► 198\]](#) tab of the EtherCAT device.

11.2.7.3 ADS Interface

Acyclic data can be transmitted to or from the EtherCAT device via ADS-Read or ADS-Write commands. It is possible to communicate with the mailboxes of EtherCAT slave devices via ADS. Every EtherCAT device has its own Net-ID. The port depends on the individual Ads service :

Port	Description
65535 (0xFFFF)	General Ads services handled by the master directly.
0x1 - 0xFFFFE (fixed address of a slave device)	This is an Ads services directed at an individual slave device. The port number is the same as the EtherCAT address

The NetId can be found in the edit field "NetId" on the EtherCAT tab of the EtherCAT master device:

NetId:

Erweiterte Einstellungen...

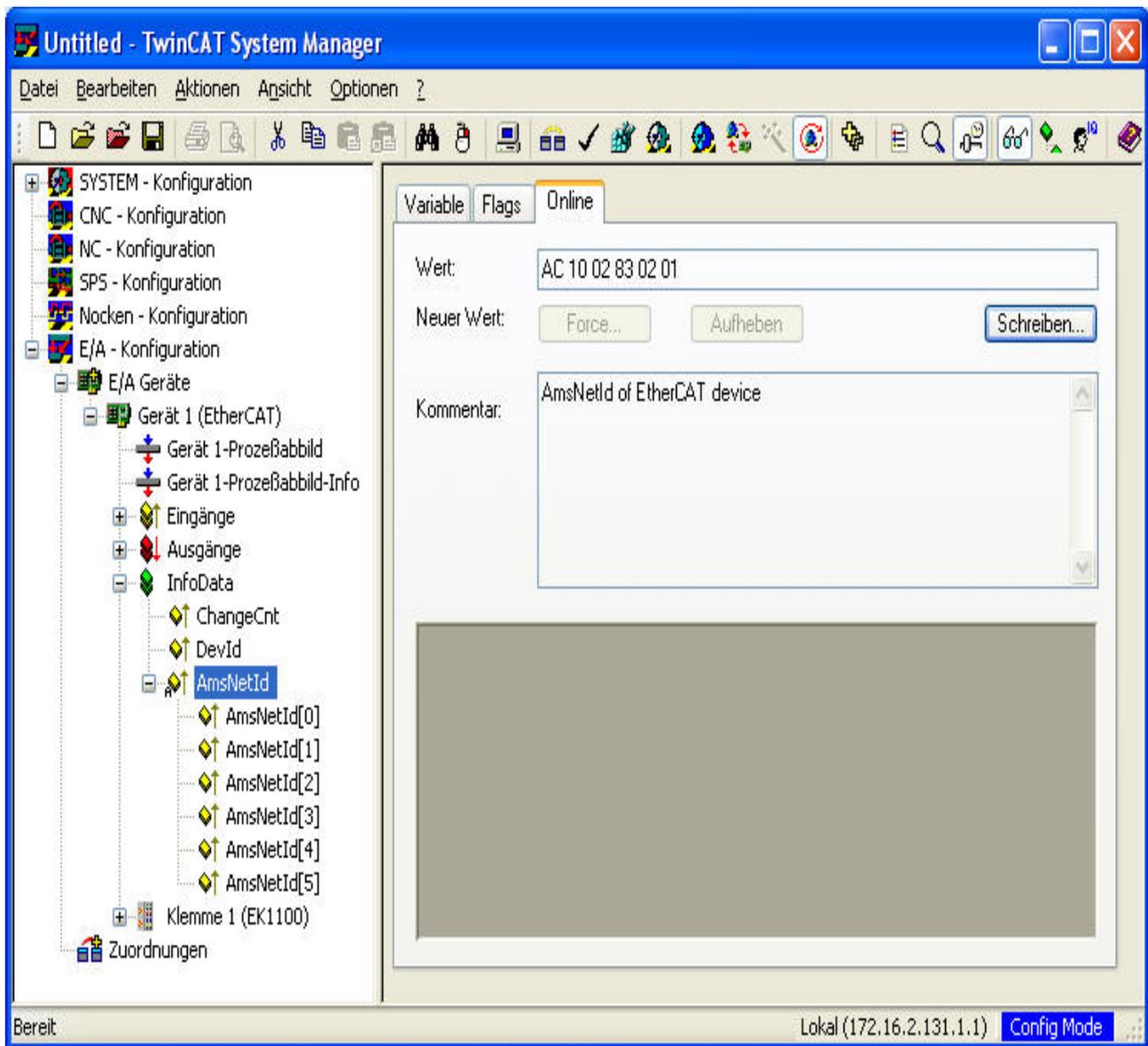
Export Konfigurationsdatei...

Sync Unit Zuordnung...

Topologie...

Frame	Cmd	Addr	Len	WC	Sync Unit	Cycle (ms)	Utilization (%)	Size / Du
0	LRW	0x00010000	7	2	<default>	5.000		
0	LWR	0x00010800	1	1	<default>	5.000		
0	LRD	0x00080000	1	1	<default>	5.000		
0	BRD	0x01300000	2	4	<default>	5.000	0.14 0.14	75 / 7.92

The NetId can also be read out from the variable InfoData.AmsNetId:



Master Ads Port (0xFFFF)

The following table lists the Ads commands supported by the EtherCAT master port(0xFFFF):

Index Group	Index Off-set	Access	Data type	Description
0x00000003	0x00000100	R	UINT16	Returns current state of master. Following values are returned by this service: 0x0000: Init State 0x0002: Pre-Operational State 0x0003: Bootstrap State 0x0004: Safe-Operational State 0x0008: Operational State
0x00000003	requested state	W		Request State from master.
0x00000006	0x00000000	R	UINT16	Returns the number of projected slaves.
0x00000007	0x00000000	R	UINT16[nSlaves]	Returns the fixed addresses of all slaves.
0x00000009	0x00000000	R	{	Returns the EtherCAT status and the Link status of all Slaves:
			BYTE	EtherCAT state of a slave. The state can adopt one of the following values: 0x0000: Init State 0x0002: Pre-Operational State 0x0003: Bootstrap State 0x0004: Safe-Operational State 0x0008: Operational State Additionally following bits can be set: 0x0010: Error State 0x0020: Invalid VPRS(VendorId, Product Code, RevisionsNo or SerialNo) 0x0040: Initialization command error
			BYTE	Link status of an EtherCAT slave. The Link status can consist of an ORing of the following bits: 0x0000: Link ok. 0x0001: Link not present 0x0002: No communication 0x0004: Link missing 0x0008: Additional link 0x0010: Port A 0x0020: Port B 0x0040: Port C 0x0080: Port D exampe: 0x0024 = Missing Link at port B.
			}[nSlaves]	
0x00000009	0x00000001-0x0000FFFF (EtherCAT slave address)	R	{	Returns the EtherCAT status of the EtherCAT slave specified in the index offset.
			BYTE	EtherCAT state of a slave. The state can adopt one of the following values: 0x0000: Init State 0x0002: Pre-Operational State 0x0003: Bootstrap State 0x0004: Safe-Operational State 0x0008: Operational State

Index Group	Index Offset	Access	Data type	Description
				<p>Additionally following bits can be set: 0x0010: Error State 0x0020: Invalid VPRS(VendorId, Product Code, RevisionsNo or SerialNo) 0x0040: Initialization command error</p>
			BYTE	<p>Link status of an EtherCAT slave. The Link status can consist of an ORing of the following bits:</p> <p>0x0000: Link ok. 0x0001: Link not present 0x0002: No communication 0x0004: Link missing 0x0008: Additional link 0x0010: Port A 0x0020: Port B 0x0040: Port C 0x0080: Port D</p> <p>exampe: 0x0024 = Missing Link at port B.</p>
			}	
0x00000009	0x00000001 - 0x0000FFFF (EtherCAT slave address)	W	UINT16	Request a new state from the selected EtherCAT slave.
0x00000011	0x00000001 - 0x0000FFFF (EtherCAT slave address)	R	{	Returns the CANopen identity object of an EtherCAT slave device.
			UINT32	Vendor Id
			UINT32	Product Code
			UINT32	Revision Number
			UINT32	Serial Number
			}	
0x00000012	0x00000000	R	{	Returns the Crc error counters of all slaves.
			UINT32	Crc error counter of port A + error counter of port B + error counter of port C + error counter of port D +
			}[nSlaves]	
0x00000012	0x00000001 - 0x0000FFFF (EtherCAT slave address)	R	{	Returns the Crc error counters of the EtherCAT slave specified in the index offset.
			UINT32	Crc error counter of port A.
			UINT32	Crc error counter of port B.
			UINT32	Crc error counter of port C.
			UINT32	Crc error counter of port D.
			}	
0x0000000C	0	R	{	Returns frame counters and and lost frame counters
			UINT32	system time
			UINT32	number of cyclic frames sent by master
			UINT32	number of lost cyclic frames
			UINT32	number of acyclic frames sent by master
			UINT32	number of lost acyclic frames

Index Group	Index Offset	Access	Data type	Description
			}	
0x0000000C	0	W		Resets the frame counters and lost frames counters

Slave Ads Port(0x1 - 0xFFFE)

The following table lists the Ads commands that can be sent to an EtherCAT slave device. The port number is same as the fixed address of the slave device:

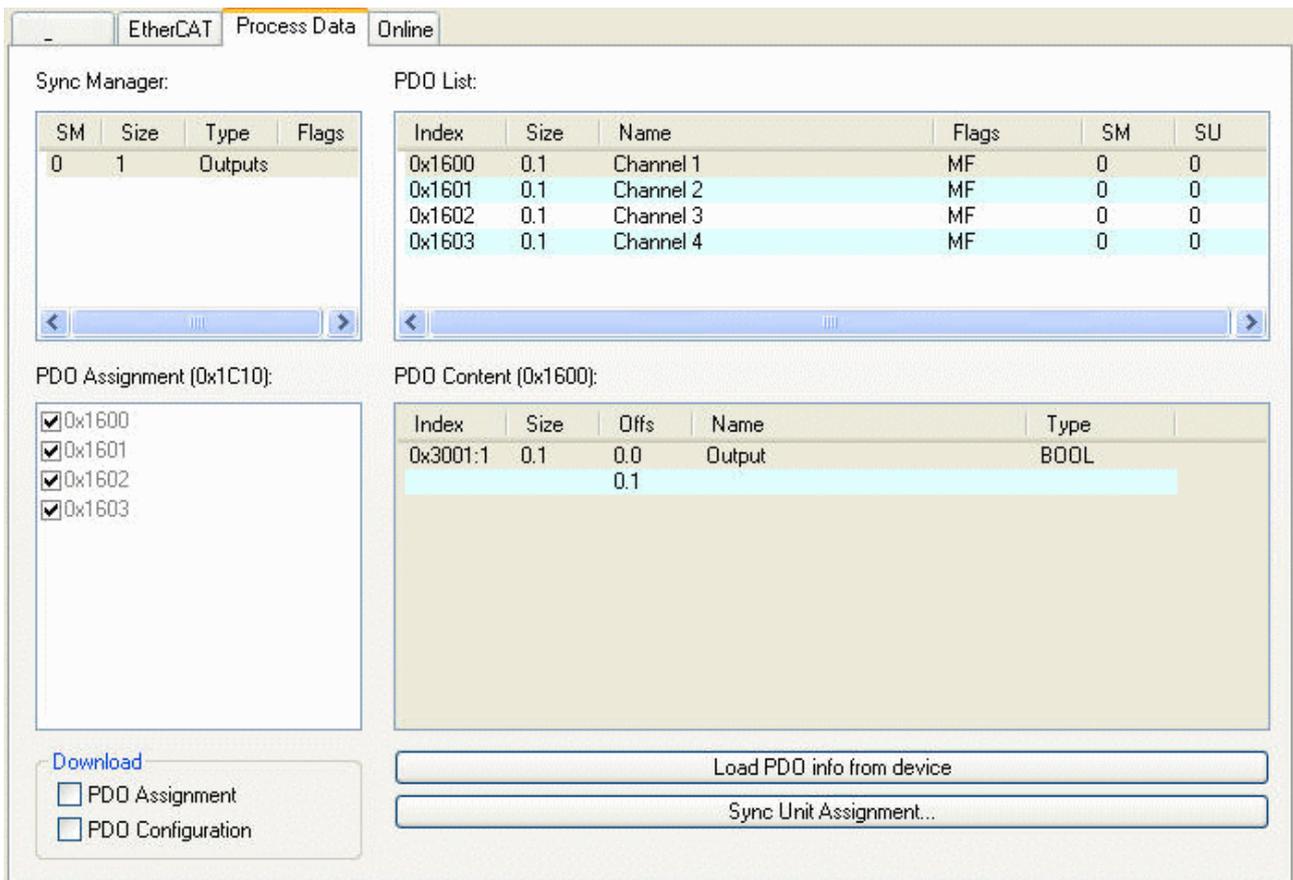
Index Group	Index Offset	Access	Data type	Description		
CANopen over EtherCAT						
0x0000F302	<p>Index and Subindex of an SDO.</p> <p>HIWORD(0xyyyy000)= index LOBYTE(0x000000yy)= subindex</p> <p>Example: 0x1c120001: index = 0x1c12 subindex = 1</p> <p>HIBYTE of LOWORD (0x0000yy00):</p> <table border="1" style="margin-left: 20px;"> <tr> <td>0x01</td> <td>Complete Access</td> </tr> </table>	0x01	Complete Access	R/W	UINT8[n]	SDO Upload/Download Request. The object is selected with the index offset.
0x01	Complete Access					
0x0000F3FC	<p>List type = HIWORD(0xyyyy000)</p> <p>Example 0x00000000: return length of the individual list types 0x00010000: return indexes of all objects</p>	R	{	Returns the indexes of the list type specified in the index offset. If 0 is passed as index offset the length of each list type is returned.		
			UINT16	list type = 0 :number of list types list type > 0 :list type		
			UINT16[n]	list type = 0: length of the list type n+1 list type > 0: length of the selected list		
			}			
0x0000F3FD	index = HIWORD(0xyyyy000)	R		Get SDO info description		
0x0000F3FE	<p>index = HIWORD(0xyyyy000)</p> <p>subindex = LOBYTE of LOWORD (0x000000yy)</p> <p>valueInfo = HIBYTE of LOWORD (0x0000yy00)</p>	R		Get SDO info entry description		
Servo Drive over EtherCAT						

Index Group	Index Offset	Access	Data type	Description	
0x0000F420	IDN = LOWORD(0x0000yyyy) element = LOBYTE of HIWORD (0x00yy0000) :	R/W	UINT8[n]	Upload/Download IDN	
	0x01				Data Status
	0x02				Name (read only)
	0x04				Attribute
	0x08				Unit
	0x10				Minimum
	0x20				Maximum
	0x40				Value
	0x80				Default
	Drive Number = Bits 1-3 of HIBYTE of HIWORD (0xy0000000)				
	Command Flag = Bit 8 of HIBYTE of HIWORD (0xy0000000)				

11.2.7.4 Sync Unit Assignment

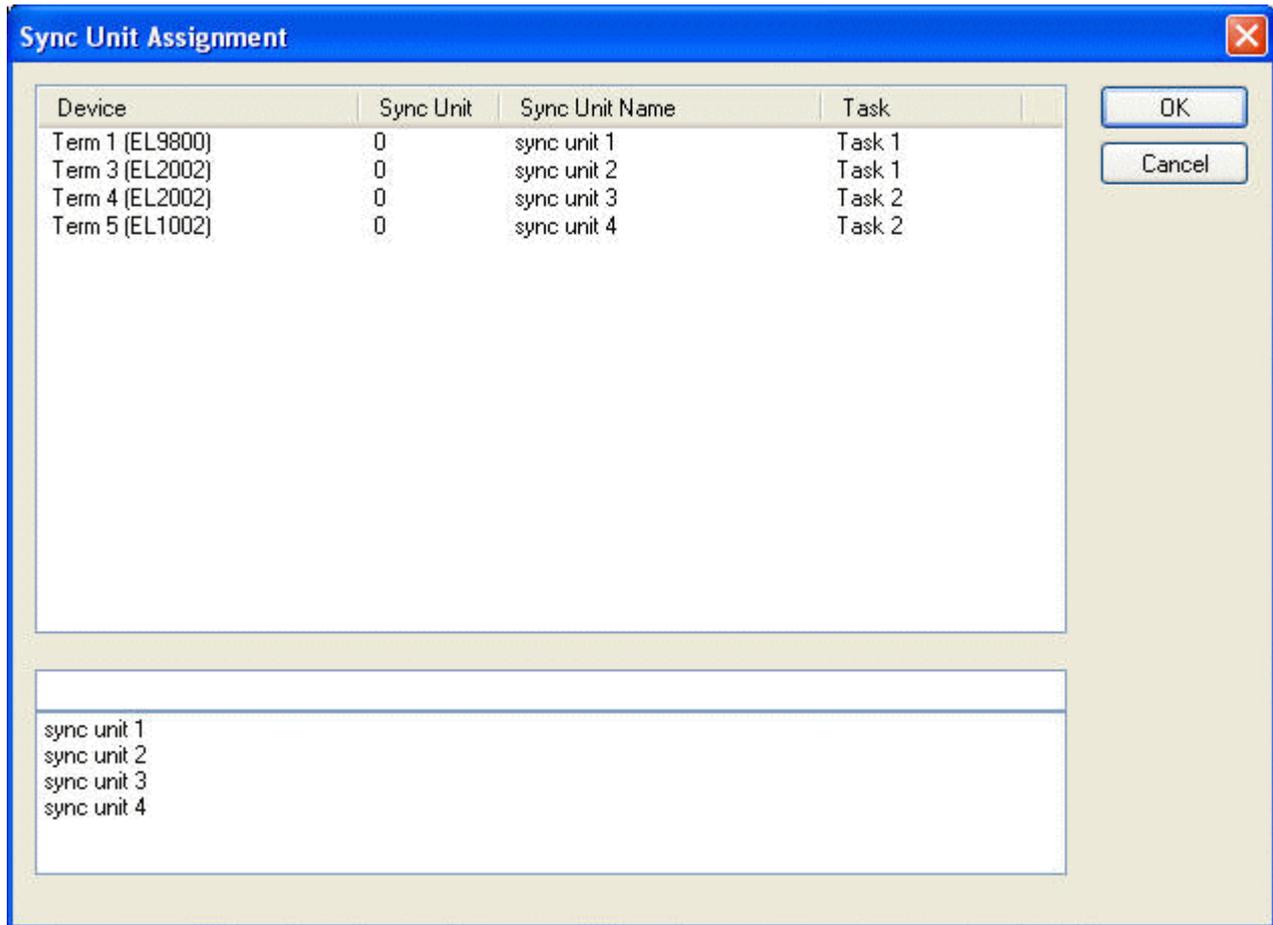
A Sync Unit describes a module, that defines a set of process data, that should be exchanged synchronously and consistently between the master and one or more EtherCAT slave devices. For each Sync Unit a separate EtherCAT command is sent synchronous with the cycle, to exchange the process data with the EtherCAT slave devices. Every Sync Unit has a diagnostic input, that is synchronous with the cycle and shows, if the complete data is valid (see [WcState \[► 202\]](#)). Sync Units are useful in applications, where parts of the machine should keep on operating, although other parts have dropped out or have been deactivated.

For each EtherCAT slave device, one can define one or more process data areas, that should be exchanged synchronously and consistently. These individual process data areas can be configured in the Process Data tab of a slave device. Normally every PDO object is assigned to the same process data area (Sync Unit). This is indicated by the column SU (Sync Unit) in the PDO List View:



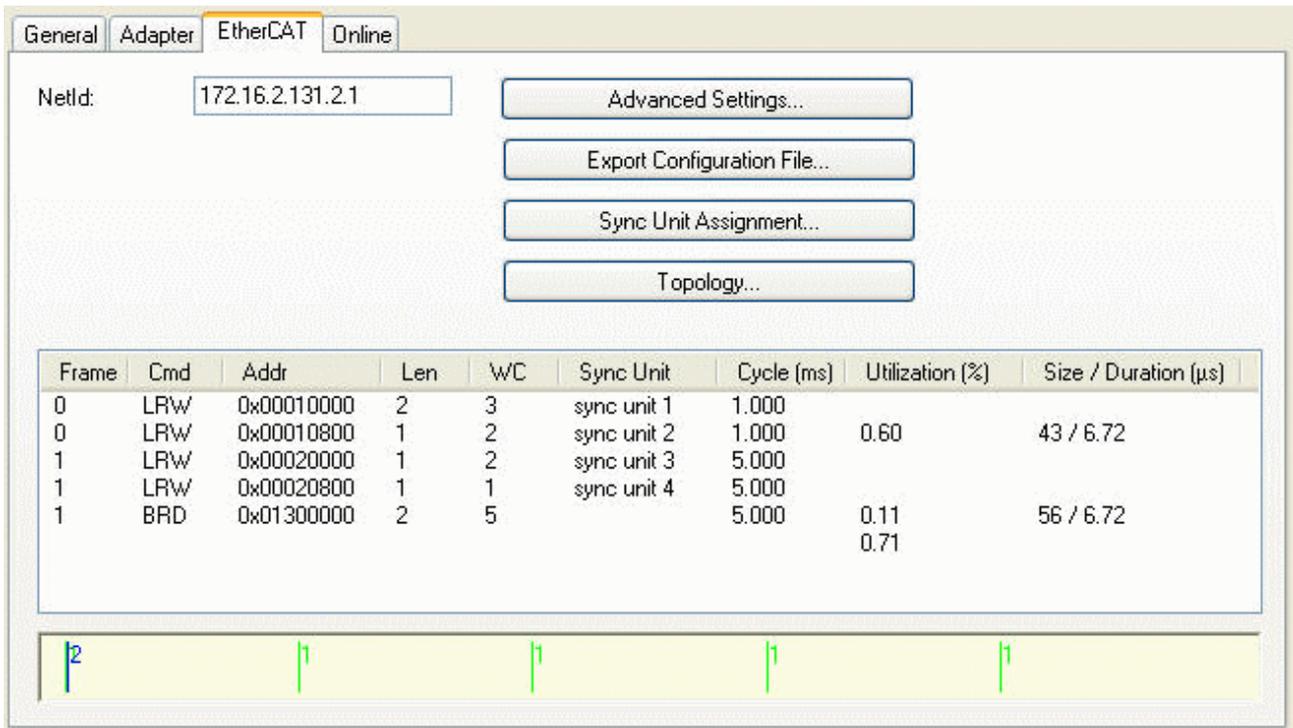
In the example above all channels are assigned to the Sync unit 0. The number of independent process data areas of an EtherCAT slave device, depends on the implementation and resources of its EtherCAT slave controller (Sync Manager and Fmmu). The Sync Units of the EtherCAT slave devices can be assigned to Sync Units of a specific Sync Task. These Sync Units are marked with freely definable names. One can either assign each Sync Unit of a slave individually to a Sync Unit, by pressing the "Sync Unit Assignment..." on the "Process data" tab of a slave (see dialog above), or one can assign one or more slave Sync Units by pressing the "Sync Unit Assignment..." button on the "EtherCAT" tab of the EtherCAT master device:

Sync Unit Assignment dialog



To assign a Sync Unit to a process data area of an EtherCAT slave device, select an entry in the list view above. Then type the name of the Sync Unit in the edit field below or select one of the entries in the list box below. In the example above 'sync unit 1' of Task 1 is assigned to Sync Unit 0 of Term 1 and 'sync unit 2' of Task 1 is assigned to Sync Unit 0 of Term 3.

The 'EtherCAT' tab of the EtherCAT slave devices displays the cyclic frames sent by the EtherCAT master for the process data communication:



For each sync task taking part in process data communication a separate frame is sent. The maximal number of sync tasks is set to 4 by default. To change the maximal number of sync tasks, one has to open the Advanced Settings Dialog and select the [Sync Tasks \[► 223\]](#) page. It is possible to assign one or more Sync Units for a specific task. Each of these Sync Units is assigned to a process data area of a slave device. For each Sync Unit of a sync task the EtherCAT frame contains a separate EtherCAT command. In the example above the first EtherCAT command of the first EtherCAT frame exchanges the process data of the EtherCAT devices assigned to the Sync Unit 1 of Task 1. In this case it is only the one EtherCAT slave device Term1(EL9800)(see Sync Unit Assignment dialog above). For each Sync Unit of a task an expected working counter is calculated, that is displayed in the column 'WC'.

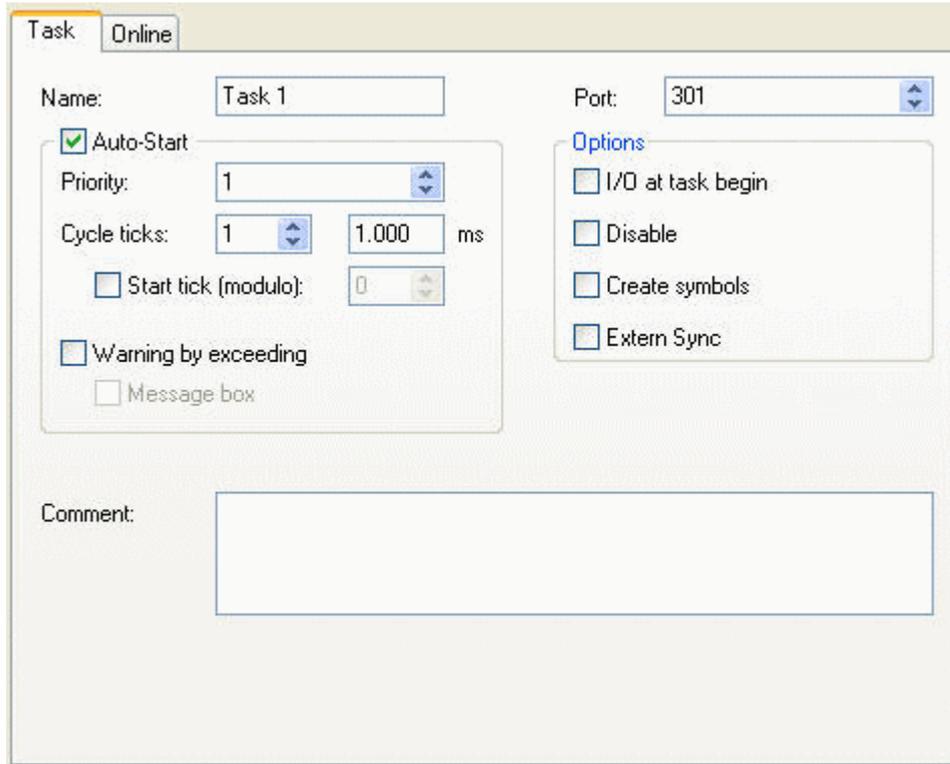
Working Counter: The working counter of an EtherCAT command is a 16-bit counter. The counter is incremented by each EtherCAT slave, that is successfully addressed by the command. If only inputs are read from the EtherCAT slave device, the working counter is incremented by 1. If outputs are written to the EtherCAT slave device, the working counter is incremented by 2. If both inputs and outputs variables are exchanged the working counter is incremented by 3. If the working counter is incorrect the EtherCAT master discards the received inputs of the EtherCAT command.

For each frame the master has a diagnostic input 'FrmXWcState' (X =frame number), that shows the working counter states of the individual EtherCAT commands of the frame (see [FrmXWcState \[► 202\]](#)). With 'FrmXWcState' it is not possible to verify which Term is responsible for the incorrect working counter. To retrieve more detailed information about the states of the individual slave devices, one has to read out the input variable [InfoData.State \[► 223\]](#) of the slaves.

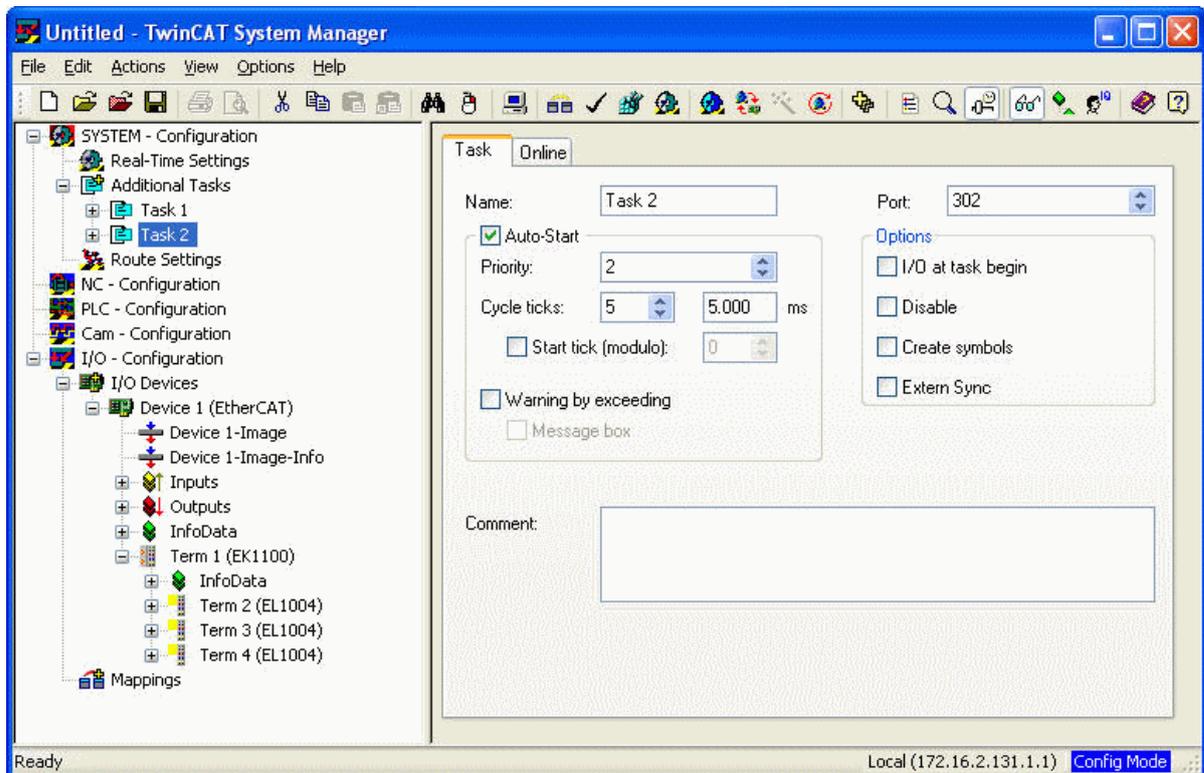
Example:

1. Open a new System Manager Project
2. Add a EtherCAT device to the I/O devices in the tree view of the system manager
3. Append an EK1100 and three EL1004 to the EtherCAT device.
4. Expand the entry 'System-Configuration' in the tree view of the system manager
5. Open the context menu of 'Additional Task' by right clicking on the subitem 'Additional Task' of 'System-Configuration'
6. Select the menu entry 'Append Task...' to add Task1

7. In the tab 'Task' of the additional task 'Task1' check the Auto-Start box and change the cycle time to 1 ms.

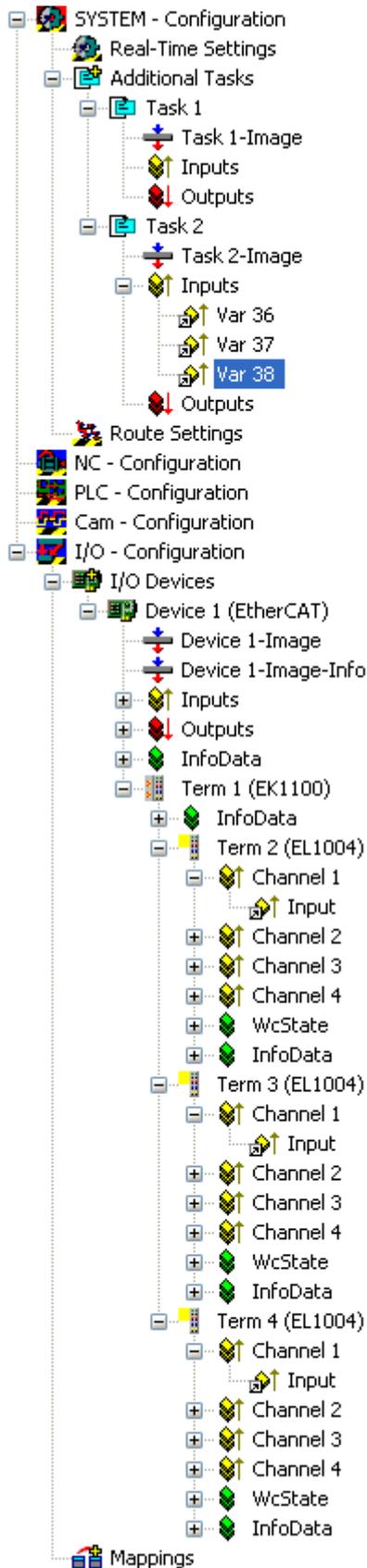


8. Repeat step 5 to 7 to add another task and set the cycle time to 5ms. The current configuration should look like this:



9. Next we will add input variables to the Task 2 and map these to the inputs of the terms. Right click on the entry 'Inputs' of Task 2 and select 'Insert Variable...' in the context menu. In the 'Insert Variable' dialog select 'Bit' as variable type and press the 'OK' button.

- Double click on the newly created variable and map this variable to first input of Term 2. Add another two variables to Task 2 and map these to the first input of Term 3 and the first input of Term 4 :

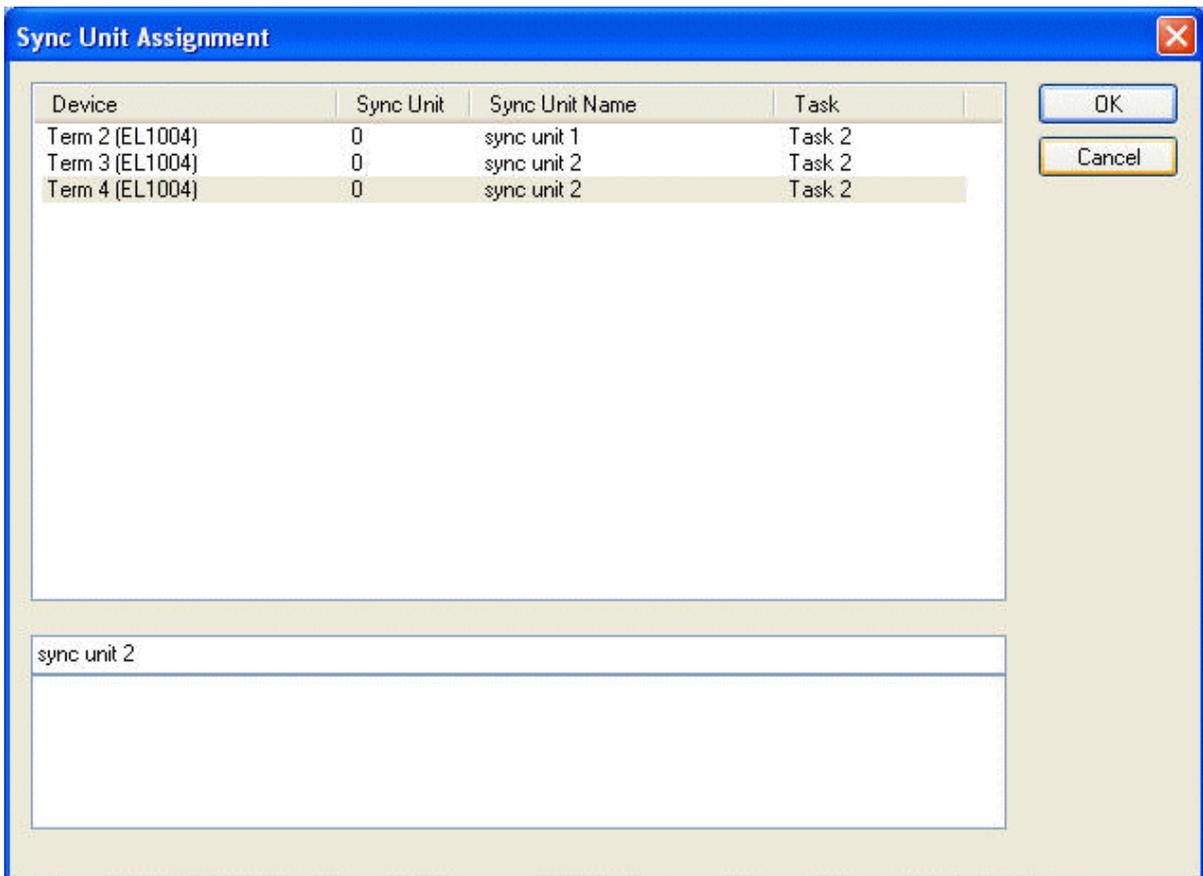


11. Select the EtherCAT device in the tree view of the system manager and open the 'EtherCAT' tab on the right:

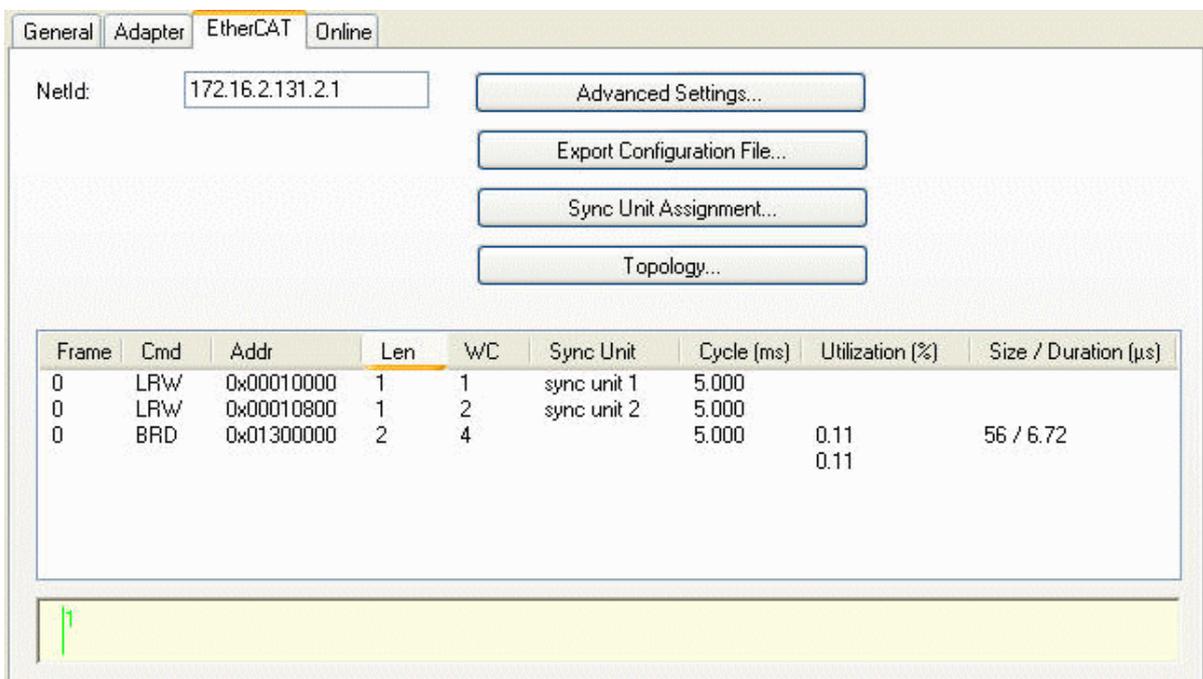
Frame	Cmd	Addr	Len	WC	Sync Unit	Cycle (ms)	Utilization (%)	Size / Duration (µs)
0	LRW	0x00010000	2	3	<default>	5.000		
0	BRD	0x01300000	2	4		5.000	0.11	44 / 6.72
							0.11	

In the list view of this page we can see that one frame containing two EtherCAT commands is sent by the master. The first command is a LRW(Logical Read Write) command and is responsible for reading the inputs and writing to the outputs of one or more slave devices. The column 'Sync Unit' specifies the Sync Unit this command is assigned to. Because we have not yet assigned any Sync Units, the default Sync Unit is used. Because all variables are mapped to Task2, the value 'Cycle (ms)' is set to 5ms, the cycle time of Task2. The expected working counter (WC) is set to 3, one for each slave device. This is the case because the connected slaves devices have only input variables.

12. Next we will add two Sync Units and will assign one to the process data of the first EL1004(Term 2) and the others to Term 3 and Term4 . Press the button 'Sync Unit Assignment...' on the EtherCAT page to open the 'Sync Unit Assignment' dialog :

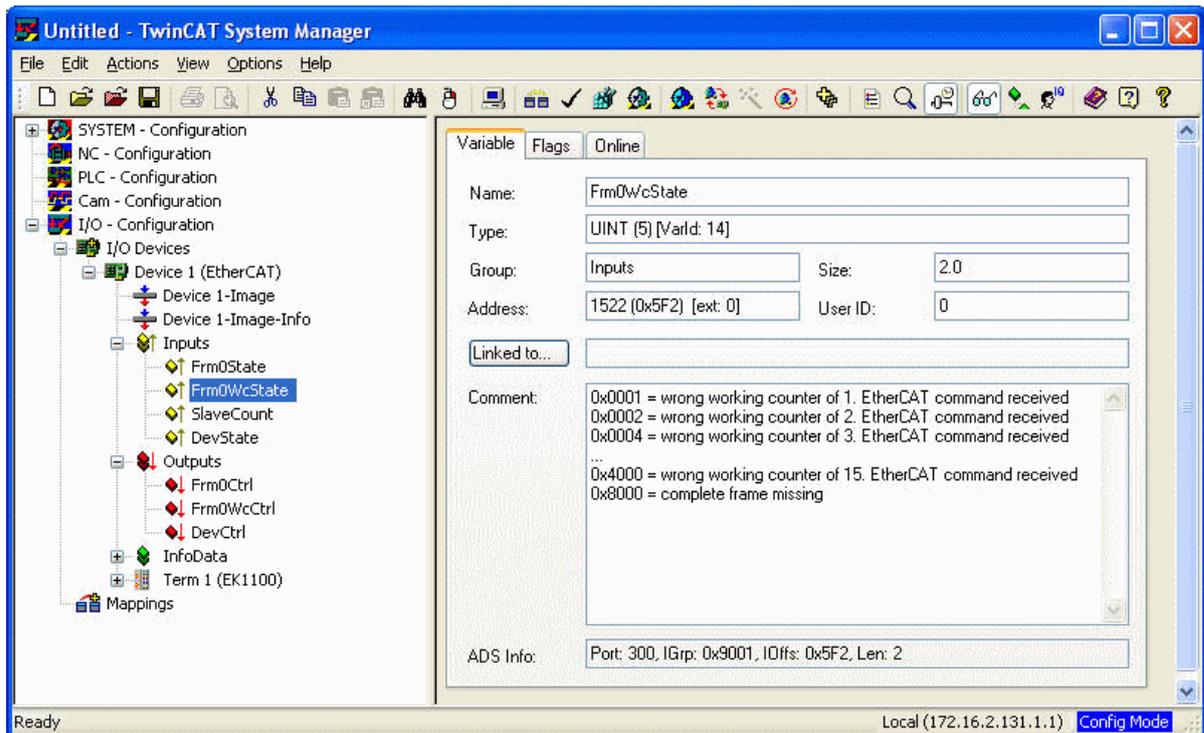


Select the first entry and type 'sync unit 1' into the edit field below. Now we have created a new Sync Unit called 'sync unit 1' and have assigned it to the Sync Unit 0 of Term2(EL2004). Then select the Term 3 and type 'sync unit 2' into the edit field and finally select term 4 and type 'sync unit 2' into the edit field again. Press the 'OK' button to close the dialog:



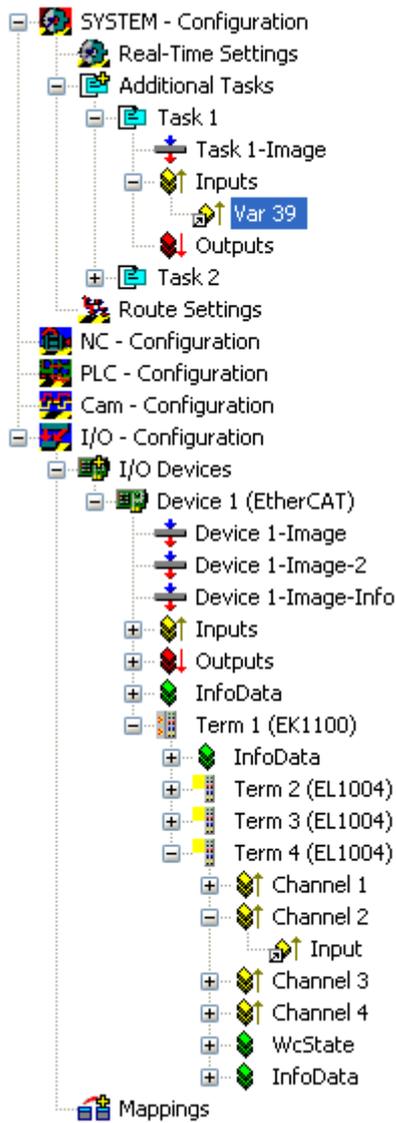
Because of the Sync Unit assignment another EtherCAT command has been added to the list of cyclic commands. The first 'LRW' command is responsible for the process data communication of all EtherCAT slave devices belonging to the Sync Unit 'sync unit 1'. In our case this is only the Term 2. The second 'LRW' command is responsible for the process data communication of all EtherCAT slave devices belonging to the Sync Unit 'sync unit 2' (here Term 3 and Term 4). Now it is possible to monitor the working counter state of the first command and second command separately with help of

the 'Frm0WcState' input variable:



If Term 2 returns an incorrect working counter bit 1 of the variable 'Frm0WcState' would be set to 1, indicating that a wrong working counter has been received for the first EtherCAT command. Therefore, the received data will be discarded and will not be copied to the input variable. If the second EtherCAT command has a correct working counter the received data for Term 3 and Term 4 will be processed normally. If the second EtherCAT command returns an incorrect working counter, bit 2 of 'Frm0WcState' is set. This indicates that either Term 2 or Term 3 or even both Term 2 and Term 3 have not incremented the working counter correctly. Therefore, it is not possible to verify with 'Frm0WcState', which Term is responsible for the incorrect working counter. To retrieve more detailed information about the states of the individual slave devices one must read out the variable InfoData.State.

13. Finally we will add a input variable to Task 1 and map this variable to Channel 2 of Term 4:



14. Select the EtherCAT device in the tree view of the system manager and open the 'EtherCAT' tab on the right:

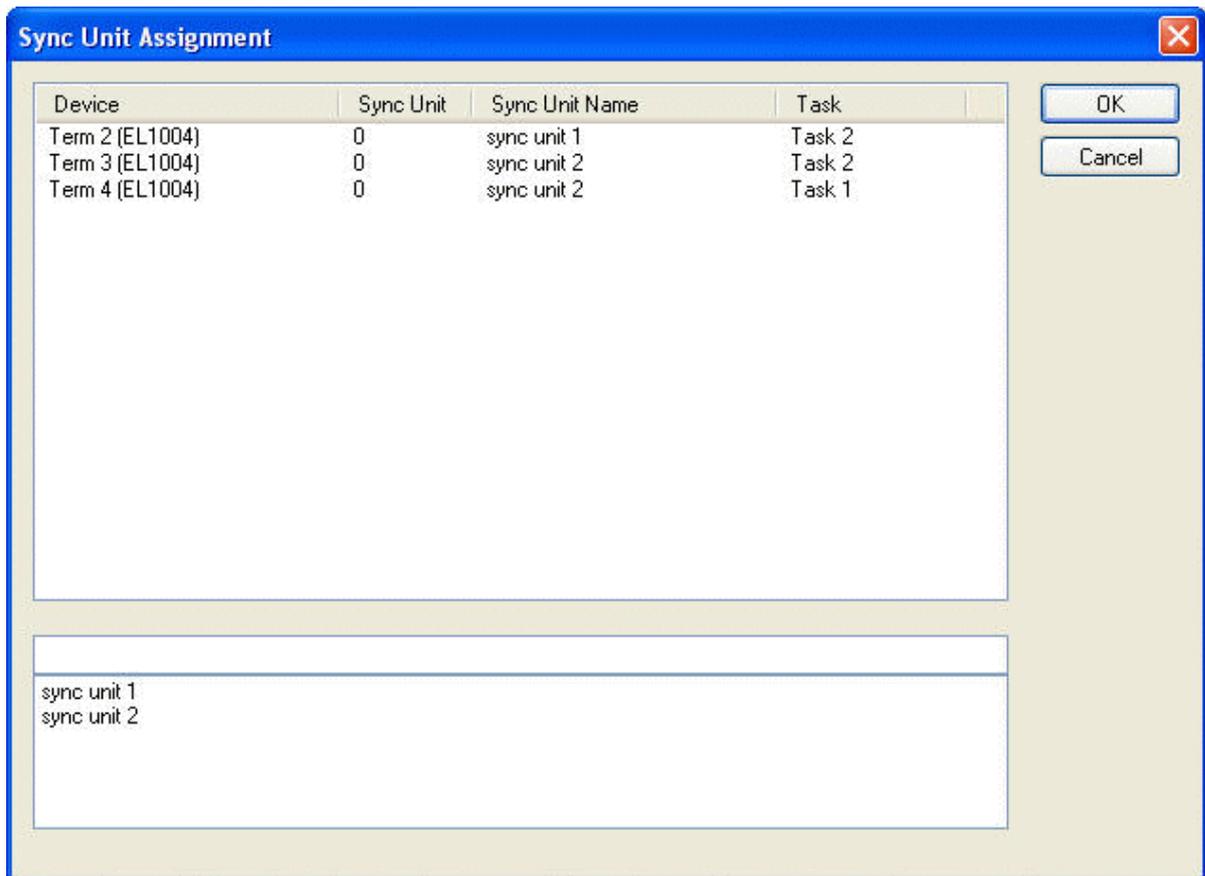
The screenshot shows the 'EtherCAT' configuration window with the following details:

- NetId: 172.16.2.131.2.1
- Buttons: Advanced Settings..., Export Configuration File..., Sync Unit Assignment..., Topology...
- Table of EtherCAT frames:

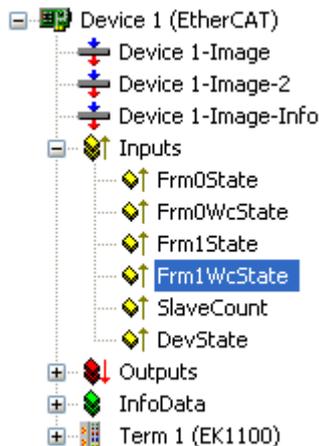
Frame	Cmd	Addr	Len	WC	Sync Unit	Cycle (ms)	Utilization (%)	Size / Duration (µs)
0	LRW	0x00010000	1	1	sync unit 2	1.000	0.60	29 / 6.72
1	LRW	0x00020000	1	1	sync unit 1	5.000		
1	LRW	0x00020800	1	1	sync unit 2	5.000		
1	BRD	0x01300000	2	4		5.000	0.11 0.71	56 / 6.72

Below the table is a status bar with a yellow background and green vertical bars, indicating the timing of the frames.

Here we can see that another frame has been added to the list. The first frame consists of only one LRW EtherCAT command with the cycle time of 1 ms, corresponding to the cycle time of Task 1. This command is sent cyclically by the Task 1 and is responsible for reading the inputs of Term 4. Although the first input of Term 4 is mapped to the Task 2 the input is also read out by the EtherCAT command belonging to the Task 1. This is the case because Term 4 only has one process data area. In this case the task with the highest priority is selected for the process data communication with the slave device. The second frame is sent cyclically by the Task 2 with a cycle time of 5ms. The BRD command is always sent by the task with the lowest priority. The individual Sync Units can be viewed by pressing the 'Sync Unit Assignment ...' button:



Here we can see that the Sync Unit 0 of Term 4 is assigned to 'sync unit 2' of Task 2. Because we now have two frames, the input variables 'Frm1State' and 'Frm1WcState' have been added to the device. With the help of these inputs the state and the working counter state of the second frame can be read out.

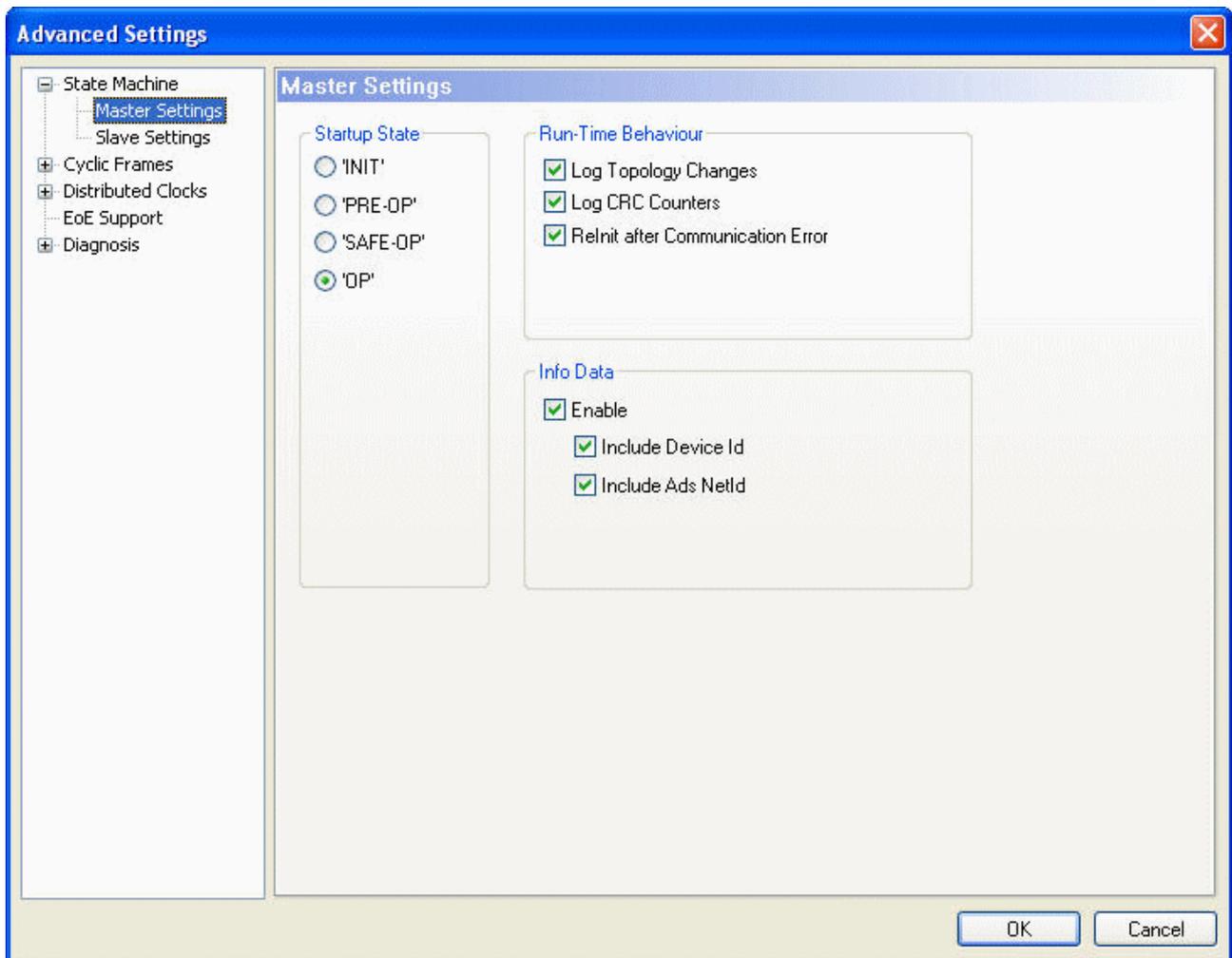


11.2.7.5 Advanced Settings

After adding an EtherCAT(Direct Mode) to the I/O configuration [► 97], open the "EtherCAT" tab on the right and press the "Advanced Settings..." button. This opens the "Advance Settings" dialog. Following dialogs are included in the 'Advanced Settings' dialog:

Dialog		Description
StateMachine	Master Settings [▶ 224]	General settings of the master.
	Slave Settings [▶ 225]	With the help of the 'Slave Settings' dialog the user can change settings for all EtherCAT slaves. To change these settings for an individual EtherCAT slave device, open the 'Advanced settings' dialog of the slave and open the 'Behavior' [▶ 366] dialog.
Cyclic Frames	Sync Tasks [▶ 227]	With the help of 'Sync Tasks' dialog one can set the maximal number of sync tasks and the MTU of the cyclic Ethernet Frames sent by the master.
Distributed Clocks	Master [▶ 227]	The 'Distributed Clocks Master' dialog enables the user to view and change the master settings of the distributed clocks.
Diagnosis	Online View [▶ 229]	The 'Online View' dialog enables the user to add additional columns to the list view of the 'Online [▶ 198]' tab of the EtherCAT device.

State Machine Master Settings



Startup State: The EtherCAT master runs to checked state after startup. If for instance 'OP' is checked the EtherCAT master runs through all EtherCAT states to arrive at 'OP' state. To stay in the state 'INIT' after startup one would have to check the 'INIT' button.

Run Time Behaviour

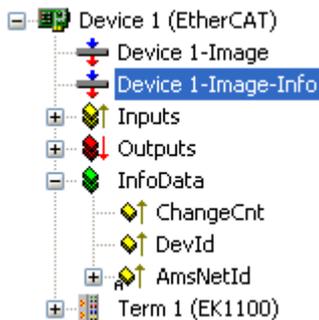
Log Topology Changes: If this box is checked, topology changes are logged.

Log CRC Counters: If this box is checked, the CRC counters are logged.

Relnit after Communication Error: If this box is checked, all slaves are set to init after a communication error has occurred.

Info Data

Enable: If this box is checked, the 'Info' device image is added to the EtherCAT device:



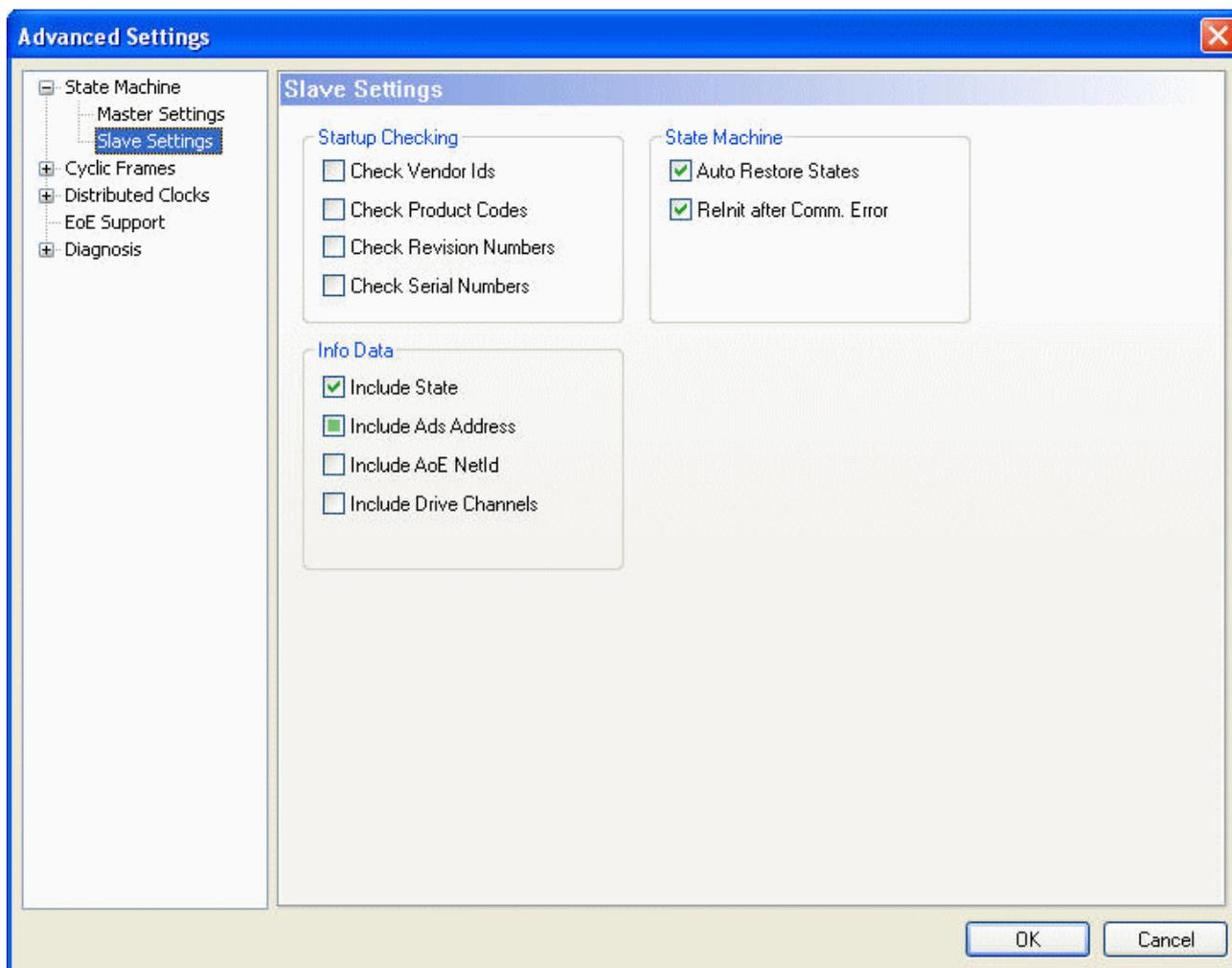
Additionally, an entry 'InfoData' is added to the EtherCAT device and to the connected EtherCAT slave devices. 'InfoData' contains input variables that supply information about the EtherCAT device, that normally do not change very often. Variables mapped to the 'Info' images are not updated cyclically, but only if the image has changed. The ChangeCnt shows how often the contents of the image has changed.

Include Device Id: If this box is checked, the input variable 'DevId' is added to InfoData. This is the device id of the EtherCAT device.

Include Ads NetId: If this box is checked, the input variable 'AmsNetId' is added to InfoData. The AmsNetId is a parameter necessary for communicating with the EtherCAT master device via ADS. The ADS port of the EtherCAT master is always 0xFFFF(65535) and the Ads Port of an EtherCAT slave device is equal to the fixed address (see [EtherCAT Addr \[p. 357\]](#)) of the slave.

State Machine Slave Settings

With the help of the 'Slave Settings' dialog the user can change settings for all EtherCAT slaves. To change these settings for an individual EtherCAT slave device, open the 'Advanced settings' dialog of the slave and open the '[Behaviour](#)' [p. 366] dialog.



Startup Checking

The user can specify which slave information should be checked by the master during startup.

Check Vendor Ids: If this box is checked, the master checks if the vendor id of each slave device is the same as the configured one.

Check Product Codes: If this box is checked, the master checks if the product code of each slave device is the same as the configured one.

Check Revision Numbers: If this box is checked, the master checks if the revision number of each slave device is the same as the configured one.

Check Serial Numbers: If this box is checked, the master checks if the serial number of each slave device is the same as the configured one.

State Machine

Auto Restore States: If this box is checked, the EtherCAT master tries to restore the state of an EtherCAT slave automatically. If an EtherCAT slave device changes from error state (ERR SAFE-OP, ERR OP etc.) to a valid state(SAFE-OP, OP etc), the EtherCAT master tries to set the device to the current state of the master.

Relnit after Comm. Error:

Info Data

To enable this group, the Info Data has to be enabled in the 'Master Settings' dialog.

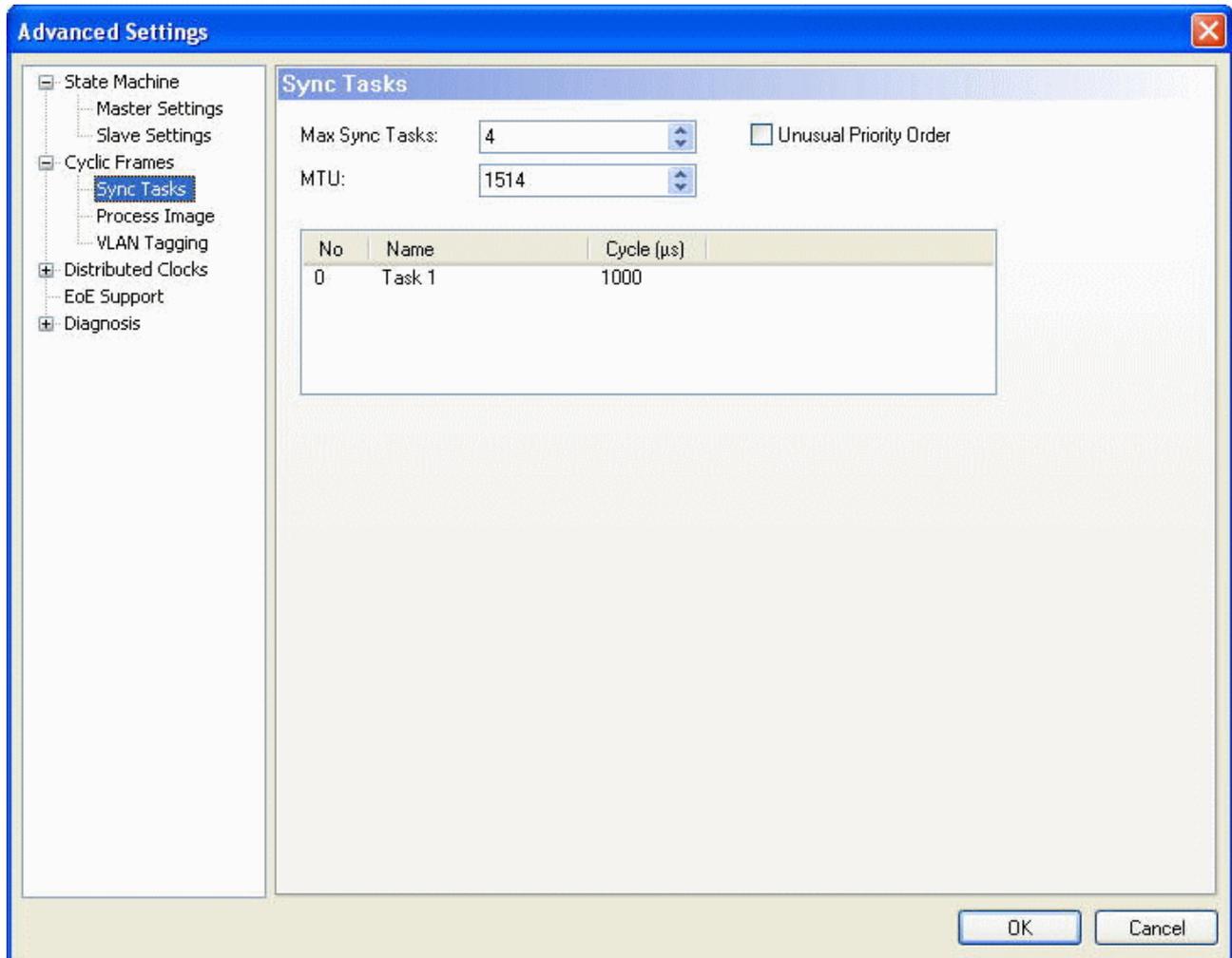
Include State: If this box is checked, the input variable 'State' is added to the InfoData entry of each EtherCAT slave. This variable holds the current EtherCAT state and link status of an EtherCAT slave.

Include Ads Address: If this box is checked, the input variable 'AdsAddress' is added to the InfoData entry Info of each EtherCAT slave. This variable is added by default for all EtherCAT slaves, that support a mailbox protocol like CoE(CANopen over EtherCAT) or SoE.

Include Drive Channels: If this box is checked, the input variables 'ChnX'(X=Channel number) are added to the InfoData entry of every drive.

Synchronization Sync Tasks

With the help of 'Sync Tasks' dialog one can set the maximal number of sync tasks and the MTU of the cyclic Ethernet Frames sent by the master.

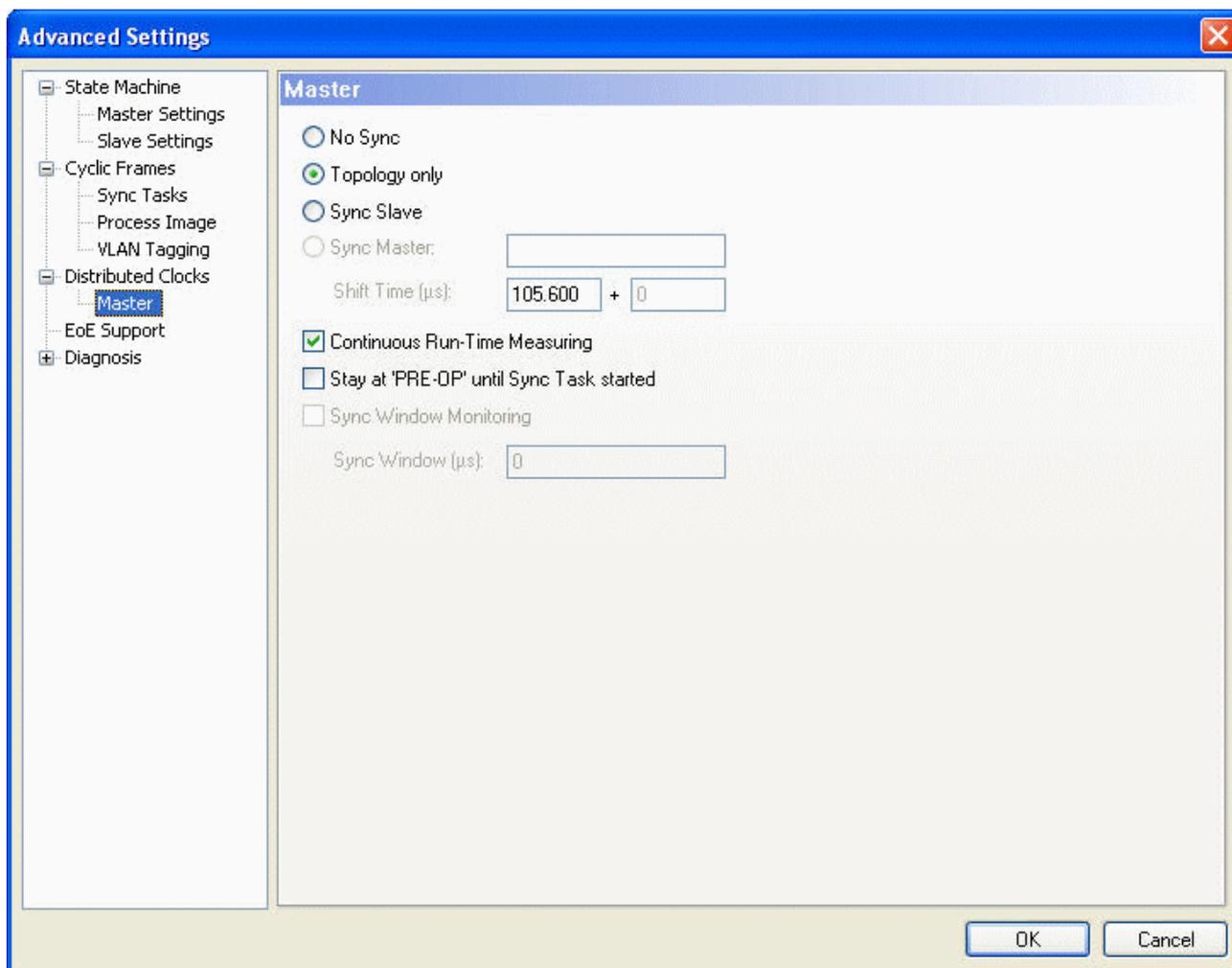


Max Sync Tasks: Maximal number of tasks that can take part in process data communication. How many tasks really take part in the process data communication, depends on the mapping of the variables of the EtherCAT slave devices. For each task that takes part in process data communication at least one EtherCAT frame is sent cyclically. If "Max Sync Tasks" is set to two and the configuration consists of two EtherCAT slave devices whose variables are mapped to two different tasks, two tasks would take part in the process data communication. If the variables were mapped to the same task, only one task would take part in the process data communication.

MTU: The MTU(Maximum Transmission Unit) specifies the maximum size in bytes of the cyclic Ethernet Frames sent by the master. The minimum size is 28 Bytes (14 Bytes(Ethernet-Header) + 2 Bytes(E88A4-Header) + 10 Bytes(EtherCAT-Header) + 0 Byte(EtherCAT Data) + 2 Bytes(EtherCAT working counter)) and the maximum size 1514 (14 Bytes(Ethernet-Header) + 2 Bytes(E88A4-Header) + 10 Bytes(EtherCAT-Header) + 1486 Bytes(EtherCAT Data) + 2 Bytes(EtherCAT working counter)).

Synchronization Distributed Clocks

The 'Distributed Clocks Master' dialog enables the user to view and change the master settings of the distributed clocks.



No Sync: In this mode no synchronization of the EtherCAT devices takes place.

Topology Only: In this mode no synchronization of the EtherCAT devices takes place, but the topology is calculated by the master. The master needs to know the topology to be able to calculate the delay time between the slaves. As a consequence, this calculation is always performed in the "Sync Slave" and "Sync Master" mode.

Sync Slave: In this mode synchronization of the EtherCAT devices takes place, and the EtherCAT master is used as reference clock. As a consequence the Master sends a BWR (Broad cast write) command cyclically to distribute the system time to all slaves. Because the master clock is not as accurate as the clock of an EtherCAT slave device one should normally prefer the 'Sync Master' mode and set the first EtherCAT device as reference clock.

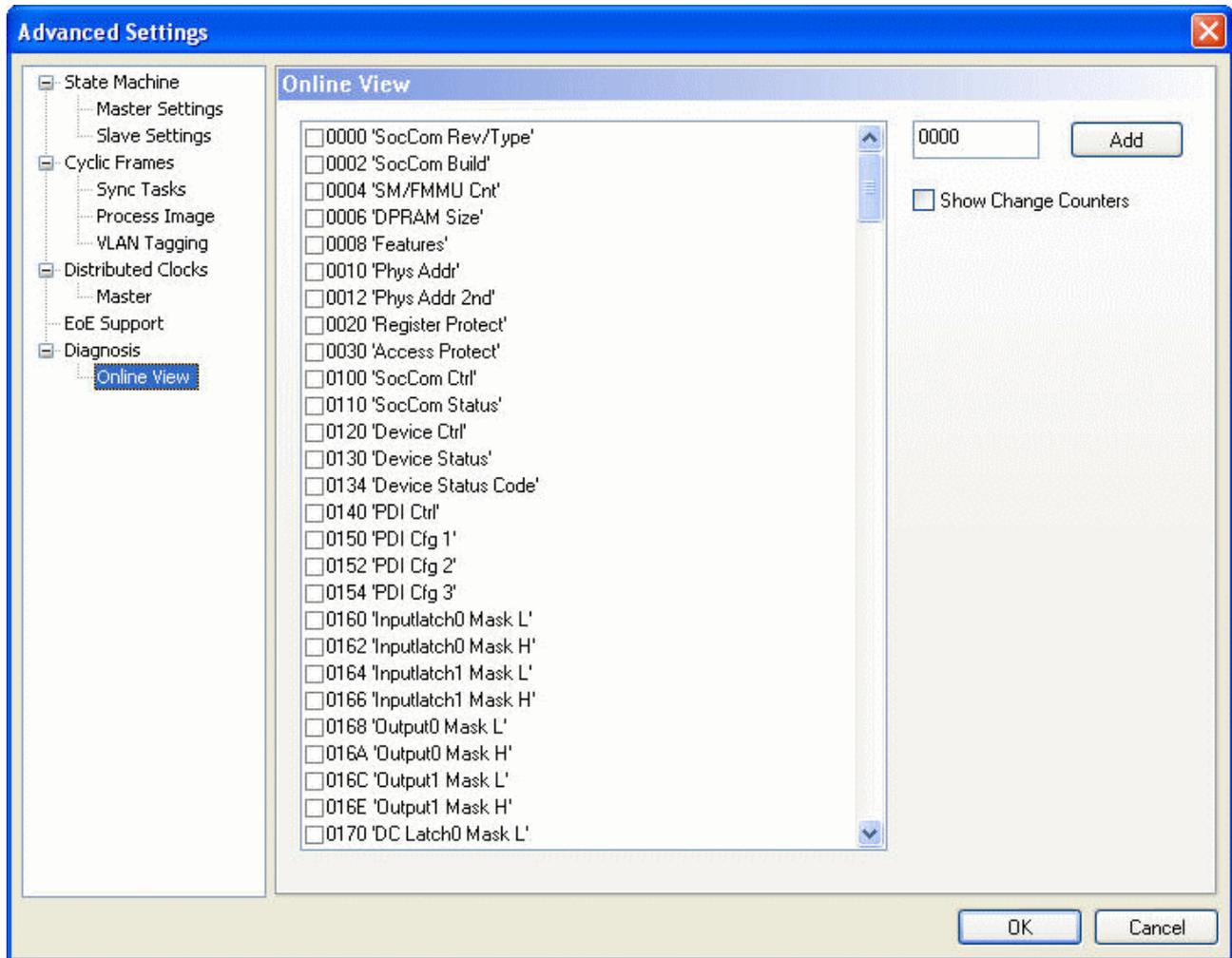
Sync Master: In this mode synchronization of the EtherCAT devices takes place, and the EtherCAT slave right to "Sync Master" is set as reference clock. As a consequence, the master cyclically sends an EtherCAT command to read out the system time of the "Sync master" device and distributes this time to all other slave devices.

The "Sync Master" mode is disabled if no device is set as reference clock. To activate this mode one has to configure a slave device as a reference clock device (see [Distributed Clock Settings \[► 371\]](#)). The first three Sync modes are disabled if a reference clock device is set. To be able to select one of these modes no slave device is allowed to be set as reference clock:

1. Select the "Sync Master" device in the tree view of the System Manager
2. Go to the EtherCAT tab and press the "Advanced Settings..." button. This opens the Advanced Settings dialog.
3. Select the entry "DistributedClocks/Settings" in the tree view of the dialog.
4. Uncheck the entry "Reference Clock Device"

Diagnosis Online View

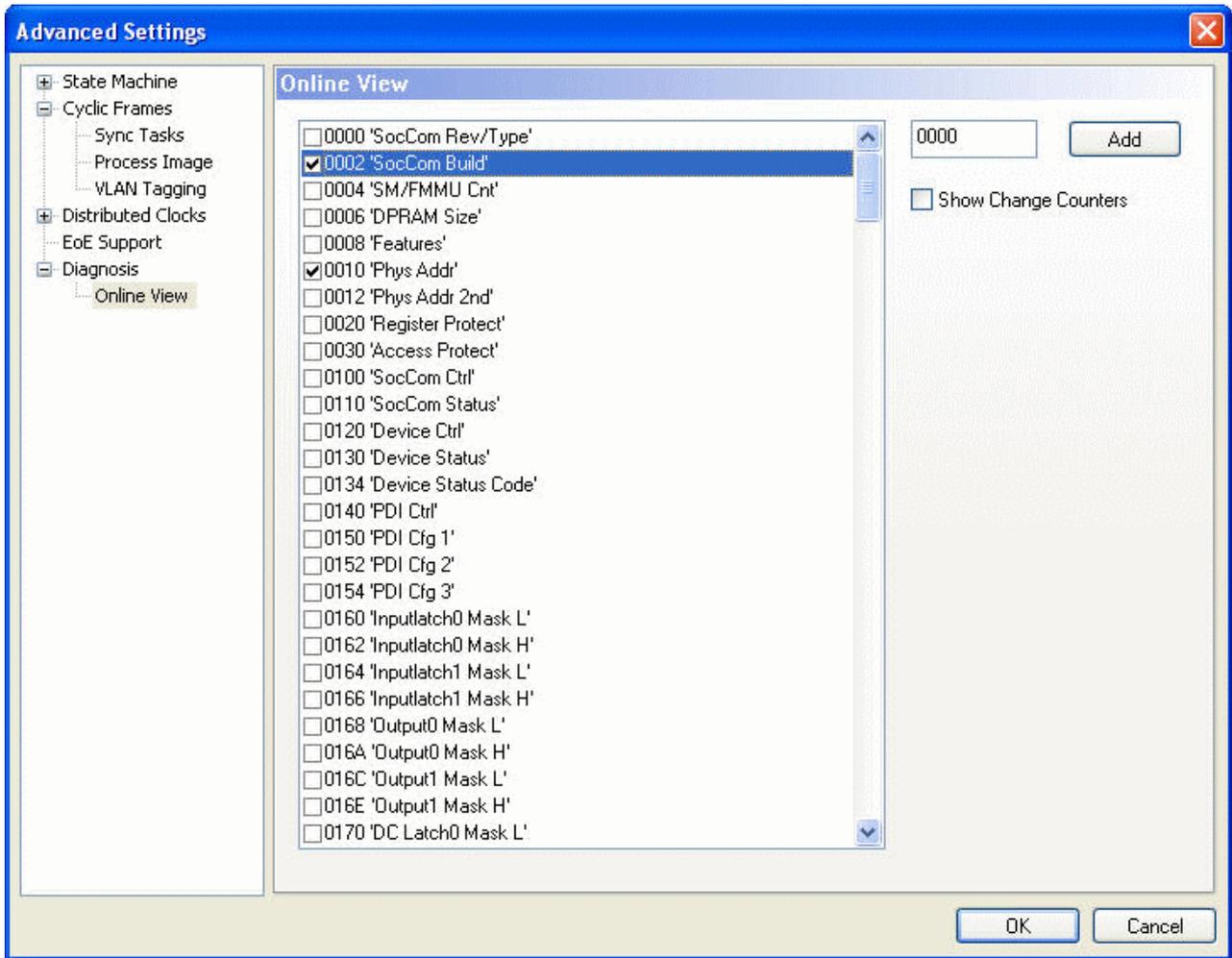
The "Online View" dialog enables the user to add additional columns to the list view of the "Online" tab of the EtherCAT device. The additional columns display the contents of the ESC registers selected in this dialog. One can either select a specific register by checking a specific item in the list view or typing an address in the edit field and pressing the "Add" button.



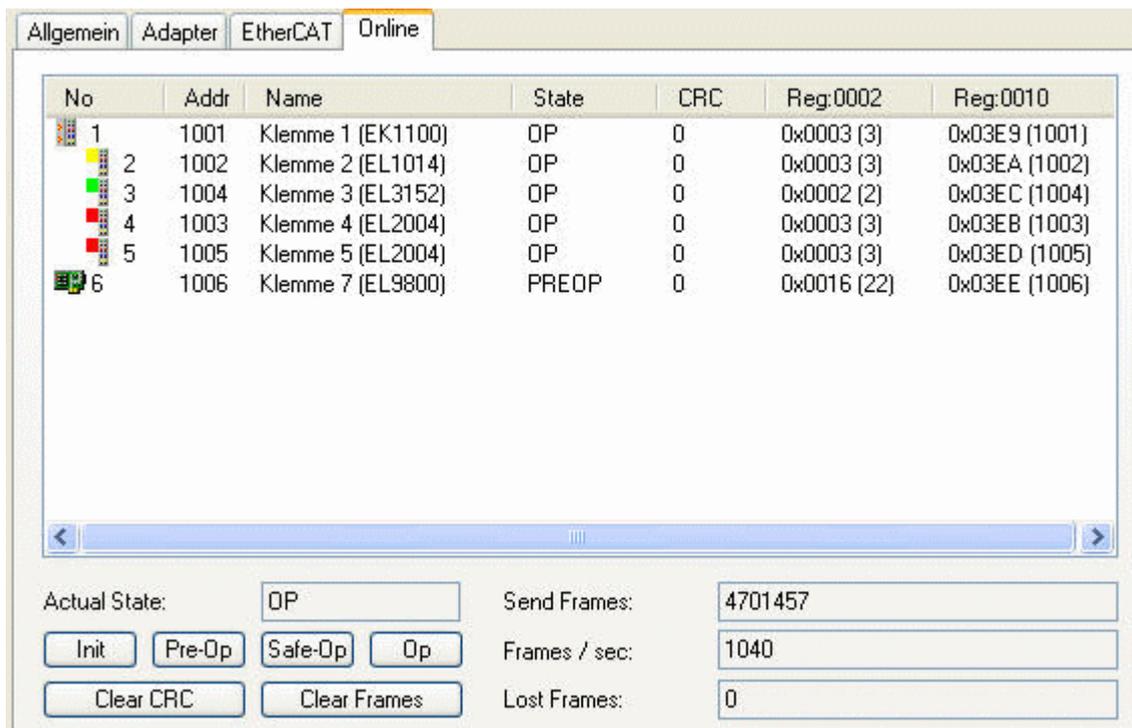
Show Change Counters: If this box is checked, a column is added to the list view of the "Online" tab displaying two counters separated by a slash. The first counter displays the number of abnormal state change. The second counter displays how often the communication to the slave device has been lost.

Example:

To display the physical address and the Soccom Build of an EtherCATSlave device we would have to select the item 0002 and the item 0010 in the list view:



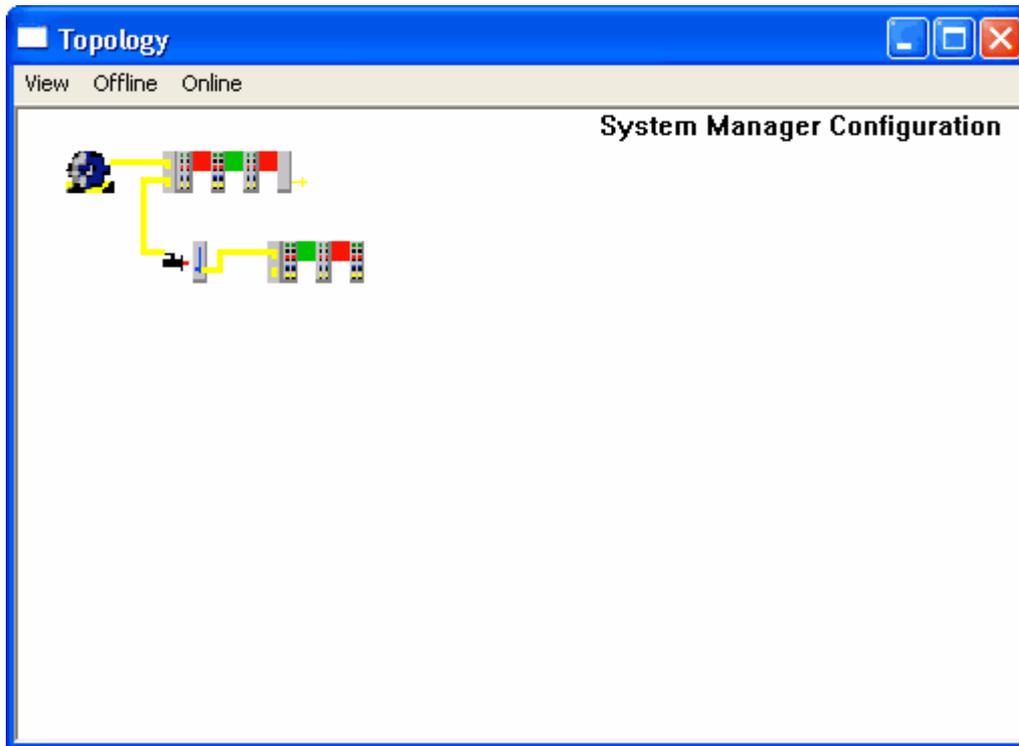
Next you must close the "Advanced Settings" dialog and go to the "Online" tab of the EtherCAT master device. Here you can see that two new columns have been added to the list view, one for the "Soccom Build"(Reg:0002) and one for the physical address of the EtherCAT device (Reg:0010).



11.2.7.6 EtherCAT Topology Dialog

Select in the tree view the EtherCAT device, whose topology should be shown. Open the EtherCAT tab on the right side and push the button *Topology...*

The following dialog opens:



Menu View

Zoom (1.0 x)

View is displayed in full scale.

Zoom (1.5 x)

Zoom in 1.5 :1.View is displayed in a larger scale, factor 1.5.

Zoom (2.0 x)

Zoom in 2 :1.View is displayed in a larger scale, factor 2.

Menu Offline

Show Topolgy

Shows offline topology of selected EtherCAT device.

Menu Online

Show Topolgy

Shows configured online topology of selected EtherCAT device. (see [Online display \[► 440\]](#)).

Compare To->Found Devices

Scans the bus and compares the actual topology with the configured topology.

Compare To->Offline Configuration

Compares the topology of the enabled online configuration with the topology of the opened TwinCAT System Manager configuration.

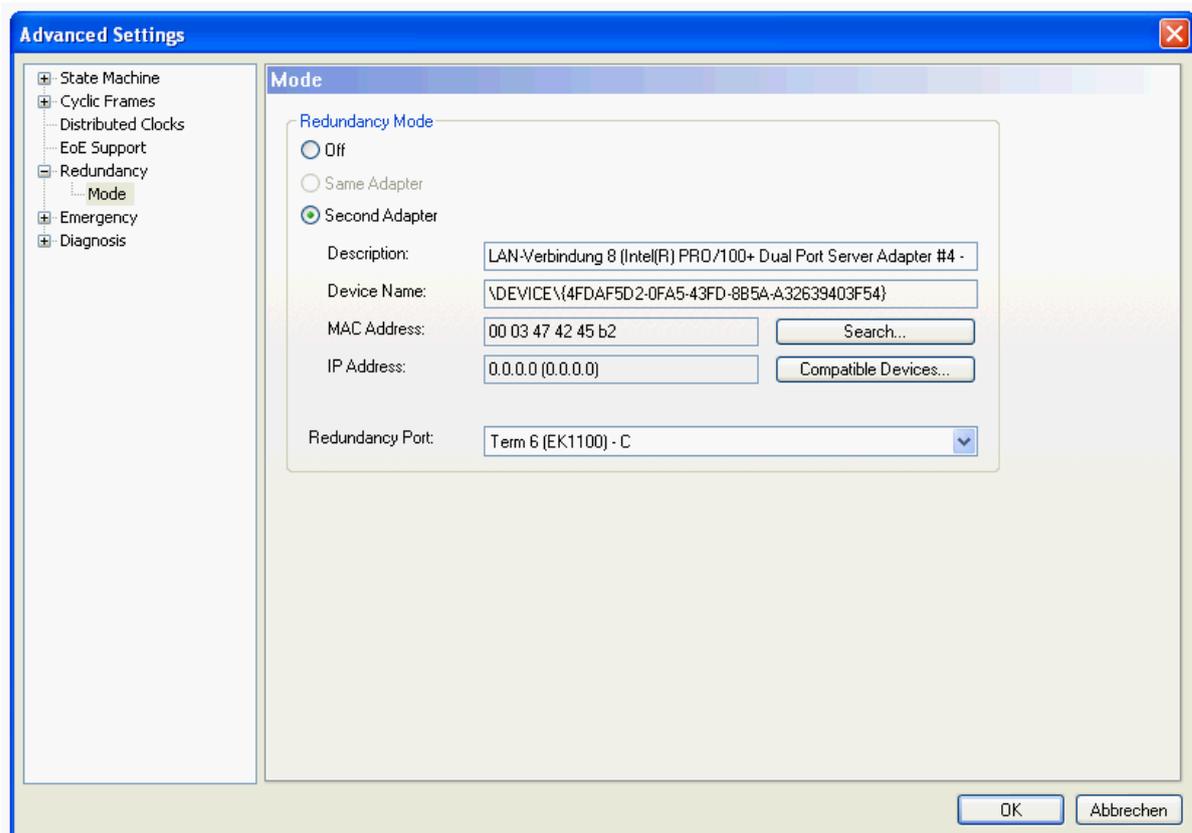
11.2.7.7 EtherCAT Cable Redundancy

TwinCAT uses a second adapter to realize EtherCAT Cable Redundancy. The EtherCAT frames are sent by both ethernet adapters simultaneously. The second adapter must be connected to a free ethernet port of an EtherCAT slave. Now the EtherCAT frames from the first EtherCAT adapter pass all EtherCAT slaves and arrive at the second adapter. The EtherCAT frames from the second adapter travel in the opposite direction. In case of a single cable fault on the path between the first EtherCAT adapter and the second adapter, all EtherCAT slaves are still accessible.

