IXXAT®

CANopen Configuration Studio

for IXXAT CME/PN

User Manual
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HMS

Table of Contents

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1 Introduction to CANopen Configuration Studio for IXXAT CME/PN

CANopen Configuration Studio for IXXAT CME/PN is an easy to use tool that supports generation of configuration data for the IXXAT CME/PN PROFINET RT to CANopen gateway from IXXAT Automation GmbH. The IXXAT CME/PN is a powerful and easily configurable gateway for connecting CANopen devices and networks to PROFINET systems.

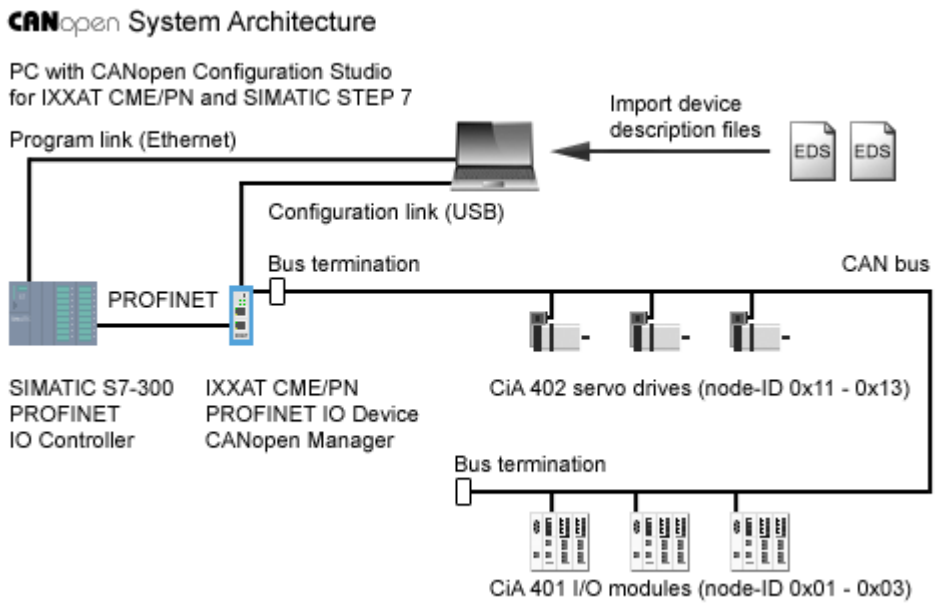
The IXXAT CME/PN converts PROFINET RT frames to CANopen frames and vice versa. On the PROFINET side it features a built-in 2-port switch. On the CANopen side up to 120 CANopen devices can be connected. Detailed hardware information is included in IXXAT CME/PN hardware manual.

The IXXAT CME/PN is configured via USB interface or remote via Ethernet. When configured it acts as customer-specific PROFINET IO device and as CANopen manager with functionality according to CiA 301 and CiA 302. The IXXAT CME/PN maps PROFINET slots to CANopen network variables. It supports a wide range of applications from short cycle times with few variables up to longer cycle times with a large number of variables.

CANopen is an internationally standardized (EN 50325-4) CAN based higher-layer protocol for embedded systems. In addition to the application layer and communication profile specified in CiA 301, the version of EN 50325-4 which is maintained by CAN in Automation (CiA), the set of CANopen specifications also covers device (CiA 401, CiA 402, CiA 404, CiA 406), application, and interface profiles. CANopen supports extensive configuration capabilities.

A CANopen network is commonly composed of several CANopen slave devices and one dedicated device acting as a network management (NMT) master. The NMT master is responsible for starting the CANopen slave devices. A NMT master that additionally supports configuration manager functionality is called CANopen manager (CiA 302-1). If the CANopen manager is integrated with a PLC runtime system, process data of the CANopen slaves are mapped into a process image on the manager. CANopen Configuration Studio for IXXAT CME/PN fully supports parameterization of the NMT master, the configuration manager, and the process image description.

In the example shown the figure below, one IXXAT CME/PN gateway operates as CANopen manager and a SIMATIC S7-300 PLC is used as PROFINET IO controller. Alternatively other PROFINET IO controllers may be deployed instead. Additional I/O modules and servo drives complete the example network. The node-IDs in the figure below have been chosen arbitrarily, but will be used in the examples contained in later sections of this documentation.



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Supported Functionality

- Selection of CANopen manager and CANopen slave devices based on a user configurable device catalog.
- Management of any number of device description files inside the device catalog.
- Configuration of CANopen manager parameters including NMT startup object, NMT slave assignment, and device type identifications.
- Configuration of NMT error control services, both heartbeat and node guarding.
- Direct configuration of device parameter objects which are written to the CANopen devices on network startup.
- Individual selection of application objects to be mapped into the process image of the CANopen manager. Alternatively, selection of application objects based on default PDO mapping of CANopen slave devices.
- Automated calculation of PDO communication and mapping parameters for both CANopen manager and CANopen slave devices.
- Manual manipulation of PDO communication and mapping parameter for CANopen slave devices.
- Inspection of the calculated process image and grouping of parameters within the process image.
- Manual adjustment of PROFINET timing parameters with estimation of the resulting CANopen bus load
- Generation of concise device description data and direct download of network configuration data to the IXXAT CME/PN.

The IXXAT CME/PN shall be solely configured by CANopen Configuration Studio for IXXAT CME/PN. The configuration process generates customer-specific concise DCF and GSDML files. Use only these generated concise DCF and GSDML files to configure the IXXAT CME/PN. Do not change the configuration in the object dictionary via SDOs because this will invalidate the configuration.

The IXXAT CME/PN maps PROFINET slots to CANopen network variables. Note that PROFINET guarantees that the data in one subslot are consistent. The mutual consistency of data in two different subslots cannot be guaranteed. If it is vital that all data of one CAN message appear consistently on PROFINET you must map all data of one CAN message to one network variable with appropriate size e. g. UNSIGNED64.

The IXXAT CME/PN acts as CANopen manager. Note that the CANopen manager does not support the optional Layer Setting Service (LSS).

This documentation assumes that the reader is familiar with CANopen communication technology and has access to the most recent CANopen specifications.

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2 Important User Information

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There are many applications of this product. Those responsible for the use of this device must ensure that all the necessary steps have been taken to verify that the applications meets all performance and safety requirements including any applicable laws, regulations, codes, and standards

IXXAT Automation GmbH will under no circumstances assume liability or responsibility for any problems that may arise as a result from the use of undocumented features, timing, or functional side effects found outside the documented scope of this product. The effects caused by any direct or indirect use of such aspects of the product are undefined, and may include e.g. compatibility issues and stability issues.

The examples and illustrations in this document are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular implementation, IXXAT Automation GmbH cannot assume responsibility for actual use based on these examples and illustrations.

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3 System Requirements

To operate CANopen Configuration Studio for IXXAT CME/PN the following system configuration is recommended:

- x86/x64 CPU with 1.8GHz or higher
- 2GB RAM
- 20MB available space on hard disk
- 1024x768 display (1280x1024 recommended)
- Microsoft® Windows® operating system, (Windows XP SP3, Windows Vista®, Windows 7, Windows 8)
- Microsoft® .NET® Framework 4 Full
- PROFINET engineering tool

3.1 Installation and First Steps

The installation procedure installs CANopen Configuration Studio for IXXAT CME/PN by default into the `%ProgramFiles%\IXXAT Automation GmbH\CANopen Configuration Studio for IXXAT CME-PN` directory. The Microsoft Windows environment variable `%ProgramFiles%` is typically set to `C:\Program Files` on US locale systems or `C:\Programme` on German locale systems.

The installation procedure installs the configuration tool and the USB driver.

> ⚠ Execute the installation procedure on the PC before connecting the IXXAT CME/PN via USB.

> ⚠ Do not connect the USB plug to an unpowered IXXAT CME/PN device. Supply the IXXAT CME/PN power first and mate the USB plug next. Otherwise the device may be subject to irreparable damage.

> The installation procedure installs the command-line tool `USBErrorLog.exe` to the PC. If a fatal error is indicated by the IXXAT CME/PN LEDs (see hardware manual) the user can read an error log via USB that supports error trace back. Note that reading the error log aborts the network communication.

The default location for project files is typically set to `C:\Users\Public\Documents\IXXAT\CANopen Configuration Studio for IXXAT CME-PN` on Microsoft Windows 7 systems and to `C:\Documents and Settings\All Users\documents\IXXAT\CANopen Configuration Studio for IXXAT CME-PN` on Microsoft Windows XP systems. The exact path depends on the operating system locale.

> To start CANopen Configuration Studio for IXXAT CME/PN open the Microsoft Windows start menu and navigate to `All Programs\IXXAT\CANopen Configuration Studio for IXXAT CME-PN \`.

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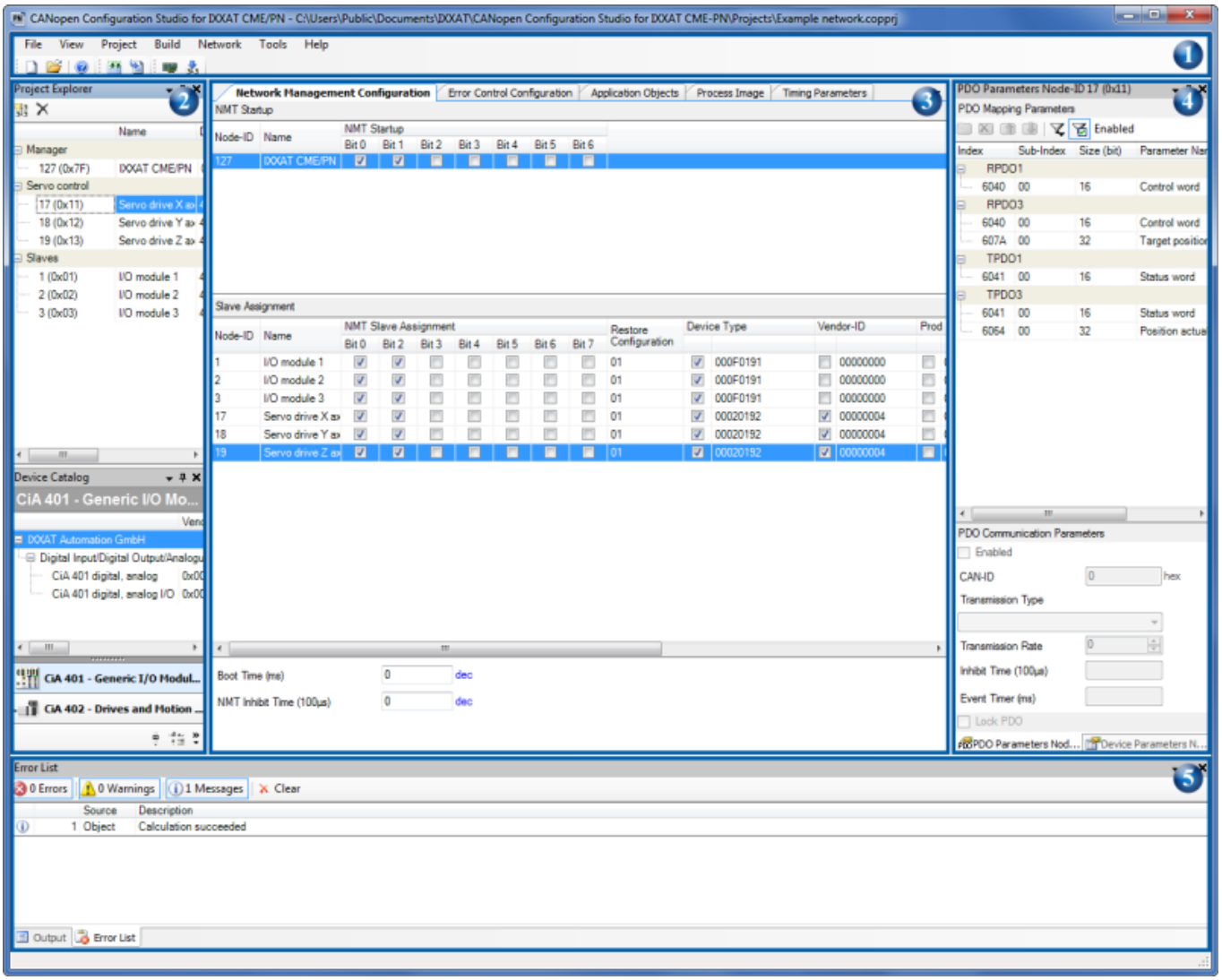
4 User Interface

The initial user interface layout of the CANopen Configuration Studio for IXXAT CME/PN main application window is shown below. The design of the user interface is similar to typical development environments, allowing for a quick familiarization with the application. Main elements of the user interface are tool windows for network definition and device specific configuration tasks and a central workspace within which most of the CANopen manager and network configuration is performed.

The user interface layout is fully customizable but may be restored to its default settings at any time.



CANopen Configuration Studio for IXXAT CME/PN main application window

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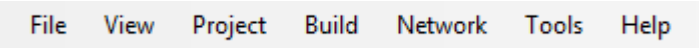
The main application window of CANopen Configuration Studio for IXXAT CME/PN is subdivided into the following main regions:

1. Menu system and toolbars.
2. CANopen network topology definition and device catalog browser.
3. Main workspace for CANopen manager configuration. Contains windows and controls for parameterization of NMT startup and NMT slave assignment objects (see CiA 302-2), NMT error control, and to select application objects to be mapped into the process image on the CANopen manager. The timing parameters page allows to configure both PROFINET cycle time and CANopen bit timing parameters.
4. Device specific parameterization tool windows. Supports additional PDO configuration. Also gives access to all device parameters that are not related to the configuration tasks performed in the main workspace windows.
5. Output tool windows containing error, warning, and status messages.

4.1 Menu System and Toolbars

The menu system and the toolbars contain a set of menu items with commands required to generate new projects, calculate I/O connections, generate and download configuration data. The menu system supports navigation via mouse pointer, keyboard shortcuts and accelerators or the cursor. For a complete list of the menu system see the tables below.

Main Menu



Standard Toolbar

Build Toolbar

Network Toolbar

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Menu Description

File (keyboard accelerator: Alt+F)

The File menu contains commands related to the CANopen project (new, open, and close project, and save project with different name).

Icon	Command	Keyboard shortcut	Keyboard accelerator
	New	Ctrl+N	Alt+F, N
	Open	Ctrl+O	Alt+F, O
	Close		
	Save As		Alt+F, A
	Recent Projects		Alt+F, R
	Exit		Alt+F, x

View (keyboard accelerator: Alt+V)

Commands for activating tool windows or workspace pages. Additionally a menu item allowing to restore the default tool window and workspace layout is available.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Network Management Configuration		Alt+V, N
	Error Control Configuration		Alt+V, E
	Application Objects		Alt+V, A
	Process Image		Alt+V, P
	Timing Parameters		Alt+V, T
	Error List		Alt+V, L
	Output		Alt+V, O
	Project Explorer		Alt+V, x
	Device Catalog		Alt+V, D
	Device Parameters		Alt+V, P
	PDO Parameters		Alt+V, P
	Restore Default Layout		Alt+V, R

Project (keyboard accelerator: Alt+P)

Contains only one menu item that opens the project properties workspace page.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Properties		Alt+P, P

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Build (keyboard accelerator: Alt+B)

The Build menu contains commands to calculate PDO connections and device specific configuration data. The calculation process can be repeated iteratively before a file with the configuration data is generated that shall be downloaded to the IXXAT CME/PN.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Calculate Configuration	F5	Alt+B, C
	Generate Configuration	F6	Alt+B, G

Network (keyboard accelerator: Alt+N)

Pop-up menu containing commands to select and configure the download link to the IXXAT CME/PN. A dialog allows to select any one of the IXXAT CME/PN gateway devices connected via USB to the host PC running CANopen Configuration Studio for IXXAT CME/PN.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Interface Configuration		Alt+N, C
	Download	F7	Alt+N, D

Tools (keyboard accelerator: Alt+T)

The Tools menu contains commands to open the device catalog management dialog and to set general options of CANopen Configuration Studio for IXXAT CME/PN.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Manage Catalog		Alt+T, M
	Options		Alt+T, O

Help (keyboard accelerator: Alt+H)

The Help menu gives access to online documentation. The technical support menu item contains a link to the support section on http://www.ixxat.com/.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	View Help		Alt+H, V
	Technical Support		Alt+H, T
	About CANopen Configuration Studio for IXXAT CME/PN		

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4.2 Tool Windows

CANopen Configuration Studio for IXXAT CME/PN implements tool windows for network definition and device specific configuration tasks. Tool windows are used to compose a CANopen network based on predefined entries in a device catalog. Tool windows are also available to set device specific parameters such as default values for output parameters, or to explicitly manipulate the PDO configuration for a selected device. Additionally output and error windows are available to inform the user on the result of a configuration calculation or errors occurred during the calculation.

For detailed information on the tool windows see the following sections:

Icon	Name	Description
	Project Explorer	Definition of CANopen devices available in the network.
	Device Catalog	Pre-configured catalog of CANopen devices.
	PDO Parameters	Explicit configuration of PDO communication and mapping parameters.
	Device Parameters	Direct configuration of device parameter that are not configured by either the PDO parameters tool window or via the automated calculation of configuration data based on the workspace tab page input settings.

	Output	Tool window containing textual status and error information generated by CANopen Configuration Studio for IXXAT CME/PN. By default auto-hide is enabled and the window is in hidden state at the bottom of the main application window. The Output tool window will become visible as soon as CANopen Configuration Studio generates new output information.
	Error List	The information in the Error List tool window is identical to the Output tool window, however the Error List tool window supports selective filtering for errors, warnings, or messages.

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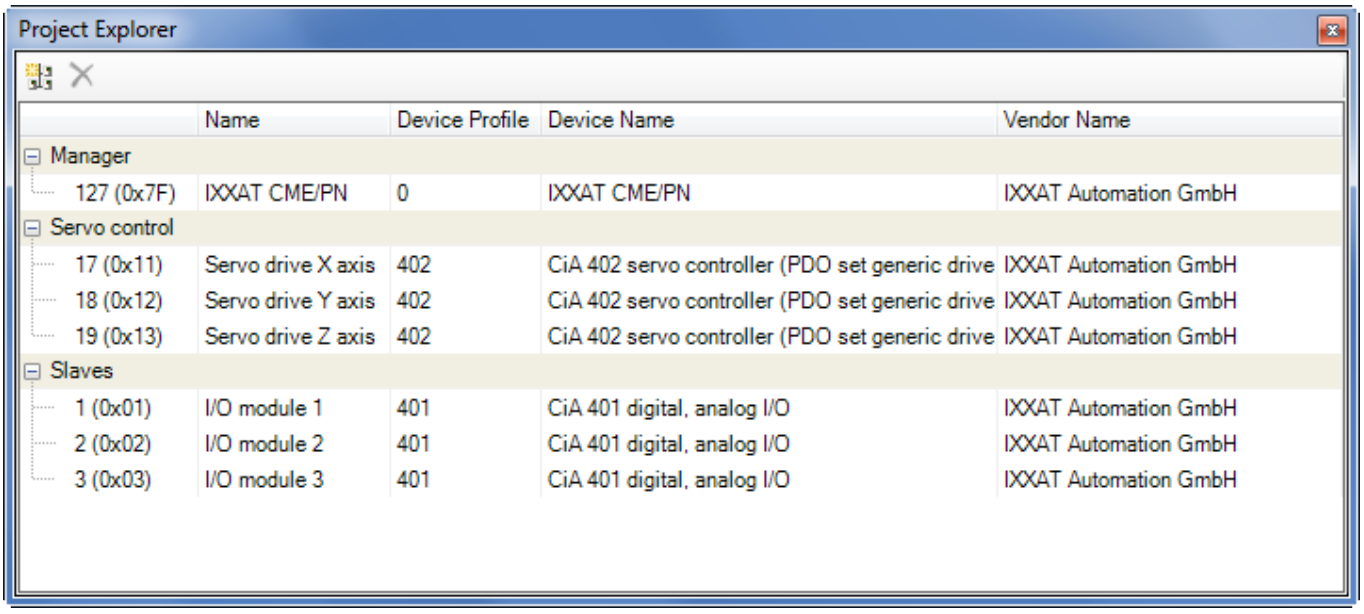
4.2.1 Project Explorer

The Project Explorer tool window lists all devices that are added to the current CANopen Configuration Studio project.



CANopen Configuration Studio for IXXAT CME/PN Project Explorer tool window

Devices are organized in user definable device groups with subordinate device trees. Within these groups, devices are sorted by their node-ID. For a not yet populated project, a Manager group containing the IXXAT CME/PN and one Slaves group for CANopen slave devices are created by default. The Slaves group may be renamed by the user to match specific project requirements. Additional groups may be created by the user to improve the structuring of the project. See the topic on device groups for more information.

> Device groups is a concept introduced to organize devices in a project according to their function. Device groups are not part of the CANopen specifications, but help understanding the logical structuring of a CANopen project. Device groups are not related in any way to the actual connection of the devices to the physical CAN network.

For each device within the network configuration, the project explorer lists the following summary information that is retrieved from the device description data (EDS). If the corresponding entries are not available in the device description files, the columns entries will be left empty.

Column	Description
	Node-ID of the device within a group. The node-ID is displayed both in decimal and hexadecimal notation.
Name	Logical device name, to be provided by the user.
Device Profile	Device profile number extracted from the lower 16 bits of object 1000_h.
Device Name	Manufacturer device name extracted from object 1008_h, if available.
Vendor Name	Name of device vendor, uses the `[VendorName]` keyword in the `[DeviceInfo]` section of the device description file for the device. Alternatively the content of object 1018_h sub-index 01_h `Vendor-ID` is used and matched against an internal reference list of device vendor names.

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Toolbar

The project explorer toolbar implements global commands with respect to the CANopen topology of the network:

Icon	Description
	Opens the Add Group dialog. The user is required to enter a name for the new device group. Optionally the user may enter a textual description for the device group.
	Removes the selected device or group from the project data. Note that a group cannot be removed as long as it contains any device. The Manager group containing the IXXAT CME/PN gateway device can neither be removed nor renamed.

Context Menu

The context menu in the project explorer offers the following menu options:

Command	Description
Add Group	Adds a new group to the project. In addition to the group name the Add Group dialog allows the entering of a textual description of the group. Please refer to the description above of device groups in CANopen.
Remove	Removes the selected device or group from the project data. Note that a group cannot be removed as long as it contains any device. The Manager group containing the IXXAT CME/PN gateway device can neither be removed nor renamed.
Properties	Shows either the device or the group properties dialog. The dialogs are identical to the Add Device, respectively Add Group dialogs and allow to review or alter the device or group properties including, in case of the Device Properties dialog, the devices node-ID or the group membership.
Collapse All	Collapses all groups such that only the group headers are visible.
Expand All	Expands all groups such that all devices in the project are visible below the group headers.

4.2.1.1 Device and Group Properties

Devices are added to a project via a drag & drop operation from the Device Catalog to the Project Explorer tool window. On this operation the Add New Device dialog is displayed allowing to enter both required and optional parameters and in addition displays basic device identification information.

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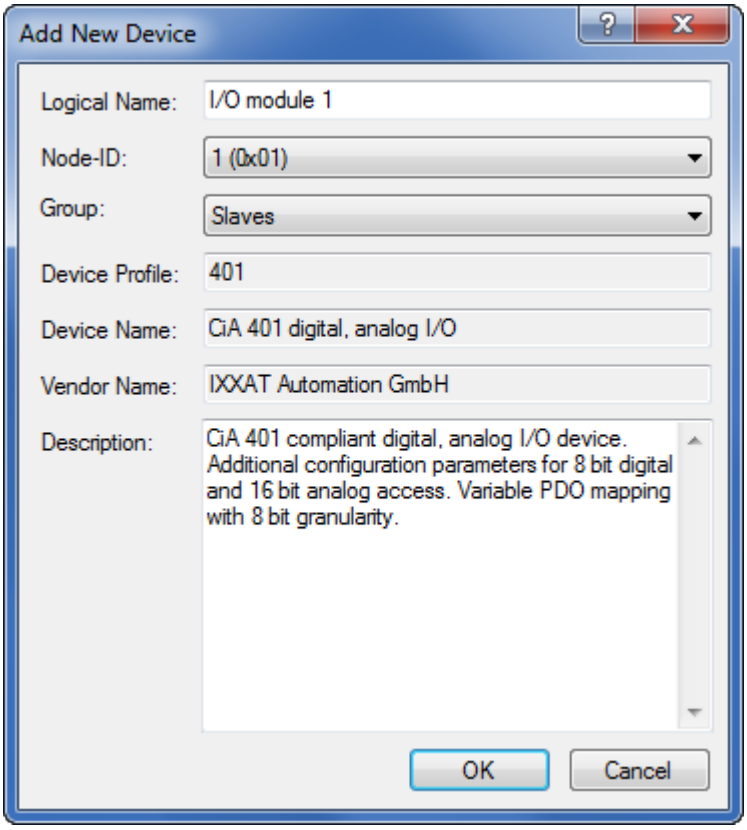

Add New Device dialog

Parameter	Category	Description
Logical Name	required input	Logical device name, to be provided by the user.
Node-ID	required input	Node-ID of the device within a group. The node-ID is displayed both in decimal and hexadecimal notation.
Group	required input	Logical device group, used to structure the project.
Device Profile	information	Device profile number extracted from the lower 16 bits of object 1000_h.
Device Name	information	Manufacturer device name extracted from object 1008_h, if available.
Vendor Name	information	Name of device vendor, uses the `[VendorName]` keyword in the `[DeviceInfo]` section of the device description file for the device. Alternatively the content of object 1018_h sub-index 01_h `Vendor-ID` is used and matched against an internal reference list of device vendor names.
Description	optional input	Textual description of the device. Typically the application functionality as defined by the system integrator is entered here.

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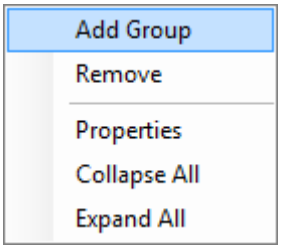
Device Groups

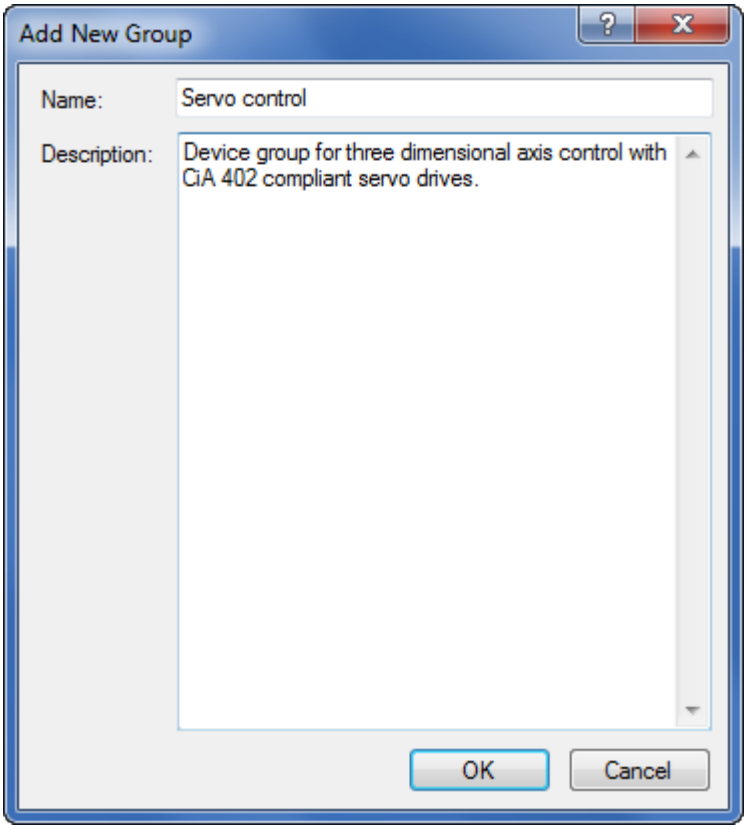
CANopen Configuration Studio for IXXAT CME/PN supports structuring CANopen devices in the network in logical groups. This concept is not described within the CANopen specifications but allows to render the project itself more clearly.

To add a new logical group to the project select the Add Group menu item in the context menu of the Project Explorer tool window.



Project Explorer context menu

This opens a dialog that allows to enter a name for the new group and a corresponding textual description.



Add New Group dialog

Both device and group properties can be modified after they have been added to the project using the corresponding Device Properties and Group Properties dialogs.