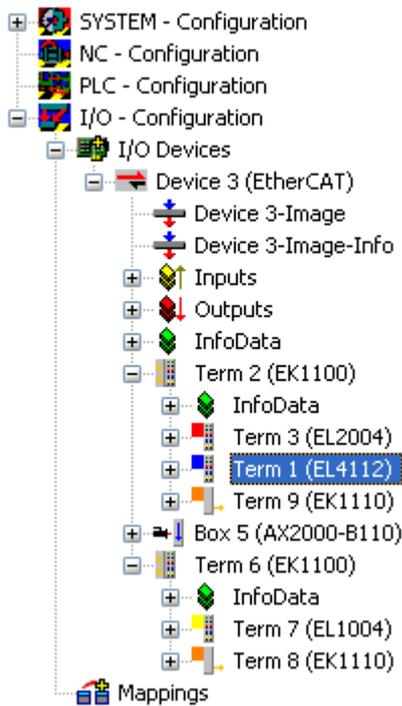
Configuring Cable Redundancy

Following steps show how to configure redundancy with the System Manager:

1. Disconnect second adapter
2. Right click on the EtherCAT device in the tree view of the System Manager and select the entry "Scan Boxes.." in the context menu of the device.
3. Open the "EtherCAT" tab of the EtherCAT device and press the "Advanced Settings..." button to open the "Advanced Settings" dialog.
4. In the "Advanced Settings dialog" you have to select "Redundancy/Mode" in the tree view on the left side:



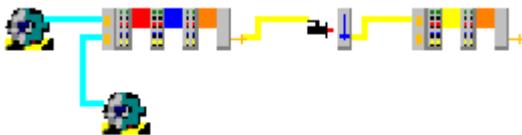
5. Select the "Second Adapter" radio button and press the "Search..." button to select the ethernet adapter.
6. Next you must select the redundancy port at the bottom. This is the ethernet port of an EtherCAT slave the second adapter is connected to. With some topologies it is possible to choose between more than one port. It is important that the ethernet device is connected to exactly this port. Otherwise the redundancy will not operate correctly.
Example:



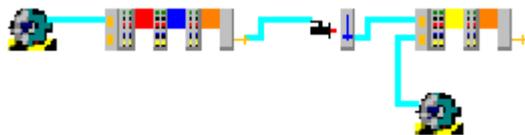
The above configuration has following topology:



The redundancy adapter can now be connected to either the free port of Term 2(EK1100):



or to the free port of Term 6(EK1100):



or to the free port of Term 8(EK1110) :



The blue line indicates the redundancy path. Along this path a single cable loss is possible without loss of communication to an EtherCAT slave.

7. Connect the second adapter to ethernet port configured under 6.
8. Activate the configuration or reload the devices in Config Mode to activate the redundancy mode.

11.2.7.8 Supported network controller

The TwinCAT RT driver is required for a network port if real-time protocols such as EtherCAT are used.

It enables the TwinCAT real-time to access the network chip.

The driver can be installed using the tool "TcRteInstall.exe", which is provided in C:\TwinCAT\System.

On the following page you will find a list of the supported Intel chips. The driver recognizes the chips by the vendor and device ID.

Support for a network card does not mean that the system is real-time capable. Beckhoff ensures this for its own IPCs and EPCs through a variety of measures. However, this cannot be guaranteed for other devices that use the same network controller.

NOTICE

Observe Beckhoff compatibility

The NICs installed in Beckhoff controllers are specially selected and qualified for RT use; no properties can be assured on third-party devices.

In case of doubt the original Intel driver must be used, which does not allow operation with the TwinCAT runtime with real-time protocols.



Last updated: TwinCAT 2.11 R3 2307

TcI8254x.INF

Vendor ID	Device ID	Description
0x8086 (Intel)	0x1000	Intel 82542
	0x1001	Intel 82543GC
	0x1004	Intel 82543GC
	0x1008	Intel 82544EI
	0x1009	Intel 82544EI
	0x100C	Intel 82543EI
	0x100D	Intel 82544GC
	0x100E	Intel 82540EM
	0x100F	Intel 82545EM
	0x1010	Intel 82546EB
	0x1011	Intel 82545EM
	0x1012	Intel 82546EB
	0x1013	Intel 82541EI
	0x1014	Intel 82541ER
	0x1015	Intel 82540EM
	0x1016	Intel 82540EP
	0x1017	Intel 82540EP
	0x1018	Intel 82541EI
	0x1019	Intel 82547EI
	0x101A	Intel 82547EI
	0x101D	Intel 82546EB
	0x101E	Intel 82540EP
	0x1026	Intel 82545GM
	0x1027	Intel 82545GM
	0x1028	Intel 82545GM
	0x1049	Intel 82566MM - ICH8
	0x104A	Intel 82566DM - ICH8
	0x104B	Intel 82566DC - ICH8
	0x104C	Intel 82562V - ICH8
	0x104D	Intel 82566MC - ICH8
	0x105E	Intel 82571EB
	0x105F	Intel 82571EB
	0x1060	Intel 82571EB
	0x1075	Intel 82547EI
	0x1076	Intel 82541GI
	0x1077	Intel 82547EI
	0x1078	Intel 82541ER
	0x1079	Intel 82546EB
	0x107A	Intel 82546EB
	0x107B	Intel 82546EB
	0x107C	Intel 82541PI
	0x107D	Intel 82572EI
	0x107E	Intel 82572EI
	0x107F	Intel 82572EI
	0x108A	Intel 82546GB
	0x108B	Intel 82573E
	0x108C	Intel 82573E
	0x1096	Intel 80003ES2LAN
	0x1098	Intel 80003ES2LAN
	0x1099	Intel 82546GB
0x109A	Intel 82573L	
0x10A4	Intel 82571EB	
0x10A7	Intel 82575	

Tcl8255x.inf

Vendor ID	Device ID	Description
0x8086 (Intel)	0x1029	Intel 82559
	0x1030	Intel 82559
	0x1031	82801CAM (PRO/100 VE Network Connection)
	0x1032	82801CAM (PRO/100 VE Network Connection)
	0x1033	82801CAM (PRO/100 VM Network Connection)
	0x1034	82801CAM (PRO/100 VM Network Connection)
	0x1038	Intel PRO/100 VM/KM Network Connection
	0x1039	Intel 82801CAM (PRO/100 VM Network Connection) ICH2
	0x103A	Intel 82801DB (LAN Controller with 82562ET/EZ (CNR) PHY) ICH4
	0x103B	Intel 82801DB (LAN Controller with 82562EM/EX PHY)
	0x103C	Intel 82801DB (LAN Controller with 82562EM/EX (CNR) PHY)
	0x103D	Intel 82801DB (PRO/100 VE Network Connection)
	0x103E	Intel 82801DB (PRO/100 VM Network Connection)
	0x1050	Intel 82801EB/ER (PRO/100 VE Network Connection) ICH5
	0x1051	Intel 82801EB/ER (PRO/100 VE Network Connection)
	0x1052	Intel 82801EB/ER (PRO/100 VM Network Connection)
	0x1053	Intel 82801EB/ER (PRO/100 VM Network Connection)
	0x1054	Intel 82801EB/ER (PRO/100 VE Network Connection (mobile))
	0x1055	Intel 82801EB/ER (PRO/100 VM Network Connection (mobile))
	0x1056	Intel 82801EB/ER (PRO/100 VM Network Connection (mobile))
	0x1057	Intel 82801EB/ER (PRO/100 VM Network Connection (mobile))
	0x1059	Intel 82551QM PRO/100 M
	0x1064	Intel 82801EB/ER (PRO/100 VE Network Connection) ICH6
	0x1065	Intel 82801FB/FR/FW/FRW
	0x1067	Intel(R) PRO/100 VE Network Connection
	0x1068	Intel(R) PRO/100 VE Network Connection
	0x1069	Intel(R) PRO/100 VE Network Connection
	0x106A	Intel(R) PRO/100 VE Network Connection
	0x106B	Intel(R) PRO/100 VE Network Connection
	0x1092	
	0x1094	
	0x1209	Intel 82551ER/IT
	0x1229	Intel 82557/8/9/0/1 (EtherExpress PRO/100(B) Adapter)
	0x2449	82801CAM i815 Boser (ICH2)
	0x2459	Intel(R) PRO/100 VE Network Connection
	0x245D	Intel(R) PRO/100 VE Network Connection
	0x27DC	Intel(R) PRO/100 VE Network Connection

11.2.8 Ethernet

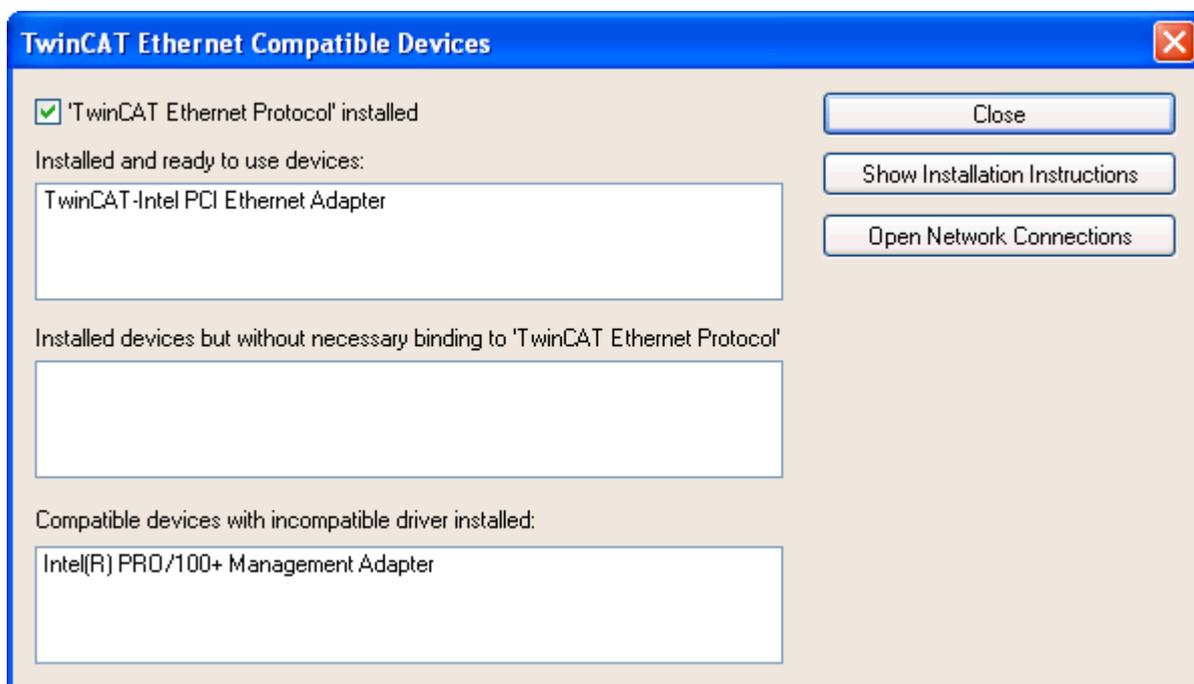
11.2.8.1 Ethernet Miniport (Real-Time)

The real-time Ethernet driver allows with **TwinCAT Real-Time Ethernet compatible devices** a simultaneous usage of the Ethernet network for TwinCAT Real-Time applications and "regular" applications which use the operating system stack (e.g. via TCP/IP).

Real-Time Ethernet compatible devices

The real-time Ethernet Miniport driver of TwinCAT works with all Ethernet adapters of the Intel 8255x series and as well with the integrated Ethernet adapter inside the Intel I/O Hub ICH4 (e.g. integrated in i845 chipset). Nevertheless, at least **Windows 2000** (or Windows XP) is required as operating system. To use the real-time environment of TwinCAT, the default operating system driver for the network adapter must be replaced with the one provided by TwinCAT v 2.9. Furthermore, an additional protocol driver "TwinCAT Ethernet Protocol" is required. How to do so, is described in [Appendix C \[▶ 413\]](#).

To verify whether compatible Ethernet adapters are available, the following dialog "TwinCAT Ethernet compatible devices" has been implemented. It can be found inside System Manager under: "[Options | Show Real Time Ethernet compatible devices... \[▶ 21\]](#)":



"TwinCAT Ethernet Protocol" installed: This checkbox indicates whether the TwinCAT Protocol driver has been installed already.

Installed and ready to use devices: Shows all adapters which are currently bound to the TwinCAT driver. These adapters should be available in System Manager configurations.

Installed devices but without necessary binding to 'TwinCAT Ethernet Protocol': Adapters which use the TwinCAT driver, but which are not bound to the TwinCAT protocol, are listed in this section. Please see installation instructions in [Appendix C \[▶ 413\]](#).

Compatible devices with incompatible driver installed: Lists all adapters which are TwinCAT Real-Time Ethernet capable if the original driver would be replaced (see: [Appendix C \[▶ 413\]](#)).

WARNING: Windows Update or Service Pack installations

The advantage that Real-Time Ethernet is based on standard hardware also has a little disadvantage: The operating system identifies the hardware and tries to update the drivers for it with the latest-greatest in certain circumstances. This happens e.g. during "Automatic Updates" as well as during installation of Service Packs. After Service Pack installation, the steps of [Appendix C \[▶ 413\]](#) have to be repeated, therefore. The

automatic Windows update feature can be disabled (please refer to: Control Panel | System | Automatic Updates and disable first checkbox). At manual updates, the recommendation about replacing the "Intel Networking Driver" should be declined. Anyway, after Service Pack installation or update, the current configuration can be checked with upper dialog in any case.

Ethernet Miniport "Adapter" tab

Ethernet Miniport "Adapter" tab

After adding an Ethernet Miniport I/O device to the I/O configuration, the following "Adapter" tab is available on the right:

The screenshot shows the configuration window for an Ethernet Miniport adapter. The 'Adapter' tab is active. The fields are as follows:

- Description:** Local Area Connection 2 (TwinCAT-Intel PCI Ethernet Adapter)
- Device Name:** \DEVICE\{F37232D3-2AD4-4877-9B23-11E548FA4CCB}
- MAC Address:** 00 02 b3 b6 0c 8c (with a 'Search...' button)
- IP Address:** 169.254.162.8 (255.255.0.0)
- Freerun Cycle (ms):** 25 (with a spin button)
- Lock I/O after Link Error

The Ethernet adapter currently selected is shown on this "Adapter" tab.

Search...: Looks for TwinCAT Real-Time Ethernet compatible devices and displays them.

MAC Address: MAC Address of this Ethernet controller (at configured network adapters)

IP Address: Settings taken from Windows Registry. These can be changed under "Control Panel | Network Connections" in the TCP/IP '*Properties..*' section.. If Real-Time Ethernet and "normal" Ethernet are both used on the same system with two different network adapters, the subnet addresses of these adapters (NICs) must differ! Nevertheless, the Real-Time Ethernet belonging devices must be configured with the same subnet address (first two quadruples) as the Ethernet Miniport adapter and vice-versa, of course.

Freerun Cycle: The cycle time used if [Free-Run \[▶ 22\]](#) is active ([Config Mode \[▶ 13\]](#) only), can be set here. The cycle time in Run mode results automatically in reference to the task with the highest priority linked to the variables of the adapter or one of its nodes.

Lock I/O after Link Error: If this box is checked, the process data exchange doesn't resume automatically after a resolved link problem (e.g. when the network cable has been unplugged). In such a situation, an I/O Reset is necessary afterwards, instead.

Supported devices / protocols

For a list of supported devices, see [Overview \[▶ 348\]](#). Since TwinCAT Real-Time Ethernet supports all Ethernet protocols by principle - means standard protocols as well as special Real-Time communication protocols - this list of supported devices is just a snapshot and will be certainly extended in the future.

Status inputs and Control outputs

Underneath a configured RT Ethernet device, a status variable and a control variable shows up and can be linked to other tasks (e.g. TwinCAT PLC tasks).

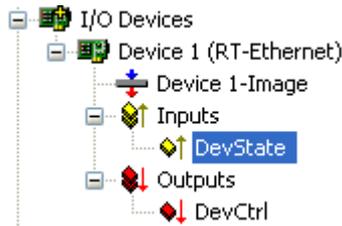


Table 6: Inputs:

Variable	Description
DevState	Device status information as WORD (or UINT) variable, assumes the following values: 0x0001 = Link error 0x0002 = I/O locked after link error (I/O reset required) 0x0010 = Out of send resources (I/O reset required) 0x0020 = Watchdog triggered 0x0040 = TwinCAT Real-Time Ethernet driver not found 0x0080 = I/O reset active

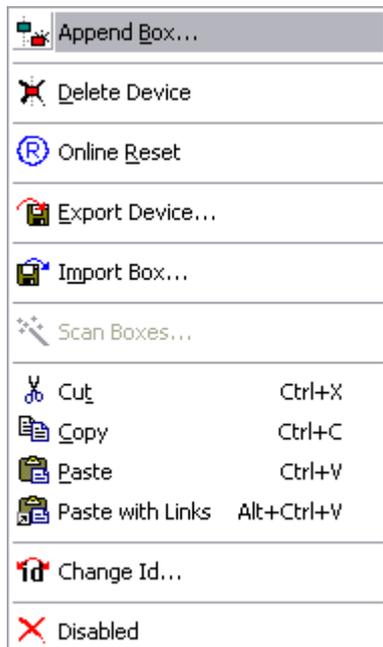
Table 7: Outputs:

Variable	Description
DevCtrl	Device control variable of type WORD (or UINT). <i>Has currently no impact on the network adapter!</i>

11.2.8.2 Virtual Ethernet Interface

The virtual Ethernet interface adds network interface cards (NIC), which are configured on a Windows NT / 2000 / XP Operating System or on a Beckhoff CX100x, to the TwinCAT I/O configuration. Via this network adaptor-independent virtual Ethernet Interface, Beckhoff Ethernet devices can be added to the TwinCAT I/O configuration, now.

Context Menü



Append Box <Ins>

Adds a Beckhoff Ethernet fieldbus device (Box) to the configuration. For an [Overview \[▶ 348\]](#) of all currently supported Beckhoff Ethernet devices, *please see [▶ 348]*...

**Delete Device **

Removes the virtual Ethernet Interface and all sub entries from the I/O configuration

Online Reset

Initiates an Online Reset on all Beckhoff Ethernet devices which are connected to this network.

"ADS" Tab

See -> ["ADS Settings at I/O Devices \[▶ 49\]"](#)

11.2.9 USB

11.2.9.1 Virtual USB Interface

The virtual USB Interface adds the PC USB ports, which are configured by the Windows2000 or Windows XP Operating System, to the TwinCAT System Manager configuration. Starting from this virtual USB interface, Beckhoff USB fieldbus devices (including Beckhoff Control Panels with USB interface and [push-button extensions](#)) can be added TwinCAT I/O configuration, now.

Context Menü**Append Box <Ins>**

Appends a Beckhoff USB fieldbus device (Box) to the configuration. For an [Overview \[▶ 376\]](#) of all currently supported Beckhoff USB devices, *please see [▶ 376]*...

**Delete Device **

Removes the virtual USB Interface and all sub entries from the I/O configuration.

Online Reset

Initiates an Online Reset on all Beckhoff USB devices which are connected to the USB ports.

Scan and create USB devices

Scans the system for connected Beckhoff USB devices (including possibly connected Bus Terminals) and adds the appropriate System Manager tree entries and dialog settings.

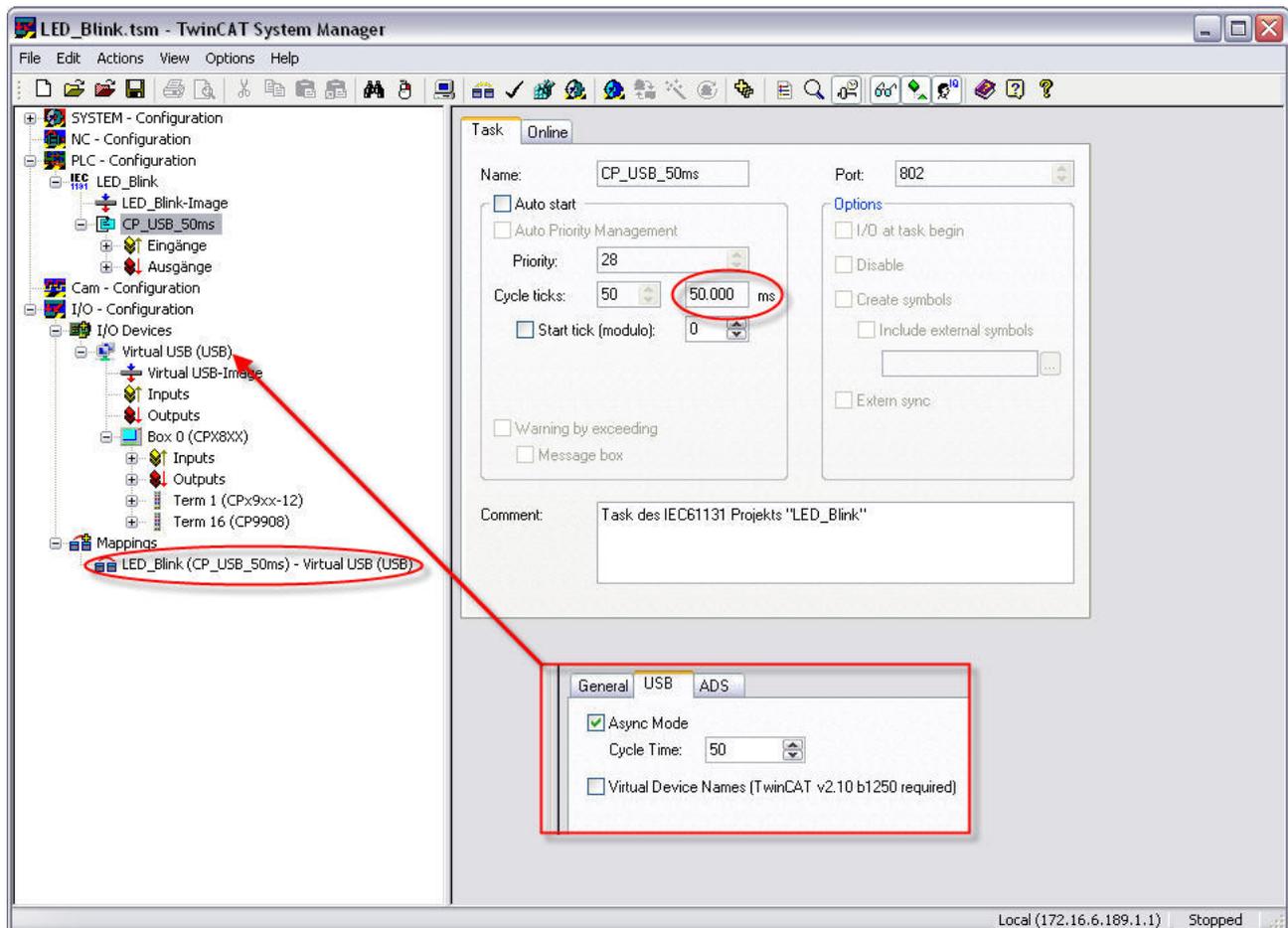
"ADS" Tab

See -> "ADS Settings at I/O Devices" [▶ 49].

11.2.9.2 Virtual USB Interface- interconnect CP68xx, CP69xx, CP78xx or CP79xx

These parameters are valid for Control Panel devices with DVI/USB interface (CP68xx, CP69xx, CP78xx und CP79xx) see screenshot below:

- **Cycle ticks:**
The PLC cycle time should be between 50 and 80 ms . Use an additional task alternatively .
- **Async Mode:**
In case of the availability of one task or due to test purposes use the Async Mode. This mode is not related to other cycles and can connect to a faster task with a cost of a slower i/o process image.
- **Mapping:**
Use the mapping to check an unintended connection of an usb device to fast task



11.2.10 Beckhoff Hardware

11.2.10.1 Beckhoff CP9030

The CP9030 card acts as a PC-side connector for the Beckhoff **Control Panel - Link** system. It can be used to connect control panels via coaxial cable to the PC over greater distances. As well as transmitting the TFT image signals, mouse pad/touch screen and keypad inputs, the Control Panels may have additional Special Keys and LED's which can be read/written to via TwinCAT (see Beckhoff IPC - Special Keys and UPS).

"CP9030" tab

The screenshot shows a configuration window for the CP9030 card. The 'DPRAM (Online)' tab is active. The 'Address' field is set to 0xCC000. The 'Buttons' and 'LEDs' fields are both set to 27. The 'Async Mode' checkbox is unchecked. The 'Firmware' field is empty. Buttons for 'Search...', 'PCI Cfg...', 'Upload Configuration...', 'Firmware Update...', and 'CP9020 Update...' are visible.

Address: The DPRAM address of the card can/must be set here. This address is jumper-defined on the card and can assume values from 0xC8000 to 0xEF000, in increments of 0x0080.

Search: This can be used to search for CP9030 cards inserted in the PC. Alternatively, the PC can be searched for TwinCAT supported I/O devices [▶ 133], via -> "Device search [▶ 54]". The set addresses of the CP9030 cards found are then automatically displayed under **Address**.

Buttons: The number of special buttons available on the control panel is set here (see also "BECKHOFF Knowledge Base").

LEDs: The number of LEDs on the control panel is set here (see also "BECKHOFF Knowledge Base").

Async mode: If this checkbox is activated, the communication of the I/O driver with the CP-Link card continues even if the linked task (e.g. a PLC task) is not active.

Firmware: Indicates the firmware version of the installed CP9030 card.

Firmware update: With this functionality, you can initiate an update of the CP9030 firmware.

● Grayed out setting options

i Setting options that are grayed out in the above image are not relevant for the CP9030 and instead refer to the Beckhoff [CP9035 \[▶ 246\]](#).

"UPS" tab

see -> "[Beckhoff IPC - Special Keys and UPS \[▶ 250\]](#)"

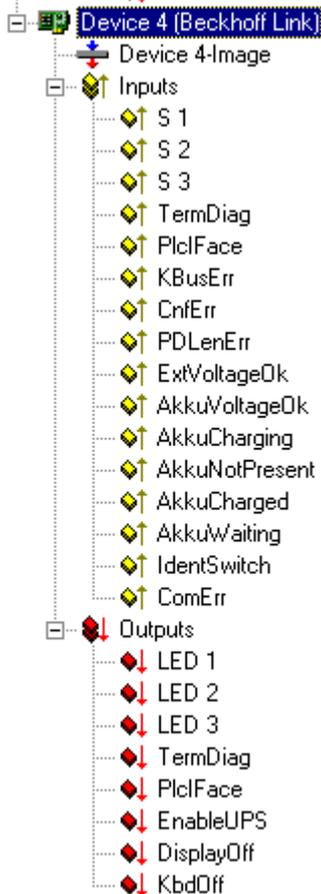
"ADS" Tab

See -> "[ADS/AMS Settings at I/O Devices \[▶ 50\]](#)"

"DPRAM (Online)" Tab

See -> "[Online Display of DPRAM \[▶ 267\]](#)"

I/O Variables:



Inputs:

S1 .. S n: Input status of corresponding Special Keys (see also -> "BECKHOFF Knowledge Base").

TermDiag: To this input, a variable (e.g. from TwinCAT PLC) for "Extended Bus Terminal Diagnosis" can be mapped.

PlcIFace: The status variable for the register access by PLC-Interface can be mapped here. If it is mapped, the actual status of communication (register access) can be checked.

KBusErr: Error status of a K-Bus (if present) connected to the Control Panel

CnfErr: Configuration error (e.g. Flash checksum error)

PDLenErr: Wrong configured length of process data (e.g. existing number of LEDs / Special Keys don't match with the System Manager configuration).

ExtVoltageOk: External voltage status (when UPS is active)

AkkuVoltageOk: Battery voltage status (when UPS is active)

AkkuCharging: Battery is charging (when UPS is active)

AkkuNotPresent: Battery not detected (when UPS is active)

AkkuCharged: Battery fully charged (when UPS is active)

AkkuWaiting: Check of Battery charging level. Charging is currently interrupted

IdentSwitch: Value of dip switch installed on card

ComErr: Communication error between Control Panel and CP9030 card

Outputs:

LED 1 -n: Output bits for controlling the LEDs (see Beckhoff Knowledge Base)

TermDiag: The status variable for the -> "Extended terminal diagnosis" can be linked here.

PclIFace: The status variable of the [PLC interface](#) can be linked or its current value can be checked here.

EnableUPS: Output bit for manual activation of UPS (only to be used if the UPS has not been activated via the UPS configuration)

DisplayOff: Switches off the background illumination on the control panel

KbdOff: Switches off the keyboard of a connected control panel (important when several control panels are connected via several CP9030 cards)

**Data exchange**

To enable the exchange of data between the control panel and CP9030, at least one variable must be linked. The linked task must be running or the async mode mentioned above must be set! Otherwise the handshake between PC and CP9030 is not performed, i.e. no data is exchanged with the control panel.

11.2.10.2 Beckhoff CP9035

The CP9035 card acts as a PC-side connector for the Beckhoff **Control Panel - Link** system. The difference to the [CP9030 \[▶ 244\]](#) card is, that the CP9035 uses a PCI slot instead of an ISA one.

With CP-Link, the Beckhoff Control Panel can be connected via coax cables to the PC, which makes long distances available. Beside TFT display, Mauspad/Touchscreen and Keyboard information, a Beckhoff Control Panel can contain Special Keys and LEDs, which can be accessed through TwinCAT (see [a/so:Beckhoff IPC - Special Keys and UPS](#)).

"CP9030/CP9035" Tab

PCI Bus/Slot: The appropriate PCI slot, where the CP9035 sits in, can/has to be selected here (see also **Search**).

Search: With the use of this button, the System Manager scans the current PC for CP9035 cards. Alternatively, the PC can be searched for by TwinCAT [supported I/O Devices \[▶ 133\]](#) with the -> "[Scan Devices \[▶ 97\]](#)" function.

Buttons: The number of implemented Special Keys at the Control Panel has to be selected here. Default number is 27, which suits for the most of the Control Panels (see also -> "BECKHOFF Knowledge Base").

LEDs: The number of implemented LEDs and/or lamps at the Control Panel has to be selected here. Default number is 27, which suits for the most of the Control Panels (see also -> "BECKHOFF Knowledge Base").

Async Mode: With activated Checkbox, the communication with the I/O driver even continuous, if the linked task (e.g. a PLC task) is not active (anymore).

PCI-Cfg: With the usage of this button, the address of the CP9035 can be set to a lower memory area (below 1 MB) of the PC.

Upload Configuration: Scans the K-Bus Extension port of the CP9035 card for connected Bus Terminals (e.g. for handwheel or potentiometers inside CP7xxx).

Firmware: Shows the Firmware version of the implemented CP9035 card.

Firmware Update: With this function an update of the CP9035 Firmware can be started.

"USV" Tab

See -> "[Beckhoff IPC - Special Keys and UPS \[▶ 250\]](#)"

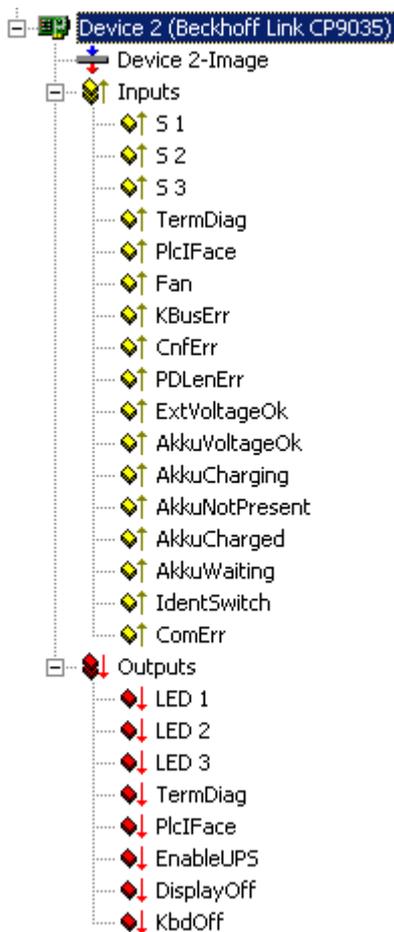
"ADS" Tab

See -> "[ADS/AMS Settings at I/O Devices \[▶ 50\]](#)"

"DPRAM (Online)" Tab

See -> "[DPRAM Online \[▶ 267\]](#)"

I/O Variables:



Inputs:

S1 .. S n: Status of corresponding Special Keys (see above description of tab "CP9030/CP9035").

TermDiag: To this input, a variable (e.g. from TwinCAT PLC) for "Extended Bus Terminal Diagnosis" can be mapped.

PlcIFace: The status variable for the register access by PLC-Interface can be mapped here. If it is mapped, the actual status of communication (register access) can be checked.

Fan: Not used

KBusErr: Error condition of an eventually to the Control Panel connected K-Bus.

CnfErr: Configuration error (e.g. Flash checksum error)

PDLenErr: Wrong configured length of process data (e.g. existing number of LEDs / Special Keys don't match with the System Manager configuration).

ExtVoltageOk: Status of external voltage (if UPS active).

AkkuVoltageOk: Voltage of battery o.k. (if UPS active).

AkkuCharging: Battery is charging (if UPS active).

AkkuNotPresent: Battery not found (if UPS active).

AkkuCharged: Battery completely charged (if UPS active).

AkkuWaiting: Charging level of battery is evaluated. Charging is currently interrupted.

IdentSwitch: Shows the value of Dip-Switch, which is set on CP9035 card.

ComErr: Communication error between Control Panel und CP9035 card.

Outputs:

LED 1 - n: Output bits for controlling the LEDs

EnableUPS: Output bit for manual activation of UPS (only to be used if the UPS has not been activated via the UPS configuration)

DisplayOff: Switches off the background illumination on the control panel

KbdOff: Switches off the keyboard of a connected control panel (important when several control panels are connected via several CP9035 cards)

● Data exchange

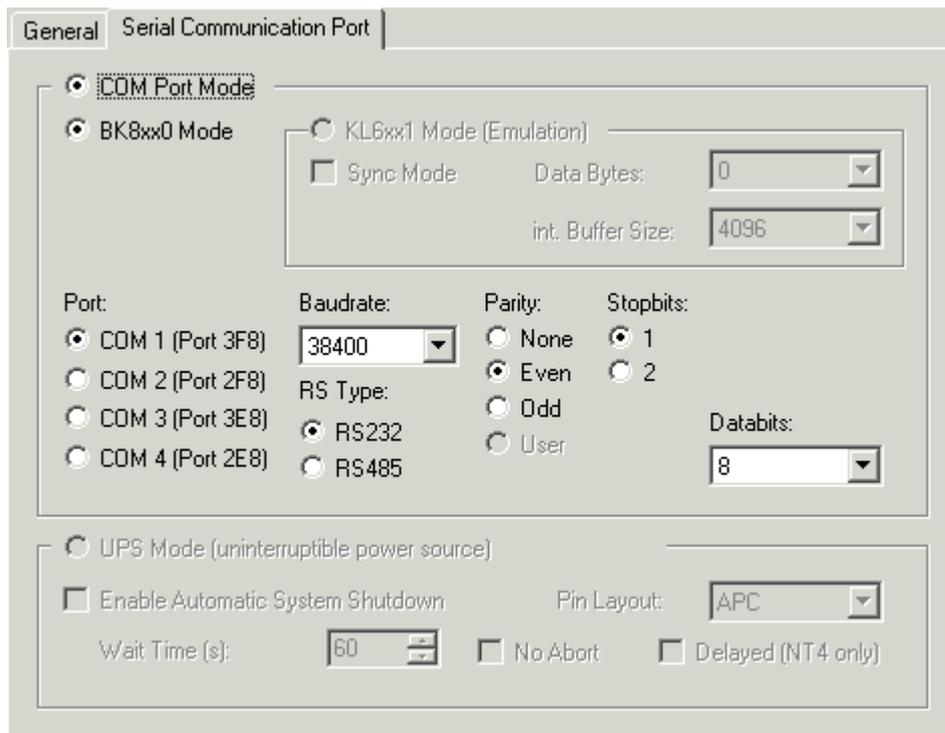


To enable the exchange of data between the control panel and CP9035, at least one variable must be linked. The linked task must be running or the async mode mentioned above must be set! Otherwise the handshake between PC and CP9035 is not performed, i.e. no data is exchanged with the control panel.

11.2.10.3 Beckhoff CP9040

The CP9040 PCB is used for the special keys and/or pushbutton extensions at Beckhoff Control Panel PC's.

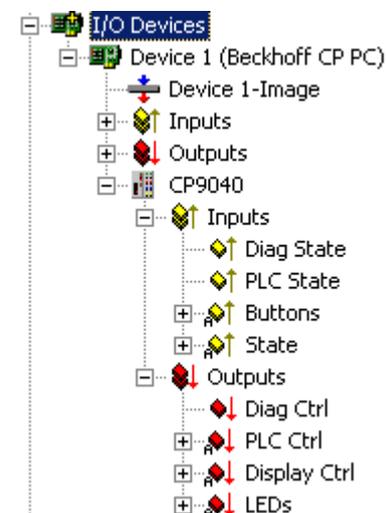
"Serial Communication Port" Tab



The description of the different options in this dialog are described under -> "[Serial COM Ports \[► 259\]](#)" in TwinCAT System Manager - Reference.

Items which are disabled in the above tab, are not relevant for a CP9040 device.

I/O Variables:



Inputs:

Diag State: To this status input, a variable (e.g. from TwinCAT PLC) for "Extended Bus Terminal Diagnosis" can be mapped.

PLC State: The status variable for the register access by PLC-Interface can be mapped here. If it is mapped, the actual status of communication (register access) can be checked.

Buttons: After opening of this Bit-Array, the single Special Keys can be mapped with Variables of another task (e.g. TwinCAT PLC) or their status can be checked. Additional information can be found under -> "BECKHOFF Knowledge Base".

State: This Bit-Array contains status bits of the CP9040 communication. The meaning of the several bits is explained in the belonging "Comment" [[▶ 37](#)] field on the right side, if this variable is highlighted in the TreeView.

Outputs:

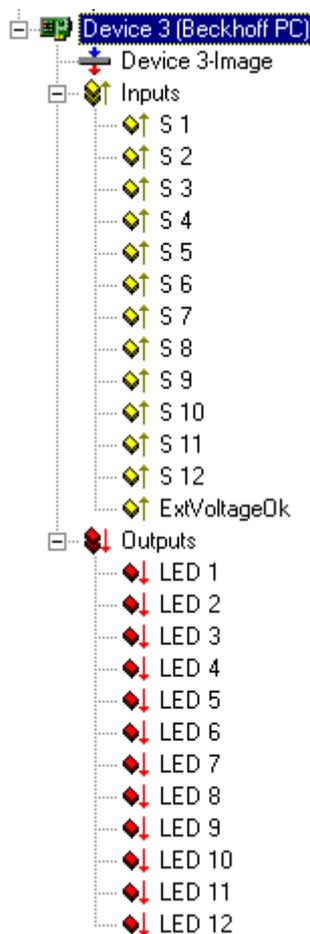
Diag Ctrl: To this control output, a variable (e.g. from TwinCAT PLC) for "Extended Bus Terminal Diagnosis" can be mapped.

PLC Ctrl: The control variable (output) for the register access by PLC-Interface can be mapped here. If it is mapped, the actual status of communication (register access) can be checked.

Display Ctrl: The variable for control over the display (e.g. enabling or disabling of the backlight) can be mapped here. Additional information to this item can be found under -> "BECKHOFF Knowledge Base".

LEDs: This Bit-Array contains the output bits for the LEDs inside the Special Keys or pushbuttons of the Beckhoff IPC. Additional information can be found under -> "BECKHOFF Knowledge Base".

11.2.10.4 Beckhoff IPC - Special Keys and UPS



Some of the Beckhoff Industrial PCs offer additional Special Keys with integrated LED's. These keys and LED's can be used and linked [[▶ 39](#)] as per normal inputs and outputs.

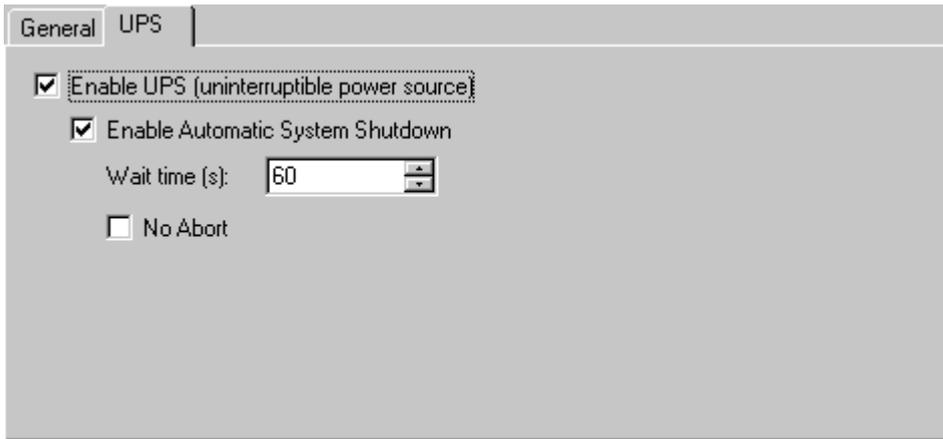
When you add the Beckhoff PC under I/O devices in the tree view, 10 bit variables are created automatically below the inputs and outputs for each one.

S 1 .. : n Inputs from corresponding Special Keys.

ExtVoltageOk: If this bit is linked [[▶ 39](#)] and its state is TRUE, the external power to the PC is ok.

LED 1 .. : n Outputs for corresponding LED's inside Special Keys.

"UPS" tab



Some Beckhoff Industrial PCs also have an integrated 24V UPS (uninterruptible power supply).

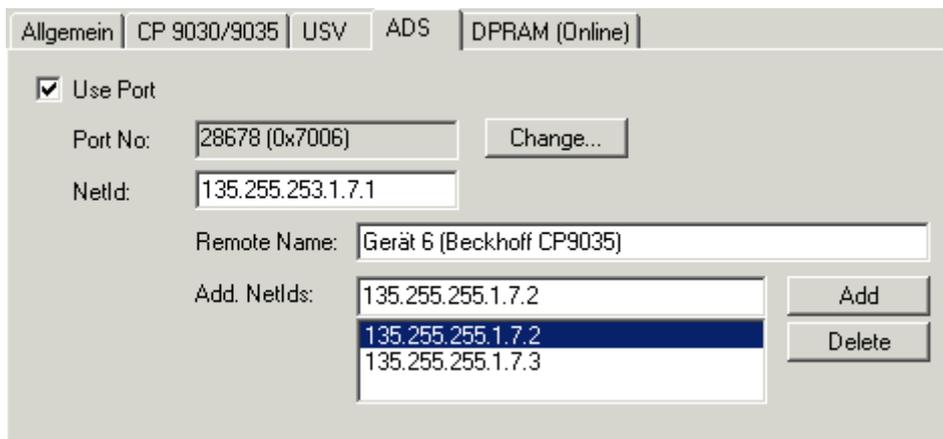
Enable: Activates the integrated 24V UPS.

Enable Automatic System Shutdown: Must be enabled if the PC shall shutdown after external power loss.

Wait time: The time, the system waits for shutdown after external power loss (time in seconds).

No Abort: If this box is checked and external power comes back during wait time, the system will stop the shutdown process.

"ADS" tab



See description: ["ADS/AMS-Settings at I/O devices" \[▶ 50\]](#)

"DPRAM (Online)" Tab

See ["Online Display of DPRAM \[▶ 267\]"](#)

11.2.10.5 Beckhoff NC Backplane

The following screenshots show the possible System Manager settings at a Beckhoff NC Backplane device.

"NC Backplane" Tab

The screenshot shows the 'NC Backplane' configuration window. At the top, there are three tabs: 'General', 'NC Backplane', and 'DPRAM (Online)'. The 'NC Backplane' tab is selected. Below the tabs, there is an 'Address' dropdown menu showing '0xCC000' and a 'Search...' button. Underneath, there are four rows of controls for ADCs: 'ADC 1 Gain', 'ADC 2 Gain', 'ADC 3 Gain', and 'ADC 4 Gain'. Each row has a numeric input field for 'Gain' and another for 'Offset', both currently set to '0'.

Address: The set address of the NC Backplane must be selected here. The possible range goes from 0xCC00 to 0xCCC0, by steps of 0x400 (see also **Search**).

Search: If this button is pressed by the user, an existing NC Backplane inside the PC will be found unless there is an address overlapping. Alternatively, with a use of -> "[Scan devices \[► 97\]](#)", the PC can be searched for all [TwinCAT supported I/O devices \[► 133\]](#). The appropriate address will be displayed in the **Address** field, after a NC Backplane was found.

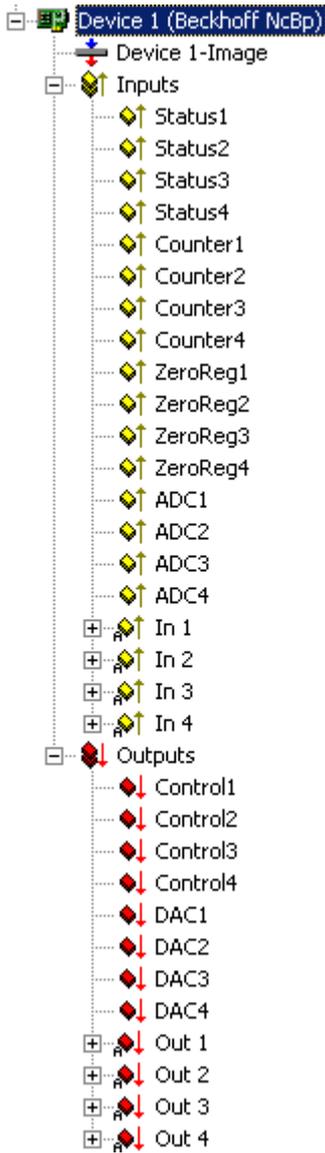
ADC Gain *n*: Hier wird

ADC Offset *n*: Hier wird

"DPRAM (Online)" Tab

See "[DPRAM-Online \[► 267\]](#)"

I/O Variables:



Inputs:

Status1: Eingangsstatus

Status2: Eingangsstatus

Status3: Eingangsstatus

Status4: Eingangsstatus

Counter1: Zähler

Counter2: Zähler

Counter3: Zähler

Counter4: Zähler

ZeroReg1: Text

ZeroReg2: Text

ZeroReg3: Text

ZeroReg4: Text

ADC1: Text

ADC2: Text

ADC3: Text

ADC4: Text

In 1: Text

In 1: Text

In 1: Text

In 1: Text

Outputs:

Control1: Text

Control2: Text

Control3: Text

Control4: Text

DAC1: Text

DAC2: Text

DAC3: Text

DAC4: Text

Out 1: Text

Out 2: Text

Out 3: Text

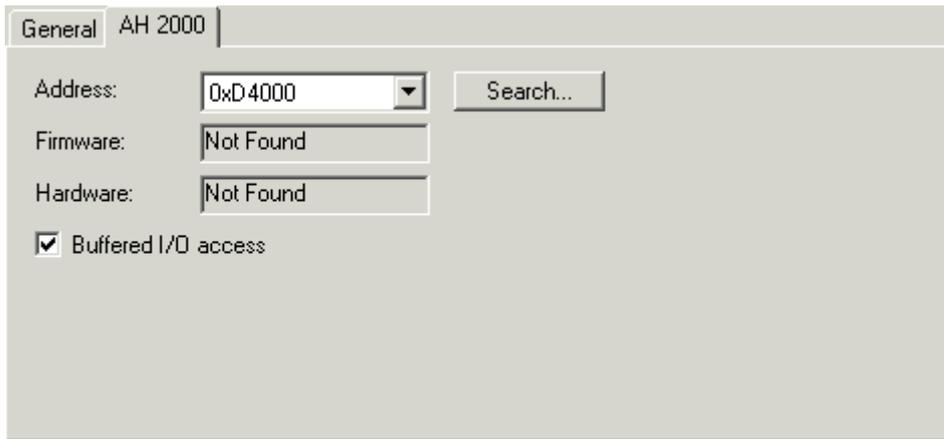
Out 4: Text

11.2.10.6 AH2000

Subsequently, the Beckhoff AH2000 hydraulic controller is described. Meant is the configuration of the TwinCAT System Manager inside the AH2000 itself.

The AH2000 has either 1 (part number: AH2001) or 3 (part number: AH2003) channels. Therefore, the below described settings must be done one time in the AH2001 and three times in the AH2003, to have the complete configuration.

"AH2000" tab



Address: The base address of the peripherals (ADC's, DAC,..) at the respective channel has to be set here.

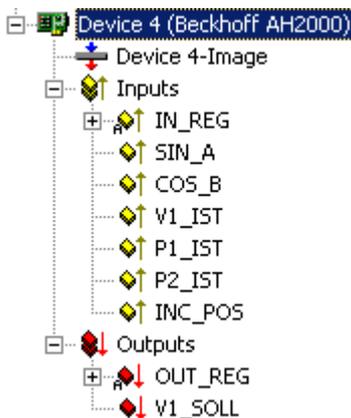
Search: Finds the base address of the peripherals of the current channel, if possible.

Firmware: Shows the loaded Firmware-Version of the AH2000.

Hardware: Shows the Hardware-Version of the AH2000.

Buffered I/O access: This Checkbox is activated by default. It shows, that the I/O access goes through a buffer but the reading and writing of the I/O's is still proceeded in real time and synchronized with the PLC task.

Diagnosis Inputs



The I/O variables in the TreeView of the AH2000 device have the following meaning and to be mapped [▶ 39] to TwinCAT PLC.

Inputs:

IN_REG: This Bit-Array contains the Hardware status bits of the respective channel. The meaning of the single bits is described inside the table below and also listed in short form inside the "Comment [▶ 37]" field on the right tab of the highlighted variable.

SIN_A: ADC value of the sinus part of the sinus/cosinus encoder.

COS_B: ADC value of the cosinus part of the sinus/cosinus encoder.

V1_IST: ADC value of the analog valve feedback.

P1_IST: ADC value of the first analog input.

P2_IST: ADC value of the second analog input.

INC_POS: Actual position feedback of the respective channel (hardware increments).

Outputs:

OUT_REG: This Bit-Array contains the Hardware control bits of the respective channel. The meaning of the single bits is described inside the table below and listed in short form inside the "Comment" field on the right tab of the highlighted variable.

V1_SOLL: DAC setpoint value for the valve.

Meaning of the single bits inside Bit-Arrays:

Variable	Data Type	Bit	Short	Description
IN_REG	BITARR16	0	V1_Stat	Valve status (1 = valve ON)
		1	EncStat	Encoder status
		2	Ref	Status of callibration
		3	In0	Status input 0 (status of 1st input)
		4	In1	Status input 1 (status of 2nd input)
		5	FB_P	Feedback power for analog inputs (1 = power ON)
		6	V1_EnAck	Feedback valve enable
		7	FB_V1	Feedback valve
		8	IncDir	Current counting direction (1 = positive)
		9	Reserv.	
		10	Reserv.	
		11	Reserv.	
		12	Reserv.	
		13	Reserv.	
		14	Reserv.	
		15	Reserv.	
Variable	Data Type	Bit	Short	Description
OUT_REG	BITARR16	0	GI_RES	Global reset (reset ALL)
		1	IncRes	Counter reset
		2	EnRef	Enable callibration
		3	Out0	Output 0 (1st output)
		4	Out1	Output 1 (2nd output)
		5	P_Pwr	Enable power for analog inputs
		6	V1_En	Enable valve
		7	V1_Pwr	0: Power for valve OFF; 1: Power for valve ON
		8	EnTTL	0: External encoder = sinus/cosinus; 1: External encoder = TTL
		9	EnShdw	Enable shadow register (contains callibration values)
		10	RefSel	0: Detect encoder Zero-signal; 1: Detect external reference signal
		11	RefPol	0: Detect rising edge; 1: Detect falling edge. <i>RefPol</i> is only evaluated if = 1RefSel
		12	Reserv.	
		13	Reserv.	
		14	Reserv.	
15	Reserv.			

11.2.10.7 CX1100 Power Supply/Terminal Device (CX1100-BK)

If the Embedded PC CX1000 is used with the optional power supply [CX1100-0002](#) or [CX1100-0003](#), it automatically comes with an interface for the [Beckhoff Bus Terminals](#). At the configuration of the CX with TwinCAT System Manager, this (*K-Bus*)-interface is handled as an I/O device with "CX1100-BK" as its device name.

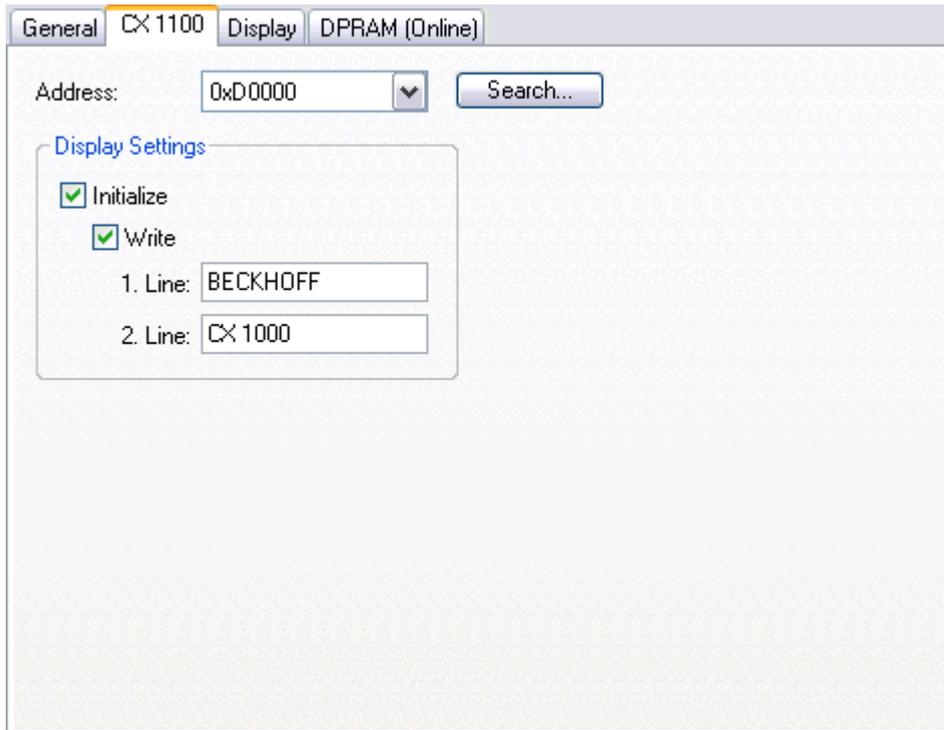
"General" Tab

The screenshot shows the configuration window for a CX1100 device. The 'General' tab is selected, and the device is identified as 'Device 1 (CX1100-BK)' with an ID of 1. The type is set to 'CX1100 Power Supplier/Terminal Device'. A comment field contains the text 'Space for useful notes!'. There are two checkboxes at the bottom: 'Disabled' (unchecked) and 'Create symbols' (checked).

Id

Shows the internal device ID of the "CX1100-BK" interface. This is especially remarked here, because this identification number is needed to access the 2-line LCDisplay (e.g. with function blocks from TwinCAT PLC).

For the rest of the labels and edit fields, please refer to "[I/O Configuration | Adding an I/O device | 97](#)".

"CX1100" tab**Address**

Is going to be detected automatically, during I/O device scan with TwinCAT System Manager. Alternatively, the button "**Search...**" can be used here.

Initialize

Initializes the display if activated (default).

Write

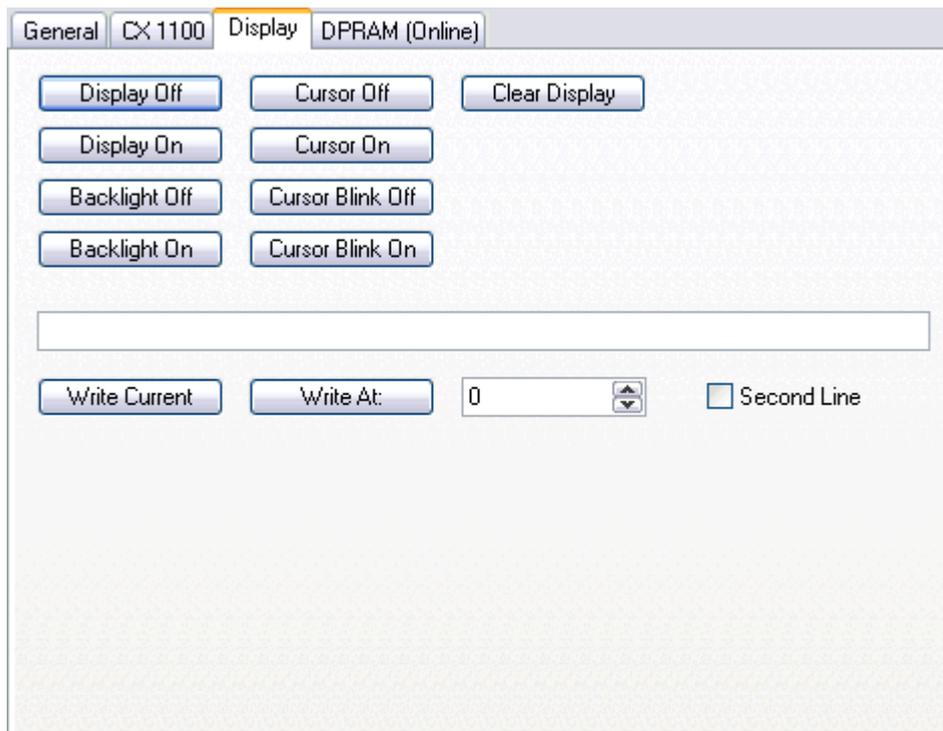
If activated, the strings assigned to "**1. Line**" resp. "**2. Line**" are going to be written to the display after system start/restart. By default, "Write" is activated.

1. Line

16-character long string for upper line of the 2-line LCD Display. The string assigned here may be overwritten from PLC, if appropriate PLC program is active.

2. Line

16-character long string for upper line of the 2-line LCD Display. The string assigned here may be overwritten from PLC, if appropriate PLC program is active.

"Display" tab

Dialog for manual access to the 2-line LC-Display of the CX1100 power supply.

"DPRAM [Online]" tab

Please refer to "[DPRAM \[Online\]](#) [[▶ 267](#)]"

11.2.10.8 BX Terminal Device (BX-BK)

The BX controller (BX3100, BX5100, BX5200) comes with an interface for the Beckhoff Bus Terminals. When configured with TwinCAT System Manager, this (*K-Bus*)-interface is handled as an I/O device named "BX-BK".

"BX Settings" tab

... under construction ...

11.2.11 Miscellaneous**11.2.11.1 Serial COM Ports**

The TwinCAT can use the PC's serial COM ports. There are two operating modes available:

1. Uninterruptible power supply (UPS)
2. COM port operation

COM port operation is divided into the following sub-operating modes:

1. Connection of serial Bus Couplers (BK8xx0)
2. General data interface (simulation of a KL6xx1)

"Serial interface" tab

General **Serial Port** Communication Properties

Onboard / ISA device

Port: COM 1 (Port 3F8)
 COM 2 (Port 2F8)
 COM 3 (Port 3E8)
 COM 4 (Port 2E8)

PCI device (C9900-A405)

PCI Bus/Slot: Search...

Port: UART 0
 UART 1
 UART 2
 UART 3

General **Serial Port** Communication Properties

COM Port Mode

BK8x0 Mode

Timeout (ms):

KL6x1 Mode (Emulation)

Data Bytes:
int. Buffer Size:
 Extended Ctrl/Status

Baudrate:
Parity: None Even Odd User
Stopbits: 1 2
Hardware Fifo (Byte):
RS Type: RS232 RS485
Databits:
 Sync Mode

UPS Mode (uninterruptible power source)

Enable Automatic System Shutdown
Pin Layout:
Wait Time (s): No Abort Delayed (NT4 only)

Operating mode: UPS

In the UPS operating mode, an external UPS is connected to the serial interface and controlled by the TwinCAT. Currently supports pin configurations APC and EFFEKTA.

In contrast to the UPS service provided with Windows NT, the TwinCAT-controlled UPS behaviour rather resembles that required for machine control. The NT service seeks to supply power to the PC for as long as possible and the computer only stops when the battery fails.

When the TwinCAT is controlling the UPS (the NT service must be disabled), the computer is shut down after a (user-) specified waiting period.

Operation mode: COM – BK8xx0

Serial bus couplers can be added under the I/O device and the couplers themselves can be fitted with terminals as required.

● Intelligent interface card required

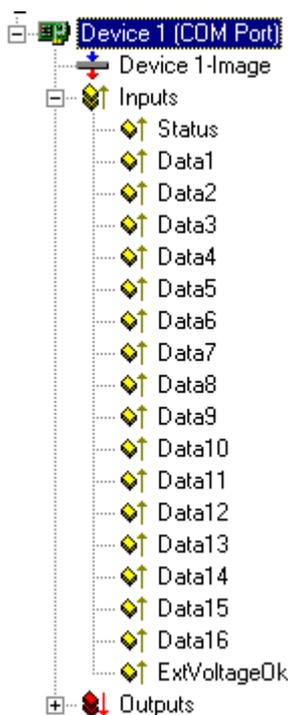
I To operate RS485 (BK80x0) you require an intelligent interface card which independently monitors the RTS/CTS leads (send and receive).

Operating mode: COM - KL6xx1

The type KL6xx1 terminals allow serial communication, e.g. of the PLC via a fieldbus - Bus Coupler and - the terminal to an external serial device (e.g. a barcode reader). The data bytes are exchanged via the terminal process image and the required handshake is controlled.

These functions can be replicated for the serial interfaces in the PC. A significantly greater data throughput can be achieved because on the one hand the baud rate can be set higher and on the other more data bytes can be transferred per cycle (maximum five for KL6xx1).

Data Bytes:



The maximum number of transferable data bytes can be set to between 16 and 4096. In addition, the internal buffer size can be adjusted, which is particularly important for the reception of data bytes (between 4096 and 65535).

The handshake is processed via the Ctrl and Status words. These words are structured in a very similar way to the Ctrl and Status bytes of the KL6xx1, with the difference that the data length to be specified is twelve, rather than three bits (maximum 4096).

- Status Bit 0: TA: Transmit Accepted
- Bit 1: RR: Receive Request
- Bit 2: IA: Init Accepted
- Bit 3: BUF_F: Buffer overflow (possible data loss)

- Bits 4-12: nIn Number of data present in buffer
- Ctrl Bit 0: TR: Transmit Request
- Bit 1: RA: Receive Accepted
- Bit 2: IR: Init Request
- Bit 3: Unused
- Bits 4-12: nOut Number of data to be sent

TA / TR

A status change from TR has the effect of loading the nOut data number (maximum 4096 bytes) from Data0-DataN into the send buffer. The interface signals the execution of this command via TA.

RA / RR

Via a status change from RR the controller interface indicates that the displayed nIn data number is in Data0-DataN. The reception of data is acknowledged in the control word using RA. Only then is new data transmitted from the interface to the controller.

IA / IR

If IR is high, the interface carries out an initialization. The send and receive functions are disabled, the FIFO indicators are reset. The execution of initialization is acknowledged by the interface with IA.

BUF_F

The receive buffer is full. Data received now will be lost.

Extended Ctrl/Status:

From TwinCAT v2.10 Build >= 1313 (CE image v2.16(x86), v2.17(ARM) and higher). This option is only supported by the standard PC interfaces COMx. If this option is selected, an additional word of process output data (ExtCtrl) and process input data (ExtStatus) is displayed to the existing data. Via these process data the following RS232 control lines can be set or requested.

ExtCtrl Bits:

0x0001 = DTR

0x0002 = RTS

If the according bit is set/reset the concerning RS232 control line is set/reset. All other bits are reserved.

ExtStatus Bits:

0x0001 = CTS

0x0002 = DSR

0x0004 = RI

0x0008 = DCD

0x8000 = TX buffer empty (this bit is set if all send buffer are empty (inclusive hardware Fifo).

The state of the rs232 control lines can be requested by masking the bits. All other bits are reserved.

Sync Mode

In *Sync mode*, communication with the interface hardware is synchronized with the communication task. This setting usually offers benefits at high baud rates, as long the cycle time of the communication task is short enough. At 115 kBaud, for example, 12 characters are received each millisecond. The interface therefore has to be operated with a maximum cycle time of 1 ms, in order to avoid overflow of the 16-byte hardware FIFO. If the cycle times are too long, there is a risk of buffer overflow.

If *Sync mode* is switched off, the interface is served via the Windows timer interrupt every millisecond, irrespective of the task cycle time. This mode is not real-time capable, and with high computer utilisation longer operating intervals may be experienced. In this case, with very high baud rates there is also a risk of buffer overflow.

It is recommended to activate *Sync mode* and to adjust the cycle time of the communication task to the baud rate in such a way that overflow of the 16-byte hardware buffer is avoided. For smaller baud rates and with a slower communication task, *Sync mode* may perhaps be deactivated.

11.2.11.2 Printer Interface

With the aid of the printer interface "Fieldbus" the eight inputs and outputs per card are ready for use.

"LPT Port" tab



There are three port address options. These echo the standard PC interfaces LPT1, LPT2 and LPT3. Your PC manual will tell you which LPT port on your computer corresponds to which port address. Alternatively check the current BIOS setting.

When you add the printer interface under I/O devices in the tree view, eight-bit variables are automatically created under the inputs and outputs. Note that with the inputs, the logic of the individual bits varies. Most inputs deliver a logical one if that pin is not connected to earth, and a logical zero if the pin is connected to earth. The logic is reversed in the case of those inputs indicated as inv.

A bi-directional interface is required for problem-free operation of the "Fieldbus".

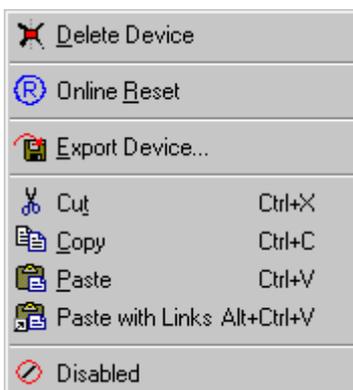
11.2.11.3 NOV/DP-RAM Interface

11.2.11.3.1 Generic NOV / DP-RAM

[NOV \[▶ 264\]](#)

To implement 3rd party PC cards with DP-RAM interface into TwinCAT, it is possible to use the generic NOV/DP--RAM device under "I/O Devices" -> *Append Device | Miscellaneous*.

Context menu



Delete Device...

Removes the DPRAM interfaced fieldbus card and all subsidiary elements from the I/O configuration.

Online Reset

Initiates an online reset on the Fieldbus.

The "Generic DPRAM" tab

PCI Slot/Irq: Displays the card address (below 1 Mb for an ISA card) or, in the case of a PCI card the logical PCI slot where the card is located along with the IRQ that has been assigned to it. The IRQ is unused.

Length: It is possible to modify the length of the memory area here, but this should only be done for ISA cards. It is read out automatically for PCI cards.

Search...: This is used to search for the address of the PCI card according to the vendor ID, device ID and the base address.

PCI-Vendor ID: The PCI vendor ID is entered here

PCI-Device ID: The PCI device ID is entered here

PCI BaseAddr: The appropriate memory area is selected here. (A PCI chip can address up to four memory areas, corresponding to the PCI chip's base addresses 2-5. Base address 0 and base address 1 are used for the PCI registers, to which access has not in the past been possible.)

"DPRAM (Online)" tab

See "[Online Display of DPRAM \[▶ 267\]](#)".

11.2.11.3.2 Generic NOV-RAM

Non-Volatile Random Access Memory (generally abbreviated as NOVRAM, NV-RAM or NOV-RAM) is a special type of memory component which, due to its principle, may be written to cyclically, but in which the final data content is saved in the internal ROM area in the event of an external power failure. A capacitor integrated in the NOVRAM supplies the energy required to copy the contents of the RAM area, which is also integrated in the NOVRAM, to the ROM area in the event of a failure of the externally applied voltage. The application (in this case TwinCAT) only writes cyclically into the RAM area of the IC.

To use the optional NOV-RAM extension of the Beckhoff fieldbus cards (e.g. [FC3101-0002 / FC3102-0002](#), [FC3151-0002](#), [FC5101-0002 / FC5102-0002](#), [FC5151-0002](#), [FC5201-0002 / FC5202-0002](#), [FC5251-0002](#), [FC7551-0002](#)) under TwinCAT, an additional I/O device, to be found in the I/O Devices | Miscellaneous area, must be included as "[General DP/NOV-RAM \[▶ 263\]](#)".

In the [CX1100-000x](#) power supply modules from the Beckhoff CX10xx series, the NOVRAM block, which is always present and in this case has a size of 8 kByte, is automatically detected during reading.

With the [CX900x](#) the ever-present NOVRAM block, which is a 128-kByte block in this case, is automatically recognized when reading.

Furthermore, the procedure described below also supports the Mini PCI NOVRAM modules with the order numbers **C9900-R230**, **C9900-R231** and **C9900-R232**.

● Only for TwinCAT 2.8

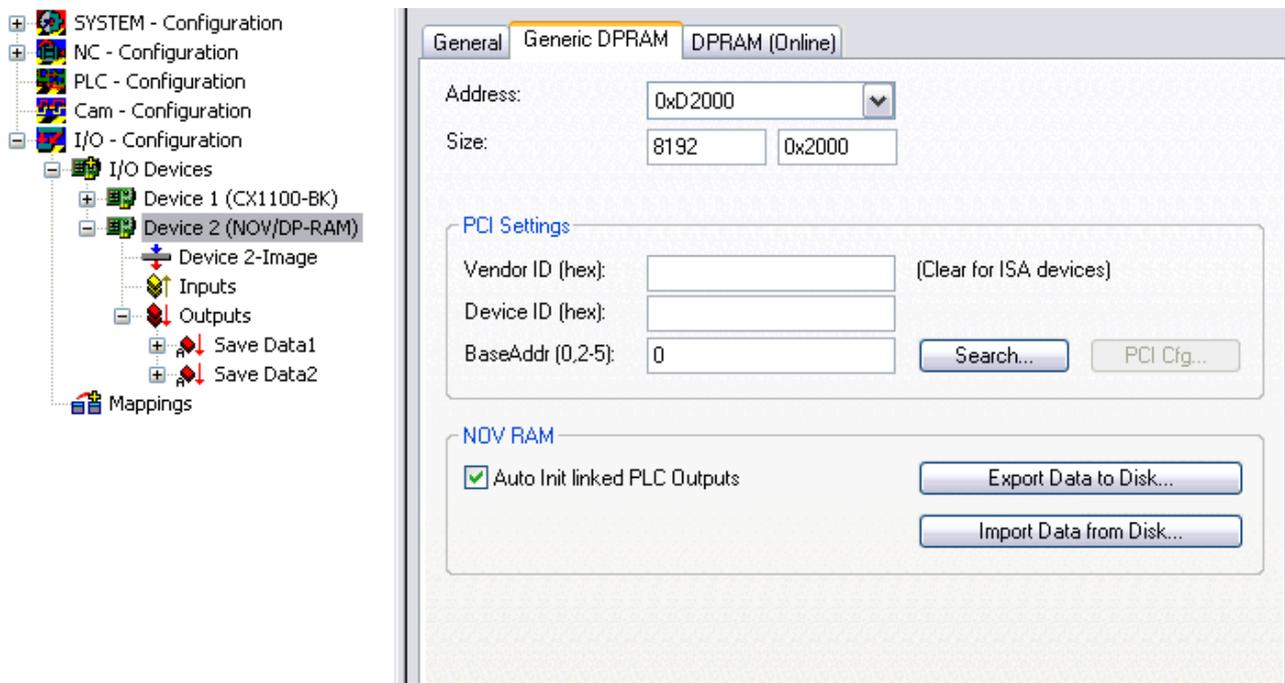
i Writing data to attached and linked output variables via PLC I/O refresh, without using the PLC function blocks, would result in the respective data areas in NOVRAM being written to NULL when the system stops. See also: [Configuration example for TwinCAT 2.8 \[► 266\]](#)

Configuration example (TwinCAT 2.9):

Configuration example (TwinCAT 2.9)

Especially for the configuration of CX1000 controllers it is important, that some variables survive a reboot. Usually no UPS is used along with this kind of devices. New to TwinCAT 2.9 is, that no PLC function blocks are necessary for read and write, and therefore synchronization, of dedicated remanent PLC variables anymore. (*Hint: The term "persistent" is not used in this context for a reason!*). The below described feature can also be used for the **FCxxx-0002** Fieldbus cards, of course.

The following dialog describes the necessary settings for the I/O driver to establish synchronized (remanent) PLC outputs, which survive a reboot.



Address: The address as well as the size of the NOVRAM which is to be set here, is usually found automatically after a "Scan for devices".

Auto Init linked PLC Outputs: This Checkbox must be activated for the implementation of remanent, means, with reboot synchronized variables.

The next step is to define output variables - with the right size and optionally right address offset - underneath 'Outputs' in the tree view (in the above picture these are e.g. the array variables 'Save Data1' and 'Save Data2'). If these outputs are going to be linked to PLC outputs (e.g. declared with `AT %Q*`), they will overwrite the initial values of these PLC variables after reboot/start of PLC boot project, automatically. Means, the PLC program will continue with the last stored NOVRAM values in this case.

A special declaration of those PLC variables is not necessary (besides the fact that they need to be declared as located output variables, of course). Especially, a declaration as `VAR xxx PERSISTENT` or `VAR xxx RETAIN`, is not allowed in the above context.

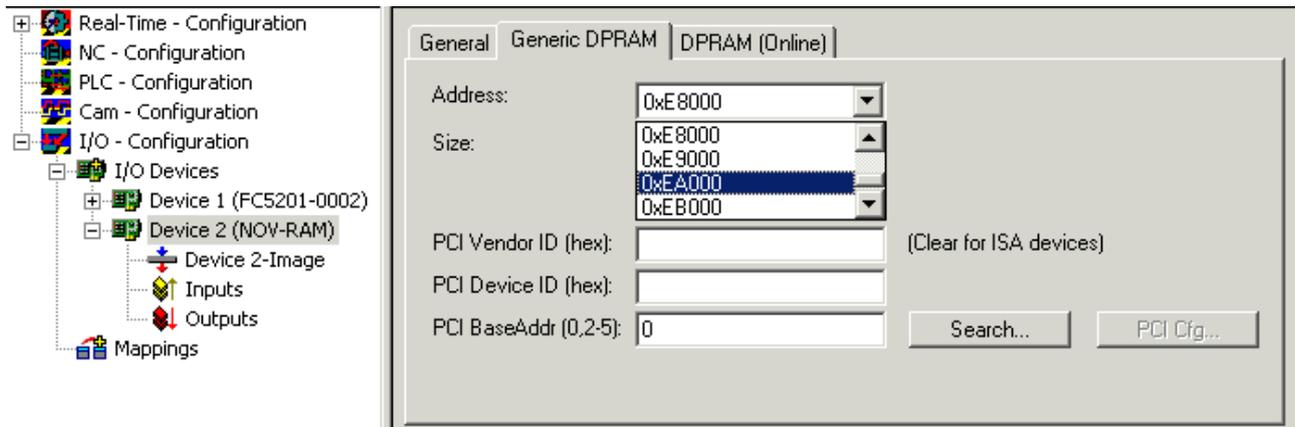
Export Data to Disk: Writes the actual content of the NOVRAM to a XML based file on disk. Blocks of 1k (1024 Byte) size are separated within dedicated identifiers inside the XML file. That gives a better overview during reading/manipulating afterwards.

Import Data from Disk: Formerly created NOVRAM XML files (XML files about complete NOVRAM size or even partial) can be read back into NOVRAM. E.g., this can be used to preset the NOVRAM with a "manufacturer data set" at a dedicated address offset prior to machine shipping. Just explore an exported NOVRAM XML file, and it will self-describe its meaning!

Configuration example for TwinCAT 2.8:

In difference to the configuration of an ordinary DP-RAM card [► 263] with TwinCAT, the data which has to be transferred to the NOV-RAM is not supposed to be linked to I/O variables underneath the "Inputs" or "Outputs" area of the device. Instead, an ADS command (e.g. from PLC) is used for direct writing of this persistent data to the NOV-RAM IC on the Fieldbus card. This means, the configured device has usually no variables underneath the "Inputs" and "Outputs" section in this case. Due to the technical habit of the NOV-RAM component, even cyclical data saving can be implemented.

The following picture shows an example of how to set up a Fieldbus card with NOV-RAM extension. However, the PCI address and other necessary device info is not configured properly in this example.



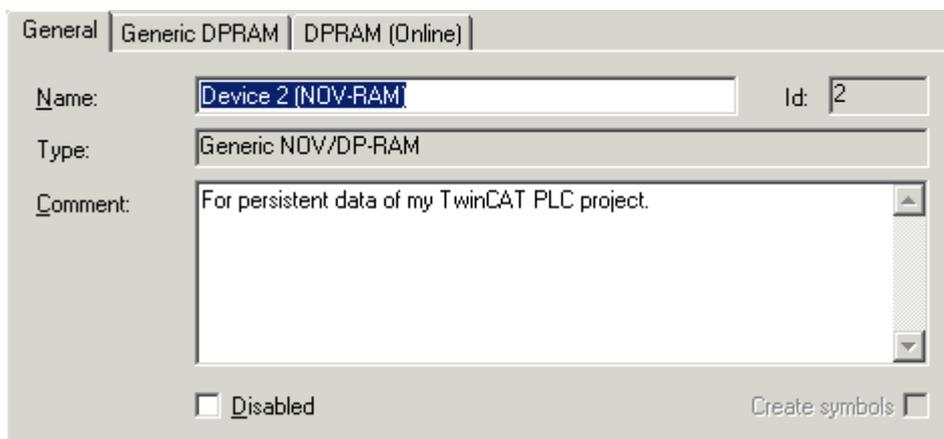
For the address and data length information to be entered here, please use the displayed data of the already configured fieldbus card (in the sample above "Device 1 (FC5201-0002)") or use the following button:

- **Search..:** With this button, the scan for PCI address corresponding to the Vendor ID, Device ID and Base Address of this card is started.

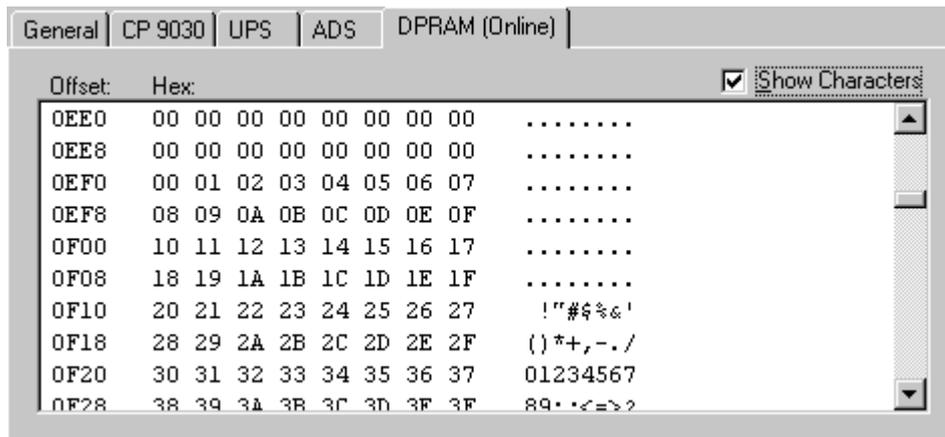
For additional details see the description of the various Beckhoff Fieldbus cards.

Access to the NOV-RAM via TwinCAT PLC Function Block:

With the help of the Function Block "FB_NovRamReadWrite", which is installed by default with the "TclIOFunctions.lib" library from TwinCAT v2.8 > Build 722, the NOVRAM IC can be read or written directly. Important is the device ID (in this sample it is ID 2, see *picture below*) of the NOV-RAM device inside the TwinCAT System Manager, which can also be read by name (see: IOF_GetDeviceIDByName). For details, see the documentation of the PLC library.



11.2.11.3.3 DPRAM [Online]



When the TwinCAT is active, the DPRAM of the current fieldbus card, resp. other devices with DPRAM interface, may be read-accessed directly for diagnosis purposes. For further details, please refer to the description of the card or the particular device.

11.2.11.4 System Management Bus (SMB)

Newer motherboards possess diagnostic modules via which the temperatures, fan speeds and operating voltages of the PCs can be monitored. These values can be read into TwinCAT with the aid of the "I/O Device" "Motherboard SMB (System Management Bus)". Unfortunately there are currently no unified standards via which these values are made available.

Supports newer motherboards with Intel chipsets. These generally provide access via the PCI-ISA-Bridge PII-X-4. Via the PCI-ISA bridge, access is gained to the register of diagnostic block and the SMB and thereby to the diagnostic data. Individual values can also be determined in the case of other chipsets (if they have, for example, a LM75 or compatible block). Therefore, tests are required to determine which values can be measured on a non-standard board.

The TwinCAT can currently generally recognize the following diagnostic IC's and interpret their data.

- LM78 (National) (e.g. on ASUS P2B-LS)
- LM78J (National) (e.g. on ASUS P2L97-DS board)
- [LM80 \[▶ 268\]](#) (National) (e.g. on QDI BrilliantX IS board)
- [LM85B or LM85C \[▶ 268\]](#) (e.g. on Intel's D865GLC or D865GBF board)
- [W83781D \[▶ 268\]](#) (Winbond) (e.g. on ASUS P2B and P2B-F boards)
- [W83782D \[▶ 268\]](#) (Winbond) (e.g. on some EPOX boards)
- [W83783S \[▶ 268\]](#) (Winbond) (e.g. on ABIT BE6 board)
- [W83627HF \[▶ 268\]](#) (Winbond) (e.g. on BECKHOFF **CB1050**, **CB1051**, **CB2050**, **CB2051**, **CB3051**, **CB3050**, **CB3053**, **CB5053**, EPOX EP-4B2A or EP-M845B board)
- [CX1020 / CX1030 \[▶ 268\]](#) diagnostic IC's (only hardware revision 2.0)

Temperature

All ICs belong to the LM78 family. The LM78 is the basic chip with which all other chips are compared. The Winbond ICs have no internal temperature sensor, in contrast to the LM78 ICs. The temperature is generally measured by the motherboard via the internal temperature sensor. The CPU temperature is measured either via a sensor below the CPU or via the Pentium thermal diode. Other temperature sensors can be connected to external connectors on the board. If the CPU temperature sensor is under the CPU a correction variable must be added to the measured temperature. This depends upon the size of the air gap between the CPU and the sensor. If the temperature is measured via the Pentium thermal diode, the measured value must also be corrected. This correction variable depends upon the type of thermal diode. If there is doubt concerning the measured values, the temperature values can generally be monitored in the BIOS set up.

Fan

All ICs possess inputs allowing the simultaneous measurement of the speed of three fans (LM80, 2 fans only) (CPU FAN, CHASSIS FAN and PWR FAN). The fans must be of a special type with tachometer outputs. These fans generally possess three connection leads. Depending upon the board, the CPU fan may be wired by the manufacturer to a different diagnostic IC input. In most cases, the inputs for two fans (CHASSIS FAN and PWR FAN) are present on the board as external connection pins.

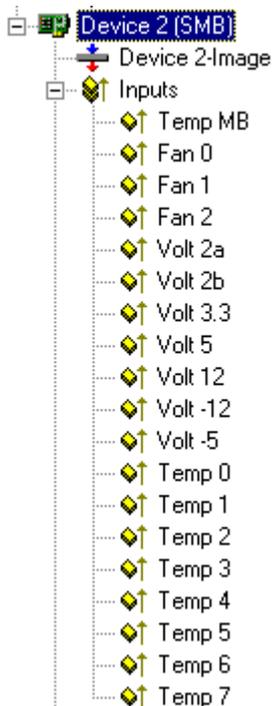
Voltages

The diagnostic ICs can measure positive and negative voltages via the analogue inputs. In general, the IC can measure a max. 4.096V at the input. To measure greater values, voltage divider can be connected upstream. The measured variable is calculated from the upstream resistances and the ADC value (Analogue Digital Converter).

The TwinCAT uses the suggested standard value given by the IC manufacturer as the resistance value for the voltage divider (find in the IC technical documentation). If a board manufacturer has wired other resistance values to the board, the measured values may vary from the real values. The correct voltages can be monitored in the BIOS set up.

Mapping the diagnostic data in the TwinCAT System Manager

The diagnostic data determined is mapped in the TwinCAT System Manager as follows:



Temperatures are given in °C.

The fan speeds are given in revolutions per minute.

The voltages are given in 1/100 volts. Negative voltages are given as positive values.

Winbond W83782D

Motherboard	EPOX EP-3BXA	
Variable	Hardware/connections description on the board	Comments
Temp MB	3TH THERMAL	Temperature of an external sensor. If this is not connected, the variable delivers the value 0. In BIOS this sensor has the description: "Extended JP2".
Fan 0	CPU FAN	CPU fan
Fan 1	CHASSIS FAN	Chassis fan
Fan 2	PWR FAN	Power supply fan
Volt 2a	Vccp1	Described as "Vcore" in BIOS
Volt 2b	Vtt	Described as "Vio" in BIOS
Volt 3.3	+3.3V voltage	
Volt 5	+5V voltage	
Volt 12	+12V voltage	
Volt -12	-12V voltage	
Volt -5	-5V voltage	
Temp 0	CPU temperature	Temperature at the Pentium thermal diode
Temp 1	RT1	Described as "System Temperature" in BIOS. A thermal sensor is located on the board (labelled RT1)
Temp 2 to Temp 7	not used	

Winbond W83627HF

Mother-board	BECKHFOF CB1050, CB1051, CB2050, CB2051, CB3051, CB3050, CB3053, CB5053		EPOX EP-4B2A		EPOX EP-M845B		EPOX IP-4GVI63		
	Variable	Hardware/ connection s description on the board	Comments	Hardware/ connection s description on the board	Comments	Hardware/ connection s description on the board	Comments	Hardware/ connection s description on the board	Comments
Temp MB	System board temperatur e	Thermal sensor located on the board near the CPU	not used		not used		not used		
Fan 0	FAN1		CPU FAN	CPU fan	Fan 3	In BIOS described as Chasis FAN	CHASIS	In BIOS described as Chasis FAN	
Fan 1	FAN2		CHASSIS FAN	Chassis fan	(CPU FAN) Fan 1	CPU fan	CPU	CPU fan	
Fan 2	FAN3		PWR FAN	Power supply fan	Fan 2	In BIOS described as Power FAN	PWR	In BIOS described as Power FAN	
Volt 2a	VCCCORE	Described as "CPU Core" in BIOS	Vccp1		Vccp1		Vagp	In BIOS described as Vagp	
Volt 2b	CS_VCCC ORE	Described as "GMCH Core" in BIOS	Vtt		Vtt		Vcore		
Volt 3.3	+3.3V voltage		+3.3V voltage		+3.3V voltage		+2.5V voltage!	In BIOS described as Vdimm	
Volt 5	+5V voltage		+5V voltage		+5V voltage		+5V voltage		
Volt 12	+12V voltage	³⁾	+12V voltage		+12V voltage		+12V voltage		
Volt -12	-12V voltage	¹⁾	-12V voltage		-12V voltage		-12V voltage		
Volt -5	-5V voltage	¹⁾	-5V voltage		-5V voltage		-5V voltage		
Temp 0	CPU temperatur e: MAX(core 1..core n)	²⁾	CPU temperatur e	Temperatur e at the Pentium thermal diode	CPU temperatur e	Temperatur e at the Pentium thermal diode	CPU temperatur e		
Temp 1	System DDR temperatur e	Thermal sensor located on the board near the memory slots	RT1	Described as "System Temperatur e" in BIOS. A thermal sensor is	TR1	Described as "System Temperatur e" in BIOS. A thermal sensor is	TR1	Described as "System Temperatur e" in BIOS. A thermal sensor is	

Mother-board	BECKHFOF CB1050, CB1051, CB2050, CB2051, CB3051, CB3050, CB3053, CB5053		EPOX EP-4B2A		EPOX EP-M845B		EPOX IP-4GVI63	
				located on the board (labelled RT1)		located on the board (labelled TR1)		located on the board (labelled TR1)
Temp 2	Power Controller Temp.	Supported only with BIOS v0.80 and higher	not used		not used		not used	
Temp 3 to 7	not used		not used		not used		not used	
	FAN4 can not be monitored. 1) Not supported by CB2051, CB3050, CB3051. 2) DTS (Digital Thermal Sensor). Supported by Core™ Duo/Core™2 Duo. MAX(core 1..core n) and Atom. Temperature at the Pentium thermal diode. 3) Not supported by CB3053, CB5053.				The EP-M845B board has 4 fan external connection pins. The Winbond IC allows only measurement of the speed of three fans. The fourth fan (Fan 4) can not be monitored!			