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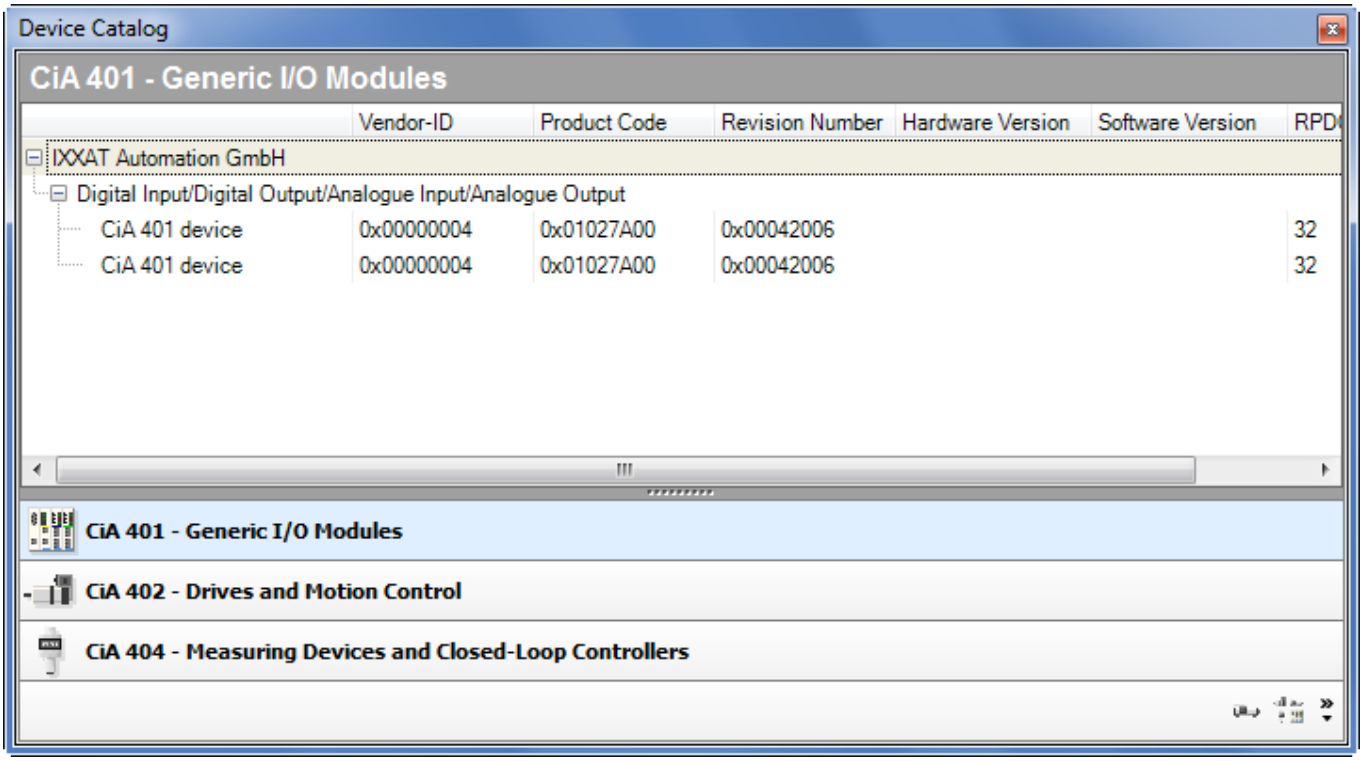
4.2.2 Device Catalog

The Device Catalog tool window lists all device descriptions currently added to a device catalog database. Internally CANopen Configuration Studio for IXXAT CME/PN implements two separate catalog databases, a core catalog than cannot be changed by the user, and a user catalog to which a user may add or from which the user may remove devices.

The Device Catalog tool window allows only for browsing the catalog contents, to add or remove particular devices to the catalog, use the Device Catalog Management dialog.

The Device Catalog tool window uses navigation panes to categorize the individual devices according to their CiA device profile.



Device Catalog Browser

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Within the individual navigation panes, the following information is displayed if it is available in the electronic data sheet for the device. If the data cannot be extracted from the device data, the corresponding column is left empty.

Column	Description
	Multi-purpose column that contains the vendor name, a textual description of the additional information field in 1000_h `Device type`, or, alternatively, the manufacturer device name in object 1008_h.
Vendor-ID	Vendor-ID as assigned by CAN in Automation, contained in object 1018_h sub-index 01_h.
Product Code	Manufacturer specific product code, contained in object 1018_h sub-index 02_h.
Revision Number	Manufacturer specific revision number, contained in object 1018_h sub-index 03_h.
Hardware Version	Hardware version as contained in the electronic data sheet for the device. The value presented in the list is extracted from object 1009_h `Manufacturer hardware version`.
Software Version	Software version as contained in the electronic data sheet for the device. The value presented in the list is extracted from object $100A_h$ `Manufacturer software version`.
RPDOs	Number of receive PDOs supported by the device.
TPDOs	Number of transmit PDOs supported by the device.

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4.2.2.1 Device Catalog Navigation

Devices are listed in navigation bar panels, with one individual pane for each device profile. To further categorize the devices contained in the device catalog CANopen Configuration Studio for IXXAT CME/PN interprets the Additional information field in object 1000_h `Device type`. Please consult the corresponding device profile specifications available from CAN in Automation for further information on object 1000_h.

The core catalog is pre-configured to contain the device description for the IXXAT CME/PN in NMT master mode. This catalog is locked against modification by the user.

The user catalog is pre-populated with device description information for selected CiA device profiles, for details see the table below. If device description information is included in the user catalog a short description of the corresponding devices functionality is included below the description of the navigation pane. The corresponding EDS files have been created on the basis of the device profile specifications available from CAN in Automation. They do not represent any existing commercially available device, they are only intended to demonstrate typical functionality of the corresponding device profile. During installation the EDS file are copied into the `C:\Users\Public\Documents\IXXAT\CANopen Configuration Studio for IXXAT CME-PN \EDS` on Microsoft Windows 7 systems. See also the information in the First Steps section on the installation directories.

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Icon	Description
	CiA 401, CANopen device profile for generic I/O modules CiA 401 device: Device description for generic I/O module with digital and analog input and output, additional device parameters such as polarity and trigger ranges. CiA 401 device (Group messaging): Device description for generic I/O module with digital and analog input and output, additional device parameters such as polarity and trigger ranges. Additional support for scanner and dispatcher list (SAM-MPDO).
	CiA 402, CANopen device profile for drives and motion control CiA 402 frequency converter (PDO set for frequency converter): Generic objects for power drive system control, with support for velocity and profile torque mode.PDO set for frequency converter according to CiA 402-3 V3.0. CiA 402 servo controller (PDO set for servo drive): Generic objects for power drive system control with support for profile position mode, interpolated position mode, profile velocity and homing mode. PDO set for servo drive according to CiA 402-3 V3.0. CiA 402 servo controller (PDO set for generic drive device): Generic objects for power drive system control with support for profile position mode, interpolated position mode, profile velocity, and homing mode. PDO set for generic drive device according to CiA 402-3 V3.0.
	CiA 404, CANopen device profile for measuring devices and closed-loop controllers CiA 404 device: Device description for CiA 404 compliant digital I/O, analog input device with variable PDO mapping, granularity 8 bit. Alarm function block with 2 alarms per channel supported.
	CiA 405, CANopen interface and device profile for IEC 61131-3 programmable devices The corresponding specification has been withdrawn by CiA and its contents has been moved to other CiA documents. The navigation pane is maintained as a container for legacy devices.
	CiA 406, CANopen device profile for encoders CiA 406 device: Encoder class C3, standard and high resolution parameters. Constant PDO mapping for TPDO1 to TPDO3, variable PDO mapping for TPDO4, granularity 8 bit.
	CiA 408, CANopen profile for fluid power technology proportional valves and hydrostatic transmissions
	CiA 410, CANopen device profile for inclinometer
	Devices that do follow a standard CiA device profile or implement a profile for which no specific navigation bar pane is implemented

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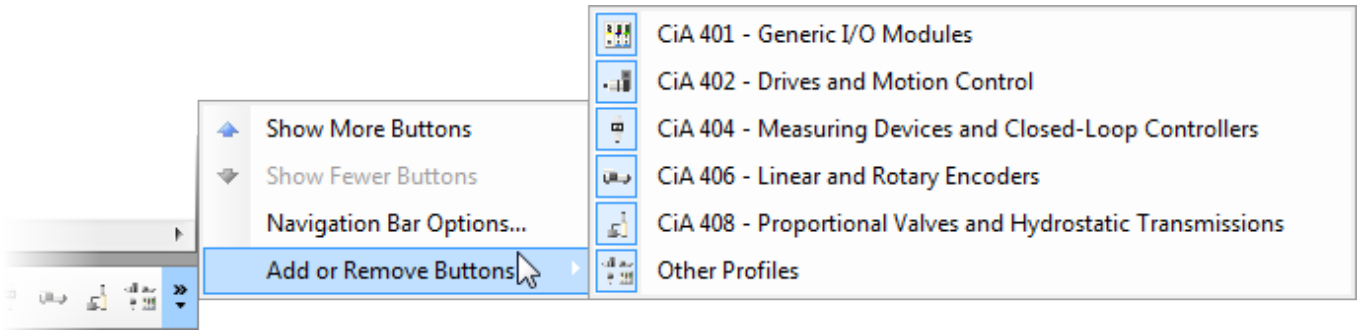
4.2.2.2 Customizing the Device Catalog Appearance

The Device Catalog tool window displays only those device profile navigation panes that are populated with matching CANopen slave device descriptions. Furthermore the navigation bar allows for user customization of which panes are shown, and in which sequence those panes are displayed via a context menu.

Context Menu



Navigation bar context menu

Icon	Command	Description
	Show More Buttons	Use this command to show more navigation panes in the device catalog tool window.
	Show Fewer Buttons	Use this command to show fewer navigation panes in the device catalog tool window.
	Navigation Bar Options...	Use this command to display the Navigation Bar Options dialog, in which you can either selectively enable or disable device profile navigation panes. You may also change the sequence in which the navigation panes are shown. Note that the sequence of navigation panes is not persisted when CANopen Configuration Studio for IXXAT CME/PN is closed. After the next restart the navigation bar will assume the default settings.
	Add or Remove Buttons	Displays a submenu to selectively enable or disable device profile navigation panes.

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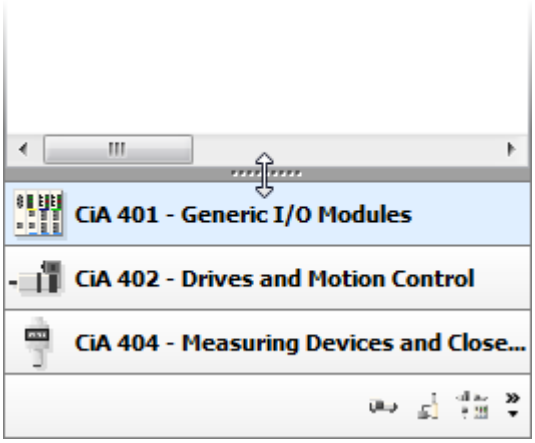
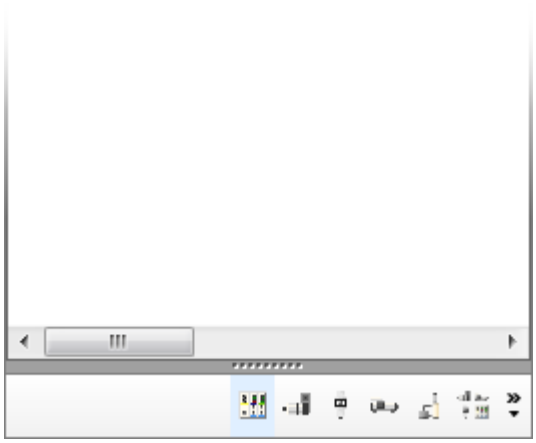
Adjusting the Navigation Bar Panes

Depending on the number of device profiles for which devices have been added to the device catalog, profile panes are moved to an overflow tray. To reserve more space in the device tree view, navigation panes may be moved to the overflow tray area at the bottom of the navigation bar control. Move the mouse pointer over the splitter bar until it changes to the arrow icon ↕, then drag the splitter bar either up or down to desired position to either increase or decrease the number of visible navigation panes.



Navigation panes visible



Navigation panes collapsed to overflow tray

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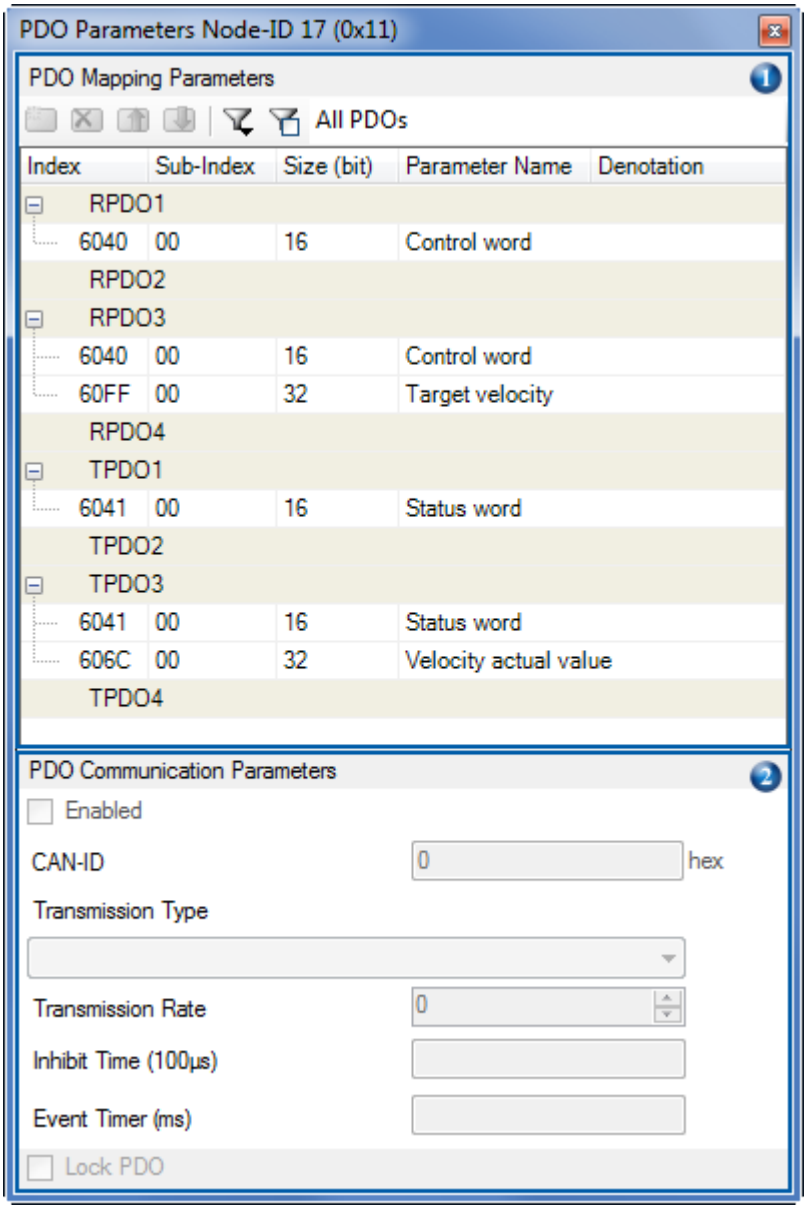
4.2.3 PDO Parameters

The PDO Parameters tool window allows direct editing of PDO communication and mapping parameters. This functionality is restricted to CANopen slave devices as the PDOs of the CANopen manager are configured indirectly via the Application Objects workspace page.

The PDO Parameters tool window is divided into two sections of control elements: one region (1) that lists all PDOs implemented by the device currently selected in the Project Explorer and the objects that are mapped onto these PDOs, and a second region (2) that allows the configuration of PDO communication parameters of the PDO currently selected in the upper region.



PDO Parameters tool window

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PDO Mapping Parameters

The PDO mapping parameters section lists all PDOs implemented by the selected CANopen device. For each of these PDOs, the transmission direction and additional status information is displayed in the header of the PDO. All currently mapped application objects are indicated below the root element of the PDO. The PDO header may be decorated by additional icons that are explained below:

Icon	Description
	The PDO has static mapping. The PDO mapping records are predefined in the device's object dictionary and are read-only, thus the PDO mapping cannot be changed. The user may modify the PDO communication parameters. To prevent the automatic PDO calculation from altering the user-selected communication parameter configuration, the PDO has to be locked (see below) before the calculation process.
	The current PDO configuration is locked and neither PDO mapping parameters nor PDO communication parameters can be changed by the user. The automatic PDO mapping and linking calculation will not affect the current configuration. To re-enable the configuration options, uncheck the Lock PDO check mark in the PDO communication parameters section.
	The PDO has static mapping. In addition the PDO is locked, which implies that the PDO communication parameter cannot be modified.
No icon	The PDO has variable PDO mapping, and thus may be modified by the user. To prevent the automatic mapping calculation from altering either the mapping or the communication parameters configuration, the PDO has to be locked by the user.

Toolbar and Context Menu

The toolbar and the context menu of the PDO list implement commands that may be used to change the PDO mapping configuration of the PDOs implemented by the selected CANopen device. By means of the available commands, additional application objects may be added to the PDO, objects may be removed from the mapping tables, or the sequence in which the objects are mapped onto the PDO may be modified. If a command is not available for the selected PDO or object the corresponding toolbar button and context menu item are disabled.

Icon	Context menu item	Description
	Add Object	Adds a new application object to the mapping table of the selected PDO.
	Remove Object	Removes the selected application object from the mapping table of the PDO.
	Move Up	Move the selected application object up in the PDO mapping table.
	Move Down	Move the selected application object down in the PDO mapping table.
	Collapse All	Move the selected application object down in the PDO mapping table.
	Expand All	Expands all PDOs such that all mapped application objects are visible below the PDO header.

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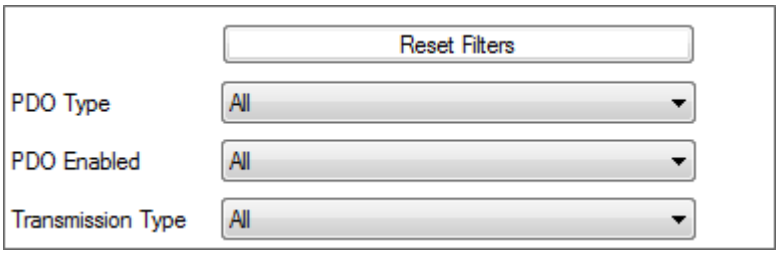
The display style of the PDO list may be adjusted to display only those PDOs that match certain filter criteria. To display or hide the filter options, click the PDO filter icons (,). The following filter options are available via combo box controls.



Selection of PDO filters via drop down menus

To activate or deactivate the PDO filter, click the toggle PDO filter button ( ) in the toolbar of the PDO mapping list. The current filter settings are display in the toolbar of the PDO list.

Filter	Description	
PDO Type	All	If the PDO filter is active, all PDOs that match the other filter criteria are visible in the PDO list.
	RPDO	If the PDO filter is active, only receive PDOs that match the other filter criteria are visible in the PDO list.
	TPDO	If the PDO filter is active, only transmit PDOs that match the other filter criteria are visible in the PDO list.
PDO Enabled	All	If the PDO filter is active, all PDOs that match the other filter criteria, are visible in the PDO list.
	Yes	If the PDO filter is active, only PDOs that are enabled and for which the other filter criteria are valid are visible in the PDO list. Enabled means that bit 31 in the COB-ID parameter of the PDO communication parameter record is set to 0.
	No	If the PDO filter is active, only PDOs that are disabled and for which the other filter criteria, are valid are visible in the PDO list. Disabled means that bit 31 in the COB-ID parameter of the PDO communication parameter record is set to 1
Transmission Type	All	If the PDO filter is active, all PDOs for which the other filter criteria are valid are visible in the PDO list.
	Event-driven	If the PDO filter is active, only event-driven PDOs are visible in the PDO list, provided they match the other filter criteria.
	Synchronous	If the PDO filter is active, only event-driven PDOs are visible in the PDO list, provided they match the other filter criteria.

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For each mapped application object the following information is available:

Column	Description
Index	Main-index of the application object in the CANopen devices object dictionary.
Sub-index	Sub-index of the application object in the CANopen devices object dictionary.
Size (bit)	Length of the application object in bits.
Parameter Name	Name of the application object as extracted from the `[ParameterName]` keyword in the electronic data sheet of the device.
Denotation	User assigned alternative object name as entered in the Denotation column of the Application Objects workspace page.

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PDO Communication Parameters

The lower section of the PDO list tool window contains the PDO communication parameters. All values that are shown in this section refer to the PDO currently selected in the PDO list in the upper section of the tool window. For each PDO the following communication parameters may be configured:

Communication Parameter	Description
Enabled	Checkbox that allows to activate (checkbox is checked) or deactivate (checkbox is unchecked) the PDO. This functionality corresponds to bit 31 in the COB-ID parameter of the PDO communication parameter structure (sub-index 01_h).
CAN-ID	CAN identifier used by this PDO in hexadecimal notation. ⚠ Note that the IXXAT CME/PN supports only 11 bit CAN-IDs. If it is attempted to enter values that exceed the supported CAN identifier range, an error icon is displayed to the right of the input field. When positioning the mouse pointer over the error icon detailed error information is available with a tooltip.
Transmission Type	Transmission type of the PDO. If the transmission type `Synchronous (cyclic)` is selected, the transmission rate may be further specified in the Transmission Rate numeric input control (see below).
Transmission Rate	Numeric input control to specify the transmission rate of the selected PDO. The control is only enabled if the transmission type `Synchronous (cyclic)` is set for the selected PDO.
Inhibit Time	Inhibit time for the selected PDO in multiples of 100 microseconds. If the value entered by the user exceeds the allowed value range an error icon is displayed to the right of the input field. When positioning the mouse pointer over the error icon detailed error information is available with a tooltip. The input field is disabled if the functionality is not supported by the selected PDO.
Event Timer	Event timer for the selected PDO in multiples of 1 millisecond. If the value entered by the user exceeds the allowed value range an error icon is displayed to the right of the input field. When positioning the mouse pointer over the error icon detailed error information is available with a tooltip. The input field is disabled if the functionality is not supported by the selected PDO.
Lock PDO	Checkbox to prevent the current PDO configuration from being modified by the PDO mapping calculator. If checked, the current PDO mapping, CAN-ID and transmission type of the PDO cannot be changed. If unchecked, the PDO mapping may be configured using the toolbar of the PDO list. For details on how to change the PDO mapping see the section on Configuring the PDO Mapping.

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4.2.3.1 Configuring the PDO Mapping

The mapping of application objects into the transmit and receive PDOs of a device can be changed using the commands available in the toolbar or the context menu. The user may add objects to a PDO, remove object from a PDO, or change the sequence in which the application objects appear within the PDO.

> To be able to modify the PDO mapping, the CANopen device has to support variable, or dynamic, PDO mapping. This implies that the object dictionary entries describing the PDO configuration have to support read-write access.

> Changes that a user has applied to the default PDO configuration, such as adding additional objects to the PDO mapping, will be overwritten by the object linker if the PDO is not locked.

Configuration Commands

Add a new Object to the PDO Mapping

To be able to add an object to the mapping tables of a PDO, adequate space has to be available to allow for the additional object without exceeding the maximum data length of a CAN frame (8 bytes). As the IXXAT CME/PN supports only byte granularity for PDOs, Boolean objects cannot be mapped onto a PDO. By default, new application objects are added at the end of the mapping table. Use the Move Up or Move Down commands to change the mapping sequence if required.

To add an application object to a PDO, select the PDO first. Clicking the toolbar button () or selecting the context menu item over the PDO header line will open the Object List dialog that allows to add one or multiple objects from a list of application objects which have the PDO mapping attribute set to true. The Object List dialog will display only those objects for which the input/output direction matches the selected PDO. For example, a read-only object cannot be mapped onto a receive PDO.

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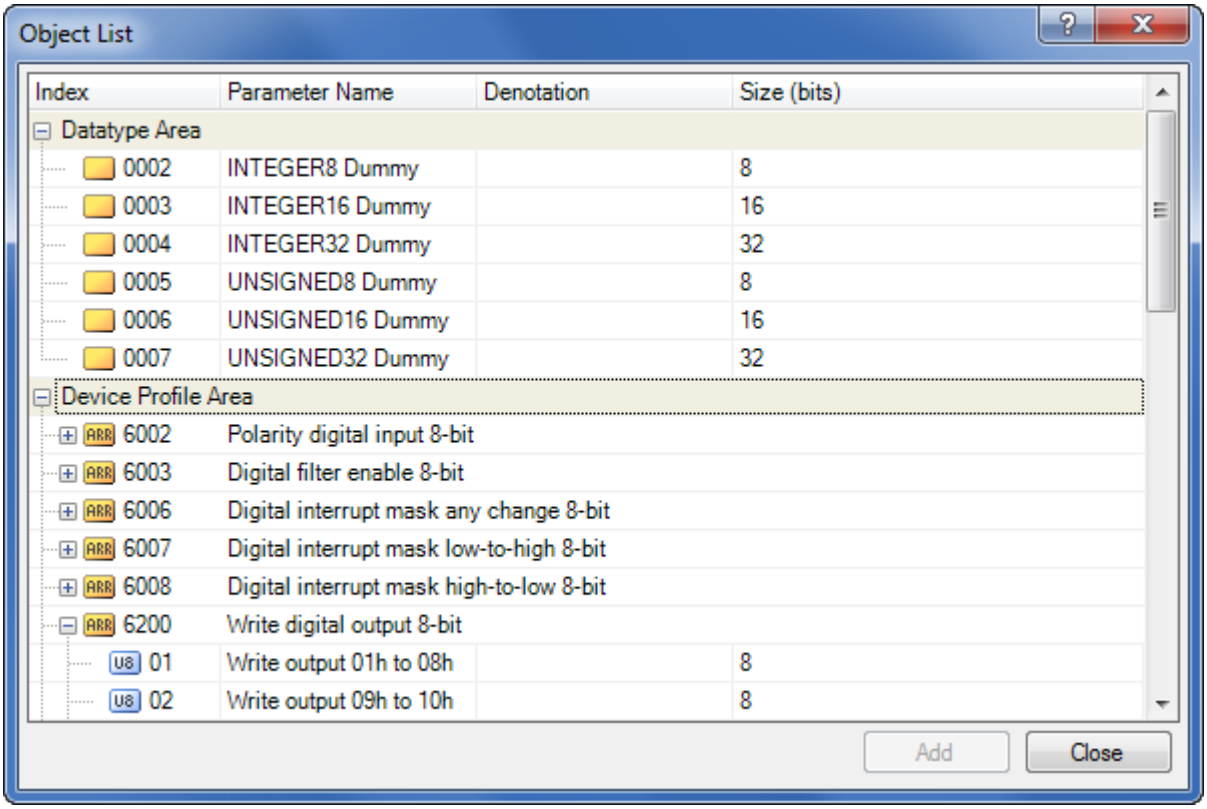

Object List dialog

Remove one Application Object from the PDO Mapping

To remove an application object from the PDO mapping tables, select the object in the PDO list and click either the Remove Object toolbar button ( ) or select the corresponding context menu item.

Reorder Objects in the PDO Mapping Table

To change the sequence with which application objects are transmitted within a PDO message, select a single object and click either the Move Up ( ) or Move Down ( ) toolbar buttons or select the corresponding menu items in the context menu of the PDO list.

> ⚠ Changes to the PDO mapping affect only the currently selected PDO. Connected PDOs on other devices are not automatically modified and need to be correspondingly changed by the user.