Winbond W83781D

Motherboard	ASUS P2B or P2B-F	
Variable	Hardware/connections description on the board	Comments
Temp MB	RT1S	Sensor on the board near the Winbond IC (system temperature)
Fan 0	CHA FAN	Chassis fan
Fan 1	CPU_FAN	CPU fan
Fan 2	PWR_FAN	Power supply fan
Volt 2a	Vccp1	
Volt 2b	Vccp2	
Volt 3.3	+3.3V voltage	
Volt 5	+5V voltage	
Volt 12	+12V voltage	
Volt -12	-12V voltage	
Volt -5	-5V voltage	
Temp 0	JTPWR	Connection for an external sensor for mains supply temperature
Temp 1	JTCPU	Connection for a sensor for the CPU chiller temperature
Temp 2 to Temp 7	not used	

LM80

Motherboard	QDI BrillantX IS	
Variable	Hardware/connections description on the board	Comments
Temp MB	Internal temperature sensor in the LM80 IC	Main board temperature
Fan 0	CHASFAN	Chassis fan
Fan 1	CPUFAN	CPU fan
Fan 2	not used	
Volt 2a	not used	
Volt 2b	+1,48V voltage	
Volt 3.3	+3.3V voltage	
Volt 5	+5V voltage	
Volt 12	+12V voltage	
Volt -12	-12V voltage	
Volt -5	-5V voltage	
Temp 0 to Temp 7	not used	

Winbond W83783S and LM75

Motherboard	ABIT BE6		BOSER HS-6237 Version 2.2		BOSER HS-6237 Version 3.0	
Variable	Hardware/connections description on the board	Comments	Hardware/connections description on the board	Comments	Hardware/connections description on the board	Comments
Temp MB	CON2	Connection for an external sensor for the CPU chiller temperature	not used		JP14	Temperature of an external sensor. If this is not connected, the variable delivers undefined value.
Fan 0	FAN2	Connection for a fan near the CPU	not used		CN2	In BIOS described as CPUFAN1 speed
Fan 1	FAN3	Connection for a fan near the ISA slot	not used		CN25	In BIOS described as CPUFAN2 speed
Fan 2	FAN1	Connection for a fan near the CPU	not used		CN26	In BIOS described as CPUFAN3 speed
Volt 2a	+2V voltage		not used		Vcore	
Volt 2b	not used		not used		not used	
Volt 3.3	+3.3V voltage		not used		+3.3V voltage	
Volt 5	+5V voltage		not used		+5V voltage	
Volt 12	+12V voltage		not used		+12V voltage	
Volt -12	-12V voltage		not used		-12V voltage	
Volt -5	not used		not used		not used	
Temp 0	RT1	System temperature. A thermal sensor is located on the board (labelled RT1)	CPU temperature	LM75 temperature sensor	CPU temperature	In BIOS described as CPU1 temperature To get the real CPU temperature add an offset of ~30°C to the read value! CPUtemp = TwinCATtemp + 30°C
Temp 1 to Temp 7	not used		not used		not used	

LM85B or LM85C

Important system requirements:

- The Intel(R) SMBus 2.0 Driver for the ICH5/ICH5-M SMBus Controller-24D3 should be installed and activated;
- Other monitoring applications (e.g Intel's Active Monitor) should be deactivated or deinstalled;
- The BIOS Option "Fan control" should be deactivated;

Motherboard		Intel D865GLC or D865GBF
Variable	Hardware/connections description on the board	Comments
Temp MB	Ambient temperature sensor (internal to hardware monitoring and fan control ASIC)	In BIOS described as "System Zone 1 Temperature".
Fan 0	CPU FAN	CPU fan
Fan 1	FRONT CHASIS FAN	
Fan 2	REAR CHASIS FAN	
Volt 2a	Vccp	In BIOS described as "Vccp"
Volt 2b	+1.5V voltage	In BIOS described as "+1.5Vin"
Volt 3.3	+3.3V voltage	
Volt 5	+5V voltage	
Volt 12	+12V voltage	
Volt -12	not used	
Volt -5	not used	
Temp 0	Thermal diode, located on processor die	Temperature on the Pentium Thermo-Diode. In BIOS described as "Processor Zone Temperature"
Temp 1	Remote ambient temperature sensor	In BIOS described as "System Zone 2 Temperature";
Temp 2 to Temp 7	not used	

Comment

If the variables Temp 0 or Temp 1 deliver a constant value 0xD0, there may be no external sensor connected to the board (open thermal input).

Winbond W83627HF + LM63

		Beckhoff CX1020 / CX1030
Variable	Hardware/connections description on the board	Comments
Temp MB	Board CX1021	Board temperature
Fan 0	FAN	reserved, not used
Fan 1	FAN	CX1030 only: CPU / Case fan else not used
Fan 2	FAN	reserved, not used
Volt 2a	CPU voltage	
Volt 2b	CPU voltage	
Volt 3.3	+3.3V voltage	
Volt 5	+5V voltage	
Volt 12	+12V voltage	
Volt -12	not used	
Volt -5	not used	
Temp 0	Board CX1021	Board temperature
Temp 1	not used	
Temp 2	Board CX1020 (LM63)	CPU temperature
Temp 3	Board CX1020 (LM63)	Board temperature
Temp 4 to Temp 7	not used	

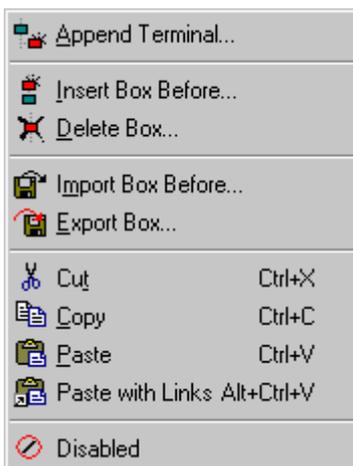
11.3 Boxes

11.3.1 Beckhoff Bus Coupler

The Beckhoff Bus Terminal system is an open Fieldbus-neutral periphery concept comprising electronic terminal blocks. The head of an electronic terminal block is the Bus Coupler with the interface to the Fieldbus. The following Field busses are currently supported via Beckhoff Bus Couplers under TwinCAT:

- [Beckhoff Lightbus \[► 299\]](#)
- [Profibus DP \[► 310\]](#)
- [Interbus \[► 315\]](#)
- [CANopen \[► 320\]](#)
- [DeviceNet \[► 336\]](#)
- [SERCOS Interface \[► 339\]](#)
- [Ethernet TCP/IP Interface \[► 348\]](#)
- [Real-Time Ethernet Interface \[► 348\]](#)
- [USB Interface \[► 376\]](#)
- Miscellaneous
 - [CX1100-BK \[► 295\]](#)

Context menu



Append Terminal ... <Insert>

Adds a Bus Terminal under the Bus Coupler. You will then see the dialogue displayed under [Terminal Selection Diagram \[► 106\]](#).

Insert Box Before...

Adds another box above the marked box.

Delete Box...

Deletes the marked box and its sub-elements from the I/O configuration.

Import Box Before...

Adds another box above the marked box. The description of the new box and its sub-elements are read from a file with the suffix "*.tce". This file is created with the following menu option.

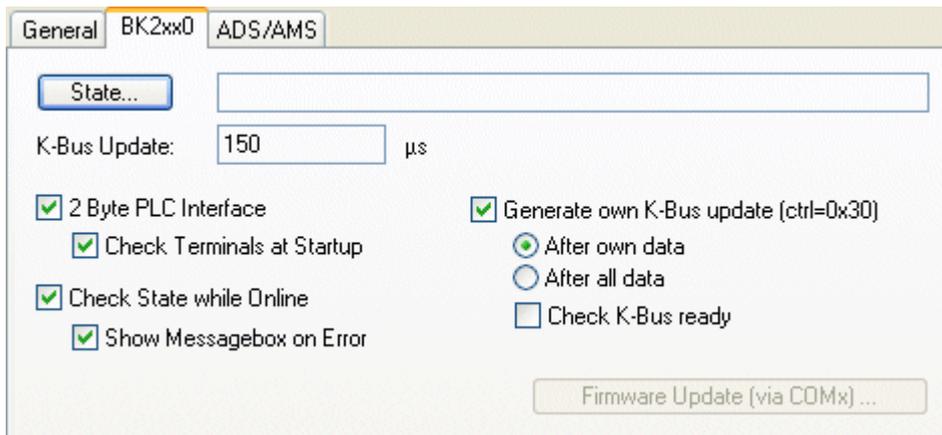
Export Box...

Exports the information from the selected box and the information about its sub-elements into a file with the suffix "*.ioe".

11.3.1.1 BK20x0 (Lightbus)

The Bus Couplers BK20x0 and Bus Terminal Controller BC2000 are used for Beckhoff Lightbus. Those specific properties which distinguish them from other Bus Couplers are described below. For an [Overview \[► 299\]](#) of all currently supported Lightbus Bus Couplers BK2xx0, *please see [► 299]*...

"BK2xx0" tab



2 Byte PLC interface: Once selected, one input and output variable for each 2-byte PLC interface is inserted below the coupler.

Check Terminals at StartUp: If you select this option (available only when the 2-byte PLC interface is active), compares the configured terminals with those physically present on the coupler during the system StartUp phase. If differences are detected, the system StartUp will be cancelled with a corresponding message.

Check State while Online: If selected, the status byte for the Bus Coupler (Address =0xFF) is evaluated and a corresponding logger entry is created if errors occur.

Show MessageBox on Error: If selected (only possible when online status checking is activated), any errors are logged, and a message box is opened.

Generate own K-Bus update: You can influence the terminal bus update. If this update is not carried out via a [C1220 \[► 135\]](#) broadcast, it must carry out its own K-Bus update (standard).

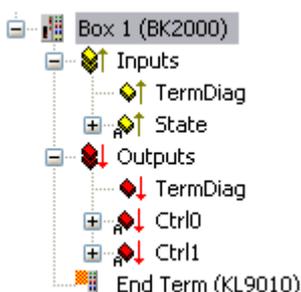
After own Data: The update takes place directly after transmission of its own data.

After All Data: The update takes place in the current CDL after all data has been transmitted.

Check K-Bus ready: Check if the K-Bus is ready.

Diagnostic Inputs and Outputs

Each BK2xx0 Bus Coupler has input and output bytes available for diagnostic and settings purposes:

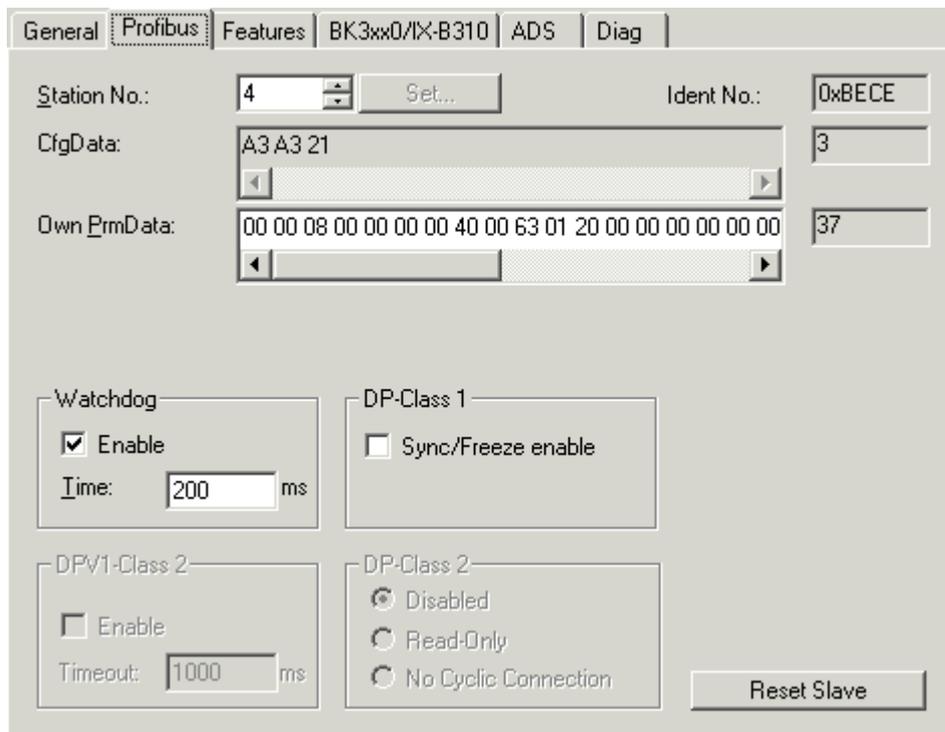


Inputs	Description
TermDiag	See also BK2000 manual
	Bit 0-7 = Terminal No
	Bit 8-9 = Channel No
	Bit 10-11 = Diag Code
	Bit 12-14 = Diag Code Ex
	Bit 15 = Fail
State	Content of the first byte of the word 255 from the process image of the Bus Coupler (see BK2000 manual).
	Bit 0 = Command Err
	Bit 1 = Input Data Err
	Bit 2 = Output Data Err
	Bit 3 = Timeout
	Bit 4 = K-Bus Reset Failure
	Bit 6 = K-Bus Overrun (no function at BK2000)
Outputs	Description
TermDiag	See BK2000 manual
Ctrl0	Content of the first byte of the word 254 from the process image of the Bus Coupler (see BK2000 manual).
Ctrl1	Ctrl1: Content of the second byte of the word 254 from the process image of the Bus Coupler (see BK2000 manual).

11.3.1.2 BK3xx0/BC3100 (Profibus)

The BK3xx0 Bus Coupler and the BC3100 Bus Controller are used for **Profibus**. Those specific properties which distinguish them from other Bus Couplers are described below. For an [Overview \[▶ 310\]](#) of currently supported Profibus Bus Couplers BK3xx0, ...see [\[▶ 310\]](#)

"Profibus" tab



Stations No.: Each Profibus device requires a unique station number.

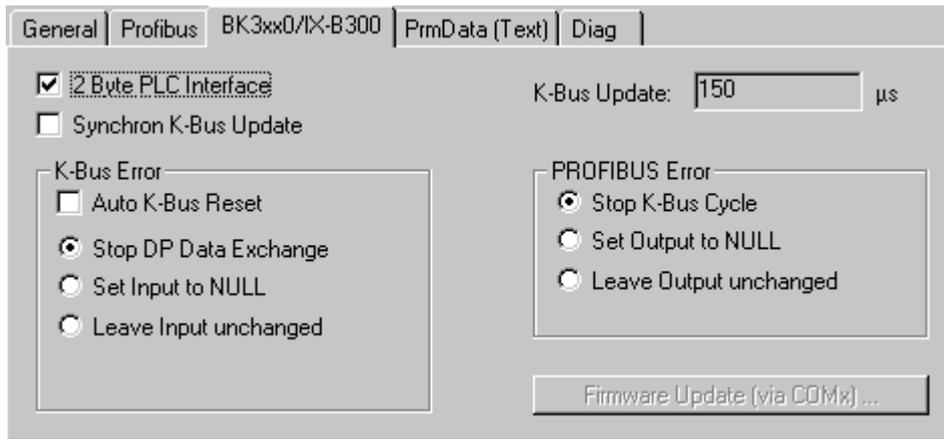
Watchdog: Switches on a watchdog function. The time (in ms) can be set when communication monitoring is actuated. The communication monitoring period should be at least 6 x greater than the cycle time. The minimum value is 10 ms.

PrmData: Allows you to edit the Profibus-specific parameter data (-> BK3xx0 Bus Coupler documentation). The size of the current parameter data is displayed. The PrmData can be entered either in text form (-> PrmData (text)) or occasionally via tabs "BK3xx0 / BC3x00".

CfgData: Displays the current configuration data (produced based on added terminals) and their lengths.

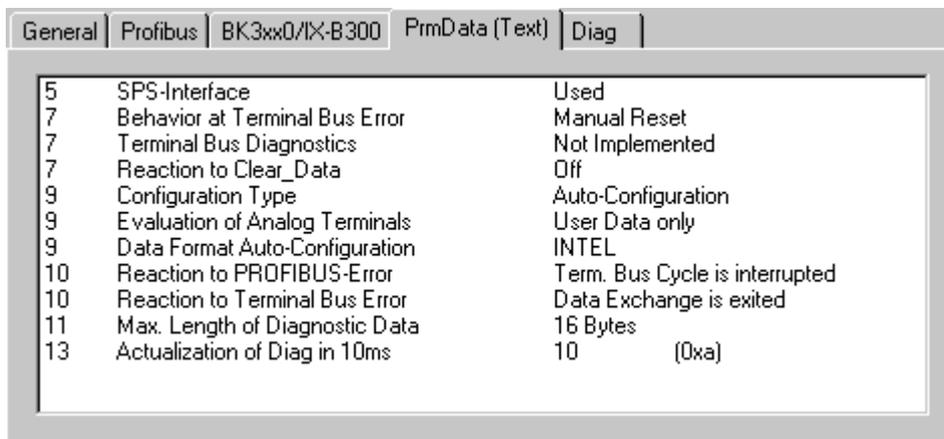
The settings **DP class 1, DP class 2, DPV1 class 2, Set and Reset slave** are only activated for FC310x (-> [PROFIBUS DP slaves at FC310x](#))

"BK3xx0 / BC3x00" tab



2 Byte PLC interface: Switches on the 2-byte PLC coupler interface. Register settings in the coupler are then carried out by, e.g. the PLC.

"PrmData (text)" tab



Click on a line to change the current value.

Diagnostic

The diagnosis for the PROFIBUS DP slaves at the FC310x is described in a separate section. The diagnosis for other I/O devices is described below.

Input Diagnosis



Each Profibus slave box contains two diagnostic input bytes which signal the state of each slave during the running time, and which can be linked, for example with the PLC.

Table 8: BoxState

Value	Description
0	No Error
1	Error - more precise description in DpState

Table 9: DpState

Value	Description
0	No Error - station is exchanging data
1	Station deactivated - slave has been deactivated, temporary state during StartUp
2	Station not exists - slave does not reply on the bus -> check whether slave is switched on, whether PROFIBUS plug is in, correct station address or bus cables
3	Master lock - slave is exchanging data with another master -> remove other master from bus or release slave again by other master
4	Invalid slave response - incorrect answer from slave, occurs temporarily if slave has ceased data exchange because of a local event
5	Parameter fault - check whether Bus Coupler / GSD file is correct, that station address is correct or that UserPrmData settings are correct
6	Not supported - DP function is not supported -> check whether GSD file is correct or whether station address is correct
7	Config fault – configuration fault -> check whether the added terminals / modules are correct
8	Station not ready -> station starting up, temporarily displayed during StartUp
9	Static diagnosis - slave signalling static diagnosis and cannot deliver valid data at present -> check operating state at the slave

PROFIBUS Diagnostic Data

The Profibus diagnostic data sent by a PROFIBUS slave can be read by any TwinCAT program via ADS and/or signalled to any TwinCAT program. In this case, set ADS parameters as follows:

Net-ID: PC Net ID.

Port: 300

IndexGroup: 0x5000 + Device-ID

IndexOffset: Hi-Word: Station Address, Lo Word: 0x100

Length: 6 - 244

The diagnostic data are structured as described in the DP standard.

11.3.1.3 BK40x0 (Interbus)

The BK40x0 Bus Couplers are used for **InterBus**. Those specific properties which distinguish them from other Bus Couplers are described below. For an Overview [▶ 315] of currently supported Interbus Bus Couplers BK4xx0, ...see [▶ 315]

"BK4xx0" tab

General		BK4xx0	
Ident. Code:	<input type="text" value="0x00"/>	<input type="checkbox"/> Diagnosis	<input type="checkbox"/> 2 Byte PLC Interface
Length Code:	<input type="text" value="12 (1 Bit)"/>	Group:	<input type="text" value="none"/>
Bus Level:	<input type="text" value="0"/>	Alternative:	<input type="text" value="none"/>
Log. Number:	<input type="text" value="1.0"/>	Data Consistent:	<input type="text" value="16 Bit"/>
K-Bus Update:	<input type="text" value="150"/> μ s	Startup (CAC)	
		<input checked="" type="radio"/> Default <input type="radio"/> Segment Off <input type="radio"/> Segment On	

Identity Code: Displays the identity code for the Bus Coupler. It is calculated dynamically - according to the connected terminals.

Length Code: Displays the length code for the Bus Coupler. It is calculated dynamically - according to the connected terminals.

Installation depth: Displays the installation depth of the Bus Coupler. It is calculated dynamically - according to the hierarchical structure of the InterBus-S.

Diagnostic: Inserts two bytes of diagnostic data into the process image per input and output (see BK4000 manual).

2 Byte PLC interface: Inserts two bytes of PLC interface into the input and output process image

Input Diagnosis



Each InterBus-S box contains one diagnostic input byte which signals the status of the current slave during the running time and can be linked, for example with the PLC.

Variable	Value	Description
BoxState	0x01	Rec: Reconfiguration
	0x02	Mod: Module error
	0x04	W2Err: Error at the W2 interface
	0x08	W1Err: Error at the W1 interface
	0x10	W2: W2 interface inactive
	0x20	W1: W1 interface inactive

11.3.1.4 BK51x0/LC5100/IPxxxx-B510 (CANopen)

The BK51x0 Bus Coupler and the IPxxx-B510 fieldbus box are installed in the **CANopen** bus. Those specific properties which distinguish them from other Bus Couplers and/or Fieldbus Box modules are described below. For an [Overview \[► 320\]](#) of currently supported CANopen Bus Couplers BK51x0, [see \[► 320\]](#)...

"BK51x0/IX-B510" tab

Node Id: Sets the node ID of the CAN bus device (between 1 and 63 (BK51x0) and/or 1 and 99 (IPxxxx-B510)). This value must comply with the value set at the Bus Coupler and/or at the compact box.

Guard time: Cycle time for the node monitoring (node guarding).

Life time factor: Guard time multiplied produces the watchdog time for the monitoring of the master by the coupler (life guarding). Life guarding is deactivated if the lifetime factor is set to zero.

Inhibit time: Displays the minimum send interval for PDOs (telegrams) with analogue and special signals. If more than digital 64 signals are present, these are also provided with this [Inhibit Time](#) [► 386].

Event Time: Sets the Event Timer Value for Transmit PDOs. The expiration of this timer is regarded as additional event for the corresponding PDO. Thus, the PDO is being sent. If the application event occurs during the event timer period, the PDO is sent as well, and the timer is reset.

K-Bus Update: Calculates the anticipated duration of a complete update of the terminal bus (according to type and number of connected terminals).

Trans.Type: Gives the [Transmission Type](#) [► 385] for digital / analogue input telegrams. 254 + 255 corresponds to the event-driven transfer, 1 ... 240 are synchronous transfer types. For further details see also BK51X0 manual.

Firmware Update: Enables the updating of the coupler firmware via the serial interface (requires KS2000 software package interface cable).

Input Diagnosis

FC510x: Each CANopen fieldbus box node contains one diagnostic input byte ([Node State](#) [► 178]), which signals the status of the current slave during the running time and can be linked, for example with the PLC. In addition a signal is sent via the "Diag Flag" bit informing as to whether the card contains new [Diagnostic Information](#) [► 174]. This can then be read off using ADS READ.

[CIF30-CAN](#) [► 182]: Each CANopen fieldbus box node contains one diagnostic input byte ([Box State](#) [► 182]), which signals the status of the current slave during the running time and can be linked, for example with the PLC. In addition there is a further bit "DataExchange", which indicates whether the node is exchanging data.

"SDOs" tab

Obj. idx	Sub. idx	Length	Value (dec)	Value (hex)
<0x1400>	2	1	255	0xFF
<0x1401>	2	1	255	0xFF
<0x1401>	3	2	0	0x0
<0x1800>	2	1	255	0xFF
<0x1801>	2	1	255	0xFF
<0x1801>	3	2	0	0x0
<0x5500>	0	4	4294901760	0xFFFF0000
<0x6423>	0	1	1	0x1

Append... Insert... Delete... Edit...

SDO inputs sent to the node at StartUp are displayed/managed on this page. Inputs with an object index in straight brackets are automatically created based on the updated terminal configuration. Other inputs can be managed using "Add", "Insert", "Delete" and "Edit".

"ADS" tab

In order to be able to read and write SDO objects during the running time (e.g. from the PLC), the node (Bus Coupler) can be allocated an ADS port (CIFx0-CAN). The FC510x always provides an ADS port for every node since the diagnostic information is transported via ADS. These ports can be used to read and write SDO objects using ADS read requests and/or write requests.

The ADS IndexGroup contains the CANopen object index and the ADS IndexOffset contains the CANopen SubIndex.

CANopen Emergency Object

Some CANopen status data and emergency objects received from a node can be read by any TwinCAT program via ADS and/or signalled to any TwinCAT program. The data structures and addresses distinguish between the FC510x and the CIFx0-CAN.

11.3.1.5 BK52x0/LC5200 (DeviceNet)

The BK52x0 Bus Coupler is used for **DeviceNet**. Those specific properties which distinguish them from other Bus Couplers are described below. For an [Overview \[▶ 336\]](#) of all currently supported DeviceNet Bus Couplers BK52x0, *please see [▶ 336]...*

"BK52x0" tab

MAC Id: Sets the node ID of the DeviceNet participant (between 0 and 63). This value must comply with the value set at the Bus Coupler.

Cycle Time: Sets the cycle time for the IO connection. This value is added to the Expected Packet Rate (EPR) attributes of the DeviceNet slave and acts as a timeout monitor for IO connections.

Electronic Key: Serves to check the devices within the network at the system StartUp. The electronic key is read from the devices at every system StartUp and compared with the saved configuration.

Polled: Produced/Consumed: Activation of the "Polling" operating mode, cyclical writing and reading of IO data. Setting of the data content of the data transmitted via the polled IO connections. You can choose from digital data, analogue data or both. The selection depends upon the BK52xx terminal arrangement.

Bit-Strobed: Produced/Consumed: Activation of the "Bit Strobe" Operating Mode. With a broadcast message all nodes are requested to send their bit strobe message (up to 7 bytes input or status data). Setting of the data content of the data transmitted via the bit-strobed IO connections. You can choose between digital data or diagnostic data.

Change of State / Cyclic:

- Produced/Consumed: Setting of the data content of the data transmitted via the change of state/cyclical IO connections. You can choose from digital data, analogue data or both. The selection depends upon the BK52xx terminal arrangement.

- Change of State / Cyclic: Selecting the Corresponding Operating Mode

- Heartbeat Rate / Scan Rate: In the "Change of State" mode the heartbeat rate gives the cycle time of the cyclical send of the lower-level (i.e. in addition to the event driven) IO data. In the "Cyclic" operating mode the scan rate gives the cycle time of the IO data send.

Inhibit time: Delay period in the "Change of State" operating mode inserts this pre-set delay period after a change of state before the IO data send.

Acknowledge Timeout: Time before the re-send in the event of faulty acknowledgement of a change of state / cyclical message.

Acknowledge Retry Limit: Maximum number of re-sends until IO connection goes into error mode.

K-Bus Update: Calculates the anticipated duration of a complete update of the terminal bus (according to the number of connected terminals).

Input Diagnosis:



Each DeviceNet fieldbus node contains one diagnostic input byte which signals the status of the current slave during the running time and can be linked, for example with the PLC.

Table 10: CouplerState

Error Code	Description	Troubleshooting
0x00	No error	
0x01	IO Error Data exchange between coupler and terminals has faulted	Check the IO error LEDs at the coupler, see error code in coupler manual
0x02	Coupler configuration error, devices non-volatile parameters are not valid	Set Manufacturers Setting e.g. with KS2000 or via register communication and reset coupler
0x08	Diagnoses of analog terminals, this feature has first to be activated via KS200 or register communication	Read the terminal diagnoses via explicite messages or via the Bit-Strobe Connection. The Bit is reseted after reading of the diagnosis data
0x80	Fieldbus Error / Idle Mode	Check Communication Parameter of the IO Connections. Send correct IO data, Check if the Device is in the Idle mode. The bit is reseted if the device receives valid IO data

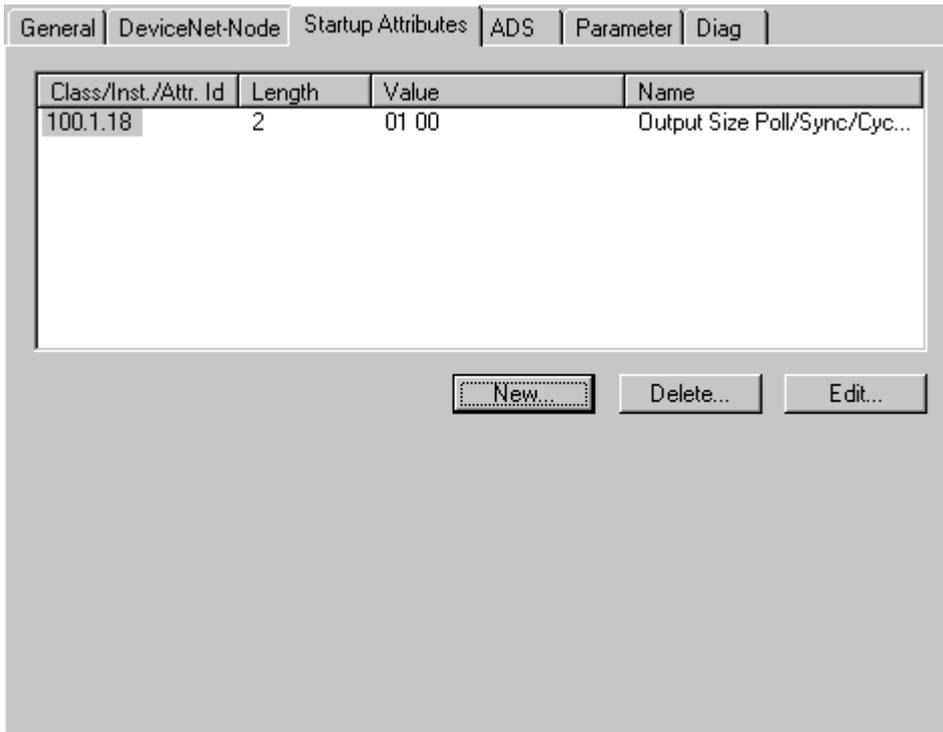
Table 11: BoxState

Error Code	Description	Troubleshooting
0x02	Station not exists, device is not responding	Inspect the device, verify connections, check cabling
0x05	Parameter fault	Check explicite access to devices attributes, check object class, instance and attribute id
0x07	Configuration fault	Check configuration settings of device
0x09	Device is deactivated	Check master and device configuration

Table 12: DataExchange

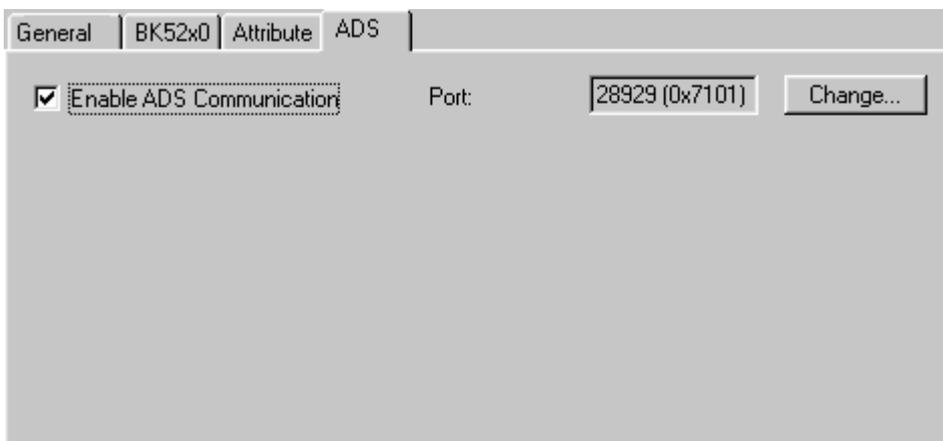
Error Code	Description	Troubleshooting
0x00	No data exchange between node and master	Inspect the field device, verify connections, check cabling
0x01	Data Exchange is active	

"Attributes" tab



DeviceNet attributes/parameters sent to the node at StartUp are displayed/managed on this page. Other inputs can be managed using "New", "Delete" and "Edit".

"ADS" tab



In order to be able to read and write attributes during the running time (e.g. from the PLC), the node (Bus Coupler) can be allocated an ADS port. These can be used to read / write attributes via ADS read requests / ADS write requests.

The ADS IndexGroup contains the ClassId and the ADS IndexOffset contains InstancelId and AttributeId (InstancelId * 256 + AttributeId).

Diagnostic data

The DeviceNet status data from a node can be read by any TwinCAT program via ADS and/or signalled to any TwinCAT program.

"Parameter" tab

Num	Name	Flags	Value
1	Input Size Poll Mode	ur	0 (0x0) Byte
2	Input Size Bit Strobe Mode	ur	0 (0x0) Byte
3	Input Size COS/Cyclic Mode	ur	0 (0x0) Byte
4	Output Size Poll/COS/Cyc Mode	ur	0 (0x0) Byte
5	FB Box Status	urm	0x0
6	Table No.	u	Table 0: FB Box configuration
7	Register No.	u	0 (0x0)
8	Get Register data+status	ur	0 (0x0)
9	Set Register data	u	0 (0x0)
10	Value Input 1	ur	OFF
11	Value Input 2	ur	OFF
12	Value Input 3	ur	OFF
13	Value Input 4	ur	OFF

Flags: u = unknown value; default value displayed, r = read only
m = possibly modified by device in real time, * = modified by user

Write Read Set Default Select All

Copy to Startup Attributes All

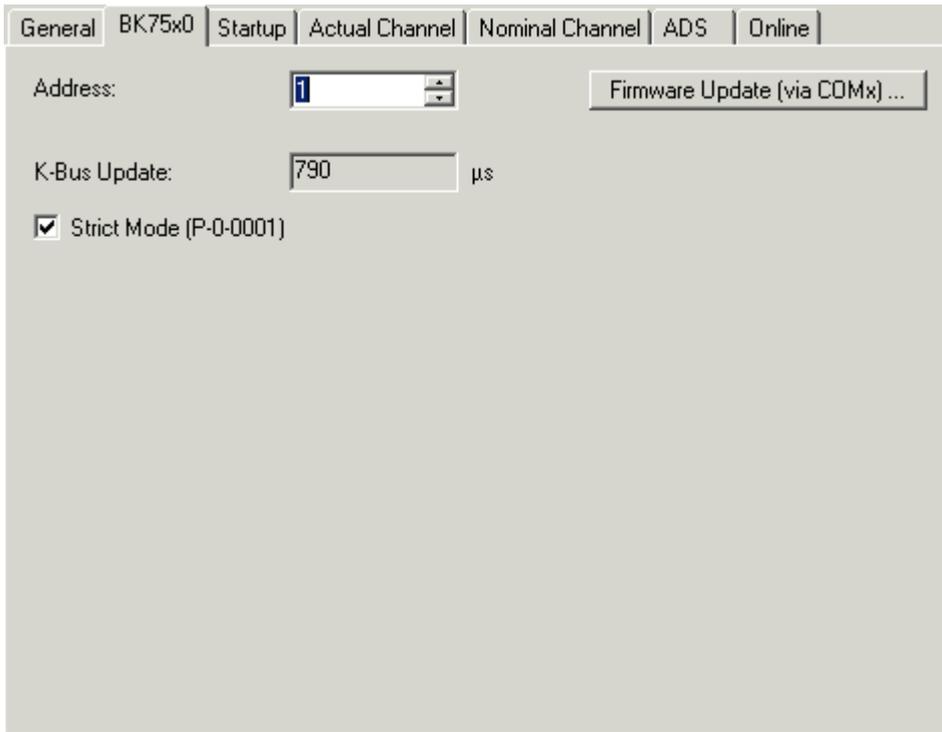
The parameters are read from the EDS when creating the box. If the system has not started up yet, the EDS default value is always displayed under the value input.

11.3.1.6 BK7500 (SERCOS interface)

The BK7500 Bus Coupler is used for controllers with **SERCOS interface**. Those specific properties which distinguish them from other Bus Couplers are described below.

The coupler has been designed according to the SERCOS I/O specification and generates corresponding I/O data channels that can be addressed via IDNs. It should therefore be possible to use it with any controller that conforms to the SERCOS interface. For an [Overview \[► 339\]](#) of all currently supported SERCOS Bus Couplers BK75x0, [please see \[► 339\]](#)...

"BK75x0" tab



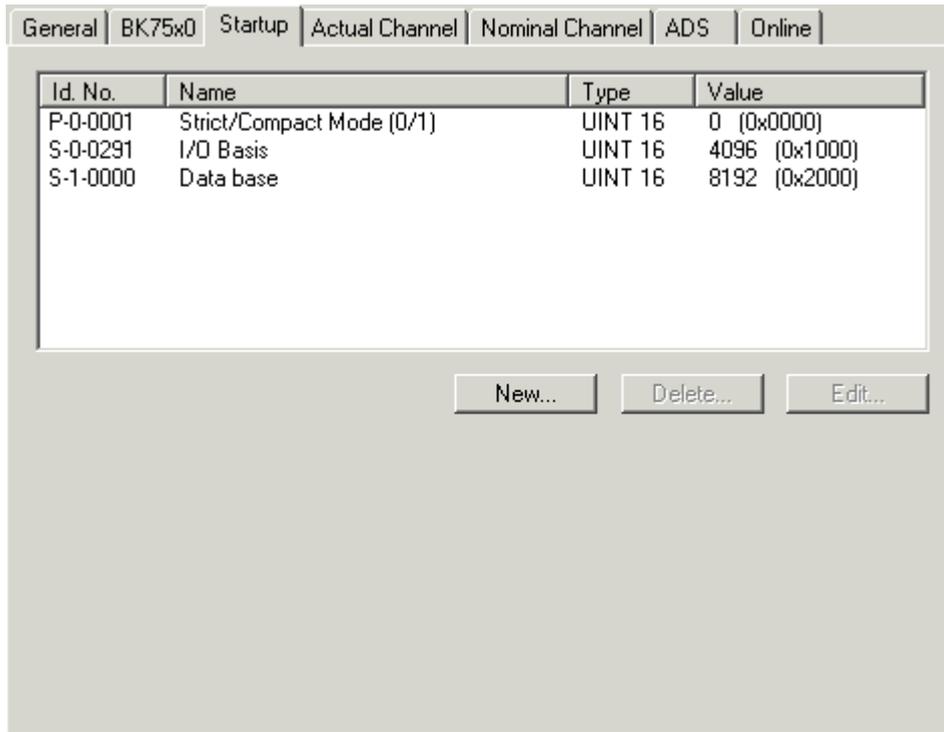
The screenshot shows a software interface with several tabs: General, BK75x0, Startup, Actual Channel, Nominal Channel, ADS, and Online. The 'BK75x0' tab is selected, and the 'General' sub-tab is active. The 'Address' field is set to 1, and the 'K-Bus Update' field is set to 790 μs. The 'Strict Mode (P-0-0001)' checkbox is checked. A 'Firmware Update (via COMx) ...' button is visible.

Address: This is used to set the Sercos address with which the coupler announces its presence on the bus.

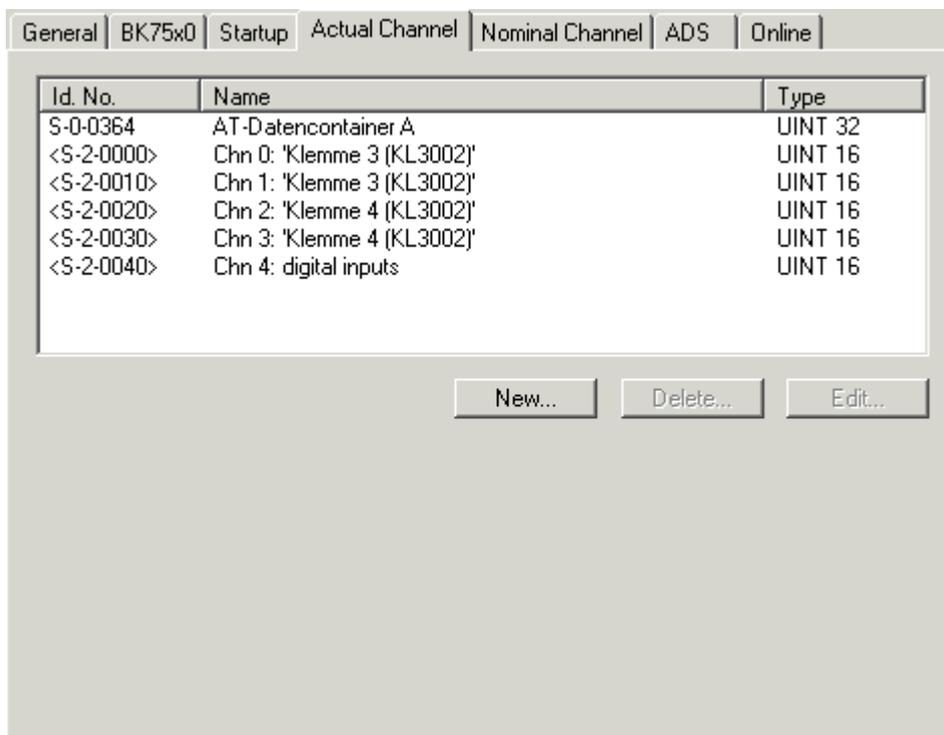
K-Bus Update: Knowing the attached terminals, the estimated K-Bus run-time is calculated and given.

Strict Mode: The manufacturer-specific parameter P-0-0001 can be used to specify whether the I/O data channels are to be allocated in strict accordance with the Sercos I/O specification, or whether a variation that saves IDNs should be used, since some controllers can only handle a limited number of IDNs in the Master Data Telegram (MDT) or Drive Telegram (AT). The checkbox on this tab only displays the selected mode. It can be modified on the next tab, under Startup, because this parameter is communicated at each start-up (change from phase 2 to phase 3), and the I/O data channels are then assigned accordingly.

Firmware Update....: The coupler's firmware can be updated by means of what is known as a KS2000 cable.

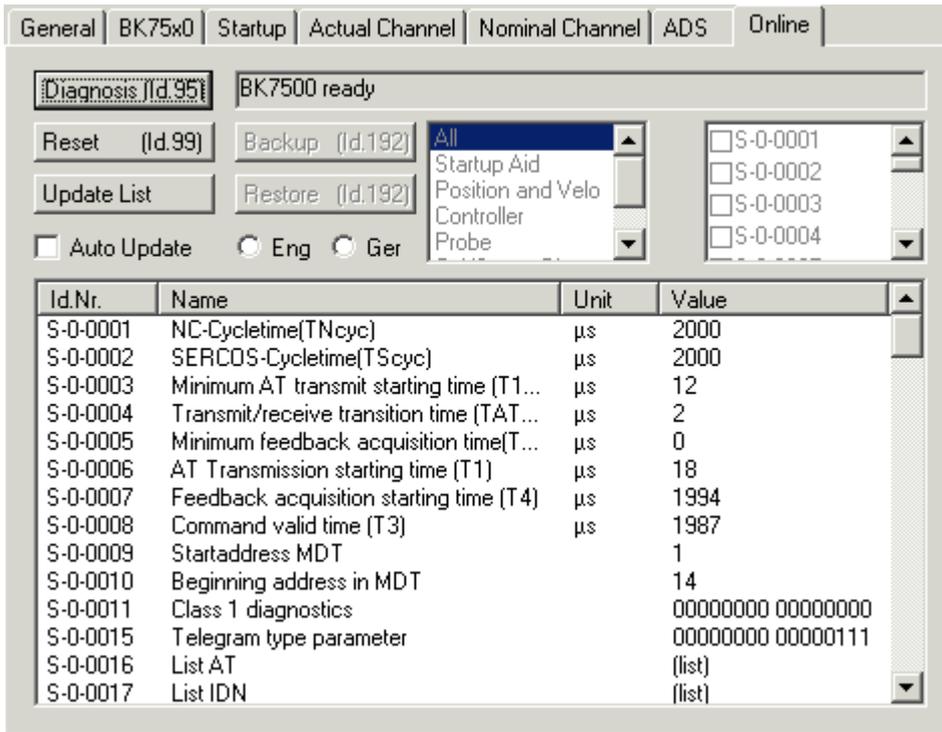
"Startup" tab

Any IDNs can be given (2 and 4 byte values) on the "Startup" file tab, and these are sent to the coupler at the change from phase 2 to phase 3. Further values can be added or deleted here.

"Actual-/Nominal Channel" tab

Both the coupler and the TwinCAT System Manager calculate the assignment of the I/O data channels in the light of the connected terminals. The value in P-0-0001, which should normally always be included in the start-up parameters, is considered here, so that both the coupler and the System Manager calculate according to the same rules. The calculated I/O data channels are included in the AT's list of IDNs (S-0-0016, actual channel), or that of the MDT (S-0-0024, nominal channel). In addition to the automatically generated entries, further IDNs can be included in the AT and MDT (as shown in the diagram of the IDN S-0-0364).

"Online" tab



Read and write access to all the coupler's IDNs is possible through the Online tab at run-time from phase 2 onwards.

11.3.1.7 BK9000 (Ethernet Interface)

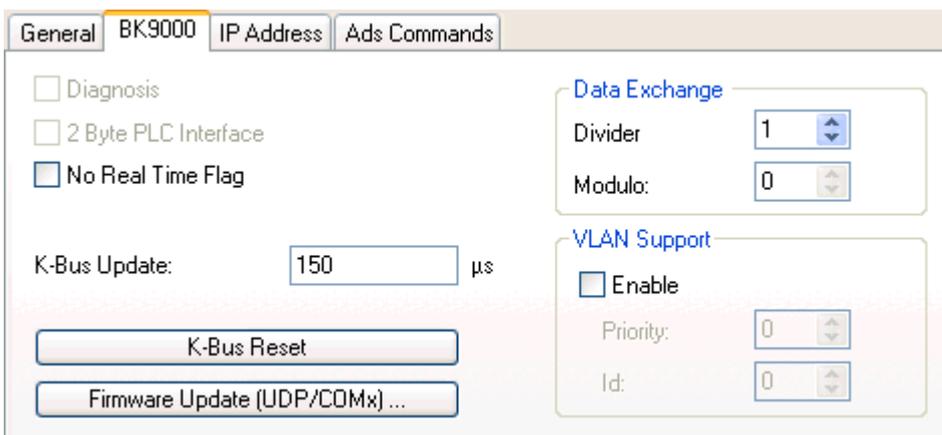
The Beckhoff BK9000 Bus Coupler can be configured in TwinCAT below a "Virtual Ethernet Interface" [▶ 241] or Ethernet Miniport (real-time) I/O device. In reference to the last which is available since TwinCAT v 2.9 is released, an introduction can be found under: Introduction of TwinCAT Real-Time Ethernet.

The following description explains the differences between a BK9000 and other Beckhoff Bus Couplers. The Ethernet coupler communicates in non-real-time applications via TCP/IP or UDP (and ADS as the *Application Layer* on top of it) with TwinCAT. For an Overview [▶ 348] of all currently supported Bus Couplers BK90x0 for **Virtual Ethernet Interface**, please see [▶ 348]...

For an Overview of all currently supported Bus Couplers BK90x0 for **Ethernet Miniport (real-time)**, please ...see

Hint: If Real-Time Ethernet and "normal" Ethernet are both used on the same system with two different network adapters, the subnet addresses of these adapters (NICs) must differ! The BK9000 must be configured with the same subnet address as the Ethernet Miniport adapter, of course (first two quadruples).

"BK9000" Tab



Diagnosis: This checkbox is deactivated for the BK9000.

2 Byte PLC Interface: This checkbox is deactivated for the BK9000.

No Real time Flag: If unchecked, the BK9000 bypasses at all incoming Ethernet frames its internal TCP/IP stack (default if used with Beckhoff TwinCAT Real-Time Ethernet in [Run Mode \[► 131\]](#)). If, i.e. for configuration purposes in [Config Mode \[► 131\]](#) sessions the TCP/IP part has to be enabled, this flag may be activated.

K-Bus Update: According to the attached Bus Terminals, the estimated K-Bus update time is calculated and displayed here.

Firmware Update: The firmware update dialog is called by pushing this button. With this function, the most recent firmware version for the BK9000 can be loaded to this device (via LAN or COM port).

Data Exchange: The data exchange with devices can be adapted to their local K-Bus update time and related application. The following description is based on the fact, that the I/O driver resolves an internal cycle counter which is always present.

Scenario: A network contains two Bus Couplers. One Coupler (A) has only a few digital Bus Terminals attached and needs to be updated fast. Another Coupler (B) has analog Bus Terminals and doesn't need to get updated that fast. In that case, at Bus Coupler (B) the

- **Divider:** would be set e.g. to '4' to force the I/O system to only exchange data with this device in every 4th I/O cycle

and the

- **Modulo:** factor takes care (in the above case it can be set to value between 0..3) that (B) doesn't get an update in the same cycle (A) gets it.

VLAN Support:

- **Enable:** Activates the VLAN support (see: *IEEE 802.1Q, RFC3518*) for the communication with this device. If enabled, the Ethernet frame is getting extended by 4 byte. This extension is called VLAN tag and contains information about ID and priority for instance
- **Priority:** A 3 bit VLAN priority value as defined by *IEEE 802.1D*. Most switches contain two queues, a high and a low priority one. Therefore priorities between 0..3 are assigned to the high priority queue and 4..7 are assigned to the low priority queue at those switch types.
- **Id:** 12 bit VLAN identifier number as defined by *IEEE 802.1Q*.

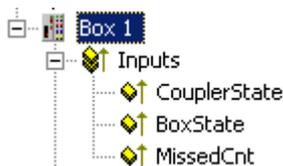
"IP Address" Tab

For further information about this tab, see -> ["IP Address" Tab \[► 298\]](#).

"ADS Commands" Tab

For further information about this tab, see -> ["ADS Command Window \[► 51\]"](#).

Diagnosis Inputs:



Each fieldbus module contains status information which can be linked to TwinCAT (e.g. to to TwinCAT PLC). This status information are mostly identical at all Beckhoff fieldbus nodes (see *CouplerState*, *MissedCnt*) and are described under -> ["Status Information - Beckhoff Fieldbus nodes \[► 298\]"](#). Only the input variable *BoxState* is specific. This variable can contain the values which are described inside the below table. Additionally, each variable status is listed in the corresponding ["Comment" field \[► 37\]](#).

Table 13: Variable "BoxState" at BK9000 couplers underneath a Virtual Ethernet Interface device:Virtual Ethernet Interface

Variable	Data Type	Value	Description
BoxState	UINT16	0x0000	No error
		0x0001	No new Input information
		0x0002	Outputs disabled (only with UDP [▶ 298])
		0xnn00	nn = current warning level (only with UDP [▶ 298])

NOTICE

The ("[cycle ticks \[▶ 62\]](#)") task time for the respective task should be selected to be so high that the value displayed at [MissedCnt \[▶ 298\]](#) is always constant. In the event of doubt, it is better to select a slightly higher cycle time.

Example:

Minimum cycle time with selected protocol [UDP \[▶ 298\]](#): 30 ms

Minimum cycle time with selected protocol [TCP \[▶ 298\]](#): 50 ms

Table 14: Variable "BoxState" at BK9000 couplers within an Ethernet Miniport (real-time) subnet:Ethernet Miniport (real-time)

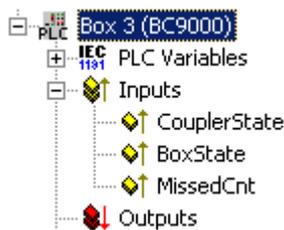
Variable	Data type	Value	Description
BoxState	UINT16	0x0000	No error
		0x0001	No inputs received
		0x0002	Outputs disabled
		0x0004	No communication
		0x0008	Old inputs
		0x0010	Invalid input length (configured input process variables don't match attached bus terminals)
		0x0020	Invalid output length (configured output process variables don't match attached bus terminals)

11.3.1.8 BC9000 (Ethernet Interface)

The Beckhoff BC9000 Bus Terminal Controller is to be configured in TwinCAT under a "Virtual Ethernet Interface". [\[▶ 241\]](#) The following description explains the differences between the BC9000 and other Bus Couplers or Bus Terminal Controllers.

The Ethernet Bus Terminal Controller communicates via TCP/IP or UDP (and [ADS](#) as the *Application Layer* on top of it) with TwinCAT. For an [Overview \[▶ 348\]](#) of all currently supported Ethernet Bus Terminal Controllers, *please see [▶ 348]*...

Diagnosis Inputs:



The directly below the Buserminal Controller listed *PLC Variables* are described under "[Data Exchange PC / Bus Terminal Controller \[▶ 112\]](#)".

Each fieldbus module contains status information which can be linked to TwinCAT (e.g. to TwinCAT PLC). These status information are mostly identical at all Beckhoff fieldbus nodes (see *CouplerState*, *MissedCnt*) and are described under -> "[Status Information - Beckhoff Fieldbus nodes \[► 298\]](#)". Only the input variable *BoxState* is specific and therefore described below. This variable can contain following values, which are described inside the below table. Additionally, each variable status is listed in the corresponding "[Comment](#)" field [[► 37](#)].

Variable	Data Type	Value	Description
BoxState	UINT16	0x0000	No error
		0x0001	No new Input information
		0x0002	Outputs disabled (only with UDP [► 298])
		0xnn00	nn = current warning level (only with UDP [► 298])

"Bx9000" Tab

The screenshot shows the configuration interface for the 'Bx9000' module. At the top, there are four tabs: 'Allgemein', 'Bx9000', 'IP Address', and 'Ads Commands'. The 'Bx9000' tab is selected. Under the 'Allgemein' sub-tab, there are two checkboxes: 'Diagnosis' and '2 Byte PLC Interface', both of which are unchecked. Below these, there is a label 'K-Bus Update:' followed by a text input field containing the value '150' and the unit 'µs'.

Diagnosis: This checkbox is deactivated for the BC9000.

2 Byte PLC Interface: This checkbox is deactivated for the BC9000.

K-Bus Update: According to the attached Bus Terminals, the estimated K-Bus update time is calculated and displayed here.

"PLC" Tab

For information about this tab, see -> "[Data Exchange PC / Bus Terminal Controller \[► 112\]](#)".

"IP Address" Tab

For information about this tab, see -> "[IP Address](#)" Tab [[► 298](#)].

"ADS Commands" Tab

For information about this tab, see -> "[ADS Command Window \[► 51\]](#)".

NOTICE

The ("[cycle ticks \[► 62\]](#)") task time for the respective task should be selected to be so high that the value displayed at [MissedCnt \[► 298\]](#) is always constant. In the event of doubt, it is better to select a slightly higher cycle time.

Example:

Minimum cycle time with selected protocol [UDP \[► 298\]](#): 30 ms

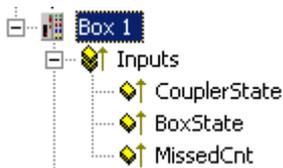
Minimum cycle time with selected protocol [TCP \[► 298\]](#): 50 ms

11.3.1.9 BK9500 (USB Interface)

The Beckhoff BK9500 Bus Coupler is configured in TwinCAT under a "Virtual USB Interface [▶ 242]". The following description explains the differences between the BK9500 and other Bus Couplers.

The USB Bus Coupler communicates via ADS with TwinCAT. For an Overview [▶ 376] of all currently supported USB Bus Couplers, please see [▶ 376]...

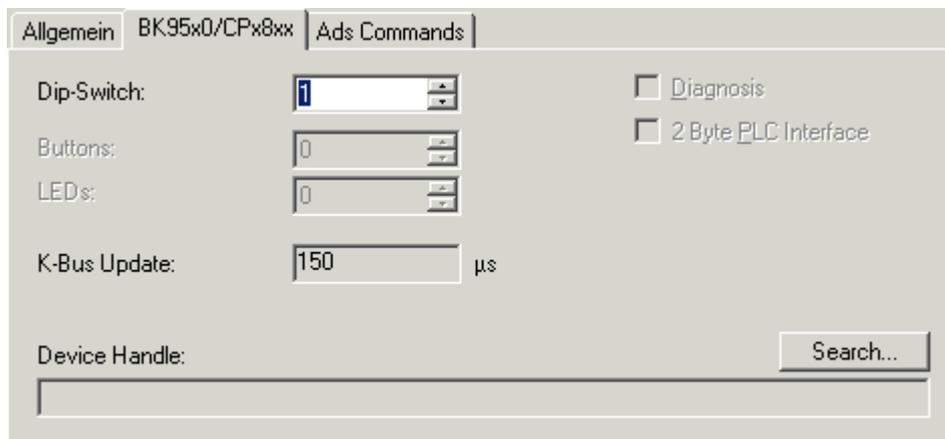
Diagnosis Inputs



Each fieldbus module contains status information which can be linked to TwinCAT (e.g. to TwinCAT PLC). This status information are mostly identical at all Beckhoff fieldbus nodes (see *CouplerState*, *MissedCnt*) and are described under -> "Status Information - Beckhoff Fieldbus nodes [▶ 298]". Only the input variable *BoxState* is specific. This variable can contain the values which are described inside the below table. Additionally, each variable status is listed in the corresponding "Comment" field [▶ 37].

Variable	Data Type	Value	Description
BoxState	UINT16	0x0000	No error condition
		0x0001	No new input information

"BK95x0/CPx8xx" Tab



Dip-Switch: The active dip-switch setting (USB address) of the USB Control Panel has to be edited here. If the BK9500 and his Bus Terminals have been found through ->"Scan Devices [▶ 97]", the appropriate address has been set here automatically.

Diagnosis: This checkbox is deactivated at the BK9500.

2 Byte PLC Interface: This checkbox is deactivated at the BK9500.

K-Bus Update: According to the attached Bus Terminals, the estimated K-Bus update time is calculated and displayed here.

Search: If this button is pressed, the **Device Handle** is searched manually (usually not necessary).

Device Handle: Shows, with activated configuration and started TwinCAT System, the *USB Device Handle* for this device, which was obtained by the Operating System (and is currently valid).

"ADS Commands" Tab

For information about this tab, see -> "[ADS Command Window \[► 51\]](#)".

11.3.1.10 Special Types

11.3.1.10.1 CP68xx / CP78xx (USB Interface)

The Beckhoff Control Panel CP68xx and CP78xx contains an USB interface (incl. integrated *USB Hub*) for PC communication to the Special Keys and/or all kind of USB devices, connected to the Control Panel. The Special Keys and USB fieldbus devices communicate with TwinCAT via [ADS](#).

Typen	Beschreibung
CP68xx / CP78xx	Beckhoff Control Panel with DVI and USB interface

"BK95x0/CPx8xx" Tab

Dip-Switch: The actual dip-switch setting (USB address) of the Control Panel with USB interface has to be edited here. If the Control Panel (plus possible Bus Terminals) have been found through -> "[Scan Devices \[► 97\]](#)", the appropriate address has been set here automatically.

Diagnosis: This checkbox is deactivated at the CP68xx and CP78xx.

2 Byte PLC Interface: This checkbox is deactivated at the CP68xx and CP78xx..

Buttons: The correct number of Special Keys has to be selected here. The default is 27, which is appropriate for the most Beckhoff Control Panels (see also -> "[BECKHOFF Knowledge Base](#)").

LEDs: The number of implemented LEDs and/or lamps inside the Special Keys of the Control Panel has to be selected here. Default number is 27, which suits for the most of the Control Panels (see also -> "[BECKHOFF Knowledge Base](#)").

K-Bus Update: According to the attached Bus Terminals, the estimated K-Bus update time is calculated and displayed here.

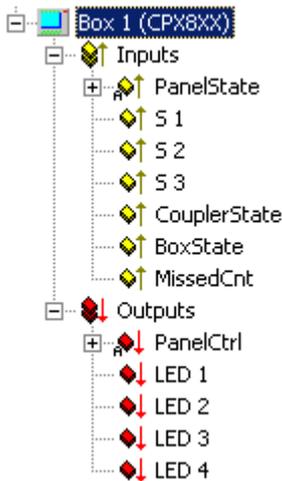
Search: If this button is pressed, the **Device Handle** is searched manually (usually not necessary).

Device Handle: Shows, with activated configuration and started TwinCAT System, the *USB Device Handle* for this device, which was obtained by the Operating System (and is currently valid).

"ADS Commands" Tab

For information about this tab, see -> "[ADS Command Window \[► 51\]](#)".

I/O Variables:



Inputs:

PanelState: This bit array is currently not used (*reserved*).

S 1 - n: The status of the control panel special buttons, along with the push buttons and switches of potential push button extensions can be queried and [linked \[► 39\]](#) with the input variables of the other task (e.g. TwinCAT PLC) here.

CouplerState: See "[Status Information – Beckhoff fieldbus node \[► 298\]](#)"

BoxState: See "[BK9500 \(USB interface\) \[► 293\]](#)"

MissedCnt: See "[Status information – Beckhoff fieldbus node \[► 298\]](#)"



USB

USB is specified for segment lengths of up to 5 m (from hub to end device, or next hub). If the -value increases during normal operation, a short commercially available USB cable (e.g. with a length of 3 m) should be used for test purposes. This would help to determine if the problem is caused by the USB cable length (total length). MissedCnt

Outputs:

PanelCtrl: With this Bit-Array, the Panel behavior can be controlled. Currently, only the control of the backlight is implemented.

Variable (Bit of DWORD)	Data Type	Value	Description
PanelCtrl[5]	BOOL	0	Display: backlight = ON
		1	Display: backlight = OFF

LED 1 .. n: The output variables from other tasks (e.g. TwinCAT PLC) can be [linked \[► 39\]](#) to the S-Key LEDs or to luminated pushbuttons, respectively their status can be watched, here.

11.3.1.10.2 CX1100 Power Supply/Terminal Device (CX1100-BK)

If the Embedded PC CX1000 is used with the optionale power supply [CX1100-0002](#) or [CX1100-0003](#), it automatically comes with an interface for the [Beckhoff Bus Terminals](#). At the configuration of the CX with TwinCAT System Manager, this (*K-Bus*)-interface is handled as an I/O device with "CX1100-BK" as its device name.

"General" Tab

General CX 1100 Display DPRAM (Online)

Name: Device 1 (CX1100-BK) Id: 1

Type: CX1100 Power Supplier/Terminal Device

Comment: Space for useful notes!

Disabled Create symbols

Id

Shows the internal device ID of the "CX1100-BK" interface. This is especially remarked here, because this identification number is needed to access the 2-line LCDisplay (e.g. with function blocks from TwinCAT PLC).

For the rest of the labels and edit fields, please refer to "[I/O Configuration | Adding an I/O device | 97](#)".

"CX1100" tab

General CX 1100 Display DPRAM (Online)

Address: 0xD0000 Search...

Display Settings

Initialize

Write

1. Line: BECKHOFF

2. Line: CX 1000

Adress

Is going to be detected automatically, during I/O device scan with TwinCAT System Manager. Alternatively, the button "**Search...**" can be used here.

Initialize

Initializes the display if activated (default).

Write

If activated, the strings assigned to "**1. Line**" resp. "**2. Line**" are going to be written to the display after system start/restart. By default, "Write" is activated.

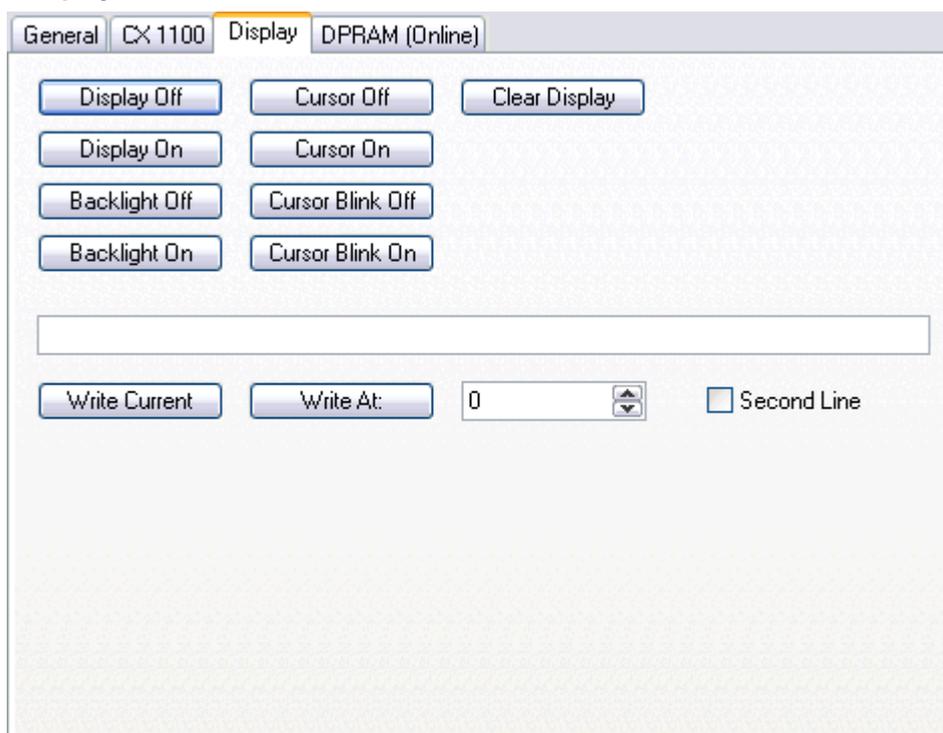
1. Line

16-character long string for upper line of the 2-line LCD Display. The string assigned here may be overwritten from PLC, if appropriate PLC program is active.

2. Line

16-character long string for upper line of the 2-line LCD Display. The string assigned here may be overwritten from PLC, if appropriate PLC program is active.

"Display" tab



Dialog for manual access to the 2-line LC-Display of the CX1100 power supply.

"DPRAM [Online]" tab

Please refer to "[DPRAM \[Online\]](#) [[▶ 267](#)]"

11.3.1.10.3 BX Terminal Device (BX-BK)

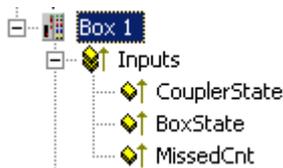
The BX controller (BX3100, BX5100, BX5200) comes with an interface for the Beckhoff Bus Terminals. When configured with TwinCAT System Manager, this (*K-Bus*)-interface is handled as an I/O device named "BX-BK".

"BX Settings" tab

... under construction ...

11.3.1.11 Common**11.3.1.11.1 Status Information - Beckhoff Fieldbus Nodes**

Each Fieldbus module contains state information which can be [linked \[▶ 39\]](#) in TwinCAT to other tasks (e.g. PLC task) for supervision. These state information are identical at all fieldbus participants for the most part. (see the following *CouplerState*, *MissedCnt*) and are therefore described below for all Beckhoff Bus Couplers, Bus Terminal Controllers and Fieldbus Boxes in common. An exception is the specific *BoxState*, to be found in the corresponding description of the device (e.g. [BC9000 \[▶ 291\]](#) under -> "TwinCAT System Manager - Reference").

Diagnosis Inputs

Variable	Value	Description
CouplerState	0x0000	no error condition
	0x0001	K-Bus error (see additional information in the corresponding Hardware description)
	0x0002	Configuration error (e.g. wrong number of configured Bus Terminals, see additional information at the corresponding Hardware description)
MissedCnt	numeric	Is incremented in every I/O cycle [▶ 62] without new (actual) input information

11.3.1.11.2 "IP Address" Tab

Ethernet components need an unique IP address to be able to communicate. Subsequently, the dialog for the configuration of the specific settings at a Beckhoff Ethernet fieldbus node is described. The following tab appears after marking or adding of such an Ethernet device in / to the System Manager tree.

Hostname: The name of the Beckhoff Ethernet node can be edited here.

IP Address: The IP address of the Beckhoff component (e.g. BK9000) has to be set here.

	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
fix IP address	0	0	Last digit of IP address e. g. 135.122.57. {Bit5-Bit0}					
Boot P	0	1	0-5 to ON stores BootP address permanently			0-5 to OFF stores BootP address volatile		
DHCP	1	0	Settings creates DHCP name					

GetHostByName: From Firmware "B2" on, an IP address for the node (Box) can be obtained from a Windows 2000 DHCP Server (*Dynamic Host Configuration Protocol*).

Set IP Address: At [TwinCAT Real-Time Ethernet \[► 409\]](#) nodes, this button can be pushed to set the IP Address conform to the subnet address used by the [Ethernet Miniport \(real-time\) \[► 239\]](#) device.

AMS Address: Specifies the AMS-Net ID of this node. This ID is generated automatically, derived from the IP address (2 additional byte values separated by dots (e.g. ".1.1").

BootP: This box can be checked, if the Beckhoff BootP Server has been installed and started on the computer (Requirements: TwinCAT 2.8 or higher).

New MAC Addresses: With a started -> "**Beckhoff Bootp Server**" and pressing of this button, newfound MAC (*Media Access Controller*) addresses are shown. They are displayed in the field under the button. In the case there is only one new Beckhoff Ethernet device hooked up to the network, only one MAC address is shown. For this MAC address an **IP address** can be assigned in the above described edit field. With adding of another Beckhoff Ethernet node, this procedure can be repeated on this tab of the new node (Box).

Communication Settings:

TCP: If this radio button is active (default at non-real time devices), the communication is done over TCP (*Transmission Control Protocol*). That means, telegram packages from and to the node are exchanged through a safed (confirmed) mechanism.

ADS (): *available at TwinCAT Real-Time Ethernet nodes* If this radio button is active ...

UDP: If this radio button is active, the communication is done via UDP (*User Datagram Protocol*). In difference to the TCP protocol, the single telegram packages are not confirmed by the recipient, nor is the order of the packages approved (means, UDP provides very few error recovery services). Damaged or interchanged telegram packages won't be sent again. The advantage of UDP consists of predictable telegram run times because there is no waiting for a confirmation by recipient. Therefore, UDP is in contrast to TCP/IP the faster communication method, since no TCP/IP stack is necessary for it.

RAW : (*available at TwinCAT Real-Time Ethernet nodes*) If this radio button is active (default at TwinCAT Real-Time Ethernet nodes), the communication to this node is handled via [TwinCAT Real-Time Ethernet \[► 409\]](#) protocol.

Max. Warning Level: This option is only available in combination with **UDP**. The maximum value for the error counter can be set here. If this max. value is reached, the master doesn't wait for a response telegram with new inputs from the node. Instead, it sends only read telegrams, based on a higher cycle time to the node.

No Auto Retries: This box can only checked in combination with **UDP** either. Is this box checked, with reaching of **Max. Warning Level** an execution of the -> "[Online Reset \[► 241\]](#)" function is necessary.

"ADS Commands" Tab

For information about this tab, see -> "ADS Command Window".

11.3.2 Beckhoff Lightbus

Following listed devices are used at Beckhoff Lightbus and currently supported by TwinCAT:

Requirements

Lightbus - Node Type ("Box")	Description
BK2000 [▶ 276]	Standard Bus Coupler
BK2010 [▶ 276]	Economy Bus Couplers
BK2020 [▶ 276]	"Economy plus" Bus Couplers
IPxxxx-B200 [▶ 276]	Fieldbus Compact Box: Lightbus in/output module, protection class IP67
ILxxxx-B200 [▶ 276]	Fieldbus Coupler Box : Expandable in/output module with Lightbus interface, protection class IP67
Generic 32-bit Box [▶ 300]	This generic 4 byte telegram is used for all Lightbus Boxes which are not listed by name on the TwinCAT System Manager device list
M1110	16 dig. I/O Box with Lightbus interface (protection class IP65), configurable as "Generic 32-bit Box [▶ 300] "
M1200, M1210	Lightbus - Interface module, configurable as "Generic 32-bit Box [▶ 300] "
M1400	Box with 32 dig. I/O, configurable as "Generic 32-bit Box [▶ 300] "
M1410	Box with 16 dig. I/O, configurable as "Generic 32-bit Box [▶ 300] "
M2400 [▶ 301]	4-channel analogue output Box
M2510	Analog input module (12 bit res., ±10 V, 0-10 V or 4-20 mA configurable)
M3000	Absolute encoder (24 bit resolution, Multi-turn, 4096 steps/rev.) with Lightbus interface, configurable M3000 [▶ 303] Box
M3100	Incremental encoder interface Box (24 Bit resolution) with Lightbus interface (protection class IP65), configurable as a 1-channel M3120 [▶ 306] Box
M3120 [▶ 306]	1 to 4-channel M3120 [▶ 306] incremental encoder Box
M3200	Incremental encoder (24 Bit resolution) with Lightbus interface, configurable as a 1-channel M3120 [▶ 306] Box
M63x0	Pushbutton stations M6310, M6320, M6330 and M6350 with Lightbus interface, configurable as "Generic 32-bit Box [▶ 300] "
C1120	Lightbus Interface to Siemens S5 controllers as slave node for TwinCAT configuration
FOX 20 [▶ 306]	The Fox-20 module has four sockets for digital and analogue sub-modules.
FOX 50 [▶ 307]	The Fox-50 module is a two channel SSI sensor interface
FOX RK001/002 [▶ 307]	The Fox-Rk001 and Fox-Rk002 modules are coupling modules which couple one fiber-optical ring with another one (Rk001) or with Profibus (Rk002)
AX2000-B200 [▶ 308]	Digital Servo drive with Lightbus interface

11.3.2.1 Generic 32-bit Box

The box type "Generic 32-bit Box" supports all Beckhoff Lightbus Boxes other than those listed separately. In the case of the Lightbus, 32 bits / 4 bytes of data are sent to the box per telegram (outputs on the fieldbus) and 32 bits of data read in again (inputs on the fieldbus).

The individual bit/byte definitions for the different boxes are taken from the corresponding box manual.

Context menu

Add Box...

Adds another box above the marked box.

**Delete Box... **

Deletes the marked box and its sub-elements from the I/O configuration.

Import Box...

Adds another box above the marked box. The description of the new box and its sub-elements are read from a file with the suffix ".tce". This file is created with the following menu option.

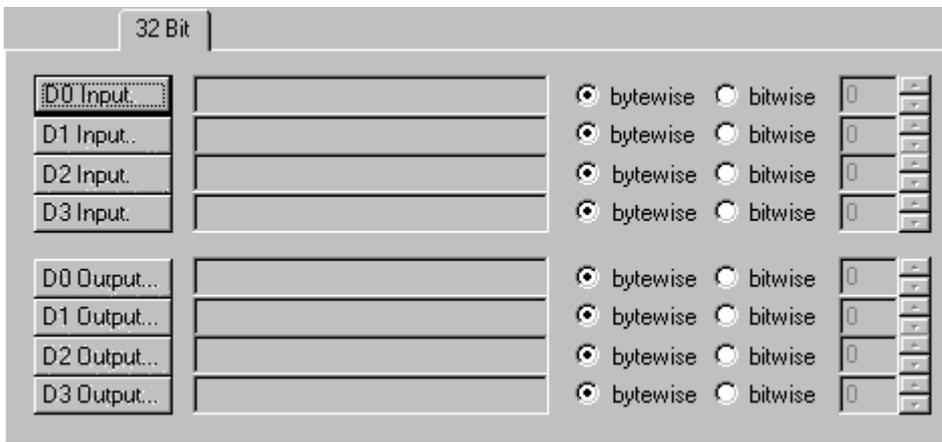
Export Box...

Exports the information from the selected box and the information about its sub-elements into a file with the suffix ".ioe".

Variables

Beneath the box, four bytes each in/outputs are automatically defined which are addressed/linked either as bytes or as individual bits.

"32 bit" tab



The individual variables can be linked at the same time for all variables via the "32 bit" tab. You can of course still create the links using the context menu or the tab view for each variable.

D0 Input...: Opens the link dialogue for the first input byte / for a bit of the first input byte if you have selected bit-wise mode. If linking by bits you can select the relevant bit.

D1 Input...: ditto.

11.3.2.2 M2400

The M2400 is an analog output box with up to four channels, which also has two digital data bytes. The box jumpers determine whether the data bytes function as input or output bytes (see M2400 manual). If the box has less than four analog channels, the corresponding DACs are not linked.

● Data telegram only for the higher priority task

i If the box is linked to several tasks (e.g. DACs with NC and data bytes with PLC), the data telegram is only created for the higher priority task. This is particularly important during commissioning if, for example, only the PLC is running.

Context menu

Add Box...

Adds another box above the marked box.

**Delete Box... **

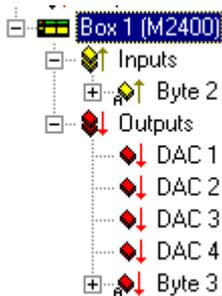
Deletes the marked box and its sub-elements from the I/O configuration.

Import Box...

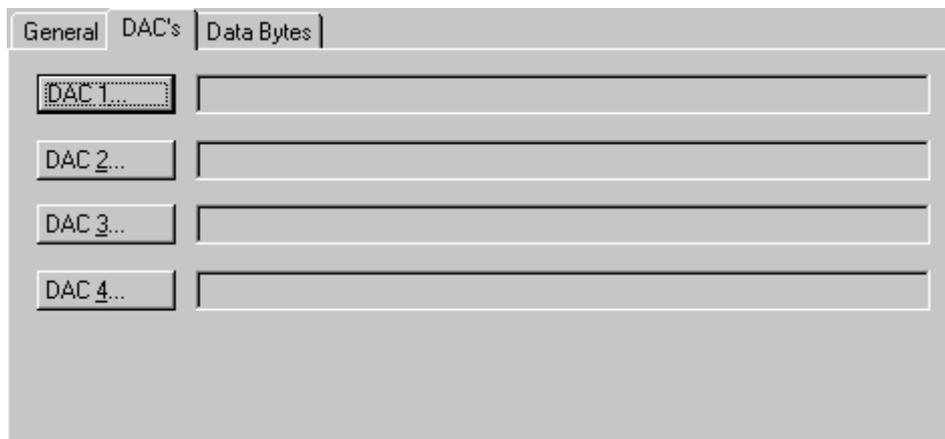
Adds another box above the marked box. The description of the new box and its sub-elements are read from a file with the suffix ".tce". This file is created with the following menu option.

Export Box...

Exports the information from the selected box and the information about its sub-elements into a file with the suffix ".ioe".

Variables

Four 16 bit output variables with the descriptors DAC 1 to DAC 4 are created and can be linked. Both data bytes are located correspondingly under inputs and/or outputs. The orientation is entered in the "Data Bytes" tab. The data bytes can be accessed as both bytes and bits.

"DAC's" tab

The individual variables can be linked for all variables via the "DACs" and "Data Bytes" tabs. You can of course still create the links using the context menu or the tab view for each variable.

DAC 1...: Opens the link dialogue for the first analogue output channel.

DAC 2...: ditto...

"Data Bytes" tab



D 2...: Opens the link dialogue for the first data byte (D2 in the telegram).

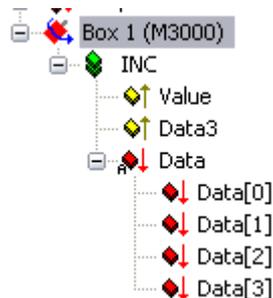
Input / Output: Determines whether the data byte is treated as an input or output (must correspond to the hardware setting).

By bytes / by bits: Determines whether the link dialogue is opened for the whole byte or for individual bits.

11.3.2.3 M3000

The absolute encoder M3000 has an integrated Beckhoff Lightbus interface and provides persistent position displacement with a measurement range of 24 bit.

Variables



Variable	Data type	Description
Value	UINT24	This 24-bit wide input variable contains the current position value of the absolute encoder.
Data3	USINT	This input variable is a "spare byte". This byte is necessary since the above-described <i>Value</i> variable is intentionally 24-bit but Lightbus modules by default have a 32-bit interface for In- and Out-direction. Therefore, <i>Data3</i> gets also mapped by default while linking the encoder to a NC axis interface.
Data	ARRAY [0..3] OF USINT	The data bytes of this array are output variables* to the encoder. * <i>Only used in Programming Mode of the encoder (not used within TwinCAT NC)!</i>

TwinCAT NC Encoder

If you add an axis to the NC part of the System Manager, you must select the adequate NC-Encoder type. For the M3000, the following types are available (selection manipulates the parameter '*Encoder Mask (Maximal Value)*' on the tab 'Global' which is shown further below):

Requirements

NC-Encoder Type	TwinCAT NC Tab	Description
Encoder connected to M3000 (24bit Multi-Turn)	Axis x_Enc 'NC-Encoder'	If this encoder type gets selected in TwinCAT NC and linked to the M3000 module, the NC will interpret the bit pattern received from 'Value' as 24bit multi-turn value.
Encoder connected to M3000 (25bit Multi-Turn)	Axis x_Enc 'NC-Encoder'	If this encoder type gets selected in TwinCAT NC and linked to the M3000 module, the NC will interpret the bit pattern received from 'Value' as 25bit multi-turn value.
Encoder connected to M3000 (12bit Single-Turn)	Axis x_Enc 'NC-Encoder'	If this encoder type gets selected in TwinCAT NC and linked to the M3000 module, the NC will interpret the bit pattern received from 'Value' as 12bit single-turn value.
Encoder connected to M3000 (13bit Single-Turn)	Axis x_Enc 'NC-Encoder'	If this encoder type gets selected in TwinCAT NC and linked to the M3000 module, the NC will interpret the bit pattern received from 'Value' as 13bit single-turn value.

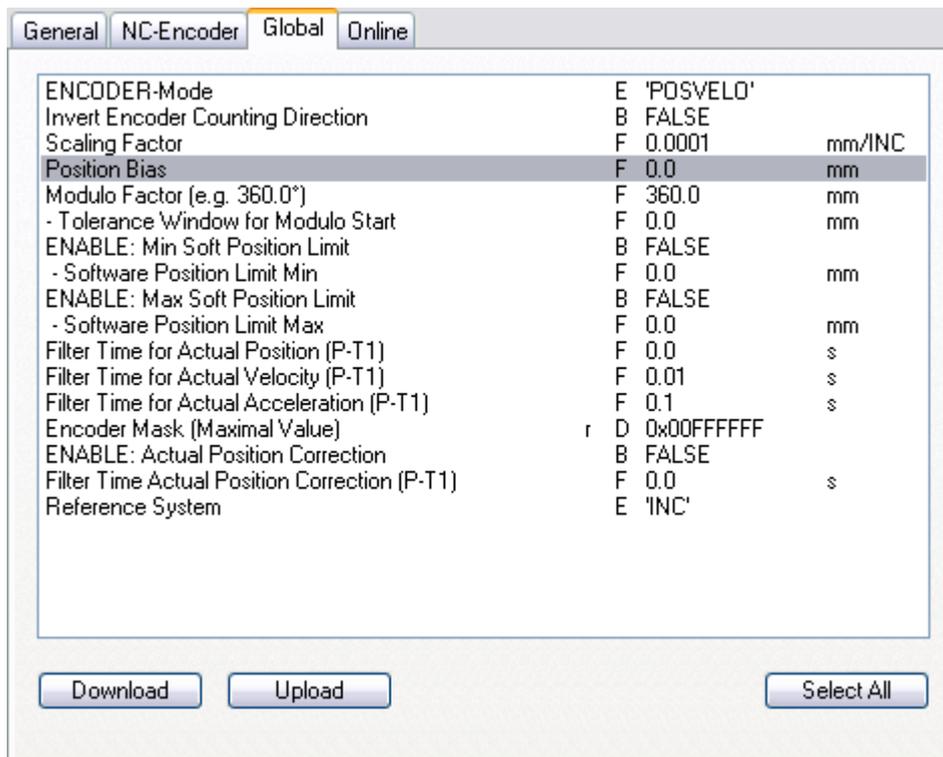
After a possible replacement of the encoder, it is important to adapt the position bias and eventually the counting direction of the new encoder. This is possible via the tab 'Global' at the 'Axis x_Enc' axis interface with the parameters

- 'Position Bias' resp.
- 'Invert Encoder Counting Direction'.

In operation, the count value should always range between the minimal (0) and the maximal counter value of the encoder type, taking the complete moving distance into account.

TwinCAT NC - Encoder 'Global'

The available dialog for the possible manipulation of 'Position Bias' and 'Invert Encoder Counting Direction' is shown below:



The following operation mode is only described because of completeness since it is normally not in use while operating with TwinCAT.

The M3000 absolute encoder is programmable via the Lightbus, which can therefore even happen with the aid of the PLC application. The programmed settings get stored within the encoder. If the programming mode gets (unlikely) used within TwinCAT, the programmer must take care that the TwinCAT NC runtime is stopped during this operation!

Programming mode:

During programming mode, the output as well as the input bytes are in use. The 4 input and output bytes of the 32-bit module have the following function:

Data[0] = value to be written to the encoder (Output)

Data[1] = status bits (acknowledge) of the transmission block from the encoder (Input, *Value*) with the following meaning:

Bit 0: = feedback of mode change towards programming mode

Bit 1: not used

Bit 2: = acknowledge data block transmission Ok., data stored

Bit 3: = acknowledge data byte accepted

Bit 4 -7: not used

Data[2] = feedback of written value from encoder (Input, *Value*). Means, the encoder sends from *Data[0]* received values back (hopefully ;-).

Data[3] = Control bits in programming mode (Output). These bits control the programming functions of the encoder (flow-control/handshaking). During programming mode operation this byte gets mirrored in the *Data3* input variable.

The bits have the following meaning:

Bit 0: '0' = count mode, '1' = programming mode

Bit 1: = 'Preset 1' take-over request to encoder

Bit 2: = 'Preset 2' take-over request to encoder

Bit 3: = strobe bit for transmission of data byte

Bit 4-6: not used

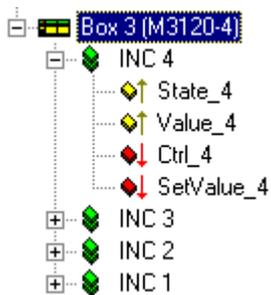
Special function Bit 7: Enable Latch function

11.3.2.4 M3120

The M3120 is an incremental encoder box with up to four channels. It is available in four different versions with one, two, three and four channels. When inserting the box, you need to choose the right type, since each channel represents in logical terms a single box. Therefore, in the event of an error input, the total number of boxes changes.

The M3120 channels are called INC 4, INC 3, INC 2 and INC 1; these descriptions correspond to the label on the box!

Variables



Each channel of the M3120 has four variables, two input variables and two output variables:

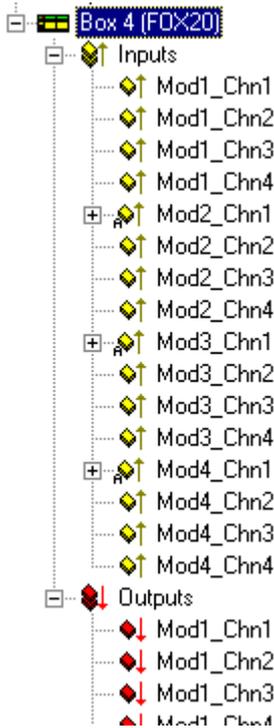
1. **Status byte** (8 bit input variable), displays the current status of that channel.
2. **Value** (24 bit input variable), delivers the current counter status/latch value.
3. **Control byte** (8 bit output variable) allows you to, e.g. toggle between counter and latch variable
4. **Set value** (24 bit output variable) to set the counter value.

Please refer to the M3120 manual for further details.

11.3.2.5 Fox20

The Fox-20 module has four sockets for digital and analogue sub-modules (the first socket is for analogue sub-modules only).

Variables



All possible variables are displayed in the tree. The variables can/must be linked depending on what is plugged into the Fox-20 module. If an analogue sub-module has been plugged into a socket, the word variables Modx_Chny in the input and/or output area can be linked. In which x stands for the sub-module socket and y for the channel corresponding to that socket.

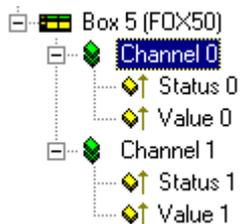
In the case of digital sub-modules (one channel only) the bit variables must be linked below the Modx_Chn1 variables.

The links tell the TwinCAT System Manager whether the fiberoptic telegram is for a digital or an analogue sub-module.

11.3.2.6 Fox50

The Fox-50 module is a two channel SSI sensor interface.

Variables

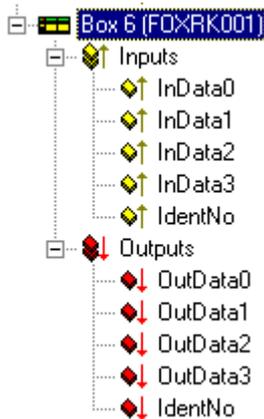


In the tree, one status byte and one 24 bit value is inserted per channel. These can be linked manually or from the NC configuration (FOX50 encoder type).

11.3.2.7 FoxRk001/002

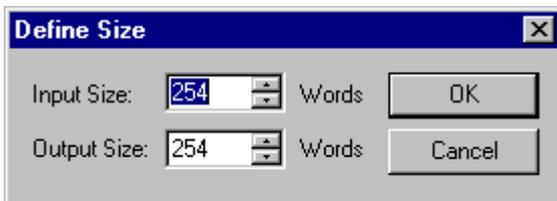
The Fox-Rk001 and Fox-Rk002 modules are coupling modules which couple the fiberoptic ring with another fibreoptic ring (Rk001) or with a Profibus (Rk002).

Variables



(RK001 with 4 words each)

When inserting the module, you will be requested to give the required number of input and output words (max. 254 Rk001 and/or 16 Rk002).



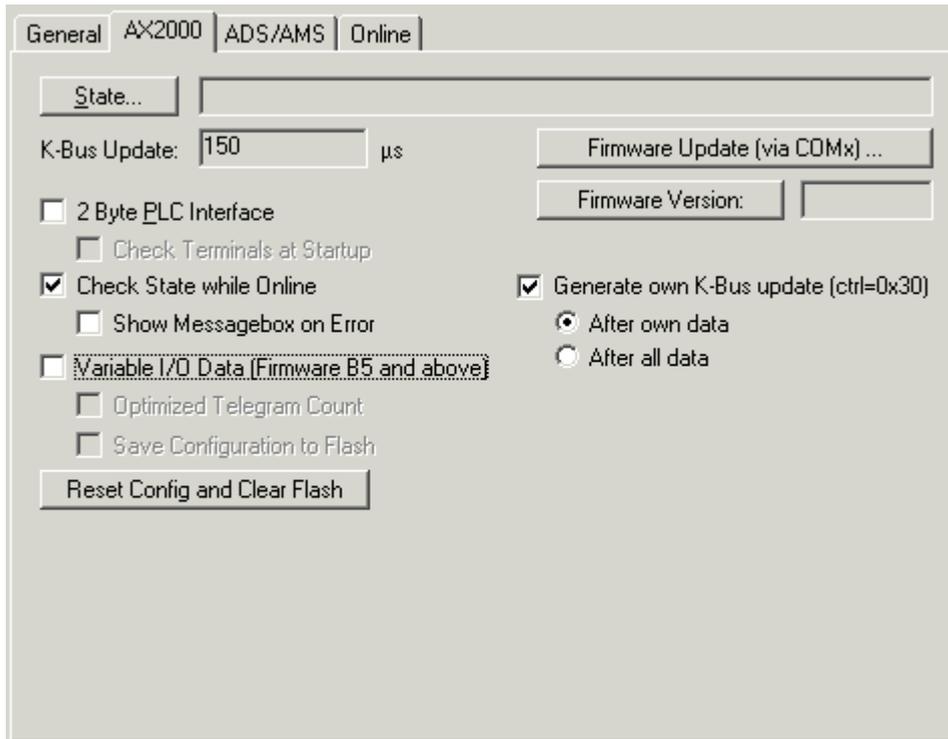
The tree will then create that number of variables.

In the case of the Rk001 an IdentNo word is also added to each input and output area, which can be exchanged with the word 0xFE in the module.

11.3.2.8 AX2000 / AX2500

11.3.2.8.1 AX2xxx-B200 Drive

The Beckhoff AX2000 and AX2500 drive is available with different (in the case of AX2000 optional) fieldbus interfaces. The following dialogs are for an AX2000 with Beckhoff Lightbus interface (e.g. part no.: AX2003-**B200**). Nevertheless, the dialogs and descriptions is also suitable for AX2500, since these drives are fully software compatible to the AX2000.

"AX2000" Tab

State: The variable "State" of the AX2000-B200 Servo drive can be linked to a variable of another process image (e.g. with TwinCAT PLC) here.

K-Bus Update: Optionally, Beckhoff Bus Terminals can be hooked up to an AX2000 drive. Based on the attached terminals, the K-Bus update time is calculated and displayed here.

Firmware Update: The Firmware of the -B200 Lightbus interface can be updated through the serial COM port of the PC, if this button is pressed.

Firmware Version: After pressing of this button, the current Firmware version of the -B200 Lightbus interface is read and displayed in the field next to it..

2 Byte PLC Interface: After checking of this box, input and output variables for the PLC Interface will be inserted below the drive symbol in the tree view.

Check Terminals at Startup: Checks during initialization phase, whether configured Bus Terminals (optional) are really connected to the K-Bus extension of the drive). It has no function at drives without K-Bus extension.

Check State while Online: Evaluates cyclical the -B200 "State" variable if checked. On error condition, a message will be brought to the System Manager Logger View [► 28].

Show Message Box on Error: Fires on error conditions, additionally to the Logger View and Event viewer entry, a Message Box to the surface.

Generate own K-Bus update: Activates own des K-Bus cycle if 0x30 telegram arrives to the Lightbus interface and the master card sends no broadcast telegram. This checkbox is activated by default at AX2xxx-B200 drives.

After own data: The K-Bus update is done directly after own data was sent.

After all data: The K-Bus update is done after all data of the current CDL were sent.

Variable I/O Data: From Firmware version "B5" of the -B200 Lightbus interface for the AX2000 drive on, the Lightbus telegram structure to the drive can be optimized (at AX2500 drives at all Firmware revisions). To allow the optimization, this and the following checkbox must be activated. For compatibility reasons, this checkbox "Variable I/O Data" is not checked by default, when a new AX2000 device is added to the System Manager configuration.

Optimized Telegram Count: See: *Variable I/O Data*

Save Configuration to Flash: If this box is checked, the configuration is going to be saved to the Flash memory of the drive with each TwinCAT start (only, if at least one parameter has changed).

Reset Config and Clear Flash: The Flash memory of the drive can be cleared by pressing this button.

"ADS/AMS" Tab

For further information about this tab, see: "[ADS/AMS Settings at I/O Devices \[► 50\]](#)".

"Online" Tab

For further information about this tab, see: "[AX2xxx Drive Tab - Online \[► 454\]](#)".

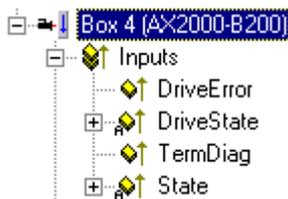
"Actual Channel" Tab

For further information about this tab, see: "[AX2xxx Drive Tab - Inputs \[► 451\]](#)".

"Nominal Channel" Tab

For further information about this tab, see: "[AX2xxx Drive Tab - Outputs](#)".

Diagnosis Inputs (optional)



If the variables *DriveError*, *DriveState* (alternatively *DriveState2* and *DriveState3*) are added to the **Variable I/O Data** (described above), they can be used for diagnosis purposes (e.g. if they are linked to a TwinCAT PLC process image, they can be evaluated inside the PLC run-time system).

For further information about the error and warning codes of the AX2xxx drive, see: "[AX2xxx Drive - Status and Error Codes \[► 456\]](#)".

11.3.3 Profibus

The following devices with PROFIBUS slave interface are currently supported by TwinCAT.



PROFIBUS devices

Naturally, all PROFIBUS devices for which a valid GSD file is available are supported by the "GSD device" which is also listed.

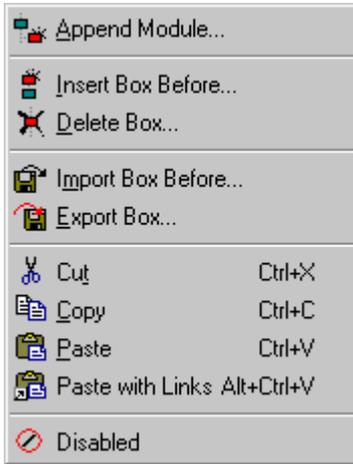
Requirements

PROFIBUS – devices ("Boxes")	Description	Restrictions / note
BK3000 [▶ 277]	Bus Coupler (max. 1.5 Mbaud)	
BK3100 [▶ 277]	Bus Coupler (max. 12 Mbaud)	
BK3010 [▶ 277]	Economy Bus Coupler (max. 1.5 Mbaud)	
BK3110 [▶ 277]	Economy Bus Coupler	
BK3120 [▶ 277]	"Economy plus" Bus Coupler (max. 12 Mbaud)	
BK3500 [▶ 277]	Bus Coupler (fiber optic, max. 1.5 Mbaud)	
BK3520 [▶ 277]	"Economy plus" Bus Coupler (fiber optic, max. 12 Mbaud)	
LC3100 [▶ 277]	Low-cost Bus Coupler max. 12 Mbaud	
BC3100 [▶ 277]	Bus Terminal Controller with integrated PLC (max. 12 Mbaud)	
IPxxx-B310 [▶ 277]	Fieldbus Compact Box: PROFIBUS input/output module with protection rating IP67 (max. 12 Mbaud)	
ILxxx-B310 [▶ 277]	Fieldbus Coupler Box Extendable input/output module with protection rating IP67 (max. 12 Mbaud)	
ILxxx-C310 [▶ 277]	Fieldbus PLC Box: coupler box with integrated PLC with protection rating IP67 (max. 12 Mbaud)	
AX2xxx-B310	Beckhoff AX2000-B310 or AX2500-B310 servo drive PROFIBUS DP slave, supported by special PLC function blocks	
AH200x [▶ 254]	Beckhoff AH2001 or AH2003 with PROFIBUS MC interface	<p>The AH200x [▶ 254] description deals exclusively with documentation of the internal I/O status and control information. It does not refer to the internally used control algorithms or the external PROFIBUS MC configuration for this slave type. For detailed information about the AH2001 / AH2003 and how to configure it on a higher-level TwinCAT master control, please refer to the BECKHOFF Drive Technology AH2000 documentation.</p> <p>Not supported by the CP5412-A2 (FC3000) or the CIF PROFIBUS cards</p>
Simodrive 611u	Siemens drive amplifier with PROFIBUS MC interface	Not supported by the CP5412-A2 (FC3000) or the CIF PROFIBUS cards
GSD device [▶ 312]	General PROFIBUS device (GSD files required from the manufacturer)	

11.3.3.1 GSD Device

Profibus devices which are not recognized by the TwinCAT System Manager can be loaded with the help of their device source file (GSD). If a "GSD Box"-type fieldbus box is inserted, an Open file dialogue appears from which you need to select the corresponding GSD file. This procedure is described in detail under [Selection of GSD and EDS boxes \[► 102\]](#).

Context menu



Add Module... <Insert>

Adds input/output modules (variables) in the case of modular GSD boxes. (Further details may be found under [Modular Profibus Devices \[► 315\]](#)).

Add Box...

Adds another fieldbus box above the marked box.

Delete Box...

Deletes the marked box and its sub-elements from the I/O configuration.

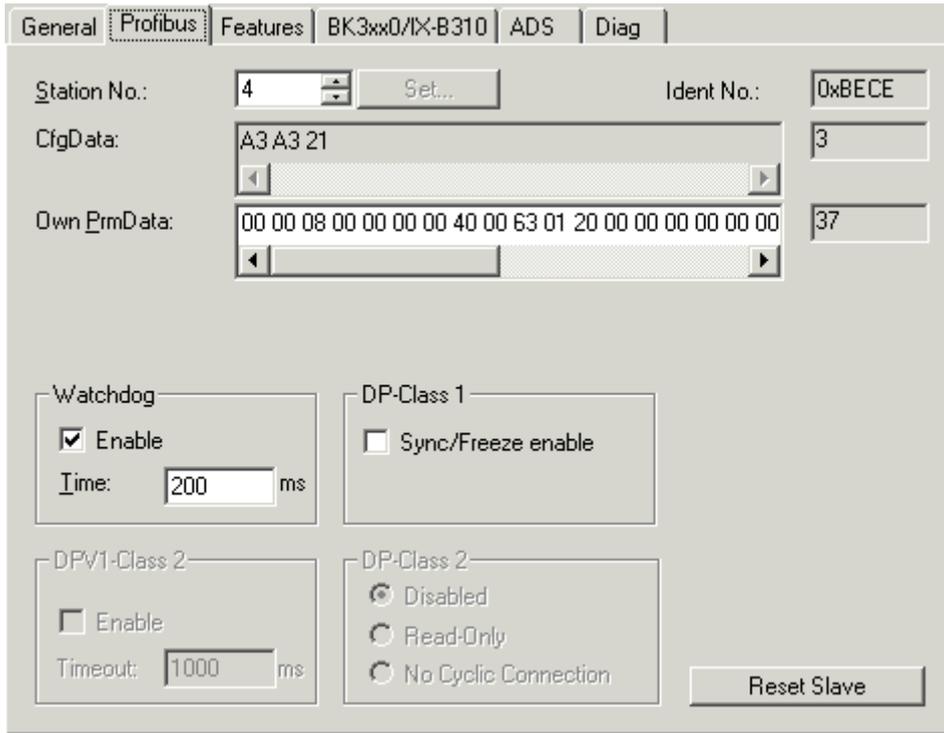
Import Box...

Adds another fieldbus box above the marked box. The description of the new box and its sub-elements are read from a file with the extension "*.tce". This file is created with the following menu option.

Export Box...

Exports the information from the selected box and the information about its sub-elements into a file with the extension "*.tce".

”Profibus” tab



Stations No.: Each Profibus device requires a unique station number.

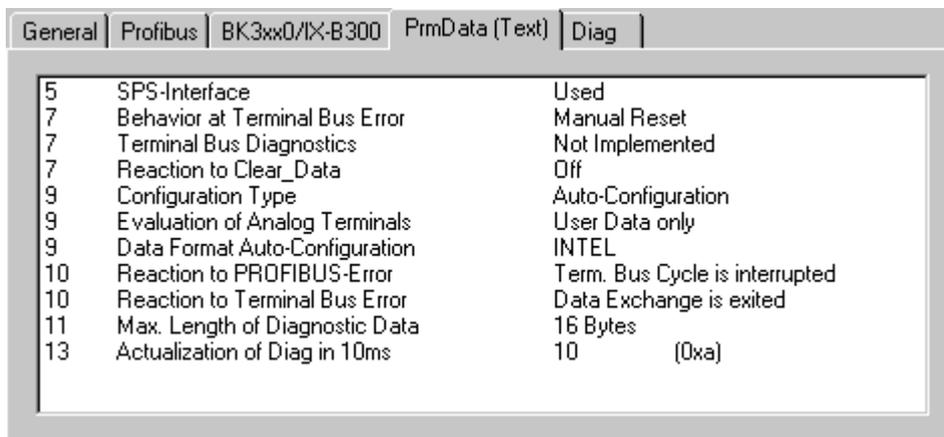
Watchdog: Switches on a watchdog function. The time period (in ms) can be set when communication monitoring is actuated. The communication monitoring period should be at least 6 x greater than the cycle time. The minimum value is 10 ms.

PrmData: Allows you to edit the Profibus-specific parameter data (-> BK3xx0 Bus Coupler documentation). The size of the current parameter data is displayed. The PrmData can be entered either in text form (-> PrmData (text)) or occasionally via tabs "BK3xx0 / BC3x00".

CfgData: Displays the current configuration data (produced on the basis of added terminals) and their lengths.

The settings **DP class 1**, **DP class 2**, **DPV1 class 2**, **Set and Reset slave** are only activated for FC310x (-> PROFIBUS DP slaves at FC310x)

”PrmData (text)” tab



Click on a line to change the current value.

Diagnostic

The diagnosis for the PROFIBUS DP slaves at the FC310x is described in a separate section. The diagnosis for other I/O devices is described below.

Input Diagnosis



Each Profibus slave fieldbus box contains two diagnostic input bytes which signal the state of each slave during the running time and which can be linked, for example with the PLC.

Table 15: BoxState

Value	Description
0	No Error
1	Error - more precise description in DpState

Table 16: DpState

Value	Description
0	No Error - station is exchanging data
1	Station deactivated - slave has been deactivated, temporary state during StartUp
2	Station not exists - slave does not reply on the bus -> check whether slave is switched on, whether PROFIBUS plug is in, correct station address or bus cables
3	Master lock - slave is exchanging data with another master -> remove other master from bus or release slave again by other master
4	Invalid slave response - incorrect answer from slave, occurs temporarily if slave has ceased data exchange because of a local event
5	Parameter fault - check whether Bus Coupler / GSD file is correct, that station address is correct or that UserPrmData settings are correct
6	Not supported - DP function is not supported -> check whether GSD file is correct or whether station address is correct
7	Config fault – configuration fault -> check whether the added terminals / modules are correct
8	Station not ready -> station starting up, temporarily displayed during StartUp
9	Static diagnosis - slave signalling static diagnosis and cannot deliver valid data at present -> check operating state at the slave

PROFIBUS Diagnostic Data

The Profibus diagnostic data sent by a PROFIBUS slave can be read by any TwinCAT program via ADS and/or signalled to any TwinCAT program. In this case, set ADS parameters as follows:

Net-ID: PC Net ID.

Port: 300

IndexGroup: 0x5000 + Device-ID

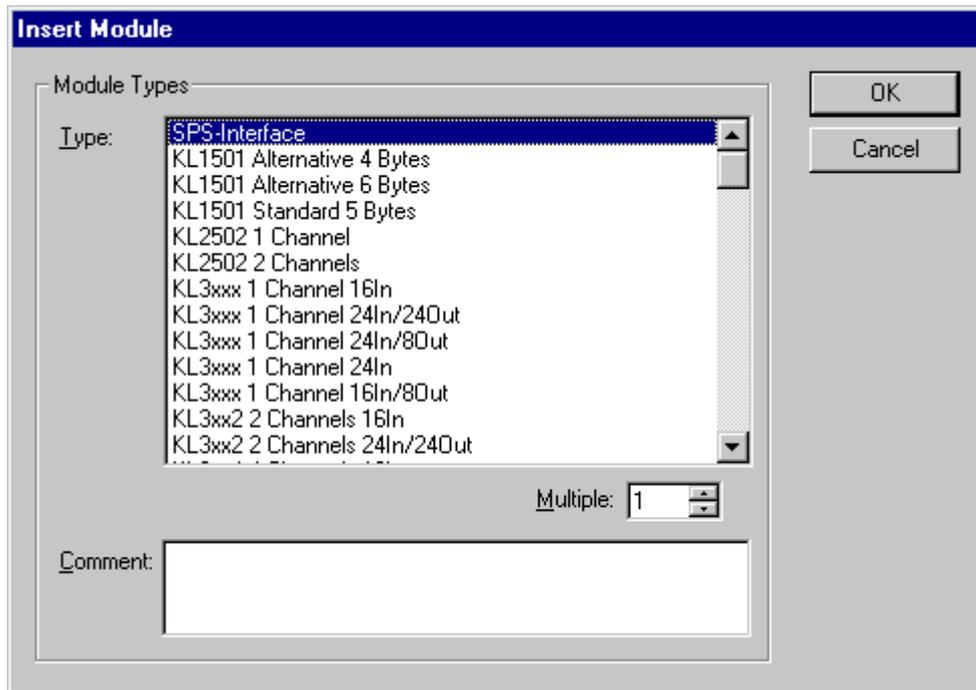
IndexOffset: Hi-Word: Station Address, Lo Word: 0x100

Length: 6 - 244

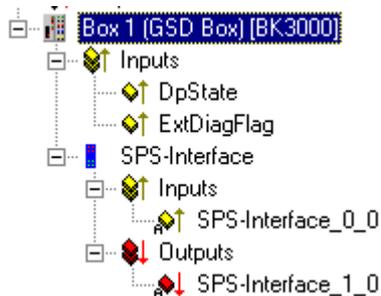
The diagnostic data are structured as described in the DP standard.

11.3.3.2 Modular Profibus Devices

Modular Profibus devices allow you to define the variables for a device by selecting one or more modules. This involves defining modules with their inputs and outputs in the GSD file of the corresponding device. The following dialogue appears when adding/inserting a module:



Variables



The variables of a module can assume one of six types:

1. Byte (8 bit)
2. Word (16 bit)
3. Byte field (n * 8 bit)
4. Word field (n * 16 bit)
5. Byte string (n * 8 bit, consistent)
6. Word string (n * 16 bit, consistent)

The module can have in and/or outputs - and different types.

11.3.4 Interbus

The following devices with an Interbus slave interface are currently supported by TwinCAT:

● Slaves

i Of course, all Interbus-compliant slaves with corresponding settings for ID code and length code are supported via the "General Interbus Box", which is also listed.

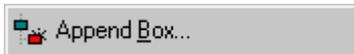
Interbus – devices ("Boxes")	Description	Restrictions/note
BK4000 [▶ 279]	Standard Bus Coupler	
BK4010 [▶ 279]	Economy Bus Coupler	
BC4020 [▶ 279]	"Economy plus" Bus Coupler	
BC4000 [▶ 279]	Bus Terminal Controller with Interbus slave interface	
IPxxx-B400 [▶ 279]	Fieldbus Compact Box: Interbus input/output module with protection rating IP67 (max. 12 Mbaud)	
ILxxx-B400 [▶ 279]	Fieldbus Coupler Box Extendable input/output module with protection rating IP67 (max. 12 Mbaud)	
ILxxx-C400	Fieldbus PLC Box: coupler box with integrated PLC with protection rating IP67 (max. 12 Mbaud)	(not yet available)
General Interbus Box [▶ 316]	General Interbus device. The <i>ID code</i> and the <i>length code</i> must be specified, or predefined boxes must be selected.	

11.3.4.1 InterBus-S Device

InterBus-S boxes which are not recognised by the TwinCAT System Manager can be inserted by inputting InterBus-S-specific length and identity codes. The length and identity codes for each device are given in the corresponding manual and are frequently marked on the device itself.

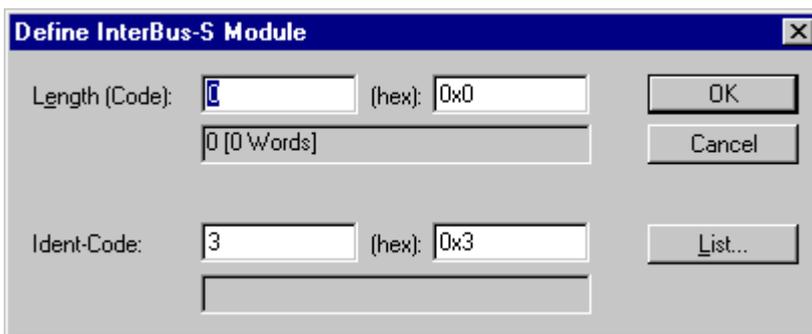
When adding an InterBus-S box you will see the following dialogue:

Context menu

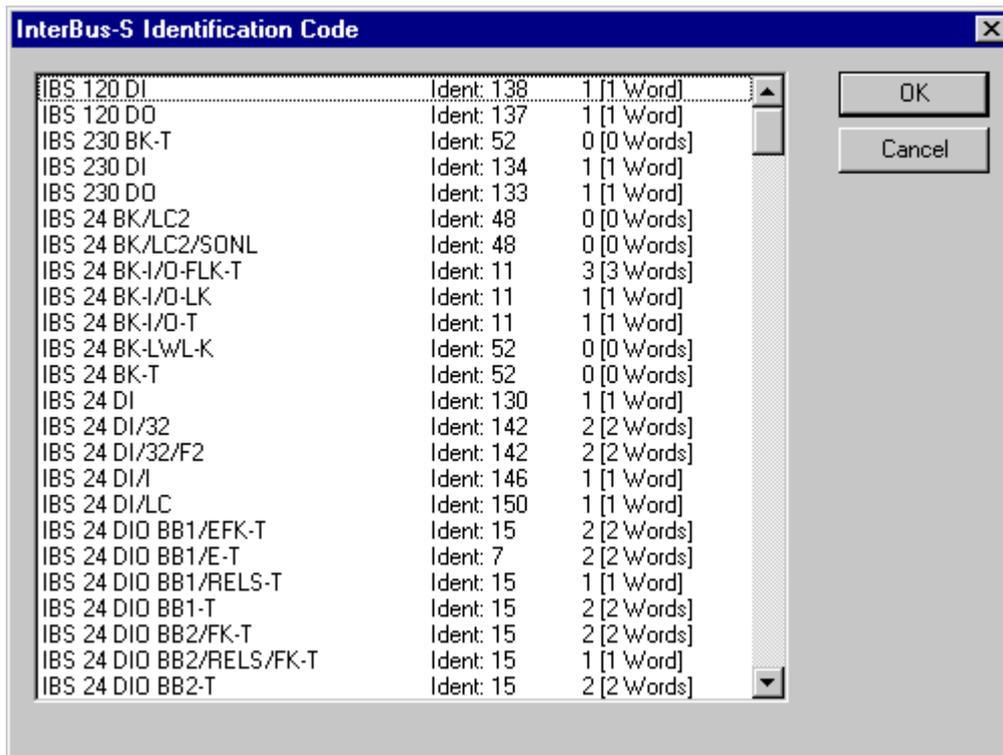


Append Box... <Insert>

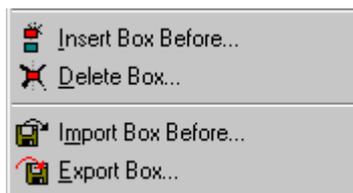
Adds, in the case of InterBus-S Bus Terminals, a box to the local or remote bus.



Actuate the "List..." button to display a list of current InterBus-S boxes, whose length and identity codes are known.



When adding another InterBus-S box you will see the following dialogue:



Insert Box Before...

Adds another box above the marked box.

Delete Box...

Deletes the marked box and its sub-elements from the I/O configuration.

Import Box Before...

Adds another box above the marked box. The description of the new box and its sub-elements are read from a file with the suffix "*.tce". This file is created with the following menu option.

Export Box...

Exports the information from the selected box and the information about its sub-elements into a file with the suffix "*.tce".

"InterBus-S" tab

Identity Code: Displays the identity code for the Bus Coupler. It is calculated dynamically - according to the connected terminals.

Length Code: Displays the length code for the Bus Coupler. It is calculated dynamically - according to the connected terminals.

Installation depth: Displays the installation depth of the Bus Coupler. It is calculated dynamically - according to the hierarchical structure of the InterBus-S.

The following settings are only possible in the case of the [Phoenix IBS ISA ST-I/T \[► 150\]](#).

Group: Allows the assignment of the device to a group (see Interbus user manual).

Alternative: Allows the assignment of the device to an alternative (see Interbus user manual).

Data consistency: Allows you to increase the data consistency for this device

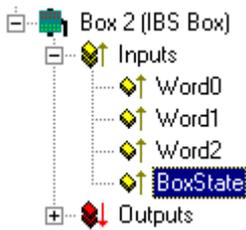
StartUp: Allows the execution of a *Control_Active_Configuration* command at the system StartUp for this device.

- **Default:** There is no command being executed for this device
- **Segment Off:** A *Segment_Off* is being executed
- **Segment On:** A *Segment_On* is being executed

"CAC/CDF" tab

Allows the execution of some firmware services of the [Phoenix IBS ISA ST-I/T \[► 150\]](#) when an ADS port is active for the master card. See Interbus user manual. Note that a *Control_Active_Configuration* command will affect subsidiary devices!

Input Diagnosis



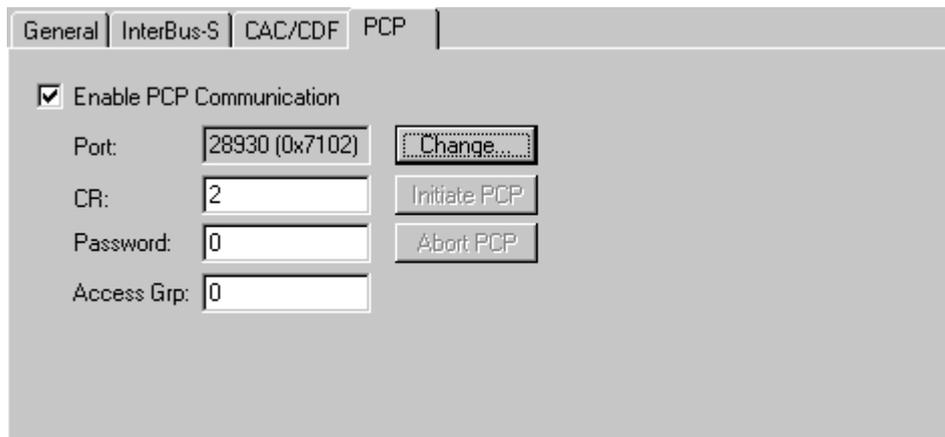
Each InterBus-S fieldbus box contains one diagnostic input byte which signals the status of the current slave during the running time and can be linked, for example with the PLC.

Variable	Value	Description
BoxState	0x01	Rec: Reconfiguration
	0x02	Mod: Module error
	0x04	W2Err: Error at the W2 interface
	0x08	W1Err: Error at the W1 interface
	0x10	W2: W2 interface inactive
	0x20	W1: W1 interface inactive

PCP Communication

Some InterBus-S devices can carry out non-cyclical communication with the master card as well as cyclical process data exchange (not CIF40-IBSM). The communication in the case of InterBus-S is called PCP communication (Peripherals Communication Protocol).

The devices are recognized by their identity code and have an additional tab.



”Enable” PCP communication assigns an AMS port to the device, via which the PCP communication is processed via ADS.

On the InterBus side, the communication connection between this device and the master card receives a communication number (CR = Communication Reference). A password and an access group number can also be specified (see description of PCP communication).

PCP services

The following services are currently supported:

1. Read (0x0081)
2. Write (0x0082)
3. Start (0x0083)
4. Stop (0x0084)
5. Resume (0x0089)
6. Reset (0x008A)

The required service is specified by entering the service code (mentioned above) in the ADS IndexGroup HIWORD (see ADS documentation).

You can simplify the process by using the code 0 for the read service in the case of an AdaReadReq and the write service in the case of an AdsWriteReq.

Index: The required PCP Index is entered in the LOWORD of the IndexGroup.

Sub-index: The required PCP sub-index is entered in the IndexOffset.

11.3.5 CANopen

The following devices with CANopen slave interface are currently supported by TwinCAT:

● Slaves

i Of course, all CAN[open]-compliant slaves with corresponding settings are supported via the general "CANopen Node", which is also listed.

CANopen – devices ("Boxes")	Description
BK5100 [▶ 280]	Bus Coupler
BK5110 [▶ 280]	Economy Bus Coupler
BK5120 [▶ 280]	Bus Coupler (successor of BK5100)
LC5100 [▶ 280]	Low-cost Bus Couplers
 Pxxxx-B510 [▶ 280]	Fieldbus Compact Box: CANopen input/output module with protection rating IP67
 Lxxxx-B510 [▶ 280]	Fieldbus Coupler Box: extendable CANopen input/output module with protection rating IP67
AX2000-B510 [▶ 328]	AX2000 servo drive with integrated CANopen interface (X6)
CANopen Slave FC510x	Beckhoff FC5101 or FC5102 fieldbus card as CANopen slave device
CANopen Node [▶ 320]	General CANopen device or general CAN device (access via CAN layer 2)

11.3.5.1 CANopen Device

CANopen devices which are not recognised by the TwinCAT System Manager can be incorporated into the network by selecting the box "CANopen Node". The CAN(open) messages (PDOs) can be configured directly for these devices. This will guarantee the optimum flexibility of this general CANopen interface.

When using the FC510x, this box also enables you to receive and send any CAN identifier - this enables communication with any CAN node. The only condition is the support of at least one of the [Baud Rates](#) [[▶ 392](#)] supported by the FC510x.

"CAN Node" tab

Node ID: Enter the general CANopen device node address here. If you select the "Automatic Adjust PDO COB IDs" box, the default identifier for the process data object can also be carried out after changing the node ID.

Profile no.: After CANopen, the parameter 0x1000 "Device Type" contains the number of the device profile supported by the device in both the lowest value bytes. These are entered here and compared with the device parameter present at the system startup. If no device profile is supported, the parameter will contain the value 0.

Add info: The additional information is located in the two highest value bytes of the object directory entry 0x1000 (device type).

FC510x: The target/actual configuration comparison is only done if Profile no. or Add. info (i.e. object directory entry 0x1000) is set to a value that is not null. If the expected values at the system startup do not match with the values present, the start of this node will be interrupted and a corresponding error message will appear in the Diag tab.

CIFx0-CAN: The values are continuously compared (even if "0" is entered in both). If values do not match, the node start is interrupted.

Guard time: The guard time determines the interval at which the node is monitored (node guarding). 0 signifies no monitoring.

Life time factor: Guard time x life time factor determines the watchdog length for the mutual monitoring of card and CANopen nodes. 0 indicates that the CANopen node is not monitoring the card. At 0 the card takes the Guard time directly as the watchdog length.

FC510x: This card also supports the heartbeat protocol and firstly attempts to start this form of node monitoring on the CANopen node (write access to objects 0x1016 and 0x1017 in the object directory). If this attempt fails, guarding is activated. The Guard time is entered as producer, heartbeat time and (guard time x lifetime factor) are entered as consumer heartbeat time. The card then transmits its heartbeat telegram with the smallest configured guard time (the guard times can be set individually for each node).

Emcy COB ID. and Guard COB ID are identifiers for emergency messages or the guarding protocol. They result from the node address.

Automatic PDO... Specifies whether TwinCAT should download the PDO communications parameters to the node at the system startup.

FC510x: If the download of the PDO parameters fails, the card attempts to read these parameters and compares them with the configured values. It thus also supports nodes which have implemented the default identifiers as read-only values, for example.

CIFx0-CAN: The PDO parameters are transmitted to the CANopen nodes, but it is tolerated if the nodes do not support these entries – only a confirmation of the SDO access is required (an SDO abort response is sufficient).

Vendor ID, Product code, Serial no., Revision no. (FC510x only): If values other than zero are entered here, these identity object entries (0x1018 in the object directory) are read at system startup and compared with the configured values. The corresponding node will only be started if the values match. It is also possible to compare a part of the value (e.g. Vendor ID and Product code) – then, only the non-desired parameters need to be set to null.

Node error response (FC510x only):

Stop node: After a detected node error, the node is set to "Stopped" state (NMT command "Stop remote node"). The node (according to each device profile) can then be switched to a safe state via the network status machine – SDO addressing is not possible in this mode.

No reaction: No NMT Stop remote node command after node error

Node restart (FC510x only):

Automatic restart: After a node error is detected, the card automatically attempts to restart the node. The start attempt is initiated by a Reset node command.

Manual restart: After a node error, this node remains in error state and is not restarted automatically. You can trigger a restart via "I/O reset".

Network reaction (FC510x only):

No reaction: The failure of a node has no effect on the other bus devices

Stop all nodes: After the failure of a node, all other previously started nodes are stopped (NMT Stop remote node command). You then need to restart the system.

General CAN node (FC510x only): If this checkbox is selected, the whole CANopen network management is disabled for this device, i.e. it is not started and monitored etc. The PDO entries are regarded as pure CAN telegrams (layer 2) and made available to the controller on an event-driven basis.

● CANopen terminology is retained

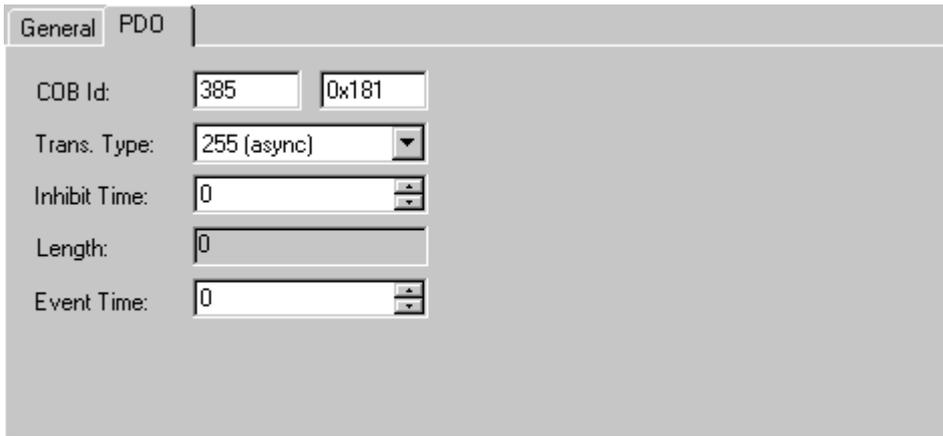
i As the CANopen terminology is retained, even for general CAN nodes, it must be noted that RxPDOs are the telegrams sent by the Fc510x and TxPDOs are the received telegrams.

This option allows any CAN node to be connected to the TwinCAT, if the [baud rate \[► 392\]](#) and the bit timing parameters match. The respective protocol can then be simulated within the PLC program. It is also possible to run CANopen devices and general CAN nodes within the same network – if there are no identifier overlaps (the system structure is such that you cannot use an identifier twice).

CANopen PDOs

[Process Data Objects \[► 382\]](#) (PDOs) are CAN telegrams which transport process data without a protocol overhead. RxPDOs are received by node, TxPDOs are sent by the node. This description is contained in the System Manager from the perspective of the configured node, i.e. RxPDOs are sent by the TwinCAT, TxPDOs are received by the TwinCAT.

"PDO" tab



COB Id: The CAN identifier of this PDO. For every two send and receive PDOs per node, CANopen provides [Default Identifiers \[► 392\]](#). These can then be changed.

Trans.Type: The [Transmission Type \[► 382\]](#) determines the send behavior of the PDO. 255 corresponds to the event driven send.

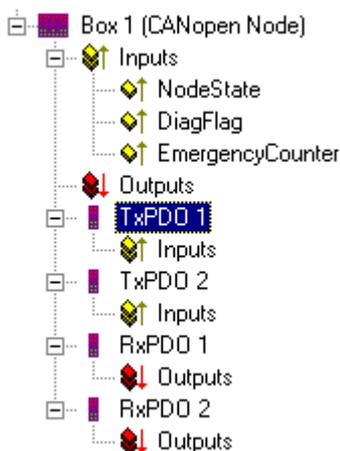
Inhibit time: [Send Delay \[► 386\]](#) between two identical PDOs. Is entered in multiples of 0.1 ms.

Length: The length of the PDO is based on the mapped variables and cannot therefore be edit here.

Event Time (FC510x only): Enter the value for the [Event Timer \[► 386\]](#) in ms. For send PDOs (here: RxPDOs, see above) the StartUp of this timer triggers an additional PDO send, for receive PDOs (here: TxPDOs) the arrival of a PDO within the pre-set value is monitored and the box state of the node is changed as appropriate. If 0, the parameter is not transferred to the node.

TwinCAT creates corresponding inputs in the node object directory based on the parameters entered here. These are transferred via SDO at the system start. You can view the inputs at the SDO tab. If this behavior is not required, you can deactivate "Auto Download of PDO Parameters" by selecting the checkbox at the CAN node tab.

Tree representation:



TwinCAT primarily provides two send and receive PDOs, marked with [Default identifiers \[► 392\]](#), for a general CANopen node. Superfluous PDOs can be selected and removed.

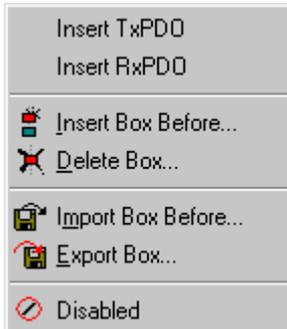
TxPDOs are sent by the CANopen node and generally contain inputs. RxPDOs are received by the node, i.e., sent by TwinCAT

Add variables to the PDOs by right clicking on "Inputs" and/or "Outputs" and selecting the corresponding variable(s). If several variables of the same type are inserted with a single action, the offset within the PDO will be created automatically. If variables are inserted one after another, you need to set the corresponding offset (start address within the CAN telegram) for each variable.

i Pay attention to the order

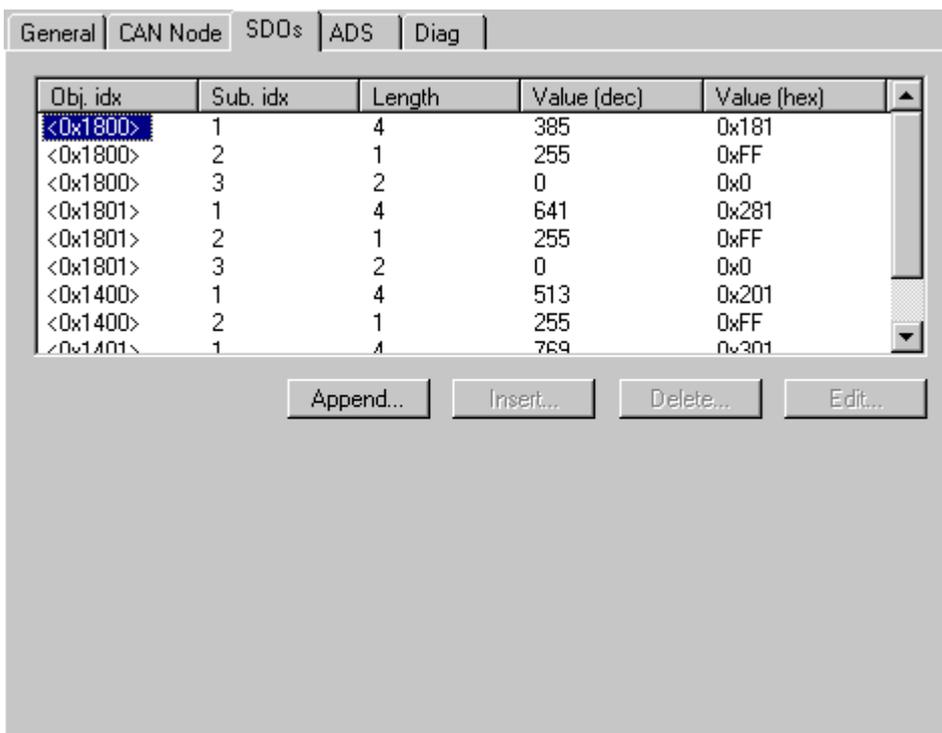
TwinCAT places the PDOs in the displayed order according to the object directory entries in the node. This way, for example, the PDO communication parameters of the third listed TxPDO are always written to index 0x1802 – regardless of the designation of the PDO in the System Manager. Thus, if only PDO1 and PDO3 are to be used, a PDO2 must also be entered – in this case without assigning variables. PDOs without variables are not transmitted and also not expected.

Context menu:



The menu alongside is obtained by right clicking on the general CANopen node. Here you can insert further Tx PDOs and/or Rx PDOs.

"SDOs" tab



SDO inputs sent to the node at StartUp are displayed/managed on this page. Inputs with an object index in straight brackets are automatically created based on the updated terminal configuration. Other inputs can be managed using "Add", "Insert", "Delete" and "Edit".

"ADS" tab

In order to be able to read and write SDO objects during the running time (e.g. from the PLC), the node (Bus Coupler) can be allocated an ADS port (CIFx0-CAN). The FC510x always provides an ADS port for every node since the diagnostic information is transported via ADS. These ports can be used to read and write SDO objects using ADS read requests and/or write requests.

The ADS IndexGroup contains the CANopen object index and the ADS IndexOffset contains the CANopen SubIndex.

CANopen Emergency Object

Some CANopen status data and up to 5 emergency objects received from a node can be read from any TwinCAT program via ADS and/or signalled to any TwinCAT program. In this case, set ADS parameters as follows:

Port: 300

IndexGroup: 0x5000 + Device-ID

IndexOffset: Hi-Word: Node-ID, Lo-Word: 0x100

Length: 8 - 48

The diagnostic data is structured as follows:

Offset: 0: Nodestatus bits

Bit 7: Node is deactivated

Bit 3: Guarding protocol is active

Bit 2: parameterisation error

Bit 1: Emergency buffer overflow

Bit 0: Mode does not respond

Offset: 1,2: Node type (Index 0x1000)

Offset: 3,4: Profile Number

Offset: 5: Node State

1: Disconnecting

2: Connecting

3: Preparing

4: Prepared

5: Operational

127: Pre-Operational

Offset: 6: Current Error

30: Guarding malfunction

31: Node has changed status

32: Sequence error in guarding protocol

33: No answer from remote frame PDO

34: No answer during a node configuration

35: Incompatible node profile number

36: Incompatible node device type number

37: Unknown SDO response received

38: SDO syntax error

39: Node in STOP mode

Offset: 7: Number of Emergency Messages

Offset: 8-47: Emergency buffer (-> node description)

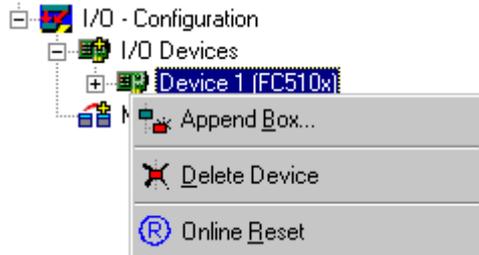
The data contain the status. The emergency buffer contains the last emergency messages received. The node status bits are collated in the box state diagnostic input.

11.3.5.2 CAN Box Reset

CAN box Reset takes place in 8 steps.

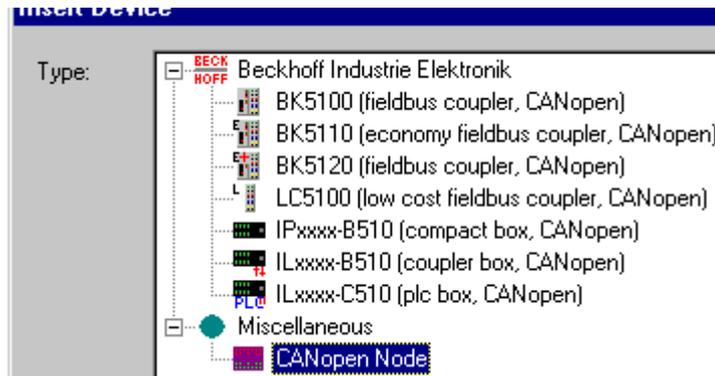
1. Step:

At first, you must add the box. Open the dialog box under the device (here FC510x, CANopen Master, PCI).



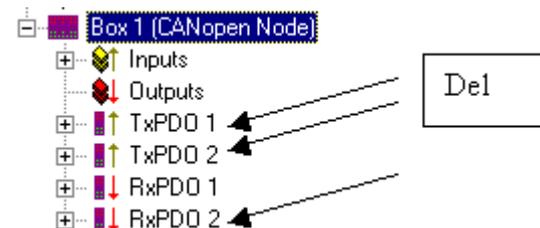
2. Step:

Choose 'CANopenNode' in the dialog 'Insert device'.



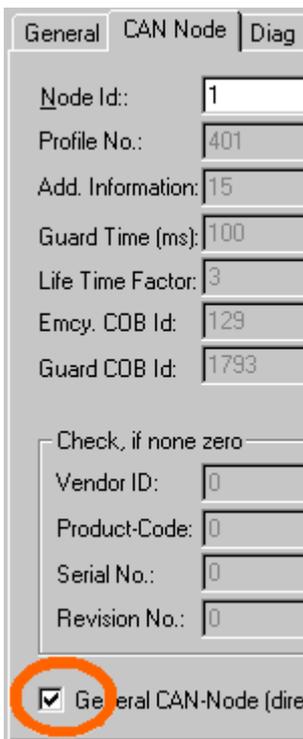
3. Step:

The box has 2 inputs and outputs. You must delete TxPDO1, TxPDO2 and RxPDO1.



4. Step:

The appropriately tab must have the following settings:

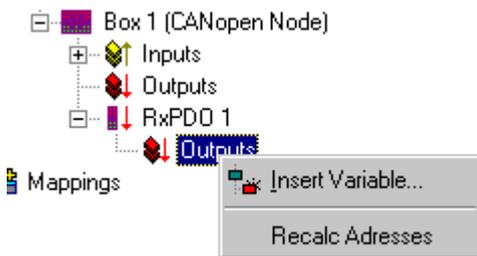


5. Step:

At the output RxPDO1 tab, the COB ID must be set to zero.

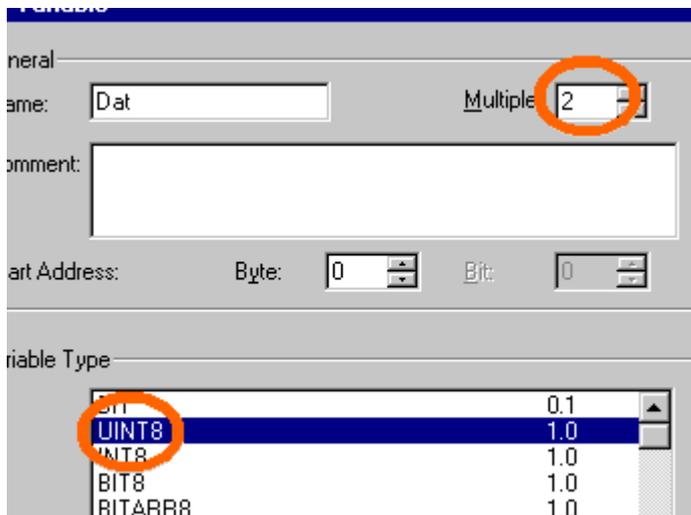
6. Step:

When you open the dialog box under RxPDO 1 'outputs', you can insert further variables.



7. Step:

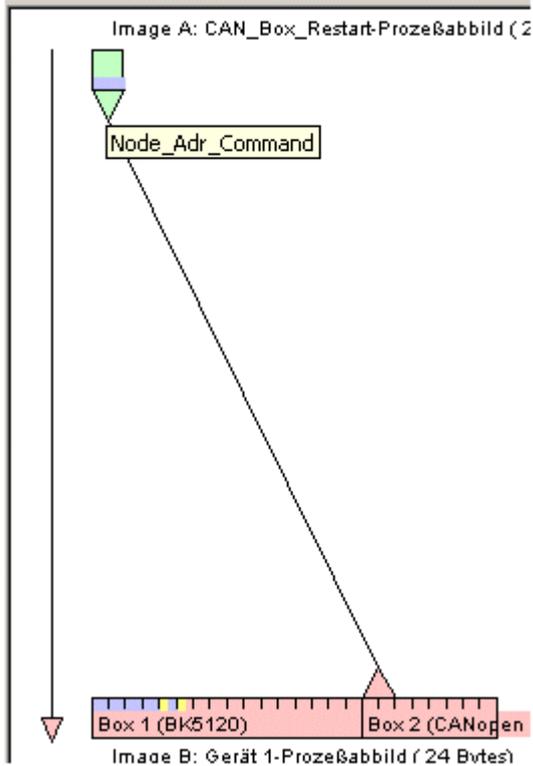
The appropriately tab must have the following settings:



8. Step:

Mapping

This is the appropriately representation.



Thus, CAN box RESET is terminated.

11.3.5.3 AX2000-B510 Axis (with cyclical CANopen interface)

The Beckhoff AX2000 drive is available with different optional Fieldbus interfaces. Besides these optional Fieldbus interfaces, the drives comes with an integrated CANopen interface already (X6). The AX2000 (from firmware **revision 4.94** on, recommended is drive firmware **revision 5.53** or higher) is in conjunction with the [FC5101 \[▶ 169\]](#) resp. [FC5102 \[▶ 169\]](#) capable of resolving the [SYNC \[▶ 384\]](#) telegrams according to [CANopen specification DS301 V4.01](#). Therefore, the AX2000 can synchronously update its input and output process image.

Intrduction

Since TwinCAT 2.9, an AX2000-B510 can be mapped in the same way as any other NC supported drive type. Means, an axis e.g. "Axis 1" can be added to the NC task, the CAN specific drive type "*AX2000-B510 Drive (CANopen)*" can be selected via "Axis type" on the "Settings" tab and this can be linked to a "AX2000-B510" node, configured under I/O Devices -> FC510x (important is here, that a Beckhoff FC5101 or FC5102 is used in this case). Below description explains the AX2000-CANopen-specific settings in detail.

For further information on the AX2000 in CAN operation mode, please consult the manuals to be found under Digital compact [Servo amplifier AX2000](#) on the Beckhoff Download page or Beckhoff Product CD.

"CAN Node" tab

Node Id: The address of the CANopen node (in this case the CAN address of the AX2000 drive) must be assigned here. The drive internal setting of this address can be set via the AX2000 configuration software SR600 or through the ASCII - communication mode. The address given in this dialog must match the internal set drive address.

Profile No.: + Add. Information : This object (0x1000) describes device type (Servo drive) and device functionality (*DS402* drive profile).

It is the combination of the following:

Description		Value	Bit	
Number of the device profile:	Drive profile	402 (dec.)	0x192 (hex.)	0 - 15
Type:	Servo drive	2 (dec.)	0x2 (hex.)	16 - 23
Mode bits: (Not shown in the dialog. Bits are going to be masked if necessary, into the Hi-Byte of the Hi-WORD)	Vendor-specific	0		24-31

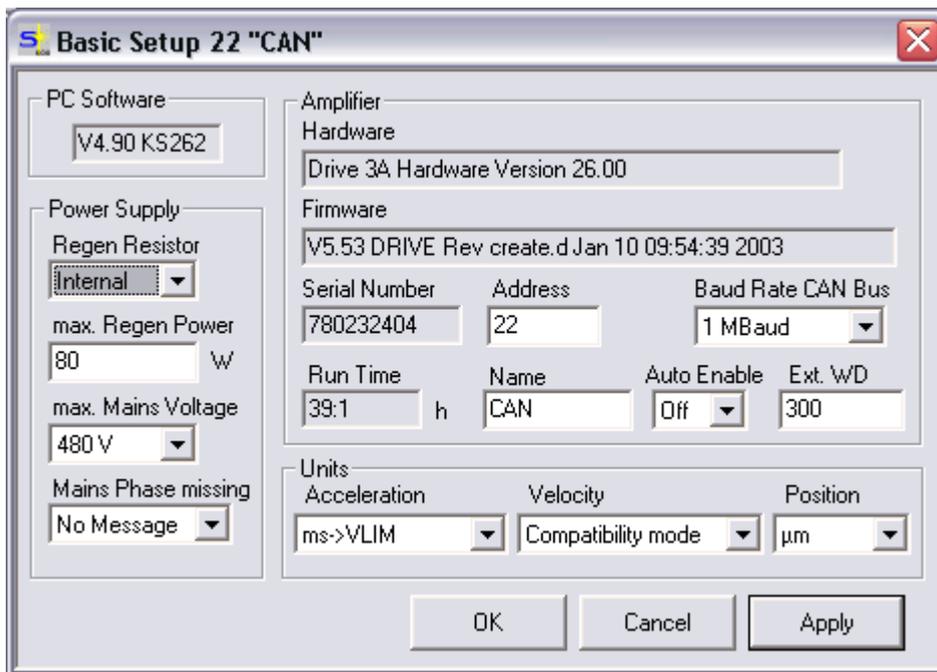
Guard Time (ms): Watchdog-time in milliseconds.

Life Time Factor: Specifies the handling of the "Guard Time". E.g. a here entered "0" deactivates the watchdog. Default value is "3".

Rest of the parameters, [see: CANopen device |> 320](#)

Adjustments of Address and Baudrate with Drive Configuration Software

The relevant settings for the CAN bus (Node Id, Baudrate,..) can be set via the basic settings of the SR600 software. By default address 1 and baudrate 500kb is set. After changing these values, a "Save to EEPROM" with a following coldstart is necessary (**SAVE command with following COLDSTART**).

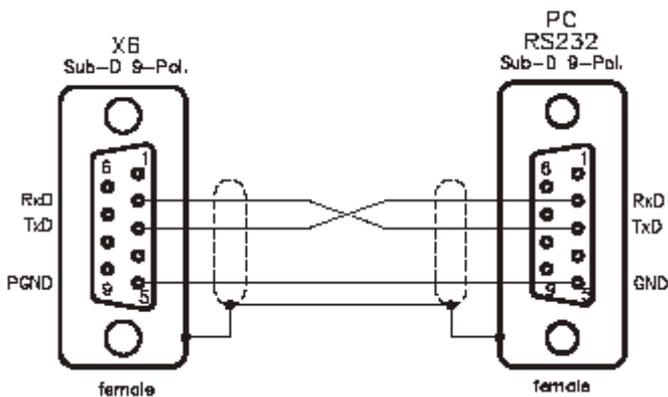


Setting the address and baud rate via the serial interface (HyperTerminal)

Setting the address and baud rate via the serial interface (HyperTerminal)

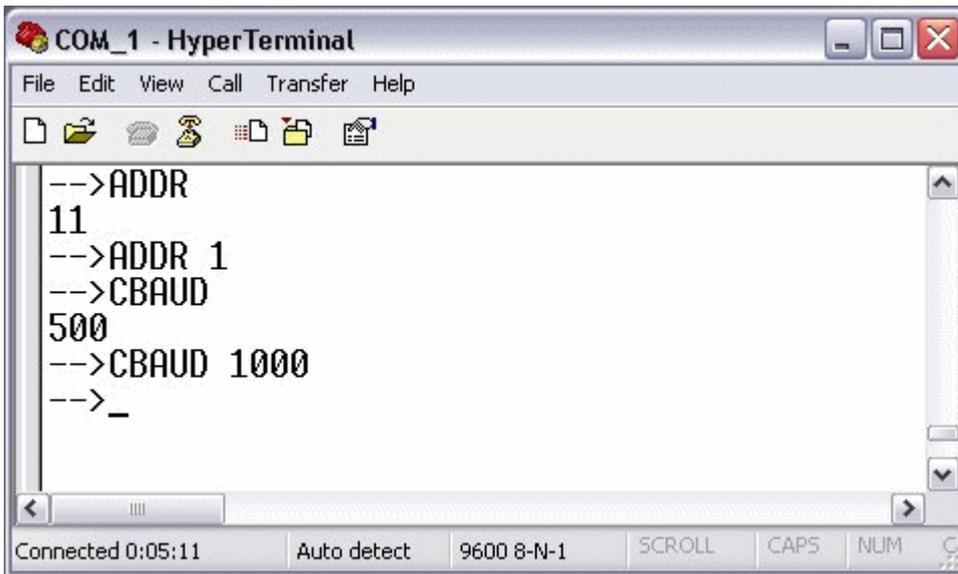
Start the MS Windows *Hyperterminal* (*Start | Run... | hypertrm.exe*). Interface setting : '9600 baud, 8 bits, 1 stop bit, **no** parity, **no** handshake'. Click in the window and press *Enter* key.

If the serial cable is connected correctly (X6 ----- RS232), the cursor " -->" appears in the window.



i Solder bridge

If you solder a bridge between pin 7 and 8 on both sockets of the serial cable, the cable is symmetrical and it does not matter which connector is connected to which of the two end devices.



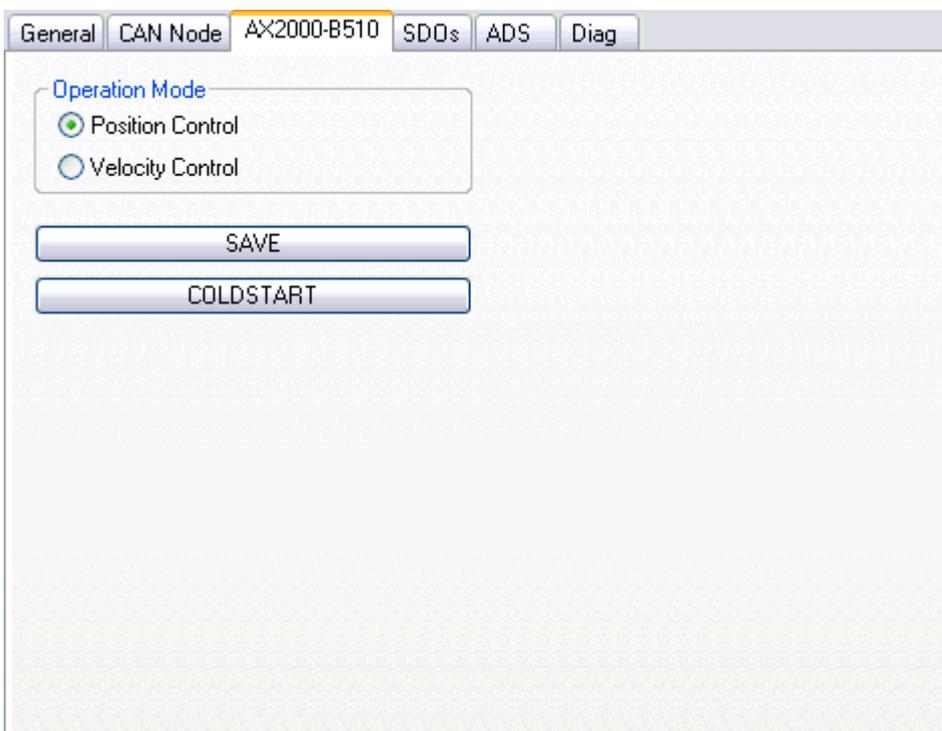
If you want to read the current parameter, enter the ASCII command without parameters (e.g. *ADDR*). The result is displayed in the next line.

If the address is to be written, the address is appended after the ASCII command (e.g. *ADDR1*).

AX2000-B510 tab

This tab is used to select the operating mode for the AX2000. Two operating modes are available.

Position Control: The default setting is "*Position Control*". In this operating mode, the NC cyclically specifies a new position. The travel profile is generated by the TwinCAT NC. In the cycle time of the SEC task (e.g. 10 ms), position values are transmitted to the AX2000 via the CAN interface. There are 3 controllers cascaded into each other on the AX2000 (current (65 μ s), speed (250 μ s), position (corresponds to the cycle time of the triggering SEC task)). The position control is handled entirely by the AX2000. The AX2000 reports the actual position back to the NC via the cyclic interface.



Velocity control: Optionally, "*Velocity Control*" can be activated. In this operating mode, the speed serves as the manipulated variable for the AX2000. This reduces the number of internal control loops of the AX2000 to 2, namely the current (65 μ s) and speed (250 μ s) controller. Compliance with the target position is checked in TwinCAT NC. The actual position is transmitted via the cyclic interface. Since the speed control on the TwinCAT NC requires shorter sampling times, the cycle time of the SEC task is set to 2 ms.

Save: When changing the cycle time of the triggering task (usually this is the NC *SEC – task*) or when changing the operating mode (OPMODE), the "SAVE" button should always be pressed.

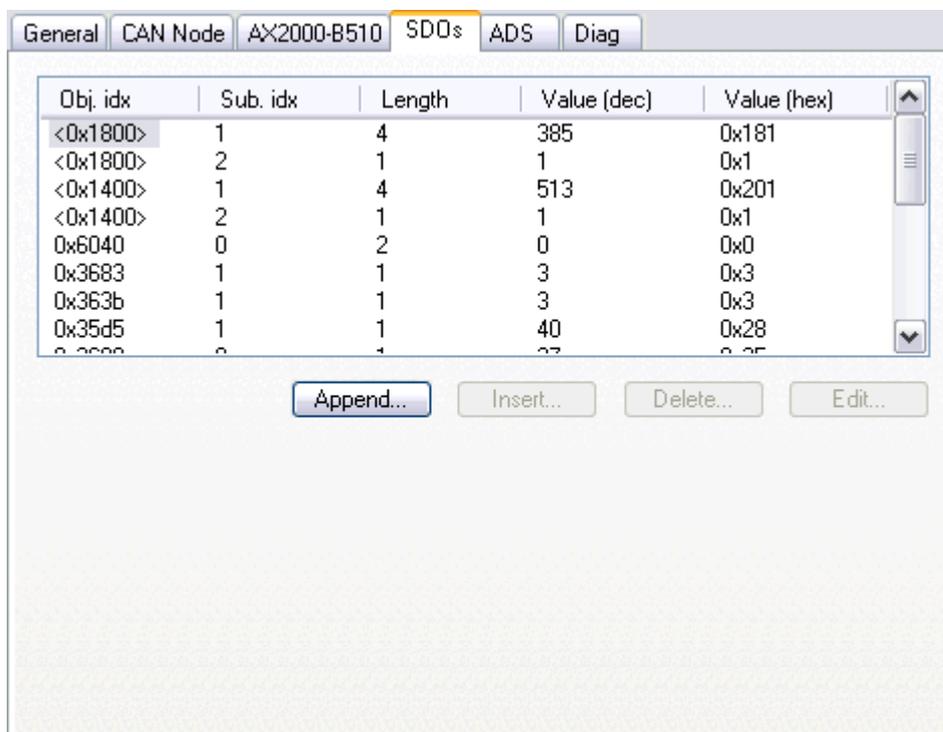
Coldstart: If the data are stored (approx. 3 s after "SAVE") a cold start ("*COLDSTART*") of the controller is necessary.



The SAVE and COLDSTART commands can also be executed when the controller is enabled!

"SDOs" tab

In this tab, the CAN node can be parameterized in the start-up phase via the service data objects (SDOs). Entries with an object index in straight brackets have been generated automatically due to the updated terminal configuration. Additional entries can be managed using "Append", "Insert", "Delete" and "Edit".



The SDO's are primarily used for parameterization of the CAN Node and the CAN *PDOs* [► 382]. The first two entries define the properties of the TxPDO1:

Object index	Sub Idx	Length	Value	Description
0x1800	1	4	0x18B	Cob ID (address for the send message of node 11) <u>Default identifier</u> [► 392]
0x1800	2	1	1	<u>Transmission type</u> [► 382]

The RxPDO is configured in the same way.

Custom SDOs

Controller configuration

Object index	Sub Idx	Length	Value	Description
0x6040	2	2	0	Sets the drive <i>ControlWord</i> to null. The controller is now in the "Switch on disable" state. The AX2000 is ready to be switched on, parameters can be transferred, DC link voltage can be switched on, motion functions cannot yet be executed
0x3683	1	1	3	ASCII command: SYNCSRC
0x363b	1	1	3	Synchronization mode specially adapted to the CAN interface, ASCII command: FPGA
0x35d5	1	1	40	Value = Task Cycl / Velocity controller Cycl 40 = 1000 μs / 250 μs, ASCII command: PTBASE
0x6060	0	2	0xFA	This sets the OPMODE of the drive: 0xFA = Position control 0xFE = Velocity control
0x3672	1	1	2	Influencing the CANopen state machine by Enable/Disable.

PDO mapping [▶ 382]

The AX2000 has 4 transmit PDOs (TxPDO1..4) and 4 receive PDOs (RxPDO1..4). The content of these messages (PDOs) depends on the operation mode and the mapping. There are 7 predefined RxPDOs and 6 predefined TxPDOs. In addition to this, there is an option to compose the message.



Do not map every object

Not every object can be mapped in a freely definable PDO.

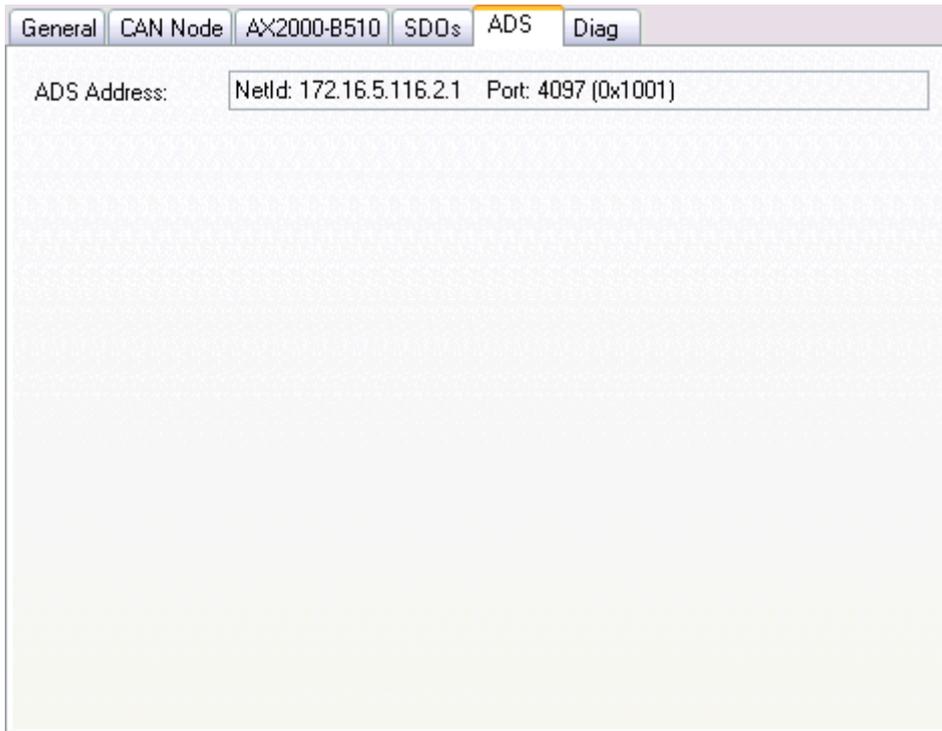
For the "Position control", both the RxPDO and the TxPDO were configured freely. For "Velocity control", the TxPDO was taken from the pool of predefined PDOs. The RxPDO was defined freely.

Example:

Object index	Sub Idx	Length	Value	Description
0x2600	0	1	0x25	Selection of a freely definable RxPDO (37..40)
0x1600	0	0	0	Delete mapping
0x1600	1	4	0x60400010	The first element of the message is the ControlWord (0x6040) Subelement SI (0x00) Length (0x10) 16-bit
0x1600	2	4	0x20220420	The first element of the message is the TargetPosition (0x2022) Subelement SI (0x04) Length (0x20) 32-bit

"ADS" Tab

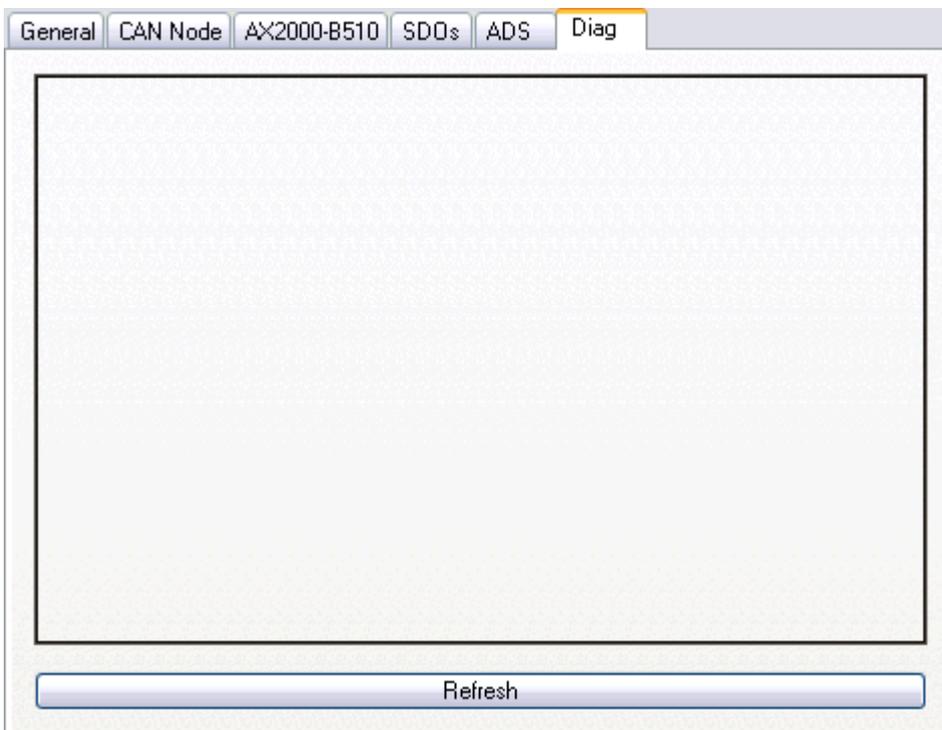
Via the shown AmsNetID + Port number (address) it is possible to read and write parameters from/to the AX2000 (e.g. from PLC).



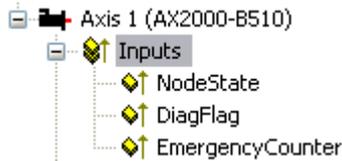
Example: To read the device type, the object information Index: 0x1000, SI: 0x0 is used.

"DIAG" Tag

Under this tab, detailed error messages are displayed. With a wrong configured *Additional Information* for example, the CANopen Master e.g. detects the difference between the configured value and the one contained in the drive. If everything is ok and the drive is ready for operation, it shows"".



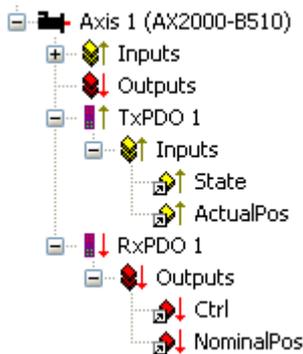
AX2000-B510 Diagnosis Inputs



The diagnosis [Inputs \[▸ 178\]](#) of an AX2000-B510 don't differ from the diagnosis inputs of other TwinCAT CANopen nodes (see also: "[FC510x: Box-Diagnosis \[▸ 177\]](#)").

Process Image

The TxPDO's and RxPDO's are to be seen from the slave point of view. The input process image (TxPDO) contains a "State" and "ActualPos" process variable. The output process image (RxPDO) contains a "Ctrl" and a "NominalPos" variable.



"State": Object information Index: 0x6041, SI: 0x0, Len: 2

Bit	Name	Bit	Name
0	Ready to switch on	8	Manufacturer specific (reserved)
1	Switched on	9	Remote (not supported)
2	Operation enable	10	Target reached
3	Fault (i.V.)	11	Internal limit active (not supported)
4	Disable voltage	12	Operation mode specific (reserved)
5	Quick stop	13	Operation mode specific (reserved)
6	Switch on disabled	14	Manufacturer specific (reserved)
7	Warning	15	Manufacturer specific (reserved)

"ActualPos": Current drive position. Object information Index: 0x2070, SI: 0x3, Len: 4

Via this index, the incremental encoder value (drive emulated) of the current position can be read. One revolution has an incremental value of a 20 bit resolution.

That means: 1 revolution 2^{20} increments = 1048576 increments. The adjusted resolution per revolution can be checked with the ASCII command "PRBASE".

Default value: 20 bit/rev.

"Ctrl": Object information Index: 0x6040, SI: 0x0, Len: 2

Bit	Name	Bit	Name
0	Switch on	8	Halt (intermediate stop command)
1	Disable Voltage	9	(reserved)
2	Quick Stop	10	(reserved)
3	Enable Operation	11	Acknowledge lag-distance and watchdog
4	Operation mode-specific	12	Reset position
5	Operation mode-specific	13	Manufacturer specific (reserved)
6	Operation mode-specific	14	Manufacturer specific (reserved)
7	Reset Fault (only active after error messages)	15	Manufacturer specific (reserved)

"NominalPos": Setpoint position. Object information Index: 0x2022, SI: 0x4, Len: 4

Via this parameter, the incremental value of the setpoint position is prescribed.

"NominalVelo": Setpoint velocity. Object information Index: 0x2060, SI: 0x0, Len: 4

Via this parameter, the scaled setpoint velocity is prescribed.

11.3.6 DeviceNet

The following devices with a DeviceNet slave interface are currently supported by TwinCAT.

● DeviceNet devices



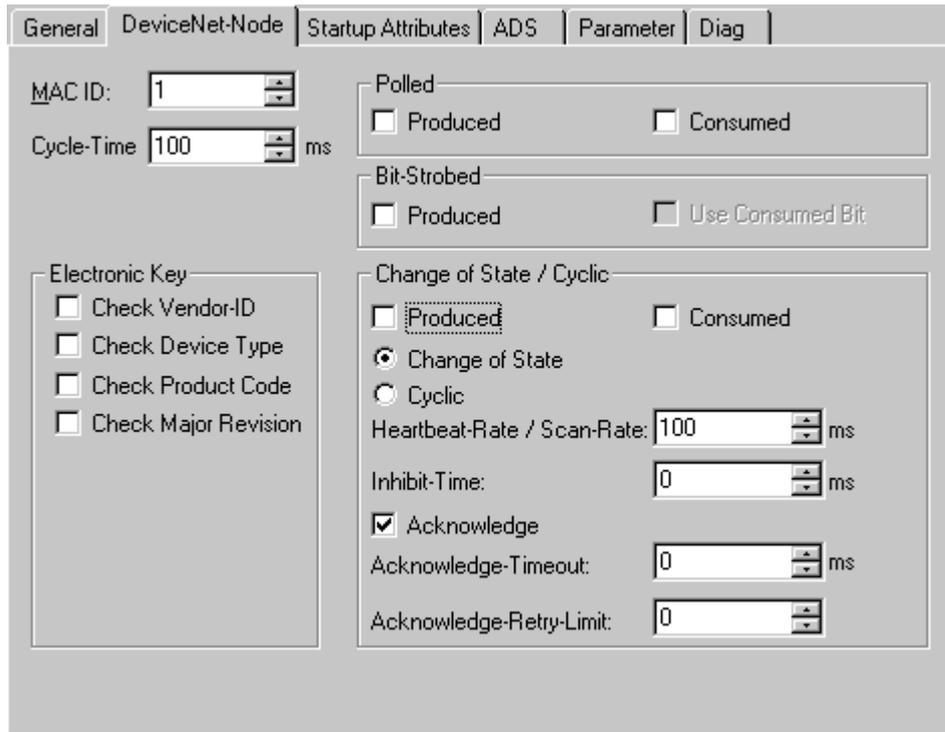
All DeviceNet devices for which a valid EDS file is available are supported via the general "DeviceNetNote", which is also listed.

DeviceNet – devices ("boxes")	Description
BK5200 [▶ 282]	Bus Coupler
BK5210 [▶ 282]	Economy Bus Coupler
BK5220 [▶ 282]	"Economy plus" Bus Coupler
LC5200 [▶ 282]	Low-Cost Bus Coupler
IPxxxx-B520 [▶ 282]	Fieldbus Compact Box: DeviceNet input/output module with protection rating IP67
ILxxxx-B520 [▶ 282]	Fieldbus Coupler BoxExtendable DeviceNet input/output module with protection rating IP67
FC5201 Slave	External FC5201 or FC5202 as slave device on the bus
DeviceNet Node [▶ 336]	General DeviceNet slave device

11.3.6.1 DeviceNet Device

Select DeviceNet node to integrate general DeviceNet devices. You then need to enter the connection parameters for these devices.

"DeviceNet Node" tab



MAC Id: Sets the node ID of the DeviceNet participant (between 0 and 63). This value must comply with the value set at the node.

Cycle Time: Sets the cycle time for the IO connection. This value is added to the Expected Packet Rate (EPR) attributes of the DeviceNet slave and acts as a timeout monitor for IO connections.

Electronic Key: Serves to check the devices within the network at the system StartUp. The electronic key is read from the devices at every system StartUp and compared with the saved configuration.

Polled: Produced/Consumed: Activation of the "Polling" operating mode, cyclical writing and reading of IO data

Bit-Strobed: Produced/Consumed: Activation of the "Bit Strobe" Operating Mode. With a broadcast message all nodes are requested to send their bit strobe message (up to 7 bytes input or status data).

Change of State / Cyclic: Produced/Consumed: Activation of "Change of State" operating mode, event controlled sending of IO data or "Cyclic", cyclical sending of IO data.

- Change of State / Cyclic: Selecting the Corresponding Operating Mode
- Heartbeat Rate / Scan Rate: In the "Change of State" mode the heartbeat rate gives the cycle time of the cyclical send of the lower-level (i.e. in addition to the event driven) IO data. In the "Cyclic" operating mode the scan rate gives the cycle time of the IO data send.

Inhibit time: Delay period in the "Change of State" operating mode inserts this pre-set delay period after a change of state before the IO data send.

Acknowledge Timeout: Time before the re-send in the event of faulty acknowledgement of a change of state / cyclical message.

Acknowledge Retry Limit: Maximum number of re-sends until IO connection goes into error mode.

K-Bus Update: Calculates the anticipated duration of a complete update of the terminal bus (according to the number of connected terminals).

Input Diagnosis:

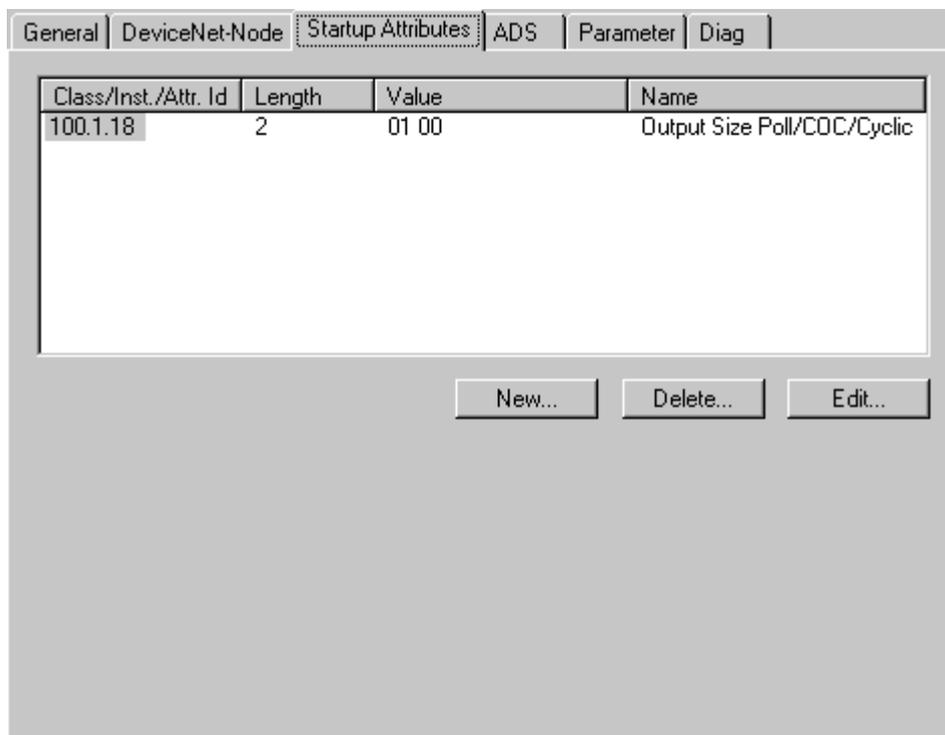
Each DeviceNet fieldbus node contains one diagnostic input byte which signals the status of the current slave during the running time and can be linked, for example with the PLC.

Table 17: BoxState

Error Code	Description	Troubleshooting
0x02	Station not exists, device is not responding	Inspect the device, verify connections, check cabling
0x05	Parameter fault	Check explicite access to devices attributes, check object class, instance, and attribute id
0x07	Configuration fault	Check configuration settings of device
0x09	Device is deactivated	Check master and device configuration

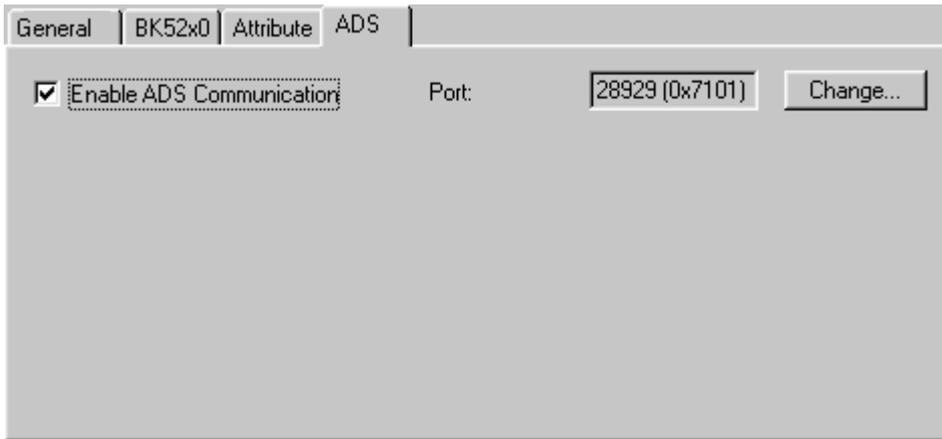
Table 18: DataExchange

Error Code	Description	Troubleshooting
0x00	No data exchange between node and master	Inspect the field device, verify connections, check cabling
0x01	Data Exchange is active	

"Attributes" tab

DeviceNet attributes/parameters sent to the node at StartUp are displayed/managed on this page. Other inputs can be managed using "New", "Delete" and "Edit".

"ADS" tab



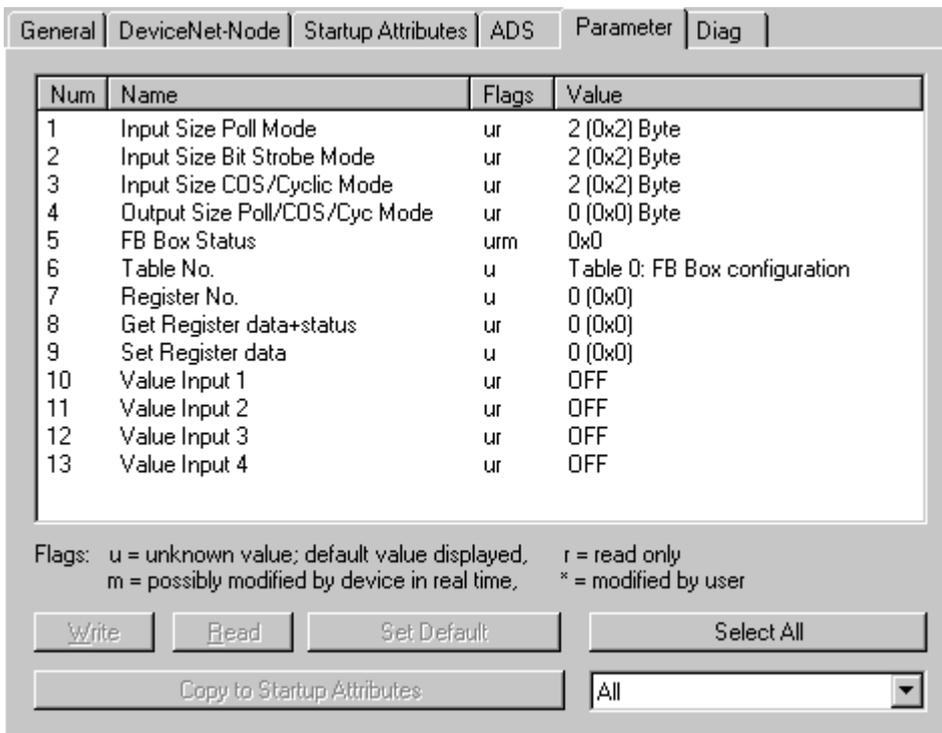
In order to be able to read and write attributes during the running time (e.g. from the PLC), the node (Bus Coupler) can be allocated an ADS port. These can be used to read / write attributes via ADS read requests / ADS write requests.

The ADS IndexGroup contains the ClassId and the ADS IndexOffset contains Instanceld and AttributeId (Instanceld * 256 + AttributeId).

Diagnostic data

The DeviceNet status data from a node can be read by any TwinCAT program via ADS and/or signalled to any TwinCAT program.

"Parameter" tab



The parameters are read from the EDS when creating the box. If the system has not started up yet, the EDS default value is always displayed under the value input.

11.3.7 SERCOS Interface

The following devices with SERCOS interface are currently supported by TwinCAT:

Requirements

SERCOS - Node Types ("Box")	Description	Restrictions / Comments
SERCOS Axis [▶ 340]	Generic SERCOS axis	The SERCOS implementation in TwinCAT is generic, means drive type independent, if the drive is SERCOS standard compliant.
BK7500 [▶ 286]	Beckhoff Standard Bus Coupler	
BK7520 [▶ 286]	Beckhoff "Economy plus" Bus Coupler	

11.3.7.1 SERCOS Axis

"SERCOS Drive" tab

The screenshot shows the 'SERCOS Drive' configuration window with the following settings:

- Address:** 11
- Operation Mode:** Velocity
- Telegram Type:** Configurable Telegram

The SERCOS interface logo is located at the bottom right of the window.

Address: SERCOS axis address which must be the same as the one on the drive amplifier.

Operating mode: Sets the SERCOS operating mode for the axis. It supports the speed operating mode (velocity control) in which speed command values are sent to the drive and the position control mode.

Operating mode	Description
Velocity	The drive receives digital velocity setpoints, which are generated by the TwinCAT NC controller on the PC.
Position 1	The drive receives digital position setpoints cyclically generated by TwinCAT NC. The loop is closed by the drive. The motor resolver provides actual position values (Position 1, Resolver, S-0-0051).
Position 2	The drive receives digital position setpoints cyclically generated by TwinCAT NC. The loop is closed by the drive. An external encoder provides actual position values (Position 2, S-0-0053).
Position 1+2	The drive receives digital position setpoints cyclically generated by TwinCAT NC. The loop is closed by the drive. Actual position feedback is provided from external encoder and from Resolver.
Position 1 without Lag	Drive-internal interpolation (drive is deployed without linkage to TwinCAT NC controller). The motor resolver provides actual position values (Position 1, Resolver, S-0-0051).
Position 2 without Lag	Drive-internal interpolation (drive is deployed without linkage to TwinCAT NC controller). An external encoder provides actual position values (Position 2, S-0-0053).
Position 1+2 without Lag	Drive-internal interpolation (drive is deployed without linkage to TwinCAT NC controller). Actual position feedback is provided from external encoder and from Resolver.

NOTICE

In the positioning operating mode, ensure that, if using a loop axis in the weighting mode for position data (S-0-0076), the modulo function is switched on and the resulting modulo value (S-0-0103) is recognized in TwinCAT (see "SERCOS" tab).

NOTICE

In speed operating mode, ensure that the output scaling for the drive is set correctly in the TwinCAT system (see "SERCOS" tab).

Telegram type: Sets the telegram structure to/from the drive. The "Configurable telegram" type is selected by default (see following table).

Telegram type	Description
Preferred telegram 1 (80 / -)	The telegram to the drive only contains the torque setpoint (IDN 80). There is no return telegram from the drive with this telegram type.
Preferred telegram 2 (36 / 40)	Telegram to drive: Velocity setpoint (IDN 36) Telegram from drive: Actual speed value (IDN 40)
Preferred telegram 3 (36 / 51)	Telegram to drive: Velocity setpoint (IDN 36) Telegram from drive: Actual position value (IDN 51)
Preferred telegram 3 ext. (36 / 53)	Telegram to drive: Velocity setpoint (IDN 36) Telegram from drive: Actual position value from external encoder (IDN 53)
Preferred telegram 4 (47 / 51)	Telegram to drive: Position setpoint (IDN 47) Telegram from drive: Actual position value (IDN 51)
Preferred telegram 4 ext. (47 / 53)	Telegram to drive: Position setpoint (IDN 47) Telegram from drive: Actual position value from external encoder (IDN 53)
Preferred telegram 5 (47 36 / 51 40)	Telegram to drive: Position and speed setpoint value Telegram from drive: Actual position and speed value
Preferred telegram 5 ext. (47 36 / 53 40)	Telegram to drive: Position and speed setpoint value Telegram from drive: Position (external encoder) and speed actual value
Preferred telegram 6 (36 / -)	The telegram to the drive only contains the speed setpoint (IDN 36). There is no return telegram from the drive with this telegram type.
Configurable telegram	A custom telegram configuration with all desired setpoints and actual values can be executed.



The calculation described for the FC750x [▶ 191] in the "Timing Offline" tab area assumes a basic telegram type (telegram type 2-4).

"Startup" tab

Id. No.	Name	Type	Value
S-0-0032	Primary mode of operation	UINT 16	2 (0x0002)
S-0-0044	Velocity data scaling type	UINT 16	1 (0x0001)
S-0-0076	Position data scaling type	UINT 16	129 (0x0081)
S-0-0103	Modulo value	UINT 32	3600000

In this case SERCOS parameters can be set here which are sent to the drive at every TwinCAT StartUp via the NC service channel and which overwrite the existing drive values.

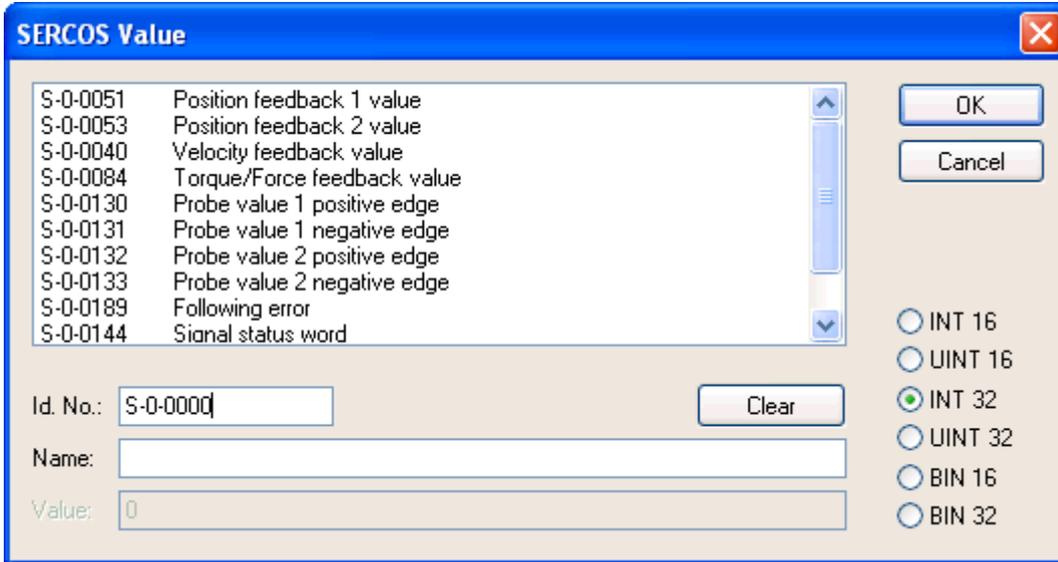
"Inputs" tab

Id. No.	Name	Type
S-0-0051	Position feedback 1 value	INT 32

Under "Inputs" (*Actual Channel*) all necessary and optional SERCOS parameters which come from the drive in this case, are listed. Corresponding variables are automatically created below the axis in the tree view. These can be linked accordingly.

A position feedback value is required in all cases!

New...: After hitting this button, additional variables can be inserted into the cyclical receive telegram from the drive:



At **Id. No.**, a supported IDN of the drive can be entered. **Name** is an edit field for a descriptive name for the IDN (suggested parameters from above shown list will fill this name field automatically). Additionally, Accordingly, the appropriate data type for the wished IDN has to be selected from the list, shown on the right.

"Outputs" tab

Variables, which must be transmitted to the drive, are specified here as in the "Outputs". Depending upon the axis operating mode, the list on this tab must contain the "Velocity command value" or the "Position command" value. Further parameters can be added in the same way as under "Inputs" here.

"ADS" tab

The ADS port number, via which all ADS access to the internal drive parameters takes place, is entered here at the [ADS tab](#) [▶ 49].

"Online" tab

Id.Nr.	Name	Unit	Value
S-0-0030	MFGver	--	FW5.41/2.43
S-0-0032	Pmode0	--	00000000 00000010
S-0-0033	Smode1	--	00000000 00000000
S-0-0036	VELcom	--	0
S-0-0038	VLIMpos	--	30000000
S-0-0039	VLIMneg	--	-30000000
S-0-0040	VELfbk	--	36120
S-0-0041	VELhome	--	592803
S-0-0042	ACChome	--	10
S-0-0043	VELpola	--	00000000 00000000
S-0-0044	VELmthd	--	00000000 00001010
S-0-0045	VELscal	--	1
S-0-0046	VELexpo	--	-4
S-0-0047	POScom	--	554593
S-0-0049	SWE2	--	1073741824
S-0-0050	SWE1	--	-1073741824
S-0-0051	POSfbk1	--	554633

The NC service channel can be served via the online tab. TwinCAT must be started for this to take place and the SERCOS ring must be in at least phase 2.

Diagnosis: After a click on this button, updated diagnostic information (see also [S-0-0095](#)) will be displayed on the field right next to it.

Reset: After a click on this button, the axis and or amplifier reset will take place (see also [S-0-0099](#)).

The list below shows all SERCOS parameters with current values. This data is read from the drive online (incl. text and units) which means that scrolling through the list takes some time. If the drive supports this function, you can choose between English and German output.