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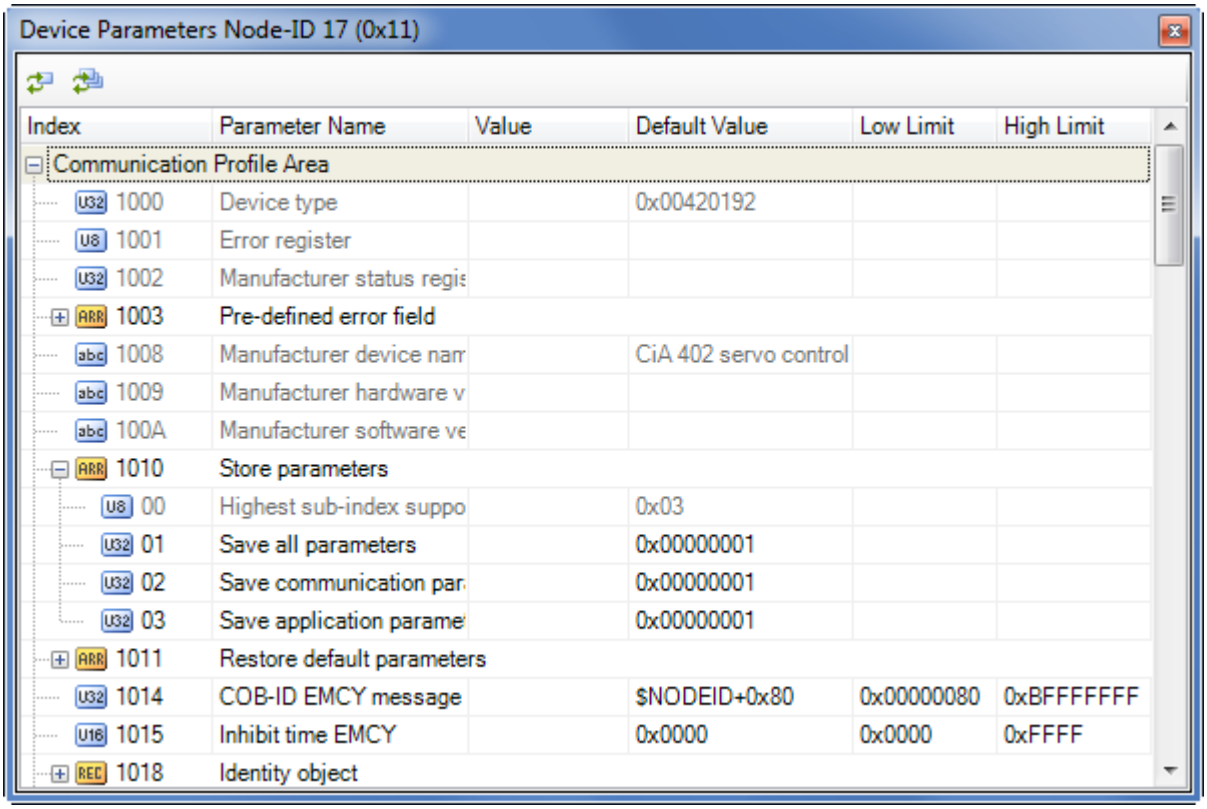
4.2.4 Device Parameters

The Device Parameters tool window provides access to parameter objects of the CANopen device that is currently selected in the Project Explorer tool window. Parameter objects may be additionally mapped onto PDO messages, depending on the PDO mapping attribute declared in the electronic data sheet (EDS) of the device. Output parameters, for example, may require specific initialization with an alternative parameter value instead of the default value during network startup.



Device Parameters tool window

Object List

The object list is populated with object information extracted from the device catalog information for the selected device. Within the list, objects are grouped according to their object dictionary area (communication, manufacturer, and device standardized device or application profile area), and for complex objects, the index. For each object, the following information is available:

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Column	Description
Index	Index and sub-index of the parameter in the object dictionary of the CANopen device. Sub-indices for complex objects such as arrays or records are listed in a tree structure attached to the main object. In addition to index and sub-index, this column contains an icon indicating the CANopen data type of the parameter object. Objects that are read only or may not be configured within the Device Parameters tool window are disabled (gray text).
Parameter Name	Name of the object entry as declared in the `[ParameterName]` keyword in the device description file.
Value	Configured value of the parameter object. The value may be changed within the limits indicated in the low limit and high limit columns. To change a parameter value, double click into the cell, enter the new value, and hit <return> when finished. The new value is verified against the permitted value range as indicated by the low and high limit columns.
Default Value	Default value of the parameter as declared in the `[DefaultValue]` keyword in the device description file. The default value is reapplied if either an individual or all parameter objects are reset using one of the toolbar buttons.
Low Limit	Minimum value for the parameter object, if available. The field uses the value declared by the `[LowLimit]` keyword in the EDS file.
High Limit	Maximum value for the parameter object, if available. The field uses the value declared by the `[HighLimit]` keyword in the EDS file.

Resetting a single Object or all Objects to their Default Values

Icon	Description
	Resets the selected parameter object to its default value as declared in the electronic data sheet (EDS).
	Resets all parameter objects on the selected device to their default values as declared in the electronic data sheet (EDS).

Context Menu

The context menu in the object list offers the following menu options:

Command	Description
Collapse All	Collapses all profile areas and complex objects such that only the headers of the object dictionary profile areas are visible
Expand All	Expands all objects such that all object entries and sub-entries are visible below the object dictionary profile area's headers.

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4.3 Workspace Pages

CANopen Configuration Studio for IXXAT CME/PN uses workspace pages for network wide configuration tasks. Workspace pages are used to configure the network management functionality of the managing device. Also the NMT error control dependencies between the devices of the network are configured by a workspace page. Additionally the process data are configured in this area, including the selection of mapped application objects and inspection of the created process image on the managing device.

For detailed information on the workspace pages see the following sections.

Icon	Name	Description
	Network Management Configuration	Configuration of the network management functionality.
	Error Control Configuration	Definition of the NMT error control dependencies of the devices providing heartbeat and/or node guarding.
	Application Objects	Configuration of the objects that shall be mapped to the managers process image.
	Process Image	Additional information about the created process image. Also contains some options to fine-tune the process image.
	Timing Parameters	Configuration of PROFINET and CANopen timing parameters.

	Properties	Basic project information such as project path, project author and creation, respectively modification dates. Allows also to enter a short textual description of the project. This page is not displayed by default. See menu system and toolbars on how to activate the properties page.

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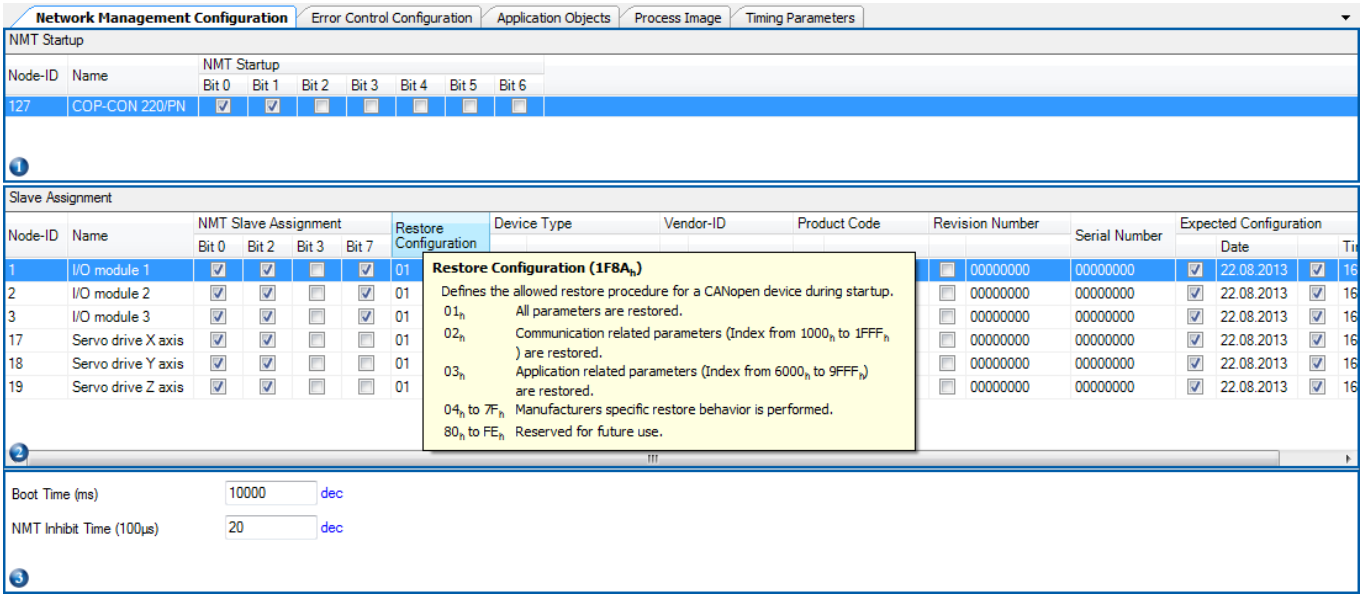
4.3.1 Network Management Configuration

The network management page supports configuration of the NMT functionality of the managing device.



Network Management Configuration

The network management configuration page is subdivided into three main regions explained in detail below. In all regions extensive tool tips provide direct help detailing the configuration settings for individual bit or the value range of the corresponding CANopen objects.

1. NMT Startup configuration
2. Slave Assignment configuration
3. Additional CANopen manager objects

NMT Startup Configuration

The NMT startup configuration specifies the behavior of managing and self-starting devices in the network. The configuration corresponds to object `1F80h NMT startup` of these devices. All bits except bit 0 `NMT master` may be configured. Bit 0 is read-only as the active manager can not be changed after the project was created.

Column	Description
Node-ID	Node-ID of the device in decimal notation.
Name	Logical device name, to be provided by the user.
NMT Startup	Gives access to the individual bits of object $1F80_h$ `NMT startup` for each device in the network implementing this object.

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$1F80_h$ NMT Startup Bit Description

Bit Number	Name	Description
0	NMT master (read-only)	0 = CANopen device is not NMT master.
		1 = CANopen device is the NMT master.
1	Start all nodes	0 = NMT service start remote node for each node-ID.
		1 = NMT service start remote node with node-ID = 0.
2	NMT master start	0 = Shall switch into NMT state Operational in the process NMT startup.
		1 = Shall not switch into the NMT state Operational by itself.
3	Start node	0 = The NMT master shall start the NMT slaves.
		1 = The NMT master shall not start the NMT slaves and the application may start the NMT slaves.
4	Reset all nodes	0 = In case of error control event of a CANopen device defined as mandatory the NMT service reset node with node-ID of the CANopen device that caused the error control event shall be executed.
		1 = In case of error control event of a CANopen device defined as mandatory the NMT service reset node with node-ID = 0 shall be executed.
5	Flying master	0 = CANopen device shall not participate the NMT flying master negotiation.
		1 = CANopen device shall participate the NMT flying master negotiation. ⚠ Note that NMT flying master functionality is not supported by the IXXAT CME/PN gateway.
6	Stop all nodes	0 = In case of error control event of a CANopen device defined as mandatory the action as defined by bit 4 shall be executed.
		1 = In case of error control event of a CANopen device defined as mandatory the NMT service Stop remote node with node-ID = 0 shall be executed. Bit 4 shall be ignored.

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Slave Assignment Configuration

The slave assignment configuration specifies how the manager will treat its slave devices. Most options are related to network startup and configuration verification which also takes place during startup.

Column	Description
Node-ID	Node-ID of the device in decimal notation.
Name	Logical device name, to be provided by the user.
NMT Slave Assignment	Configures the Configuration byte of object $1F81_h$ `NMT slave assignment` in the manager. `Retry factor` and `Guard time` bytes of object $1F81_h$ `NMT slave assignment` are configured on the Error Control page in the workspace.
Restore Configuration	Configuration of object $1F8A_h$ `Restore configuration` on the CANopen manager that defines the restore procedure for a CANopen device during startup.
Device Type	Contains the device type that shall be expected during the verification. Corresponds to object $1F84_h$ `Device type identification`. The checkbox activates the identification of the device type for the specific slave. The value for the device type is read from the EDS and can not be entered manually.
Vendor-ID	Contains the vendor-ID that shall be expected during verification. Corresponds to object $1F85_h$ `Vendor identification`. The check-box activates the identification of the vendor-ID for the specific slave. The value for the vendor-ID is read from the EDS and can not be entered manually.
Product Code	Contains the product code that shall be expected during verification. Corresponds to object $1F86_h$ `Product code`. The checkbox activates the identification of the product code for the specific slave. The value for the product code is read from the EDS and can not be entered manually.
Revision Number	Contains the revision number that shall be expected during verification. Corresponds to object $1F87_h$ `Revision number`. The checkbox activates the identification of the revision number for the specific slave. The value for the revision number is read from the EDS and can not be entered manually.
Serial Number	Contains the serial number that shall be expected during verification. Corresponds to object $1F88_h$ `Serial number`. The value is entered in hexadecimal format. All values other than 00000000_h activate the verification of the serial number.
Expected Configuration	Contains the expected date of the configuration of the device in the manager. Corresponds to objects $1F26_h$ `Expected configuration date` and $1F27_h$ `Expected configuration time`. The value cannot be entered manually. It is set from system time during configuration file generation. By means of the check boxes the mechanism may be deactivated.

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$1F81_h$ NMT Slave Assignment Bit Description (Byte 0 Configuration)

Bit Number	Name	Description
0	NMT slave	0 = NMT master or not available in the network.
		1 = NMT slave and available in the network.
2	NMT boot slave	0 = Configuration and NMT service Start remote node shall not be allowed in case of error control event or NMT service Boot-up. The application is responsible for the NMT slave startup.
		1 = Configuration and NMT service Start remote node shall be performed in case of error control event or NMT service Boot-up.
3	Mandatory	0 = CANopen device may be present prior to network startup (CANopen device is optional).
		1 = CANopen device shall be present prior to network startup (CANopen device is mandatory).
7	Restore	0 = CANopen device may be used without prior resetting.
		1 = CANopen device shall be reset to factory defaults by issuing a restore to defaults (object 1011_h).

$1F8A_h$ Restore Configuration Value Description

Value	Description
01_h	All parameters are restored.
02_h	Communication related parameters. All objects from index 1000_h to $1FFF_h$ are restored.
03_h	Application related parameters All objects from index 6000_h to $9FFF_h$ are restored.
04_h to $7F_h$	Manufacturer specific restore behavior is performed.
80_h to FE_h	Reserved for future use.

Additional Manager Objects

The active managing device supports additional objects used to configure the startup behavior.

Object $1F89_h$ Boot time defines the time out in milliseconds between start of the process Start process boot NMT slave and signaling of successful boot of all mandatory NMT slaves.

Object $102A_h$ `NMT Inhibit Time` specifies the configured inhibit time in units of 100µs between two subsequent NMT node control messages. Not yet transmitted NMT messages are queued and transmitted in order of their occurrence respecting the specified inhibit time.

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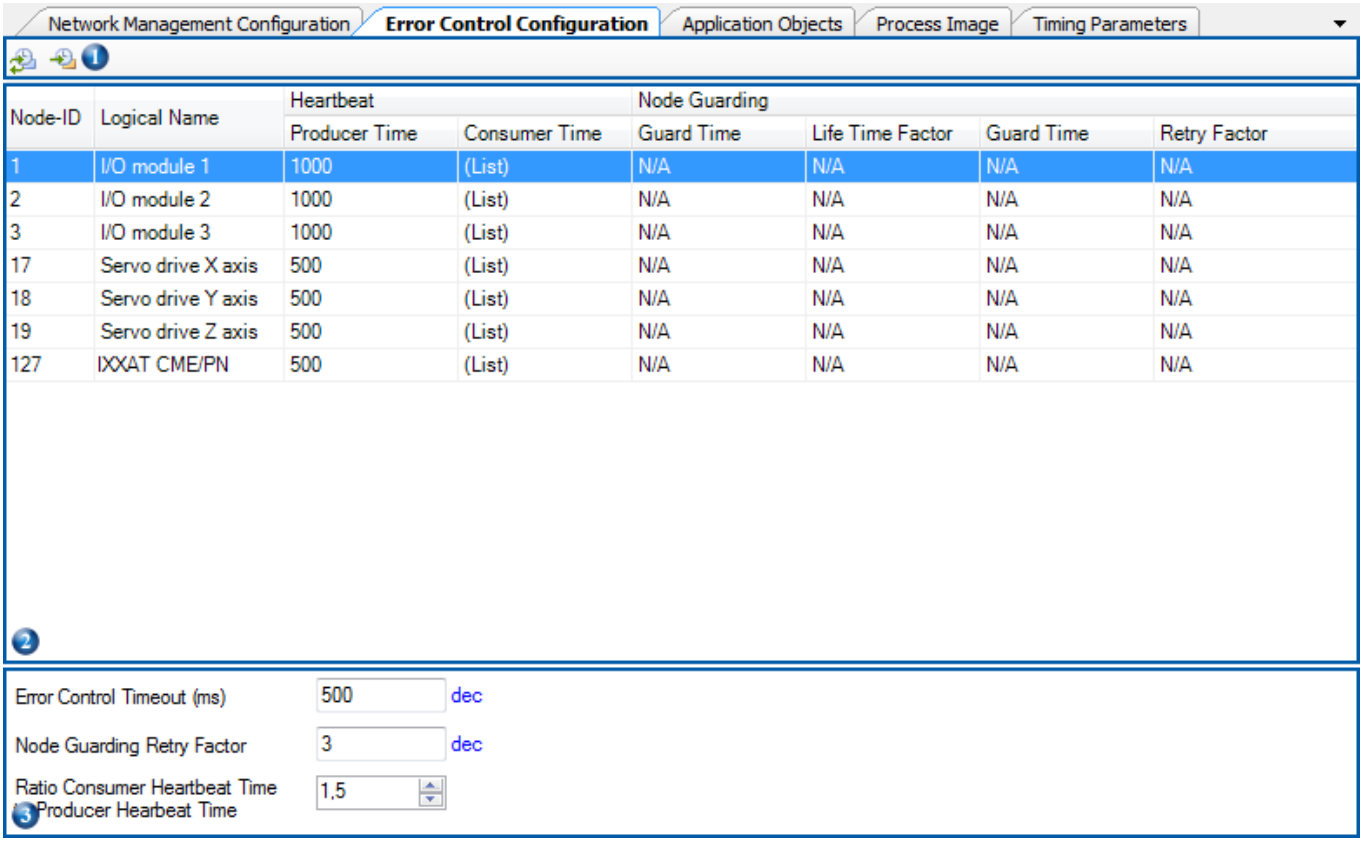
4.3.2 Error Control Configuration

The Error Control Configuration page implements user interface controls enabling the user to configure the NMT error control functionality and dependencies of the devices within the network. Depending on the functionality implemented by the devices, the configuration of either heartbeat or node guarding functionality is supported.



Error Control Configuration

The Error Control Configuration page is subdivided into the following main regions:

1. Toolbar
2. Error control configuration
3. Default values

Toolbar

The toolbar implements commands that perform global operations on the NMT error control parameters.

Icon	Description
	Resets all error control objects of the devices to the EDS defaults.
	Initializes all values in the error control objects of the devices to the values preset in the default values region in the lower part of the workspace page. If both heartbeat and node guarding are supported by a device, heartbeat is enabled and node guarding is disabled.

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Error Control Configuration

The error control list supports the parameterization of the individual error control objects implemented by the devices in the network. If a device does not support a particular functionality the corresponding entry will be marked as not available (N/A).

Column	Description
Node-ID	Node-ID of the device in decimal notation.
Logical Name	Logical device name, to be provided by the user.
Producer Heartbeat Time	Configures object 1017_h `Producer heartbeat time` of the selected CANopen device. The value is measured in milliseconds and defines the configured cycle time of the heartbeat message transmitted by the CANopen device. A value of 0 (zero) deactivates the transmission of the heartbeat message.
Consumer Heartbeat Time	Configures object 1016_h `Consumer heartbeat time` of the selected CANopen device. The value is specified in milliseconds and defines the expected heartbeat cycle times. The monitoring of a heartbeat producer will start with the reception of the first heartbeat transmitted by the CANopen device. As this entry may contain a different value for each monitored device a drop-down menu is available for detailed configuration of the consumer heartbeat times. The drop-down menu may be opened by clicking the ellipsis button (...) which appears if a cell is selected.
Guard Time (Slave)	Configures object $100C_h$ `Guard time` for the selected CANopen device. The value is specified in milliseconds and specifies the interval within which the slave expects a guarding request by the NMT master in order to consider it functional.
Life Time Factor	Configures object $100D_h$ `Life time factor` for the selected CANopen device. The value is specified in milliseconds. The value specifies how many successive times a missing guarding by the NMT master e will be tolerated before an error event is raised on the CANopen device.
Guard Time (Master)	Configures the `Guard time` field of object $1F81_h$ `NMT slave assignment`. The value is specified in milliseconds and configures the cycle time for the node guarding of the CANopen device.
Retry Factor	Configures the `Retry factor` field of object $1F81_h$ `NMT slave assignment`. The value specifies how many successive times a missing guarding response will be tolerated before the CANopen slave is considered unavailable.

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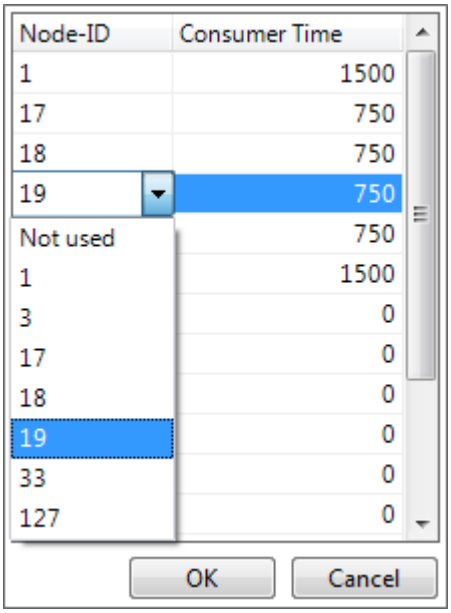
The CANopen specifications state that heartbeat and node guarding must not be concurrently used for the same device. Thus CANopen Configuration Studio for IXXAT CME/PN will require the user to deactivate one of the mechanisms if an entered value would cause both mechanisms to be activated.

The consumer heartbeat time(s) (object 1016_h) is configured in an extended context menu. The menu is opened by clicking the ellipsis button (...) which appears when the consumer heartbeat cell is selected. The list contains as many entries as supported by the selected device.



Configuration of Consumer heartbeat time

Column	Description
Node-ID	Contains the node-ID of a CANopen device that shall be monitored by the selected device. Entries containing the text string `Not used` are not active.
Consumer Time	Configures the consumer heartbeat time that shall be applied for the selected device. When a new device is added the initial value will be preset based on the values in the default section.

Default Values

The default values are used for configuration operations on the error control page.

The value entered in the Error Control Timeout field is used to preset object 1017_h `Producer heartbeat time` respectively object $100C_h$ `Guard time` on the CANopen slave. It is also used to set the `Guard time` field of the sub-index in object $1F81_h$ `NMT slave assignment` on the NMT master corresponding to the node-ID of the CANopen slave. If the Set command of the tool bar is executed the value is written to all devices as either producer heartbeat time or guard time. As CANopen specifies that only either heartbeat or node guarding may be used to monitor a CANopen device, CANopen Configuration Studio for IXXAT CME/PN will first configure the heartbeat functionality. Only if heartbeat is not supported by a device CANopen Configuration Studio for IXXAT CME/PN will configure node guarding.

The Node Guarding Retry Factor is used as an initial default for object $100D_h$ `Life time factor` on the CANopen slave and the `Retry factor` field in the sub-indices in object $1F81_h$ `NMT slave assignment` on the NMT master if guarding is activated.

The value entered in Ratio Consumer Heartbeat Time to Producer Time is used to calculate the initial value for the consumer heartbeat time based on the producer heartbeat time configured for the CANopen device to be monitored.

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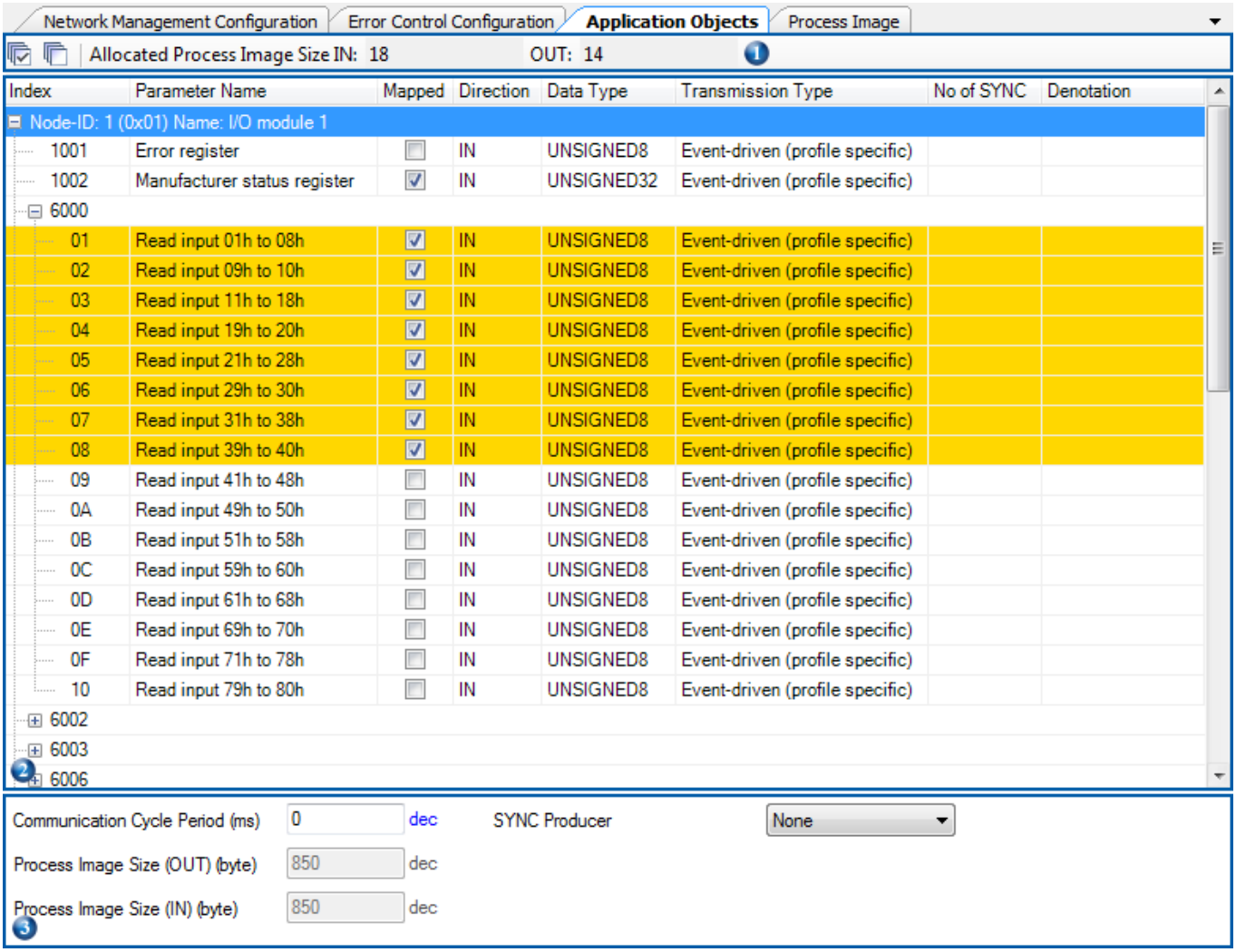
4.3.3 Application Objects

The specification which of the process data implemented by CANopen slave devices in the network are mapped to the process image on the CANopen manager device is performed on the Application Objects workspace page.



Application Objects workspace page

The application objects page is subdivided into the following main regions:

1. Toolbar
2. Application objects list
3. Global parameters

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Toolbar

The toolbar implements the interface to commands that globally select or deselect application objects for mapping onto the process image on the CANopen manager.

Icon	Description
	Adds all mappable application objects to the process image of the manager.
	Removes all currently selected objects from the process image of the manager.

The toolbar also displays the number of bytes currently allocated in the process image on the CANopen manager for the direction IN and OUT. If one of these values exceeds the upper limit specified in the global values section, the display changes to text color red.

Application Objects List

The application objects list displays all mappable objects on the CANopen slave devices in the network in a tree list view. The application objects are sorted according to the node-ID of the device, their object index, and finally the sub-index of the entry.

Column	Description
Index	Contains index and sub index of all mappable application objects organized in a tree structure.
Parameter Name	The name of the object entry as declared in the `[ParameterName]` keyword in the device description data (EDS).
Mapped	Checkbox that is used to map or unmap an object to the managers process image.
Direction	Indicates the data direction of the object. IN means the data is transferred from the network devices to the manager. OUT means data is transferred from the manager to the network devices.
Data Type	Indicates the CANopen data type of the object.
Transmission Type	Configures the CANopen transmission type that shall be used for transferring the object data. May be set to: • Synchronous (acyclic) • Synchronous (cyclic) • Event-driven (profile specific) This field is read-only if the object is mapped via default mapping.
No of SYNC	If the transmission type is set to `Synchronous (cyclic)`, this field allows to configure the number of SYNC messages that have to be received before the PDO producer samples input data and triggers the PDO transmission. The field is disabled if a transmission type other than `Synchronous (cyclic)` is configured. The default value is 1, the allowed value range 1 - 240.
Denotation	Configures an alternative name for the object entry.