Change the parameters by double-clicking on the relevant ID no. to display a corresponding dialogue.

Context menu:

The list of SERCOS parameters may also be printed and exported (includes via drag and drop e.g. in Excel). Right click with the mouse to open a corresponding context menu:

Print List: Output of list on printer

Copy List: Copies the list into the Windows Clipboard

Copy selected IDN to Startup: If active, the selected IDN can be added to the [Startup](#) [[▶ 342](#)] parameters here.

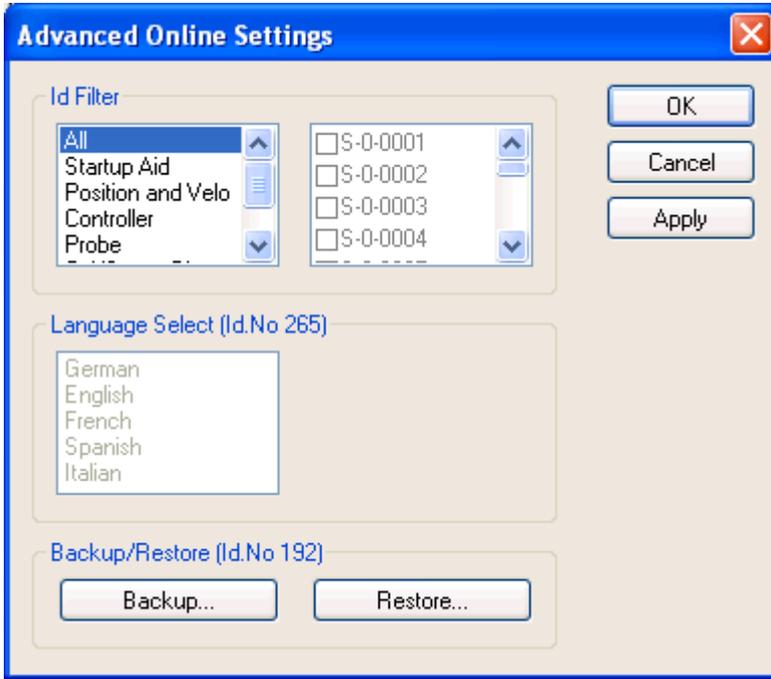
Export Complete List (CSV): After exporting the variable into a *.csv file (= *omma eparated aluescsv*), the parameters could be further used in applications which support this file format (e.g. MS Excel).

Export Complete (PAR): Exports the parameters into the DriveTop compatible *.par file format.

Update List: Click on this button to reload the currently viewed values from the drive.

Auto Update: Check this box to initiate a regular timed update (update rate approx. 2sec.).

Advanced: After a click on this button, the following dialog for the "Advanced Online Settings" comes up:



The upper left-hand list box allows you to place thresholds on the values displayed in the list on the "Online" tab. The system suggests a series of groups which define associated values in certain contexts. The last group on the list is a user-defined group. Any combination can be created in the right-hand list in this case.

Backup / Restore: These two buttons are used to save the parameters defined by the drive (see also S-0-0192) to a (backup) file and subsequently reload those parameters into a replacement drive (restore). The format of the backup file corresponds to the parameter format (*.par), which is used by the DriveTop tool supplied by company Rexroth-Indramat. This enables you to carry out data exchange using this tool.

SERCOS IDs via ADS

SERCOS IDs can also be read and written (e.g. from the PLC) during runtime via ADS. In this case the axis must be allocated an ADS port via the ADS tab [▶ 49]. This takes place as standard.

ADS read/write requests can be executed via this port. The IndexGroup corresponds to the required SERCOS IDN and the IndexOffset to the element of the SERCOS value:

Port No.: Number shown on "ADS" tab (see above)

IndexGroup: SERCOS ID, e.g.:

S-0-0123 = 123 (0x007B)

S-7-0101 = 101 + 0x7000 = 0x7065

P-0-0002 = 2 + 0x8000 = 0x8002

P-7-0004 = 4 + 0x8000 + 0x7000 = 0xF004

IndexOffset: Required element:

0 or 7 = value,

- 1 = Data Status,
- 2 = Name (read only),
- 3 = Attribute (see SERCOS specification),
- 4 = Unit,
- 5 = Minimum,
- 6 = Maximum

Reset via ADS

The drive amplifier can be reset (e.g. after exceeded max. lag-distance) via ADS. To the SERCOS IDN S-0-0099 an ADSWrite command (or sequence) has to be sent. The command varies depending on the used SERCOS master card

- FC7501 [▶ 191] resp. FC7502 [▶ 191]:

a drive reset can be achieved if to *IndexGroup*: 0x0063, *IndexOffset*: 8, a **3** is send ("ByRef", that means in this case: The address of a constant **3** has to be passed on to SrcAddr).

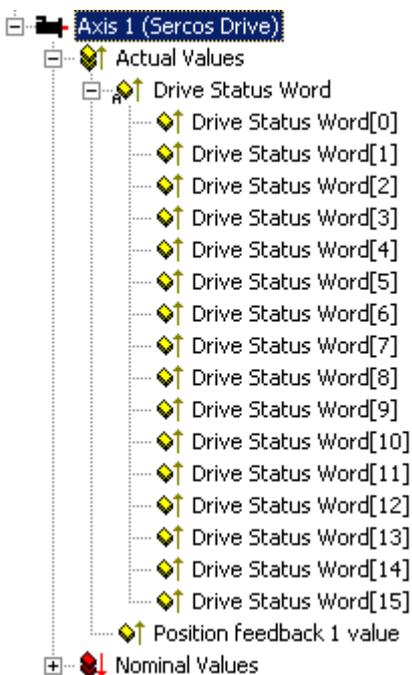
or at a

- SERCANS SCS-P Master card:

if the values **3**, **0**, **3** and **0** again, are sent "ByRef" (**SrcAddr**) one after another to *IndexGroup*: 0x0063, *IndexOffset*: 7.

(By the way, this is done internally by the TwinCAT System Manager, if you press the "Reset" button on the "Online" tab).

Diagnosis Inputs



The *Drive Status Word* is a SERCOS specific return telegram, all SERCOS drives have to provide.

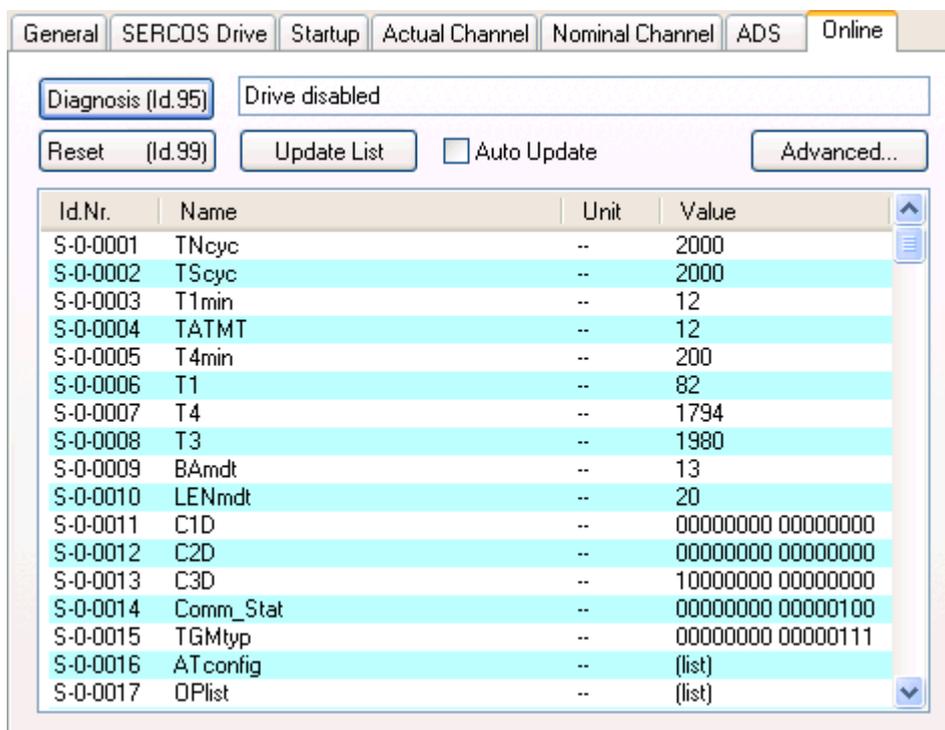
Variable	Data type	Bit	Description
Drive Status Word	UINT16	0..2	Control information for service channel
		5	Bit change command
		6+7	Real time status bits 1 + 2
		8+9	Actual type of operation 00: Main type of operation active 01: Secondary type of operation, etc.
		11	Bit change class 3 diagnostics
		12	Bit change class 2 diagnostics
		13	Drive lock, error in class 1 diagnostics
		14+15	Ready to operate 00: Drive not ready for power on, since internal checks aren't finished positively 01: Ready to power on 10: Control and power circuit ready for operation, torque free 11: In operation, under torque

11.3.7.2 AX2xxx-B750 Axis

The Beckhoff AX2000 or **AX2500** drive is available with different (optional) Fieldbus interface. One variant is the AX2000 with SERCOS interface (order no.: AX2000-**B750**).

The AX2000-B750 or AX2500-B750 is implemented in TwinCAT as a generic "SERCOS Axis [▶ 340]" like all others SERCOS drives, obviously shown on below screenshot. The following description reflects therefore only the internal objects (parameters) which are displayed on the "Online" tab.

"Online" tab



The buttons on the above dialog are documented under "SERCOS Axis [▶ 340]", as already mentioned.

The shown SERCOS S - and P - parameters, as well as other parameters supported by the AX2000-B750 drive are described under chapter: "Drive Technology: AX2000-B750 - IDN Reference".

11.3.8 Ethernet Interface

The following devices with Ethernet TCP/IP interface are currently supported by TwinCAT:

Beckhoff Ethernet - Node Types ("Box")	Description	Limitations / Comments
BK9000 [▶ 289]	Beckhoff Ethernet Standard Bus Coupler	
BC9000 [▶ 291]	Beckhoff Ethernet Bus Terminal Controller	
IPxxxx-B900	Beckhoff Ethernet Kompakt Box	(not yet available)
ILxxxx-B900	Beckhoff Ethernet Coupler Box	(not yet available)
ILxxxx-C900	Beckhoff Ethernet PLC Box	(not yet available)

11.3.9 Real-Time Ethernet Interface

The following listed devices for **Beckhoff's** [TwinCAT Real-Time Ethernet](#) [[▶ 409](#)] are currently supported by TwinCAT:

Real-Time Ethernet – devices (boxes)	Description	Restrictions/note
BK9000 [▶ 289]	BK9000 for Beckhoff Real-Time Ethernet	BK9000 firmware version from 'B8' required
AX2000-B900 [▶ 354]	AX20xx drive with optional Real-Time Ethernet interface card	AX2000-B900 firmware from 'B8' required (Ethernet interface)
Subscriber network variable	Beckhoff TwinCAT target system variable as "Subscriber"	
"Publisher" network variable	Beckhoff TwinCAT target system variable as "Publisher"	



Instructions for installing the Beckhoff Real-Time Ethernet driver can be found here ... [[▶ 413](#)]

11.3.9.1 Network Variable Publisher

The BeckhoffTwinCAT Real-Time Ethernet [[▶ 409](#)] solution contains from TwinCAT v2.9 on the ability to configure variables for deterministic data exchange between several TwinCAT-based controllers. The last could be other TwinCAT PCs or CX controllers. These variables are the so-called *Network Variables*. For this solution it is required to configure the [Ethernet Miniport \(Real-Time\)](#) [[▶ 239](#)] I/O device type at first.

For an [Overview](#) [[▶ 348](#)] of TwinCAT Real-Time Ethernet devices, [see..](#) [[▶ 348](#)]

The *Publisher* is the send-type network variable. It sends its information out without waiting for acknowledgement. The communication is only monitored by the [Subscriber](#) [[▶ 351](#)].

"General" dialog

The screenshot shows the 'General' dialog box with the 'Publish' tab selected. The 'Name' field contains 'NV 1 (Publisher)' and the 'Id' field contains '1'. The 'Type' is set to 'Network Variable Publisher'. There is a large empty text area for 'Comment'. At the bottom, there are two checkboxes: 'Disabled' (unchecked) and 'Create symbols' (unchecked).

Standard dialog as for all TwinCAT I/O devices. Nevertheless, a descriptive name for this *Publisher* (sender) should be edited here. Additionally, a useful comment (i.e. about the target/subscriber this publisher sends its data to) could be very helpful.

Id: A Real-Time Ethernet *Publisher* ident. number.



If several Publisher variables must be set up in same network at other TwinCAT controllers, make sure that they all have network-unique Id's (means in above case for instance, that '1' is already in use and can't be assigned to a second Publisher network variable).

"Publish" dialog

The screenshot shows the 'Publish' dialog box with the 'Publish' tab selected. It is divided into three main sections:

- Sending Options:** Three radio buttons: 'Broadcast', 'Multicast', and 'Unicast'. The 'Unicast' option is selected. Below 'Unicast' are two sub-options: 'MAC Address' (selected) with a text field containing '00 02 b3 b6 0c 8c', and 'AMS NetId' with an empty text field.
- Data Exchange:** Two spinners: 'Divider' set to '1' and 'Modulo' set to '0'.
- VLAN Support:** A checkbox for 'Enable' (unchecked), and two spinners: 'Priority' set to '0' and 'Id' set to '0'.

Sending Options

Broadcast: If this option is selected and the node receives the Ethernet frame in its receiving queue, it evaluates whether the data is addressed to him or not. This is not a very "economical" way of communication.

Multicast: If this option is selected, the Ethernet frame is getting evaluated by all attached nodes of the subnet. But instead of processing it with the receive queue, the Ethernet controller detects whether the data is for "him" or not.

Unicast: If selected, the switch opens parallel communication paths and forwards the Ethernet frame directly to the appropriate [Subscriber \[► 351\]](#) (receiver).

MAC Address: Subscriber MAC Address. For further information, see: [Ethernet Miniport \(Real-Time\) \[► 239\]](#)

AMS Netid: ...

Data Exchange: see: **BK9000**

[BK9000 \[► 289\]](#)

VLAN Support: see: **BK9000**

[BK9000 \[► 289\]](#)

Diagnosis

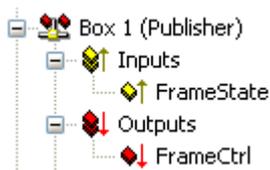


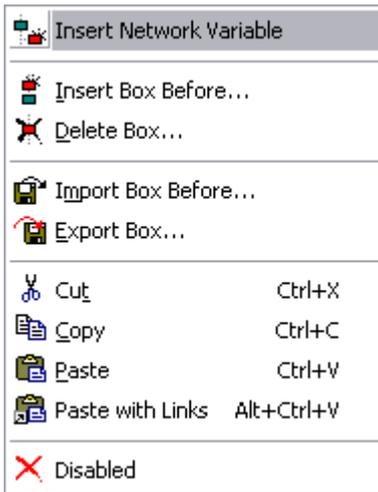
Table 19: Inputs

Variable	Description
FrameState	Real-Time Ethernet frame status information as WORD (or UINT) variable, assumes the following values: 0x0001 = Not sent (frame skipped), means <i>FrameCtrl</i> is currently = '1' 0x0002 = Error (frame oversized)

Table 20: Outputs

Variable	Description
FrameCtrl	Real-Time Ethernet frame control as WORD (or UINT) variable, accepts the following values: 0x0001 = Disable sending If <i>FrameCtrl</i> receives above value (e.g. from mapped PLC variable), this frame doesn't get sent. The sending will be continued if <i>FrameCtrl</i> has been released again (= '0'). The <i>FrameState</i> variable assumes the value '1' in the meantime. The related subscriber variables CycleIndex [► 354] and Quality [► 354] will notice on the other side that the frame transmission has been suppressed.

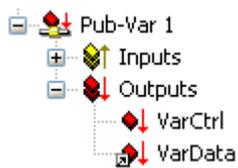
Context menu



Insert Network Variable: Please see description under [Subscriber \[▶ 351\]](#)

Other items: Please see [Adding Input/Output Modules \[▶ 100\]](#)

Publisher variable - Outputs



Requirements

Variable	Data type	Description
VarCtrl	UINT	Can be set to 0x0001 = Disable publishing The transmission of this publisher variable is suppressed in above case (until VarCtrl becomes '0' again). The subscriber CycleIndex [▶ 354] variable stays static and the Quality [▶ 354] counts up (to a maximum of 65535).
VarData	as specified [▶ 354]	To be linked to the output variable (e.g. PLC output) to be transmitted via TwinCAT Real-Time Ethernet.

11.3.9.2 Network Variable Subscriber

The Beckhoff [TwinCAT Real-Time Ethernet \[▶ 409\]](#) solution contains from TwinCAT v2.9 on the ability to configure variables for deterministic data exchange between several TwinCAT-based controllers. The last could be other TwinCAT PCs or CX100x controllers. For this solution it is required to configure the [Ethernet Miniport \(Real-Time\) \[▶ 239\]](#) I/O device type first.

For an [Overview \[▶ 348\]](#) of TwinCAT Real-Time Ethernet devices, see.. [\[▶ 348\]](#)

The *Subscriber* is the receive-type variable of the TwinCAT target system. It receives values from the [Publisher \[▶ 348\]](#) variable of the networked TwinCAT controller.

"General" dialog

Standard dialog as for all TwinCAT I/O devices. Nevertheless, a descriptive name for this *Subscriber* should be edited here. Additionally, a useful comment (i.e. about the *Publisher* the data is coming from) could be very helpful.

Diagnosis

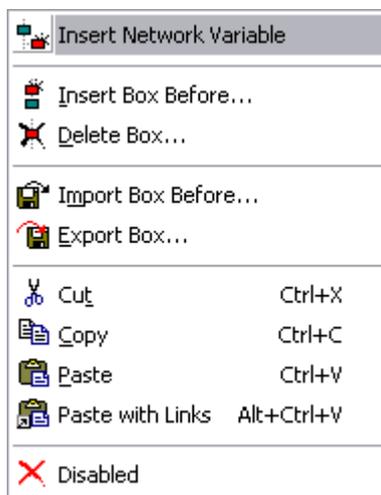
Table 21: Inputs

Variable	Description
FrameState	This variable is currently not in use at subscribers

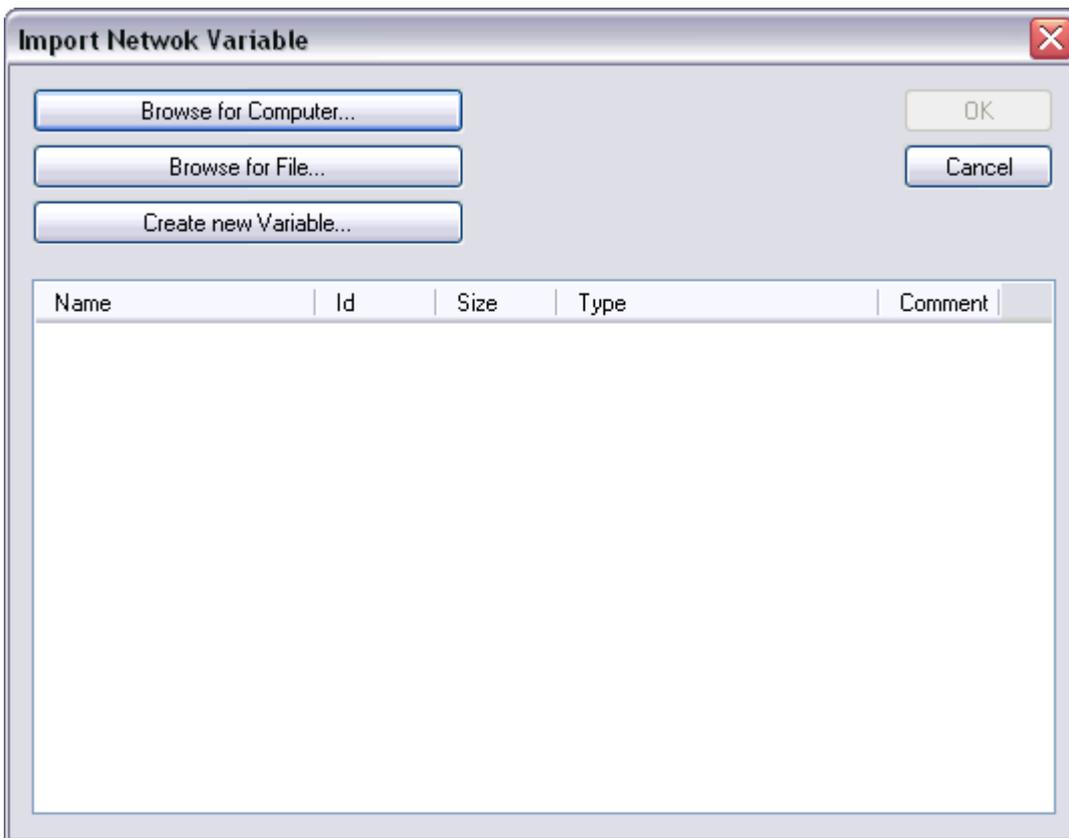
Table 22: Outputs

Variable	Description
FrameCtrl	This variable is currently not in use at subscribers

Context menu



Insert Network Variable: Calls the following dialog:



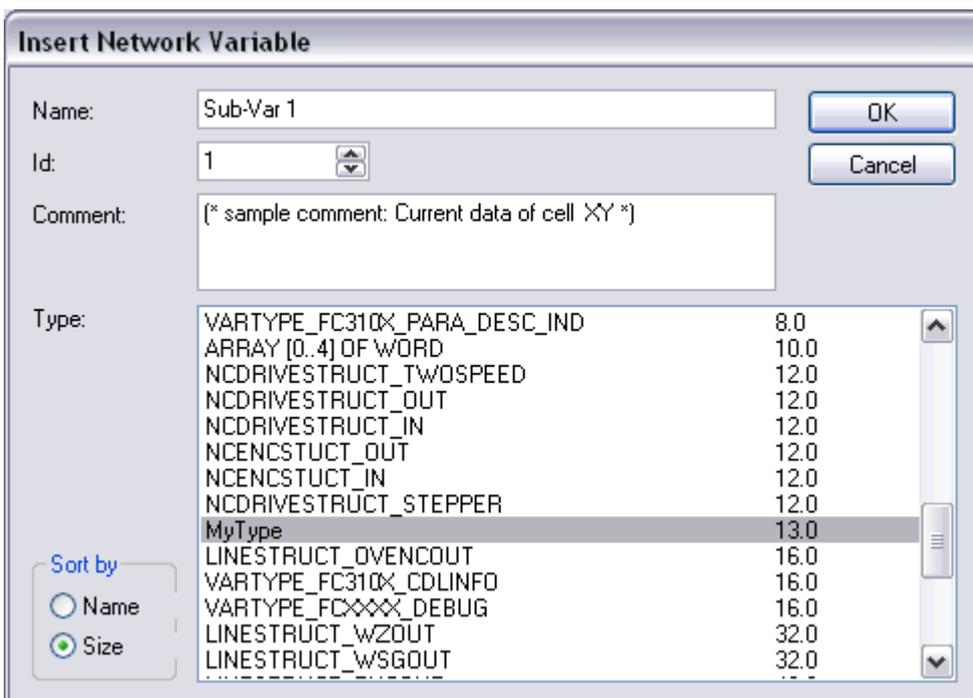
Browse for Computer: Calls the [Choose Target System \[▶ 23\]](#) dialog.

Browse for File: Calls the file selection dialog for existing TwinCAT System Manager project files (*.tsm). If [Publisher \[▶ 348\]](#) variables have been found in the selected file, these variables get listed in the *Name*, *Id*, *Size*, *Type* section of above dialog.

Create new Variable: Calls the **Insert Network Variable** dialog described below.

"Insert Network Variable" Dialog

"Insert Network Variable" Dialog



Name: A descriptive name for the subscriber variable should be edited here.

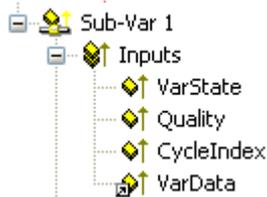
Id: ...

Comment: Space for a helpful comment about this subscriber variable.

Type: Lists available [data types](#) [► 49] for this variable. The appropriate type must be selected here. This could be standard data type, an array or a complex structure.

If e.g. the process image of the configured PLC project contains a [user-defined data type](#) (i.e. a structure) with the name 'MyType', it would show up on the list like shown above.

Subscriber variable - Inputs



Variable	Data type	Description
VarState	UINT	This variable is currently not in use
Quality	UINT	This variable shows how "old" the value of this subscriber variable is. Means, every 100µs the data variable is not updated this value gets increased by 1. This could happen e.g. when the link of the network connection is lost. After re-establishing it, the value is set back to 0 again. Max. value of Quality is 65535.
CycleIndex	UINT	This variable value increments with every I/O cycle the publisher does. The subscriber extracts this value out of the Ethernet frame.
VarData	as specified	To be linked to input variable (e.g. to PLC input).

Variable	Data type	Description
VarCtrl	UINT	This variable is currently not in use

11.3.9.3 AX2xxx-B900 Axis (Real-Time Ethernet Interface)

The Beckhoff AX2000 resp. AX2500 drive is available with different (optional) Fieldbus interfaces. One variant is the AX2000 with [TwinCAT Real-Time Ethernet](#) [► 409] interface (part no.: AX20xx-**B900**). The AX2xxx-B900 is implemented in TwinCAT as a real-time capable device if used in an [Ethernet Miniport](#) [► 239] subnet. For an [Overview](#) [► 348] of all currently supported devices for **Ethernet Miniport**, please ...see [► 348]



If Real-Time Ethernet and "normal" Ethernet are both used on the same system with two different network adapters, the subnet addresses of these adapters (NICs) must differ! The AX2xxx-B900 must be configured with the same subnet address (first two quadruples) as the Ethernet Miniport adapter in this case, of course.

"AX2000-B900" tab

The screenshot shows the configuration window for the AX2000-B900 module. The tabs at the top are: General, AX2000-B900 (selected), IP Address, Ads Commands, Inputs, Outputs, and Online. Under the 'General' sub-tab, there are three checkboxes: 'Diagnosis' (unchecked), '2 Byte PLC Interface' (unchecked), and 'No Real Time Flag' (checked). Below these is a text input for 'K-Bus Update' set to '150' with a 'µs' unit. There are two buttons: 'K-Bus Reset' and 'Firmware Update (UDP/COMx) ...'. To the right, there are two sections: 'Data Exchange' with 'Divider' (1) and 'Modulo' (0) spinners, and 'VLAN Support' with 'Enable' (unchecked), 'Priority' (0), and 'Id' (0) spinners.

Diagnosis: This checkbox is deactivated for the AX2000-B900.

2 Byte PLC Interface: This checkbox is deactivated for the AX2000-B900.

No Real Time Flag: If the AX2000-B900 belongs to an **Ethernet Miniport** subnet but is not intended to be used for real-time data exchange, this box has to be checked.

K-Bus Update: Estimated internal update time for the -B900 interface.

Firmware Update: The firmware update dialog is called by pushing this button. With this function, the most recent firmware version for the -B900 slot interface can be loaded (via LAN or COM port).

Data Exchange:

- **Divider:** see: [BK9000 \[► 289\]](#)

- **Modulo:** see: [BK9000 \[► 289\]](#)

VLAN Support:

- **Enable:** Activates the VLAN support (see: *IEEE 802.1Q, RFC3518*) for the communication with this device. If enabled, the Ethernet frame is getting extended by 4 byte. These extension is called VLAN tag and contains for instance information about ID and priority .
- **Priority:** A 3 bit VLAN priority value as defined by *IEEE 802.1D*. Most switches contain two queues, a high and a low priority one. Therefore priorities between 0..3 are assigned to the high priority queue and 4..7 are assigned to the low priority queue at those switch types.
- **Id:** 12 bit VLAN identifier number as defined by *IEEE 802.1Q*.

"IP Address" Tab

For further information about this tab, see -> ["IP Address" Tab \[► 298\]](#).

"ADS Commands" Tab

For further information about this tab, see -> ["ADS Command Window \[► 51\]"](#).

"Online" Tab

Online

For further information about this tab, see: "[AX2xxx Drive Tab - Online \[▶ 454\]](#)".

"Inputs" Tab

Inputs

For further information about this tab, see: "[AX2xxx Drive Tab - Inputs \[▶ 451\]](#)".

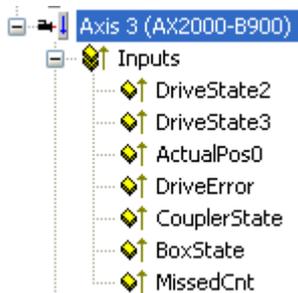
"Outputs" Tab

Outputs

For further information about this tab, see: "[AX2xxx Drive Tab - Outputs](#)".

Diagnosis Inputs

The below shown variable *DriveError* has been added manually!



If the variables *DriveError*, *DriveState2* (default) and *DriveState3* (default) are added as described under [AX2xxx Drive Tab - Inputs \[▶ 451\]](#), they can be used for diagnosis purposes. If they are linked to a TwinCAT PLC process image for instance, they can be evaluated inside the PLC run-time system.

For further information about the error and warning codes of the AX2xxx drive, see: "[AX2xxxx Drive - Status and Error Codes \[▶ 456\]](#)".

11.3.10 EtherCAT

With EtherCAT the division into boxes and bus terminals does not exist anymore. Every terminal has an EtherCAT Slave controller (ESC) integrated and therefore is a full EtherCAT slave device. An EtherCAT slave device can either be added to the [EtherCAT\(Direct Mode\) \[▶ 198\]](#) Device or to the Real-Time Ethernet device. The basic property pages for the EtherCAT slave devices are the same for every connected device, be it a terminal, a drive or a bus coupler.

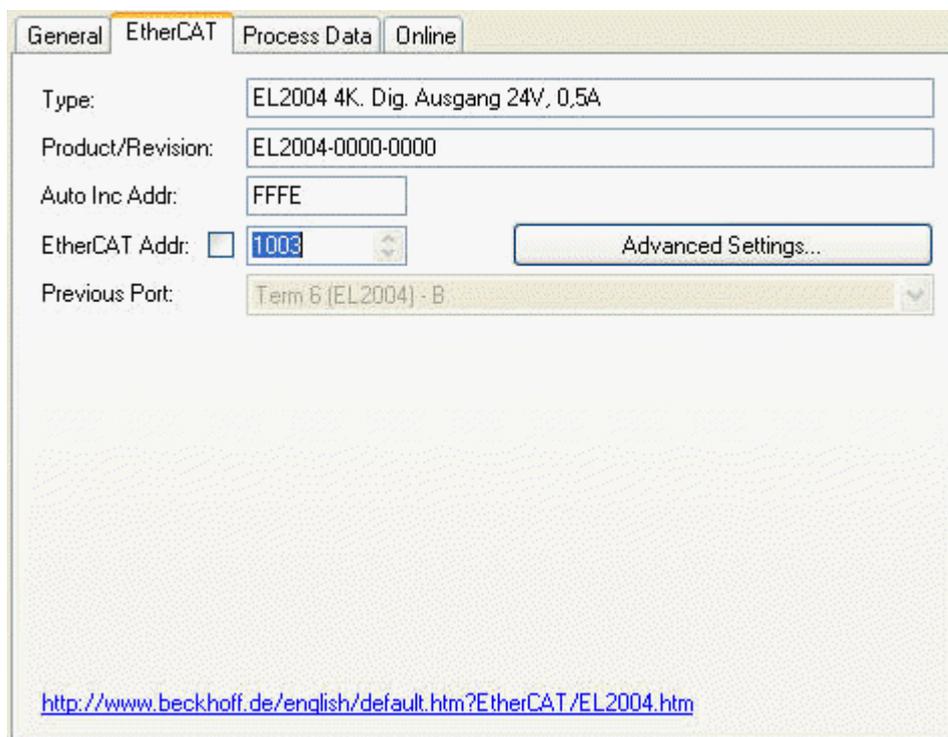
Tab	Description
General	General information.
EtherCAT [▶ 357]	EtherCAT specific configuration.
Process Data [▶ 358]	Configuration of the process data.
Online [▶ 359]	Displays online information about the EtherCAT slave device.

Intelligent devices (for instance drives) that support a mailbox protocol for asynchronous communication have one or more of the following additional tabs:

Tab	Description
Mailbox [▶ 361]	Mailbox configuration
Startup [▶ 365]	The "Startup" tab is displayed, if the slave device has a mailbox and supports either the CANopen over EtherCAT(CoE) protocol or the Servo Drive over EtherCAT(SoE) protocol. With the help of the "Startup" tab the user can configure which download requests are sent to the mailbox during startup.
Coe-Online [▶ 363]	If the EtherCAT slave device supports the CANopen over EtherCAT(CoE) protocol the additional tab "CoE-Online" appears. This tab enables the user to view the contents of the object dictionary of the slave (SDO-Upload) and to change the contents of an object in the dictionary (SDO-Upload).
SoE-Online	If the EtherCAT slave device supports, the Servo Drive over EtherCAT(SoE) protocol the additional tab "SoE-Online" appears.

11.3.10.1 EtherCAT Slave Device

EtherCAT Slave Device "EtherCAT" tab:



Type: Name of the EtherCAT Slave device.

Product/Revision: Product and Revision number of the EtherCAT slave device.

Auto Inc Addr: The Auto Increment Address of the EtherCAT slave device. Auto-increment addressing can be used to address each slave device via its physical position in the communication ring. Auto-increment addressing is used during the start-up phase, during which the master assigns the EtherCAT Address to the slaves. The first slave in the ring has an address of 0 and for each following the addresses is decremented (0xFFFF(-1), 0xFFFE(-2) etc.).

EtherCAT Addr: The fixed Address of the EtherCAT slave device. This address is set by the master during the start-up phase. To change the default value, you must check the box left to the address.

Advanced Settings: Opens the [Advanced Settings \[▶ 365\]](#) dialog.

Previous Port: The port and name of the EtherCAT slave device this device is connected to. If it is possible to connect this device to a different without changing the order of the EtherCAT slave devices in the communication ring, the combo box is enabled, and one can select the EtherCAT device this device should be connected to.

EtherCAT Slave Device "Process Data" tab:

Displays the configuration of the process data. The input and output variables of the slave device are displayed as CANopen Process Data Objects (PDO). If supported by the slave device this dialog enables the user to select a different PDO via PDO Assignment and to alter to contents of an individual PDO.

The screenshot shows the 'Process Data' configuration window. At the top, there are tabs: General, EtherCAT, Process Data (selected), Mailbox, Startup, CoE - Online, and Online. The main area is divided into four sections:

- Sync Manager:** A table with columns SM, Size, Type, and Flags. It lists four sync managers: SM 0 (MbxOut, Size 246), SM 1 (MbxIn, Size 246), SM 2 (Outputs, Size 0), and SM 3 (Inputs, Size 6).
- PDO List:** A table with columns Index, Size, Name, Flags, SM, and SU. It lists three PDOs: 0x1A00 (Size 3.0, Name Channel 1, Flag F, SM 3, SU 0), 0x1A01 (Size 3.0, Name Channel 1, Flag F, SM 3, SU 0), and 0x1A10 (Size 4.0, Name Channel 1, Flag F, SM 3, SU 0).
- PDO Assignment (0x1C13):** A list of checkboxes for PDOs: 0x1A00 (checked), 0x1A01 (checked), and 0x1A10 (unchecked, excluded by 0x1A01).
- PDO Content (0x1A00):** A table with columns Index, Size, Offs, Name, and Type. It shows two entries: 0x3101:1 (Status, BYTE, 1.0 size, 0.0 offset) and 0x3101:2 (Value, UINT, 2.0 size, 1.0 offset).

At the bottom, there are several controls: a 'Download' button with 'PDO Assignment' and 'PDO Configuration' checked; a 'Load PDO info from device' button; and a 'Sync Unit Assignment...' button.

Sync Manager: Lists the configuration of the sync managers. If the device has a mailbox the sync manager 0 is used for the mailbox output and the sync manager 1 is used for the mailbox input. The next Sync Manager is used for the process data outputs and the last sync manager for the process data inputs. If an item is selected the corresponding PDO Assignment is displayed in the list view "PDO Assignment(0x1C1Sm)" (where *Sm* is the number of the sync manager).

PDO Assignment (0x1C1Sm) (where *Sm* is the number of the sync manager): PDO Assignment for the selected Sync Manager. Here all PDOs defined for this Sync Manager type are listed with their index. If the Outputs Sync Manager is selected in the "Sync Manager" list view, all TxPDOs are displayed. If the Inputs Sync Manager is selected, all RxPDOs are selected. The checked items are the PDOs, that take part in the process data communication. These PDOs are displayed in the tree view of the System Manager as variables of this EtherCAT slave device. The name of the variable is identical to the Parameter "Name" of the PDO, as displayed in the list view "PDO List". If an item in the "PDO Assignment" list is disabled (unchecked and gray), it indicates that this item is excluded for the current PDO assignment. To be able to select this PDO, one has to uncheck the currently checked PDOs.

PDO List: Lists all PDOs supported by this EtherCAT slave device. The content of the selected PDO is displayed in the "PDO Content (*index of PDO*):" list view. By double clicking on an entry one can change the configuration of the PDO.

Column	Description:	
Index	Index of the PDO.	
Size	Size of the PDO in bytes.	
Name	Name of the PDO. If this PDO is assigned to a sync manager, it appears as variable of the slave device with this Parameter as name.	
Flags	F	Fixed Content. The content of the PDO is fixed and cannot be changed by the System Manager.
	M	Mandatory PDO. This PDO is mandatory and therefore must be assigned to a Sync Manager. Therefore, one cannot uncheck this item in the "PDO Assignment" list.
SM	The Sync Manager this PDO is assigned to. If this entry is empty the PDO does not take part in the process data communication.	
SU	Sync Unit this PDO is assigned to.	

PDO Content (Index of PDO): Displays the contents of a PDO. If the Fixed Content Flag(Flag = F) of the PDO is not set, the content can be changed by the user.

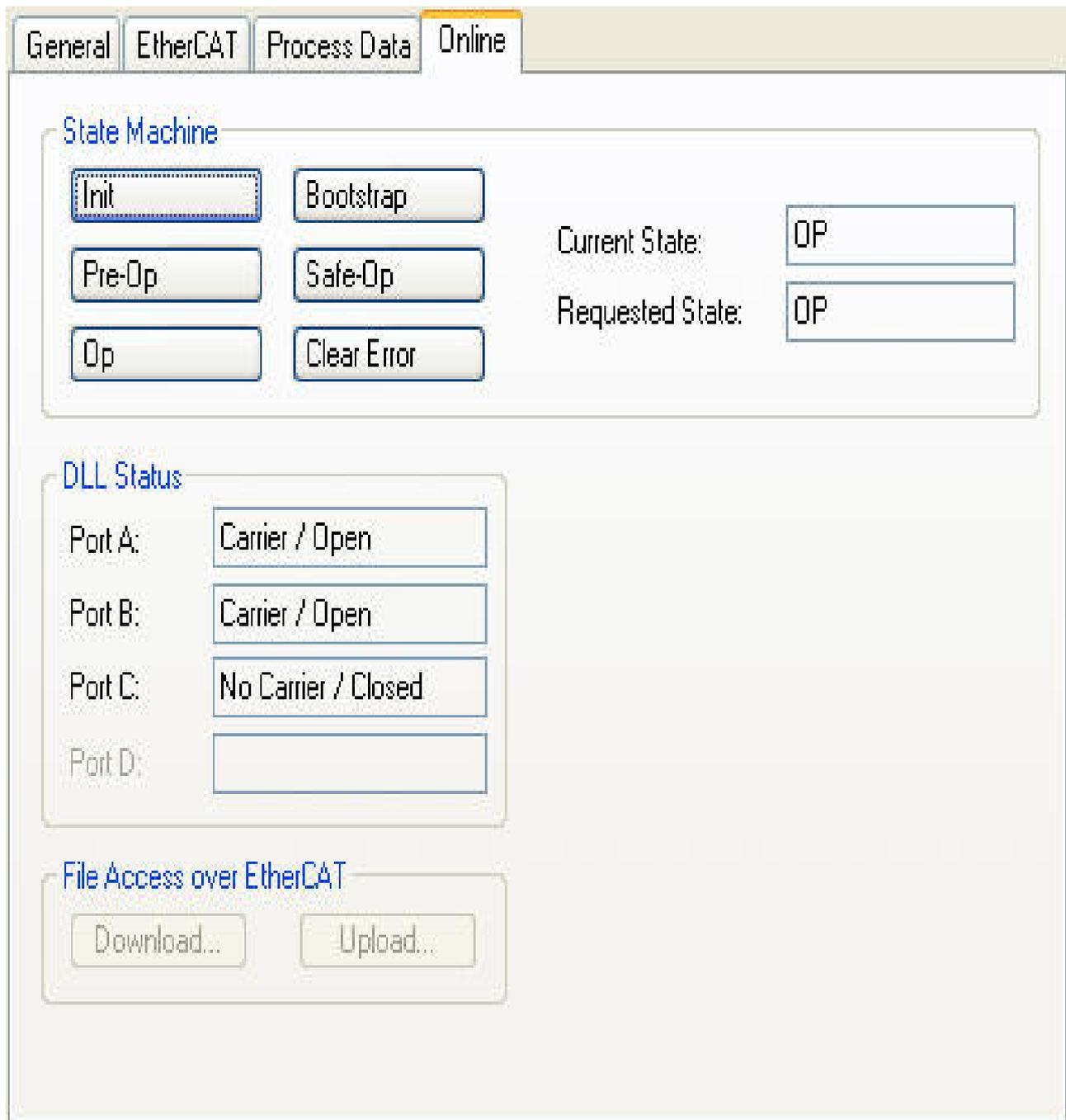
Download: If the device is an intelligent device and has a mailbox, the configuration of the PDOs and the PDO assignments can be downloaded to the device. This is an optional feature and is not supported by all slave devices.

PDO Assignment: If this box is checked, the PDO Assignment configured in the "PDO Assignment" list view is downloaded to the slave device during startup. The necessary commands sent to the device can be viewed in the "[Startup](#)" [[▶ 365](#)] tab.

PDO Configuration: If this box is checked, the configuration of the individual PDOs as displayed in the "PDO List" and PDO Content" view are downloaded to the EtherCAT slave device.

EtherCAT Slave Device "Online" tab:

Displays online information about the EtherCAT slave device.



State Machine:

Init: Tries to set the EtherCAT slave device to the Init State.

Pre-Op: Tries to set the EtherCAT slave device to the Pre-Operational State.

Safe-Op: Tries to set the EtherCAT slave device to the Safe-Operational State.

Op: Tries to set the EtherCAT slave device to the Operational State.

Bootstrap: Tries to set the EtherCAT slave device to the Bootstrap State.

Clear Error: Tries to clear the error flag. If a slave device fails to change to another state, it sets the error flag. For instance, a slave device is currently in the Pre-Operational state. Then the master requests the Safe-Operational state. If the slave device fails to change to Safe-Operational, it sets the error flag. The current state would be displayed as "ERR PREOP". After pressing the Clear Error, the error flag is cleared and the current state would be displayed as "PREOP" again.

Current State: Current EtherCAT State of the slave device.

Requested State: EtherCAT State the master tried to set the slave to.

DII Status:

The Data Link Layer (DLL) Status contains status information concerning the individual ports(A, B and C) of a slave device. Four different values for the DLL status are possible:

Status	Description
Carrier / Open	No carrier signal is present on the port, but the port is open.
Carrier / Closed	No carrier signal is present on the port and the port is closed
Carrier / Open	Carrier signal is present on the port and the port is open.
Carrier / Closed	Carrier signal is present on the port, but the port is closed.

EtherCAT Slave Device "Mailbox" tab:

If the EtherCAT slave devices supports one or more mailbox protocols the additional tab "mailbox" appears. In this dialog the supported mailbox protocols are listed, and the configuration of the mailbox can be changed.

The screenshot shows the 'Mailbox' configuration window. It is divided into several sections:

- Mailbox Polling:**
 - Cyclic
 - Cycle Time (ms):
 - State Change
- Mailbox Configuration:**
 - Special Bootstrap Config
 - Normal Bootstrap
 - Out Addr (hex):
 - In Addr (hex):
 - Out Size == In Size
 - Out Size (hex):
 - In Size (hex):
- Ethernet over EtherCAT (EoE):**
 -
- CANopen over EtherCAT (CoE):**
 - CANopen over EtherCAT (CoE)
 - SDO Info Support
- File Access over EtherCAT (FoE):**
 - File Access over EtherCAT (FoE)
- Servo Drive Profile over EtherCAT (SoE):**
 -
- ADS Info:**
 - ADS Port:

Mailbox Polling:

Cyclic: If this box is checked, the master cyclically tries to read out the mailbox .

Cycle Time(ms): If the "Cyclic" box is checked, this value determines how often the master reads out the mailbox of the slave.

State Change: If this box is checked, the master checks a status bit of the slave, to determine if unread data is available in the mailbox. Only then does the master read out the total mailbox. This mode is more efficient than the "Cyclic" mode, because the master can read out the status of several slave mailboxes with one EtherCAT command(LRD).

CANOpen over EtherCAT(CoE): If this box is checked, the slave supports the CANOpen over EtherCAT(CoE) mailbox protocol.

SDO Info Support: If this box is checked, the object dictionary of the slave device can be loaded by the master.

File Access over EtherCAT(FoE): If this box is checked, the master supports the File Access over EtherCAT(Foe) mailbox protocol.

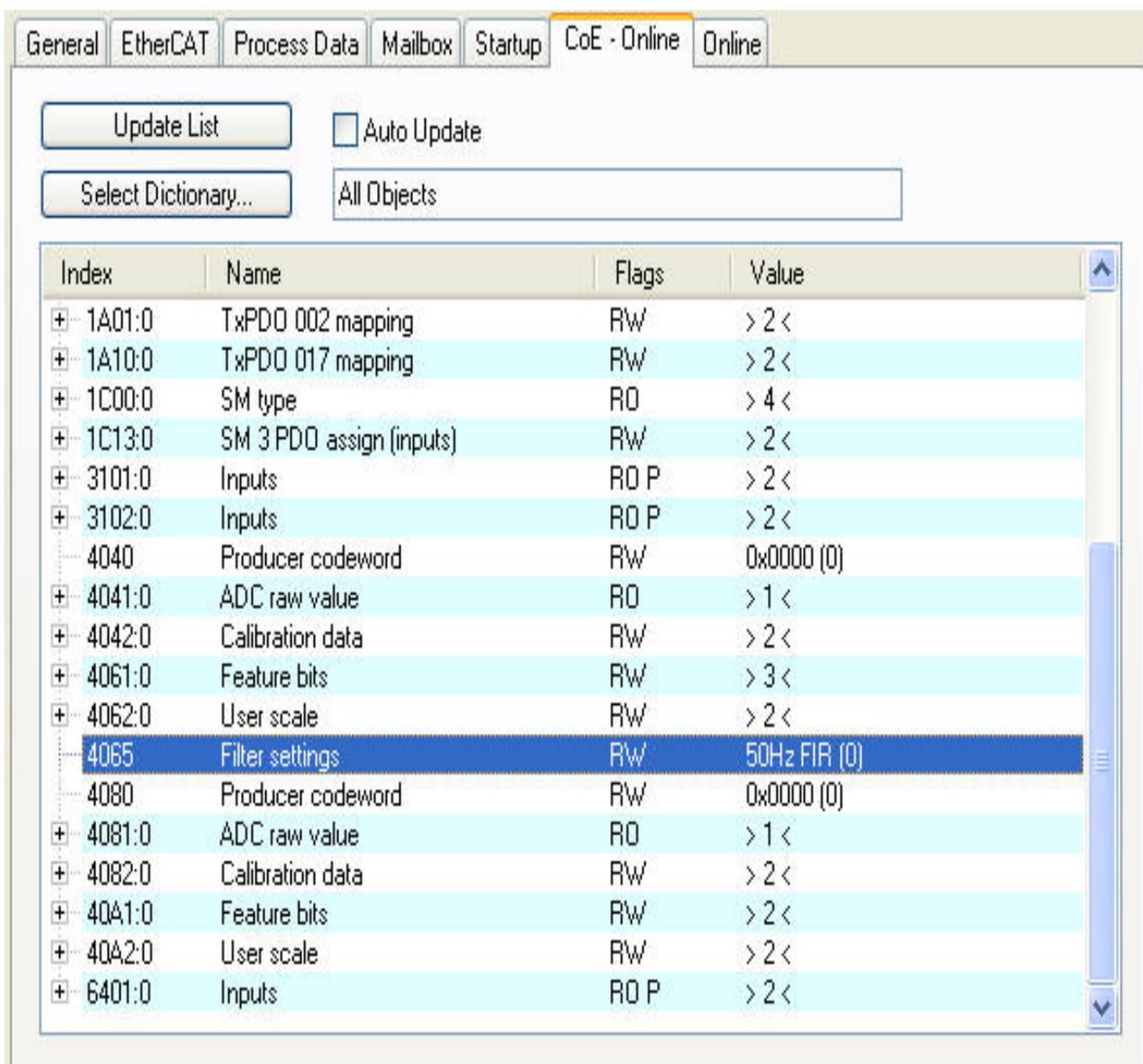
Servo Drive over EtherCAT(SoE): If this group is enabled, the slave supports the Servo Drive over EtherCAT mailbox protocol.

Configuration...: Opens a dialog for configuring the Servo Drive over EtherCAT mailbox protocol.

ADS Info: The ADS identification of the EtherCAT slave device. The ADS Net id is the same as the [NetId \[► 200\]](#) of the EtherCAT device, the ADS Port is the same as the fixed address of the EtherCAT device (see **EtherCAT Addr**). With the help of ADS one can communicate with the the mailbox of the slave device (e.g. SDO Upload Request).

EtherCAT Slave Device "CoE-Online" tab:

If the EtherCAT slave device supports the CANopen over EtherCAT(CoE) protocol, the additional tab "CoE-Online" appears. This tab enables the user to view the contents of the object dictionary of the slave (SDO-Upload) and to change the contents of an object in the dictionary(SDO-Upload).



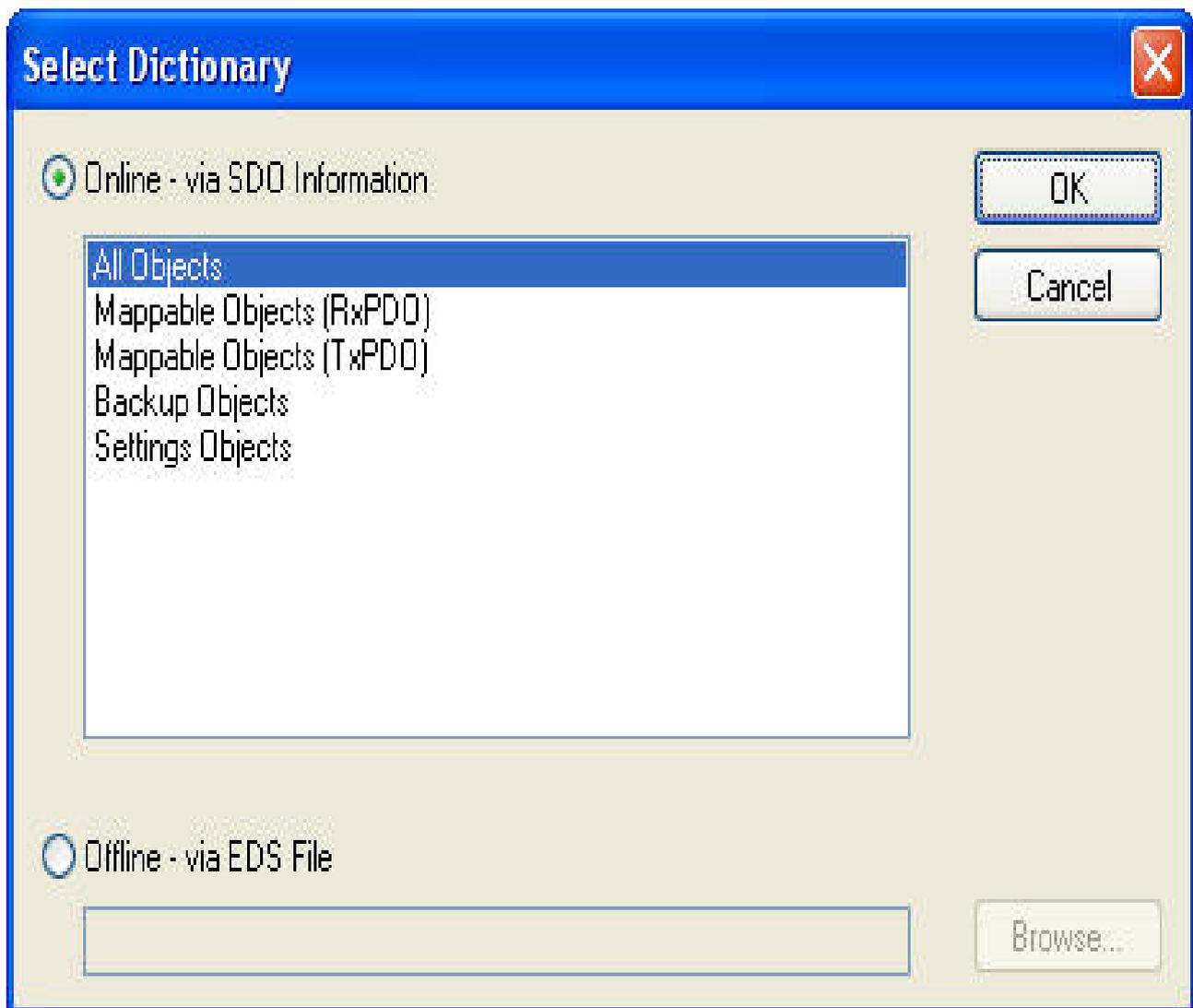
Object List View:

Column	Description	
Index	Index and Subindex of the object.	
Name	Name of the object.	
Flags	RW	The object can be read out and data can be written to the object.
	RO	The object can be read out but is not possible to write data to the object.
	P	
Value	Value of the object.	

Update List: Updates all objects displayed in the list view.

Auto Update: If this box is checked, the contents of the objects is updated automatically.

Select Dictionary...: Opens the Select Dictionary dialog. Here one can specify which objects are displayed in the list view.

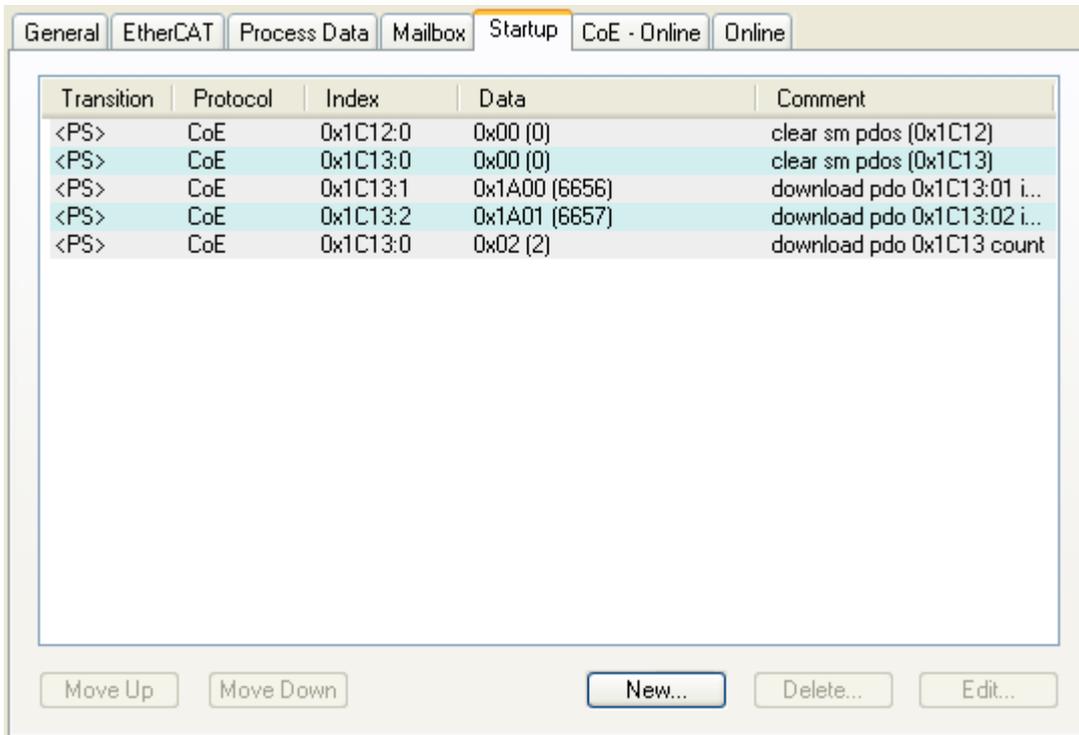


Online - via SDO information: If this box is selected, the list of objects contained in the object dictionary of the slave is uploaded from the slave via SDO information. In the list view below one can specify which type of objects should be uploaded.

Offline - via EDS File: If this box is selected, the list of objects contained in the object dictionary is read from an EDS File supplied by the user.

EtherCAT Slave Device "Startup" tab:

The "Startup" tab is displayed if the slave device has a mailbox and supports either the CANopen over EtherCAT(Coe) protocol or the Servo Drive over EtherCAT(SoE) protocol. With the help of the "Startup" tab the user can view which download requests are sent to the mailbox during startup. It is also possible to add new mailbox requests to the list view. The download requests are sent to the slave in the same order as displayed in the list view.



Column	Description
Transition	Transition the request is sent in. This can be either Pre-Operational to Safe-Operational (PS) or Safe-Operational to Operational (SO). If the transition is enclosed in "<>" (e.g. <PS>), the mailbox request is fixed and cannot be changed or deleted by the user.
Protocol	Mailbox protocol.
Index	Index of the object.
Data	Data that is downloaded to the object.
Comment	Description of the request sent to the mailbox.

Move Up: Moves the selected request up one position in the list.

Move Down: Moves the selected request down one position in the list.

New...: Adds a new mailbox Download request, that should be sent during startup, to the list.

Delete...: Deletes the selected item

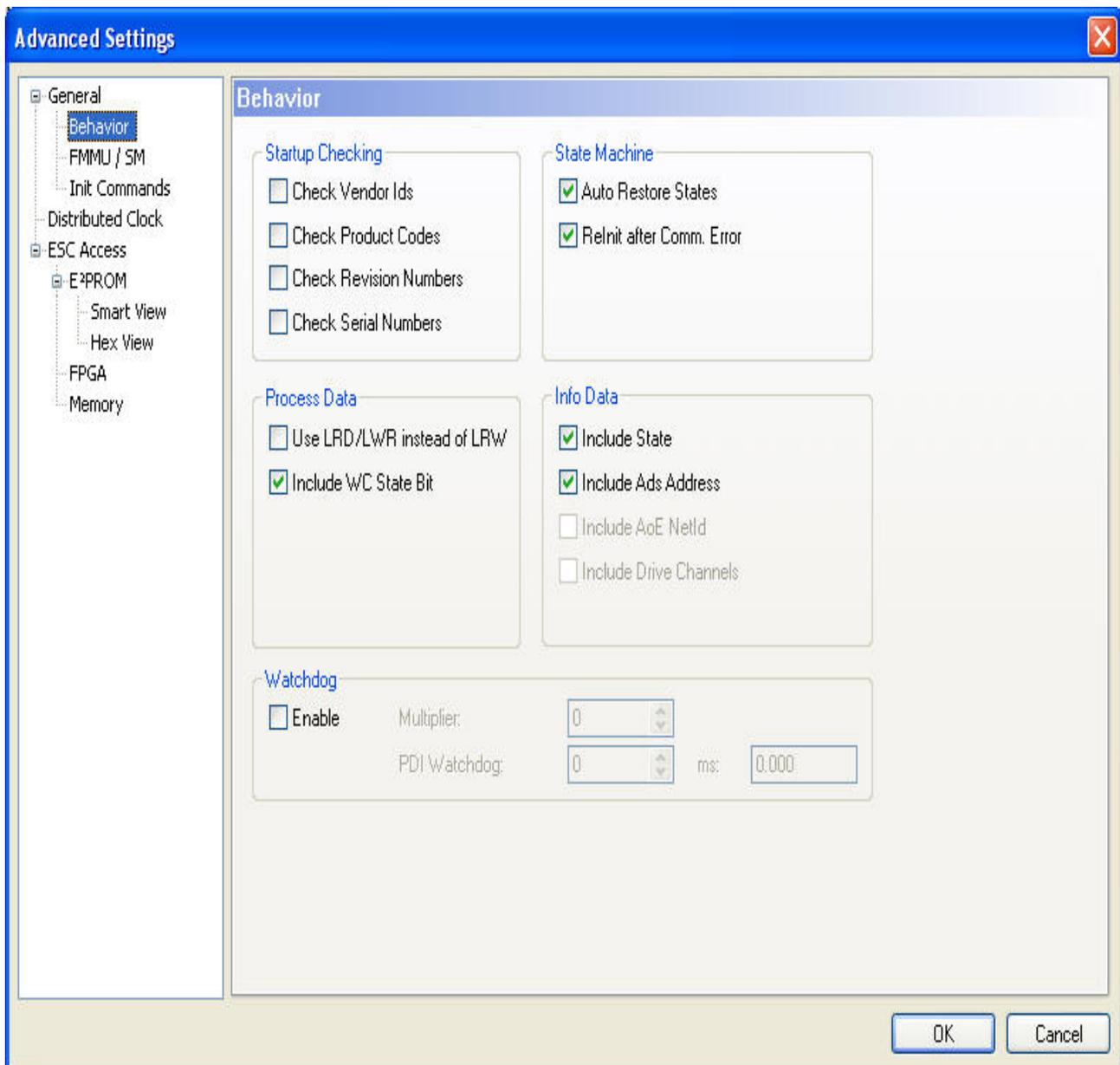
Edit...: Edits an existing request.

11.3.10.1 Advanced Settings Dialog

To open the 'Advanced Settings' of an EtherCAT slave device, select the slave in the tree view of the system manager and open the 'EtherCAT' tab on the right. Next press the "Advanced Settings..." button, to open the "Advance Settings" dialog. Following dialogs are included in the 'Advanced Settings' dialog:

Dialog		Description	
General	Behaviour [▶ 366]	General behavior settings	
	FMMU/SM [▶ 367]	The "FMMU/SM" dialog displays the current configuration of the FMMUs and Sync Managers and allows the user to change these configurations.	
	Init Commands	Displays the init commands sent by the master during specific state transition.	
Distributed Clock	Settings [▶ 371]	With the help of the "Distributed Clock Settings" dialog the user can select the reference clock device and configure the sync signals of the slave.	
ESC Access	E²PROM	Smart View [▶ 365]	Displays the contents of the E ² PROM.
		Hex View	Displays the contents of the E ² PROM in hex format.
	FPGA	Enables the user to read out the current FPGA and to update the FPGA.	
	Memory [▶ 365]	The memory dialog allows the user to read out and write data into the memory of the EtherCAT slave controller.	

Behavior Dialog



Startup Checking: The user can specify which slave information should be checked by the master during startup.

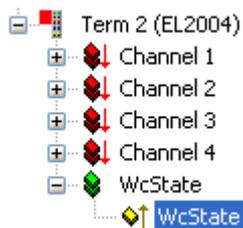
- **Check Vendor Ids:** If this box is checked, the master checks if the vendor id of the slave device is the same as the configured one.
- **Check Product Codes:** If this box is checked, the master checks if the product code of the slave device is the same as the configured one.
- **Check Revision Numbers:** If this box is checked, the master checks if the revision number of the slave device is the same as the configured one.
- **Check Serial Numbers:** If this box is checked, the master checks if the serial number of the slave device is the same as the configured one.

State Machine:

- **Auto Restore States:** If this box is checked, the EtherCAT master tries to restore the state of the slave automatically. If an EtherCAT slave device changes from error state (ERR SAFE-OP, ERR OP etc.) to a valid state (SAFE-OP, OP etc), the EtherCAT master tries to set the device to the current state of the master.
- **Relnit after Comm. Error:** If this box is checked, the master sets the Slave back to the "Init" after an communication error.

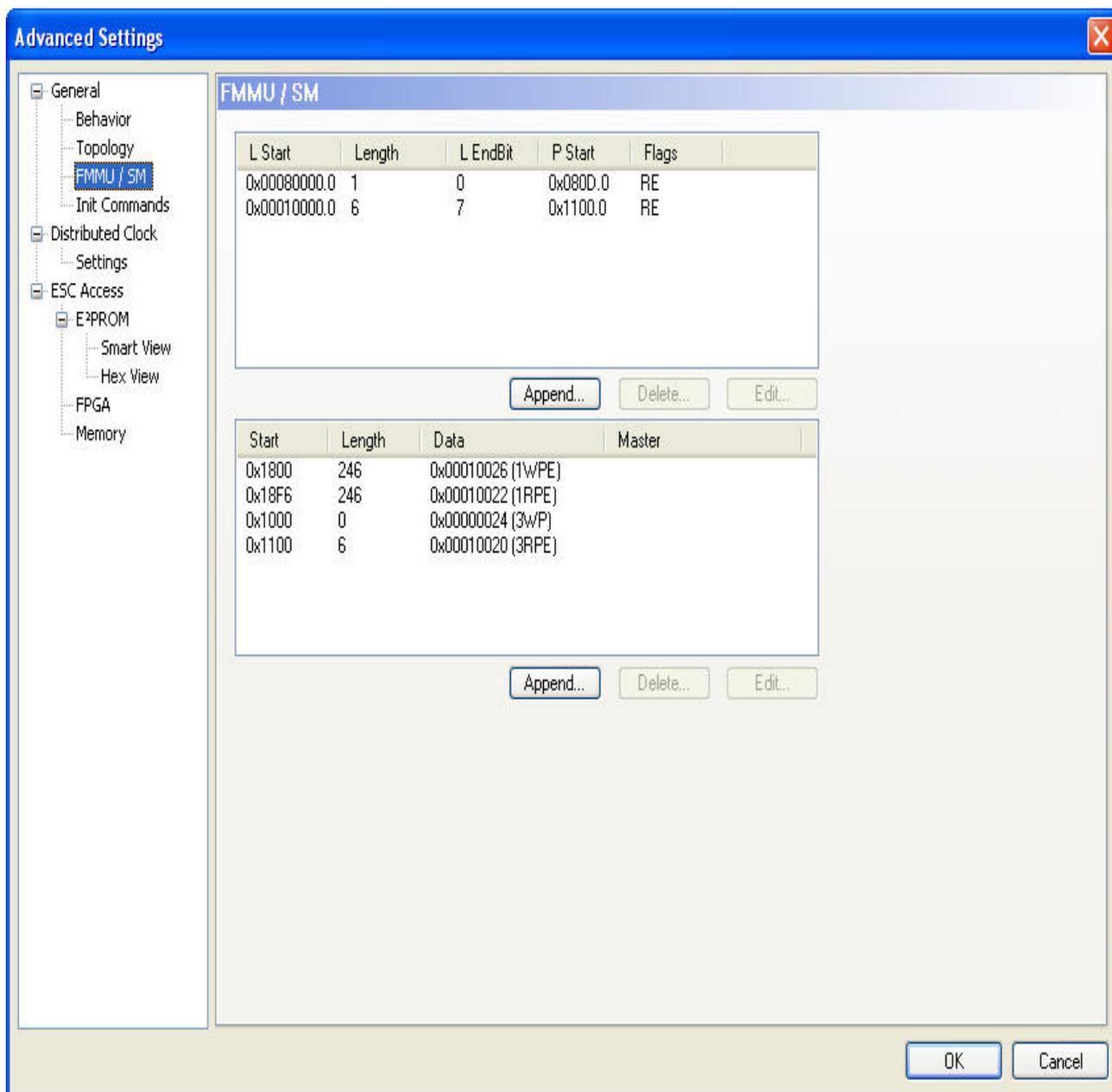
Process Data:

- **Use LRD/LWR instead of LRW:** If this box is checked, a LRD (Logical Read) command is used for reading out the inputs of this device and a LWR (Logical Write) command is used for writing data to the outputs of this device. Otherwise a LRW (Logical Read Write) command is used for reading out the inputs and writing data to the outputs.
- **Include WC State Bit:** If this box is checked, a input variable is added to the slave device, that shows the working counter state of the EtherCAT slave device :



FMMU/SM Dialog

The "FMMU/SM" dialog displays the current configuration of the FMMUs and Sync Managers and allows the user to change these configurations.



The first list view displays the configuration of the FMMUs

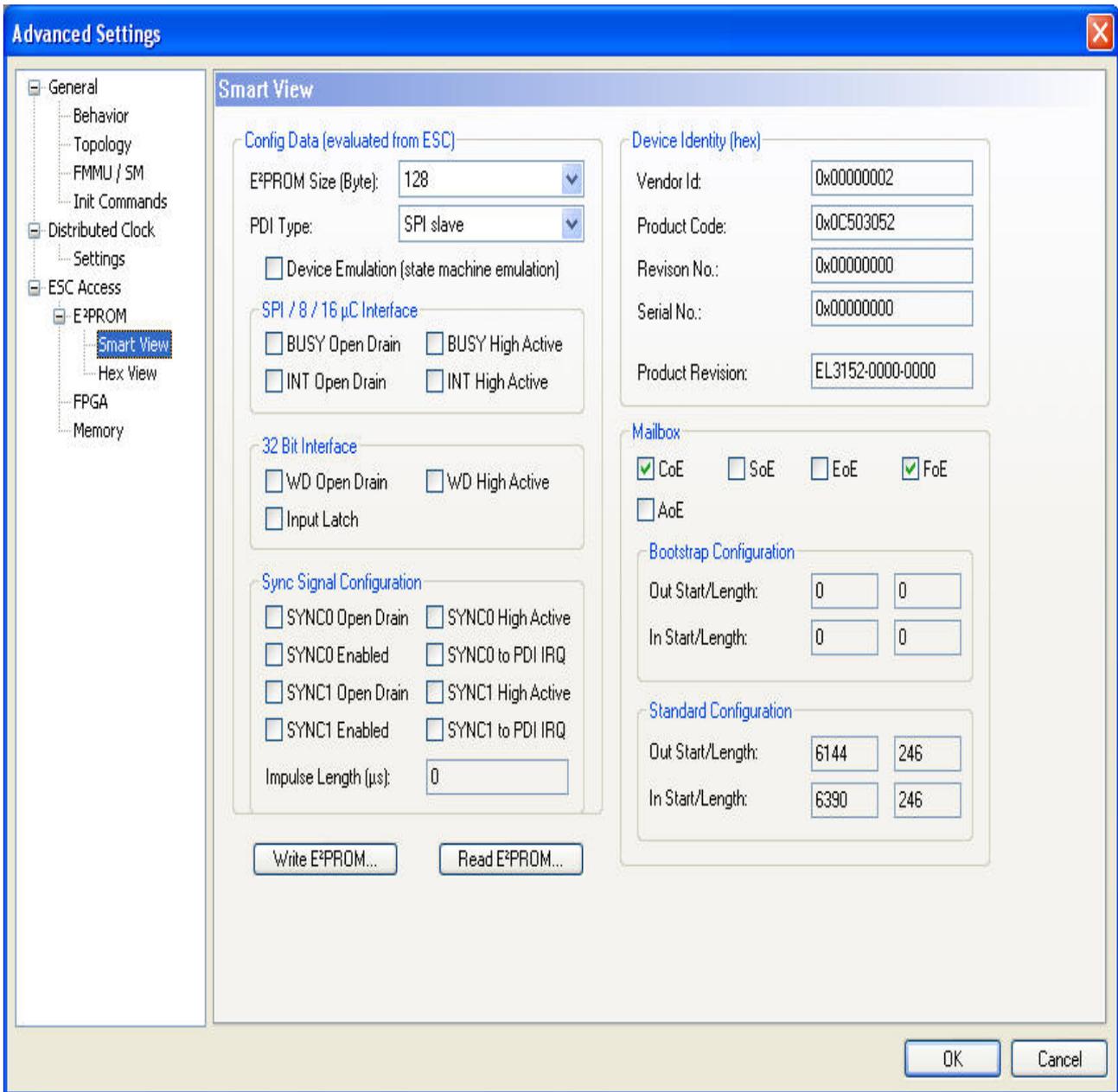
Column	Description
L Start	Specifies from which logical address the FMMU starts to map the data. The start bit is set according to the number that follows the point (0Xnnnnnnnnn. <i>StartBit</i> .)
Length	Specifies how many bytes are mapped by the logical addressing.
L EndBit	End bit of the logical address. If the logical address should be configured to a byte, the start bit must be configured to 0(L Start = 0xnnnnnnnn.0) and this entry must be set to 7.
P Start	Specifies the physical address the logical address points to.

The second list view displays the configuration of the Sync Manager:

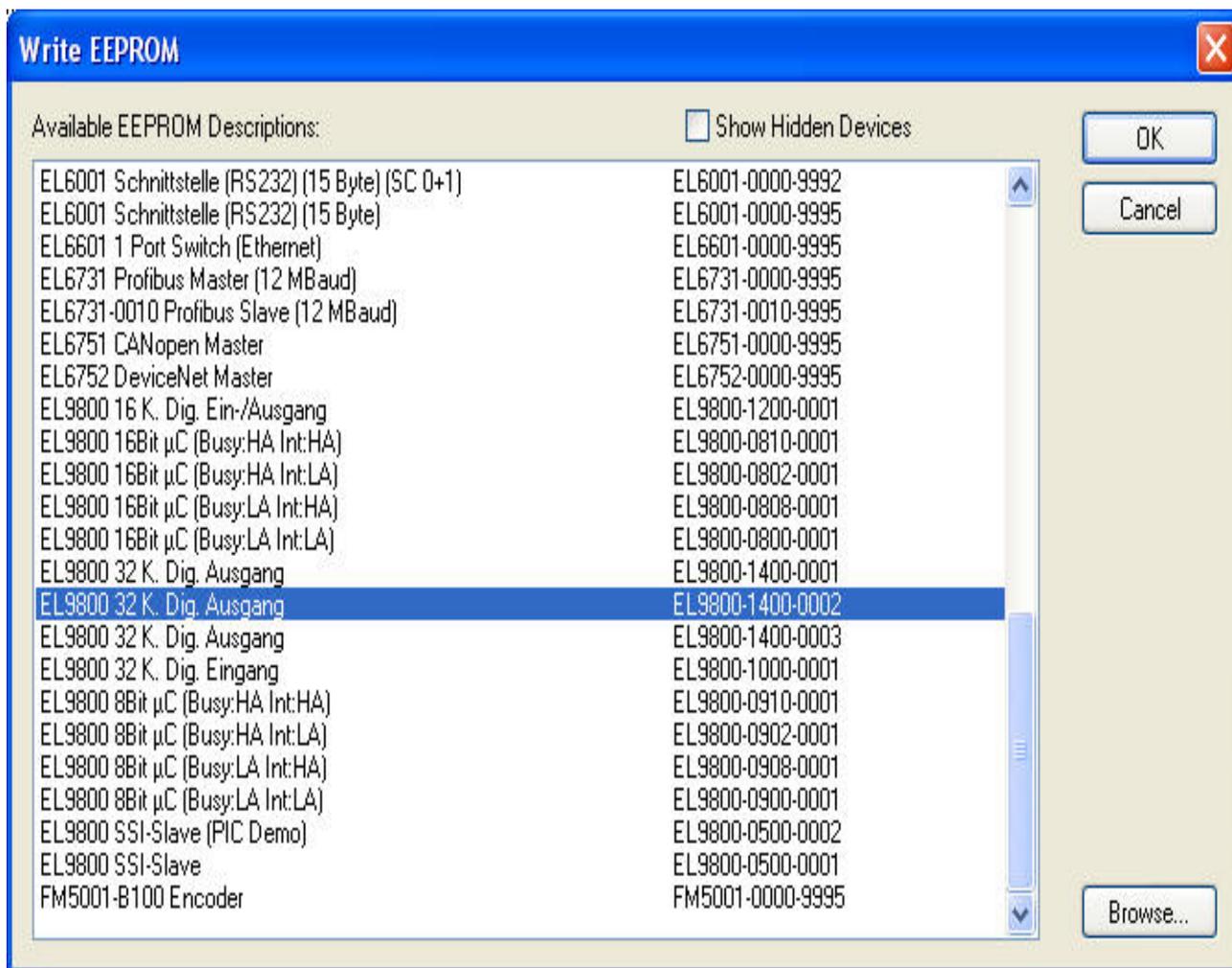
Column	Description
Start	Specifies from which address the Sync channel is active.
Length	Length of the Sync channel in bytes. If the length is 0 the Sync channel is not activated.
Data	Configuration data written to the sync manager.

Smart View

The smart view dialog displays the settings stored in the E²Prom of the EtherCAT slave controller. To view the binary contents of the E²Prom choose the Hex View dialog.



Write E²Prom...: Opens the "Write EEPROM" dialog:

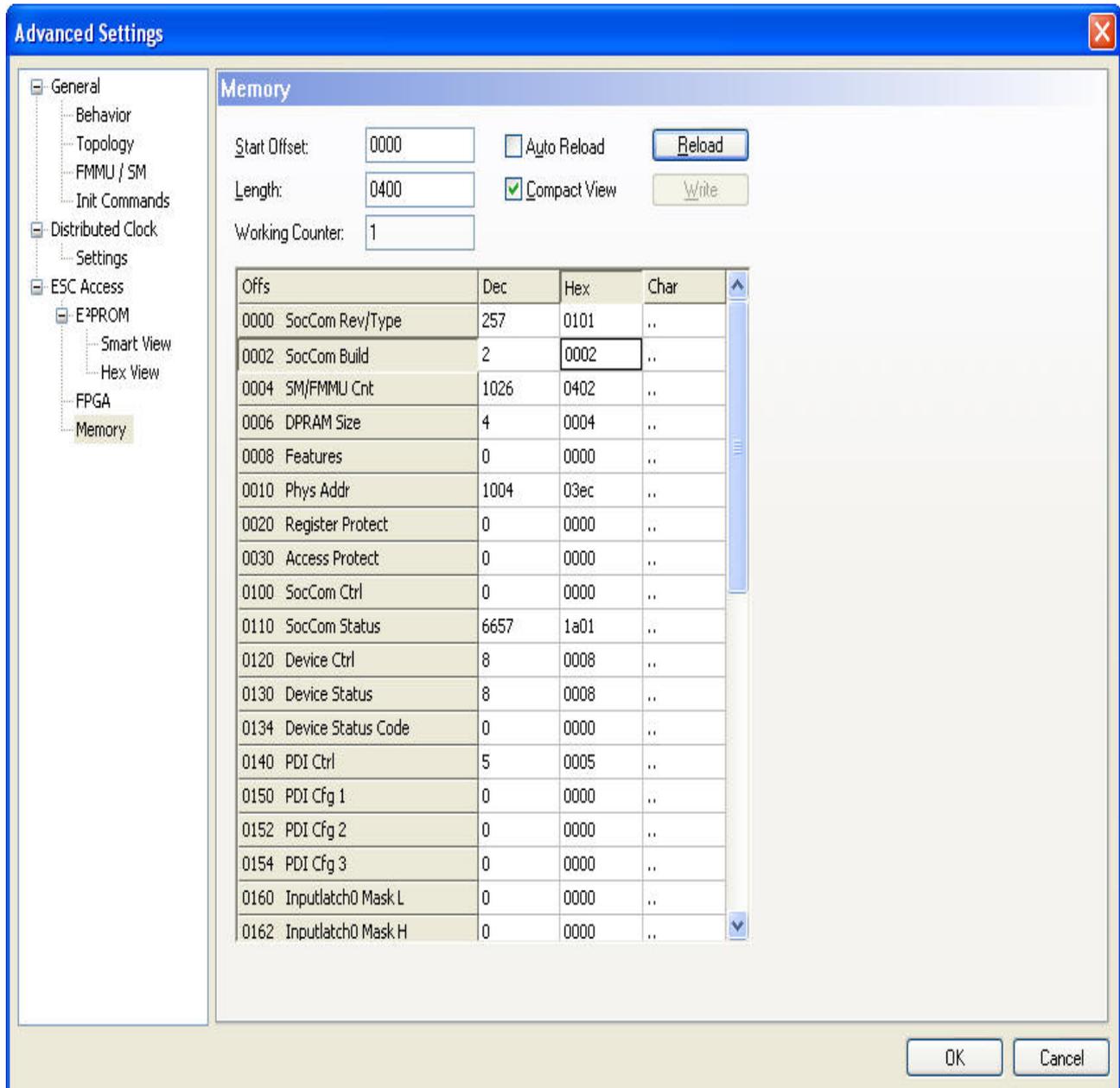


To write a EEPROM Description to the device select a description in the list view and press OK.

Read E²Prom...: Enables the user to save the contents of the E²Prom in binary format.

The memory dialog allows the user to read out and write data into the memory (DPRAM) of the EtherCAT slave controller. The list view below displays the memory of the EtherCAT slave controller. The start offset is equal to the value configured in the edit box "Start Offset". Each entry displays one register (2 bytes). If the System Manager has a description for a register, it is displayed in the "Offs" column of the list view. To write a value to a register one must edit the "Dec", "Hex" or "Char" field of the register. After selecting a different register or setting the focus to different control in the dialog, the edited register value is displayed in red and the "Write" button is enabled. Now one can press the "Write" button, to write the data to the slave.

Memory



Start Offset: Start Address of the first register to be displayed in the list view. The format of the number is hexadecimal.

Length: Length of the data to be displayed in bytes. The format of the number is hexadecimal. The maximal length is 0400(=1024).

Working Counter: If the master succeeded in writing to or reading from the slave, the working counter is 1, otherwise the working counter is 0.

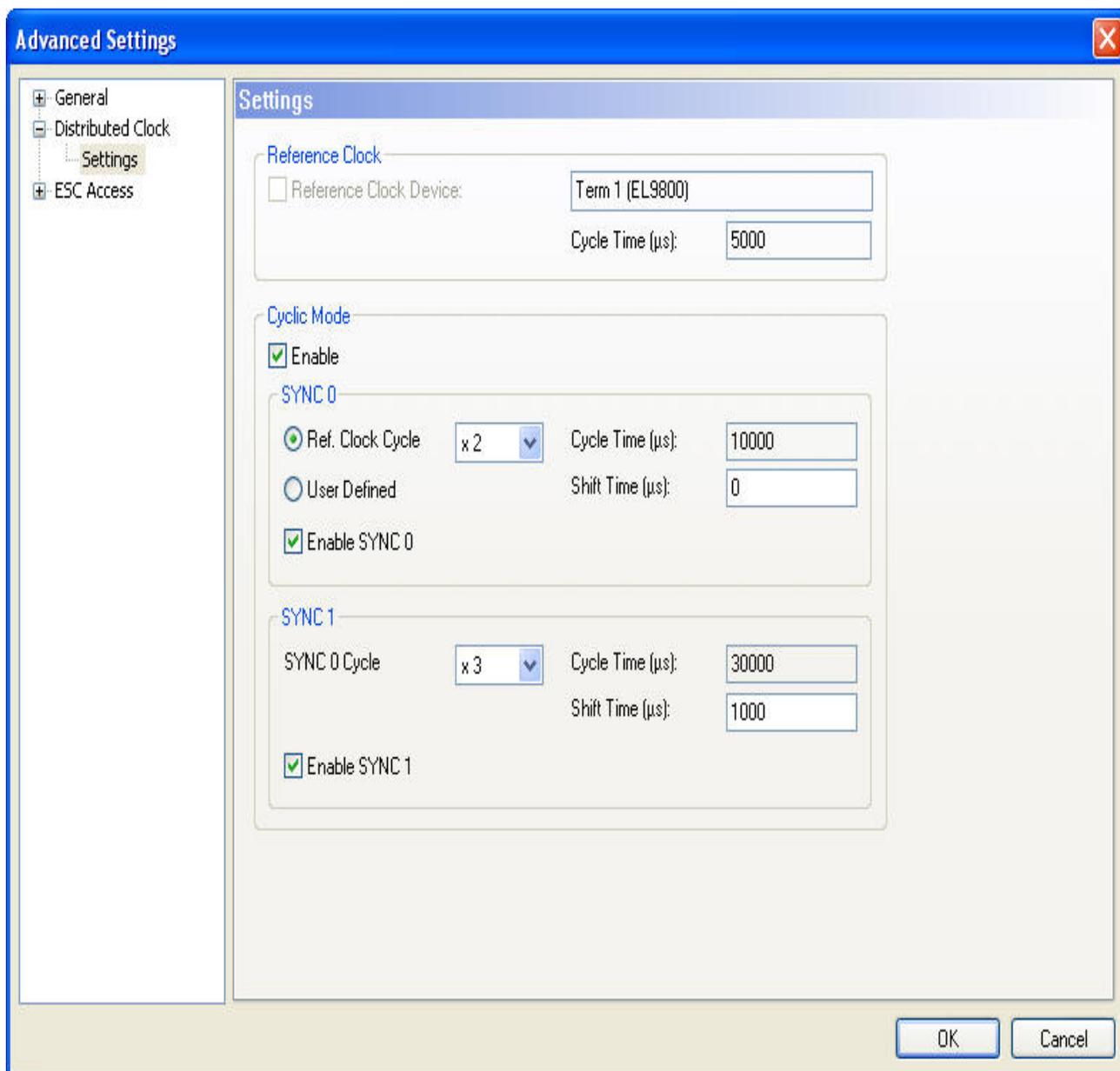
Auto Reload: If this box is checked, the memory is read out cyclically.

Compact View: If this box is checked, only the registers are displayed, for which the System manager has a description for.

Write: Tries to write the changed register entries (displayed in red) to the slave.

11.3.10.1.2 Distributed Clocks settings

To open the 'Distributed Clock Settings' dialog, open the 'Advanced Settings [▶ 365]' Dialog of the EtherCAT slave device and select the entry 'Distributed Clock/Settings' in the tree view of the dialog:



Reference Clock:

- **Reference Clock Device:** Displays the name of the EtherCAT slave device, that is used as reference clock. If the checkbox on the left is checked, this slave device is used as reference clock device. If another slave device is already set as reference clock, the checkbox is disabled. To be able to set this device as reference clock, one would have to select the current reference clock device and uncheck the "Reference Clock Device" checkbox in the dialog above.
- **Cycle Time (µs):** The cycle time of the reference clock in microsecond. This is a read only value. To change the cycle time of the reference clock, select the current reference clock device in the tree view of the System Manager and open the "Distributed Clocks/Settings" dialog (see above) for this device. Then change the settings for SYNC 0 accordingly.

Cyclic Mode:

- **Enable:** Enables/Disable the cyclic mode. If the check box "Enable" is checked the settings for SYNC 0 and SYNC 1 are enabled.
- **SYNC 0:** Here one can set the cycle time and shift time of the SYNC 0 signal. If the current device is the reference clock device (checkbox "Reference Clock Device" checked), the cycle time of the reference clock is set to the same value as the cycle time of SYNC 0.

- **Task Cycle** (if reference clock device) : If this checkbox is enabled, the cycle time of SYNC 0 is set to a multiple of the task cycle time. The multiplier can be set in the combo box next to the checkbox.
 - or **Ref. Clock Cycle** (if not reference clock device): If this checkbox is enabled, the cycle time of SYNC 0 is set to a multiple of the cycle time of the reference clock. The multiplier can be set in the combo box next to the checkbox.
 - **User defined:** If this checkbox is enabled, the cycle time can be defined by the user in the "Cycle Time (µs)" edit box.
 - **Cycle Time (µs):** Cycle time of the SYNC 0 signal in microseconds. If the "User defined" checkbox is not checked, this is a read only value.
 - **Shift Time (µs):** Shift time in microseconds between the task cycle(if reference clock device) or reference clock cycle and the SYNC 0 signal.
 - **Enable SYNC 0:** Enables/Disables the SYNC 0 signal. If this checkbox is set the SYNC 0 signal is enabled.
- **SYNC 1:**

Here one can set the cycle time and shift time of the SYNC 1 signal. The cycle time is always a multiple of the cycle time of the SYNC 0 signal.

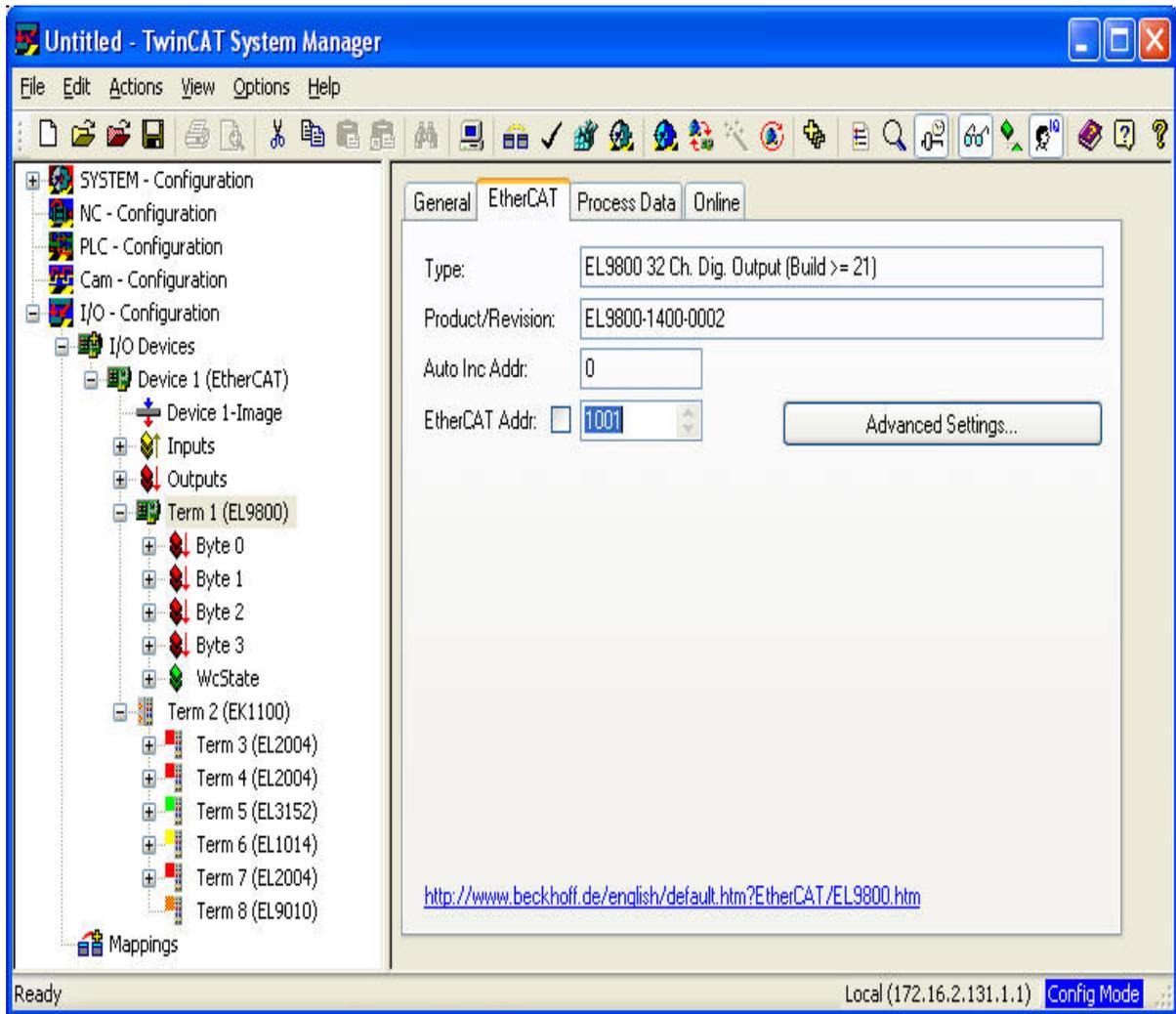
 - **Task Cycle** (if reference clock device) : If this checkbox is enabled, the cycle time of SYNC 1 is set to a multiple of SYNC 0 cycle time. The multiplier can be set in the combo box next to the checkbox.
 - **Cycle Time (µs):** Cycle time of the SYNC 1 signal in microseconds.
 - **Shift Time (µs):** Shift time between the SYNC 1 and the SYNC 0 signal in microseconds.
 - **Enable SYNC 1:** Enables/Disables the SYNC 1 signal. If this checkbox is set the SYNC 1 signal is enabled.