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Context Menu

Command	Description
Select All of Device	Adds all application objects of the selected device for which the PDO mapping attribute is set to true to the process image of the CANopen manager.
Select Default Mappings of Device	Opens a dialog which allows the selection of PDOs including their default application object mapping according to the device description data in the EDS file.
Remove All of Device	Removes all currently selected application objects of the selected device from the process image of the CANopen manager.

Global Parameters

The global value section allows to configure parameters which apply to the PDO mapping and PDO communication in general.

The Communication Cycle Period specifies with which interval a SYNC producer shall transmit a SYNC message. The field corresponds to object 1006_h `Communication cycle period` of the CANopen manager in the IXXAT CME/PN.

> ⚠ Please note that the value entered in the text field uses one millisecond as time basis, and not one micro second as specified in the CANopen application layer and communication profile specification CiA 301.

The SYNC Producer combo box allows to select an alternative producer of the CANopen synchronization message from a list of all devices in the network that support SYNC producer functionality. This will cause the specified communication cycle period object to be configured on the selected device and the generate bit (bit 30) in object 1005_h `COB-ID SYNC` to be set to 1_b. On all other devices the generate bit in object 1005_h is set to 0_b.

Process Image Size (IN/OUT) define the upper limit for the process image on the IXXAT CME/PN in byte that may be allocated by network variables. In CANopen Configuration Studio for IXXAT CME/PN those values are read only and correspond to the fixes sizes supported by the IXXAT CME/PN gateway. The currently allocated part of the process image is indicated in the toolbar.

4.3.3.1 Network Variables

Internally IXXAT CME/PN implements a process image with dynamically created network variables according to CiA 302-4 to map the application objects of the connected CANopen slave devices into the process image of the PROFINET gateway application. Due to the restrictions of PROFINET with respect to supported data types, not all data types defined in the CANopen specifications are supported by IXXAT CME/PN. For details consult the related PROFINET specifications and see the table below.

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Data Type Definitions and Object Dictionary Index Range

Input network variables

Index range	Data type
$A000_h$ to $A03F_h$	INTEGER8
$A040_h$ to $A07F_h$	UNSIGNED8
$A080_h$ to $A0BF_h$	BOOLEAN1)
$A0C0_h$ to $A0FF_h$	INTEGER16
$A100_h$ to $A13F_h$	UNSIGNED16
$A140_h$ to $A17F_h$	INTEGER241)
$A180_h$ to $A1BF_h$	UNSIGNED241)
$A1C0_h$ to $A1FF_h$	INTEGER32
$A200_h$ to $A23F_h$	UNSIGNED32
$A240_h$ to $A27F_h$	REAL32
$A280_h$ to $A2BF_h$	UNSIGNED401)
$A2C0_h$ to $A2FF_h$	INTEGER401)
$A300_h$ to $A33F_h$	UNSIGNED481)
$A340_h$ to $A37F_h$	INTEGER481)
$A380_h$ to $A3BF_h$	UNSIGNED561)
$A3C0_h$ to $A3FF_h$	INTEGER561)
$A400_h$ to $A43F_h$	INTEGER64
$A440_h$ to $A47F_h$	UNSIGNED64

Output network variables

Index range	Data type
$A480_h$ to $A4BF_h$	INTEGER8
$A4C0_h$ to $A4FF_h$	UNSIGNED8
$A500_h$ to $A53F_h$	BOOLEAN1)
$A540_h$ to $A57F_h$	INTEGER16
$A580_h$ to $A5BF_h$	UNSIGNED16
$A5C0_h$ to $A5FF_h$	INTEGER241)
$A600_h$ to $A63F_h$	UNSIGNED241)
$A640_h$ to $A67F_h$	INTEGER32
$A680_h$ to $A6BF_h$	UNSIGNED32
$A6C0_h$ to $A6FF_h$	REAL32
$A700_h$ to $A73F_h$	UNSIGNED401)
$A740_h$ to $A77F_h$	INTEGER401)
$A780_h$ to $A7BF_h$	UNSIGNED481)
$A7C0_h$ to $A7FF_h$	INTEGER481)
$A800_h$ to $A83F_h$	UNSIGNED561)
$A840_h$ to $A87F_h$	INTEGER561)
$A880_h$ to $A8BF_h$	INTEGER64
$A8C0_h$ to $A8FF_h$	UNSIGNED64

1) Not supported by IXXAT CME/PN

4.3.3.2 Default PDO Mapping

CANopen Configuration Studio for IXXAT CME/PN supports the explicit selection of PDO mapping records as declared in the device description information for the CANopen slave devices. To select individual PDOs to be mapped into the process image of the CANopen manager, right click in the application object list to open the Select Default Mapping dialog. In this dialog all PDOs declared for the CANopen device are listed with the application objects mapped onto the PDO.

By selecting the desired PDOs and confirming the dialog, all application objects of the PDOs are added to the mapping and corresponding network variables are created in the process image of the CANopen manager. Objects that were selected via a default mapping are displayed with a yellow background in the application object list. Such objects are treated as one unit and can only be removed together.

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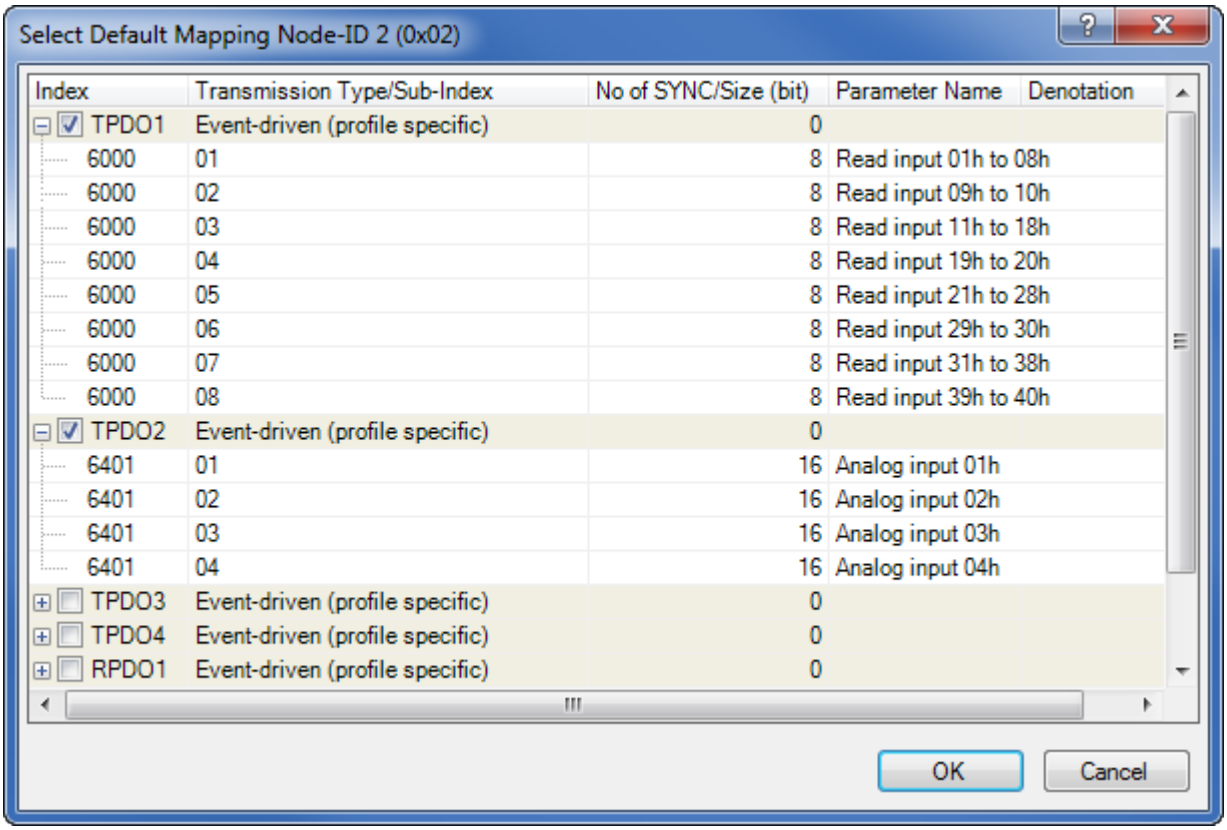
Select Default Mapping Dialog

The default mapping dialog is shown if the corresponding option in the context menu was selected.



Selection of PDO default mapping as contained in the device description file

Column	Description
Index	Contains the main-index of the application object contained in the default mapping of the PDO.
Transmission Type / Sub-index	Allows to configure the PDO transmission type in the corresponding header row individually for each PDO / Contains the sub-index of the application object contained in the default mapping of the PDO.
No of SYNC / Size (bit)	If synchronous (cyclic) is selected as transmission type the number of SYNC messages after which a TPDO is transmitted may be specified / Contains the size of the object in bits.
Parameter Name	The name of the default mapped object according to the EDS.
Denotation	The alternative name for the object as specified by the user. The value can not be changed here.

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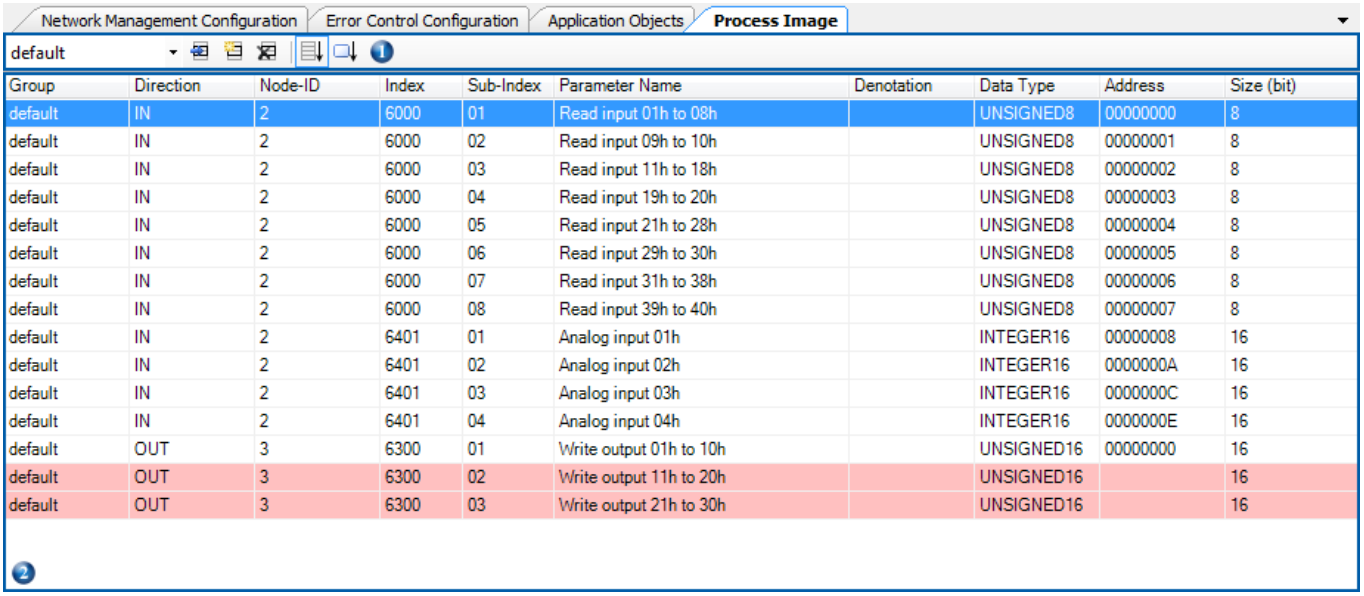
4.3.4 Process Image

The process image page displays the process image of the CANopen manager that is created by the configuration.



Group	Direction	Node-ID	Index	Sub-Index	Parameter Name	Denotation	Data Type	Address	Size (bit)
default	IN	2	6000	01	Read input 01h to 08h		UNSIGNED8	00000000	8
default	IN	2	6000	02	Read input 09h to 10h		UNSIGNED8	00000001	8
default	IN	2	6000	03	Read input 11h to 18h		UNSIGNED8	00000002	8
default	IN	2	6000	04	Read input 19h to 20h		UNSIGNED8	00000003	8
default	IN	2	6000	05	Read input 21h to 28h		UNSIGNED8	00000004	8
default	IN	2	6000	06	Read input 29h to 30h		UNSIGNED8	00000005	8
default	IN	2	6000	07	Read input 31h to 38h		UNSIGNED8	00000006	8
default	IN	2	6000	08	Read input 39h to 40h		UNSIGNED8	00000007	8
default	IN	2	6401	01	Analog input 01h		INTEGER16	00000008	16
default	IN	2	6401	02	Analog input 02h		INTEGER16	0000000A	16
default	IN	2	6401	03	Analog input 03h		INTEGER16	0000000C	16
default	IN	2	6401	04	Analog input 04h		INTEGER16	0000000E	16
default	OUT	3	6300	01	Write output 01h to 10h		UNSIGNED16	00000000	16
default	OUT	3	6300	02	Write output 11h to 20h		UNSIGNED16		16
default	OUT	3	6300	03	Write output 21h to 30h		UNSIGNED16		16

Process Image workspace page

The process image page is subdivided into the following main regions:

1. Toolbar
2. Process image list

Toolbar

The tool bar interfaces to commands related to the process group mechanism and process image sorting.

Process image groups provide a way to optimize the process image layout. This is a concept that is not defined by CANopen. Objects that are placed in the same group will be allocated in a continuous memory space inside the process image to allow for a more efficient exchange of process data with the PLC program. The process groups are managed via the tool bar.

Icon	Description
Combo box	The combo box allows to select the process groups that were created. The group `default` is always available.
	Assigns the process group selected in the combo box to all entries selected in the process image list.
	Adds a new process group which is subsequently displayed in the combo box.
	Removes the group selected in the combo box. All process image entries that are in the removed group are moved to the `default` group.
	Sorts the entries of the process image list by ascending order of addresses.
	Sorts the entries of the process image list by ascending order of node-ID, main-index and sub-index.

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Process Image List

The process image list displays all objects that were mapped to the process image of the CANopen manager. Objects that are highlighted with a alternate background color have been added to the list of objects selected for inclusion into the process image after the last calculation of the PDO connections and the process image layout. The Address column for those objects will remain empty until the project is recalculated.

Column	Description
Group	Contains the process group that was assigned to the object.
Direction	Displays the transfer direction of the data as seen from the manager.
Node-ID	The node-ID of the CANopen slave device implementing the object that is mapped onto the process image.
Index	Main-index of the object on the CANopen slave device.
Sub-Index	Sub-index of the object on the CANopen slave device.
Parameter Name	The name of the object on the slave according to the device description data (EDS).
Denotation	The optional alternative name entered on the application objects page. The value cannot be changed here.
Data Type	The CANopen data type of the object.
Address	The address of the objects value in the process image in hexadecimal representation. The address space is divided into an IN and OUT direction. Thus the same address may occur twice. If the mapping was not calculated since an object was added the address column is empty for this object.
Size (bit)	The size of the object in bits.

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4.3.5 IXXAT CME/PN Timing Parameters

The Timing Parameters page is used to configure basic timing parameters such as the bit rate of the CAN network connected to the IXXAT CME/PN or the PROFINET update time for the IXXAT CME/PN I/O device.

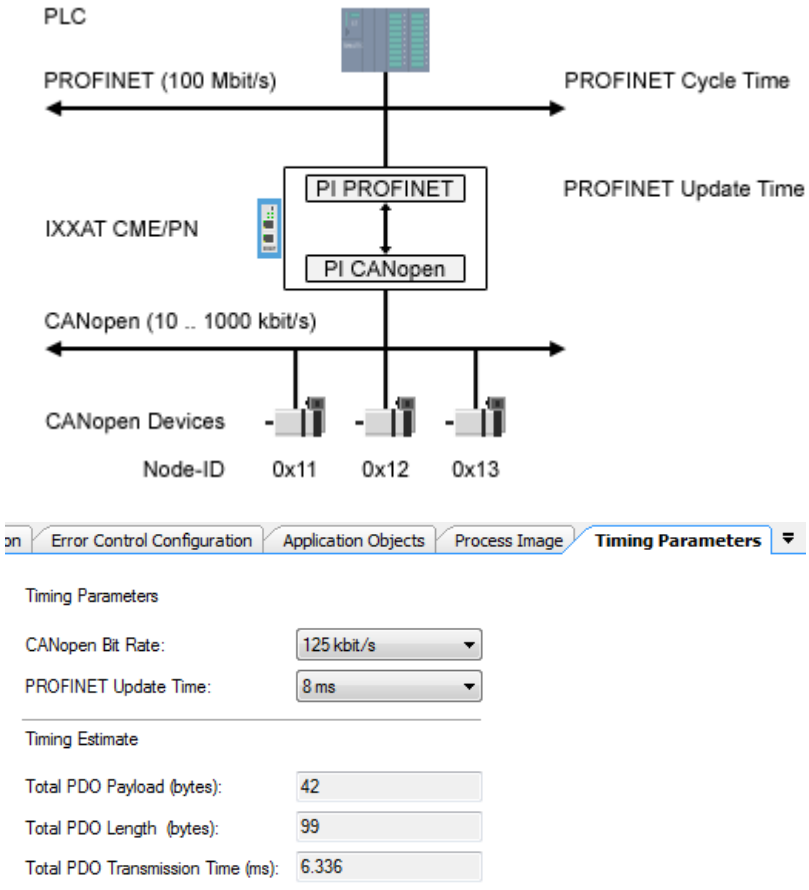
⚠ Note that due to the higher bit rate of PROFINET (100 Mbit/s) compared to CANopen (10 .. 1000 kbit/s) the available bandwidth of PROFINET is significantly higher than that of CANopen. It has to be taken care to carefully adjust the PROFINET update time as a function of:

- the shortest duration of process data to be exchanged between the CANopen slave devices and the PROFINET network
- the CANopen bit rate
- the amount of process data

to avoid loss of data.

Note that the source of process data (the PLC) and the PROFINET bus are not synchronized. Therefore the following two criteria shall be met:

1. The PROFINET update time shall be greater than the transmission time of all configured TPDOs and RPDOs.
2. The PROFINET update time shall be less or equal to half of the shortest process data duration.



CANopen and PROFINET timing parameters

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Based on the configured timing parameters and the calculated PDO configuration an approximation of the time required to transmit each TPDO exactly once per PROFINET update time is calculated. This estimated transmission time, and thus also the expected busload, is independent of the configured PDO transmission type. If the TPDO transmission type is set to event-driven, an input device may transmit its TPDOs more than once per PROFINET update time. The estimated transmission time and busload on the CANopen network may therefore differ from the observed busload in the final network installation.

Parameter	Control Type	Category	Description
CANopen Bit Rate	Drop Down List	Input	Bit rate used in the CANopen network. According to CiA 301, the CAN bit rate can be selected within the range of 10 kbit/s to 1 Mbit/s.
PROFINET Update Time	Drop Down List	Input	The cycle time in a PROFINET system within which the I/O device is polled by the I/O controller. The PROFINET update time is an integer multiple of the basic PROFINET cycle time. The IXXAT CME/PN supports PROFINET update times between 1 ms and 512 ms.
Total PDO Payload	Textbox	Information	Accumulated payload of all active TPDOs transmitted within one PROFINET update time. The value in this textbox depends on the selected application objects in the Application Objects page and additional TPDOs configured in the PDO Parameters tool window.
Total PDO Length	Textbox	Information	For each active TPDO, 47 bits for the additional CAN protocol information (start of frame, arbitration, control, CRC, and ACK fields, EOF, and inter frame space) are added. An estimated 4% is added to each TPDO to cover for possible stuff bits in the CAN frames. The resulting value is rounded up to the next full byte. This estimate is based on the assumption that each TPDO is transferred exactly once within one PROFINET update time.
Total PDO Transmission Time	Textbox	Information	Total PDO length divided by the CANopen bit rate. A warning icon is displayed next to this textbox if the estimated total PDO transmission time exceeds the PROFINET update time.

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Example Calculation of the PDO Transmission Time

For the example calculation the CANopen project as depicted above is used.

- IXXAT CME/PN as CANopen manager device
- 3 CiA 402 compliant CANopen servo drives,
  each with RPDO1 (2 byte payload), RPDO3 (6 byte payload) and TPDO3 (6 byte payload) active

Node-ID	PDO Number	PDO Mapping				Payload (byte)	Payload (bit)	PDO Frame Length[1)]	Total PDO frame Length[2)]
		Name	Index	Sub-index	Data Type				
0x11	RPDO1	Control word	6040_h	00_h	UNSIGNED16	2	16	63	66
	RPDO3	Control word	6040_h	00_h	UNSIGNED16	6	48	95	99
		Target position	$607A_h$	00_h	UNSIGNED32				
	TPDO3	Status word	6041_h	00_h	UNSIGNED16	6	48	95	99
		Actual position	6064_h	00_h	UNSIGNED32				
0x12	RPDO1	Control word	6040_h	00h	UNSIGNED16	2	16	63	66
	RPDO3	Control word	6040_h	00_h	UNSIGNED16	6	48	95	99
		Target position	$607A_h$	00_h	UNSIGNED32				
	TPDO3	Status word	6041_h	00_h	UNSIGNED16	6	48	95	99
		Actual position	6064_h	00_h	UNSIGNED32				
0x13	RPDO1	Control word	6040_h	00h	UNSIGNED16	2	16	63	66
	RPDO3	Control word	6040_h	00_h	UNSIGNED16	6	48	95	99
		Target position	$607A_h$	00_h	UNSIGNED32				
	TPDO3	Status word	6041_h	00_h	UNSIGNED16	6	48	95	99
		Actual position	6064_h	00_h	UNSIGNED32				

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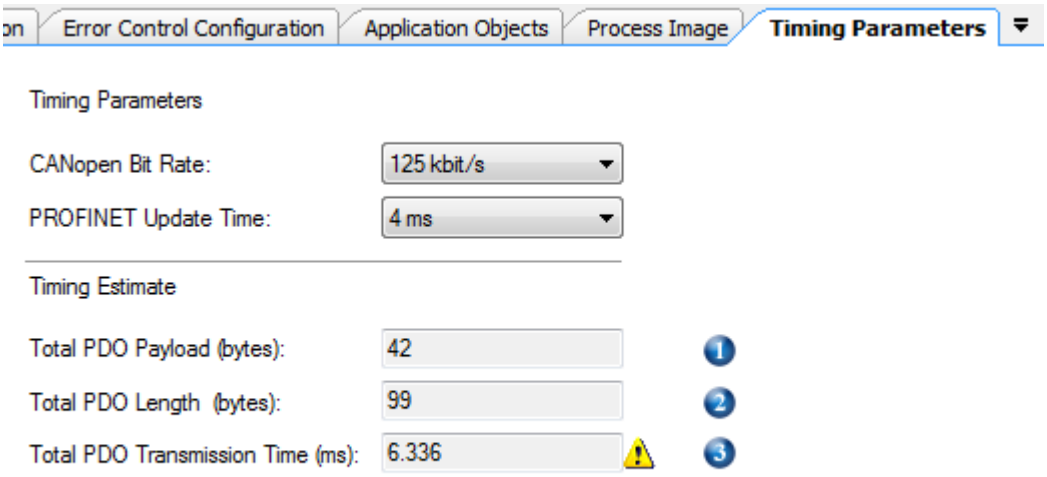
Node-ID	PDO Number	PDO Mapping				Payload (byte)	Payload (bit)	PDO Frame Length[1)]	Total PDO frame Length[2)]
		Name	Index	Sub-index	Data Type				
					Total PDO payload (byte)	**42** (1)		Total PDO length (bit)	792
								Total PDO length (byte)	**99** (2)

1) Frame length in bits covering payload plus CAN protocol overhead (44 bit) plus inter frame space (3 bit)

2) Total frame length in bit allowing for 4% overhead due to CAN stuff bits for statistically generated data bit sequences

PROFINET update time according to criterion 1

At a CAN bit rate of 125 kbit/s this results in a total PDO transmission time of 6.3 ms (3). Not considering asynchronous services and events such as SDO transfers or emergency messages or NMT error control services, the PROFINET update time has to be set to at least 8 ms to avoid loss of process data. If the PROFINET update time was set to 4 ms, a warning icon would be displayed behind the total PDO transmission.



CANopen and PROFINET timing parameters with PROFINET update time too short

Allowing for additional available bandwidth, it is recommended to set the PROFINET update time for this configuration to no shorter than 16 ms.

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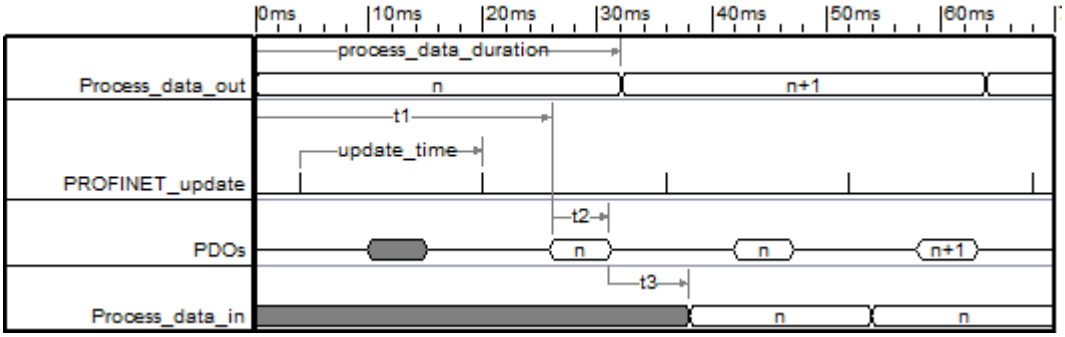
PROFINET update time according to criterion 2

With the PROFINET update time equal to 16 ms the shortest duration of process data shall be 32 ms or longer. See figure below:



Timing diagram for 16 ms update time and 32 ms process data duration. t1, t3: internal delay times of PLC and IXXAT CME/PN. t2: total PDO transmission time

If criterion 2 is not met criterion 1 must be re-calculated based on a higher bit rate, e. g. 250 kBit/s.

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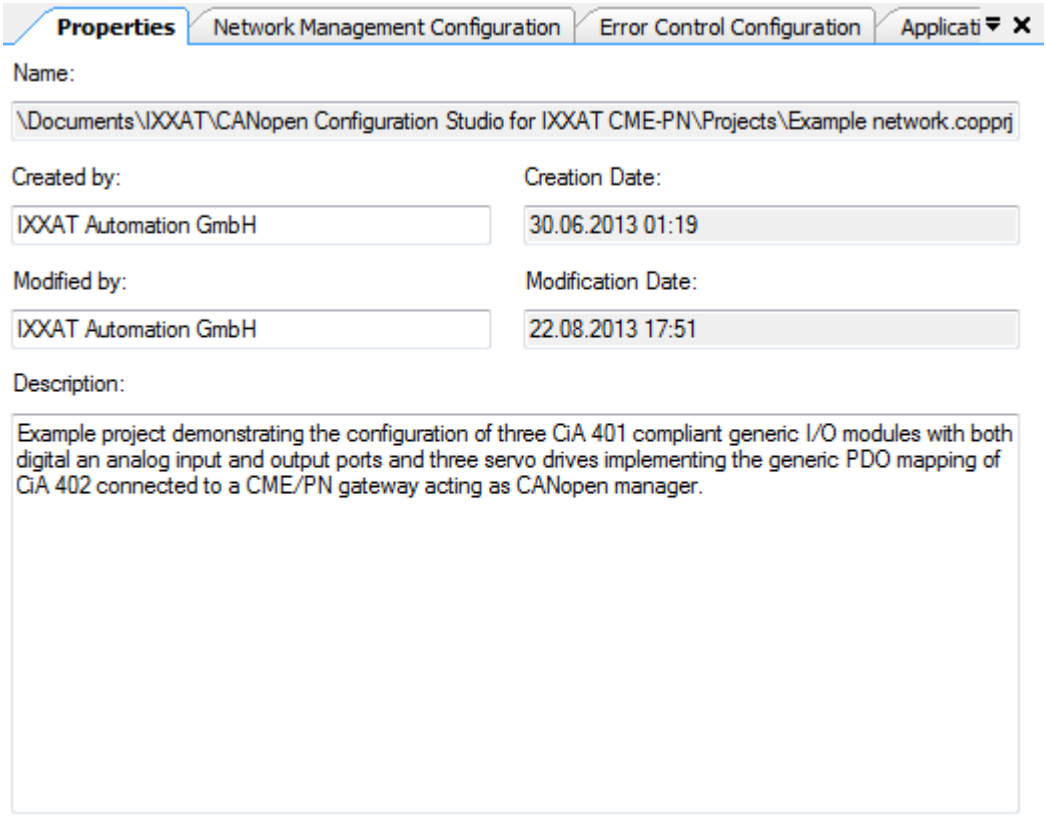
4.3.6 Project Properties

The project properties page displays some basic information about the current project. The page is not displayed by default. It is available via the Properties item in the Project menu.



Project Properties

Parameter	Description
Name	Contains the full path and name of the project file.
Created by	The name of the creator of the project. This value may be freely assigned.
Creation Date	Time and date of the creation of the project. This value is automatically set on creation based on system time.
Modified by	The name of the modifier of the project. This value may be freely assigned.
Modification Date	Time and date of the last modification of the project. This value is automatically set on save based on system time.
Description	An optional description of the project. This value may be freely assigned.

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4.4 Dialogs

CANopen Configuration Studio for IXXAT CME/PN implements four global dialogs that allow to configure basic settings of the application.

Icon	Name	Description
	Interface Settings	Configuration of the network interface used for downloading the generated configuration data to the IXXAT CME/PN.
	Download	Selection of the configuration data to be downloaded to the IXXAT CME/PN. The status of the download operation is indicated by a progress bar.
	Device Catalog Management	Use the Device Catalog Management dialog to add CANopen devices to or remove them from the user catalog. See also the help information on the Device Catalog tool window.
	Options	Supports setting of general application options.

4.4.1 Interface Configuration

The Interface Settings dialog is used for the basic configuration of the download interfaces. The dialog is available via the Network→Interface Configuration menu item or the corresponding tool bar item. CANopen Configuration Studio for IXXAT CME/PN supports download via a USB link directly connected to a IXXAT CME/PN.

USB Configuration

The USB port tree provides a list of all IXXAT CME/PN devices that are attached to the PC via USB. By selecting a device this device will be targeted by the download via USB. The USB interface does not require further configuration.

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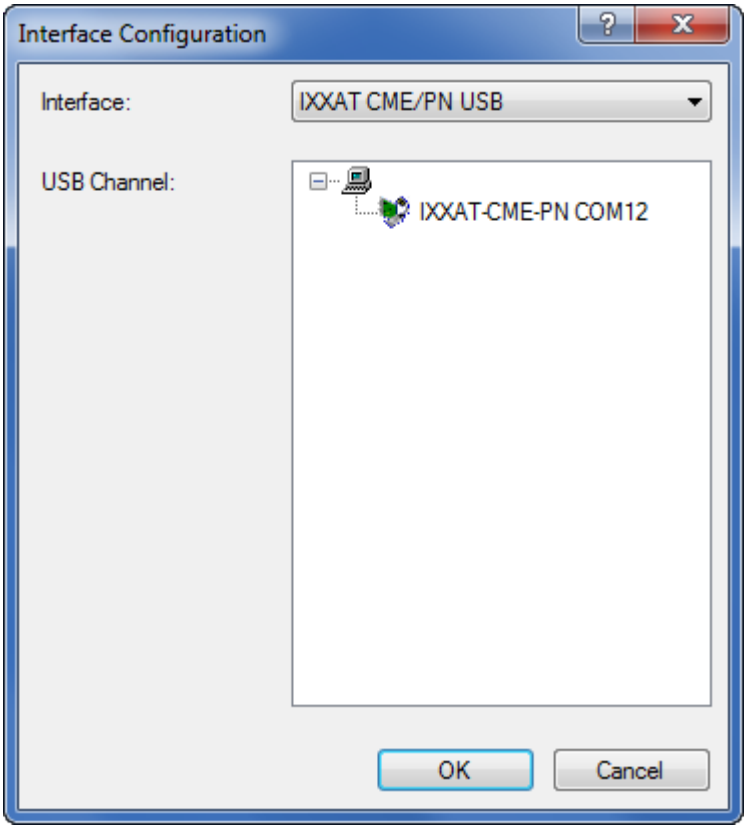

Selection of a IXXAT CME/PN gateway as target device for the configuration download

4.4.2 Download of Configuration Data

The Download dialog is used to download network configuration data to a IXXAT CME/PN. The dialog is available via the Network→Download menu item or the corresponding toolbar button ( ). CANopen Configuration Studio for IXXAT CME/PN supports download via a direct USB link between the host PC running CANopen Configuration Studio for IXXAT CME/PN and a IXXAT CME/PN gateway. See also the help page on network interface configuration.

The desired download interface may be selected via the Download Interface combo box. The Configure button opens the Interface Configuration dialog of the currently selected interface. The file that shall be downloaded is selected via the ellipsis button ( ). CANopen Configuration Studio for IXXAT CME/PN currently supports *.profinetcdc files (for generated configuration data) and *.bin files (for firmware updates).

> ⚠ Only a binary file supplied by IXXAT shall be selected for a firmware update.
>
> The HOST LED of the IXXAT CME/PN is permanently RED during the download process. After the download process the HOST LED is off until the boot process is finished. A firmware update may take 1-2 minutes to complete. Note that the progress bar pauses some time before indicating the first update progress. Do not interrupt the IXXAT CME/PN power supply during the download process.

The download is controlled by the buttons at the bottom of the dialog. Download starts the download of the selected file using the selected interface. While the download is running the progress bar will indicate the current status. A running download may be aborted by means of the abort button.

After the download, a message box confirms the successful completion of the procedure. Click OK and then Close to close the dialog.

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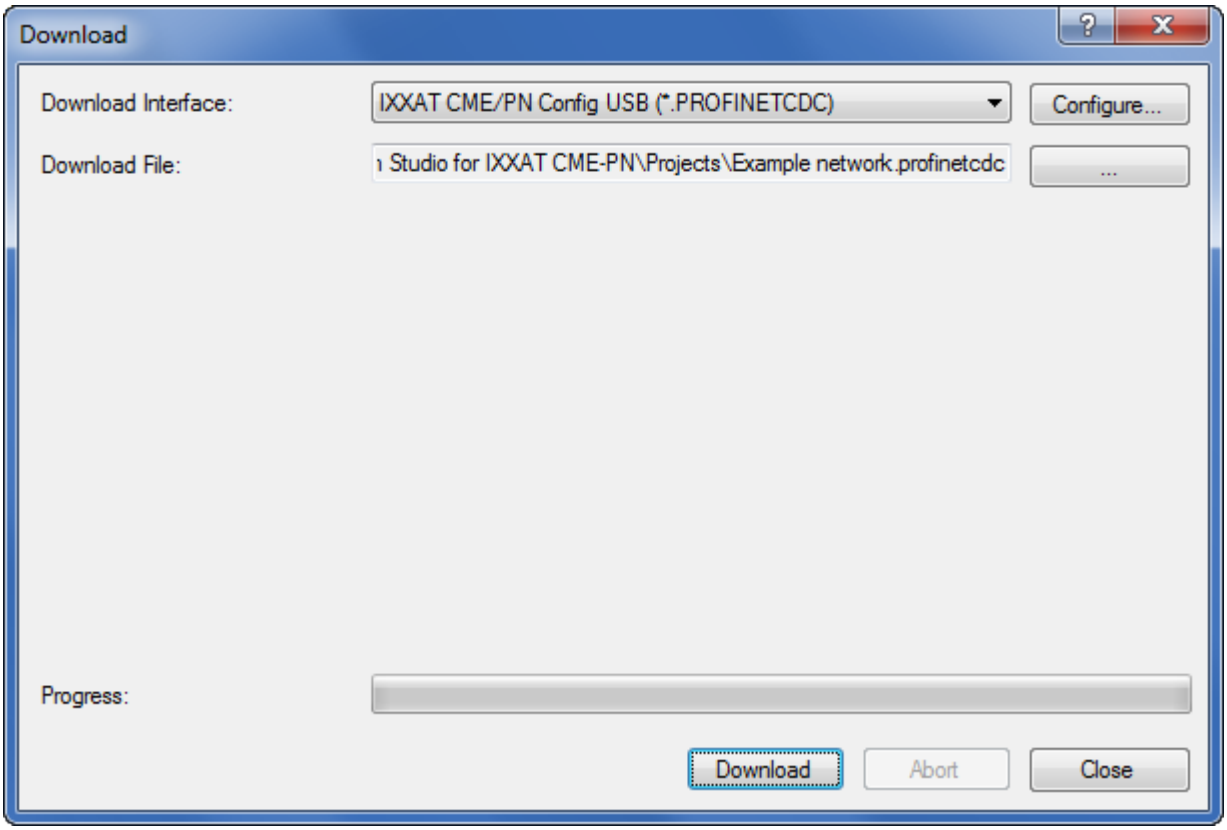
Download via direct USB Link to a IXXAT CME/PN

USB does not have special options that may be selected from within the Download dialog.



USB Download dialog

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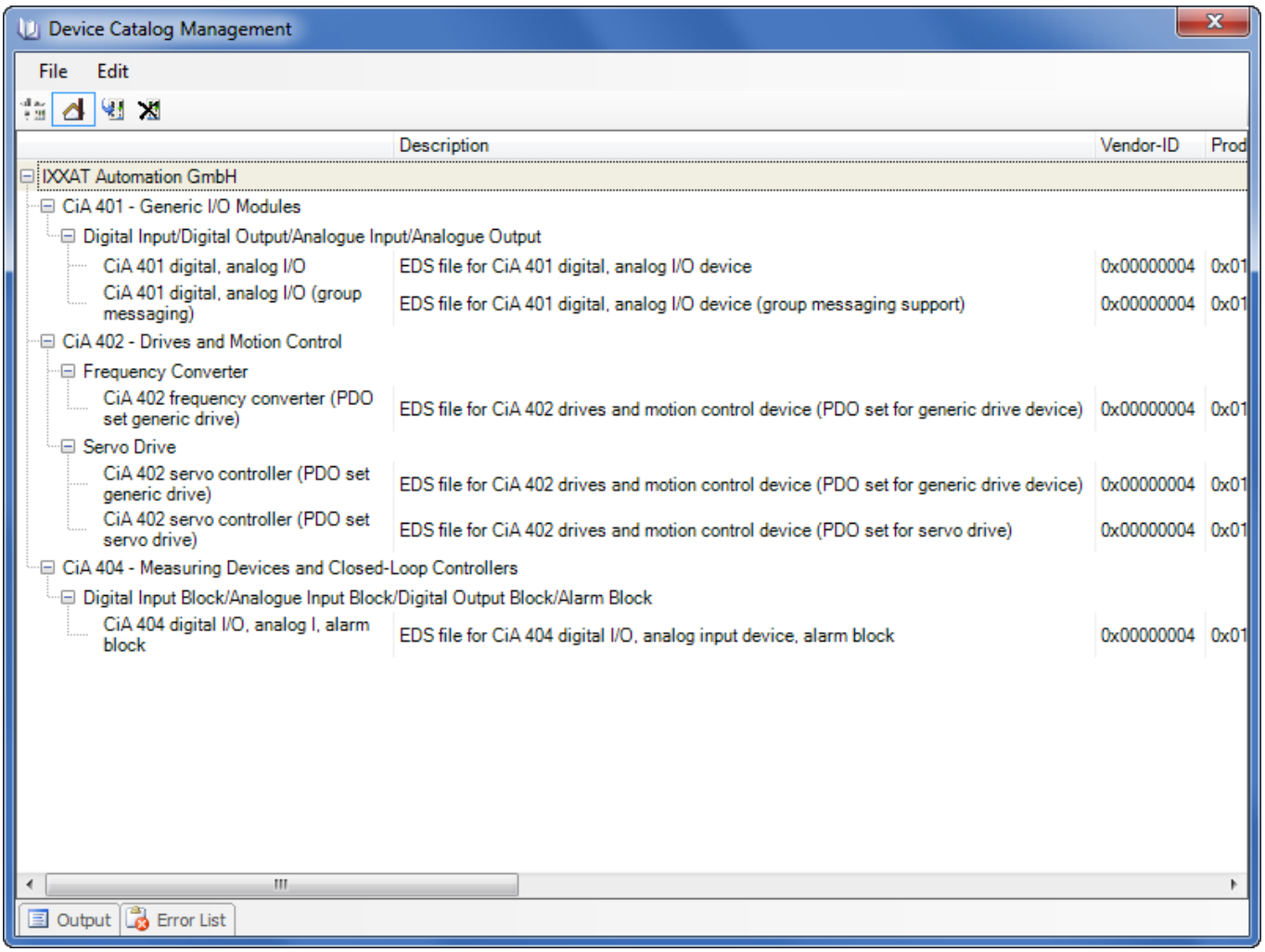
4.4.3 Device Catalog Management

The Device Catalog Management dialog is used for configuration of the devices available in the catalog. The dialog is available via the Tools→Manage Catalog menu item. Only devices that have been imported into the device catalog may be used in projects. The dialog is related to the Device Catalog tool window.



Device Catalog Management dialog

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Within the list of imported devices, the following information is displayed if available in the electronic data sheet for the device. If the data cannot be extracted from the device data, the corresponding column is left empty.

Column	Description
	Multi-purpose column that contains the vendor name, a textual description of the additional information field in 1000_h `Device type`. The nodes may be ordered by manufacturer or device profile.
Description	The value of the description field of the [FileInfo] section in the EDS file.
Vendor-ID	Vendor-ID as assigned by CAN in Automation, contained in object 1018_h sub-index 01_h.
Product Code	Manufacturer specific product code, contained in object 1018_h sub-index 02_h.
Revision Number	Manufacturer specific revision number, contained in object 1018_h sub-index 03_h.
Hardware Version	Hardware version as contained in the electronic data sheet for the device. The value presented in the list is extracted from object 1009_h `Manufacturer hardware version`.
Software Version	Software version as contained in the electronic data sheet for the device. The value presented in the list is extracted from object $100A_h$ `Manufacturer software version`.
RPDOs	Number of receive PDOs supported by the device.
TPDOs	Number of transmit PDOs supported by the device.
Granularity	The granularity value defined in the `[DeviceInfo]` section of the EDS.
Group Messaging	Indicates if the device support group messaging.
File Version	The file version according the `[FileInfo]` section of the EDS.
Modification Date & Time	The date and time of the last modification of the EDS file.
File	The original file name of the EDS file.

At the lower border of the dialog an output and an error window are docked that display errors, warnings and information created during device import.

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Menu system

File (keyboard accelerator: Alt+F)

The File menu contains commands basic commands.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Close		Alt+F,C

Edit (keyboard accelerator: Alt+E)

Commands for importing or removing devices from the catalog.

Icon	Command	Keyboard shortcut	Keyboard accelerator
	Import Device		Alt+E, I
	Remove Device		Alt+E, R

Toolbar

The toolbar implements the interface to commands that sort the devices and add or remove devices.

Icon	Description
	If this tool bar item is clicked the device tree is sorted by device profile at the first level.
	If this tool bar item is clicked the device tree is sorted by device vendor at the first level.
	Imports a new device to the catalog. Opens a file open dialog for EDS files.
	Removes the currently selected device from the catalog.

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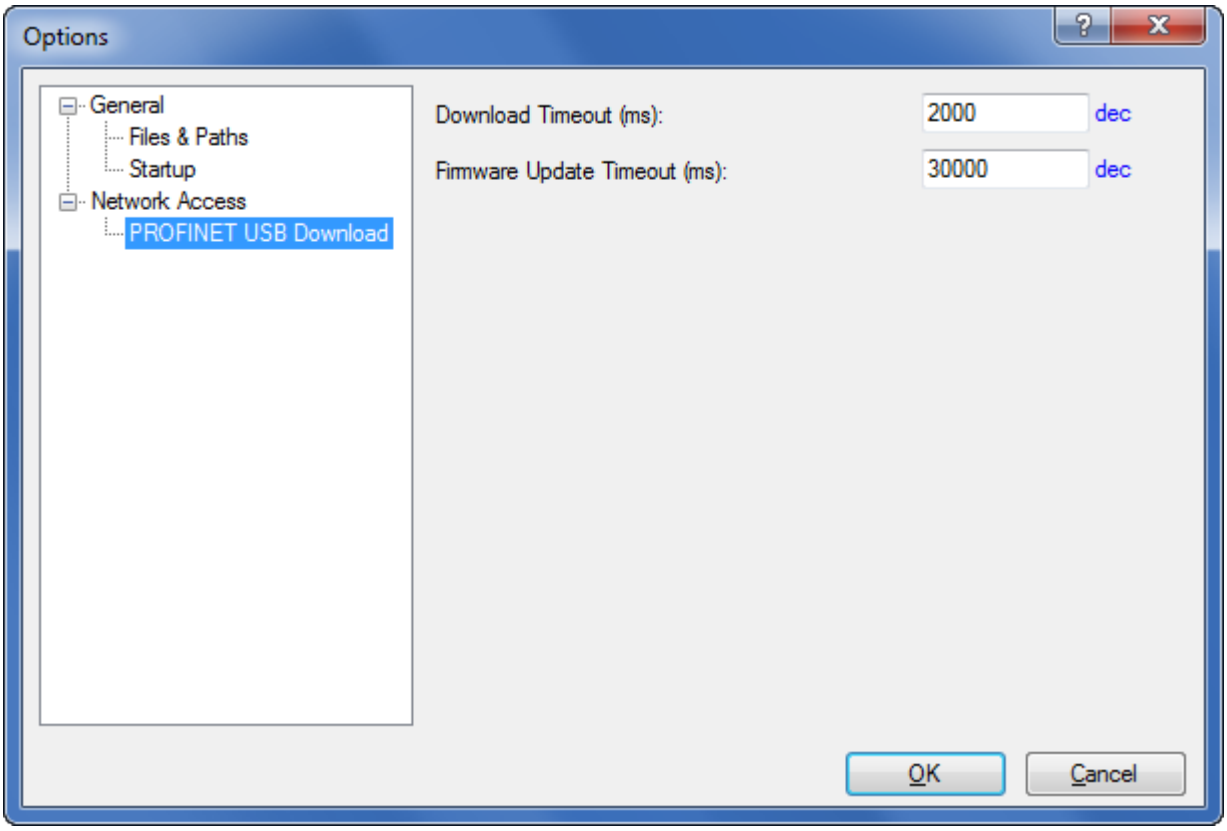
4.4.4 Options

The Options dialog contains all global options of the application. The dialog is available via the Tools→Options menu item.



CANopen Configuration Studio for IXXAT CME/PN Options dialog

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Group	Sub-Group	Option	Description
General	Files & Paths	Default Project Directory	The default path CANopen Configuration Studio for IXXAT CME/PN will propose if projects are saved or loaded.
		Default EDS Directory	The default path the application will search for EDS files.
	Startup	Show Splash Screen on Startup	If checked the splash screen will be shown on startup.
Network Access	PROFINET USB Download	Download Timeout	Default timeout used for a down operation.
		Firmware Update Timeout	Default timeout used for a firmware update operation. As firmware update requires some long running internal operations, the timeout is higher than the normal download timeout.

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4.5 CANopen Configuration Studio for IXXAT CME/PN Workspace Customization

The user interface of CANopen Configuration Studio for IXXAT CME/PN is fully customizable. Customization may involve hiding or displaying, floating or docking tool windows, or arranging the workspace tab pages in individual horizontal or vertical groups.

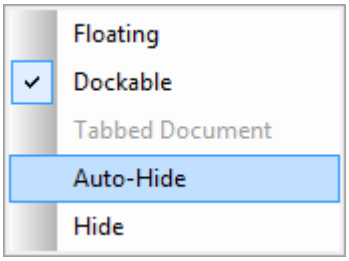
Tool windows are used for network topology definition and device specific configuration tasks. The following tool window states are supported:

Floating	**Tool windows may be freely positioned on the desktop, also in front of other windows.**
Dockable	The tool window is in either docked or floating state. If in floating state it may be freely positioned on the desktop, but also may be attached to the main application window.
Tabbed Document	This option is only available for the Project Explorer tool window. The tool window is available as an additional tab page in the central workspace area. If in tabbed state, the tool window may be set to any other state using the context menu on the tab page header.
Auto-Hide	The tool window may be unpinned to enter the auto-hide state. A tab appears for each tool window that is unpinned. As soon as a tool window looses focus it is minimized. As the mouse pointer moves over a tab, the corresponding tool window and its content is redisplayed.
Hide	The control is hidden from the user. This state is equal to the control being closed. To redisplay the control select the corresponding menu item under the View menu in the main menu bar of the application.

The default state of tool windows is docked to the main application window.

Tool Window Context Menu

For tool windows, the available menu options are accessible via the context menu (see figure below) which opens on right-click on the window title bar or by clicking the tool window pull down menu icon 



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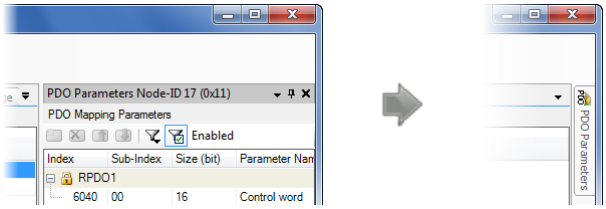
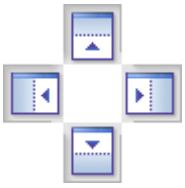
Tool Window Control Icons

The title bar of a tool window contains the following icons to control the window state:

Icon	Description
	Opens the tool window context menu.
	Tool windows with docking buttons may be hidden at the border of the CANopen Configuration Studio for IXXAT CME/PN main application window. Press the button in the upper left corner of the tool windows title bar. The tool window will be represented by a tab at the nearest border of the CANopen Configuration Studio for IXXAT CME/PN main application window. 
	If a tool window is in auto-hide state, press the button to un-hide the tool window again.
	Press this button to close a tool window. The tool window may be made visible again by selecting the corresponding menu item in the View menu.

Docking Guides

Verify that the menu item Dockable is checked in the tool window context menu. While dragging tool windows, dock guides are displayed to indicate valid drop locations. A preview of where the window is to be placed is shown when the mouse is hovered over a single dock guide.



When dragging tool windows while holding the Control key down dock guides are not displayed and the tool window will be floating when the mouse pointer is released.

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5 CANopen Configuration Studio for IXXAT CME/PN Configuration Examples

The tutorials that are part of this chapter give short step by step instructions how to create CANopen network projects with the CANopen Configuration Studio for IXXAT CME/PN.

Creating a CANopen configuration involves creating an empty project, populating the project with devices, selection of application objects that are to be mapped into the process image of the IXXAT CME/PN, setting up NMT error control, and finally generating and downloading the configuration data into the IXXAT CME/PN.

The examples in the following sections are based on a network topology similar to that described in the introduction to this online help.

Example	Demonstrated functionality
Creating a CANopen project and basic network configuration	• Create a new CANopen project • Working with the CANopen device catalog • Selection of application objects to be mapped into the process image of the CANopen managing device • Configuration of NMT error control • Configuration of CANopen and PROFINET timing parameters • Generate and download the CANopen configuration
Integrating the configured IXXAT CME/PN device into a PROFINET network	• Select the PLC hardware • Add the GSDML file (generated by CANopen Configuration Studio for IXXAT CME/PN) to the SIMATIC STEP 7 device catalog • Add and configure the IXXAT CME/PN • Work in online mode • Use of CANopen SDO services

⚠ Note that the examples presented here use device description information from EDS files that have been compiled based on the published CiA specifications. These files do not necessarily correspond to EDS files describing commercially available CANopen devices.

CANopen Configuration Studio for IXXAT CME/PN generates configuration data that may be downloaded into the IXXAT CME/PN gateway only for those objects in the CANopen devices for which the configured value differs from the default value as declared in the device description files. If the device description files used to generate the configuration do not exactly match the functionality of the devices used to implement the CANopen network, the configuration data may be successfully downloaded into IXXAT CME/PN, however after having started the CANopen network, the devices may not operate as intended.

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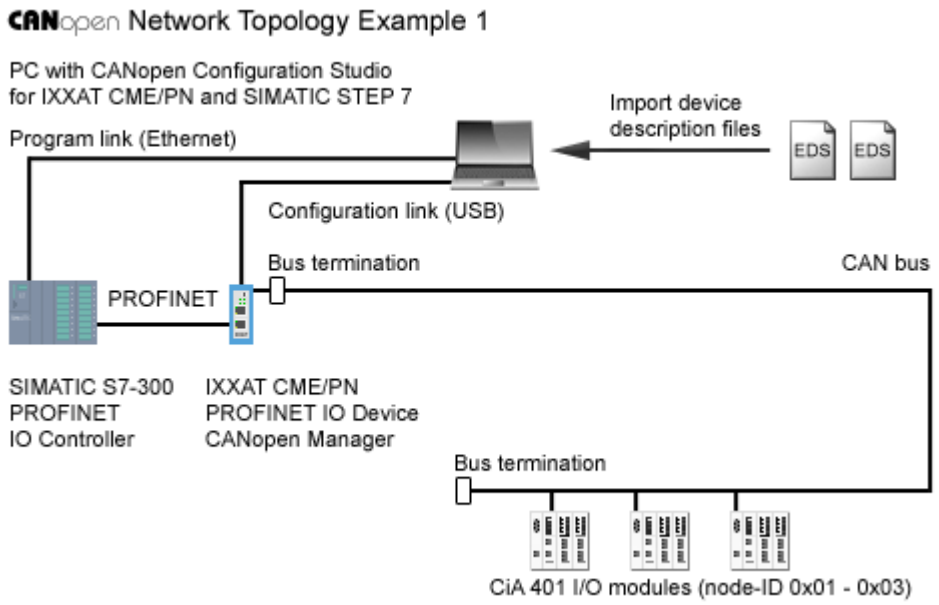
5.1 Basic CANopen Network Configuration

This tutorial gives a short step by step introduction in how to create a simple CANopen network project with CANopen Configuration Studio for IXXAT CME/PN. The project described in this section is composed of three CiA 401 compliant I/O modules and one IXXAT CME/PN PROFINET to CANopen gateway device.



1. Create a new CANopen network project with CANopen Configuration Studio for IXXAT CME/PN
2. Configuration of the byte order representation of the IXXAT CME/PN process image
3. Add CANopen slave devices to the project
4. Selection of the application objects to be mapped into the process image of the IXXAT CME/PN
5. PDO calculation and inspection of the process image layout
6. Configuration of NMT error control functionality
7. Configuration of CANopen and PROFINET timing parameters
8. Generation of CANopen configuration data
9. Download of configuration data to a IXXAT CME/PN gateway

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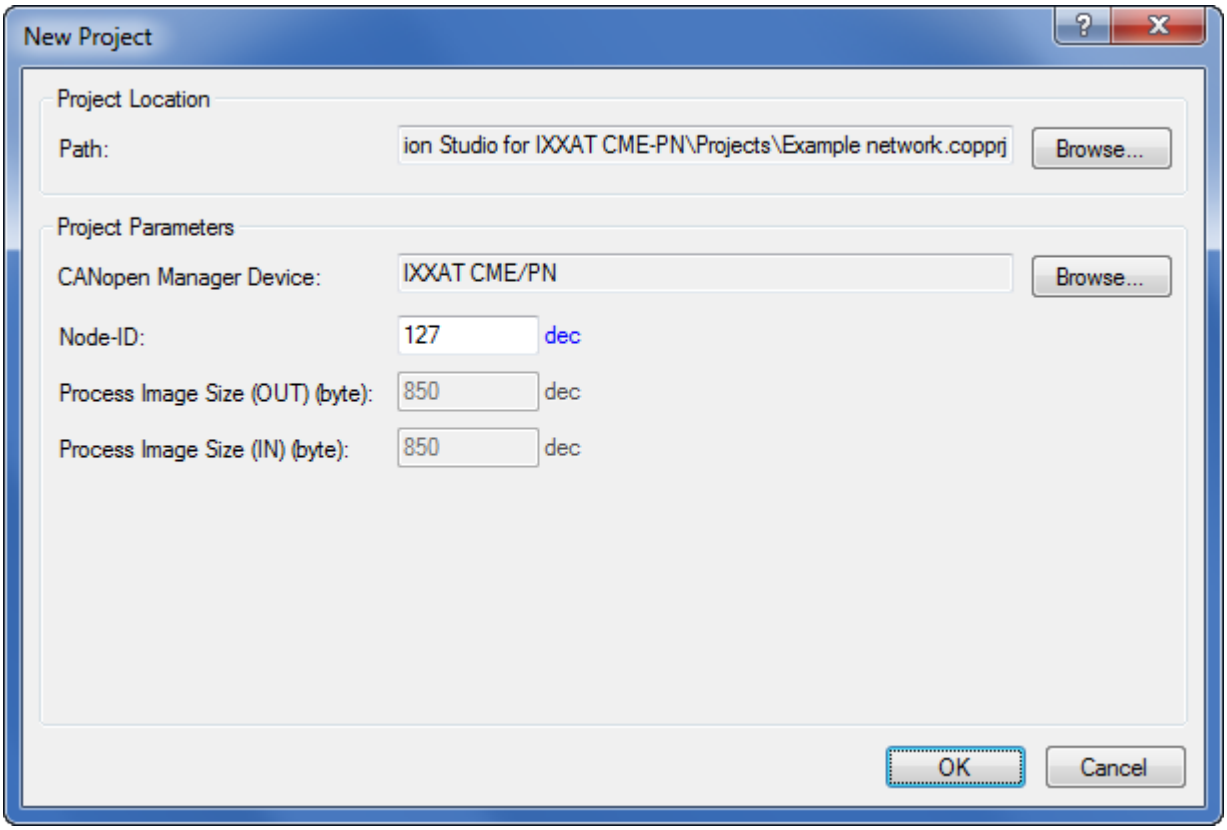
5.1.1 Create a new Project

To prepare a new configuration for a IXXAT CME/PN by IXXAT Automation GmbH, start CANopen Configuration Studio for IXXAT CME/PN and create a new project. To create a new project, either select the File→New menu item or use the `Ctrl+N` or `Alt+F, N` keyboard shortcuts or accelerators. This operation will open the New Project dialog.