The first step is to set the EtherCAT slave device that should be used as reference clock. This should normally be the first Slave Device (Auto Inc Addr. = 0) connected to the EtherCAT master device.

Set Reference Clock Device

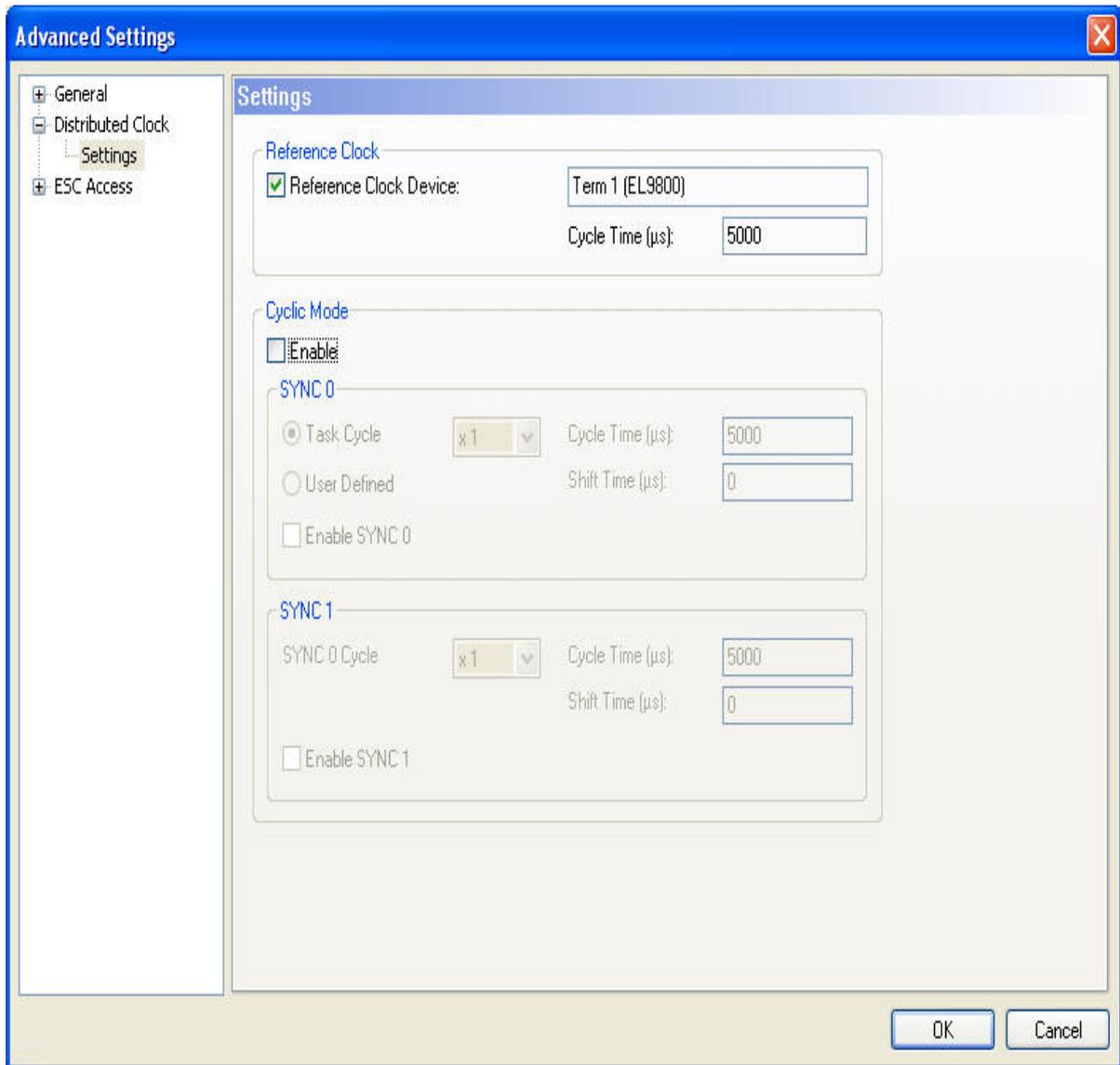
1. Select the first EtherCAT slave device connected to the master in the tree view of the System Manager. .

2. Next select the tab "EtherCAT" of this device:



3. press the "Advanced Settings..." button to open the "Advanced Settings" dialog.
4. Select the tree view item "Distributed Clocks/Settings" (see [Distributed Clock Settings \[▶ 371\]](#)) in the "Advanced Settings".

5. Check the "Reference Clock Device." check box to set this device as reference clock:



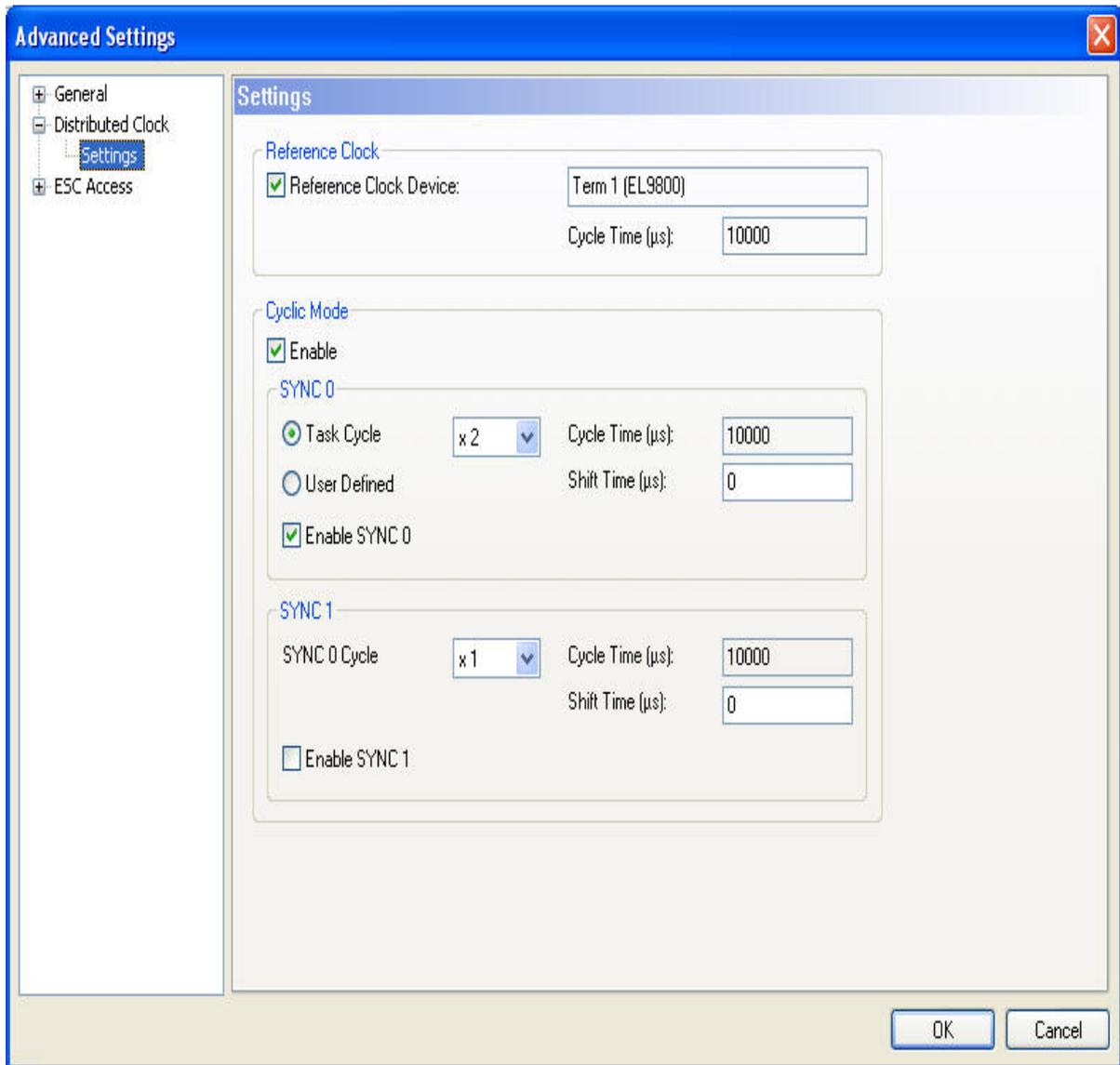
As default the cycle time of the reference clock is set to the task cycle time. To change this cycle time one has to change the cycle time of the SYNC 0 signal (see [Distributed Clock Settings](#) | 371).

Configuring SYNC 0 and SYNC 1 Signals

Now we can set the SYNC 0 and SYNC 1 signals of the other EtherCAT slave devices:

1. select the EtherCAT slave device you want to enable the SYNC 0 and SYNC 1 signals for
2. go to the "EtherCAT" page of this device
3. open the "Advanced Settings" dialog
4. select the entry "Distributed Clock/Settings" in the "Advanced Settings" dialog.
5. Enable Cyclic Mode by checking the "Enable" button.

6. Enable the SYNC 0 signal by checking the "Enable SYNC 0" button :



7. Set the desired cycle time and shift time of the SYNC 0 signal (see [Distributed Clock Settings](#) [► 371]). As default the cycle time is equal to the cycle time of the reference clock. To set a different cycle time one can change the multiplier in the "Ref. Clock Cycle" Combo Box.

If SYNC 1 is required as well:

8. check the "Enable SYNC 1" button.
9. Set the desired cycle time and shift time of the SYNC 1 signal (see [Distributed Clock Settings](#) [► 371]). The cycle time of SYNC 1 is always a multiple of the cycle time of the SYNC 0 signal. Additionally, you can set a shift time between the SYNC 0 and SYNC 1 signal.

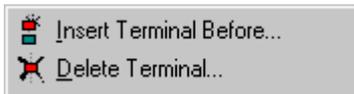
11.3.11 USB Interface

The following devices with USB interface are currently supported by TwinCAT:

USB - Node Types ("Box")	Description
BK9500 [► 293]	Beckhoff USB Bus Coupler
Control Panel (USB) [► 294]	Beckhoff Control Panel / Control Panel-PC CP68xx / CP78xx, CP63xx, CP64xx and CP65xx with DVI and USB interface

11.4 Beckhoff Bus Terminals

Context menu



Add Terminal... <Insert>

Adds another terminal above the marked terminal. The corresponding dialogue opens.

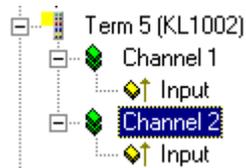
Delete Terminal

Deletes the currently marked terminal.

Digital terminals

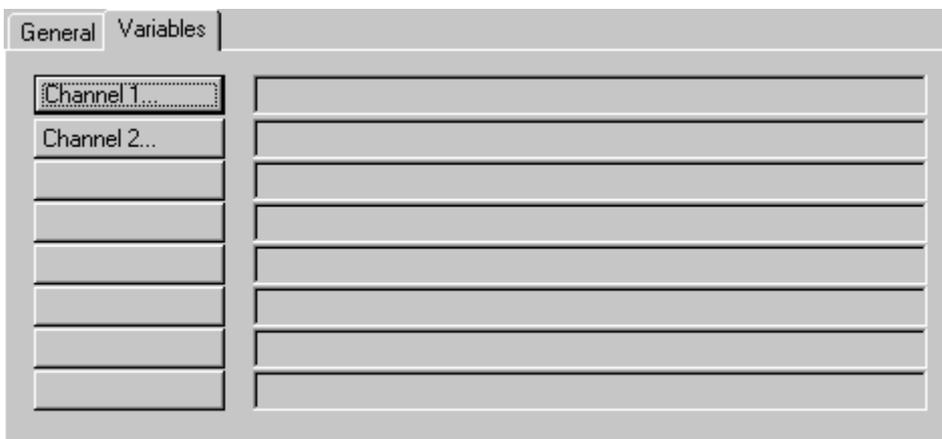
Digital terminals automatically create the bit variable corresponding to each type. These variables are organized in channels whose number depends upon the type of terminals.

Variables



On the left, for example, the tree view shows the digital input terminal KL1002 with two channels. Two channels have been created, each of which contains a binary input variable.

"Variable" tab



The individual variables can be linked at the same time for all variables via the "variables" tab. You can of course still create the links using the context menu or the tab view for each variable.

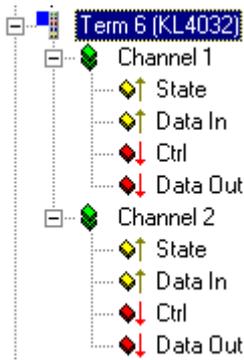
Channel 1...: Opens the link dialogue for the binary variable of the first channel.

Channel 2...: ditto.

Analogue terminals

Analogue terminals automatically create the variable corresponding to each type. These variables are arranged in channels whose number and structure depend upon the type of terminal.

Variables

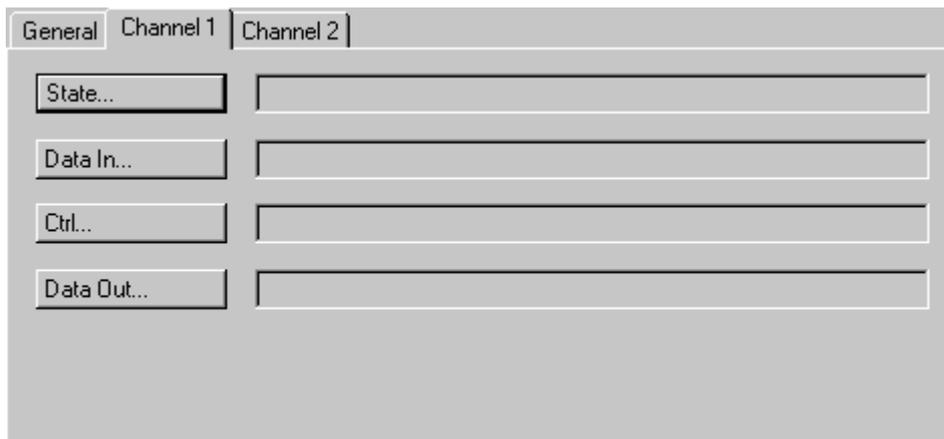


On the left, for example, the tree view shows the analogue output terminal KL4032 with two channels. Two channels have been created, each of which has two input and two output variables (I/O Lightbus and Profibus).

Analogue in/outputs have one status byte per channel (8 bit input), one input data word (16 bit input), one control byte (8 bit output) and one output data word (16 bit output). In the case of the InterBus-S there are no status and control bytes.

The number of variables per channel offered depends upon the fieldbus used!

"Channel X" tab



The individual variables for a channel can be linked at the same time for all variables via the "Channel X" tab. You can of course still create the links using the context menu or the tab view for each variable.

Status ...: Opens the link dialogue for the status byte.

Data In ...: Opens the link dialogue for the input data word.

Control ...: Opens the link dialogue for the control byte.

Data Out ...: Opens the link dialogue for the output data word.

11.4.1 Beckhoff Bus Terminals - Overview Signal Types

A technical description for the various **Beckhoff Bus Terminals** can be reached with the links inside the following table. The exact Bus Terminal type can be selected within the respective category.

Category	Short description
Bus Terminals Digital Input	Bus Terminals for 5 V, 12 V, 24 V, 120 V, 230 V input voltages, counter, ...
Bus Terminals Digital Output	Bus Terminals for 5 V, 24 V output voltages, relays, triac, PWM, stepper/DC-motor control...
Bus Terminals Analog Input	Bus Terminals for various analog input signals, RTD, thermocouple, energy monitoring, ...
Bus Terminals Analog Output	Bus Terminals for various analog output signals, ...
Bus Terminals with special functions <ul style="list-style-type: none"> • KL/KS5xxx: Position measurement • KL/KS6xxx: Communication • KL8xxx: Manual operating modules 	Bus Terminals for position displacement (motion), communication, stepper/DC motor control, motor protection ...
TwinSAFE Terminals	Digital Input, output and logic terminals for TwinSAFE
System Terminals	Bus function terminals for potential feeding, power distribution, termination, ...
Special Terminals - KL/KSxxxx-yyyy	Application-specific and customized Bus Terminals with special part number extensions

Further information can be found on our website under [Bus Terminal](#).

11.4.2 Beckhoff EtherCAT Terminals - Overview Signal Types

A technical description for the various Beckhoff EtherCAT Terminals can be reached via the links inside the following table. The exact EtherCAT Terminal type can be selected within the respective category.

Category	
EtherCAT Terminals - Digital Input	EtherCAT Terminals for 5 V, 12 V, 24 V, 120 V, 230 V input voltages, counter, ...
EtherCAT Terminals - Digital Output	EtherCAT Terminals for 5 V, 24 V output voltages, relays, triac, PWM, ...
EtherCAT Terminals - Analog Input	EtherCAT Terminals for various analog input signals, RTD, thermocouple, ...
EtherCAT Terminals - Analog Output	EtherCAT Terminals for various analog output signals, ...
EtherCAT Terminals - Special Functions <ul style="list-style-type: none"> • EL/ES5xxx: Position measurement • EL/ES6xxx: Communication • EL/ELM7xxx: Compact drive technology 	EtherCAT Terminals for position displacement (motion), communication, stepper/DC motor control, ...
EtherCAT Terminals - System Terminals	EtherCAT Terminals for potential distribution, ...

12 Appendix

12.1 Appendix A: Fieldbus Know how

12.1.1 PROFIBUS cabling

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

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

If these measurements are okay, the cable is in working order. If bus errors still occur, however, these will generally be due to EMC interference, in which case refer to the PROFIBUS user organisation installation instructions (www.profibus.com).

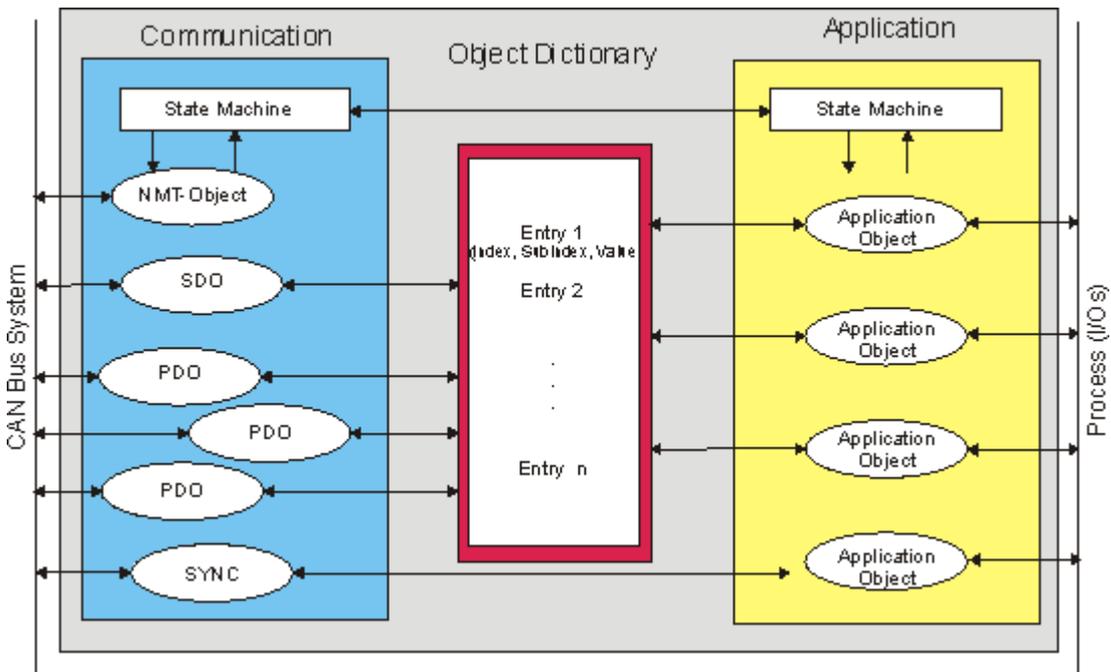
12.1.2 CANopen Introduction



CANopen is a widely used CAN application layer, developed by the CAN in Automation association, and which has meanwhile been adopted for international standardization.

Device Model

CANopen consists of the protocol definitions (communication profile) and of the device profiles that standardize the data contents for the various device classes. Process data objects (PDO) [► 382] are used for fast communication of input and output data. The CANopen device parameters and process data are stored in a structured object directory. Any data in this object directory is accessed via service data objects (SDO). There are, additionally, a few special objects (such as telegram types) for network management (NMT), synchronisation, error messages and so on.



Communication Types

CANopen defines several communication classes for the input and output data (process data objects):

- Event driven [▶ 384]: Telegrams are sent as soon as their contents have changed. This means that the process image is not continuously transmitted, only its changes.
- Cyclic synchronous [▶ 384]: A SYNC telegram causes the modules to accept the output data that was previously received, and to send new input data.
- Requested [▶ 384]: A CAN data request telegram causes the modules to send their input data.

The desired communication type is set by the "Transmission Type [▶ 382]" parameter.

Device Profile

The Beckhoff CANopen devices support all types of I/O communication and correspond to the device profile for digital and analog input/output modules (DS401).

Transmission Rates

Nine transmission rates from 10 kbaud up to 1 Mbaud are available for different bus lengths. The effective utilization of the bus bandwidth allows CANopen to achieve short system reaction times at relatively low data rates.

Topology

CAN is based on a linear topology. The number of devices participating in each network is logically limited by CANopen to 128, but physically the present generation of drivers allows up to 64 nodes in one network segment. The maximum possible size of the network for any data rate is limited by the signal transit time required on the bus medium. For 1 Mbaud, for instance, the network may extend 25 m, whereas at 50 kbaud the network may reach up to 1000 m. At low data rates the size of the network can be increased by repeaters, which also allow the construction of tree structures.

Bus access procedures

CAN utilizes the Carrier Sense Multiple Access (CSMA) procedure, i.e. all participating devices have the same right of access to the bus and may access it as soon as it is free (multi-master bus access). The exchange of messages is thus not device-oriented but message-oriented. This means that every message is unambiguously marked with a prioritized identifier. To avoid collisions on the bus when messages are sent by different devices, a bit-wise bus arbitration is carried out at the start of the data transmission. The bus

arbitration assigns bus bandwidth to the messages in the sequence of their priority. At the end of the prioritization phase only one bus device occupies the bus, collisions are avoided, and the bandwidth is optimally exploited.

Configuration and parameterization

The TwinCAT System Manager allows all the CANopen parameters to be set conveniently. An "eds" file (an electronic data sheet) is available on the Beckhoff website for the parameterization of Beckhoff CANopen devices using configuration tools from other manufacturers.

Certification

The Beckhoff CANopen devices have a powerful implementation of the protocol, and are certified by CiA, the CAN in Automation association.

12.1.2.1 Process Data Objects (PDO)

Introduction

In many fieldbus systems the entire process image is continuously transferred - usually in a cyclic manner. CANopen is not limited to this communication principle, since the multi-master bus access protocol allows CAN to offer other methods. Under CANopen the process data is not transferred in a master/slave procedure but follows instead the producer-consumer model. In this model, a bus node transmits its data, as a producer, on its own accord. This might, for example, be triggered by an event. All the other nodes listen and use the identifier to decide whether they are interested in this telegram, and handle it accordingly. These are the consumers.

The process data in CANopen is divided into segments with a maximum of 8 bytes. These segments are known as process data objects (PDOs). The PDOs each correspond to a CAN telegram, whose specific CAN identifier is used to allocate them and to determine their priority. Receive (Rx) PDOs and transmit (Tx) PDOs are distinguished, the name being chosen from the point of view of a device: an input/output module sends its input data with TxPDOs and receives its output data in the RxPDOs. This naming convention is retained in the TwinCAT System Manager.

Communication parameters

The PDOs can be given different communication parameters according to the requirements of the application. Like all the CANopen parameters, these are also available in the device's object directory, and can be accessed by means of the service data objects. The parameters for the receive PDOs are at index 0x1400 (RxPDO1) onwards. There can be up to 512 RxPDOs (ranging up to index 0x15FF). In the same way, the entries for the transmit PDOs are located from index 0x1800 (TxPDO1) to 0x19FF (TxPDO512).

The Bus Couplers or Fieldbus Box modules make 16 RxPDO and 16 TxPDOs available for the exchange of process data (although the figure for Economy and LowCost BK5110 and LC5100 couplers and the Compact Box modules is 5 PDOs each since these devices manage a lower quantity of process data).

For each existing process data object there is an associated communication parameter object. The TwinCAT System Manager automatically assigns the set parameters to the relevant object directory entries. These entries and their significance for the communication of process data are explained below.

PDO Identifier

The most important communication parameter in a PDO is the CAN identifier (also known as the communication object identifier, or COB-ID). It is used to identify the data and determines their priority for bus access. For each CAN data telegram there may only be one sender node (producer), although all messages sent in the CAN broadcast procedure can be received, as described, by any number of nodes (consumers). Thus, a node can make its input information available to several bus devices at the same time - even without transferring them through a logical bus master. The identifier is in subindex 1 of the communication parameter set. It is coded as a 32-bit value in which the least significant 11 bits (bits 0...10) contain the identifier itself. The data width of 32 bits also allows 29-bit identifiers in accordance with CAN 2.0B to be entered, although the [default identifiers](#) [[▶ 392](#)] always refer to the more usual 11-bit versions.

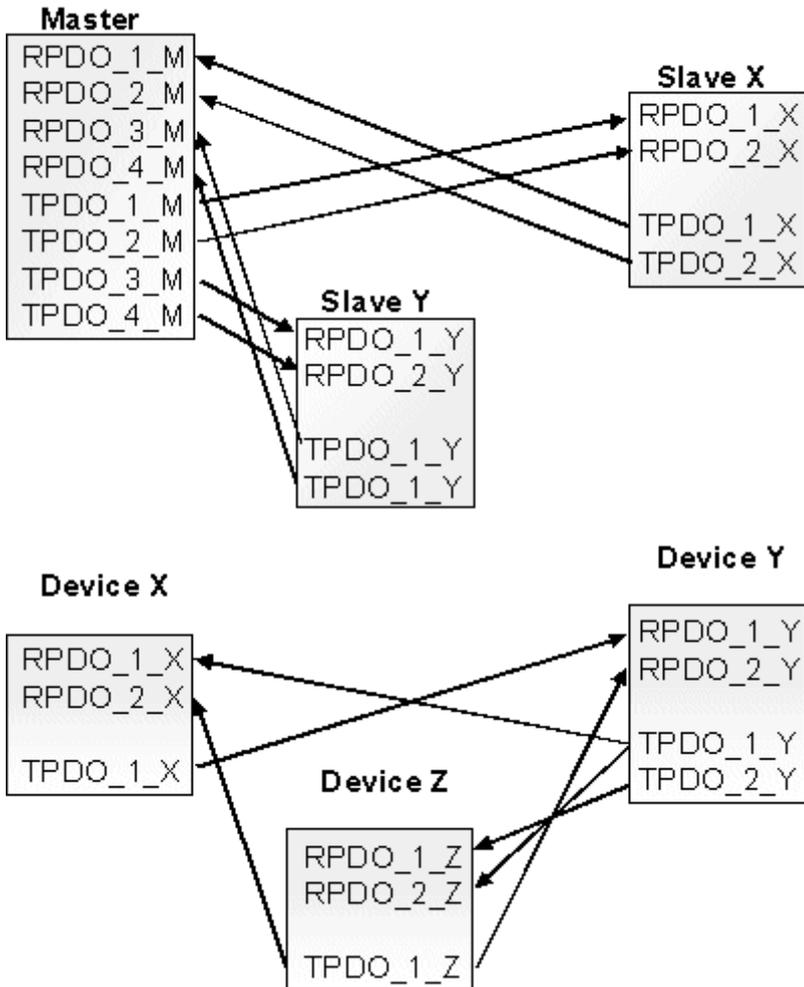
CANopen is economical in its use of the available identifiers, so that the use of the 29-bit versions remains limited to unusual applications. The highest bit (bit 31) can be used to activate the process data object or to turn it off.

A complete [identifier list \[▶ 394\]](#) is provided here.

PDO Linking

PDO Linking

In the system of default identifiers, all the nodes (here: slaves) communicate with one central station (the master) since slave nodes do not listen by default to the transmit identifier of any other slave node.



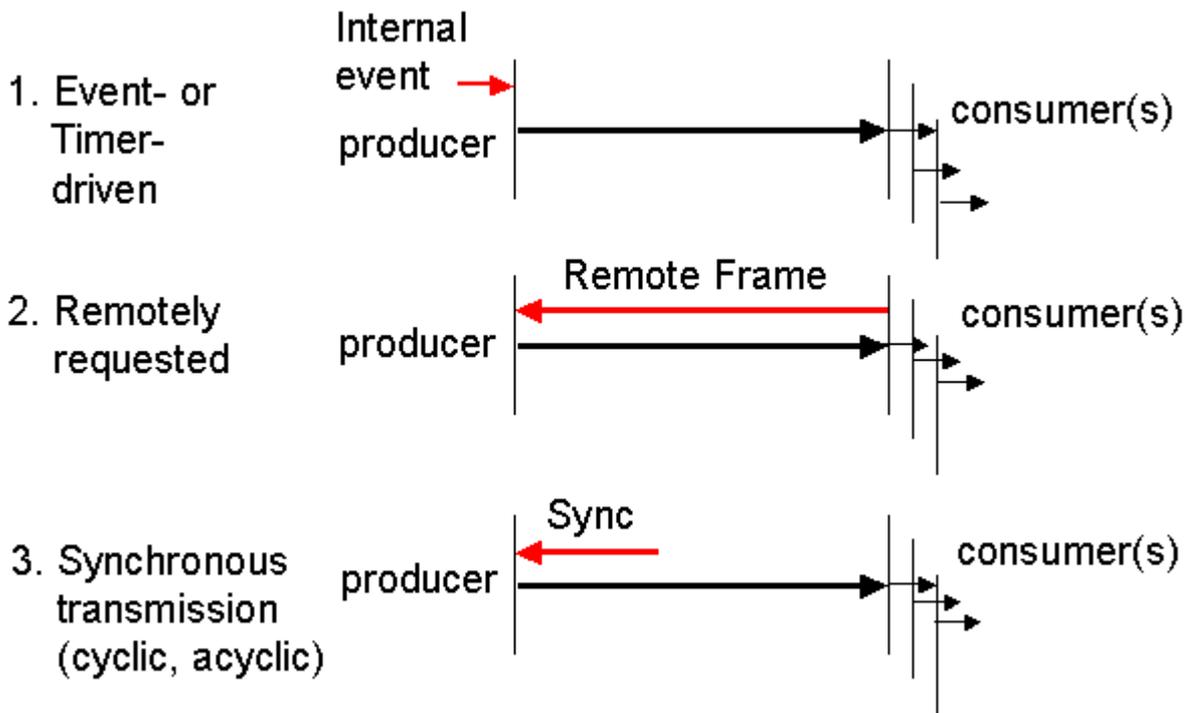
Default identifier assignment: Master/Slave PDO Linking: Peer to Peer

If the consumer-producer model of CANopen PDOs is to be used for direct data exchange between nodes (without a master), the distribution of identifiers must be appropriately adapted, so that the TxPDO identifier of the producer agrees with the RxPDO identifier of the consumer. This procedure is known as PDO linking. It permits, for example, easy construction of electronic drives in which several slave axes simultaneously listen to the actual value in the master axis TxPDO.

PDO Communication Types: Outline

PDO Communication Types: Outline

CANopen offers several possible ways to transmit process data (see also: [Notes on PDO Parameterisation \[▶ 388\]](#)).



Event driven

The "event" is the alteration of an input value, the data being transmitted immediately after this change. The event-driven flow can make optimal use of the bus bandwidth, since instead of the whole process image it is only the changes in it that are transmitted. A short reaction time is achieved at the same time, since when an input value changes it is not necessary to wait for the next interrogation from a master.

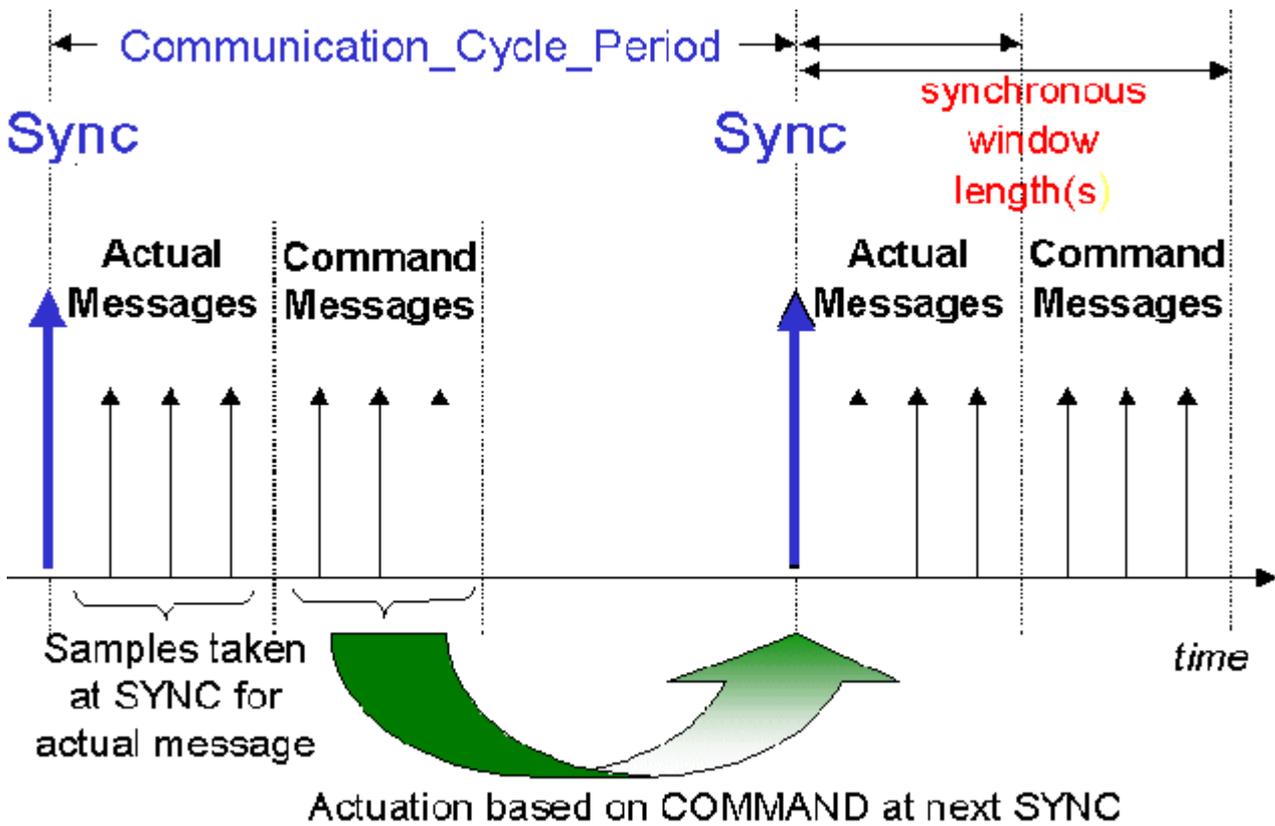
Polled

The PDOs can also be polled by data request telegrams (remote frames). In this way it is possible to get the input process image of event-driven inputs onto the bus, even when they do not change, for instance through a monitoring or diagnostic device brought into the network while it is running. The time behavior of remote frame and answer telegrams depends on what CAN controller is in use (Fig. 8). Components with full integrated message filtering ("FullCAN") usually answer a data request telegram immediately, transmitting data that is waiting in the appropriate transmit buffer - it is the responsibility of the application to see that the data there is continuously updated. CAN controllers with simple message filtering ("BasicCAN") on the other hand pass the request on to the application which can now compose the telegram with the latest data. This does take longer but does mean that the data is "fresh". Beckhoff use CAN controllers following the principle of Basic CAN.

Since this device behaviour is usually not transparent to the user, and because there are CAN controllers still in use that do not support remote frames at all, polled communication can only with reservation be recommended for operative running.

Synchronized

It is not only for drive applications that it is worthwhile to synchronize the determination of the input information and the setting the outputs. For this purpose CANopen provides the SYNC object, a CAN telegram of high priority but containing no user data, whose reception is used by the synchronized nodes as a trigger for reading the inputs or for setting the outputs.



PDO transmission types: Parameterization

The PDO transmission type parameter specifies how the transmission of the PDO is triggered, or how received PDOs are handled.

Transmission type	Cyclical	Acyclical	Synchronous	Asynchronous	Only RTR
0		X	X		
1-240	X		X		
241-251	- reserved -				
252			X		X
253				X	X
254, 255				X	

Acyclic Synchronous

PDOs of transmission type 0 function synchronously, but not cyclically. An RxPDO is only evaluated after the next SYNC telegram has been received. In this way, for instance, axis groups can be given new target positions one after another, but these positions only become valid at the next SYNC - without the need to be constantly outputting reference points. A device whose TxPDO is configured for transmission type 0 acquires its input data when it receives the SYNC (synchronous process image) and then transmits it if the data correspond to an event (such as a change in input) having occurred. Transmission type 0 thus combines transmission for reasons that are event driven with a time for transmission (and, as far as possible, sampling) and processing given by the reception of "SYNC".

Cyclic Synchronous

In transmission types 1-240 the PDO is transmitted cyclically: after every "nth" SYNC (n = 1...240). Since transmission types can be combined on a device as well as in the network, it is possible, for example, for a fast cycle to be agreed for digital inputs (n = 1), whereas the data for analog inputs is transmitted in a slower cycle (e.g. n = 10). RxPDOs do not generally distinguish between transmission types 0...240: a PDO that has been received is set to valid when the next SYNC is received. The cycle time (SYNC rate) can be monitored (object 0x1006), so that if the SYNC fails the device reacts in accordance with the definition in the device profile, and switches, for example, its outputs into the fault state.

The CANopen CIFx0 PC cards always transmit under event control, even if the transmission type is set in the range from 1-240. This behaviour is quite like transmission type 0. The FC510x PC cards support cyclic synchronous transmission types completely.

Only RTR

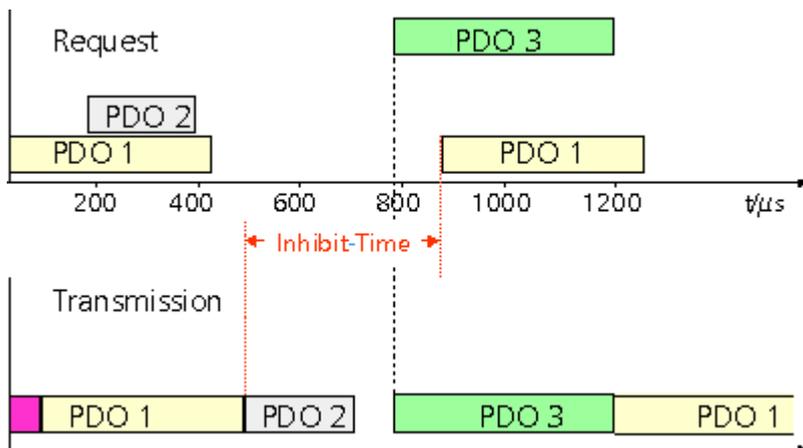
Transmission types 252 and 253 apply to process data objects that are transmitted exclusively on request by a remote frame. 252 is synchronous: when the SYNC is received the process data is acquired. It is only transmitted on request. 253 is asynchronous. The data here is acquired continuously and transmitted on request. This type of transmission is not supported by the Beckhoff PC cards.

Asynchronous

The transmission types 254 + 255 are asynchronous but may also be event-driven. In transmission type 254, the event is specific to the manufacturer, whereas for type 255 it is defined in the device profile. In the simplest case, the event is the change of an input value - this means that every change in the value is transmitted.

Inhibit time

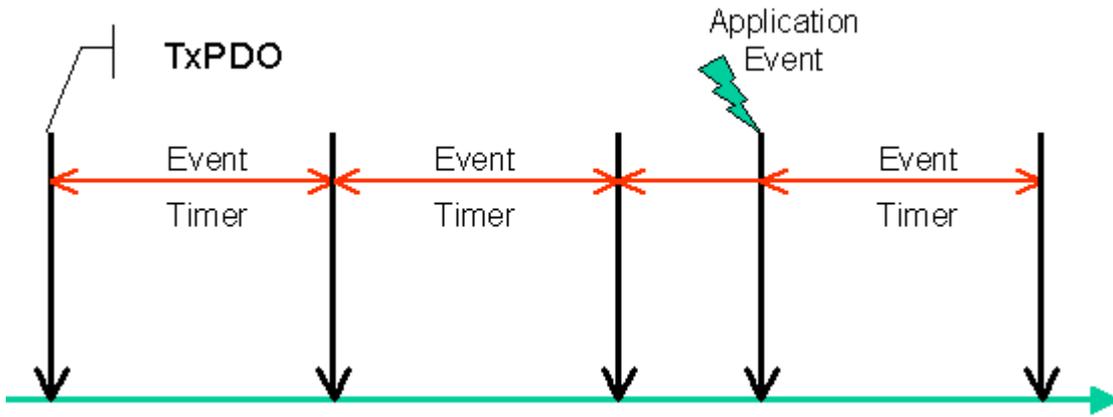
The "inhibit time" parameter can be used to implement a "transmit filter" that does not increase the reaction time for relatively new input alterations, but is active for changes that follow immediately afterwards. The inhibit time (transmit delay time) specifies the minimum length of time that must be allowed to elapse between the transmission of two of the same telegrams. If the inhibit time is used, the maximum bus loading can be determined, so that the worst case latency can then be found.



Although the Beckhoff FC510x PC cards can parameterize the inhibit time on slave devices, they do not themselves support it. The transmitted PDOs become automatically spread out (transmit delay) because of the selected PLC cycle time - and there is little value in having the PLC run faster than the bus bandwidth permits. The bus loading, furthermore, can be significantly affected by the synchronous communication.

Event Timer

An event timer for transmit PDOs can be specified by subindex 5 in the communication parameters. Expiry of this timer is treated as an additional event for the corresponding PDO, so that the PDO will then be transmitted. If the application event occurs during a timer period, it will also be transmitted, and the timer is reset.



In the case of receive PDOs, the timer is used to set a watchdog interval for the PDO: the application is informed if no corresponding PDO has been received within the set period.

Notes on PDO Parameterisation [▶ 388]

PDO Mapping

PDO mapping refers to mapping of the application objects (real time data) from the object directory to the process data objects. The CANopen device profile provide a default mapping for every device type, and this is appropriate for most applications. Thus, the default mapping for digital I/O simply represents the inputs and outputs in their physical sequence in the transmit and receive process data objects.

The first 4 analog inputs or outputs are in the second PDO. These PDOs are accordingly occupied by the Beckhoff fieldbus I/O modules - if, for instance, no digital outputs are present, RxPDO1 remains empty.

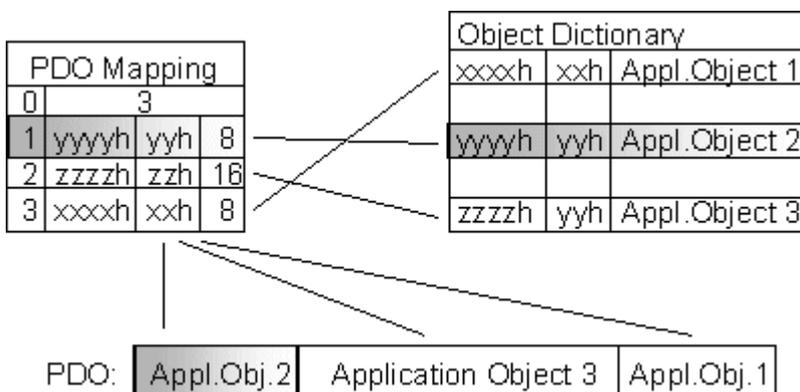
In this way the PDO assignment for the Compact Box Modules is determined by the signal variants: digital input/output data is in PDO1, analog in PDO2, special signals in PDO3.

The extendable I/O modules occupy the PDOs automatically: during the start-up phase the coupler reads in which terminals are plugged in and which Extension Box Modules are present and allocates the data to the PDOs. A distinction is made here between digital, analog, and special terminals, and the PDOs are each occupied with one type. In other words, different types of data (such as digital and analog inputs) are not packed into one PDO, but a new PDO is started for each new data type.

Automatic PDO Assignment in Beckhoff Bus Couplers [▶ 390]

The default PDOs for drives contain 2 bytes each of a control and status word and a set or actual value for the relevant axis.

The current mapping can be read by means of corresponding entries in the object directory. These are known as the mapping tables. The first location in the mapping table (sub-index 0) contains the number of mapped objects that are listed after it. The tables are in the object directory at index 0x1600ff for the RxPDOs and at 0x1A00ff for the TxPDOs.



Dummy Mapping

A further feature of CANopen is the mapping of placeholders, or dummy entries. The data type entries stored in the object directory, which do not themselves have data, are used as placeholders. If such entries are contained in the mapping table, the corresponding data from the device is not evaluated. In this way, for instance, a number of drives can be supplied with new set values using a single CAN telegram, or outputs on a number of nodes can be set simultaneously, even in event-driven mode.

12.1.2.2 PDO Parameterisation

Even though the majority of CANopen networks operate satisfactorily with the default settings, i.e. with the minimum of configuration effort, it is wise at least to check whether the existing bus loading is reasonable: 80% bus loading may be acceptable for a network operating purely in cyclic synchronous modes, but for a network with event-driven traffic this value would generally be too high, as there is hardly any bandwidth available for additional events.

Consider the Requirements of the Application

The communication of the process data must be optimized in the light of application requirements which are likely to be to some extent in conflict. These include

- Little work on parameterization - useable default values are optimal
- Guaranteed reaction time for specific events
- Cycle time for regulation processes over the bus
- Safety reserves for bus malfunctions (enough bandwidth for the repetition of messages)
- Maximum baud rate - depends on the maximum bus length
- Desired communication paths - who is speaking with whom

The determining factor often turns out to be the available bus bandwidth (bus load).

Baud rate

We generally begin by choosing the highest baud rate that the bus will permit. It should be borne in mind that serial bus systems are always more sensitive to interference at higher baud rates, so the better rule is "just as fast as needed". 1000 kbit/s are not usually necessary, and only to be unreservedly recommended on networks within a control cabinet where there is no electrical isolation between the bus nodes. Experience also tends to show that estimates of the length of bus cable laid are often over-optimistic - the length actually laid tends to be longer.

Determine the Communication Type

Once the baud rate has been chosen it is appropriate to specify the PDO communication type(s). These have different advantages and disadvantages:

- Cyclic synchronous communication provides an accurately predictable bus loading, and therefore a defined time behavior - you could say that the standard case is the worst case. It is easy to configure: The SYNC rate parameter sets the bus loading globally. The process images are synchronized: Inputs are read at the same time, output data is set valid simultaneously, although the quality of the synchronization depends on the implementation. The Beckhoff FC510x PC cards are capable of synchronizing the CANopen bus system with the cycles of the application program (PLC or NC).

The guaranteed reaction time under cyclic synchronous communication is always at least as long as the cycle time, and the bus bandwidth is not exploited optimally, since "old" data, i.e. data that has not changed, is continuously transmitted. It is however possible to optimise the network through the selection of different SYNC multiples (transmission types 1...240), so that data that changes slowly is transmitted less often than, for instance, time-critical inputs. It must, however, be borne in mind that input states that last for a time that is shorter than the cycle time will not necessarily be communicated. If it is necessary for such conditions to be registered, the associated PDOs for asynchronous communication should be provided.

- Event-driven asynchronous communication is optimal from the point of view of reaction time and the exploitation of bus bandwidth - it can be described as "pure CAN". Your choice must, however, also take account of the fact that it is not impossible for many events to occur simultaneously, leading to

corresponding delays before a PDO with a relatively low priority can be sent. Proper network planning therefore necessitates a worst-case analysis. Through the use of, for instance, [inhibit time \[▶ 386\]](#), it is also necessary to prevent a constantly changing input with a high PDO priority from blocking the bus (technically known as a "babbling idiot"). It is for this reason that event driving is switched off by default in the device profile of analog inputs and must be turned on specifically. Time windows for the transmit PDOs can be set using progress timers: the telegram is not sent again before the inhibit time has elapsed, and not later than the time required for the progress timer to complete.

- The communication type is parameterized by means of the [transmission type \[▶ 382\]](#).

It is also possible to combine the two PDO principles. It can, for instance, be helpful to exchange the set and actual values of an axis controller synchronously, while limit switches, or motor temperatures with limit values are monitored with event driven PDOs. This combines the advantages of the two principles: synchronicity for the axis communication and short reaction times for limit switches. Despite being event-driven, the distributed limit value monitoring avoids a constant addition to the bus load from the analog temperature value.

In this example it can also be of value to deliberately manipulate the [identifier allocation \[▶ 392\]](#), in order to optimize bus access by means of priority allocation: the highest priority is given to the PDO with the limit switch data, and the lowest to that with the temperature values.

Optimization of bus access latency time through modification of the identifier allocation is not, however, normally required. On the other hand the identifiers must be altered if "masterless" communication is to be made possible ([PDO linking \[▶ 383\]](#)). In this example it would be possible for one RxPDO for each axis to be allocated the same identifier as the limit switch TxPDO, so that alterations of the input value can be received without delay.

Determining the Bus Loading

Determining the Bus Loading

It is always worth determining the bus loading. But what bus loading values are "permitted", or indeed sensible? It is first necessary to distinguish a short burst of telegrams in which several CAN messages follow one another immediately - a temporary 100% bus loading. This is only a problem if the sequence of receive interrupts that it caused at the CAN nodes cannot be handled. This would constitute a data overflow (or "CAN queue overrun"). This can occur at very high baud rates (> 500 kbit/s) at nodes with software telegram filtering and relatively slow or heavily loaded microcontrollers if, for instance, a series of remote frames (which do not contain data bytes, and are therefore very short) follow each other closely on the bus (at 1 Mbit/s this can generate an interrupt every 40 µs; for example, an NMT master might transmit all its guarding requests in an unbroken sequence). This can be avoided through skilled implementation, and the user should be able to assume that the device suppliers have taken the necessary trouble. A burst condition is entirely normal immediately after the SYNC telegram, for instance: triggered by the SYNC, all the nodes that are operating synchronously try to send their data at almost the same time. Many arbitration processes take place, and the telegrams are sorted in order of priority for transmission on the bus. This is not usually critical, since these telegrams do contain some data bytes, and the telegrams trigger a sequence of receive interrupts at the CAN nodes which is indeed rapid but is nevertheless manageable.

Bus loading most often refers to the value averaged over several primary cycles, that is the mean value over 100-500 ms. CAN, and therefore CANopen, is indeed capable of managing a bus loading of close to 100% over long periods, but this implies that no bandwidth is available for any repetitions that may be necessitated by interference, for asynchronous error messages, parameterization and so on. Clearly, the dominant type of communication will have a large influence on the appropriate level of bus loading: a network with entirely cyclic synchronous operation is always in any case near to the "worst case" state and can therefore be operated with values in the 70-80% range. The figure is very hard to state for an entirely event-driven network: an estimate must be made of how many events additional to the current state of the system might occur, and of how long the resulting burst might last - in other words, for how long the lowest priority message will be delayed. If this value is acceptable to the application, then the current bus loading is acceptable. As a rule of thumb, it can usually be assumed that an event-driven network running with a base loading of 30-40% has enough reserve for worst-case scenarios, but this assumption does not obviate the need for a careful analysis if delays could have critical results for the plant.

The Beckhoff FC510x PC cards indicate the bus loading via the System Manager. This variable can also be processed in the PLC, or can be displayed in the visualization system.

The amount data in the process data objects is of course as relevant as the communication parameters: the [PDO mapping](#) [[▶ 387](#)].

12.1.2.3 Automatic PDO Mapping

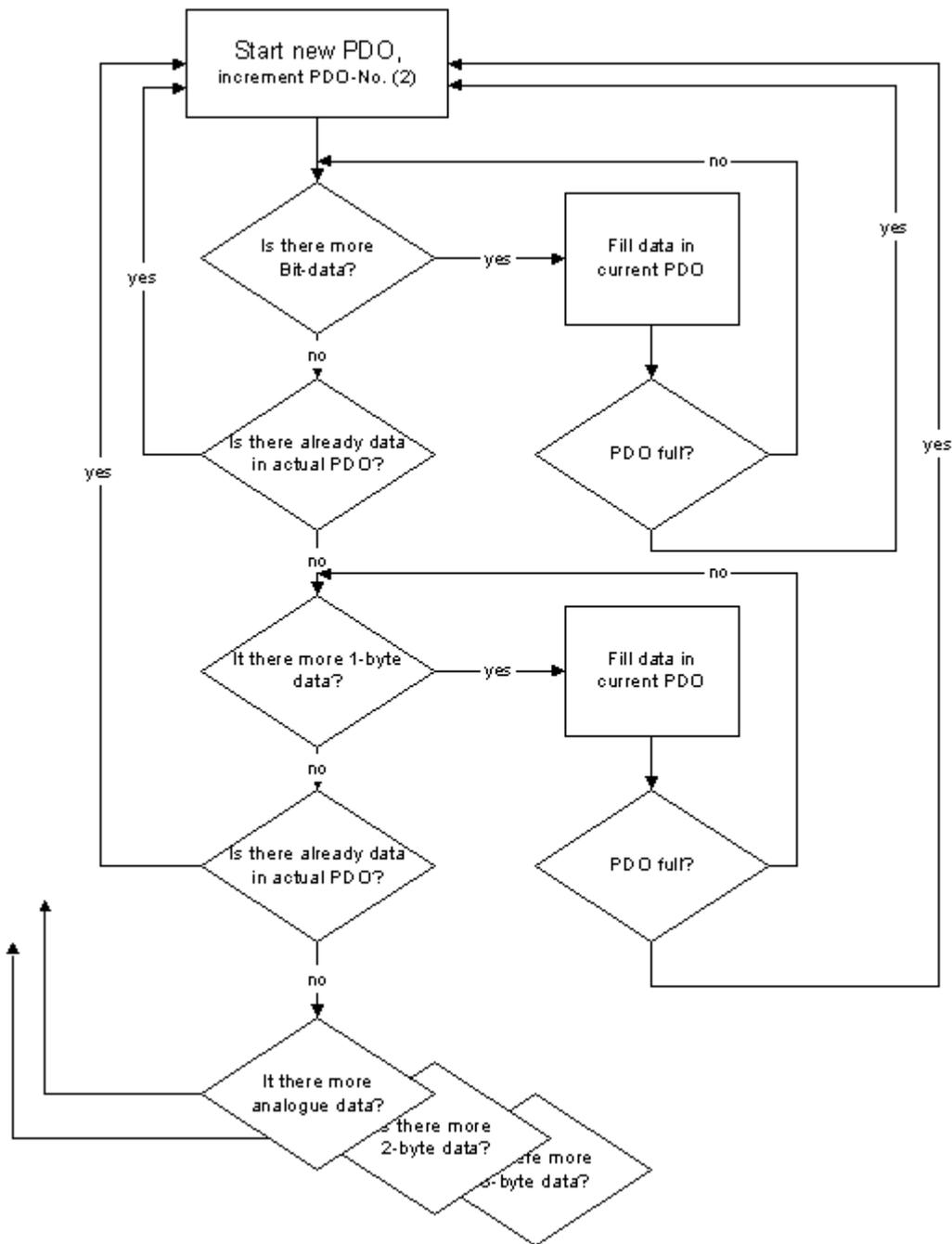
BK51x0, IL23x0-B510

PDO1 and PDO2 are occupied, as described, with digital and analog process data. For each additional PDO the CANopen node acts in accordance with the following procedure, and puts process data into the PDOs in the following sequence:

1. Digital I/Os (if more than 64 are present)
2. 1-bytes special terminals
3. Analog I/Os
4. 2-bytes special terminals
5. 3-bytes special terminals
6. ...10. 8-bytes special terminals

Data types are not mixed, and a new PDO is taken for each new data type. for [example](#) [[▶ 391](#)]

The procedure is illustrated in the flow diagram below.



Example

Example

A BK5120 CANopen coupler has altogether 78 digital inputs and 48 digital outputs, 6 analog inputs and 10 analog outputs, 1 SSI transducer interface (by default 2 x 2 bytes input), 1 serial interface (by default 2 x 2 bytes each input + output) and an incremental encoder interface (6 bytes each input + output):

PDO	Data contents (mapping)	PDO	Data contents (mapping)
RxPDO1	digital outputs 1..48	TxPDO1	digital inputs 1..64
RxPDO2	analog outputs 1.0.4	TxPDO2	analog inputs 1..4
RxPDO3	analog outputs 5..8	TxPDO3	digital inputs 65...78
RxPDO4	analog outputs 9+10	TxPDO4	analog inputs 5+6
RxPDO5	2x2 serial interface	TxPDO5	2x2 SSI+2x2 serial
RxPDO6	6 bytes encoder output	TxPDO6	6 bytes encoder input

12.1.2.4 Bit Timing

The following baud rates and entries in the bit-timing register are supported by the CANopen devices:

Baud rate [kbaud]	BTR0	BTR1
1000	00	14
800	00	16
500	00	1C
250	01	1C
125	03	1C
100	43	2F
50	47	2F
20	53	2F
10	6F	2F

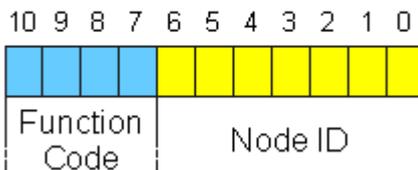
The bit-timing register settings given (BTR0, BTR1) apply, for example, for the Philips 82C200, SJA1000, Intel 80C527, Siemens 80C167 and other CAN controllers. They are optimised for the maximum bus length.

12.1.2.5 Identifier Allocation

Default identifier

CANopen provides default identifiers for the most important communication objects, and these are derived from the 7-bit node address (the node ID) and a 4-bit function code in accordance with the following scheme:

11 Bit Identifier



For broadcast objects, the node ID is set to "0". This gives rise to the following default identifiers:

Broadcast objects

Object	Function	Function code	resulting COB ID hex / dec	Object for comm. parameter / map- ping
NMT	Boot up	0	0x00 / 0	- / -
SYNC	Synch.	1	0x80 / 128	0x1005 + 0x1006 / -

Peer-to-peer objects

Object	Function	Function code	resulting COB ID hex / dec	Object for comm. parameter / mapping
Emergency	Status / error	1	0x81 - 0xFF/ 129 - 255	- / -
PDO1 (tx)	dig. inputs	11	0x181 - 0x1FF / 385 - 511	0x1800 / 0x1A00
PDO1 (rx)	digital outputs	100	0x201 - 0x27F/ 513-639	0x1400 / 0x1600
PDO2 (tx)	analog inputs	101	0x281 - 0x2FF/ 641-767	0x1801 / 0x1A01
PDO2 (rx)	Analog outputs	110	0x301 - 0x37F/ 769-895	0x1401 / 0x1601
SDO (tx)	Parameter	1011	0x581 - 0x5FF/ 1409-1535	- / -
SDO (rx)	Parameter	1100	0x601 - 0x67F/ 1537-1663	- / -
Guarding	Life/node guarding	1110	0x701 - 0x77F/ 1793-1919	(0x100C, 0x100D, 0x100E)

i Default identifier

Up until version 3 of the CANopen specification, default identifiers were assigned to 2 PDOs at a time. The Beckhoff Bus Couplers correspond to this issue of the specification. After version 4, default identifiers are provided for up to 4 PDOs.

Manufacture-Specific Default Identifiers for Additional PDOs

Default Identifiers for Additional PDOs

Identifiers are not assigned to the additional PDOs that are filled by the Beckhoff Bus Couplers in accordance with the standard scheme. The user must enter an identifier for these PDOs in the object directory. It is easier to activate the occupied PDOs by means of object 0x5500.

This entry in the object directory extends the allocation of default identifiers up to 11 PDOs. This creates the following identifiers:

Object	Function code	Resulting COB ID (hex)	Resulting COB ID (dec)
PDO3 (tx)	111	0x381 - 0x3BF	897 - 959
PDO3 (rx)	1000	0x401 - 0x43F	1025 - 1087
PDO4 (tx)	1001	0x481 - 0x4BF	1153 - 1215
PDO4 (rx)	1010	0x501 - 0x53F	1281- 1343
PDO5 (tx)	1101	0x681 - 0x6BF	1665 - 1727
PDO5 (rx)	1111	0x781 - 0x7BF	1921- 1983
PDO6 (tx)	111	0x1C1 - 0x1FF	449 - 511
PDO6 (rx)	1001	0x241 - 0x27F	577 - 639
PDO7 (tx)	1011	0x2C1 - 0x2FF	705 - 767
PDO7 (rx)	1101	0x341 - 0x37F	833 - 895
PDO8 (tx)	1111	0x3C1- 0x3FF	961 - 1023
PDO8 (rx)	10001	0x441 - 0x47F	1089 - 1151
PDO9 (tx)	10011	0x4C1 - 0x4FF	1217 - 1279
PDO9 (rx)	10101	0x541 - 0x57F	1345 - 1407
PDO10 (tx)	10111	0x5C1 - 0x5FF	1473 - 1535
PDO10 (rx)	11001	0x641 - 0x67F	1601- 1663
PDO11 (tx)	11011	0x6C1 - 0x6FF	1729 - 1791
PDO11 (rx)	11101	0x741 - 0x77F	1857 - 1919



Ensure that index 0x5500 is not used if bus couplers with more than 5 PDOs are present in networks with node numbers >64, otherwise identification overlaps can occur.

12.1.2.6 Identifier Full List

Identifiers marked with * are given manufacturer-specific assignments on the bus couplers after writing index 0x5500

0x201 [[▶ 394](#)] 0x301 [[▶ 394](#)] 0x401 [[▶ 394](#)] 0x501 [[▶ 394](#)] 0x601 [[▶ 394](#)] 0x701 [[▶ 394](#)]

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
0	0	NMT	874	36A	RxPDO7*, Nd.42	1430	596	SDO Tx Nd.22
128	80	SYNC	875	36B	RxPDO7*, Nd.43	1431	597	SDO Tx Nd.23
129	81	EMCY Nd.1	876	36C	RxPDO7*, Nd.44	1432	598	SDO Tx Nd.24
130	82	EMCY Nd.2	877	36D	RxPDO7*, Nd.45	1433	599	SDO Tx Nd.25
131	83	EMCY Nd.3	878	36E	RxPDO7*, Nd.46	1434	59A	SDO Tx Nd.26
132	84	EMCY Nd.4	879	36F	RxPDO7*, Nd.47	1435	59B	SDO Tx Nd.27
133	85	EMCY Nd.5	880	370	RxPDO7*, Nd.48	1436	59C	SDO Tx Nd.28
134	86	EMCY Nd.6	881	371	RxPDO7*, Nd.49	1437	59D	SDO Tx Nd.29
135	87	EMCY Nd.7	882	372	RxPDO7*, Nd.50	1438	59E	SDO Tx Nd.30
136	88	EMCY Nd.8	883	373	RxPDO7*, Nd.51	1439	59F	SDO Tx Nd.31
137	89	EMCY Nd.9	884	374	RxPDO7*, Nd.52	1440	5A0	SDO Tx Nd.32
138	8A	EMCY Nd.10	885	375	RxPDO7*, Nd.53	1441	5A1	SDO Tx Nd.33
139	8B	EMCY Nd.11	886	376	RxPDO7*, Nd.54	1442	5A2	SDO Tx Nd.34
140	8C	EMCY Nd.12	887	377	RxPDO7*, Nd.55	1443	5A3	SDO Tx Nd.35
141	8D	EMCY Nd.13	888	378	RxPDO7*, Nd.56	1444	5A4	SDO Tx Nd.36
142	8E	EMCY Nd.14	889	379	RxPDO7*, Nd.57	1445	5A5	SDO Tx Nd.37
143	8F	EMCY Nd.15	890	37A	RxPDO7*, Nd.58	1446	5A6	SDO Tx Nd.38
144	90	EMCY Nd.16	891	37B	RxPDO7*, Nd.59	1447	5A7	SDO Tx Nd.39
145	91	EMCY Nd.17	892	37C	RxPDO7*, Nd.60	1448	5A8	SDO Tx Nd.40
146	92	EMCY Nd.18	893	37D	RxPDO7*, Nd.61	1449	5A9	SDO Tx Nd.41
147	93	EMCY Nd.19	894	37E	RxPDO7*, Nd.62	1450	5AA	SDO Tx Nd.42
148	94	EMCY Nd.20	895	37F	RxPDO7*, Nd.63	1451	5AB	SDO Tx Nd.43
149	95	EMCY Nd.21	897	381	TxPDO3*, Nd.1	1452	5AC	SDO Tx Nd.44
150	96	EMCY Nd.22	898	382	TxPDO3*, Nd.2	1453	5AD	SDO Tx Nd.45
151	97	EMCY Nd.23	899	383	TxPDO3*, Nd.3	1454	5AE	SDO Tx Nd.46
152	98	EMCY Nd.24	900	384	TxPDO3*, Nd.4	1455	5AF	SDO Tx Nd.47
153	99	EMCY Nd.25	901	385	TxPDO3*, Nd.5	1456	5B0	SDO Tx Nd.48

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
154	9A	EMCY Nd.26	902	386	TxPDO3*, Nd.6	1457	5B1	SDO Tx Nd.49
155	9B	EMCY Nd.27	903	387	TxPDO3*, Nd.7	1458	5B2	SDO Tx Nd.50
156	9C	EMCY Nd.28	904	388	TxPDO3*, Nd.8	1459	5B3	SDO Tx Nd.51
157	9D	EMCY Nd.29	905	389	TxPDO3*, Nd.9	1460	5B4	SDO Tx Nd.52
158	9E	EMCY Nd.30	906	38A	TxPDO3*, Nd.10	1461	5B5	SDO Tx Nd.53
159	9F	EMCY Nd.31	907	38B	TxPDO3*, Nd.11	1462	5B6	SDO Tx Nd.54
160	A0	EMCY Nd.32	908	38C	TxPDO3*, Nd.12	1463	5B7	SDO Tx Nd.55
161	A1	EMCY Nd.33	909	38D	TxPDO3*, Nd.13	1464	5B8	SDO Tx Nd.56
162	A2	EMCY Nd.34	910	38E	TxPDO3*, Nd.14	1465	5B9	SDO Tx Nd.57
163	A3	EMCY Nd.35	911	38F	TxPDO3*, Nd.15	1466	5BA	SDO Tx Nd.58
164	A4	EMCY Nd.36	912	390	TxPDO3*, Nd.16	1467	5BB	SDO Tx Nd.59
165	A5	EMCY Nd.37	913	391	TxPDO3*, Nd.17	1468	5BC	SDO Tx Nd.60
166	A6	EMCY Nd.38	914	392	TxPDO3*, Nd.18	1469	5BD	SDO Tx Nd.61
167	A7	EMCY Nd.39	915	393	TxPDO3*, Nd.19	1470	5BE	SDO Tx Nd.62
168	A8	EMCY Nd.40	916	394	TxPDO3*, Nd.20	1471	5BF	SDO Tx Nd.63
169	A9	EMCY Nd.41	917	395	TxPDO3*, Nd.21	1473	5C1	TxPDO10*, Nd.1
170	AA	EMCY Nd.42	918	396	TxPDO3*, Nd.22	1474	5C2	TxPDO10*, Nd.2
171	AB	EMCY Nd.43	919	397	TxPDO3*, Nd.23	1475	5C3	TxPDO10*, Nd.3
172	AC	EMCY Nd.44	920	398	TxPDO3*, Nd.24	1476	5C4	TxPDO10*, Nd.4
173	AD	EMCY Nd.45	921	399	TxPDO3*, Nd.25	1477	5C5	TxPDO10*, Nd.5
174	AE	EMCY Nd.46	922	39A	TxPDO3*, Nd.26	1478	5C6	TxPDO10*, Nd.6
175	AF	EMCY Nd.47	923	39B	TxPDO3*, Nd.27	1479	5C7	TxPDO10*, Nd.7
176	B0	EMCY Nd.48	924	39C	TxPDO3*, Nd.28	1480	5C8	TxPDO10*, Nd.8
177	B1	EMCY Nd.49	925	39D	TxPDO3*, Nd.29	1481	5C9	TxPDO10*, Nd.9
178	B2	EMCY Nd.50	926	39E	TxPDO3*, Nd.30	1482	5CA	TxPDO10*, Nd.10
179	B3	EMCY Nd.51	927	39F	TxPDO3*, Nd.31	1483	5CB	TxPDO10*, Nd.11
180	B4	EMCY Nd.52	928	3A0	TxPDO3*, Nd.32	1484	5CC	TxPDO10*, Nd.12

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
181	B5	EMCY Nd.53	929	3A1	TxPDO3*, Nd.33	1485	5CD	TxPDO10*, Nd.13
182	B6	EMCY Nd.54	930	3A2	TxPDO3*, Nd.34	1486	5CE	TxPDO10*, Nd.14
183	B7	EMCY Nd.55	931	3A3	TxPDO3*, Nd.35	1487	5CF	TxPDO10*, Nd.15
184	B8	EMCY Nd.56	932	3A4	TxPDO3*, Nd.36	1488	5D0	TxPDO10*, Nd.16
185	B9	EMCY Nd.57	933	3A5	TxPDO3*, Nd.37	1489	5D1	TxPDO10*, Nd.17
186	BA	EMCY Nd.58	934	3A6	TxPDO3*, Nd.38	1490	5D2	TxPDO10*, Nd.18
187	BB	EMCY Nd.59	935	3A7	TxPDO3*, Nd.39	1491	5D3	TxPDO10*, Nd.19
188	BC	EMCY Nd.60	936	3A8	TxPDO3*, Nd.40	1492	5D4	TxPDO10*, Nd.20
189	BD	EMCY Nd.61	937	3A9	TxPDO3*, Nd.41	1493	5D5	TxPDO10*, Nd.21
190	BE	EMCY Nd.62	938	3AA	TxPDO3*, Nd.42	1494	5D6	TxPDO10*, Nd.22
191	BF	EMCY Nd.63	939	3AB	TxPDO3*, Nd.43	1495	5D7	TxPDO10*, Nd.23
385	181	TxPDO1, DI, Nd.1	940	3AC	TxPDO3*, Nd.44	1496	5D8	TxPDO10*, Nd.24
386	182	TxPDO1, DI, Nd.2	941	3AD	TxPDO3*, Nd.45	1497	5D9	TxPDO10*, Nd.25
387	183	TxPDO1, DI, Nd.3	942	3AE	TxPDO3*, Nd.46	1498	5DA	TxPDO10*, Nd.26
388	184	TxPDO1, DI, Nd.4	943	3AF	TxPDO3*, Nd.47	1499	5DB	TxPDO10*, Nd.27
389	185	TxPDO1, DI, Nd.5	944	3B0	TxPDO3*, Nd.48	1500	5DC	TxPDO10*, Nd.28
390	186	TxPDO1, DI, Nd.6	945	3B1	TxPDO3*, Nd.49	1501	5DD	TxPDO10*, Nd.29
391	187	TxPDO1, DI, Nd.7	946	3B2	TxPDO3*, Nd.50	1502	5DE	TxPDO10*, Nd.30
392	188	TxPDO1, DI, Nd.8	947	3B3	TxPDO3*, Nd.51	1503	5DF	TxPDO10*, Nd.31
393	189	TxPDO1, DI, Nd.9	948	3B4	TxPDO3*, Nd.52	1504	5E0	TxPDO10*, Nd.32
394	18A	TxPDO1, DI, Nd.10	949	3B5	TxPDO3*, Nd.53	1505	5E1	TxPDO10*, Nd.33
395	18B	TxPDO1, DI, Nd.11	950	3B6	TxPDO3*, Nd.54	1506	5E2	TxPDO10*, Nd.34
396	18C	TxPDO1, DI, Nd.12	951	3B7	TxPDO3*, Nd.55	1507	5E3	TxPDO10*, Nd.35
397	18D	TxPDO1, DI, Nd.13	952	3B8	TxPDO3*, Nd.56	1508	5E4	TxPDO10*, Nd.36
398	18E	TxPDO1, DI, Nd.14	953	3B9	TxPDO3*, Nd.57	1509	5E5	TxPDO10*, Nd.37
399	18F	TxPDO1, DI, Nd.15	954	3BA	TxPDO3*, Nd.58	1510	5E6	TxPDO10*, Nd.38
400	190	TxPDO1, DI, Nd.16	955	3BB	TxPDO3*, Nd.59	1511	5E7	TxPDO10*, Nd.39

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
401	191	TxPDO1, DI, Nd.17	956	3BC	TxPDO3*, Nd.60	1512	5E8	TxPDO10*, Nd.40
402	192	TxPDO1, DI, Nd.18	957	3BD	TxPDO3*, Nd.61	1513	5E9	TxPDO10*, Nd.41
403	193	TxPDO1, DI, Nd.19	958	3BE	TxPDO3*, Nd.62	1514	5EA	TxPDO10*, Nd.42
404	194	TxPDO1, DI, Nd.20	959	3BF	TxPDO3*, Nd.63	1515	5EB	TxPDO10*, Nd.43
405	195	TxPDO1, DI, Nd.21	961	3C1	TxPDO8*, Nd.1	1516	5EC	TxPDO10*, Nd.44
406	196	TxPDO1, DI, Nd.22	962	3C2	TxPDO8*, Nd.2	1517	5ED	TxPDO10*, Nd.45
407	197	TxPDO1, DI, Nd.23	963	3C3	TxPDO8*, Nd.3	1518	5EE	TxPDO10*, Nd.46
408	198	TxPDO1, DI, Nd.24	964	3C4	TxPDO8*, Nd.4	1519	5EF	TxPDO10*, Nd.47
409	199	TxPDO1, DI, Nd.25	965	3C5	TxPDO8*, Nd.5	1520	5F0	TxPDO10*, Nd.48
410	19A	TxPDO1, DI, Nd.26	966	3C6	TxPDO8*, Nd.6	1521	5F1	TxPDO10*, Nd.49
411	19B	TxPDO1, DI, Nd.27	967	3C7	TxPDO8*, Nd.7	1522	5F2	TxPDO10*, Nd.50
412	19C	TxPDO1, DI, Nd.28	968	3C8	TxPDO8*, Nd.8	1523	5F3	TxPDO10*, Nd.51
413	19D	TxPDO1, DI, Nd.29	969	3C9	TxPDO8*, Nd.9	1524	5F4	TxPDO10*, Nd.52
414	19E	TxPDO1, DI, Nd.30	970	3CA	TxPDO8*, Nd.10	1525	5F5	TxPDO10*, Nd.53
415	19F	TxPDO1, DI, Nd.31	971	3CB	TxPDO8*, Nd.11	1526	5F6	TxPDO10*, Nd.54
416	1A0	TxPDO1, DI, Nd.32	972	3CC	TxPDO8*, Nd.12	1527	5F7	TxPDO10*, Nd.55
417	1A1	TxPDO1, DI, Nd.33	973	3CD	TxPDO8*, Nd.13	1528	5F8	TxPDO10*, Nd.56
418	1A2	TxPDO1, DI, Nd.34	974	3CE	TxPDO8*, Nd.14	1529	5F9	TxPDO10*, Nd.57
419	1A3	TxPDO1, DI, Nd.35	975	3CF	TxPDO8*, Nd.15	1530	5FA	TxPDO10*, Nd.58
420	1A4	TxPDO1, DI, Nd.36	976	3D0	TxPDO8*, Nd.16	1531	5FB	TxPDO10*, Nd.59
421	1A5	TxPDO1, DI, Nd.37	977	3D1	TxPDO8*, Nd.17	1532	5FC	TxPDO10*, Nd.60
422	1A6	TxPDO1, DI, Nd.38	978	3D2	TxPDO8*, Nd.18	1533	5FD	TxPDO10*, Nd.61
423	1A7	TxPDO1, DI, Nd.39	979	3D3	TxPDO8*, Nd.19	1534	5FE	TxPDO10*, Nd.62
424	1A8	TxPDO1, DI, Nd.40	980	3D4	TxPDO8*, Nd.20	1535	5FF	TxPDO10*, Nd.63
425	1A9	TxPDO1, DI, Nd.41	981	3D5	TxPDO8*, Nd.21	1537	601	SDO Rx Nd.1
426	1AA	TxPDO1, DI, Nd.42	982	3D6	TxPDO8*, Nd.22	1538	602	SDO Rx Nd.2
427	1AB	TxPDO1, DI, Nd.43	983	3D7	TxPDO8*, Nd.23	1539	603	SDO Rx Nd.3

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
428	1AC	TxPDO1, DI, Nd.44	984	3D8	TxPDO8*, Nd.24	1540	604	SDO Rx Nd.4
429	1AD	TxPDO1, DI, Nd.45	985	3D9	TxPDO8*, Nd.25	1541	605	SDO Rx Nd.5
430	1AE	TxPDO1, DI, Nd.46	986	3DA	TxPDO8*, Nd.26	1542	606	SDO Rx Nd.6
431	1AF	TxPDO1, DI, Nd.47	987	3DB	TxPDO8*, Nd.27	1543	607	SDO Rx Nd.7
432	1B0	TxPDO1, DI, Nd.48	988	3DC	TxPDO8*, Nd.28	1544	608	SDO Rx Nd.8
433	1B1	TxPDO1, DI, Nd.49	989	3DD	TxPDO8*, Nd.29	1545	609	SDO Rx Nd.9
434	1B2	TxPDO1, DI, Nd.50	990	3DE	TxPDO8*, Nd.30	1546	60A	SDO Rx Nd.10
435	1B3	TxPDO1, DI, Nd.51	991	3DF	TxPDO8*, Nd.31	1547	60B	SDO Rx Nd.11
436	1B4	TxPDO1, DI, Nd.52	992	3E0	TxPDO8*, Nd.32	1548	60C	SDO Rx Nd.12
437	1B5	TxPDO1, DI, Nd.53	993	3E1	TxPDO8*, Nd.33	1549	60D	SDO Rx Nd.13
438	1B6	TxPDO1, DI, Nd.54	994	3E2	TxPDO8*, Nd.34	1550	60E	SDO Rx Nd.14
439	1B7	TxPDO1, DI, Nd.55	995	3E3	TxPDO8*, Nd.35	1551	60F	SDO Rx Nd.15
440	1B8	TxPDO1, DI, Nd.56	996	3E4	TxPDO8*, Nd.36	1552	610	SDO Rx Nd.16
441	1B9	TxPDO1, DI, Nd.57	997	3E5	TxPDO8*, Nd.37	1553	611	SDO Rx Nd.17
442	1BA	TxPDO1, DI, Nd.58	998	3E6	TxPDO8*, Nd.38	1554	612	SDO Rx Nd.18
443	1BB	TxPDO1, DI, Nd.59	999	3E7	TxPDO8*, Nd.39	1555	613	SDO Rx Nd.19
444	1BC	TxPDO1, DI, Nd.60	1000	3E8	TxPDO8*, Nd.40	1556	614	SDO Rx Nd.20
445	1BD	TxPDO1, DI, Nd.61	1001	3E9	TxPDO8*, Nd.41	1557	615	SDO Rx Nd.21
446	1BE	TxPDO1, DI, Nd.62	1002	3EA	TxPDO8*, Nd.42	1558	616	SDO Rx Nd.22
447	1BF	TxPDO1, DI, Nd.63	1003	3EB	TxPDO8*, Nd.43	1559	617	SDO Rx Nd.23
449	1C1	TxPDO6*, Nd.1	1004	3EC	TxPDO8*, Nd.44	1560	618	SDO Rx Nd.24
450	1C2	TxPDO6*, Nd.2	1005	3ED	TxPDO8*, Nd.45	1561	619	SDO Rx Nd.25
451	1C3	TxPDO6*, Nd.3	1006	3EE	TxPDO8*, Nd.46	1562	61A	SDO Rx Nd.26
452	1C4	TxPDO6*, Nd.4	1007	3EF	TxPDO8*, Nd.47	1563	61B	SDO Rx Nd.27
453	1C5	TxPDO6*, Nd.5	1008	3F0	TxPDO8*, Nd.48	1564	61C	SDO Rx Nd.28
454	1C6	TxPDO6*, Nd.6	1009	3F1	TxPDO8*, Nd.49	1565	61D	SDO Rx Nd.29
455	1C7	TxPDO6*, Nd.7	1010	3F2	TxPDO8*, Nd.50	1566	61E	SDO Rx Nd.30

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
456	1C8	TxPDO6*, Nd.8	1011	3F3	TxPDO8*, Nd.51	1567	61F	SDO Rx Nd.31
457	1C9	TxPDO6*, Nd.9	1012	3F4	TxPDO8*, Nd.52	1568	620	SDO Rx Nd.32
458	1CA	TxPDO6*, Nd.10	1013	3F5	TxPDO8*, Nd.53	1569	621	SDO Rx Nd.33
459	1CB	TxPDO6*, Nd.11	1014	3F6	TxPDO8*, Nd.54	1570	622	SDO Rx Nd.34
460	1CC	TxPDO6*, Nd.12	1015	3F7	TxPDO8*, Nd.55	1571	623	SDO Rx Nd.35
461	1CD	TxPDO6*, Nd.13	1016	3F8	TxPDO8*, Nd.56	1572	624	SDO Rx Nd.36
462	1CE	TxPDO6*, Nd.14	1017	3F9	TxPDO8*, Nd.57	1573	625	SDO Rx Nd.37
463	1CF	TxPDO6*, Nd.15	1018	3FA	TxPDO8*, Nd.58	1574	626	SDO Rx Nd.38
464	1D0	TxPDO6*, Nd.16	1019	3FB	TxPDO8*, Nd.59	1575	627	SDO Rx Nd.39
465	1D1	TxPDO6*, Nd.17	1020	3FC	TxPDO8*, Nd.60	1576	628	SDO Rx Nd.40
466	1D2	TxPDO6*, Nd.18	1021	3FD	TxPDO8*, Nd.61	1577	629	SDO Rx Nd.41
467	1D3	TxPDO6*, Nd.19	1022	3FE	TxPDO8*, Nd.62	1578	62A	SDO Rx Nd.42
468	1D4	TxPDO6*, Nd.20	1023	3FF	TxPDO8*, Nd.63	1579	62B	SDO Rx Nd.43
469	1D5	TxPDO6*, Nd.21	1025	401	RxPDO3*, Nd.1	1580	62C	SDO Rx Nd.44
470	1D6	TxPDO6*, Nd.22	1026	402	RxPDO3*, Nd.2	1581	62D	SDO Rx Nd.45
471	1D7	TxPDO6*, Nd.23	1027	403	RxPDO3*, Nd.3	1582	62E	SDO Rx Nd.46
472	1D8	TxPDO6*, Nd.24	1028	404	RxPDO3*, Nd.4	1583	62F	SDO Rx Nd.47
473	1D9	TxPDO6*, Nd.25	1029	405	RxPDO3*, Nd.5	1584	630	SDO Rx Nd.48
474	1DA	TxPDO6*, Nd.26	1030	406	RxPDO3*, Nd.6	1585	631	SDO Rx Nd.49
475	1DB	TxPDO6*, Nd.27	1031	407	RxPDO3*, Nd.7	1586	632	SDO Rx Nd.50
476	1DC	TxPDO6*, Nd.28	1032	408	RxPDO3*, Nd.8	1587	633	SDO Rx Nd.51
477	1DD	TxPDO6*, Nd.29	1033	409	RxPDO3*, Nd.9	1588	634	SDO Rx Nd.52
478	1DE	TxPDO6*, Nd.30	1034	40A	RxPDO3*, Nd.10	1589	635	SDO Rx Nd.53
479	1DF	TxPDO6*, Nd.31	1035	40B	RxPDO3*, Nd.11	1590	636	SDO Rx Nd.54
480	1E0	TxPDO6*, Nd.32	1036	40C	RxPDO3*, Nd.12	1591	637	SDO Rx Nd.55
481	1E1	TxPDO6*, Nd.33	1037	40D	RxPDO3*, Nd.13	1592	638	SDO Rx Nd.56
482	1E2	TxPDO6*, Nd.34	1038	40E	RxPDO3*, Nd.14	1593	639	SDO Rx Nd.57

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
483	1E3	TxPDO6*, Nd.35	1039	40F	RxPDO3*, Nd.15	1594	63A	SDO Rx Nd.58
484	1E4	TxPDO6*, Nd.36	1040	410	RxPDO3*, Nd.16	1595	63B	SDO Rx Nd.59
485	1E5	TxPDO6*, Nd.37	1041	411	RxPDO3*, Nd.17	1596	63C	SDO Rx Nd.60
486	1E6	TxPDO6*, Nd.38	1042	412	RxPDO3*, Nd.18	1597	63D	SDO Rx Nd.61
487	1E7	TxPDO6*, Nd.39	1043	413	RxPDO3*, Nd.19	1598	63E	SDO Rx Nd.62
488	1E8	TxPDO6*, Nd.40	1044	414	RxPDO3*, Nd.20	1599	63F	SDO Rx Nd.63
489	1E9	TxPDO6*, Nd.41	1045	415	RxPDO3*, Nd.21	1601	641	RxPDO10*, Nd.1
490	1EA	TxPDO6*, Nd.42	1046	416	RxPDO3*, Nd.22	1602	642	RxPDO10*, Nd.2
491	1EB	TxPDO6*, Nd.43	1047	417	RxPDO3*, Nd.23	1603	643	RxPDO10*, Nd.3
492	1EC	TxPDO6*, Nd.44	1048	418	RxPDO3*, Nd.24	1604	644	RxPDO10*, Nd.4
493	1ED	TxPDO6*, Nd.45	1049	419	RxPDO3*, Nd.25	1605	645	RxPDO10*, Nd.5
494	1EE	TxPDO6*, Nd.46	1050	41A	RxPDO3*, Nd.26	1606	646	RxPDO10*, Nd.6
495	1EF	TxPDO6*, Nd.47	1051	41B	RxPDO3*, Nd.27	1607	647	RxPDO10*, Nd.7
496	1F0	TxPDO6*, Nd.48	1052	41C	RxPDO3*, Nd.28	1608	648	RxPDO10*, Nd.8
497	1F1	TxPDO6*, Nd.49	1053	41D	RxPDO3*, Nd.29	1609	649	RxPDO10*, Nd.9
498	1F2	TxPDO6*, Nd.50	1054	41E	RxPDO3*, Nd.30	1610	64A	RxPDO10*, Nd.10
499	1F3	TxPDO6*, Nd.51	1055	41F	RxPDO3*, Nd.31	1611	64B	RxPDO10*, Nd.11
500	1F4	TxPDO6*, Nd.52	1056	420	RxPDO3*, Nd.32	1612	64C	RxPDO10*, Nd.12
501	1F5	TxPDO6*, Nd.53	1057	421	RxPDO3*, Nd.33	1613	64D	RxPDO10*, Nd.13
502	1F6	TxPDO6*, Nd.54	1058	422	RxPDO3*, Nd.34	1614	64E	RxPDO10*, Nd.14
503	1F7	TxPDO6*, Nd.55	1059	423	RxPDO3*, Nd.35	1615	64F	RxPDO10*, Nd.15
504	1F8	TxPDO6*, Nd.56	1060	424	RxPDO3*, Nd.36	1616	650	RxPDO10*, Nd.16
505	1F9	TxPDO6*, Nd.57	1061	425	RxPDO3*, Nd.37	1617	651	RxPDO10*, Nd.17
506	1FA	TxPDO6*, Nd.58	1062	426	RxPDO3*, Nd.38	1618	652	RxPDO10*, Nd.18
507	1FB	TxPDO6*, Nd.59	1063	427	RxPDO3*, Nd.39	1619	653	RxPDO10*, Nd.19
508	1FC	TxPDO6*, Nd.60	1064	428	RxPDO3*, Nd.40	1620	654	RxPDO10*, Nd.20
509	1FD	TxPDO6*, Nd.61	1065	429	RxPDO3*, Nd.41	1621	655	RxPDO10*, Nd.21

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
510	1FE	TxPDO6*, Nd.62	1066	42A	RxPDO3*, Nd.42	1622	656	RxPDO10*, Nd.22
511	1FF	TxPDO6*, Nd.63	1067	42B	RxPDO3*, Nd.43	1623	657	RxPDO10*, Nd.23
513	201	RxPDO1, DO, Nd.1	1068	42C	RxPDO3*, Nd.44	1624	658	RxPDO10*, Nd.24
514	202	RxPDO1, DO, Nd.2	1069	42D	RxPDO3*, Nd.45	1625	659	RxPDO10*, Nd.25
515	203	RxPDO1, DO, Nd.3	1070	42E	RxPDO3*, Nd.46	1626	65A	RxPDO10*, Nd.26
516	204	RxPDO1, DO, Nd.4	1071	42F	RxPDO3*, Nd.47	1627	65B	RxPDO10*, Nd.27
517	205	RxPDO1, DO, Nd.5	1072	430	RxPDO3*, Nd.48	1628	65C	RxPDO10*, Nd.28
518	206	RxPDO1, DO, Nd.6	1073	431	RxPDO3*, Nd.49	1629	65D	RxPDO10*, Nd.29
519	207	RxPDO1, DO, Nd.7	1074	432	RxPDO3*, Nd.50	1630	65E	RxPDO10*, Nd.30
520	208	RxPDO1, DO, Nd.8	1075	433	RxPDO3*, Nd.51	1631	65F	RxPDO10*, Nd.31
521	209	RxPDO1, DO, Nd.9	1076	434	RxPDO3*, Nd.52	1632	660	RxPDO10*, Nd.32
522	20A	RxPDO1, DO, Nd.10	1077	435	RxPDO3*, Nd.53	1633	661	RxPDO10*, Nd.33
523	20B	RxPDO1, DO, Nd.11	1078	436	RxPDO3*, Nd.54	1634	662	RxPDO10*, Nd.34
524	20C	RxPDO1, DO, Nd.12	1079	437	RxPDO3*, Nd.55	1635	663	RxPDO10*, Nd.35
525	20D	RxPDO1, DO, Nd.13	1080	438	RxPDO3*, Nd.56	1636	664	RxPDO10*, Nd.36
526	20E	RxPDO1, DO, Nd.14	1081	439	RxPDO3*, Nd.57	1637	665	RxPDO10*, Nd.37
527	20F	RxPDO1, DO, Nd.15	1082	43A	RxPDO3*, Nd.58	1638	666	RxPDO10*, Nd.38
528	210	RxPDO1, DO, Nd.16	1083	43B	RxPDO3*, Nd.59	1639	667	RxPDO10*, Nd.39
529	211	RxPDO1, DO, Nd.17	1084	43C	RxPDO3*, Nd.60	1640	668	RxPDO10*, Nd.40
530	212	RxPDO1, DO, Nd.18	1085	43D	RxPDO3*, Nd.61	1641	669	RxPDO10*, Nd.41
531	213	RxPDO1, DO, Nd.19	1086	43E	RxPDO3*, Nd.62	1642	66A	RxPDO10*, Nd.42
532	214	RxPDO1, DO, Nd.20	1087	43F	RxPDO3*, Nd.63	1643	66B	RxPDO10*, Nd.43
533	215	RxPDO1, DO, Nd.21	1089	441	RxPDO8*, Nd.1	1644	66C	RxPDO10*, Nd.44
534	216	RxPDO1, DO, Nd.22	1090	442	RxPDO8*, Nd.2	1645	66D	RxPDO10*, Nd.45
535	217	RxPDO1, DO, Nd.23	1091	443	RxPDO8*, Nd.3	1646	66E	RxPDO10*, Nd.46
536	218	RxPDO1, DO, Nd.24	1092	444	RxPDO8*, Nd.4	1647	66F	RxPDO10*, Nd.47
537	219	RxPDO1, DO, Nd.25	1093	445	RxPDO8*, Nd.5	1648	670	RxPDO10*, Nd.48