New Project dialog

In the dialog the user needs to specify where to save the project. The default path for CANopen Configuration Studio for IXXAT CME/PN is set to `C:\Users\Public\Public Documents\IXXAT\CANopen Configuration Studio for IXXAT CME-PN` on English locale Windows 7 systems. Use `Example network` as name for our first project.

Next we need to specify the type of CANopen manager device that shall be used for this project. Click on the Browse button and select IXXAT CME/PN from the list of available manager devices.

We also need to specify the node-ID of the CANopen manager device in the network. We leave this at the default value of `127`.

Finally the maximum sizes of process image OUT and process image IN have to be specified. The process image is the buffer where process data are stored in the CANopen manager and from where the process data are exchanged with the PROFINET network. CANopen Configuration Studio for IXXAT CME/PN uses the values hard-coded in IXXAT CME/PN to check that no more application objects are selected than supported by the IXXAT CME/PN.

Closing the New Project dialog now with OK will create an empty new project containing the IXXAT CME/PN module as managing device with node-ID 127.

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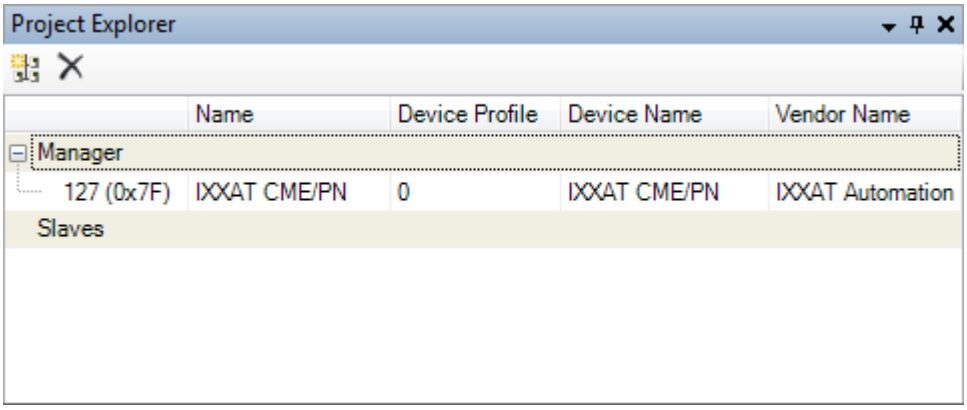

New project populated with only the IXXAT CME/PN

We have now concluded the first step in the generation of a CANopen network configuration for the IXXAT CME/PN gateway. We can now continue to add devices to the CANopen network.

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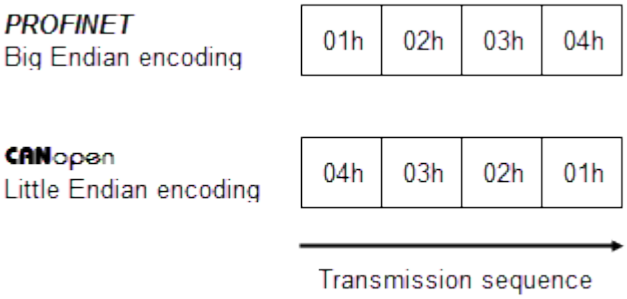
5.1.2 Byte Order Representation of the IXXAT CME/PN Process Image

PROFINET and CANopen use different network byte order conventions to transfer multi-byte data objects. PROFINET by default uses the big endian format, CANopen uses the little endian format in which the lowest order byte is transferred first in the CAN frame.

The example below illustrates how an UNSIGNED32 value 01020304_h will be transmitted over the PROFINET and the CANopen networks.



By default IXXAT CME/PN swaps bytes in a multi-byte object such as INTEGER32 so that in the process image those objects are stored in big endian format, allowing for easier processing by PROFINET IO devices. This byte swapping is only supported for numerical data objects that are transmitted with PDO services. Automatic byte swapping is not possible for SDO services as this CANopen protocol provides no intrinsic possibility to distinguish between numeric data objects and streams such as VISIBLE_STRING or DOMAIN type objects.

This requires different handling for data objects depending on if they are transmitted via SDO services or via the process image and PDO services. It has to be ensured that data objects that are to be transmitted using SDO services are provided in little endian format. IXXAT CME/PN may be alternatively configured such that data in the process image are stored in little endian format as well. This however necessitates that data objects located in the process image of IXXAT CME/PN are transmitted in little endian format by the PROFINET IO controller. Data have therefore to be converted into little endian format on the PROFINET IO controller.

The configuration for big endian or little endian handling may be parameterized in object 4000h of the IXXAT CME/PN. To modify the default value, select the IXXAT CME/PN node in the Project Explorer of CANopen Configuration Studio for IXXAT CME/PN and navigate to object 4000_h in the Device Parameters tool window. Enter a configuration value in the Value column according to your requirements.

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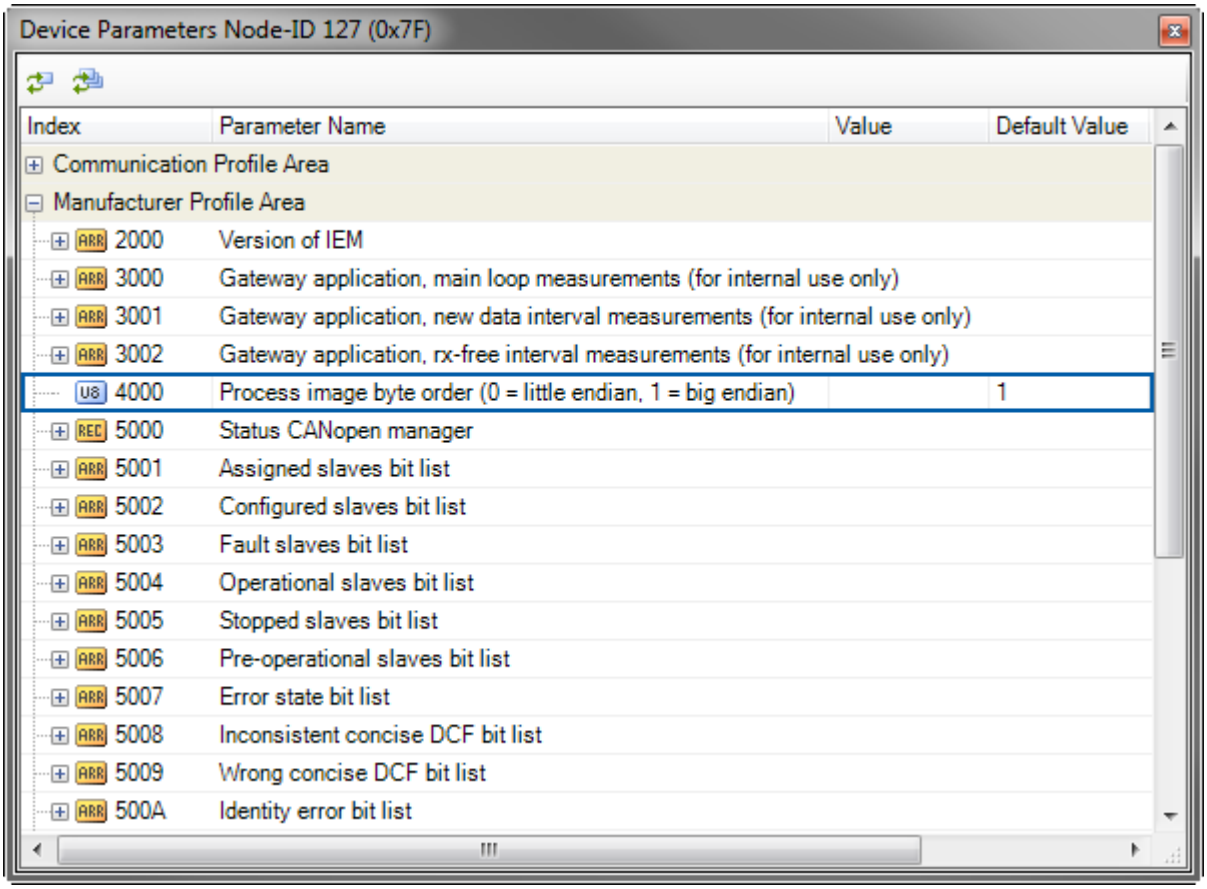

Configuration of the process image byte order

5.1.3 Add Devices to the Project

After an empty project has been created in CANopen Configuration Studio for IXXAT CME/PN slave devices can be added to the network. In this example one of the CANopen slave device templates that are included in the device catalog by default is used, but it can be any other type of CANopen device that has been added to the device catalog prior to this step.

To use any other device, the corresponding device description file (EDS) for this device has to be imported into the device catalog.

To add a device to the CANopen network, open the corresponding navigation pane in the Device Catalog tool window, select the device that shall be added to the network description and drag it to the Project Explorer window and drop it there.

For each device a logical name has to be assigned, allowing the user to distinguish between different devices of identical type. It is also required to specify the CANopen node-ID for the device and a group to which the device will be added. The user may also enter a textual description of the device's functionality in the Description field.

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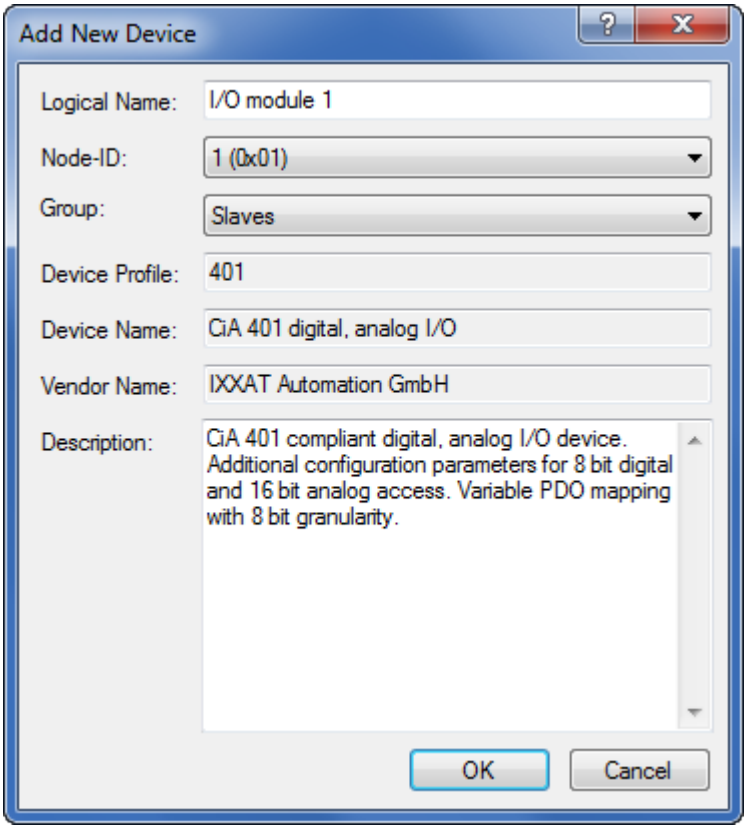
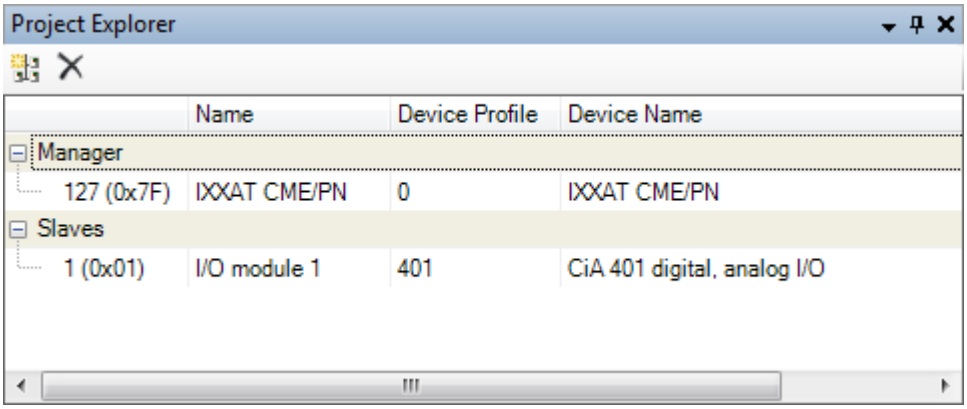


Add a new device to the CANopen project

When the dialog is closed with OK, the device is added to the Project Explorer window:



CANopen project populated with a CANopen manager and one CANopen slave I/O device

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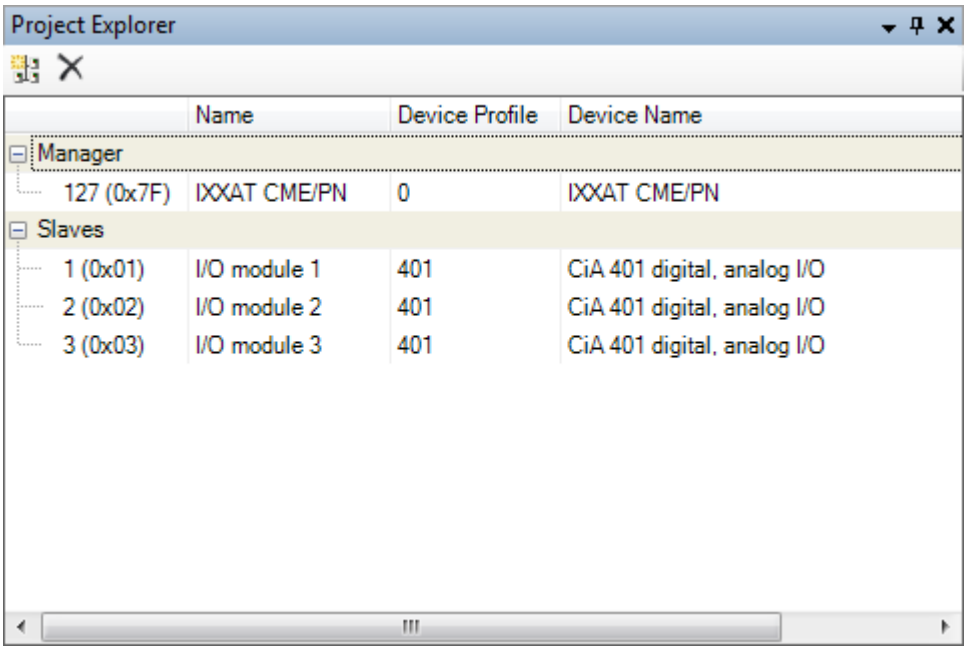
Repeat this operation to add two more I/O devices to the project. The Project Explorer will display the following project structure with one CANopen manager device and three I/O modules:



CANopen project populated with a CANopen manager and three CANopen slave I/O devices

Now that we have described the composition of the network, we can continue to select the process data that shall be exchanged between the CANopen manager and the slave devices.

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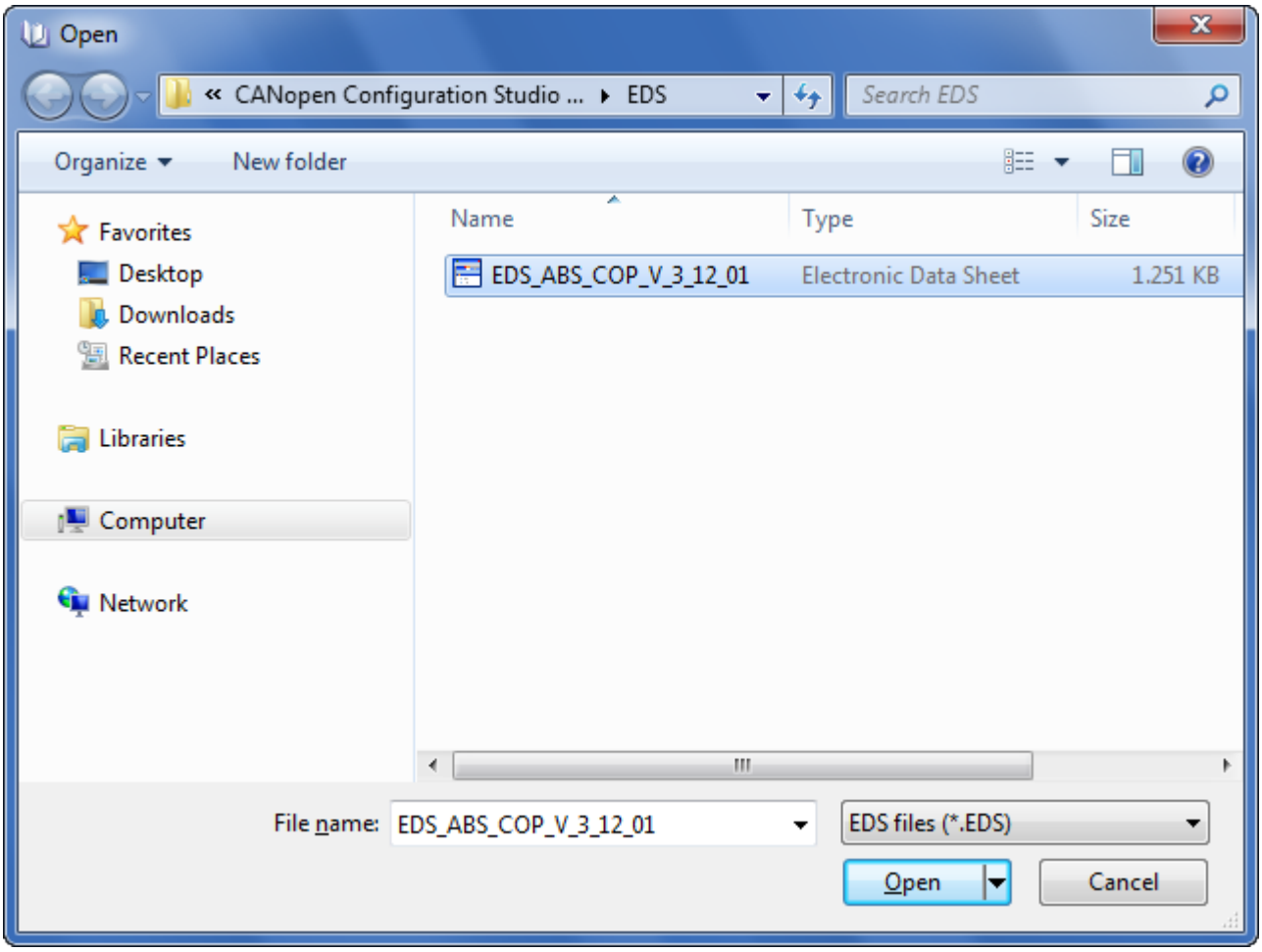
5.1.3.1 Import CANopen Devices to the Device Catalog

If it is required to integrate additional devices into a CANopen network to configure them with CANopen Configuration Studio for IXXAT CME/PN, their device description information has to be imported into the device catalog first.

To do this, the corresponding EDS files are required. Those files are either shipped with the devices or available from the WWW pages of the device vendor. In the example the description for an Anybus-S module by HMS Industrial Networks is imported into the device catalog.



Selection of an EDS device description file

This adds the device to the device catalog. It can now be used in CANopen Configuration Studio for IXXAT CME/PN projects.

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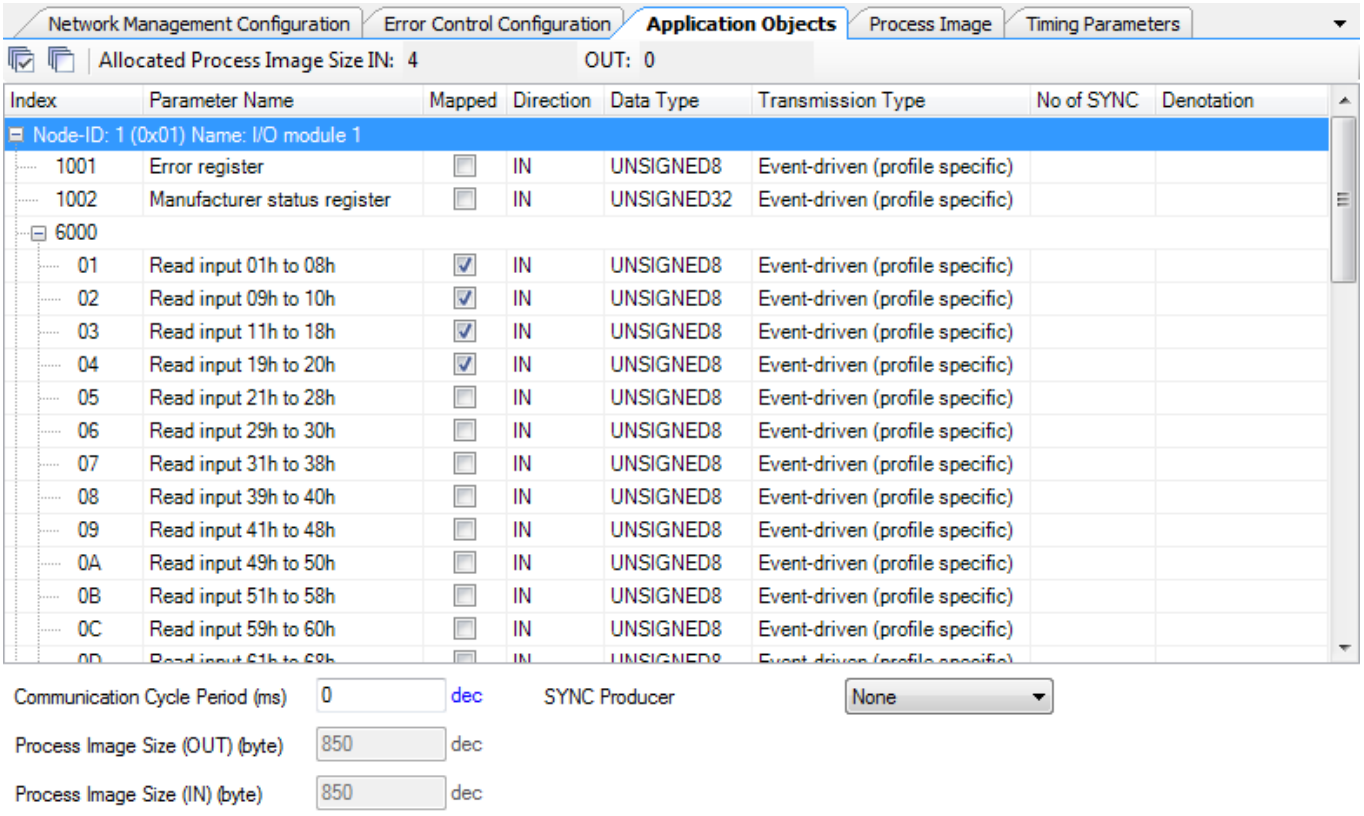
5.1.4 Selection of Process Data

To select the process data of the CANopen slave devices that shall be mapped into the process image on the IXXAT CME/PN, navigate to the Application Objects workspace page. On this page, a list of all the application objects that are mappable as process data is displayed. The application objects are sorted according to the node-ID of the device, their object index, and finally the sub-index of the entry.

Select individual application objects

To select application objects, click the checkbox in the `Mapped` column next to the parameter name. In the example below the first four digital input blocks of the CANopen I/O module 1 (object dictionary index 6000_h, sub-index range 01_h to 04_h) have been selected.



Selection of individual application objects for mapping into the process image of the IXXAT CME/PN

The buffer size allocated in the process image on the IXXAT CME/PN gateway can be simultaneously monitored in the application objects toolbar. As we have selected four UNSIGNED8 input objects, we see that 4 bytes are allocated in the process image. In the notation used by CANopen Configuration Studio for IXXAT CME/PN, IN denotes input objects on the CANopen slave devices, OUT denotes output objects on the slaves.

Current allocation status for process image IN and OUT

To verify the configuration of the PDO communication based on this object selection, navigate to the Build menu and select Calculate Configuration. This creates a structure with four new network variables in the process image on the IXXAT CME/PN gateway.

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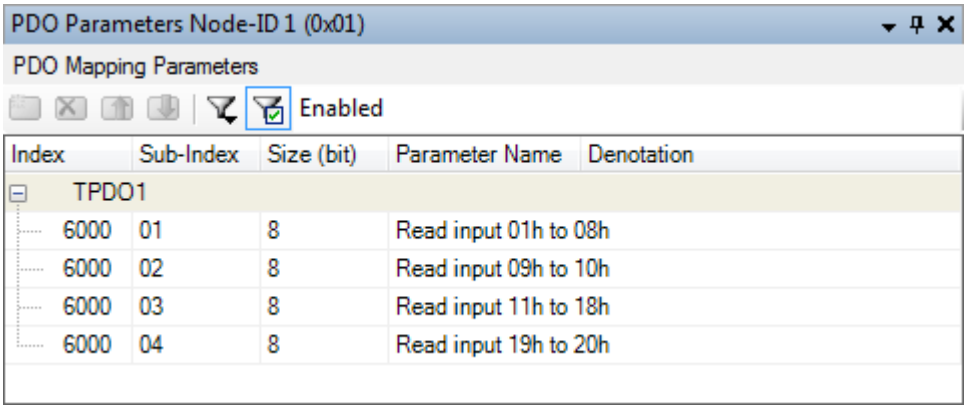
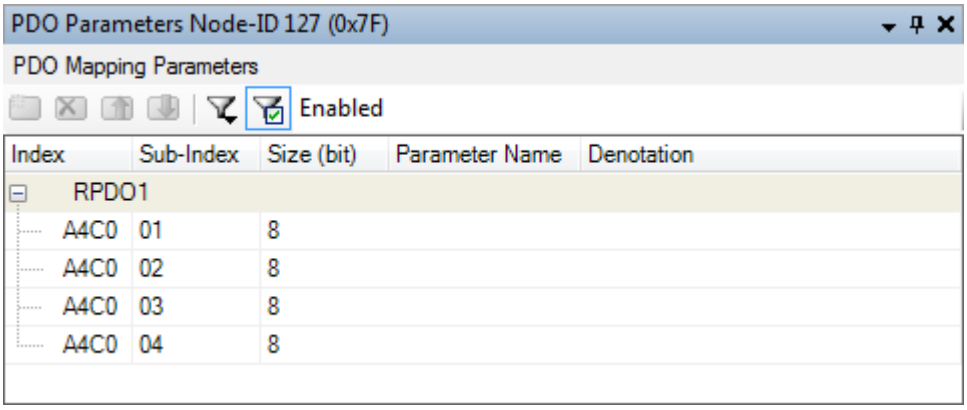
To inspect the resulting PDO configuration on the devices with node-ID 1 (I/O module) and node-ID 127 (IXXAT CME/PN) select the devices in the Project Explorer. In the PDO Parameters tool window we find that four network variables with object index $A4C0_h$, sub-indices 01_h to 04_h are mapped into RPDO1 on the IXXAT CME/PN gateway.



PDO mapping configuration for TPDO1 on node-ID 01_h



PDO mapping configuration for RPDO1 on node-ID $7F_h$

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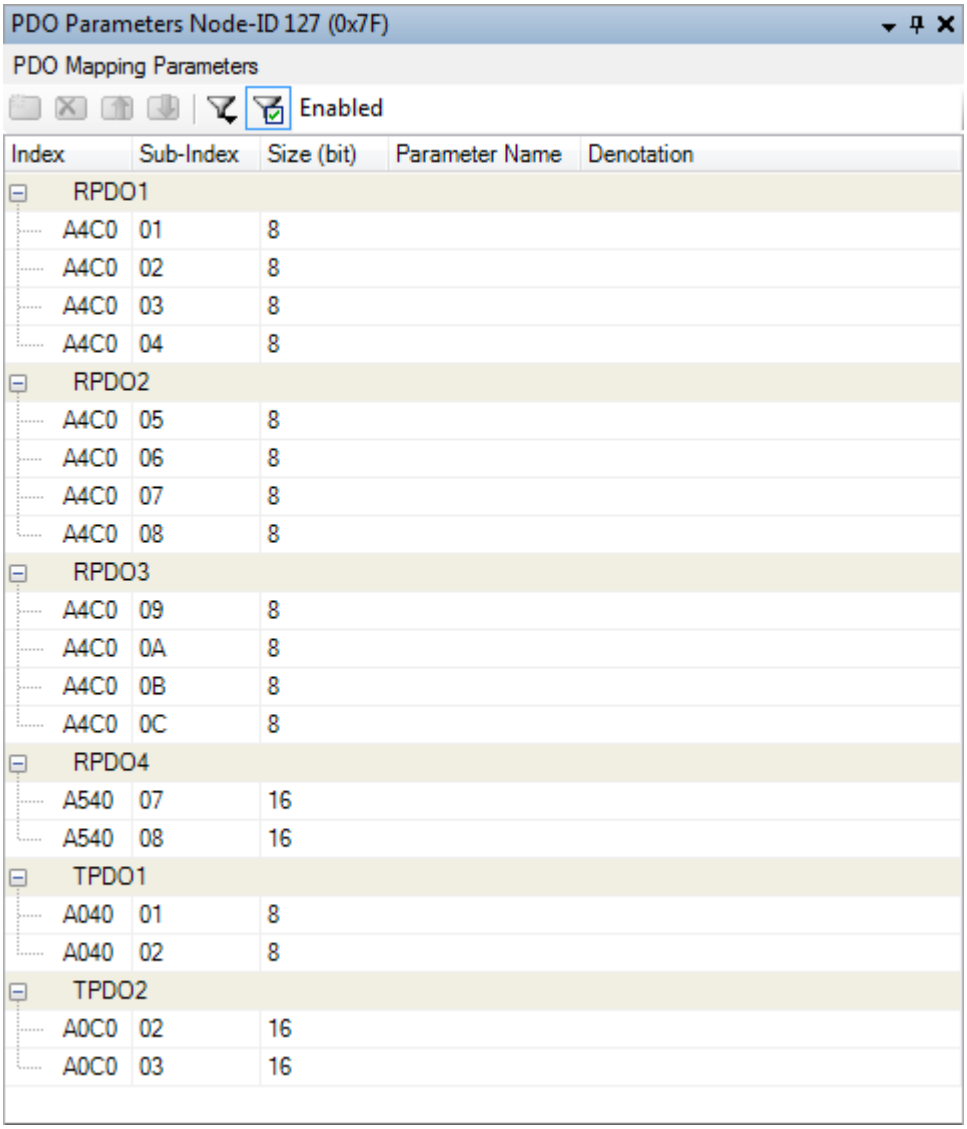
Repeat this operation for the other two I/O modules in the example network such that for each I/O module 4 digital input blocks are mapped. For I/O module 1 additionally select 2 digital output blocks (object dictionary index 6200_h, sub-index 01_h and 02_h), 2 analog input channels (object dictionary index 6401_h, sub-index 01_h and 02_h), and 2 analog output channels (object dictionary index 6411_h, sub-index 01_h and 02_h). A recalculation will result in the following PDO configuration on the IXXAT CME/PN gateway.



Index	Sub-Index	Size (bit)	Parameter Name	Denotation
RPDO1				
A4C0	01	8		
A4C0	02	8		
A4C0	03	8		
A4C0	04	8		
RPDO2				
A4C0	05	8		
A4C0	06	8		
A4C0	07	8		
A4C0	08	8		
RPDO3				
A4C0	09	8		
A4C0	0A	8		
A4C0	0B	8		
A4C0	0C	8		
RPDO4				
A540	07	16		
A540	08	16		
TPDO1				
A040	01	8		
A040	02	8		
TPDO2				
A0C0	02	16		
A0C0	03	16		

Final PDO mapping on the IXXAT CME/PN

Continue now with and inspection of the resulting process image layout.

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5.1.5 Inspection of the Process Image Layout

To see the resulting process image on the IXXAT CME/PN gateway after the calculation process, navigate to the Process Image workspace page. We see that we have created 14 input variables (1) and 4 output variables (2). Their exact offset in the process images IN and OUT is listed in the Address column (3), (4) on the right.

Network Management Configuration | Error Control Configuration | Application Objects | **Process Image** | Timing Parameters

default

Group	Direction	Node-ID	Index	Sub-Index	Parameter Name	Denotation	Data Type	Address	Size (bit)
default	IN (1)	1	6000	01	Read input 01h to 08h		UNSIGNED8	00000000 (3)	8
default	IN	1	6000	02	Read input 09h to 10h		UNSIGNED8	00000001	8
default	IN	1	6000	03	Read input 11h to 18h		UNSIGNED8	00000002	8
default	IN	1	6000	04	Read input 19h to 20h		UNSIGNED8	00000003	8
default	IN	2	6000	01	Read input 01h to 08h		UNSIGNED8	00000004	8
default	IN	2	6000	02	Read input 09h to 10h		UNSIGNED8	00000005	8
default	IN	2	6000	03	Read input 11h to 18h		UNSIGNED8	00000006	8
default	IN	2	6000	04	Read input 19h to 20h		UNSIGNED8	00000007	8
default	IN	3	6000	01	Read input 01h to 08h		UNSIGNED8	00000008	8
default	IN	3	6000	02	Read input 09h to 10h		UNSIGNED8	00000009	8
default	IN	3	6000	03	Read input 11h to 18h		UNSIGNED8	0000000A	8
default	IN	3	6000	04	Read input 19h to 20h		UNSIGNED8	0000000B	8
default	IN	1	6401	01	Analog input 01h		INTEGER16	0000000C	16
default	IN	1	6401	02	Analog input 02h		INTEGER16	0000000E	16
default	OUT (2)	1	6200	01	Write output 01h to 08h		UNSIGNED8	00000000 (4)	8
default	OUT	1	6200	02	Write output 09h to 10h		UNSIGNED8	00000001	8
default	OUT	1	6411	01	Analog output 01h		INTEGER16	00000002	16
default	OUT	1	6411	02	Analog output 02h		INTEGER16	00000004	16

Resulting process image layout on the IXXAT CME/PN after calculation of the PDO configuration

> Columns in the process image list may be freely reordered, thus the actual layout in your installation may differ from the screen dump pictured above.

Before we download the configuration to the IXXAT CME/PN gateway, we will setup device monitoring via CANopen NMT error control to detect device failures, or changes the NMT state that were not explicitly triggered by the NMT master in the network.

5.1.6 Configuration of NMT Error Control

With CANopen Configuration Studio for IXXAT CME/PN, the setup of the CANopen error control functionality is performed in the Error Control Configuration workspace page, in which the so called heartbeat parameters can be specified. Heartbeat is one of the two error control mechanisms specified by CAN in Automation in CiA 301. CiA recommends to use the heartbeat mechanism instead of the alternative node guarding protocol.

Node-ID	Logical Name	Heartbeat		Node Guarding			
		Producer Time	Consumer Time	Gua			ctor
1	I/O module 1	0	(List)	N/A			
2	I/O module 2	0	(List)	N/A			
3	I/O module 3	0	(List)	N/A	N/A	N/A	N/A
11	Servo drive X ax	0	(List)	N/A	N/A	N/A	N/A

Heartbeat Error Control
Parameters for the heartbeat based error control mechanism

Configuration entries for heartbeat or node guarding

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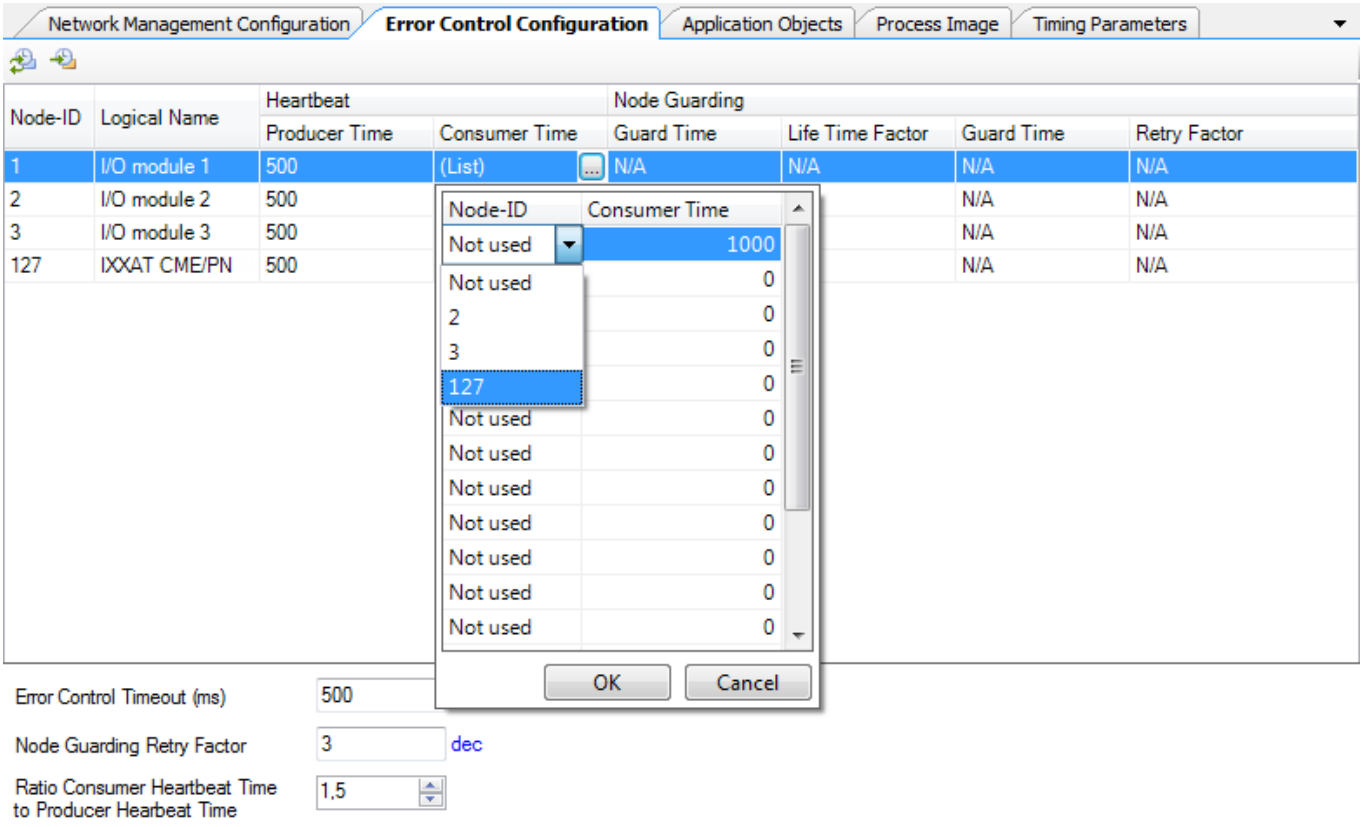
In the Producer Time column, we can configure how often we want the I/O module and the IXXAT CME/PN gateway to transmit heartbeat messages to indicate that they are operating as expected. In the example below, this is set to 500 milliseconds.

We also need to specify the heartbeat consumer time which is the time frame in which the receiving device expects a heartbeat message from the producer. For the I/O module 1, we click into the Consumer Time cell in the list. This will display an ellipsis button. If we click this button a list containing all available entries in the Consumer heartbeat time list on node-ID 1 will open.

In this list, we specify that I/O module 1 shall expect heartbeat messages from the IXXAT CME/PN, which is using node-ID 127, once every 1000 milliseconds. If the I/O module does not receive a corresponding heartbeat message from the IXXAT CME/PN, it will transmit an emergency message.

> According to CiA 301, heartbeat is an optional functionality. CANopen requires only that either heartbeat or node guarding shall be supported. If heartbeat is not implemented by a device, N/A will be displayed in the corresponding list cells. It is not mandatory to activate either heartbeat or node guarding.



Configuration of object 1016_h Consumer heartbeat on I/O module 1

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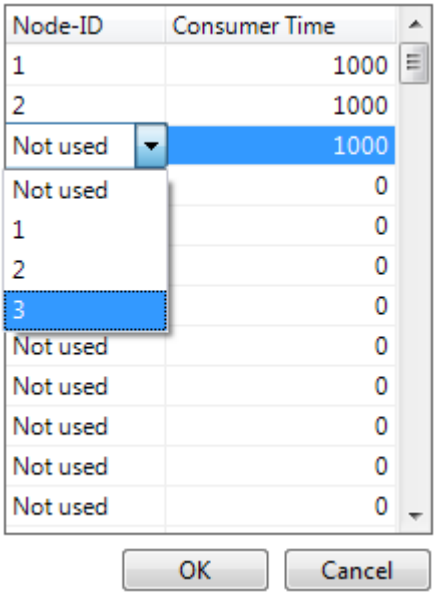
We repeat this configuration step for the other I/O modules and IXXAT CME/PN device, such that it expects a heartbeat message from the I/O module with node-ID 1, 2, and 3 once every 1000 milliseconds.



Configuration of object 1016_h Consumer heartbeat on the IXXAT CME/PN

We have now concluded our configuration and can continue to adjust the timing parameters for the IXXAT CME/PN module.

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5.1.7 Configuration of CANopen and PROFINET Timing Parameters

The setup of the IXXAT CME/PN timing parameters is performed in the Timing Parameters workspace page of CANopen Configuration Studio for IXXAT CME/PN. Two combo boxes support the specification of CANopen bit rate and PROFINET update time.

Select the CANopen bit rate first, for example 125 kBit/s. Then select the PROFINET update time less or equal to half of the shortest process data duration. Based on the configured parameters CANopen Configuration Studio calculates the PDO payload and estimates the total PDO transmission time.

If the estimated PDO transmission time is in the recommend range your selection will work even if all configured TPDOs and RPDOs are transmitted once during the PROFINET update time. You may now continue with the next step.

If the estimated PDO transmission time is out of the recommended range a warning icon will be displayed behind the total PDO transmission time field. In that case you should adjust the current settings. The following options are suggested:

- Select a higher CANopen bit rate to shorten the estimated PDO transmission time until the warning icon disappears.
- Select a slower PROFINET update time to reduce the frequency of PDO bursts. As a consequence the warning icon will disappear.

> ⚠ The PROFINET update time must be less or equal to half of the shortest process data duration.

- Ignore the warning icon if you have reliable information about the real PDO transmission time of your process and if this time is lower than the PROFINET update time.

Additional information is provided in the page on IXXAT CME/PN Timing Parameters

5.1.8 Generation of Configuration Data

Before the configuration can be downloaded to the IXXAT CME/PN gateway, the configuration data for the CANopen network have to be generated. This is performed by selecting Generate Configuration from the Build menu or the corresponding toolbar button. We save the generated configuration data into the same folder as our example network project.

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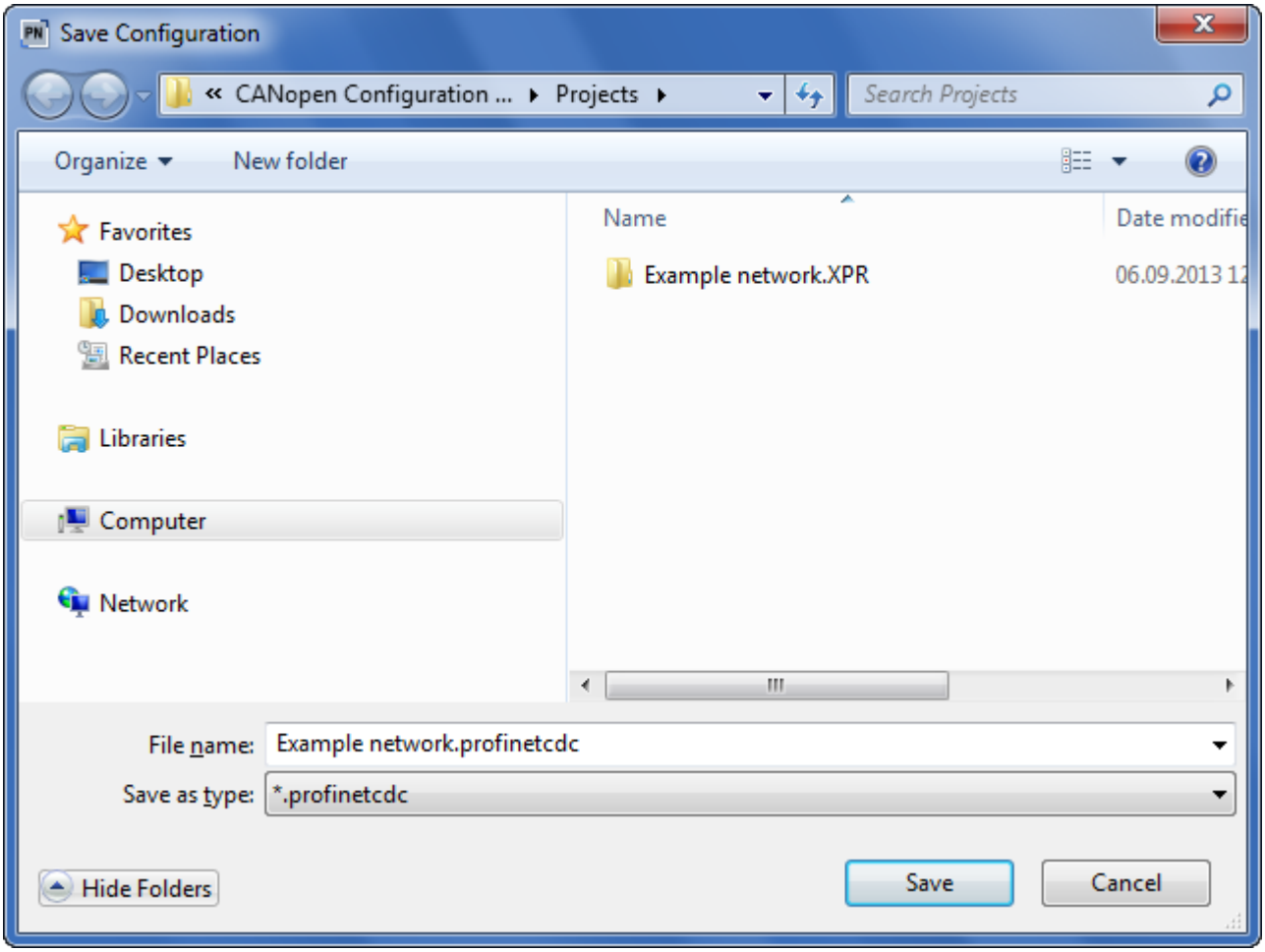

Selection of the device configuration file into which the network configuration data are written

This concludes the configuration and we can now download the configuration data to the IXXAT CME/PN gateway.

5.1.9 Download to the IXXAT CME/PN

Before starting the download it is required to specify the interface that will be used to transfer the configuration data to the IXXAT CME/PN. This may be performed via selecting the Network→Interface Configuration menu item or the corresponding toolbar button ( ) or directly from within the Download dialog via the Configure... button.

In this case the PC running CANopen Configuration Studio for IXXAT CME/PN is connected to the IXXAT CME/PN gateway via a USB cable.

If several IXXAT CME/PN devices are connected to the host PC, we need to select the module we want to download the configuration to.

Finally, we need to select the configuration file generated earlier and start the download process.

We have now generated and downloaded a simple CANopen configuration to the IXXAT CME/PN gateway. This step concludes the first tutorial.

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5.2 IXXAT CME/PN in a PROFINET Network

The subsequent sections demonstrate the integration of a CANopen network into a PROFINET system with the help of the IXXAT CME/PN gateway. The examples use the SIMATIC STEP 7 engineering software and SIMATIC S7-300 PLC as PROFINET IO controller.

The chapter is subdivided into:

1. Integration of the IXXAT CME/PN gateway into the SIMATIC STEP 7 project
2. Using the command and diagnostics interface

5.2.1 Integration of IXXAT CME/PN into the SIMATIC STEP 7 project

The following sections demonstrate how to integrate a configured IXXAT CME/PN into a PROFINET network. The example uses a SIMATIC S7-300 PLC as PROFINET IO controller. The system is configured with the SIMATIC STEP 7 engineering tool. The example covers the following steps:

1. Creating a new SIMATIC STEP 7 project
2. Configuration of the SIMATIC S7-300 PLC
3. Add the PROFINET device description for the configured IXXAT CME/PN gateway to the SIMATIC STEP 7 device catalog
4. Add the IXXAT CME/PN gateway to the PROFINET IO system
5. Set IP configuration and assign device name to IXXAT CME/PN
6. Add S7 Program Blocks
7. Compile and Download to the SIMATIC S7-300 PLC
8. Working with the SIMATIC S7-300 PLC and the IXXAT CME/PN in online mode

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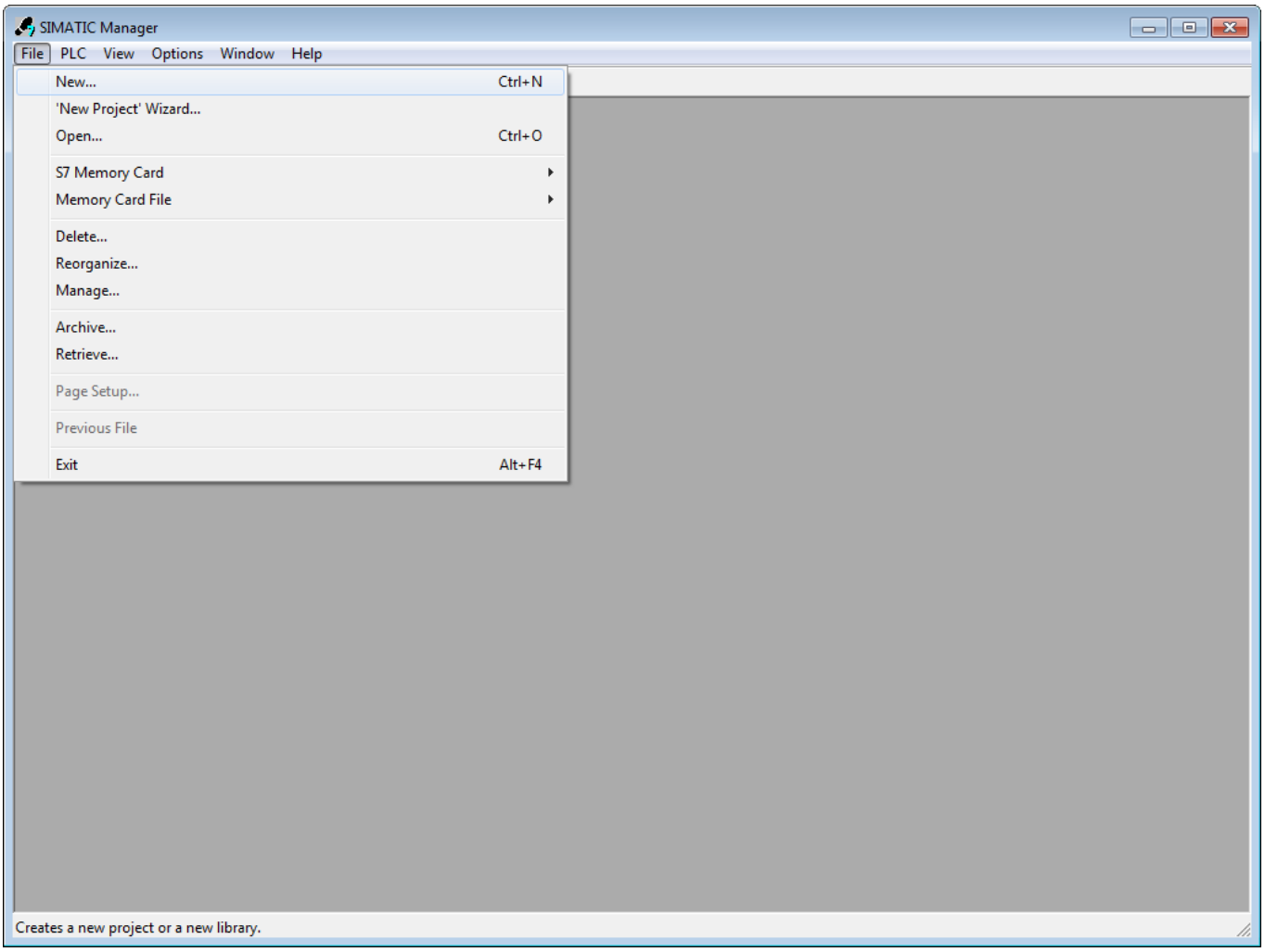
5.2.1.1 Creating a SIMATIC STEP 7 Project

To create a new SIMATIC S7 project open the SIMATIC Manager from the Windows start menu. The SIMATIC Manager is typically installed in the SIEMENS Automation→SIMATIC program group.



SIMATIC Manager

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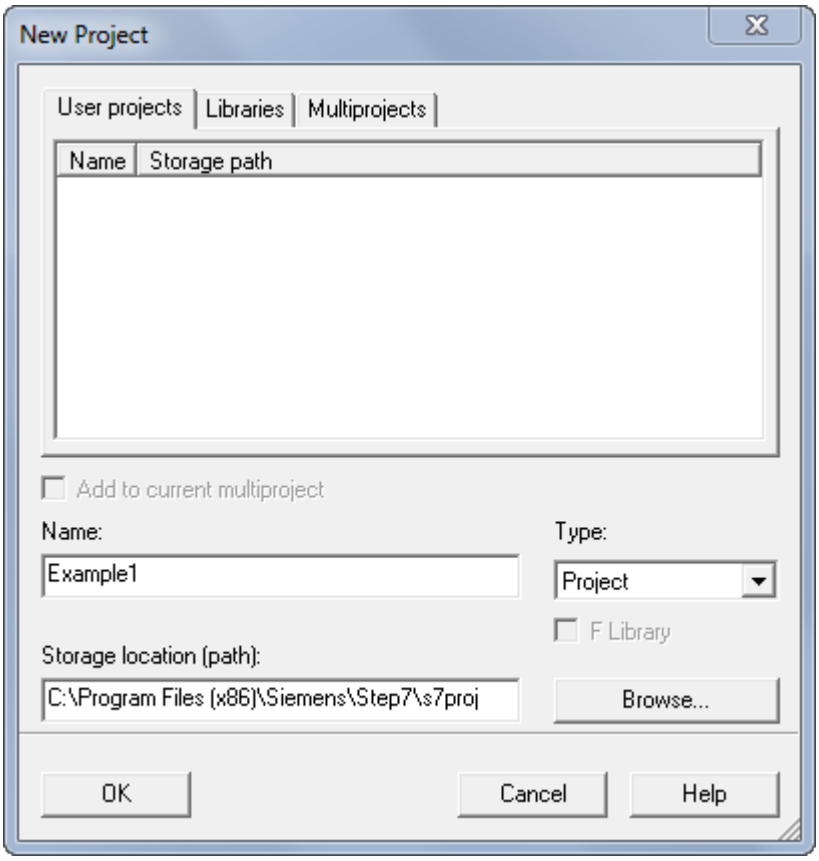
Open the New Project dialog with the File→New... menu item or the corresponding toolbar button and enter Example1 as project name.