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
538	21A	RxPDO1, DO, Nd.26	1094	446	RxPDO8*, Nd.6	1649	671	RxPDO10*, Nd.49
539	21B	RxPDO1, DO, Nd.27	1095	447	RxPDO8*, Nd.7	1650	672	RxPDO10*, Nd.50
540	21C	RxPDO1, DO, Nd.28	1096	448	RxPDO8*, Nd.8	1651	673	RxPDO10*, Nd.51
541	21D	RxPDO1, DO, Nd.29	1097	449	RxPDO8*, Nd.9	1652	674	RxPDO10*, Nd.52
542	21E	RxPDO1, DO, Nd.30	1098	44A	RxPDO8*, Nd.10	1653	675	RxPDO10*, Nd.53
543	21F	RxPDO1, DO, Nd.31	1099	44B	RxPDO8*, Nd.11	1654	676	RxPDO10*, Nd.54
544	220	RxPDO1, DO, Nd.32	1100	44C	RxPDO8*, Nd.12	1655	677	RxPDO10*, Nd.55
545	221	RxPDO1, DO, Nd.33	1101	44D	RxPDO8*, Nd.13	1656	678	RxPDO10*, Nd.56
546	222	RxPDO1, DO, Nd.34	1102	44E	RxPDO8*, Nd.14	1657	679	RxPDO10*, Nd.57
547	223	RxPDO1, DO, Nd.35	1103	44F	RxPDO8*, Nd.15	1658	67A	RxPDO10*, Nd.58
548	224	RxPDO1, DO, Nd.36	1104	450	RxPDO8*, Nd.16	1659	67B	RxPDO10*, Nd.59
549	225	RxPDO1, DO, Nd.37	1105	451	RxPDO8*, Nd.17	1660	67C	RxPDO10*, Nd.60
550	226	RxPDO1, DO, Nd.38	1106	452	RxPDO8*, Nd.18	1661	67D	RxPDO10*, Nd.61
551	227	RxPDO1, DO, Nd.39	1107	453	RxPDO8*, Nd.19	1662	67E	RxPDO10*, Nd.62
552	228	RxPDO1, DO, Nd.40	1108	454	RxPDO8*, Nd.20	1663	67F	RxPDO10*, Nd.63
553	229	RxPDO1, DO, Nd.41	1109	455	RxPDO8*, Nd.21	1665	681	TxPDO5*, Nd.1
554	22A	RxPDO1, DO, Nd.42	1110	456	RxPDO8*, Nd.22	1666	682	TxPDO5*, Nd.2
555	22B	RxPDO1, DO, Nd.43	1111	457	RxPDO8*, Nd.23	1667	683	TxPDO5*, Nd.3
556	22C	RxPDO1, DO, Nd.44	1112	458	RxPDO8*, Nd.24	1668	684	TxPDO5*, Nd.4
557	22D	RxPDO1, DO, Nd.45	1113	459	RxPDO8*, Nd.25	1669	685	TxPDO5*, Nd.5
558	22E	RxPDO1, DO, Nd.46	1114	45A	RxPDO8*, Nd.26	1670	686	TxPDO5*, Nd.6
559	22F	RxPDO1, DO, Nd.47	1115	45B	RxPDO8*, Nd.27	1671	687	TxPDO5*, Nd.7
560	230	RxPDO1, DO, Nd.48	1116	45C	RxPDO8*, Nd.28	1672	688	TxPDO5*, Nd.8
561	231	RxPDO1, DO, Nd.49	1117	45D	RxPDO8*, Nd.29	1673	689	TxPDO5*, Nd.9
562	232	RxPDO1, DO, Nd.50	1118	45E	RxPDO8*, Nd.30	1674	68A	TxPDO5*, Nd.10
563	233	RxPDO1, DO, Nd.51	1119	45F	RxPDO8*, Nd.31	1675	68B	TxPDO5*, Nd.11
564	234	RxPDO1, DO, Nd.52	1120	460	RxPDO8*, Nd.32	1676	68C	TxPDO5*, Nd.12

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
565	235	RxPDO1, DO, Nd.53	1121	461	RxPDO8*, Nd.33	1677	68D	TxPDO5*, Nd.13
566	236	RxPDO1, DO, Nd.54	1122	462	RxPDO8*, Nd.34	1678	68E	TxPDO5*, Nd.14
567	237	RxPDO1, DO, Nd.55	1123	463	RxPDO8*, Nd.35	1679	68F	TxPDO5*, Nd.15
568	238	RxPDO1, DO, Nd.56	1124	464	RxPDO8*, Nd.36	1680	690	TxPDO5*, Nd.16
569	239	RxPDO1, DO, Nd.57	1125	465	RxPDO8*, Nd.37	1681	691	TxPDO5*, Nd.17
570	23A	RxPDO1, DO, Nd.58	1126	466	RxPDO8*, Nd.38	1682	692	TxPDO5*, Nd.18
571	23B	RxPDO1, DO, Nd.59	1127	467	RxPDO8*, Nd.39	1683	693	TxPDO5*, Nd.19
572	23C	RxPDO1, DO, Nd.60	1128	468	RxPDO8*, Nd.40	1684	694	TxPDO5*, Nd.20
573	23D	RxPDO1, DO, Nd.61	1129	469	RxPDO8*, Nd.41	1685	695	TxPDO5*, Nd.21
574	23E	RxPDO1, DO, Nd.62	1130	46A	RxPDO8*, Nd.42	1686	696	TxPDO5*, Nd.22
575	23F	RxPDO1, DO, Nd.63	1131	46B	RxPDO8*, Nd.43	1687	697	TxPDO5*, Nd.23
577	241	RxPDO6*, Nd.1	1132	46C	RxPDO8*, Nd.44	1688	698	TxPDO5*, Nd.24
578	242	RxPDO6*, Nd.2	1133	46D	RxPDO8*, Nd.45	1689	699	TxPDO5*, Nd.25
579	243	RxPDO6*, Nd.3	1134	46E	RxPDO8*, Nd.46	1690	69A	TxPDO5*, Nd.26
580	244	RxPDO6*, Nd.4	1135	46F	RxPDO8*, Nd.47	1691	69B	TxPDO5*, Nd.27
581	245	RxPDO6*, Nd.5	1136	470	RxPDO8*, Nd.48	1692	69C	TxPDO5*, Nd.28
582	246	RxPDO6*, Nd.6	1137	471	RxPDO8*, Nd.49	1693	69D	TxPDO5*, Nd.29
583	247	RxPDO6*, Nd.7	1138	472	RxPDO8*, Nd.50	1694	69E	TxPDO5*, Nd.30
584	248	RxPDO6*, Nd.8	1139	473	RxPDO8*, Nd.51	1695	69F	TxPDO5*, Nd.31
585	249	RxPDO6*, Nd.9	1140	474	RxPDO8*, Nd.52	1696	6A0	TxPDO5*, Nd.32
586	24A	RxPDO6*, Nd.10	1141	475	RxPDO8*, Nd.53	1697	6A1	TxPDO5*, Nd.33
587	24B	RxPDO6*, Nd.11	1142	476	RxPDO8*, Nd.54	1698	6A2	TxPDO5*, Nd.34
588	24C	RxPDO6*, Nd.12	1143	477	RxPDO8*, Nd.55	1699	6A3	TxPDO5*, Nd.35
589	24D	RxPDO6*, Nd.13	1144	478	RxPDO8*, Nd.56	1700	6A4	TxPDO5*, Nd.36
590	24E	RxPDO6*, Nd.14	1145	479	RxPDO8*, Nd.57	1701	6A5	TxPDO5*, Nd.37
591	24F	RxPDO6*, Nd.15	1146	47A	RxPDO8*, Nd.58	1702	6A6	TxPDO5*, Nd.38
592	250	RxPDO6*, Nd.16	1147	47B	RxPDO8*, Nd.59	1703	6A7	TxPDO5*, Nd.39

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
593	251	RxPDO6*, Nd.17	1148	47C	RxPDO8*, Nd.60	1704	6A8	TxPDO5*, Nd.40
594	252	RxPDO6*, Nd.18	1149	47D	RxPDO8*, Nd.61	1705	6A9	TxPDO5*, Nd.41
595	253	RxPDO6*, Nd.19	1150	47E	RxPDO8*, Nd.62	1706	6AA	TxPDO5*, Nd.42
596	254	RxPDO6*, Nd.20	1151	47F	RxPDO8*, Nd.63	1707	6AB	TxPDO5*, Nd.43
597	255	RxPDO6*, Nd.21	1153	481	TxPDO4*, Nd.1	1708	6AC	TxPDO5*, Nd.44
598	256	RxPDO6*, Nd.22	1154	482	TxPDO4*, Nd.2	1709	6AD	TxPDO5*, Nd.45
599	257	RxPDO6*, Nd.23	1155	483	TxPDO4*, Nd.3	1710	6AE	TxPDO5*, Nd.46
600	258	RxPDO6*, Nd.24	1156	484	TxPDO4*, Nd.4	1711	6AF	TxPDO5*, Nd.47
601	259	RxPDO6*, Nd.25	1157	485	TxPDO4*, Nd.5	1712	6B0	TxPDO5*, Nd.48
602	25A	RxPDO6*, Nd.26	1158	486	TxPDO4*, Nd.6	1713	6B1	TxPDO5*, Nd.49
603	25B	RxPDO6*, Nd.27	1159	487	TxPDO4*, Nd.7	1714	6B2	TxPDO5*, Nd.50
604	25C	RxPDO6*, Nd.28	1160	488	TxPDO4*, Nd.8	1715	6B3	TxPDO5*, Nd.51
605	25D	RxPDO6*, Nd.29	1161	489	TxPDO4*, Nd.9	1716	6B4	TxPDO5*, Nd.52
606	25E	RxPDO6*, Nd.30	1162	48A	TxPDO4*, Nd.10	1717	6B5	TxPDO5*, Nd.53
607	25F	RxPDO6*, Nd.31	1163	48B	TxPDO4*, Nd.11	1718	6B6	TxPDO5*, Nd.54
608	260	RxPDO6*, Nd.32	1164	48C	TxPDO4*, Nd.12	1719	6B7	TxPDO5*, Nd.55
609	261	RxPDO6*, Nd.33	1165	48D	TxPDO4*, Nd.13	1720	6B8	TxPDO5*, Nd.56
610	262	RxPDO6*, Nd.34	1166	48E	TxPDO4*, Nd.14	1721	6B9	TxPDO5*, Nd.57
611	263	RxPDO6*, Nd.35	1167	48F	TxPDO4*, Nd.15	1722	6BA	TxPDO5*, Nd.58
612	264	RxPDO6*, Nd.36	1168	490	TxPDO4*, Nd.16	1723	6BB	TxPDO5*, Nd.59
774	306	RxPDO2, AO, Nd.6	1329	531	RxPDO4*, Nd.49	1885	75D	RxPDO11*, Nd.29
775	307	RxPDO2, AO, Nd.7	1330	532	RxPDO4*, Nd.50	1886	75E	RxPDO11*, Nd.30
776	308	RxPDO2, AO, Nd.8	1331	533	RxPDO4*, Nd.51	1887	75F	RxPDO11*, Nd.31
777	309	RxPDO2, AO, Nd.9	1332	534	RxPDO4*, Nd.52	1888	760	RxPDO11*, Nd.32
778	30A	RxPDO2, AO, Nd.10	1333	535	RxPDO4*, Nd.53	1889	761	RxPDO11*, Nd.33
779	30B	RxPDO2, AO, Nd.11	1334	536	RxPDO4*, Nd.54	1890	762	RxPDO11*, Nd.34
780	30C	RxPDO2, AO, Nd.12	1335	537	RxPDO4*, Nd.55	1891	763	RxPDO11*, Nd.35

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
781	30D	RxPDO2, AO, Nd.13	1336	538	RxPDO4*, Nd.56	1892	764	RxPDO11*, Nd.36
782	30E	RxPDO2, AO, Nd.14	1337	539	RxPDO4*, Nd.57	1893	765	RxPDO11*, Nd.37
783	30F	RxPDO2, AO, Nd.15	1338	53A	RxPDO4*, Nd.58	1894	766	RxPDO11*, Nd.38
784	310	RxPDO2, AO, Nd.16	1339	53B	RxPDO4*, Nd.59	1895	767	RxPDO11*, Nd.39
785	311	RxPDO2, AO, Nd.17	1340	53C	RxPDO4*, Nd.60	1896	768	RxPDO11*, Nd.40
786	312	RxPDO2, AO, Nd.18	1341	53D	RxPDO4*, Nd.61	1897	769	RxPDO11*, Nd.41
787	313	RxPDO2, AO, Nd.19	1342	53E	RxPDO4*, Nd.62	1898	76A	RxPDO11*, Nd.42
788	314	RxPDO2, AO, Nd.20	1343	53F	RxPDO4*, Nd.63	1899	76B	RxPDO11*, Nd.43
789	315	RxPDO2, AO, Nd.21	1345	541	RxPDO9*, Nd.1	1900	76C	RxPDO11*, Nd.44
790	316	RxPDO2, AO, Nd.22	1346	542	RxPDO9*, Nd.2	1901	76D	RxPDO11*, Nd.45
791	317	RxPDO2, AO, Nd.23	1347	543	RxPDO9*, Nd.3	1902	76E	RxPDO11*, Nd.46
792	318	RxPDO2, AO, Nd.24	1348	544	RxPDO9*, Nd.4	1903	76F	RxPDO11*, Nd.47
793	319	RxPDO2, AO, Nd.25	1349	545	RxPDO9*, Nd.5	1904	770	RxPDO11*, Nd.48
794	31A	RxPDO2, AO, Nd.26	1350	546	RxPDO9*, Nd.6	1905	771	RxPDO11*, Nd.49
795	31B	RxPDO2, AO, Nd.27	1351	547	RxPDO9*, Nd.7	1906	772	RxPDO11*, Nd.50
796	31C	RxPDO2, AO, Nd.28	1352	548	RxPDO9*, Nd.8	1907	773	RxPDO11*, Nd.51
797	31D	RxPDO2, AO, Nd.29	1353	549	RxPDO9*, Nd.9	1908	774	RxPDO11*, Nd.52
798	31E	RxPDO2, AO, Nd.30	1354	54A	RxPDO9*, Nd.10	1909	775	RxPDO11*, Nd.53
799	31F	RxPDO2, AO, Nd.31	1355	54B	RxPDO9*, Nd.11	1910	776	RxPDO11*, Nd.54
800	320	RxPDO2, AO, Nd.32	1356	54C	RxPDO9*, Nd.12	1911	777	RxPDO11*, Nd.55
801	321	RxPDO2, AO, Nd.33	1357	54D	RxPDO9*, Nd.13	1912	778	RxPDO11*, Nd.56
802	322	RxPDO2, AO, Nd.34	1358	54E	RxPDO9*, Nd.14	1913	779	RxPDO11*, Nd.57
803	323	RxPDO2, AO, Nd.35	1359	54F	RxPDO9*, Nd.15	1914	77A	RxPDO11*, Nd.58
804	324	RxPDO2, AO, Nd.36	1360	550	RxPDO9*, Nd.16	1915	77B	RxPDO11*, Nd.59
805	325	RxPDO2, AO, Nd.37	1361	551	RxPDO9*, Nd.17	1916	77C	RxPDO11*, Nd.60
806	326	RxPDO2, AO, Nd.38	1362	552	RxPDO9*, Nd.18	1917	77D	RxPDO11*, Nd.61
807	327	RxPDO2, AO, Nd.39	1363	553	RxPDO9*, Nd.19	1918	77E	RxPDO11*, Nd.62

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
808	328	RxPDO2, AO, Nd.40	1364	554	RxPDO9*, Nd.20	1919	77F	RxPDO11*, Nd.63
809	329	RxPDO2, AO, Nd.41	1365	555	RxPDO9*, Nd.21	1921	781	RxPDO5*, Nd.1
810	32A	RxPDO2, AO, Nd.42	1366	556	RxPDO9*, Nd.22	1922	782	RxPDO5*, Nd.2
811	32B	RxPDO2, AO, Nd.43	1367	557	RxPDO9*, Nd.23	1923	783	RxPDO5*, Nd.3
812	32C	RxPDO2, AO, Nd.44	1368	558	RxPDO9*, Nd.24	1924	784	RxPDO5*, Nd.4
813	32D	RxPDO2, AO, Nd.45	1369	559	RxPDO9*, Nd.25	1925	785	RxPDO5*, Nd.5
814	32E	RxPDO2, AO, Nd.46	1370	55A	RxPDO9*, Nd.26	1926	786	RxPDO5*, Nd.6
815	32F	RxPDO2, AO, Nd.47	1371	55B	RxPDO9*, Nd.27	1927	787	RxPDO5*, Nd.7
816	330	RxPDO2, AO, Nd.48	1372	55C	RxPDO9*, Nd.28	1928	788	RxPDO5*, Nd.8
817	331	RxPDO2, AO, Nd.49	1373	55D	RxPDO9*, Nd.29	1929	789	RxPDO5*, Nd.9
818	332	RxPDO2, AO, Nd.50	1374	55E	RxPDO9*, Nd.30	1930	78A	RxPDO5*, Nd.10
819	333	RxPDO2, AO, Nd.51	1375	55F	RxPDO9*, Nd.31	1931	78B	RxPDO5*, Nd.11
820	334	RxPDO2, AO, Nd.52	1376	560	RxPDO9*, Nd.32	1932	78C	RxPDO5*, Nd.12
821	335	RxPDO2, AO, Nd.53	1377	561	RxPDO9*, Nd.33	1933	78D	RxPDO5*, Nd.13
822	336	RxPDO2, AO, Nd.54	1378	562	RxPDO9*, Nd.34	1934	78E	RxPDO5*, Nd.14
823	337	RxPDO2, AO, Nd.55	1379	563	RxPDO9*, Nd.35	1935	78F	RxPDO5*, Nd.15
824	338	RxPDO2, AO, Nd.56	1380	564	RxPDO9*, Nd.36	1936	790	RxPDO5*, Nd.16
825	339	RxPDO2, AO, Nd.57	1381	565	RxPDO9*, Nd.37	1937	791	RxPDO5*, Nd.17
826	33A	RxPDO2, AO, Nd.58	1382	566	RxPDO9*, Nd.38	1938	792	RxPDO5*, Nd.18
827	33B	RxPDO2, AO, Nd.59	1383	567	RxPDO9*, Nd.39	1939	793	RxPDO5*, Nd.19
828	33C	RxPDO2, AO, Nd.60	1384	568	RxPDO9*, Nd.40	1940	794	RxPDO5*, Nd.20
829	33D	RxPDO2, AO, Nd.61	1385	569	RxPDO9*, Nd.41	1941	795	RxPDO5*, Nd.21
830	33E	RxPDO2, AO, Nd.62	1386	56A	RxPDO9*, Nd.42	1942	796	RxPDO5*, Nd.22
831	33F	RxPDO2, AO, Nd.63	1387	56B	RxPDO9*, Nd.43	1943	797	RxPDO5*, Nd.23
833	341	RxPDO7*, Nd.1	1388	56C	RxPDO9*, Nd.44	1944	798	RxPDO5*, Nd.24
834	342	RxPDO7*, Nd.2	1389	56D	RxPDO9*, Nd.45	1945	799	RxPDO5*, Nd.25
835	343	RxPDO7*, Nd.3	1390	56E	RxPDO9*, Nd.46	1946	79A	RxPDO5*, Nd.26

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
836	344	RxPDO7*, Nd.4	1391	56F	RxPDO9*, Nd.47	1947	79B	RxPDO5*, Nd.27
837	345	RxPDO7*, Nd.5	1392	570	RxPDO9*, Nd.48	1948	79C	RxPDO5*, Nd.28
838	346	RxPDO7*, Nd.6	1393	571	RxPDO9*, Nd.49	1949	79D	RxPDO5*, Nd.29
839	347	RxPDO7*, Nd.7	1394	572	RxPDO9*, Nd.50	1950	79E	RxPDO5*, Nd.30
840	348	RxPDO7*, Nd.8	1395	573	RxPDO9*, Nd.51	1951	79F	RxPDO5*, Nd.31
841	349	RxPDO7*, Nd.9	1396	574	RxPDO9*, Nd.52	1952	7A0	RxPDO5*, Nd.32
842	34A	RxPDO7*, Nd.10	1397	575	RxPDO9*, Nd.53	1953	7A1	RxPDO5*, Nd.33
843	34B	RxPDO7*, Nd.11	1398	576	RxPDO9*, Nd.54	1954	7A2	RxPDO5*, Nd.34
844	34C	RxPDO7*, Nd.12	1399	577	RxPDO9*, Nd.55	1955	7A3	RxPDO5*, Nd.35
845	34D	RxPDO7*, Nd.13	1400	578	RxPDO9*, Nd.56	1956	7A4	RxPDO5*, Nd.36
846	34E	RxPDO7*, Nd.14	1401	579	RxPDO9*, Nd.57	1957	7A5	RxPDO5*, Nd.37
847	34F	RxPDO7*, Nd.15	1402	57A	RxPDO9*, Nd.58	1958	7A6	RxPDO5*, Nd.38
848	350	RxPDO7*, Nd.16	1403	57B	RxPDO9*, Nd.59	1959	7A7	RxPDO5*, Nd.39
849	351	RxPDO7*, Nd.17	1404	57C	RxPDO9*, Nd.60	1960	7A8	RxPDO5*, Nd.40
850	352	RxPDO7*, Nd.18	1405	57D	RxPDO9*, Nd.61	1961	7A9	RxPDO5*, Nd.41
851	353	RxPDO7*, Nd.19	1406	57E	RxPDO9*, Nd.62	1962	7AA	RxPDO5*, Nd.42
852	354	RxPDO7*, Nd.20	1407	57F	RxPDO9*, Nd.63	1963	7AB	RxPDO5*, Nd.43
853	355	RxPDO7*, Nd.21	1409	581	SDO Tx Nd.1	1964	7AC	RxPDO5*, Nd.44
854	356	RxPDO7*, Nd.22	1410	582	SDO Tx Nd.2	1965	7AD	RxPDO5*, Nd.45
855	357	RxPDO7*, Nd.23	1411	583	SDO Tx Nd.3	1966	7AE	RxPDO5*, Nd.46
856	358	RxPDO7*, Nd.24	1412	584	SDO Tx Nd.4	1967	7AF	RxPDO5*, Nd.47
857	359	RxPDO7*, Nd.25	1413	585	SDO Tx Nd.5	1968	7B0	RxPDO5*, Nd.48
858	35A	RxPDO7*, Nd.26	1414	586	SDO Tx Nd.6	1969	7B1	RxPDO5*, Nd.49
859	35B	RxPDO7*, Nd.27	1415	587	SDO Tx Nd.7	1970	7B2	RxPDO5*, Nd.50
860	35C	RxPDO7*, Nd.28	1416	588	SDO Tx Nd.8	1971	7B3	RxPDO5*, Nd.51
861	35D	RxPDO7*, Nd.29	1417	589	SDO Tx Nd.9	1972	7B4	RxPDO5*, Nd.52
862	35E	RxPDO7*, Nd.30	1418	58A	SDO Tx Nd.10	1973	7B5	RxPDO5*, Nd.53

dec	hex	Meaning	dec	hex	Meaning	dec	hex	Meaning
863	35F	RxPDO7*, Nd.31	1419	58B	SDO Tx Nd.11	1974	7B6	RxPDO5*, Nd.54
864	360	RxPDO7*, Nd.32	1420	58C	SDO Tx Nd.12	1975	7B7	RxPDO5*, Nd.55
865	361	RxPDO7*, Nd.33	1421	58D	SDO Tx Nd.13	1976	7B8	RxPDO5*, Nd.56
866	362	RxPDO7*, Nd.34	1422	58E	SDO Tx Nd.14	1977	7B9	RxPDO5*, Nd.57
867	363	RxPDO7*, Nd.35	1423	58F	SDO Tx Nd.15	1978	7BA	RxPDO5*, Nd.58
868	364	RxPDO7*, Nd.36	1424	590	SDO Tx Nd.16	1979	7BB	RxPDO5*, Nd.59
869	365	RxPDO7*, Nd.37	1425	591	SDO Tx Nd.17	1980	7BC	RxPDO5*, Nd.60
870	366	RxPDO7*, Nd.38	1426	592	SDO Tx Nd.18	1981	7BD	RxPDO5*, Nd.61
871	367	RxPDO7*, Nd.39	1427	593	SDO Tx Nd.19	1982	7BE	RxPDO5*, Nd.62
872	368	RxPDO7*, Nd.40	1428	594	SDO Tx Nd.20	1983	7BF	RxPDO5*, Nd.63
873	369	RxPDO7*, Nd.41	1429	595	SDO Tx Nd.21			

12.2 Appendix B: Real-Time Ethernet Installation

Ethernet communication in real-time

Ethernet takes the next step as a “Fieldbus” in Beckhoff’s TwinCAT control system. In addition to tough real-time requirements, it permits the use of standard components “on the same wire”. The [BK9000](#) [▶ 289] Ethernet Bus Coupler and the [AX2000-B900](#) [▶ 354] servo amplifier are the first Fieldbus components to benefit from the real-time capability. New network variables accelerate the real-time data exchange between controllers, making it as easy to implement as connecting another digital input.

Beckhoff’s range of Ethernet products has been in use for years, and is becoming increasingly popular. The advantages of using the office Ethernet standard communication method in industrial settings are clear:

- **Uses standard hardware components (e.g. a standard of-the-shelf)Switch**
- **Standard protocols** can be employed
- **Data transmission rates are very high compared to other networks**
- **Linking the network to the rest of the world over the Internet is straightforward**
- **Remote maintenance and diagnosis**

Communication over Ethernet has now become accepted in industrial automation and many groups and committees are concerning themselves with this topic. The absence of effective real-time capability, however, is a problem, which has limited Ethernet’s use in the classical fieldbus area. Some techniques do allow a certain degree of real-time capability, but are based on proprietary systems, and do not allow standard components and protocols to be used at the same time.

- "Real-time capability" is a somewhat flexible term when used in control theory.
- "Real-time" depends heavily on the requirements of the particular application and the control loops in which the automation components are used. However, from the point of view of automation engineering, and against the background that fieldbus specialist Beckhoff have to offer, a rough division can be drawn:
 - **The toughest requirements** involve cycle times of around 50 µs and permissible jitter (deviations from the desired cycle time) of around 10 µs. Requirements tighter than this are currently still handled with the aid of special hardware rather than directly over fieldbusses. Typical cycle time requirements with position-controlled drives are in the range of milliseconds (1-4 ms), in which case jitter times should be less than 20 µs. Pure PLC applications often require cycle times no shorter than 10 ms; correspondingly, jitter times may

here be significantly longer, and lie in the millisecond range. Data communication between the controller and the supervisory system can often satisfactorily be handled with cycle times in the range of seconds. In fact it may not be configured cyclically, but may be event driven.

Remote servicing and diagnosis should also be mentioned. Cycle and jitter times here are less relevant than reaction times and the general possibility of being able to communicate across the boundaries of networks. TwinCAT automation software now offered with Real-time Ethernet means that all the communication requirements that have just been mentioned can be satisfied using one and the same technology, both from the point of view of the devices used and of the protocols employed.

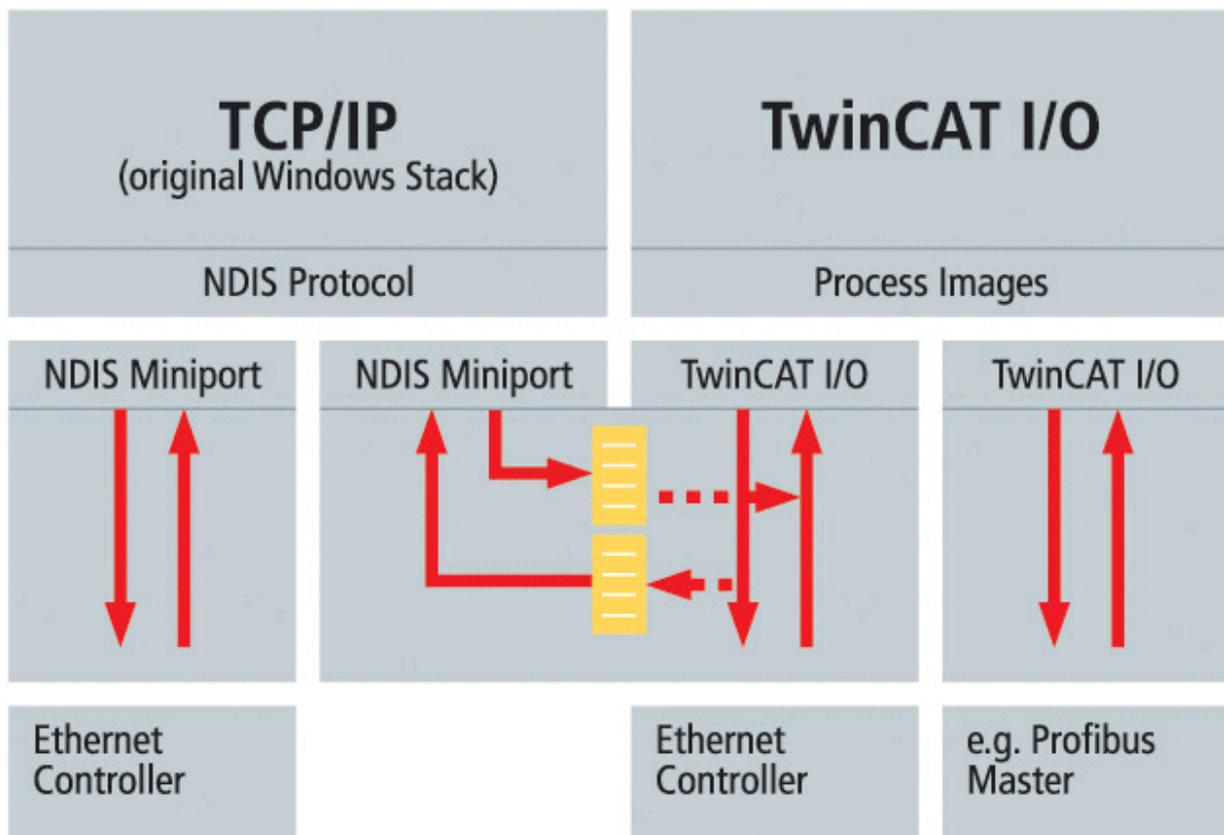
Principle of operation

The TwinCAT network card driver is linked into the system in such a way that it appears as a network driver, compatible with the operating system, and additionally as a TwinCAT fieldbus card. An internal prioritization system and buffer is provided at the transmitter end which always finds a free transmission channel for Ethernet frames from the real-time system that may be queuing. **The operating system's Ethernet frames are only later transmitted in the "gaps" if sufficient time is available.**

At the receiving end, all the Ethernet frames received are examined by the TwinCAT I/O system, and those with real-time relevance are filtered out. All other frames are passed on to the operating system after examination, outside the context of the real-time system.

Using commercially available switches, all of which support full duplex operation at 100 Mbaud, the transmitted frames are passed on to the receiver with a constant delay. A switch ensures that collisions are avoided and only delays occur. In a cyclic control system it is therefore only necessary to ensure that all the relevant input information has arrived before the next cycle starts. When, or in what sequence, they have arrived is not significant.

If the number of participating devices or the frame rate is restricted in accordance with the required cycle time, the preconditions for Ethernet communication with real-time capability are satisfied.



The above picture shows the principle of how the original Windows operating system protocol stack (TCP/IP and UDP/IP) is used besides TwinCAT Real-Time Ethernet. We call this principle "Y-driver" architecture.

Operating modes/protocols

In contrast to the widely used TCP/IP and UDP/IP protocols, which are responsible for the provision of individual Ethernet frames around the world, real-time communication does not leave the local subnet. The overhead involved in TCP/IP, and even that of UDP/IP, can be omitted, and the devices can be addressed directly by means of the hardware addresses (MAC-ID) of the network cards. The structure of Ethernet frames ensures that it is always possible to co-exist with other protocols; even the “real-time frames” can, if necessary, be transmitted with TCP or UDP, if they have to leave their own subnet.

A number of different operating modes have been defined for use in control engineering. They serve different communication tasks, and can, of course, be employed simultaneously.

1.) Master-slave process data communication

Cyclic or event-driven transmission of I/O data – the typical use of modern fieldbuses

2.) Publisher-subscriber process data communication

Process data according to the publisher-subscriber model (also referred to as network variables) is used for regular communication between controllers when a fixed master-slave relationship would not be appropriate. The [Publisher \[▶ 348\]](#) sends out its information without concerning itself with where it is going. The communication is only monitored in the [Subscriber \[▶ 351\]](#). Mutual publisher-subscriber relationships permit bi-directional and multi-directional communication. The publisher can be configured to send the data by broadcast, multicast or unicast. Multicasts reduce the loads at the network devices' receive queues, because the messages are evaluated as soon as they reach the Ethernet controller. Only if unicasts are used the switch (without extensive configuration) can open parallel communication paths and increase the useful bandwidth.

3.) Data communication as required

This is a type of communication made possible in the TwinCAT system through ADS communication, and which sends communication strings from one device to another “as required”. Services are executed and parameters exchanged in this way.

The chosen protocol structure means that other operating modes or communication profiles can easily be integrated in the future, and can co-exist with the existing modes without difficulty.

Compatible components

The first components from the Beckhoff product range to have been extended for real-time Ethernet application are the [BK9000 \[▶ 289\]](#) Ethernet Bus Coupler and the [AX2000-B900 \[▶ 354\]](#) drive. These two components open up almost the entire range of industrial signals and applications.

All TwinCAT controllers (from Version 2.9 upwards) are compatible, and can participate both as “fieldbus masters” and in communication using network variables. TwinCAT Real-Time Ethernet supports all controllers (network adapters) of the Intel 8255x family. This is one of the most widespread Ethernet controllers, a component in the latest Intel chip set, which already include a compatible network connection. Support for further Ethernet controllers in the future may be considered – in the light of the wide popularity of the Intel family and its compatibility even with Gigabit Ethernet (Intel 8254x family) – but not absolutely essential. The new Embedded-PC CX1000 small controller is, of course, always fitted with an appropriate Ethernet controller.

Performance

Judging the performance of a fieldbus system exclusively on the basis of the baudrate is, without doubt, too simple, ignoring as it does other significant communication parameters such as the efficiency of the protocols, reaction time, jitter, minimum telegram length, pause times and so forth. All the same, 100 Mbaud permit significantly faster data transfer than is usual at present in fieldbus environments. In addition to this, the protocols used provide a significantly improved efficiency in contrast with TCP or UDP communication, in

particular when data telegrams are short.

One factor which is often ignored when considering the capacity of a fieldbus system is the transfer of data between the controller CPU to the communication chip or processor; that is to say, between the host system memory and the subsystem memory. In PC based controllers, the data is usually copied over the ISA or PCI bus into the DPRAM of a fieldbus master card, and vice-versa. Whereas PC processors have reached speeds of around 3 GHz, even the supposedly fast PCI bus has become a bottleneck, so that 20-30 % of the CPU performance is lost for PCI transfers.

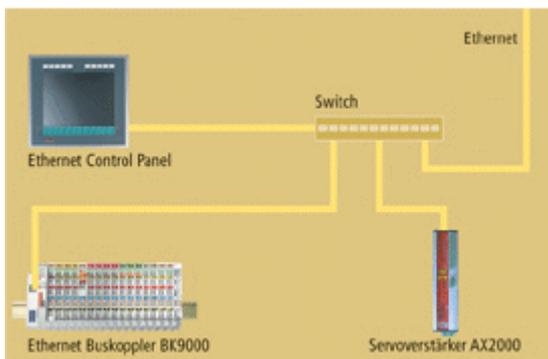
Modern network controllers operate in what is known as the “bus master DMA mode”, accessing the host system’s memory directly. This occurs in parallel with other CPU tasks, and therefore significantly reduces the CPU load.

Applications/Linking to TwinCAT

The high data transfer capacity, the fundamental real-time capability and the protocols that are employed cover all the communication demands made by a fast machine controller. When all these features are considered we are soon led to the conclusion that classical fieldbusses are no longer needed.

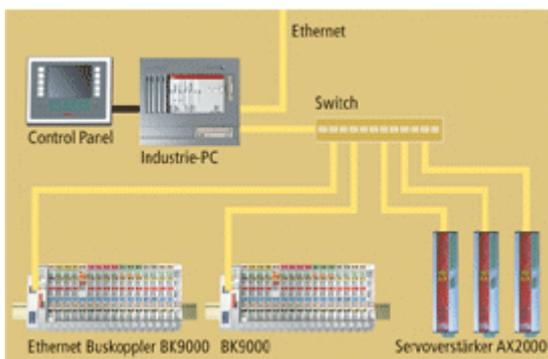
First of all, however, Ethernet technology must still be proven at the field level, and must meet all requirements such as those for simplicity of installation and configuration, mutual compatibility, EMC immunity and, not least, efficiency and device costs relevant to the industrial environment. Standard fieldbusses are widely accepted, and there are many devices offered by many vendors including Beckhoff. Therefore, they will continue to have great significance to the market. Here once again, TwinCAT’s flexible I/O system offers a way forward: It permits multiple fieldbusses to be operated in parallel, including, of course, the parallel operation of classical fieldbusses with real-time Ethernet – and all of this is entirely transparent to the application.

Application Example 1:



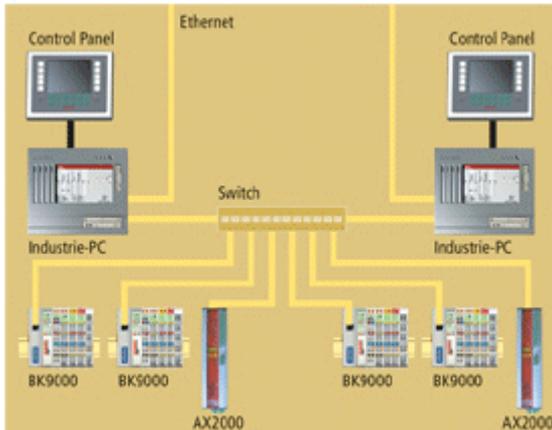
Relatively simple applications can manage with a single Ethernet connection, both for the real-time communication to the I/O level and for the higher-level communication for the purposes of administration and remote diagnosis. The prioritization that is used ensures that the real-time communication takes place without difficulty.

Application Example 2:



Larger applications make use of a second Ethernet connection, and divide the real-time communication and the higher level communication between two networks. The routing that is required in order, for instance, to remotely diagnose a drive that is connected to a real-time network is performed automatically by the operating system's IP stack, and does not require any proprietary conversion to a different protocol.

Application Example 3:

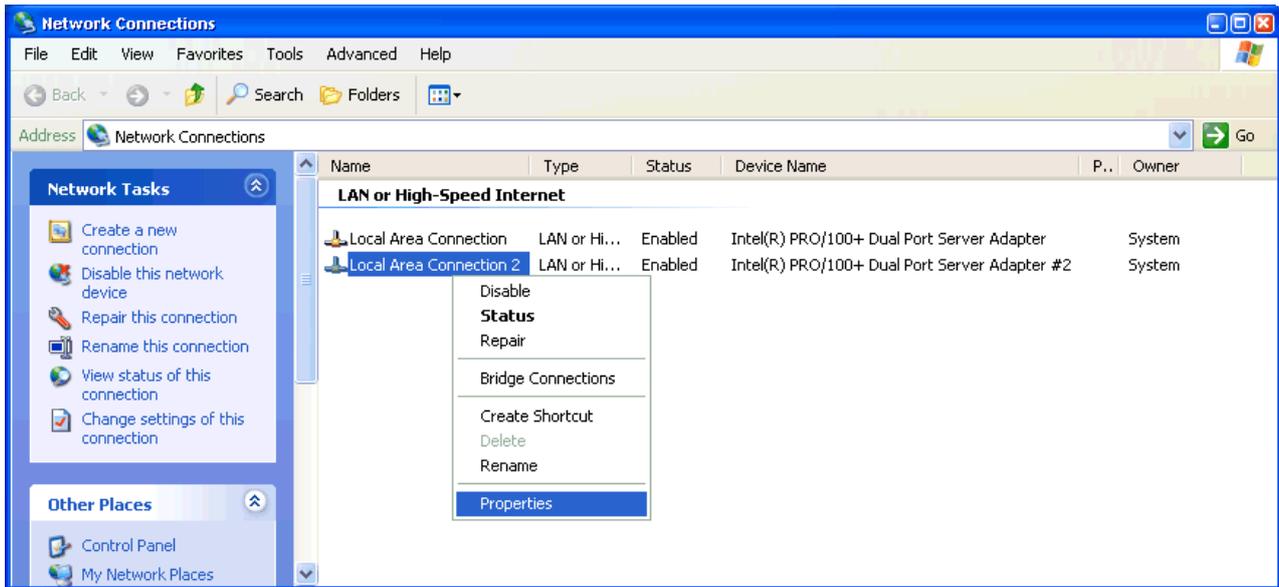


Very large applications, for which the computing power even of a 3 GHz system is insufficient, can distribute the control tasks between a number of PC controllers, and can exchange even large amounts of data quasi-synchronously with the cycles (even at sub-millisecond speeds), using the real-time capable network variables.

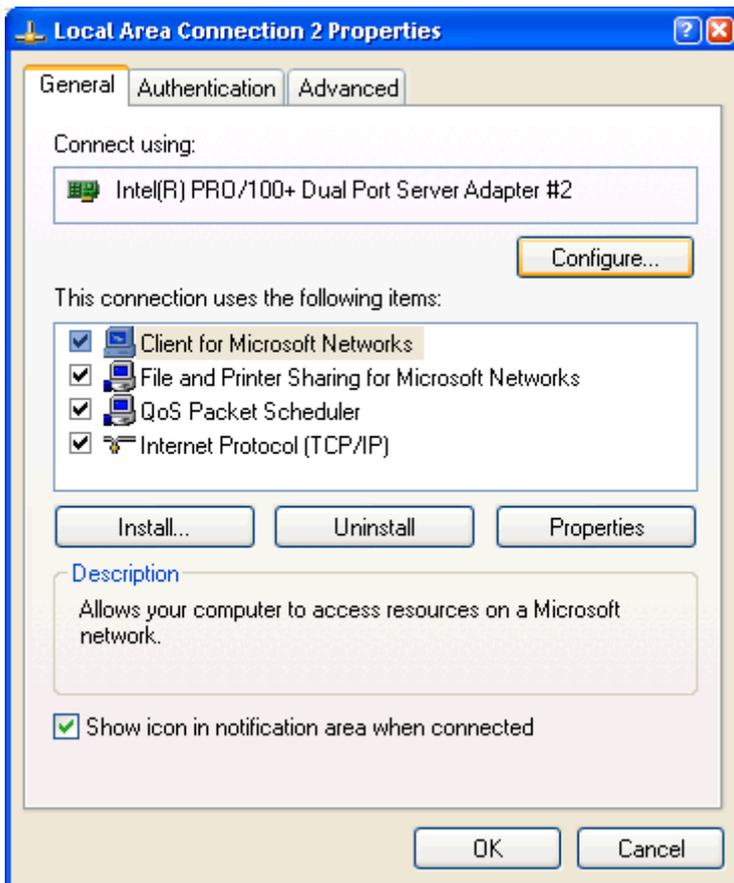
12.2.1 TwinCAT Ethernet Driver - Installation

The Intel 825x based network interface card (NIC) should be plugged in and - automatically - detected and installed from Windows XP / 2000. After that, the driver of the device has to be changed. Open the 'Network Connections' (via Control Panel or 'Properties' of 'My Network Places') and open the 'Properties' of the LAN connection. If more than one NIC is installed, choose the one the Real-Time Ethernet shall be connected to.

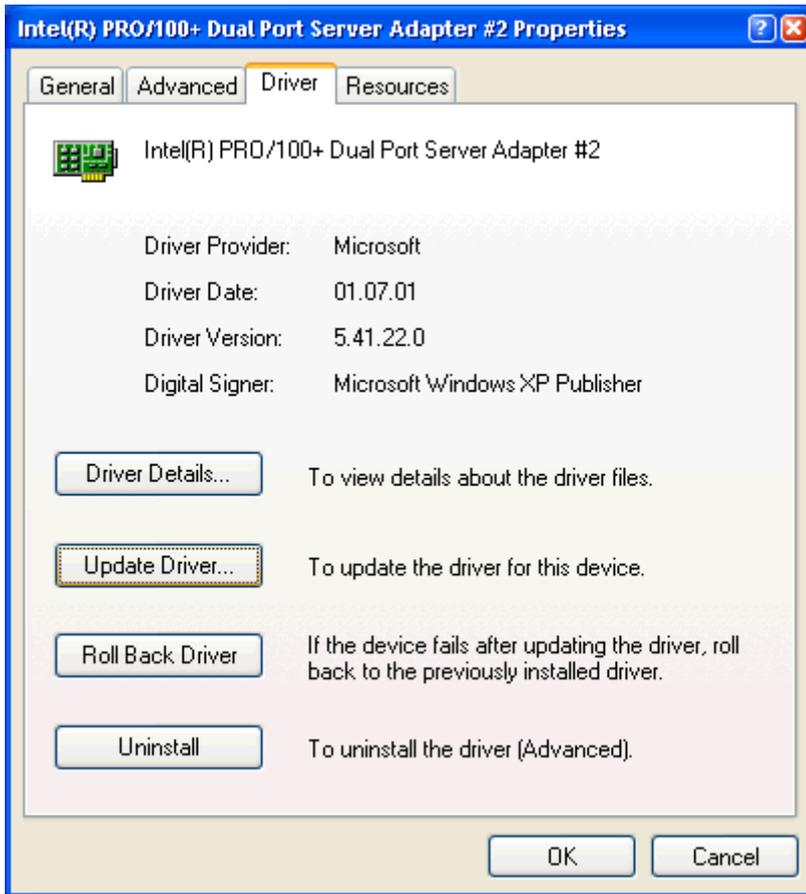
The following screenshots are showing the necessary steps for the driver setup under Windows XP Professional.



The 'Properties' page appears. Please push the 'Configure...' button.



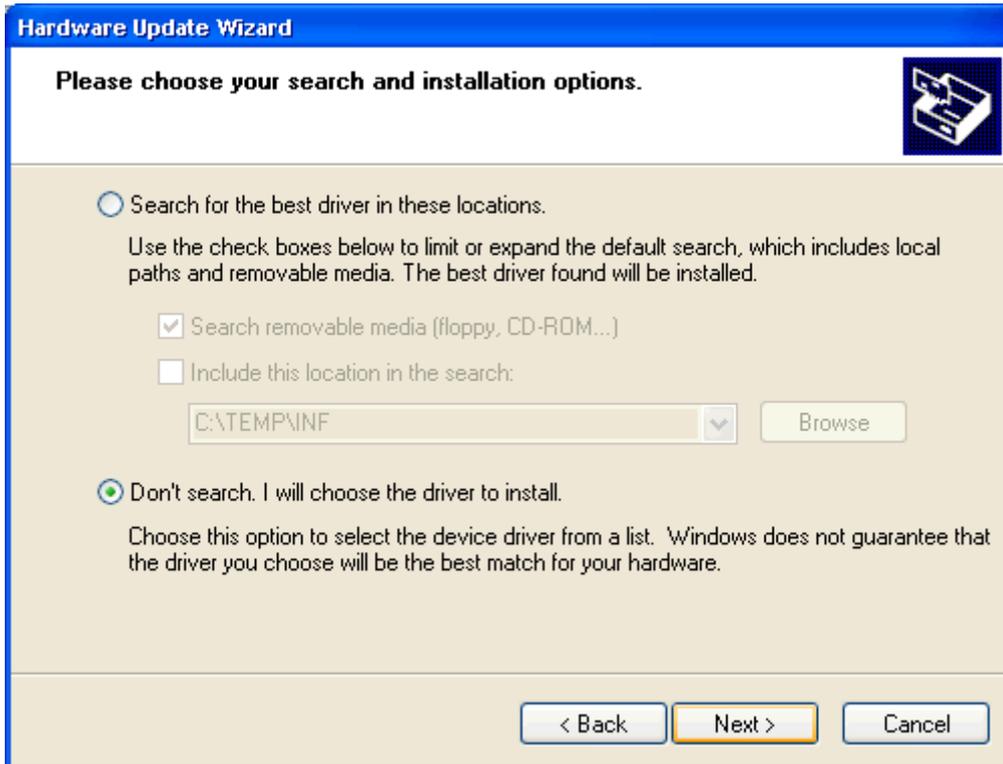
Select the 'Driver' Page and press the 'Update Driver...' button.



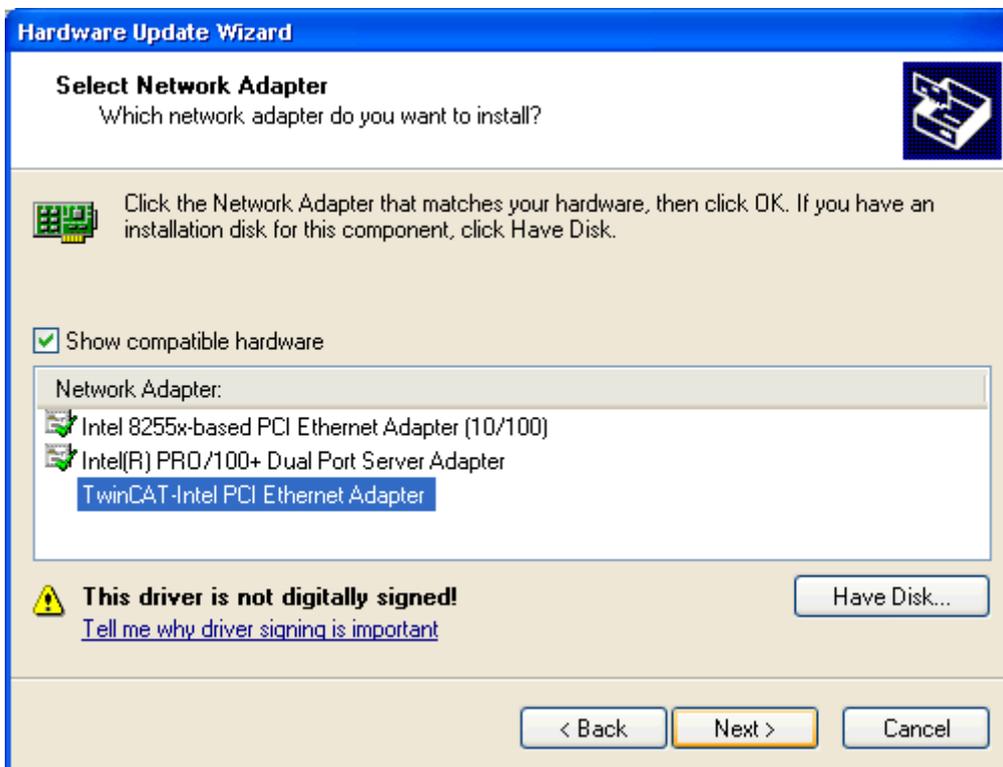
The 'Hardware Update Wizard' appears. Please select 'Install from a list or specific location (Advanced)' radio button and push 'Next'.



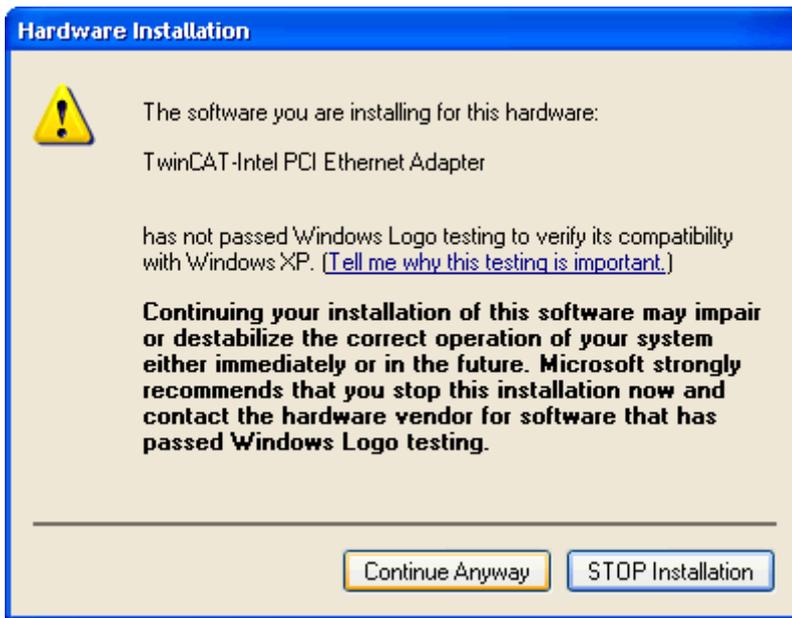
On the following dialog select the 'Don't search' option and press 'Next'.



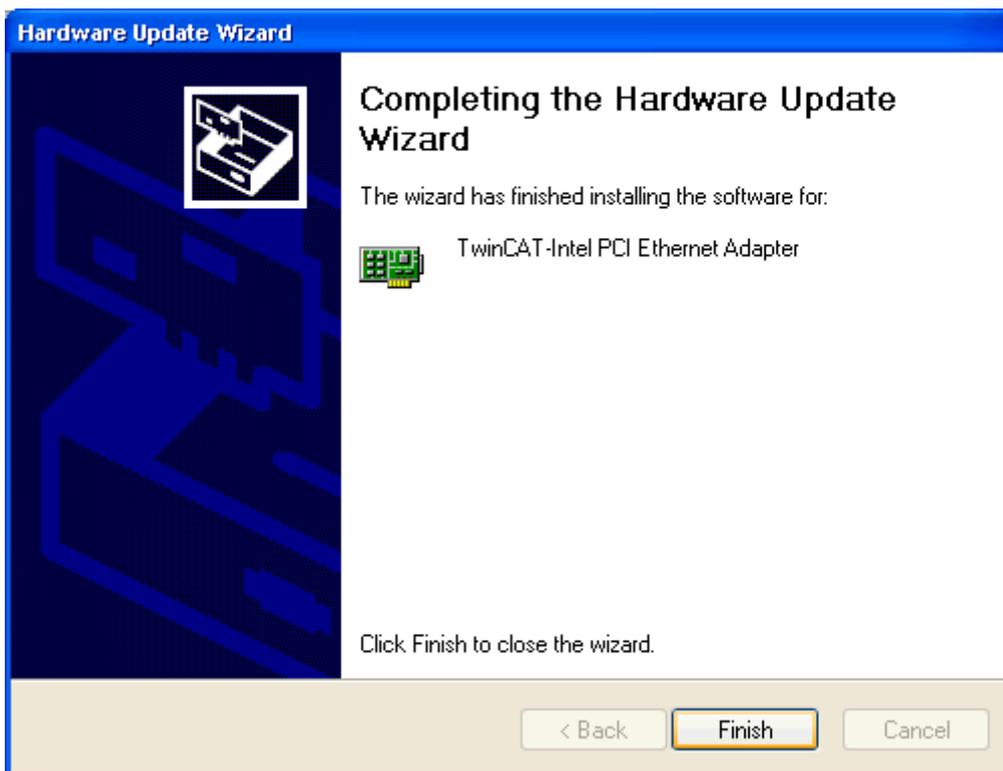
Select the 'TwinCAT-Intel PCI Ethernet Adapter' and push 'Next'



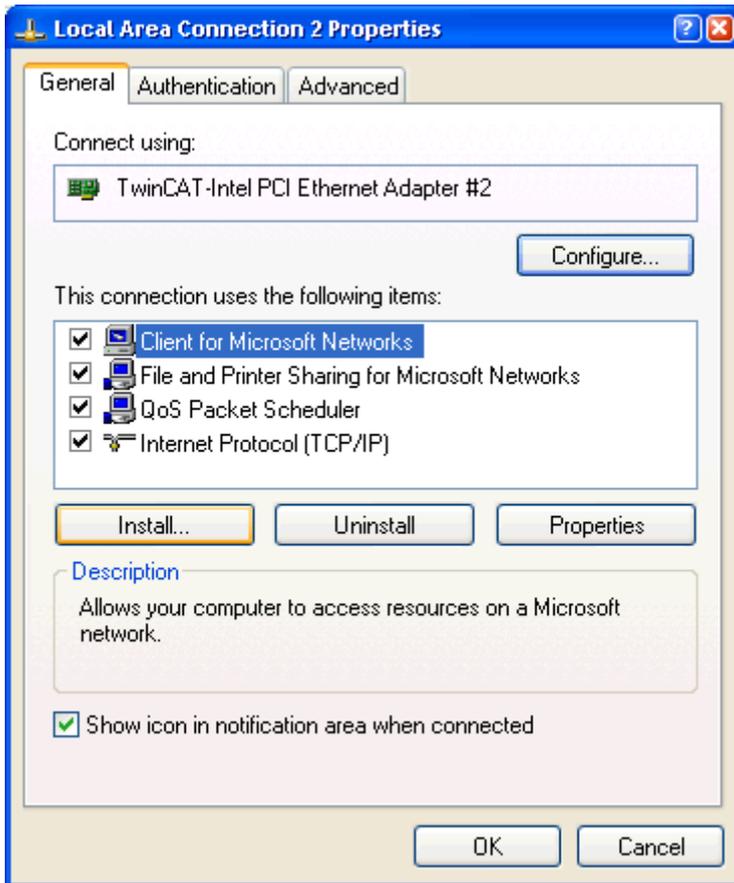
A warning will appear because the TwinCAT driver is not digitally signed by Microsoft - just trust Beckhoff...



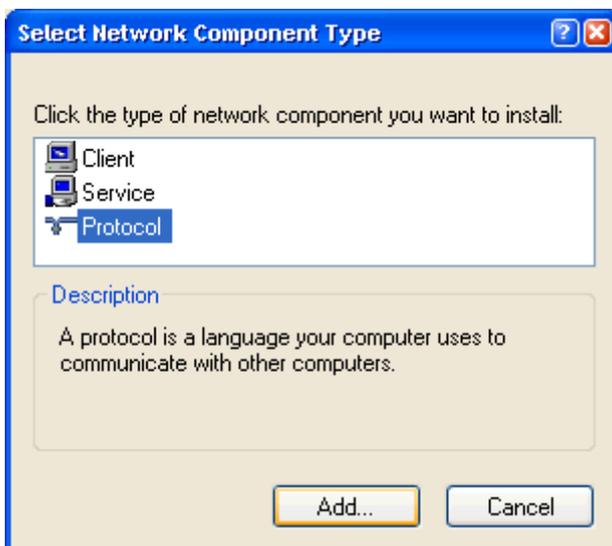
The installation of the driver is now finished, but the TwinCAT protocol driver has to be installed still.



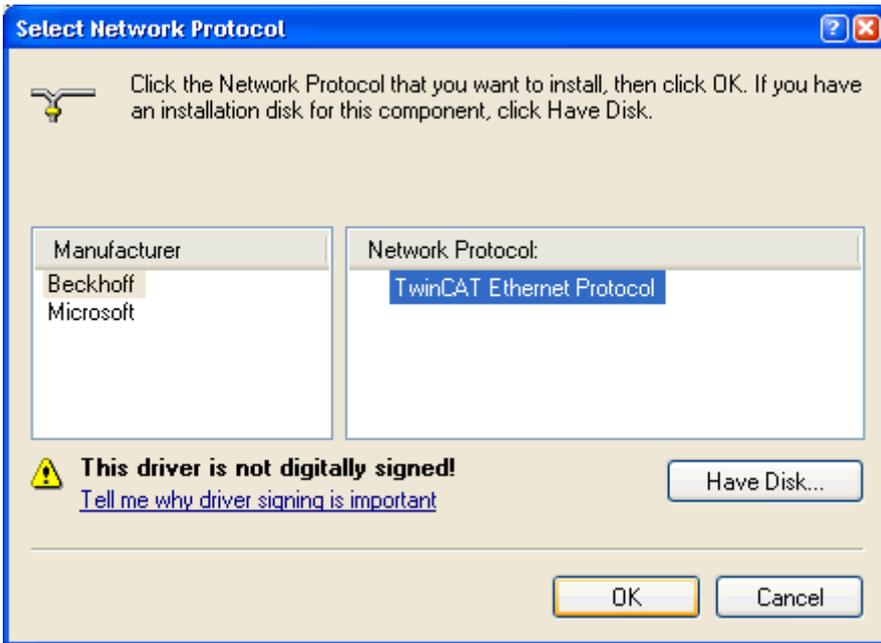
Please re-open the 'Properties' of the LAN connection - the new adapter driver should appear.



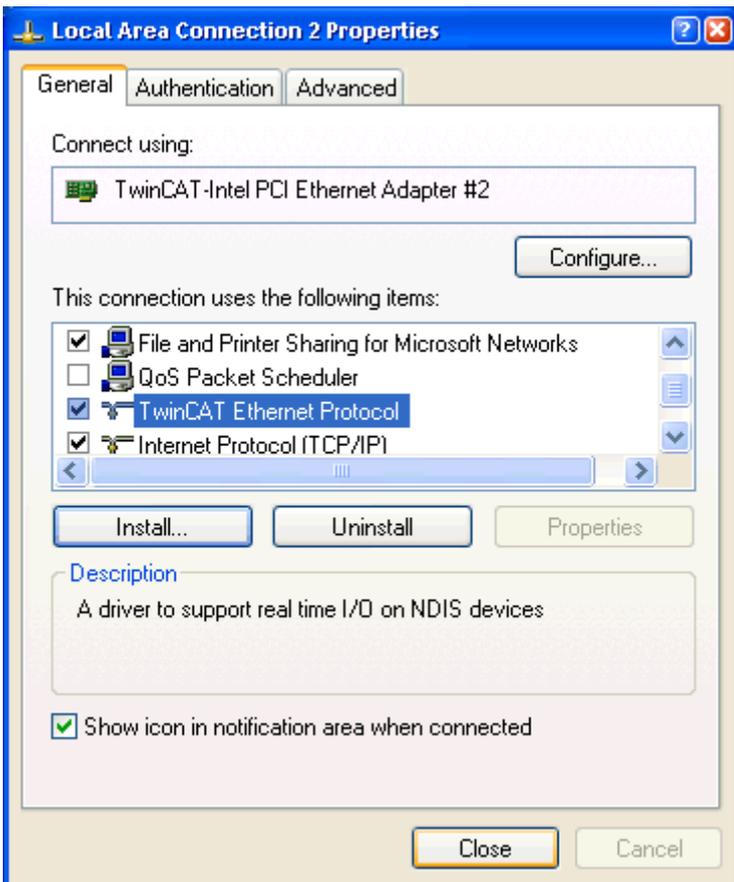
Push the 'Install...' button and select the 'Protocol' choice. Press 'Add...' after this selection.



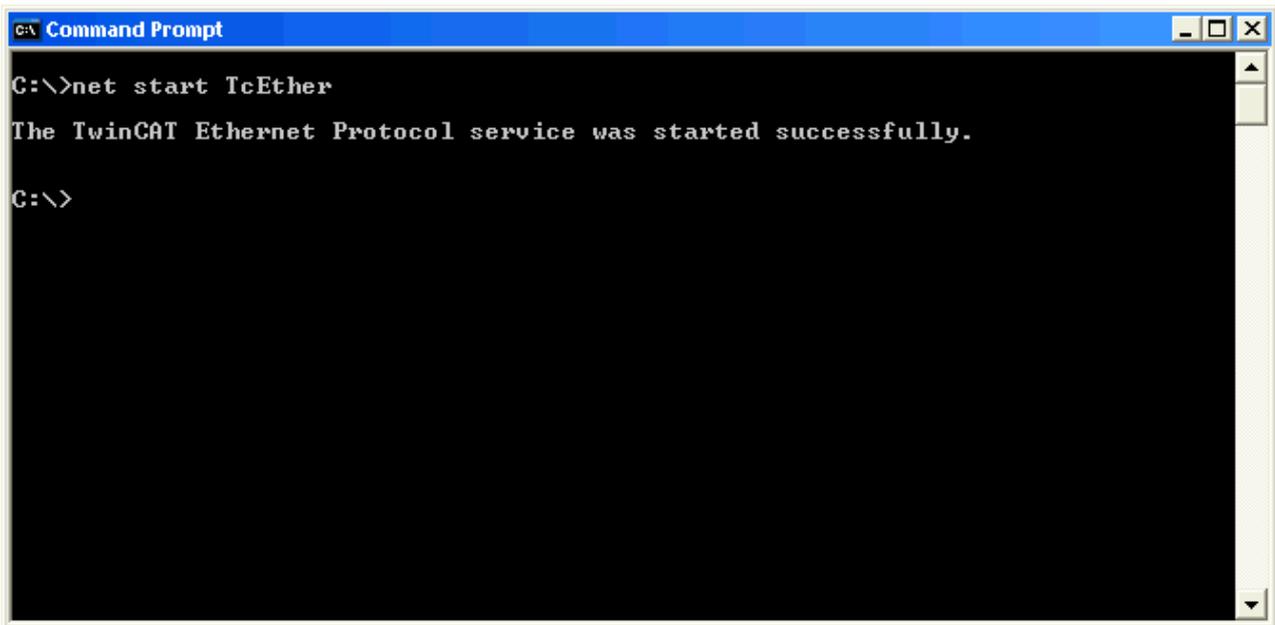
Select the 'TwinCAT Ethernet Protocol' from manufacturer 'Beckhoff'. If the protocol does not appear push the "Have Disk..." button and select the \Windows\Inf (Windows XP) or \WinNt\Inf (Windows 2000) directory. If the directory is not visible check the "Show hidden files or folder" radio button in the Explorer Tools/Folder Options/View dialog. After selecting the folder (doesn't matter which file is selected) the Beckhoff TwinCAT Ethernet Protocol should appear.



The new protocol should appear. The quality of service (QoS) packet scheduler filter driver can be disabled, because it has no function in reference to the TwinCAT driver.



Now the required steps are made. Only the 'TwinCAT Ethernet Protocol' did not start automatically for the first time. You have the choice to reboot the system or to start the protocol manually (only the very first time). To start the protocol manually, please open the command window (e.g. via the 'Run...' button on the start menu and enter 'cmd'). Enter in the command window the string 'net start TcEther' and press enter.



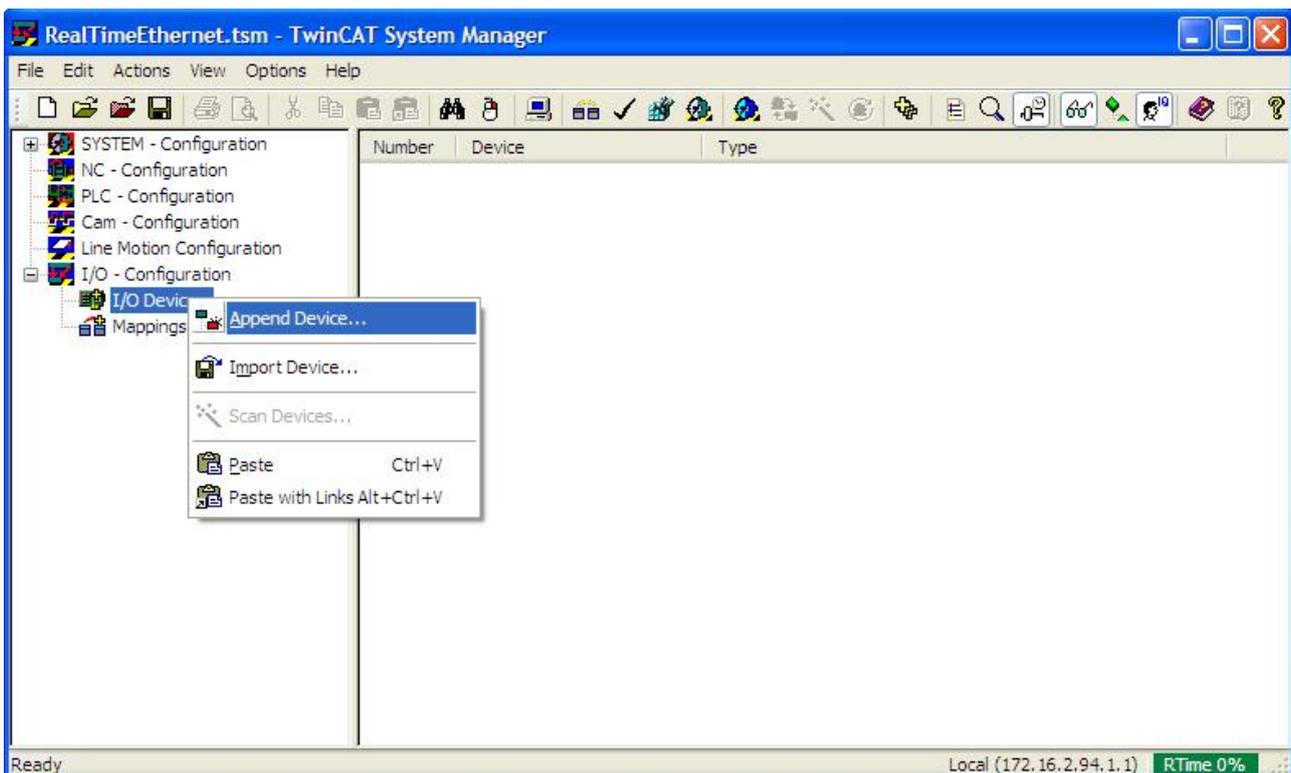
After that, the TwinCAT System Manager should find this new adapter underneath "I/O Devices".

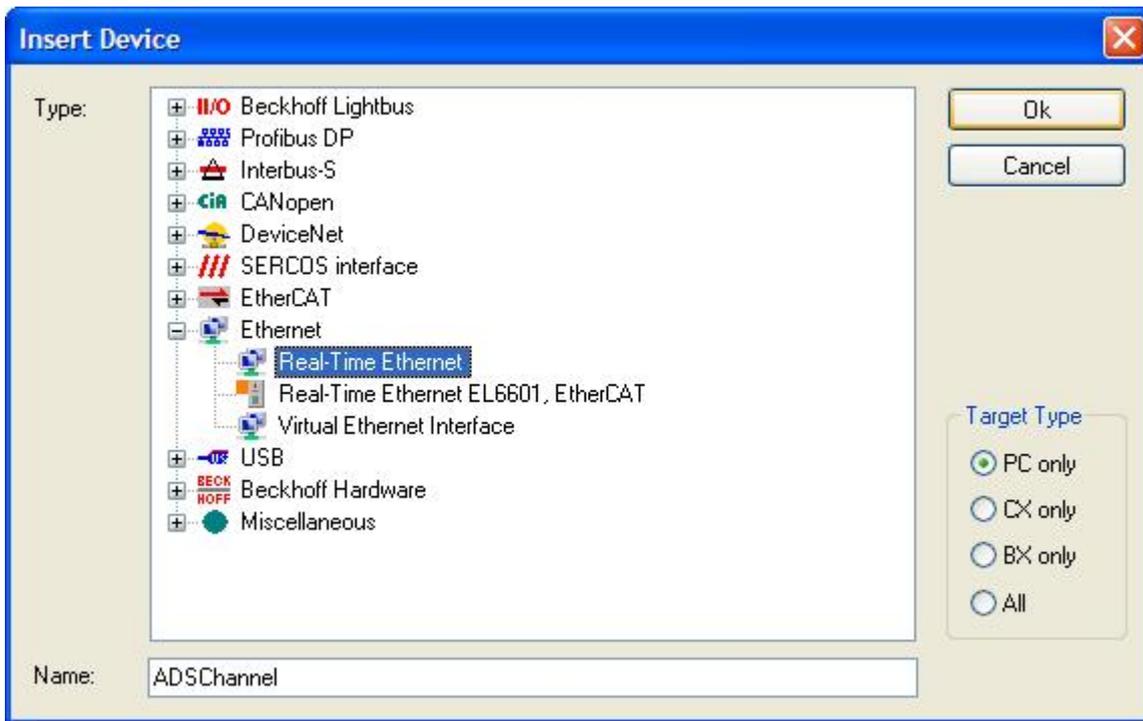
12.2.2 Configuration

Configuration example for ADS server/client communication.

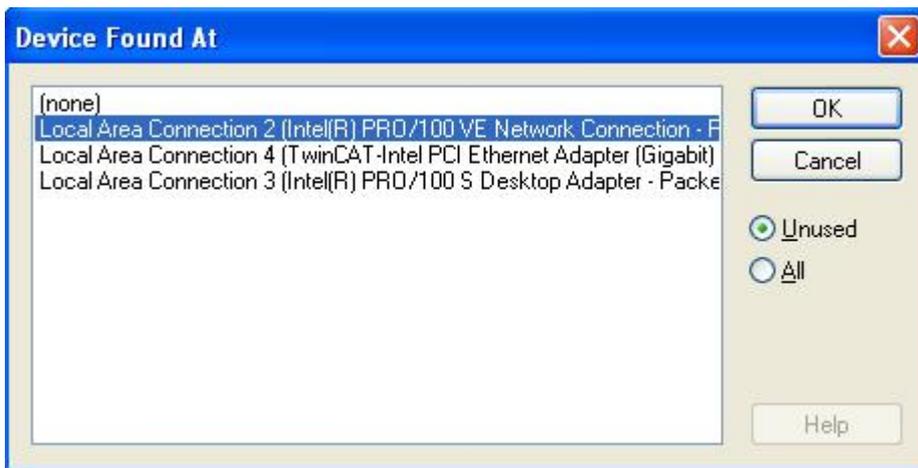
Server:

In the TwinCAT System Manager select the local target system for the server. Right-click on "I/O devices" under "I/O configuration" to insert a new device. In the window that opens you can select "Real-Time Ethernet" device under Ethernet.





Before confirming your selection with OK, you can allocate a new name to the device at the bottom of the window. After confirmation select the appropriate network card, as shown in the next image.



Activate the "Enable Routing" checkbox in the "Routes" tab of new device. The NetID of the added RT Ethernet device is automatically entered in the associated field.

General Adapter **Routes** Statistics

Enable Routing

Own NetId:

Route:
e.g.: 172.16.2.3.1.1 Name / Description

Routes:

Add
Change
Delete

In the next step you can enter the NetID of a client under Route, and under "Add" you can add the NetID to other NetIDs with which the server can then communicate.

Client:

The same settings apply to the clients as for the server, except that the NetID of the server must be specified under "Routes" in the real-time Ethernet device.

General Adapter **Routes** Statistics

Enable Routing

Own NetId:

Route:
e.g.: 172.16.2.3.1.1 Name / Description

Routes:

Add
Change
Delete

12.2.2.1 Example

Based on the configuration described above you can now carry out a test with the following PLC project. In this example the server fetches a handle via ADS for a client variable and writes the value 500 to it. A useful application is shown in conjunction with ADS.

Server:

```

PROGRAM Server
VAR
    state      : UINT;
    trigger    : R_TRIG;
    bExecute   : BOOL;
    bBusy      : BOOL;
    bError     : BOOL;
    uErrorID   : UDINT;

    fbWRI     : ADSWRITE;
    fbRW      : ADSRDWRT;

    uTransmit  : UDINT := 500;
    uHandle    : UDINT;
    sTest     : STRING := 'MAIN.uReceive';
END_VAR

trigger(CLK := bExecute);
IF trigger.Q THEN
    state := 1;
    bBusy := TRUE;
END_IF
CASE state OF

    0: (* Wait state *)
        bBusy := FALSE;

    1:
        fbRW( WRTRD := FALSE);
        fbRW( NETID := '172.16.2.94.2.1',
            PORT := 801,
            IDXGRP := 16#F003,
            IDXOFFS := 16#0000,
            WRITELEN := LEN(sTest)+1,
            READLEN := SIZEOF(uHandle),
            SRCADDR := ADR(sTest),
            DESTADDR := ADR(uHandle),
            WRTRD := TRUE,
            TMOUT := t#5s,
            BUSY => ,
            ERR => bError,
            ERRID => uErrorID);
            state := 2;

    2:
        fbRW( WRTRD := FALSE);
        IF NOT fbRW.BUSY THEN
            IF NOT fbRW.ERR THEN
                state := 3;
            ELSE
                state := 100;
            END_IF
        END_IF

    3:
        fbWRI( WRITE := FALSE);
        fbWRI( NETID := '172.16.2.94.2.1',
            PORT := 801,
            IDXGRP := 16#F005,
            IDXOFFS := uHandle,
            LEN := SIZEOF(uTransmit),
            SRCADDR := ADR(uTransmit),
            WRITE := TRUE,
            TMOUT := t#5s,
            BUSY => ,
            ERR => bError,
            ERRID => uErrorID);
            state := 4;

    4:
        fbWRI(WRITE := FALSE);

```

```

    IF NOT fbWRI.BUSY ANDNOT fbWRI.ERR THEN
        state := 0;
    ELSIF fbWRI.ERR THEN
        state := 100;
    END_IF

    100:
    ; (* Error *)
END_CASE

```

Client:

```

PROGRAM Client
VAR
    uReceive : UDINT;
END_VAR

```



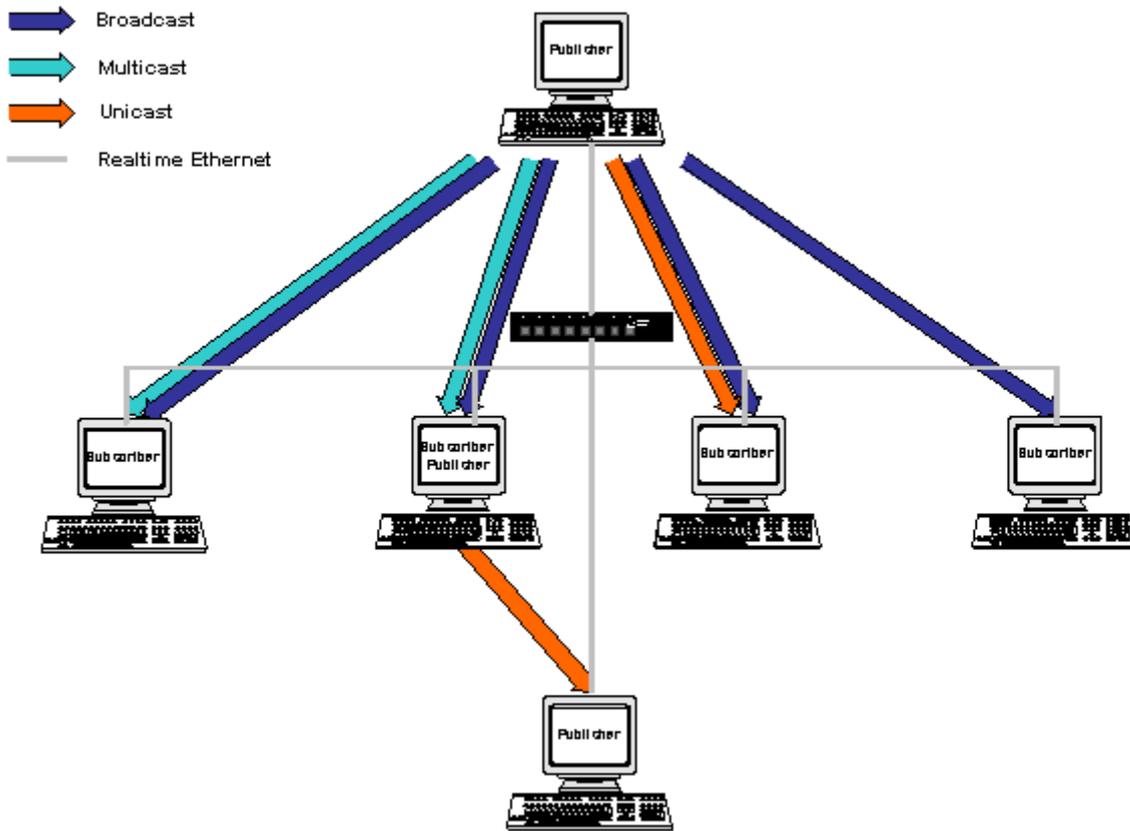
- On the client-side creation of a UDINT variable is sufficient.
 - To use the source code for a test you must adapt the NetIDs to your system.
-

12.3 Appendix C: Network variables

Network variables are variables which can be exchanged cyclic between PC/CX1000. Any elementary or complex datatypes can be exchanged. A Publisher/Subscriber model is used. For deterministic communication the [Realtime-Ethernet](#) Driver for TwinCAT has to be installed.

Publisher/Subscriber Model

With the Publisher/Subscriber model one publisher makes variable available in the network. Any PC/CX1000 can 'subscribe' to one of these variables. The publisher can allow access for one PC/CX1000, a set of PC/CX1000 or all PC/CX1000 in the network. With a Broadcast the variable can be accessed from all PC/CX1000, a Multicast allows access to a set of selected PC/CX1000 and a Unicast allows access only to one PC/CX1000. A Subscriber can also be a Publisher. With this a bidirectional connection is possible.



Unicast

The Publisher allows access of a network variable only for one selected PC.

Multicast

The Publisher allows access of a network variable to a set of selected PCs.

Broadcast

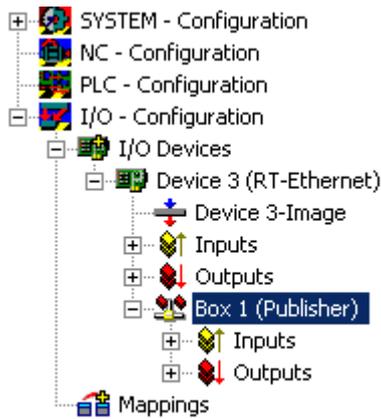
The Publisher allows access of a network variable to all PCs in the network.

12.3.1 Configuration of the Publisher

Add a new Publisher Box beneath the RT-Ethernet device.

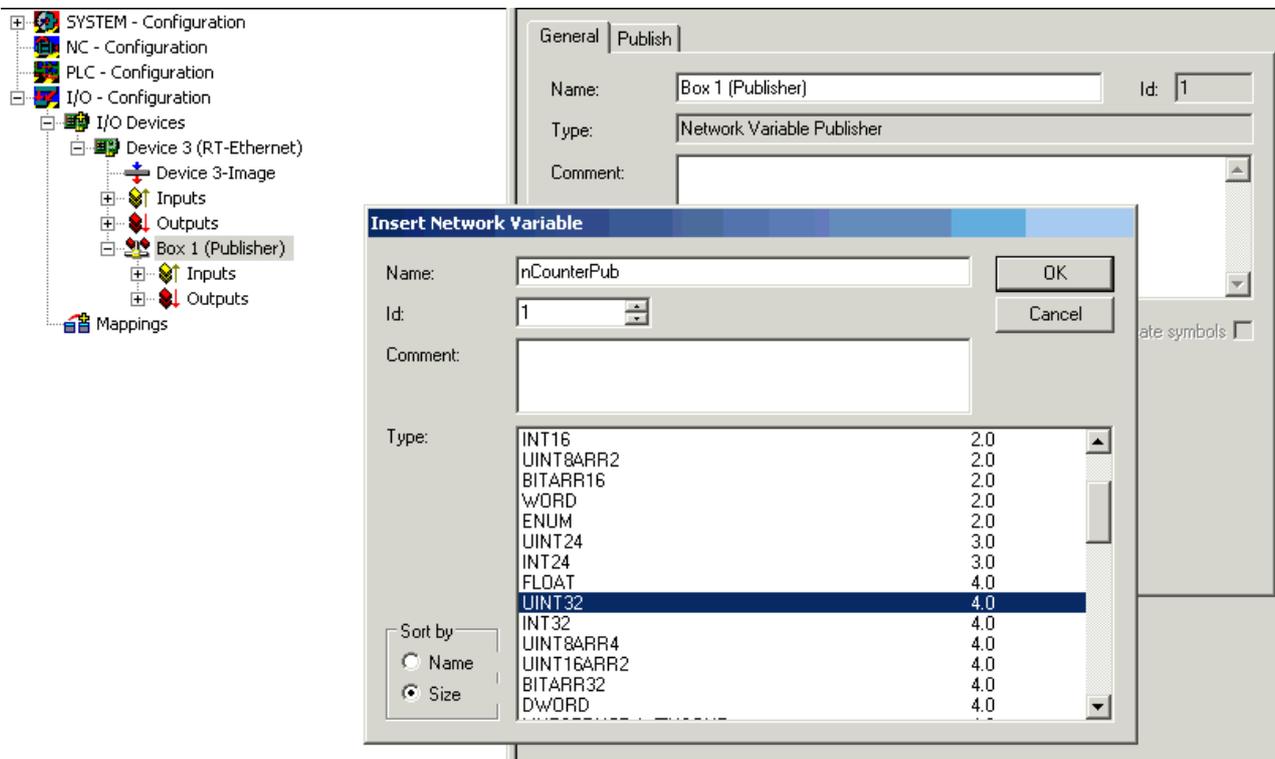
Insert a Publisher Box

Add a new Publisher Box beneath the RT-Ethernet device.

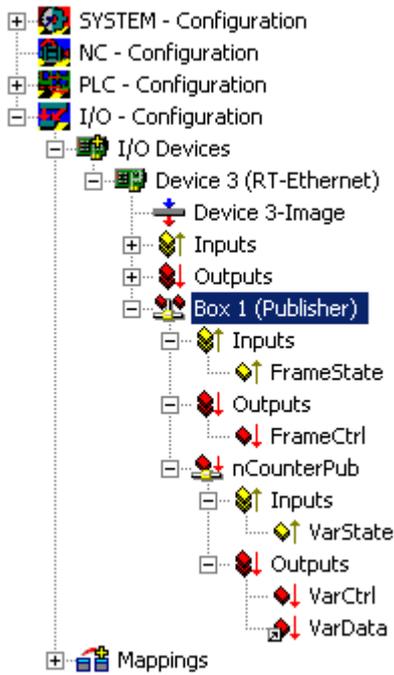


Insert a Network variable

Insert a Network Variable beneath the box. A name and a datatype for the new network variable is necessary (i.e. nCounterPub and UINT32/UDINT).



New inputs and outputs will appear beneath the network variable.



FrameState shows the state of the send Ethernet frames.

Possible values are:

Short description	Value	Description
Not sent (frame skipped)	0x0001	
Error (frame oversized)	0x0001	The limit of a Ethernet frame is exceeded. The mapped variable must have a lower number of bytes.

With FrameCtrl a Control Word can be written for Ethernet frame.

Possible values are:

Short description	Value	Description
Disable sending	0x0001	Sending frames is interrupted. When FrameCtrl is zero again sending of frames begins again.

VarState input shows the state of the network variable.

Possible values are:

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

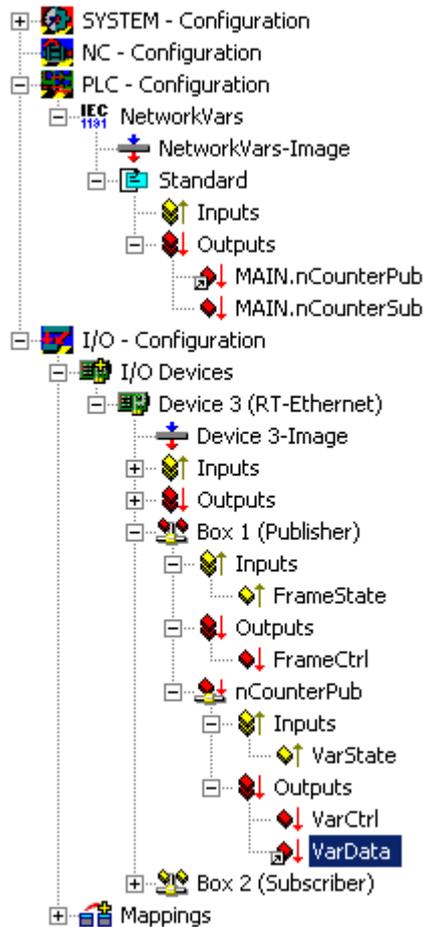
With VarCtrl a control word can be written for each network variable.

Possible values are:

Short description	Value	Description
Disable publishing	0x0001	Sending network variable is interrupted. When VarCtrl is zero again sending of network variable begins again.

Mapping

A network variable on the publisher side can be mapped to an output variable of the right datatype of any device. The example shows a mapping of a network variable to an output variable of a PLC.

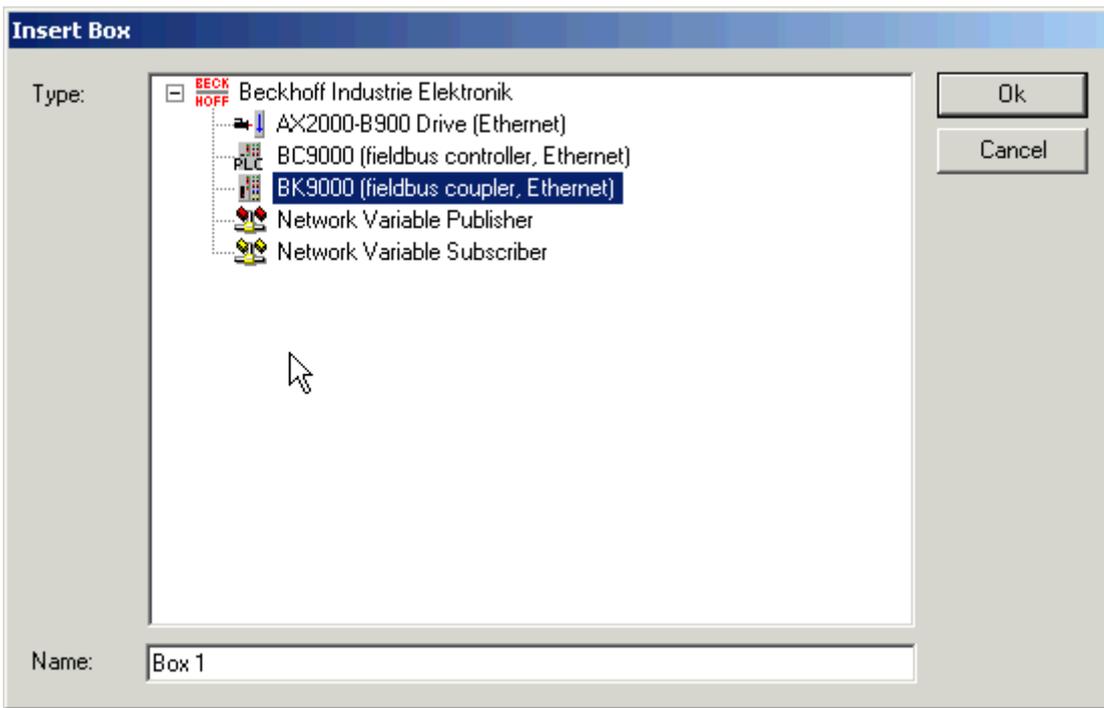
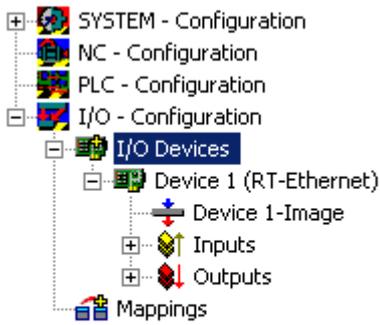


12.3.2 Configuration of the Subscriber

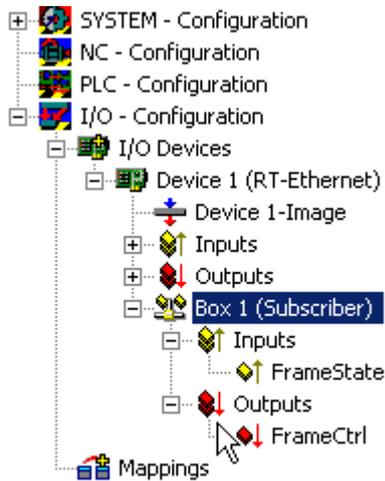
Add a new Subscriber Box beneath the RT-Ethernet device.

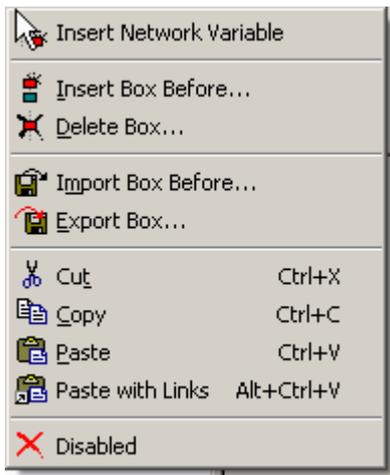
Insert a Subscriber Box and connect to Publisher

Add a new Subscriber Box beneath the RT-Ethernet device.

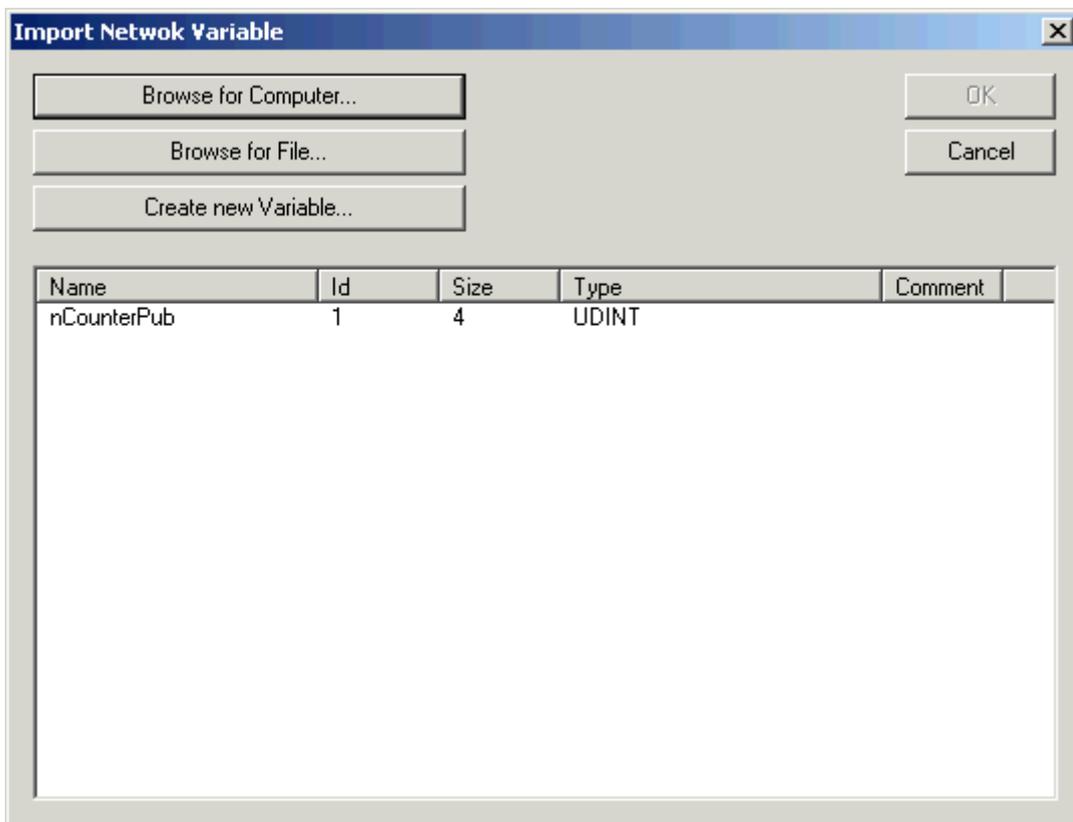


Insert a Network Variable beneath the box.

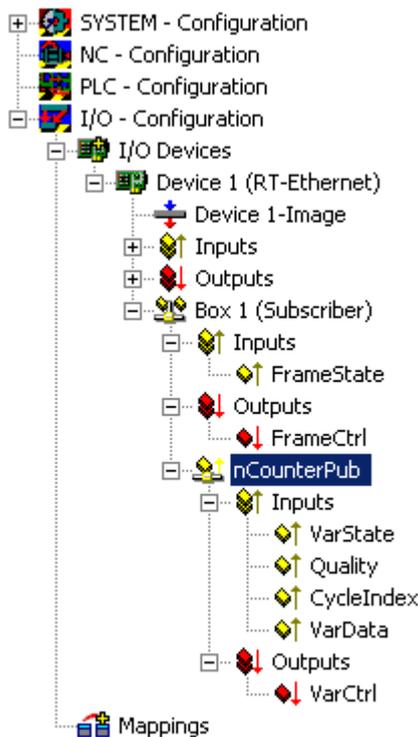




The connection to the publisher network variable can be done automatically. Select the publisher computer and select a variable. Name and datatype information is given by the publisher.



New inputs and outputs will appear beneath the network variable.

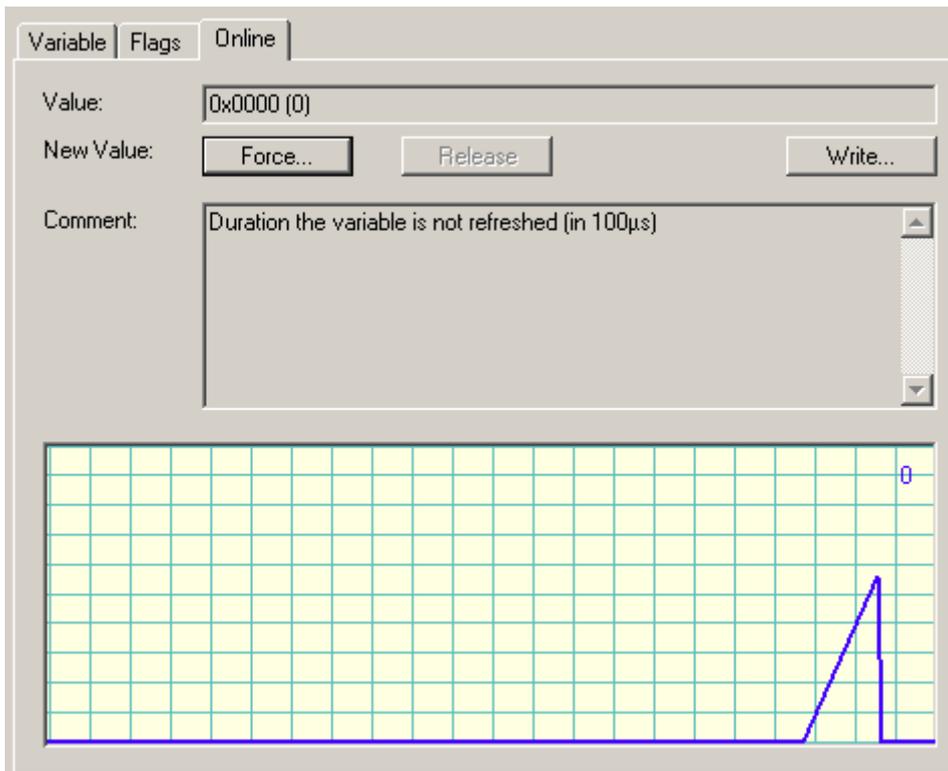


FrameState and FrameCtrl show the state/control of the received Ethernet frames. Both variables are reserved and not supported on the subscriber side.

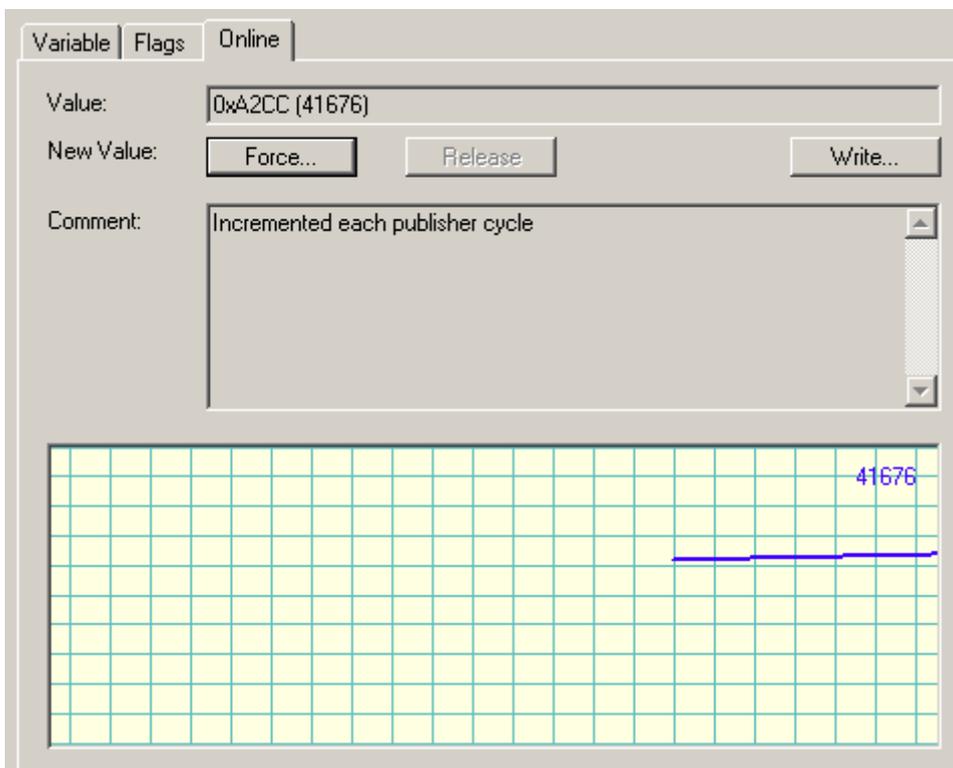
VarState and VarCtrl show the state/control of the received network variable. Both variables are reserved and not supported on the subscriber side.

Quality of Network variables

The quality of a network variable is shown on the subscriber side. Two inputs can be used. The variable quality shows a counter in 100µs resolution. The counter is incremented when the update of the variable is not in time. The sample shows the online quality variable after disconnection of the network plug for a while (counter is incremented) and plug in again (counter is zero).



The CycleIndex variable is incremented with each publisher cycle.



12.3.3 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 example, 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 x88A4 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](#) [▶ 436] 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 switched mode (MAC addressing) communication cycles of approx. 10 ms and below can be achieved, in routed mode (IP addressing) a few 100 ms may be achievable in some cases.

● Diagnostic variable "quality"

i If the processing tasks operate with different cycle times or the user changes the DataExchangeDivider, this must be considered 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 Quality variable). Dynamic temporary blocking of sending a publisher must also be considered. In this case the subscriber registers poor quality.

● Diagnostic variable "CycleIndex"

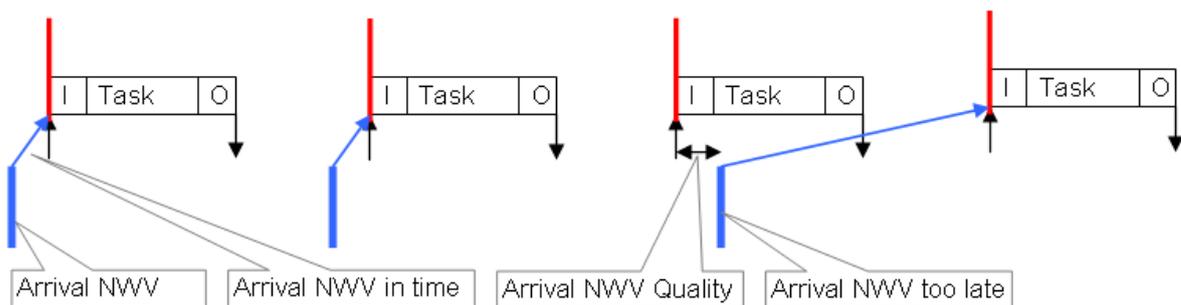
i Please note the following information to decide whether you have to serve the variable CycleIndex.

Basic principles of Beckhoff network variables

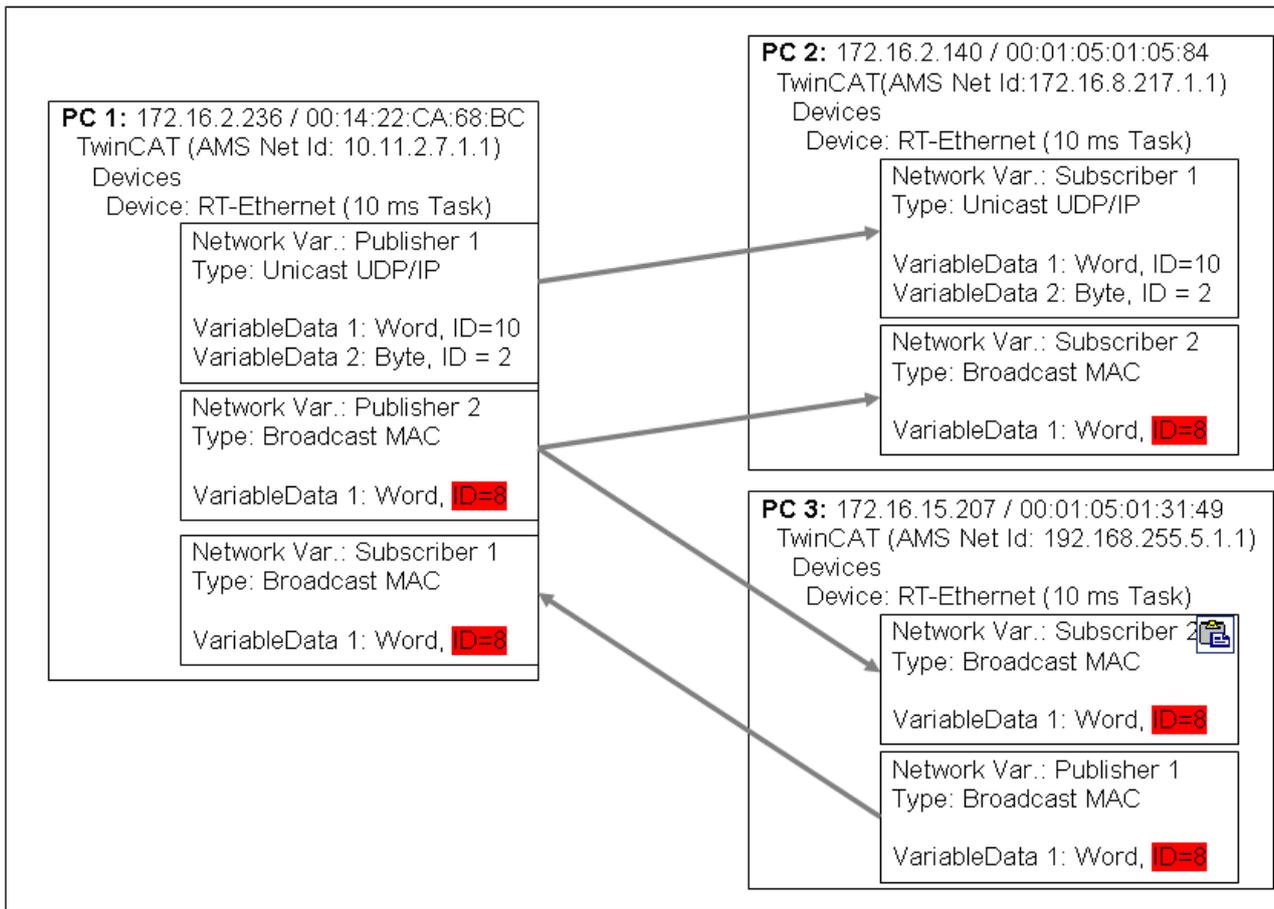
- **Quality:**
Time in [100 µs] by which this NWV arrived too late at the publisher.
Referred arrival location:
Input process image of the TwinCAT system
Referred arrival time:
Time that the input image will be loaded in the next cycle,

The displayed "delay" is determined in such a finely scaled manner because the NWV management is managed directly by the I/O driver, independent of the cycle. Regardless of this, the data of an NWV that arrived too late by a few percent of the cycle time is only taken into account in the next task cycle when the input process image is read.

EL6601/EL6614: Even when using the EL66xx, the arrival time of the NWV is when the data is present in the input process image of the RT device, not when it arrives at the EL66xx or in the input image of the EtherCAT device.



- **Variable ID**
The variable ID (16-bit) is used for global identification of the individual process data – therefore an ID may not be used more than once within a TwinCAT device in the publisher or subscriber group, see Fig. 2: Publisher 1 and 2 on PC1 must have different IDs (10 and 8), but both Publisher 2 and Subscriber 1 may have ID = 8.
In order to achieve unambiguous allocation we recommend using different IDs for each data transmission between connected PCs. Justification: In Fig. 2, PC2/Subscriber2 not only receives the designated 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 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 occurrence differs depending on the publisher platform:
 - Publisher on a PC: the variable *CycleIndex* is not visible and is automatically incremented cyclically by the System Manager
 - Publisher on an EL66xx: the variable *CycleIndex* is visible and must be incremented/operated by the user so that it is not equal to 0 on the subscriber side.



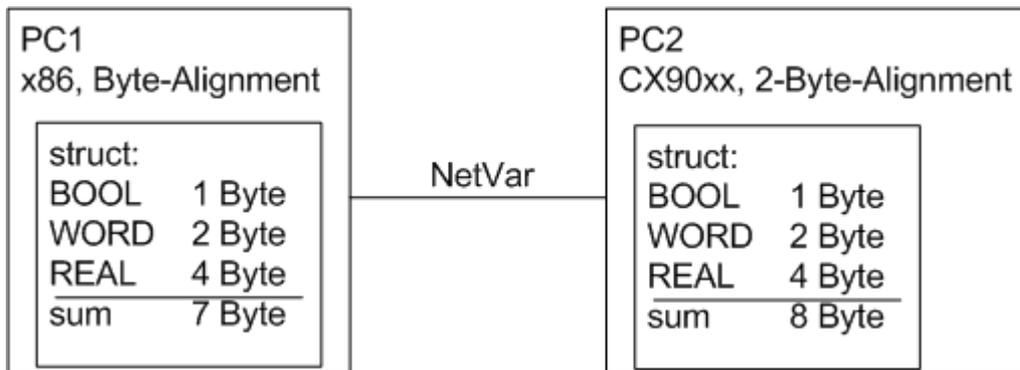
Data representation on different platforms



Please note that the depictions of simple and complex data (WORD, ARRAYS, REAL, STRING, user-defined structures) may vary internally on different platforms!

x86 platforms use byte-alignment, others use (ARM) 2-byte or 4-byte alignment.

This means that if a complex structure is created in an x86/PC PLC project and in an ARM PLC project, they can each have a different effective size and a different internal structure.



Recommendation for structures that are identical on both end devices

- firstly, all 4-byte variables (must be on an address that is divisible by 4)
- then all 2-byte variables (must be on an address that is divisible by 2)
- then all 1-byte variables

Further recommendation

- if STRING(x) is used, then the "EndOfString" null is also considered to be a sign; hence, x+1 must be divisible by 4
- the above rules also apply to substructures.

Please refer to the notes in the [Structure](#) section of the Infosys.

Use of bus terminal controllers (BCxxxx, 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 example, can be used for signed values.

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

a) on a PC network interface, see Fig. 3

b) on an EL66xx, see Beckhoff network variables - Settings

Publisher, Box

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

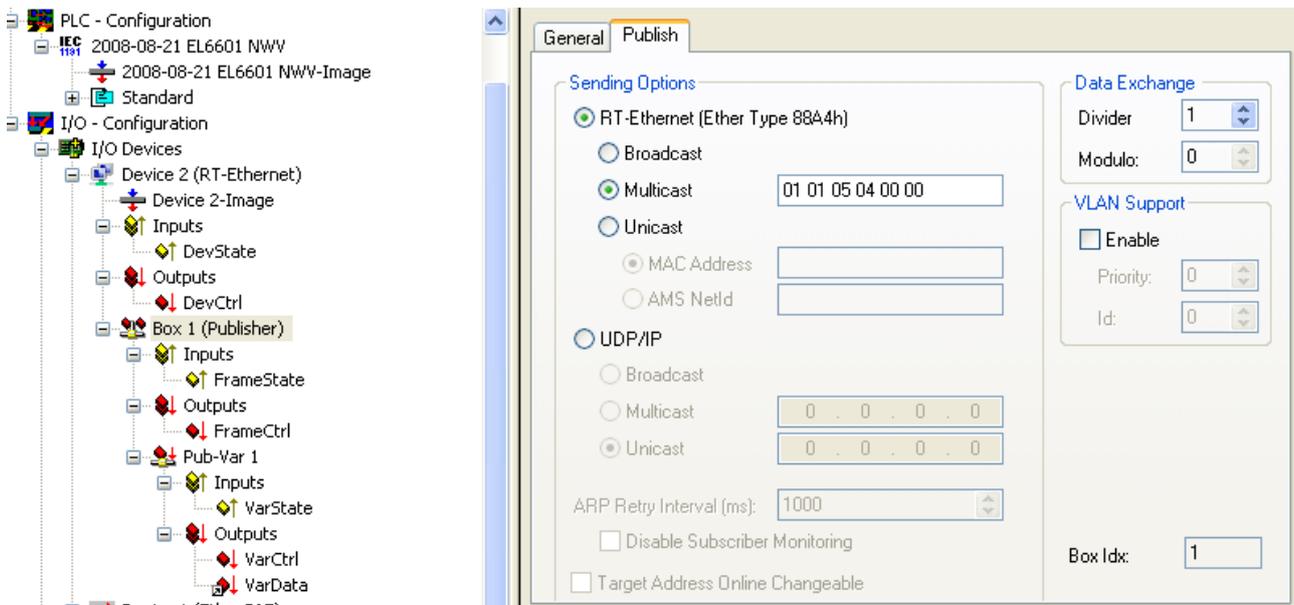


Fig. 1: Fig. 3: Publisher RT Ethernet settings

RT Ethernet settings:

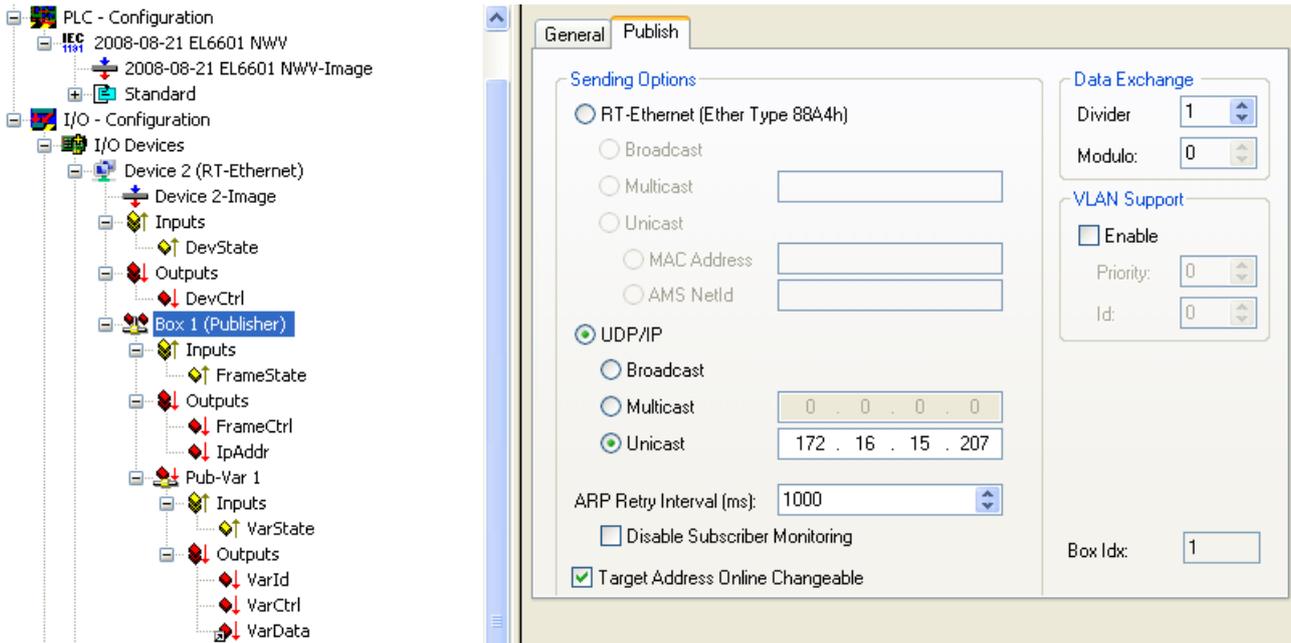
- **MAC-Broadcast:** Sent to all network devices, destination MAC FF:FF:FF:FF:FF:FF.
- **Multicast:** A destination MAC address becomes a multicast address if the first bit in the first byte of the MAC (the so-called group bit) is set. With the Beckhoff ID "00 01 05" the default target address "01 01 05 04 00 00" is formed, as shown in Fig. 3.
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, considering 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).



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.

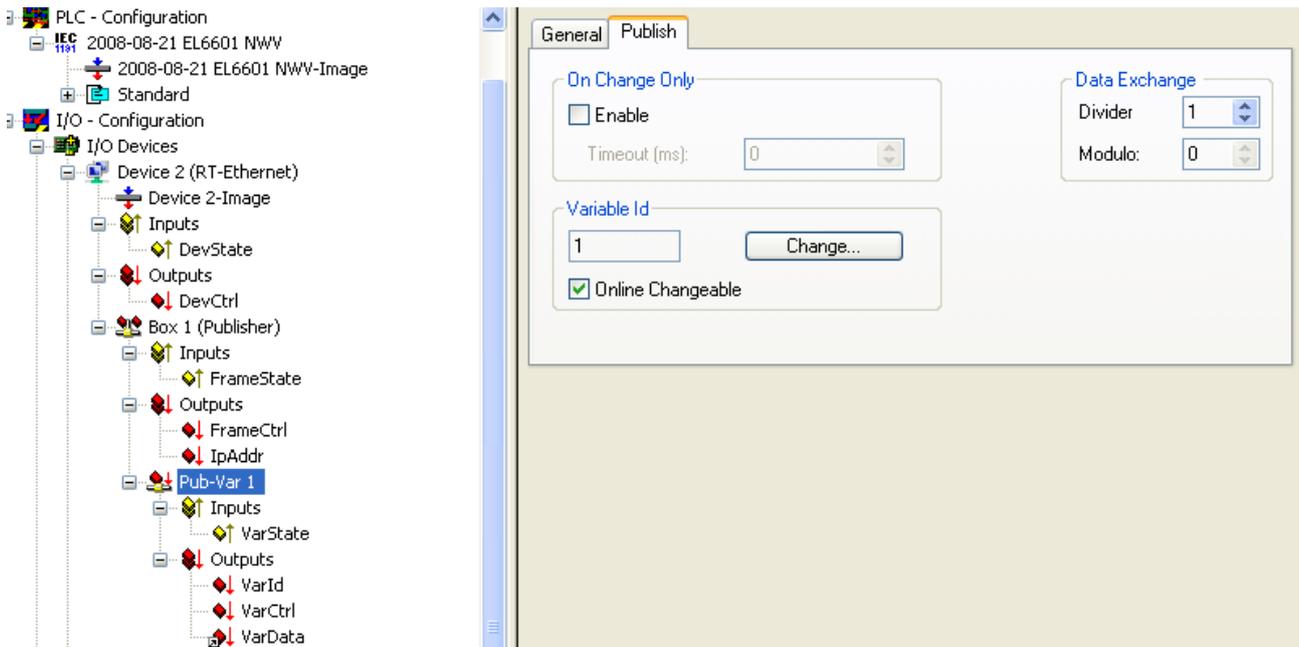
ARP handling (ARP = Address Resolution Protocol: allocation of hardware/MAC addresses to network addresses [IP]) is managed by the operating system (Windows).

Advanced Settings:

- "ARP Retry Interval": 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.
- "Disable Subscriber Monitoring": Deactivates the procedure described above

- "Target Address changeable": In this case the destination IP can be changed dynamically

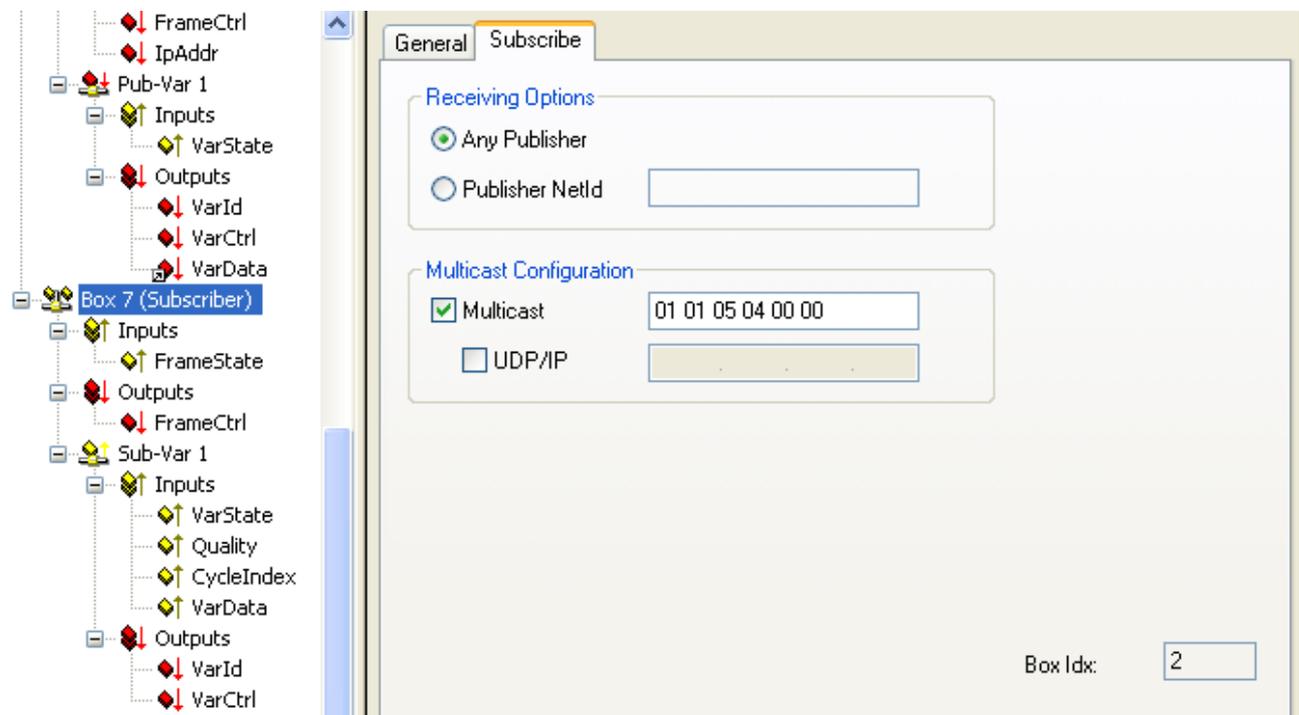
Publisher, Variable



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 when the value changes (not for EL66xx)

Subscriber, box



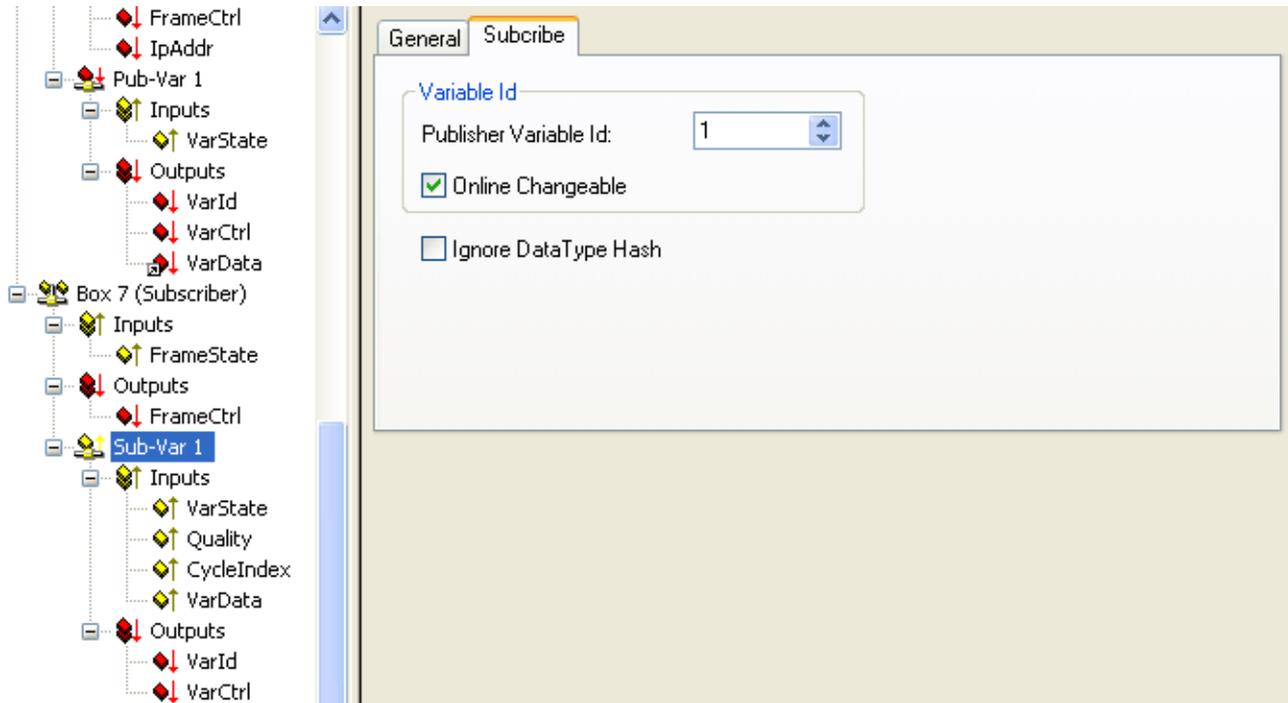
Settings:

- "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



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

12.4 Appendix D: EtherCAT Topology ActiveX Control

The EtherCAT topology view ActiveX control is used to display the current topology of an TwinCAT EtherCAT master device. The ActiveX Control either displays the topology of the currently active configuration or the current topology determined by a bus scan. The Topology control supports three different view modes:

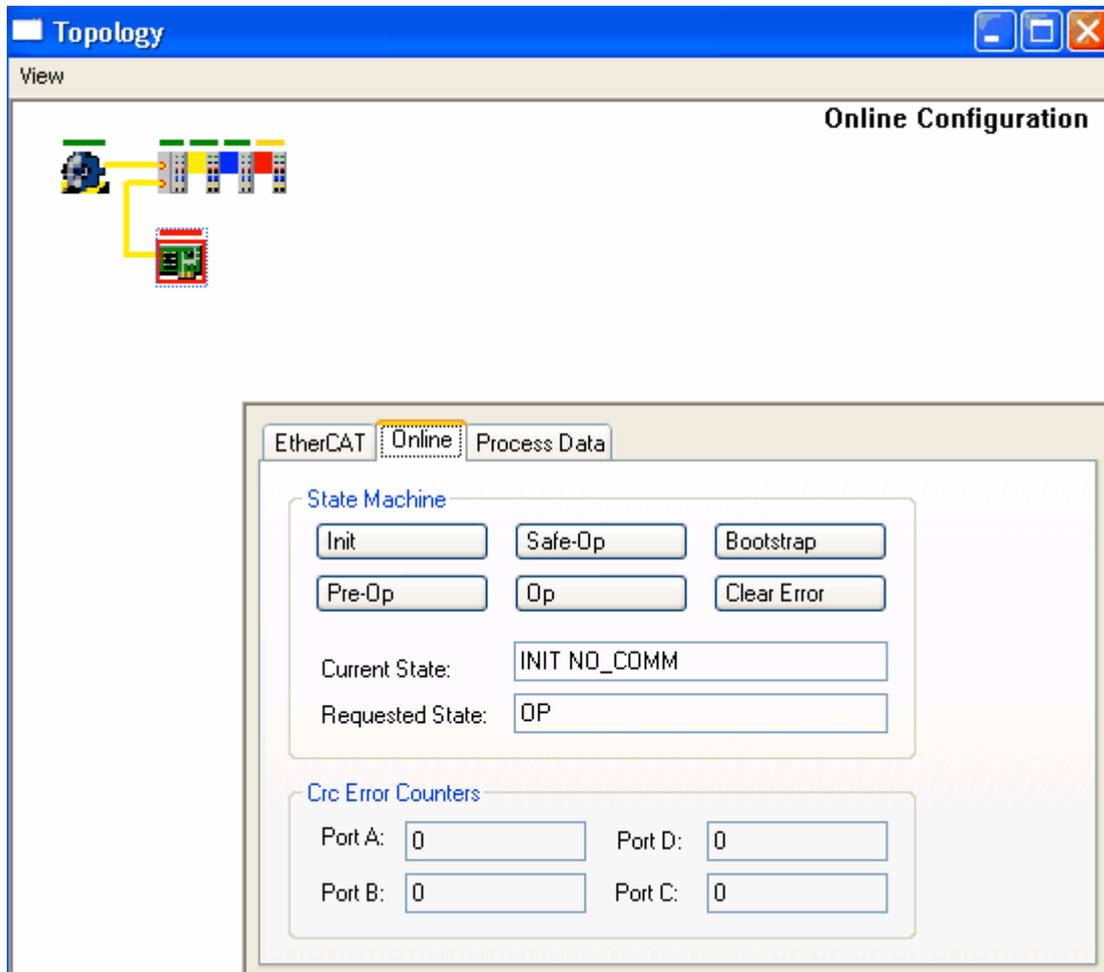
- offline view
Displays the topology of an EtherCAT device belonging to an opened System Manager project
- online view
Displays the topology of a currently active EtherCAT device. The topology view displays following online information of the individual EtherCAT slaves connected to the EtherCAT master:
 - EtherCAT State (Init, Pre-Operational, Safe-Operational, Operational or Bootstrap)
 - Crc error
 - Link state
 - Communication error
- Topology compare view

There are two possibilities to work with the topology control:

- opening the [Topology dialog](#) [► 231] in the System Manager
- [Embedding the control](#) [► 443] in your application (C++, .Net, VB etc.).

12.4.1 Online topology view

The TwinCAT icon in the view represents the EtherCAT master. The EtherCAT slave devices connected to the master are displayed to the right of the master.



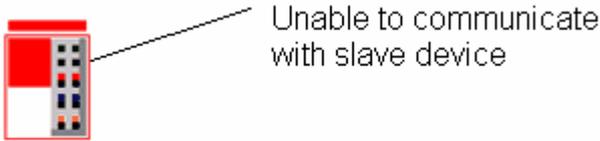
EtherCAT State Indicator

Every device in the view has a state bar displaying the current EtherCAT of the slave:



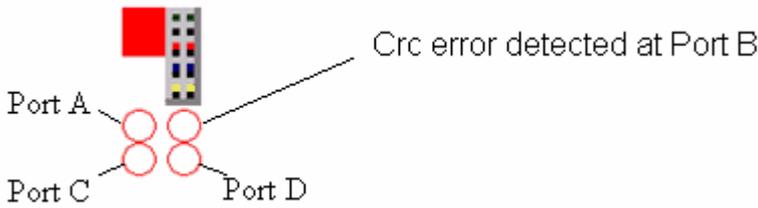
No Communication

A red box around the slave device indicates that the master is unable to communicate with the slave.



Crc error

If a crc error is detected at a port (A,B,C or D) of an EtherCAT slave, a red circle is displayed for each port that has a crc error.

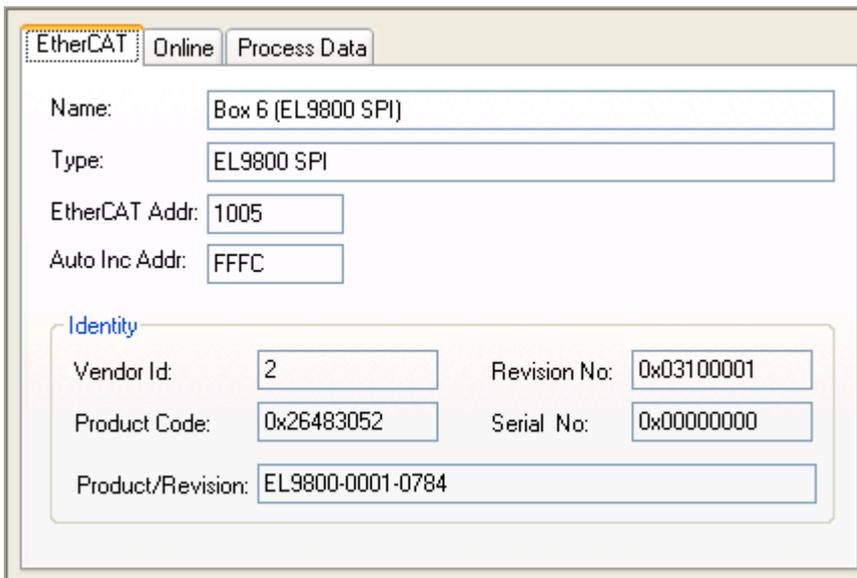


The tooltips of the ports display the actual count of crc errors.

Slave Information Dialog

If you select an EtherCAT slave with the left mouse button, the Slave information dialog is opened:

EtherCAT Tab:



Name:	Name of the EtherCAT slave
Type:	Type of the EtherCAT slave
EtherCAT Addr:	The fixed Address of the EtherCAT slave device. This address is set by the master during the start-up phase. To change the default value, you must check the box left to the address.
Auto Inc Addr:	The Auto Increment Address of the EtherCAT slave device. Auto-increment addressing can be used to address each slave device via its physical position in the communication ring. Auto-increment addressing is used during the start-up phase, during which the master assigns the EtherCAT Address to the slaves. The first slave in the ring has an address of 0 and for each following the addresses is decremented (0xFFFF(-1), 0xFFFE(-2) etc.).
Identity:	Identity of the slave device
Vendor Id:	Vendor Id of the slave
Product Code:	Product code of the slave
Revision No:	Revision number of the slave
Serial No:	Serial number of the slave
Product/Revision:	Readable name for the product code and revision number.

Karteireiter *Online*:

The screenshot shows the 'EtherCAT Online' interface with three tabs: 'EtherCAT', 'Online', and 'Process Data'. The 'Online' tab is active. It contains two main sections:

- State Machine:** A grid of buttons for 'Init', 'Safe-Op', 'Bootstrap', 'Pre-Op', 'Op', and 'Clear Error'. Below the buttons are two text boxes: 'Current State: PREOP LNK_MIS B' and 'Requested State: PREOP'.
- Crc Error Counters:** Four text boxes showing error counts for 'Port A: 0', 'Port B: 1', 'Port C: 0', and 'Port D: 0'.

Init: Tries to set the EtherCAT slave device to the Init State.

Pre-Op: Tries to set the EtherCAT slave device to the Pre-Operational State.

Safe-Op: Tries to set the EtherCAT slave device to the Safe-Operational State.

Op: Tries to set the EtherCAT slave device to the Operational State.

Bootstrap: Tries to set the EtherCAT slave device to the Bootstrap State.

Clear Error: Tries to clear the error flag. If a slave device fails to change to another state, it sets the error flag. For instance a slave device is currently in the Pre-Operational state. Then the master requests the Safe-Operational state. If the slave device fails to change to Safe-Operational, it sets the error flag. The current state would be displayed as "ERR PREOP". After pressing the Clear Error the error flag is cleared and the current state would be displayed as "PREOP" again.

Current State: Current EtherCAT State of the slave device.

Requested State: EtherCAT State the master tried to set the slave to.

State Machine

Init:	Tries to set the EtherCAT slave device to the Init State.	
Pre-Op:	Tries to set the EtherCAT slave device to the Pre-Operational State.	
Safe-Op:	Tries to set the EtherCAT slave device to the Safe-Operational State.	
Op:	Tries to set the EtherCAT slave device to the Operational State.	
Bootstrap:	Tries to set the EtherCAT slave device to the Bootstrap State.	
Clear Error:	Tries to clear the error flag. If a slave device fails to change to another state, it sets the error flag. For instance, a slave device is currently in the Pre-Operational state. Then the master requests the Safe-Operational state. If the slave device fails to change to Safe-Operational, it sets the error flag. The current state would be displayed as "ERR PREOP". After pressing the Clear Error, the error flag is cleared, and the current state would be displayed as "PREOP" again.	
Current State:	Current EtherCAT State of the slave device.	
	Abbreviation	Description
	INIT	Slave is in Init
	PREOP	Slave is in Pre-Operational
	SAFEOP	Slave is in Safe-Operational
	OP	Slave is in Operational
	BOOT	Slave is in Bootstrap
	ERR	Error state set in slave
	VPRS	Vendor Id, product code, revision number or serial number are incorrect
	NO_COMM	No communication to the slave is possible
	LNK_MIS <i>Port</i>	Link at the given port is missing (<i>Port</i> = A, B, C or D).
	LNK_ADD <i>Port</i>	Additional link at given port.
LNK_ERR <i>Port</i>	Link without communication detected	
Requested State:	State requested by the master.	

Table 23: Crc Error Counters

Port A:	Count of crc errors at port A
Port B:	Count of crc errors at port B
Port C:	Count of crc errors at port C
Port D:	Count of crc errors at port D

12.4.2 Methods of the ActiveX control

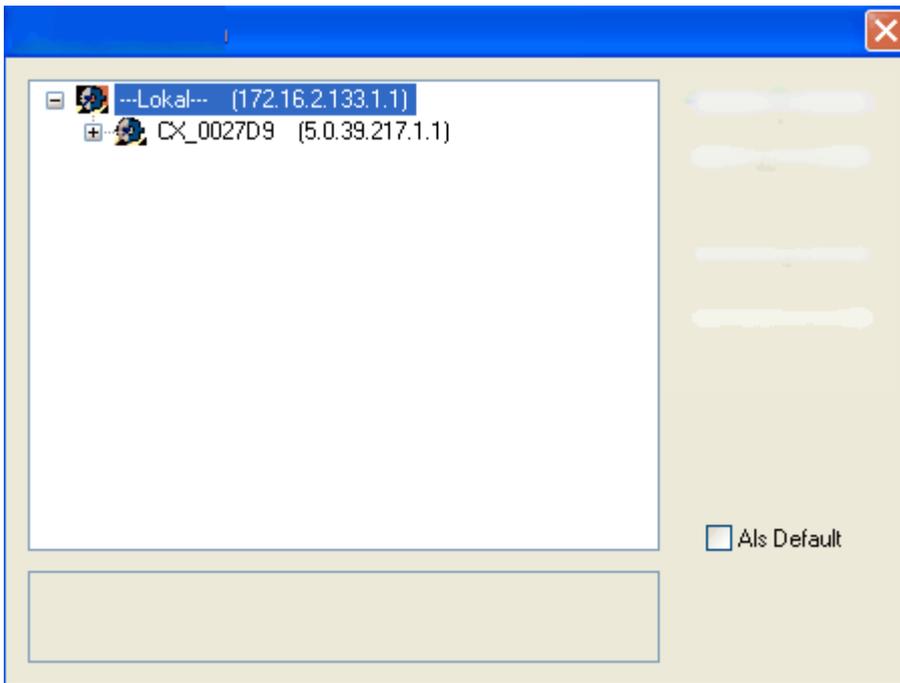
The ActiveX control has two properties to define the EtherCAT master, who's topology should be displayed :

- TargetNetId
- DeviceId

TargetNetId

The *TargetNetId* defines the TwinCAT System the ActiveX control should connect to. The remote TwinCAT Systems, that are registered on the local system, can be displayed with the help of the system manager.

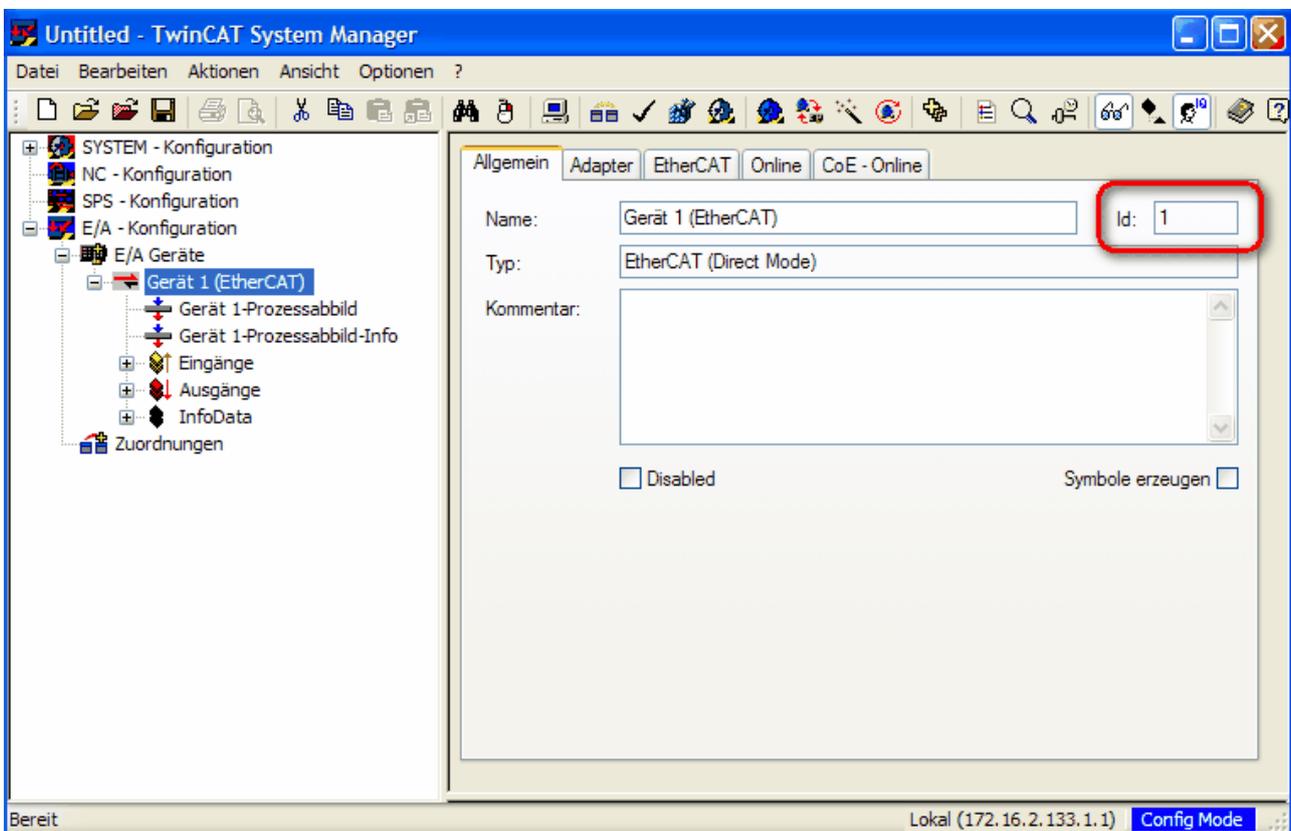
Press the button *Choose Target Systems...* Icon() in the toolbar to display these:



In the example above you can either enter '172.16.2.133.1.1' or an empty string as *TargetNetId* to connect to the local TwinCAT System. With '5.0.39.217.1.1' as *TargetNetId* you can connect to the remote computer *CX_0027D9*.

Deviceld

The *Deviceld* is the unique Id of the EtherCAT master device in the TwinCAT I/O system. This Id is displayed in the configuration dialog of the EtherCAT device in the System Manager. Select the EtherCAT device in the tree view of the System Manager and open the Tab *General*. Here the device Id is displayed in the textbox *Id*:



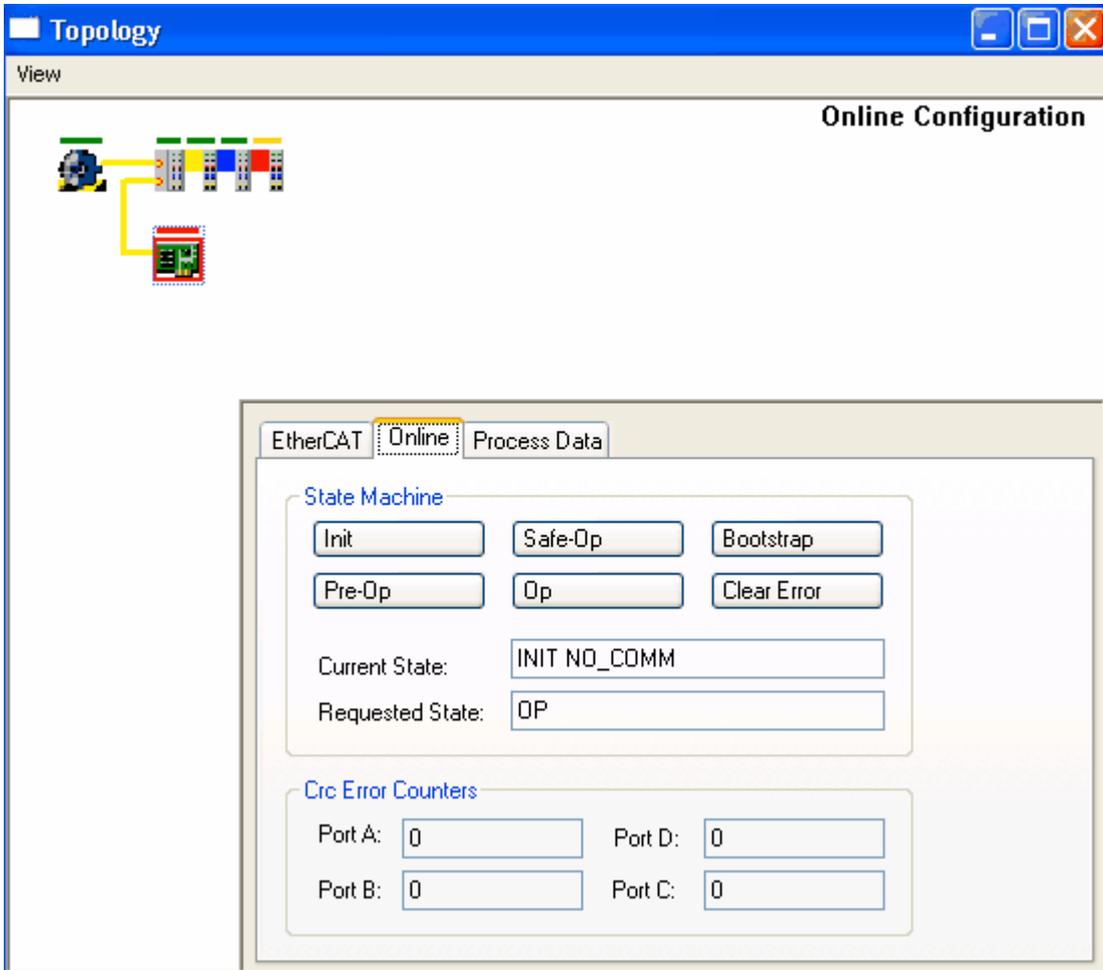
In the example above you must choose 1 as *Deviceld*.

Display the online topology

You can either display the topology of the current configuration, or the topology that is determined by a bus scan. The property *OnlineMode* is used for this:

- scanned topology: *OnlineMode* = `TOPOLOGY_ONLINE_MODE_SCANNED`
- Currently configured topology: *OnlineMode* = `TOPOLOGY_ONLINE_MODE_CONFIGURED`

Next you must call *ShowOnlineTopology*, to display the topology:



Deviceld

Description

The property *Deviceld* defines the EtherCAT device of the TwinCAT target system one wants to display. The *Deviceld* is the unique Id of the EtherCAT master device in the TwinCAT I/O System

Property type

Read-write property

Default value

0

Syntax (C#)

```
int DeviceId { set; get; }
Member of IEcTopologyCtrl
```

Example(C#)

```
//Read DeviceId from SystemManager
axEcTopologyCtrl1.DeviceId = 1;
axEcTopologyCtrl1.ShowOnlineTopology();

//Get DeviceId via IEnumEtherCATDevices interface
IEnumEtherCATDevices devices;
IEtherCATDevice device;

axEcTopologyCtrl1.GetEnumEtherCATDevices(out devices);
uint fetched = 0;

devices.Next(1, out device, out fetched);
if (fetched == 1)
    axEcTopologyCtrl1.DeviceId = device.DeviceId;

axEcTopologyCtrl1.ShowOnlineTopology();
```

TargetNetId**Description**

The property *TargetNetId* defines to which TwinCAT system the ActiveX control should connect to. The *TargetNetId* is the AMS NetId, that is used in the TwinCAT system to identify a TwinCAT computer.

Property type

Read-write property

Default value

AMS NetId of the local system

Syntax (C#)

```
string TargetNetId { set; get; }
    Member of IEcTopologyCtrl
```

Example(C#)

```
axEcTopologyCtrl1.TargetNetId = ""; // Connection local TwinCAT-System
//axEcTopologyCtrl1.TargetNetId = "172.16.2.122.1.1"; // Connection TwinCAT-
System with AMS NetId 172.16.2.122.1.1
axEcTopologyCtrl1.DeviceId = 1;
axEcTopologyCtrl1.ShowOnlineTopology();
```

ZoomFactor**Description**

The property *ZoomFactor* defines the zoom factor of the topology display.

Property type

Read-write property

Default value

3

Syntax (C#)

```
double ZoomFactor { set; get; }
    Member of IEcTopologyCtrl
```

SlaveDescriptionPath

Description

The property *SlaveDescriptionPath* defines the path where the device descriptions of the EtherCAT slaves are stored. Normally one does not have to change this value, because the default path is the path where TwinCAT stores these description files.

Property type

Read-write property

Default value

%\TwinCAT\Io\EtherCAT

Syntax (C#)

```
string SlaveDescriptionPath { set; get; }
    Member of IEcTopologyCtrl
```

OnlineMode

Description

The property *OnlineMode* defines which Topology is to be displayed when calling ShowOnlineTopology. OnlineMode can hold following values:

OnlineMode	Description
TOPOLOGY_ONLINE_MODE_SCANNED	The topology determined with a bus scan.
TOPOLOGY_ONLINE_MODE_CONFIGURED	The currently configured topology.

Property type

Read-write property

Default value

TOPOLOGY_ONLINE_MODE_CONFIGURED

Syntax (C#)

```
ECTOPOLOGYLib.TOPOLOGY_ONLINE_MODE OnlineMode { set; get; }
    Member of IEcTopologyCtrl
```

Example(C#)

```
axEcTopologyCtrl1.TargetNetId = "172.16.2.122.1.1"; // Connection TwinCAT-
System with AMS NetId 172.16.2.122.1.1
axEcTopologyCtrl1.DeviceId = 1;
axEcTopologyCtrl1.OnlineMode = TOPOLOGY_ONLINE_MODE.TOPOLOGY_ONLINE_MODE_CONFIGURED; //
Show topology of current configuration
axEcTopologyCtrl1.ShowOnlineTopology();
```

MasterState

Description

The read only property contains the current state of the master:

MasterState	Description
TOPOLOGY_MASTER_STATE_INVALID	Master is in an invalid state
TOPOLOGY_MASTER_STATE_INT	Master is in the EtherCAT state Init
TOPOLOGY_MASTER_STATE_PREOP	Master is in the EtherCAT state Pre-Operational
TOPOLOGY_MASTER_STATE_SAFEOP	Master is in the EtherCAT state Safe-Operational
TOPOLOGY_MASTER_STATE_OP	Master is in the EtherCAT state Operational
TOPOLOGY_MASTER_STATE_OFFLINE	No connection to the master exists at the moment. This is the case for instance, if the the TwinCAT system is stopped.

Property type

Read-Only property

Default value**Syntax (C#)**

```
ECTOPOLOGYLib.TOPOLOGY_MASTER_STATE MasterState { get; }
    Member of IEcTopologyCtrl
```

ShowCrcErrorMarker**Description**

The property *ShowCrcErrorMarker* defines, if the existence of crc errors should be displayed graphically in the online view. If this value is true, a red circle for every ethernet port with a detected error is displayed beneath the EtherCAT slave.

Property type

Read-write property

Default value

false

Syntax (C#)

```
bool ShowCrcErrorMarker { set; get; }
    Member of IEcTopologyCtrl
```

ShowSlaveInfo**Description**

The property *ShowSlaveInfo* defines, if the information dialog for the selected device should be displayed in the online view. The dialog is display in the right corner of the view and contains additional information about the EtherCAT slave

Property type

Read-write property

Default value

false

Syntax (C#)

```
bool ShowSlaveInfo { set; get; }
    Member of IEcTopologyCtrl
```

ShowAdvancedSettingsMenu

Description

The property *ShowAdvancedSettingsMenu* defines, if the entry *AdvancedSettings...* should be added to the context menu of an EtherCAT slave. If this menu entry is selected, the event *OnAdvancedSettings* is fired.

Property type

Read-write property

Default value

false

Syntax (C#)

```
bool ShowAdvancedSettingsMenu { set; get; }
    Member of IEcTopologyCtrl
```

BackColor

Description

The property *BackColor* determines the background color.

Property type

Read-write property

Default value

0x00FFFFFF(white)

Syntax (C#)

```
uint BackColor { set; get; }
    Member of IEcTopologyCtrl
```

ShowOnlineTopology

Description

Displays the online topology of an EtherCAT device. The device is selected with the help of the properties *DeviceId* and *TargetNetId*. With the help of the parameter *OnlineMode* one can additionally specify, how the topology is determined

Syntax (C#)

```
void ShowOnlineTopology()
    Member of IEcTopologyCtrl
```

Example(C#)

```
axEcTopologyCtrl1.TargetNetId = "172.16.2.122.1.1"; // Connection TwinCAT-
System with AMS NetId 172.16.2.122.1.1
axEcTopologyCtrl1.DeviceId = 1; // EtherCAT device with Id 1
axEcTopologyCtrl1.ShowOnlineTopology(); // show topology
```

ShowOfflineTopology

Description

Displays the offline topology of an EtherCAT device belonging to an opened System Manager configuration.

Parameter

TCatSysManagerLib.ITcSmTreeItem pEtherCATDevice

interface to the System Manager treeItem interfaces of an EtherCAT device

Syntax (C#)

```
void ShowOfflineTopology(TCatSysManagerLib.ITcSmTreeItem pEtherCATDevice)
    Member of IEcTopologyCtrl
```

GetEnumEtherCATDevices**Description**

With the help of GetEnumEtherCATDevices one receives an enumeration interface for the open EtherCAT Devices in the TwinCAT system. With this interface one can enumerate over the individual EtherCAT devices and one can read out the name and the *DeviceId* of these EtherCAT devices.

Parameter

out IEnumEtherCATDevices ppEnum

Interface IEnumEtherCATDevices

Syntax (C#)

```
void GetEnumEtherCATDevices(out IEnumEtherCATDevices ppEnum)
    Member of IEcTopologyCtrl
```

Example(C#)

```
//Get DeviceId via IEnumEtherCATDevices interface
IEnumEtherCATDevices devices;
IEtherCATDevice device;

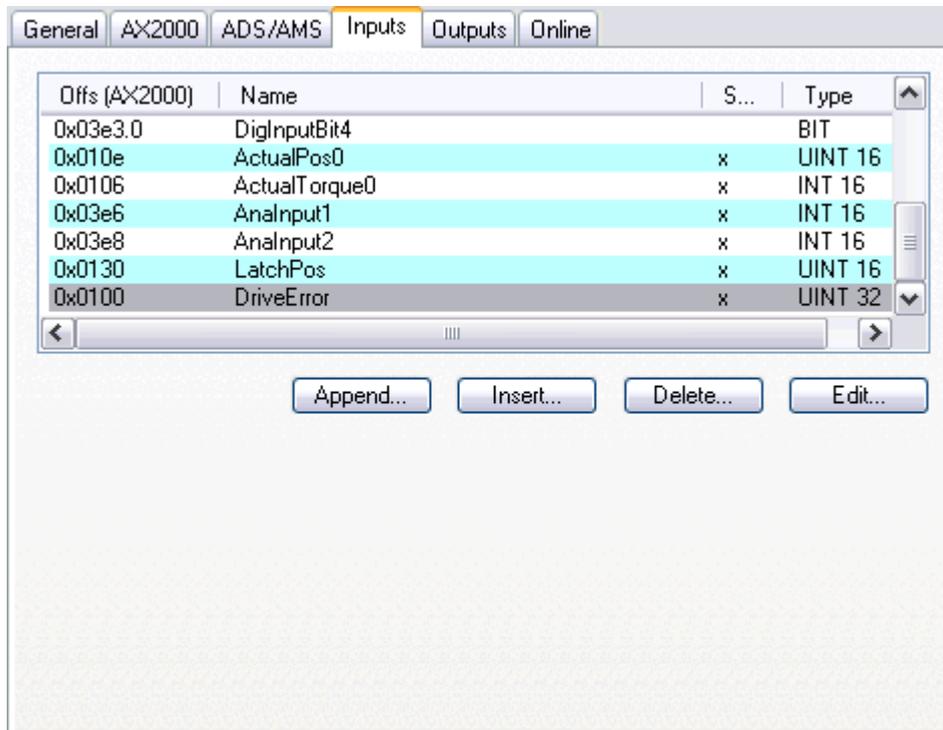
axEcTopologyCtrl1.GetEnumEtherCATDevices(out devices);
uint fetched = 0;

do
{
    devices.Next(1, out device, out fetched);
    if (fetched == 1)
        Console.WriteLine(String.Format("Name:{0} Device Id:{0:d}", device.Name, device.DeviceId));
} while (fetched == 1);
```

12.5 Appendix E: AX2xxx parameters

12.5.1 AX2xxx Drive Tab - Inputs

"Inputs" Tab



If the option *Variable I/O Data* is checked on the "AX2000" tab, additionally the tabs "Inputs" and "Outputs" appear at the AX2xxx drive device.

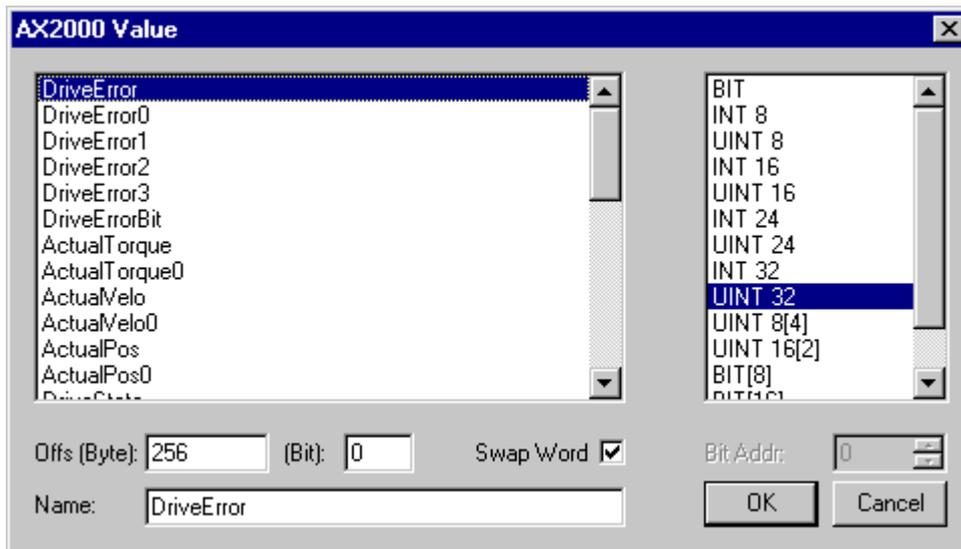
On "Inputs", the optional input variables which may be required in the cyclical drive telegram at some applications (and which appear inside the "Inputs" area below the drive symbol in the tree view), can be added or removed manually.

Append: Calls the dialog described below for selecting the variable incl. their data type and appends the variable in the tree view of the device.

Insert: Calls the dialog described below for selecting the variable incl. their data type and inserts the variable at a specified position in the tree view of the device.

Delete: Removes the selected variable from the tree view of the drive inputs (and from the Lightbus telegram).

Edit: Calls the dialog below for editing a variable.



Offs (Byte): Automatically assigned offset for the variable in the AX2xxx drive telegram.

(Bit): Bit-offset of variable.

Swap Word: Word swap in 32bit telegrams for passing values to process image (active by default).

Bit Addr: Points to the bit address of a variable for the automatic masking.

Name: Shows the name of the selected variable. If a different variable name should show up in the drive tree view, it can be edited here.

OK: Accepts the changes of the AX2xxx drive telegram.

Cancel: Closes the dialog without changing the telegram.

Important:

If the added variables should be linked with a not NC-SAF_Task, this task has to be used with a lower priority (priority number higher)

List of input variables

Name	Data type/ value range	Description
DriveError	UDINT	see DriveError [► 456]
ActualTorque	ARRAY 0..1 of UINT16 0..3280 -> 0..IPEAK	current current / torque of AX2000-B200 or B900. The given value refers to the set surge current of the current controller. ASCII command IPEAK. Calculation of the torque by multiplication with the torque constant of the used motor.
ActualVelo	UDINT / u/min * 139,8	current velocity
ActualPos	UINT16 / 0..FFFF	current position. Via hardware counter 16 Bit at OPMODE = 0.
DriveState	UDINT	see DriveState [► 456]
DriveStateErrBit	BIT DriveState.7	drive error
DriveStateAmplEnableBit	BIT DriveState.6	output stage enabled
DriveStateInitReadyBit	BIT DriveState.2	ready for operation
ActualPosEx	UDINT	contains position value of absolute encoder (built in the motor) (e.g. EnDAT, Hiperface). Depends on the parameter PRBASE
PulseConnect	UINT16	untreated actual position in increments without SI- units
LatchPos	UINT16	latched position
LatchValid	Byte	Latch occurs
LatchPosValidBit	LatchValid.0	positive latch
LatchNegValidBit	LatchValid.1	negative latch
DigInputBit n	BIT	Digital input 1,2,3,4
AnalInput n	UINT16 / 10V -> 404 Dig	Monitor output
Button n	BYTE	display of button under 7 segment display

List of output variables

Name	Data type/ value range	Description
DriveCtrl 0..3	UDINT	controller control bytes
DriveCtrlEnable	DriveCtrl1.0	1-> output stage enabled 0-> output stage disabled. A negative flank of this bit 0 creates a reset on the controller.
DriveCtrlDigCurrent	DriveCtrl0.1	
DriveCtrlEnableLatchPos	DriveCtrl3.0	Enable positive latch
DriveCtrlEnableLatchNeg	DriveCtrl3.1	Enable negative latch
NominalTorque	UDINT	Default set value of current at the digital torque interface (OPMODE 2)
NominalVelo24	UINT24 / u/min * 139,8	Set velocity, optimised to 24 bit
NominalPos	UDINT	Set position. Depends on the settings of parameter PRBASE
CurrentLimiting	UINT16	Default set value current at the digital speed frequency interface (OPMODE 1) as auxiliary operation mode
DigOutputBit 1 & 2	BIT	digital monitor output
AnaOutput 1 & 2	UINT16 / 1,25mV/dig	analog monitor output
NullImpulse	BIT	zero point of resolver
LED-Control	BYTE	If a value unequal zero is entered, the interface to the 7 segment display is active.
LEDs 1,2,3	BIT	Value for the three 7 segment displays

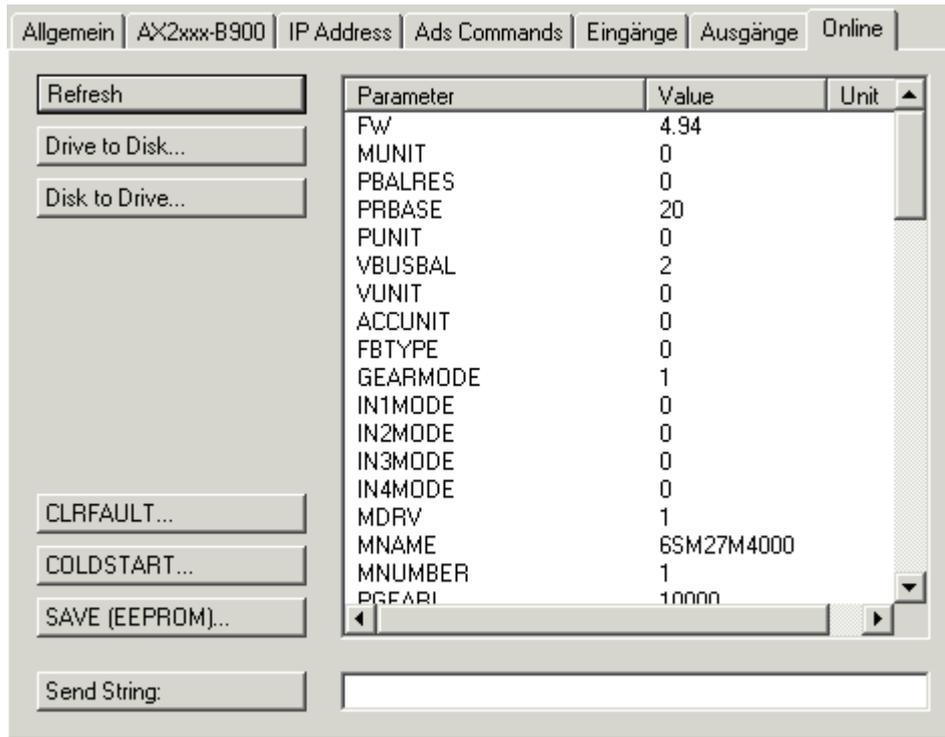
12.5.2 AX2xxx Drive Tab - Online

"Online" Tab of AX2000-B200

The screenshot shows the 'Online' tab for the AX2000-B200 drive. The window has tabs for 'General', 'AX2000', 'ADS/AMS', and 'Online'. On the left, there are buttons for 'Refresh', 'Drive to Disk...', 'Disk to Drive...', 'CLRFAULT...', 'COLDSTART...', 'SAVE (EEPROM)...', and 'Send String:'. The main area is a table with columns for 'Parameter', 'Value', and 'Unit'.

Parameter	Value	Unit
FW	3.51	
PRBASE	20	
FBTYPE	0	
GEARMODE	6	
IN1MODE	0	
IN2MODE	0	
IN3MODE	0	
IN4MODE	0	
MDRV	1	
MNAME	NN	
MNUMBER	0	
MSPEED	8000	RPM
PBALRES	0	
PGEARI	1	
PGEARO	1	
VBUSBAL	2	
VCOMM	300	
VLM	4000	RPM
VIMN	4000	

"Online" Tab of AX2000-B900



The [ASCII Objects \[► 467\]](#) of the AX2xxx drive are listed on this tab with current values (values are determined during tab opening). See *also*: **Refresh**

Refresh: To update the values shown in the listing, press this button.

Drive to Disk: Saves parameters with currently displayed values to disk. The file is stored in ASCII format and has the file extension *.axp.

Disk to Drive: Loads the parameter values of an previously stored *.axp file into the AX2xxx drive.

CLRFAULT: Calls the command for clearing of some defined drive errors (see AX2xxx manuals supplied on "Beckhoff Drive Technology" CD, *also*).

COLDSTART: Call the command for a initialising the drive (the Firmware) once again. Previously appeared errors are cleared then.

SAVE (EEPROM): Saves the downloaded parameters to the EEPROM of the drive. Therefore, the previous parameter changes will be active even after a coldstart of the drive.

Send String: Sends a single command (edited in the field right next to it) with a request for a parameter value to the drive. The feedback will be displayed in a message box after arrival.

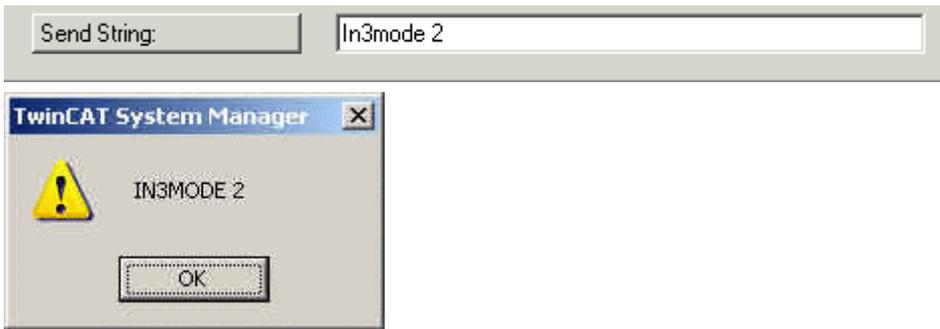
Example:

If you enter the string *FW*, it would display e.g. the current drive Firmware version.



Example:

If you enter the string *In3mode 2* the function of the third digital input (PSTP) will be changed.



12.5.3 AX2xxx Drive - Status and Error Codes

At AX2xxx-B200 drives, the variables *DriveError*, *DriveState* and *Status* are added via **Variable I/O Data**.

At AX2xxx-B900 drives, the I/O variables *DriveState2* and *DriveState3* appear by default under "Inputs", but the *DriveError* variables are to be added manually. Please find additional info under: [AX2xxx Drive Tab - Inputs](#) [▶ 451].

These input variables can be used for diagnosis purposes (e.g. if they are linked to a TwinCAT PLC process image, they can be evaluated inside the TwinCAT PLC run-time system).

In any case, the error and warning codes are displayed on the 7-segment display of the AX2xxx drive (see column: "**AX2xxx Display**").

Table 24: The below error messages and warnings could appear:

Variable	Data Type	Value	AX2xxx Display	Designation
DriveError (can also be linked byte-wise with help of the variables <i>DriveError0, DriveError1, DriveError2 and DriveError3</i>) The equivalent ASCII command is: <u>ERRCODE</u> * resp. <u>ERRCODE</u>	UINT32	0x00000001	F01	Error heat sink temperature is set if the current heat sink temperature (<u>TEMPH</u>) goes beyond the max. allowed value (<u>MAXTEMPH</u>)
		0x00000002	F02	Error overvoltage is set, if the voltage inside the DC-link circuit goes beyond the max. allowed value (<u>VBUSMAX</u>).
		0x00000004	F03	Error position controller (drive) if drive internal position controller is used (<u>OPMODE=6/ SERCOS</u>) and the lag distance is too high. Means, if in the above case the max. revolutions per minute value goes beyond (<u>VLIM</u> / <u>VLIMN</u>).
		0x00000008	F04	Feedback error (Resolver) is set, if the amplitude of the resolver / encoder signals goes below the min. value.
		0x00000010	F05	Error undervoltage is set, if the voltage inside the DC-link circuit goes below the min. allowed value (<u>VBUSMIN</u>
		0x00000020	F06	Error motor temperature is set if the resistance of the motor thermoelement (<u>TEMPM</u>) goes beyond the max. allowed value (<u>MAXTEMPM</u>).
		0x00000040	F07	Internal supply voltage (aux. voltage) not ok..
		0x00000080	F08	Speed error is set if the current motor revolution per

Variable	Data Type	Value	AX2xxx Display	Designation
				minute value (<u>V</u>) goes beyond the max. allowed value (<u>VOSPD</u>).
		0x00000100	F09	Error EEPROM is set, if the read/write process with the serial EEPROM fails. It can happen because of a bad EEPROM or wrong checksum. In the second case, an additional try to save to EEPROM, may help.
		0x00000200	F10	Reserved
		0x00000400	F11	Brake error is set, if the brake input notices an error (e.g. brake not connected).
		0x00000800	F12	Reserved
		0x00001000	F13	Error ambient temperature is set, if the ambient temperature (<u>TEMPE</u>) goes beyond the max. allowed value (<u>MAXTEMPE</u>)
		0x00002000	F14	Amplifier error Following problems could cause the error: Line output grounded to earth, motor short circuit or ballast circuit shorted.
		0x00004000	F15	Error I2T exceeded <i>max</i> is set, if <u>I2T</u> is at 115% (at <u>FOLDMODE</u> =0) respectively 105% (at <u>FOLDMODE</u> =1).
		0x00008000	F16	Supply voltage not correct is set, if 2 or 3 phases of supply voltage are missing. For additional information see manuals supplied with AX2xxx drive, also.
		0x00010000	F17	Error A/D Converter

Variable	Data Type	Value	AX2xxx Display	Designation
				is set if offsets of drive current values are too high during startup.
		0x00020000	F18	Ballast transistor error with bad ballast transistor respectively preselection of "external ballast resistor" in combination with connected internal ballast resistor, this error is going to be set.
		0x00040000	F19	Error missing phase. at PMODE=2.
		0x00080000	F20	Slot Error This error condition is generated if there are problems with present slot expansion card (e.g. AX2xxx-B200). This error message is depending on the used expansion slot card type. It usually points to a faulty interface hardware.
		0x00100000	F21	PROFIBUS Handling Error This error can only happen in combination with the use of a Profibus expansion card (part no.: AX2xxx-B310).
		0x00200000	F22	Drive circuits are grounded to earth potential (PE)
		0x00400000	F23	Error in CAN communication This error message BUSOFF is generated directly by level 2 of the internal CAN controller.
		0x00800000	F24	Error Watchdog This error is displayed, if the telegram update time exceeded the value set in EXTWD.

Variable	Data Type	Value	AX2xxx Display	Designation
		0x01000000	F25	Error in commutation At this error message, the motor has a commutation problem (uncontrolled motor behavior). The commutation treshold value can be changed under <u>VCOMM</u> , the unit is RPM (rounds per minute).
		0x02000000	F26	Error in calibration (hardware limit switch) is defined by <u>REFLS</u> .
		0x04000000	F27	Error AS-Option is set, if amplifier was enabled during activation of the optional starting inhibiting circuit (part no.: AX20xx- <u>yyyy-0001</u>).
		0x08000000	F28	Error "external position setpoint offset" External position setpoint offset beyond limit.
		0x10000000	F29	SERCOS error
		0x20000000	F30	SERCOS emergency stop timeout
		0x40000000	F31	Reserved
		0x80000000	F32	System error shows an internal error. This error is generated at drive startup if system check didn't succeed during initialization. For further information, see detailed AX2000 / AX2500 manuals supplied with drive.
<i>DriveState</i> (can also be linked byte-wise with help of the variables	UINT32	0x00000001	n01	Warning I2T-threshold value exceeded is set, if <u>I2T</u> goes beyond the limit set under <u>I2TLIM</u> .

Variable	Data Type	Value	AX2xxx Display	Designation
<i>DriveState0, DriveState1, DriveState2 and DriveState3</i>) The equivalent ASCII command is: <u>DRVSTAT</u>		0x00000002	n02	Warning ballast circuit is set, if the current regen circuit exceeds the threshold value set under <u>PBALMAX</u> . The warning is cleared as soon as the value goes below <u>PBALMAX</u> .
		0x00000004	n03	Warning lag-distance exceeded is set, as soon as the distance between the set position and the position controller trajectory exceed the set value <u>PEMAX</u> . It can be deleted with the command <u>CLRFAULT</u> .
		0x00000008	n04	Watchdog warning is set, if the fieldbus watchdog time <u>EXTWD</u> was exceeded.
		0x00000010	n05	Warning: At least one supplied phase is missing is displayed, if not all three phases of supply voltage are supplied.
		0x00000020	n06	Warning: Software limit switch 1 below minimum is set, if the value of the software limit switch 1 is below <u>SWE1</u> . In addition, the warning is set, if a motion task was started with a target position below the value specified in drive object <u>SWE1</u> . The warning message is cleared as soon as <u>SWE1</u> is exceeded and a positive speed setpoint value is passed over (means, when a

Variable	Data Type	Value	AX2xxx Display	Designation
				start command with valid position values is supplied).
		0x00000040	n07	<p>Warning: Software limit switch 2 beyond maximum</p> <p>is set, if the value of the software limit switch 2 is beyond <u>SWE2</u>.</p> <p>In addition, the warning is set, if a motion task was started with a target position beyond the value specified in drive object SWE2. The warning message is cleared as soon as SWE2 stays below and a negative speed setpoint value is passed over (means, when a start command with valid position values is supplied).</p>
		0x00000080	n08	<p>Warning: Wrong start command</p> <p>is set if it was tried to start an undefined (missing checksum) motion task. The warning is cleared automatically if a valid start command is supplied.</p>
		0x00000100	n09	<p>Warning: Reference point (calibration) not set</p> <p>is set if a motion task was initiated without a calibration/homing done before.</p>
		0x00000200	n10	<p>Warning: PSTOP activated</p> <p>is set if hardware limit switch PSTOP (stop switch in positive direction) is activated. Warning is cleared as soon as the limit switch is released again.</p>
		0x00000400	n11	<p>Warning: NSTOP activated</p>

Variable	Data Type	Value	AX2xxx Display	Designation
				is set if hardware limit switch NSTOP (stop switch in negative direction) is activated. Warning is cleared as soon as the limit switch is released again.
		0x00000800	n12	Warning: Default motor data loaded is set during drive startup, if the motor ID of the serial EEPROM and the motor ID of the SIN/COS encoder don't match.
		0x00001000	n13	Slot warning (I/O card) is set, if there is a dysfunctionality with the optional I/O card (part no.: AX2090-I001), which is for starting of predefined (inside drive) motion tasks.
		0x00002000	n14	Recognition of MPHASE (FBTYPE=7)
		0x00004000	n15	Warning: Wrong VCT-Entry selected (table error) is set, when a wrong <u>VCT</u> entry is selected and to be activated.
		0x00008000	n16	Warning active <i>n17 .. n31</i> is set, if one or several warnings in the range between <i>n17.. n31</i> are active
		0x00010000		Motion task active Is set, if a motion task is started (motion task, jog or homing move). Is cleared, if the action is finished or a <u>STOP</u> - command is executed
		0x00020000		Reference point is set. Is set, if the homing move was done or a absolute encoder feedback device is

Variable	Data Type	Value	AX2xxx Display	Designation
				used. Is cleared if a homing move is started
		0x00040000		Home switch Is high, if the homing switch is closed, otherwise low.
		0x00080000		In-Position Is high, if the distance between the target position and the actual position is smaller than <u>PEINPOS</u> , otherwise low. When several motion tasks are tied together, only the last motion task enables this bit.
		0x00100000		Position latch occurred (positive edge) Is set, if a positive edge at the latch input (Input2 with <u>IN2MODE</u> =26) was detected. Is cleared, if the latched position was read (<u>LATCH16</u> / <u>LATCH32</u>).
		0x00200000		Position register 0 Is high, if the configured condition (<u>SWCNFG2</u> , <u>SWE0</u> , <u>SWE0N</u>) is true, otherwise low
		0x00400000		Position register 1 Is high, if the configured condition (<u>SWCNFG</u> , <u>SWE1</u> , <u>SWE1N</u> is true, otherwise low
		0x00800000		Position register 2 Is high, if the configured condition (<u>SWCNFG</u> , <u>SWE2</u> , <u>SWE2N</u>) is true, otherwise low
		0x01000000		Position register 3 Is high, if the configured condition

Variable	Data Type	Value	AX2xxx Display	Designation
				(SWCNFG , <u>SWE3</u> , <u>SWE3N</u>) is true, otherwise low
		0x02000000		Position register 4 Is high, if the configured condition (SWCNFG , <u>SWE4</u> , <u>SWE4N</u>) is true, otherwise low
		0x04000000		Initialization phase finished Is set, if the initialization phase of the drive is finished (takes about 15s).
		0x08000000		Position register 5 Is high, if the configured condition (<u>SWCNFG2</u> , <u>SWE5</u> , <u>SWE5N</u>) is true, otherwise low
		0x10000000		Motor stand still message Is high, if the actual motor velocity is lower than the threshold <u>VELO</u> , otherwise low.
		0x20000000		Safety relays selected Is high, if the safety relay of the AS-option (part no: AX20xx-yyyy-0001) is switched on, otherwise low.
		0x40000000		Output stage enabled Is high, if the soft- and the hardware enable is present, otherwise low.
		0x80000000		Drive is in error condition Is set, if the drive has a fault (output stage is disabled, error number is displayed). The command <u>ERRCODE</u> gives the error in plain text. The bit is cleared if the drive is reset or the command <u>CLRFAULT</u> is send.

Variable	Data Type	Value	AX2xxx Display	Designation
State	UINT8	0x01		Command error from AX2xxx-Bx00 interface.
		0x02		Error in input data from AX2xxx-Bx00 interface.
		0x04		Error in output data from AX2xxx-Bx00 interface.
		0x08		Timeout from AX2xxx-Bx00 interface.
		0x10		Error K-Bus Reset from AX2xxx-Bx00 interface.

12.5.4 ASCII Object Description

The Beckhoff **AX2000** and AX2500 drive contains numerous ASCII objects to read or manipulate internal parameters. These ASCII objects can be accessed fieldbus-independently via ASCII commands in read- and some of them even in write mode. Some networks are using the ASCII commands during initialization of the axes through TwinCAT (e.g. Beckhoff Lightbus or Real-Time Ethernet). However, not all parameters are relevant in combination with TwinCAT NC-PTP or TwinCAT NC-I.

In any case, the support of the individual command depends on the Firmware revision of the drive (=> VER)!

A listing of the supported commands can be found under: [AX2xxx Reference - ASCII Object Description](#).

At drives used under SERCOS, similar parameters are defined according to the IEC 61491 standard. For a description of the Sercos **IDent Numbers** supported by AX2000 respectively AX2500, please refer to: [AX2xxx-B750 Reference](#). If a dedicated IDN matches the function of one of the ASCII objects, it is named in the table of the correlating IDN (*for example*: S-0-0030 == VER).

12.6 Automation Interface

TwinCAT Automation Interface enables an efficient engineering process by giving customers the possibility to automate the configuration of a full TwinCAT project configuration.

The documentation of the TwinCAT Automation Interface is located in TwinCAT > System > [Automation Interface](#)

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