New Project dialog of the SIMATIC Manager

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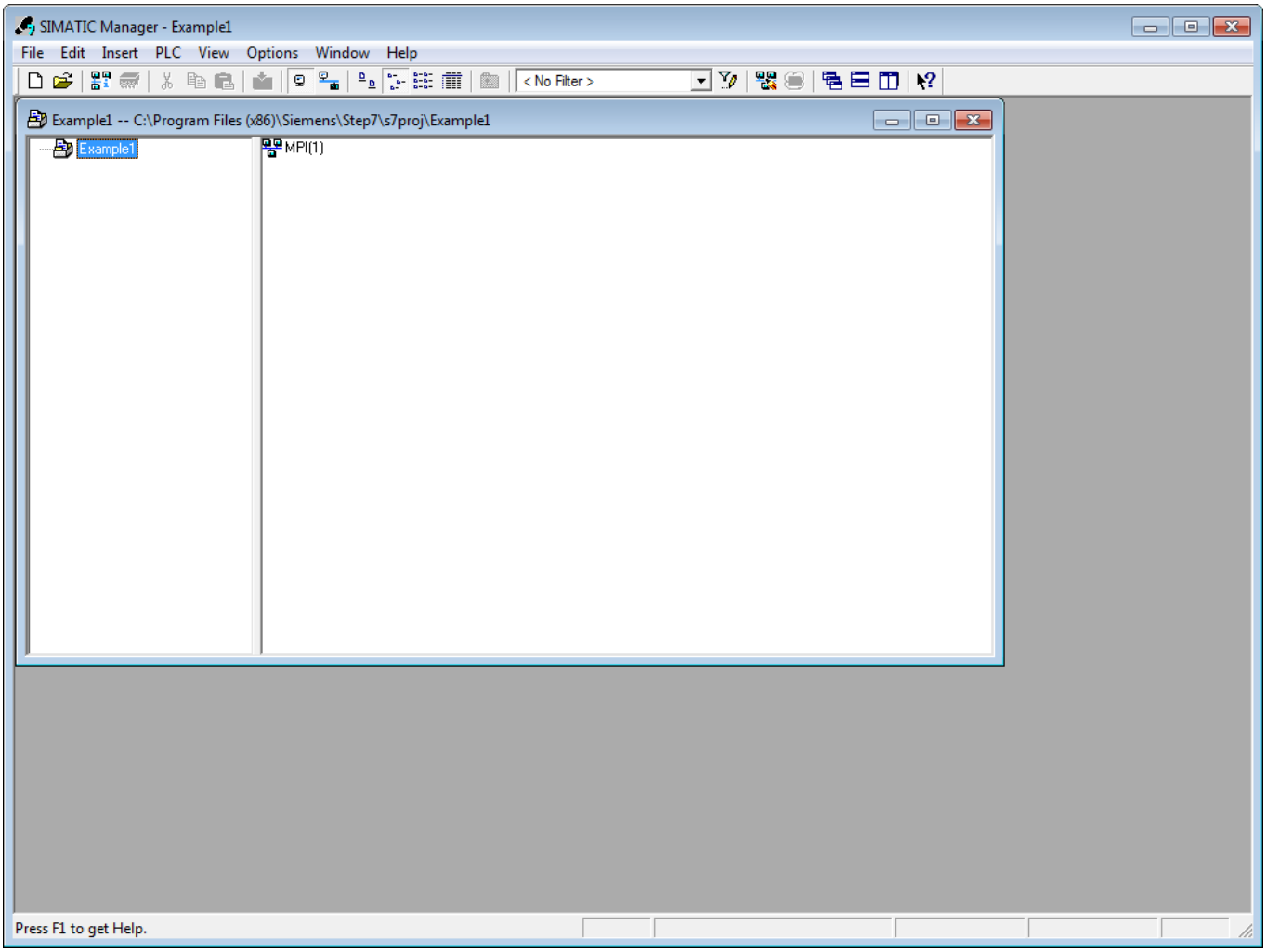

Empty Example1 SIMATIC project

Now that an empty SIMATIC STEP 7 project has been created, we continue to specify the SIMATIC S7-300 CPU unit and the PROFINET configuration to which we will connect the IXXAT CME/PN.

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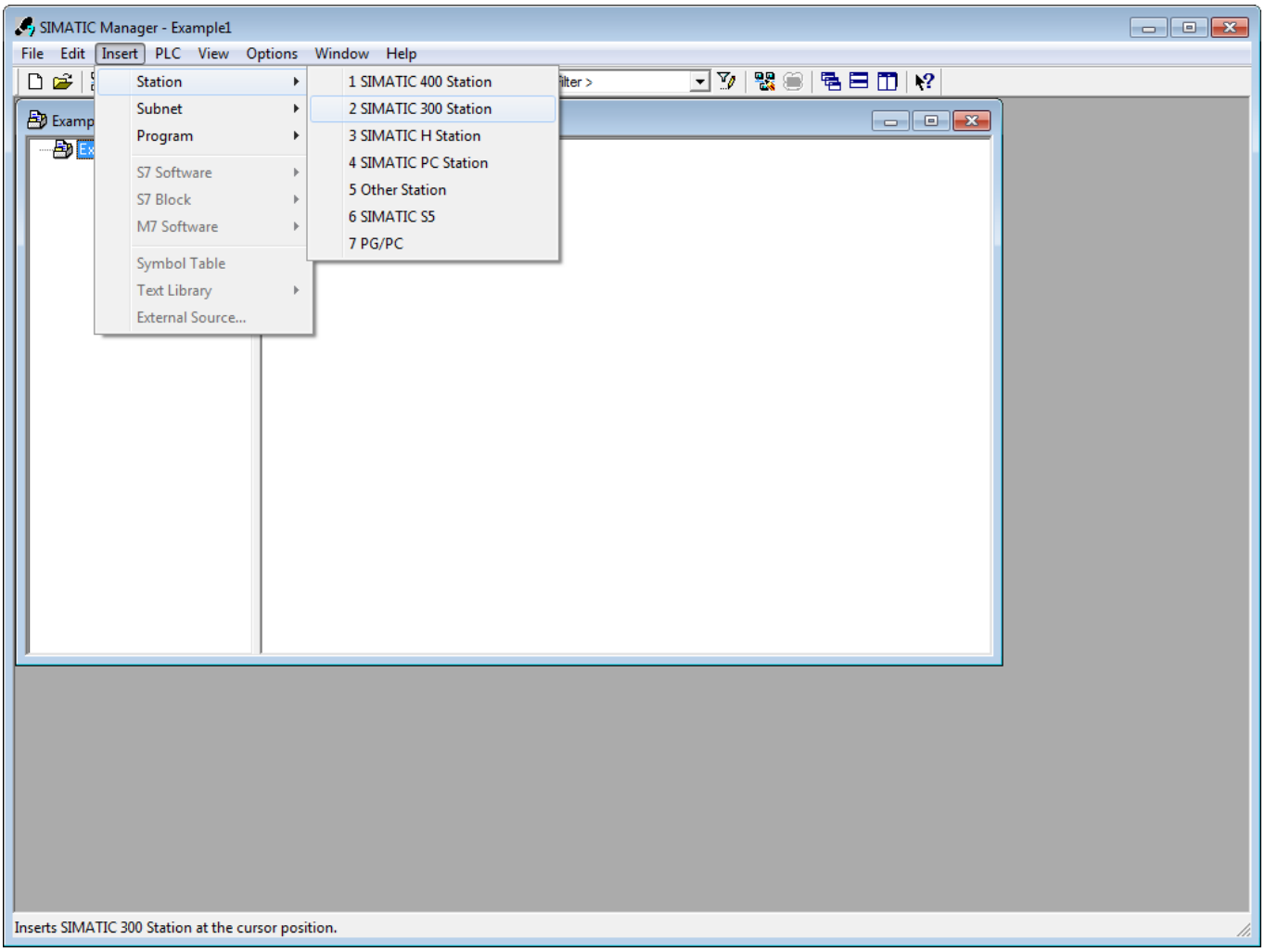
5.2.1.2 Configuration of the SIMATIC S7-300 PLC

In the first step of the definition of the PLC setup a SIMATIC station is inserted into the Example1 project. Select Insert→Station→SIMATIC 300 Station from the main menu of the SIMATIC Manager.



Insert SIMATIC 300 station

This adds one new SIMATIC 300 station to the project.

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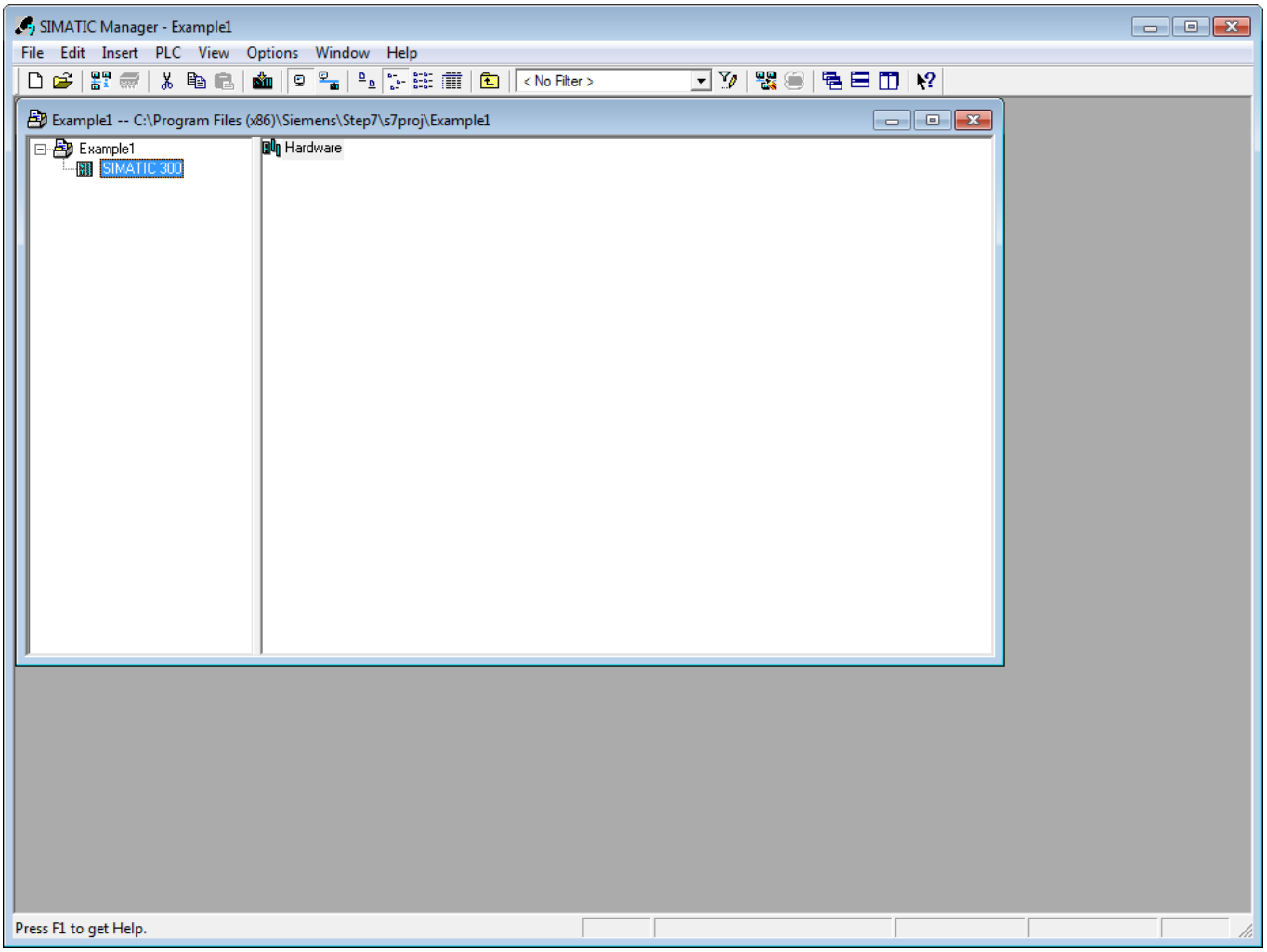

Example1 project with SIMATIC 300 station

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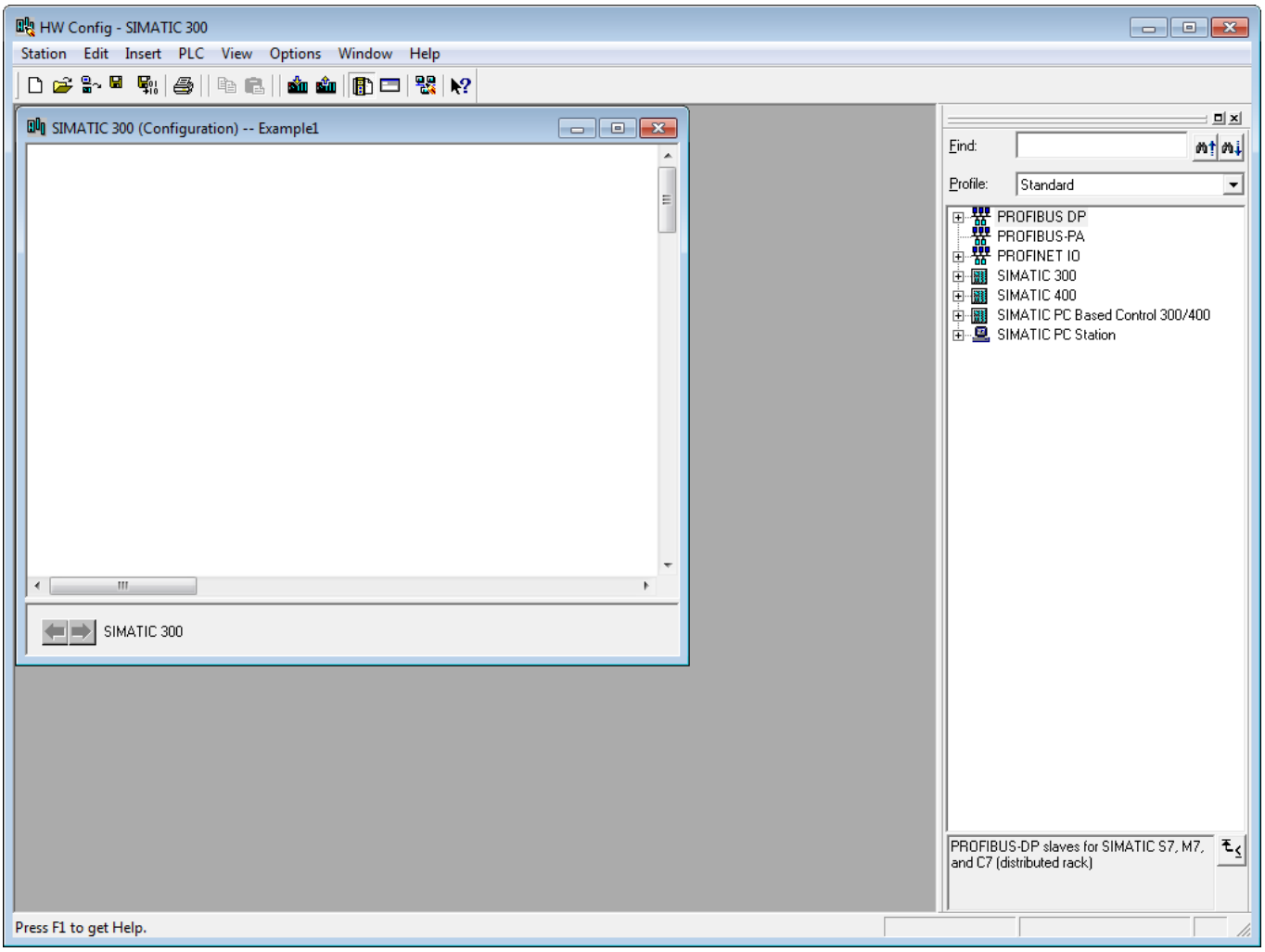
Opening the SIMATIC 300 object via the context menu, with the keyboard shortcut Ctrl+Alt+O, or by double-clicking the Hardware icon in the project will start the HW Config window the allows further configuration of the SIMATIC 300 station.



Hardware configuration windows of the SIMATIC STEP 7 software

Proceed in the following sequence:

1. In the hardware catalog, expand the SIMATIC 300 node ( ) and then expand the RACK-300 node. Drag the Rail icon ( ) and drop it in the configuration window.
2. In the hardware catalog, expand the SIMATIC 300 node ( ) and then expand the CPU-300 node. Expand the node that corresponds to CPU type used in your setup and drag the icon corresponding to the exact CPU version used ( ) and drop it in slot 2 of the rail previously added in step 1. In the case of the example demonstrated here this is a CPU 317-2 PN/DP → 6ES7 317-2EK13-0AB0 → V2.6.
3. When the CPU is dropped onto the rail a configuration dialog is displayed that requests the user to specify the IP address of the PN-IO interface.

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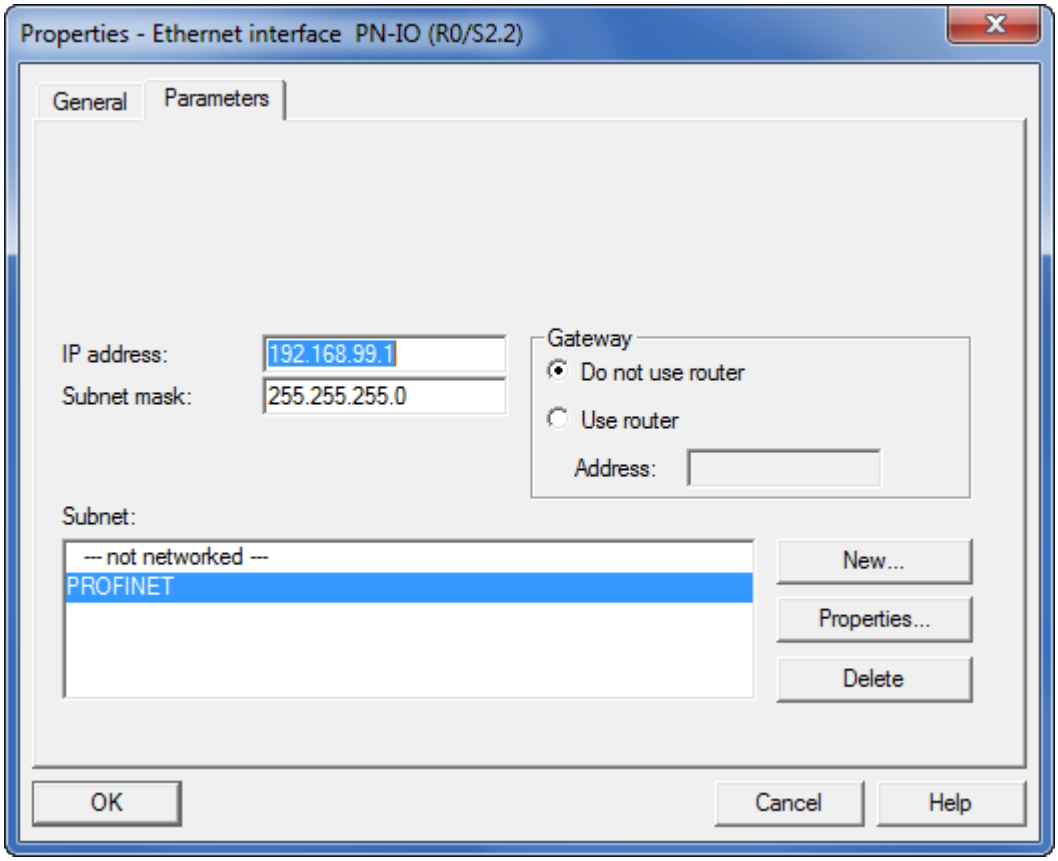

Properties of the PN-IO interface

For this example enter 192.168.99.1 and retail the subnet mask 255.255.255.0. Press New... to open the dialog to set the properties of the new industrial Ethernet subnet.

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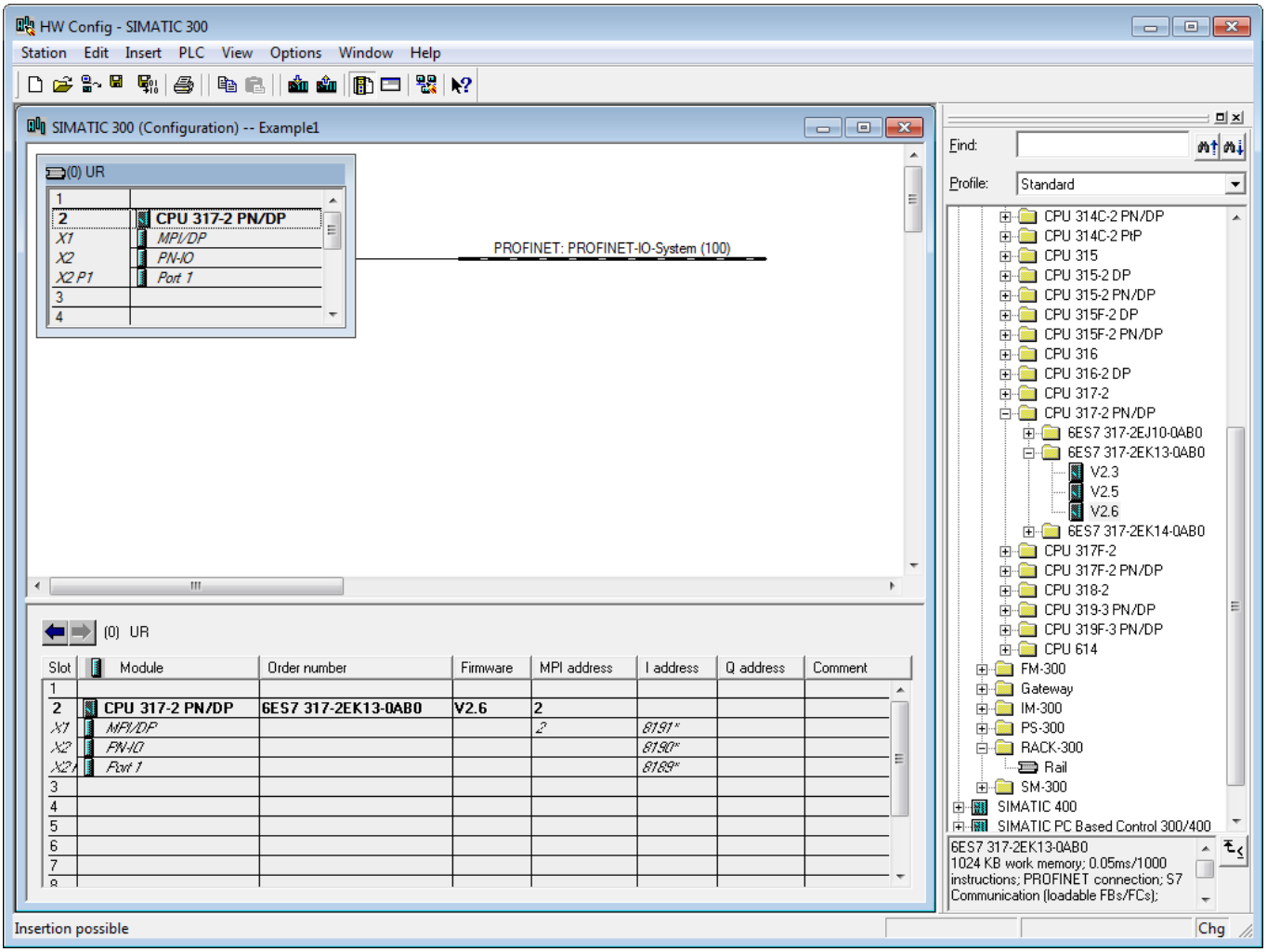

SIMATIC STEP 7 hardware configuration with CPU 317-2 PN/DP CPU and PROFINET IO system

Continue now to add the PROFINET device description for the Example1 IXXAT CME/PN project to the hardware catalog.

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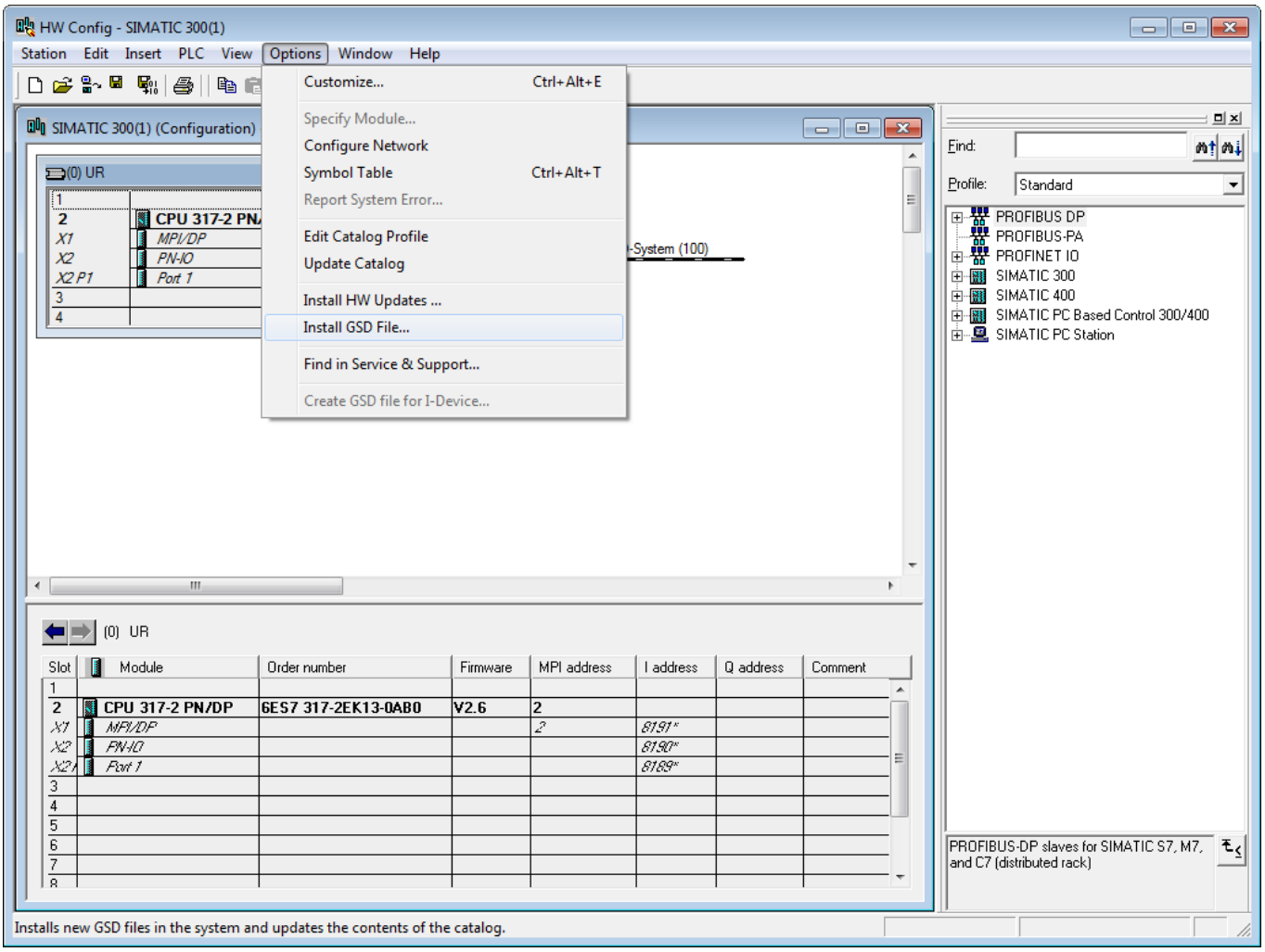
5.2.1.3 Add the PROFINET Device Description

In the hardware configuration window select Options→Install GSD File... from the main menu.



Open the Insert GSD Files dialog

In the dialog, navigate to the directory in your file system where the GSD file created in the Example1 has been saved. Select the corresponding XML file and click Install. The file name of the GSD file is composed according to the PNO GSDML specification:

1. "GSDML"
2. The version ID in format Vx.y whereby "x" and "y" are unsigned numbers. The version ID refers to the ID of the GSDML schema used. IXXAT CME/PN is based on version 2.3.
3. Vendor name, here "IXXAT"
4. Device family name. To distinguish between multiple projects, the name of the CANopen project is used. In our case this is "Example1"
5. Release date of the GSD in format yyyymmdd
6. Release time of the GSD in format hhmmss. "hh" is "00" up to "24". The indication of the release time is optional but used by IXXAT Automation GmbH
7. ".xml" (file extension)

For the example project the file name of the GSDML file is thus `GSDML-V2.3-IXXAT-Example1-20131022-234911.xml`.

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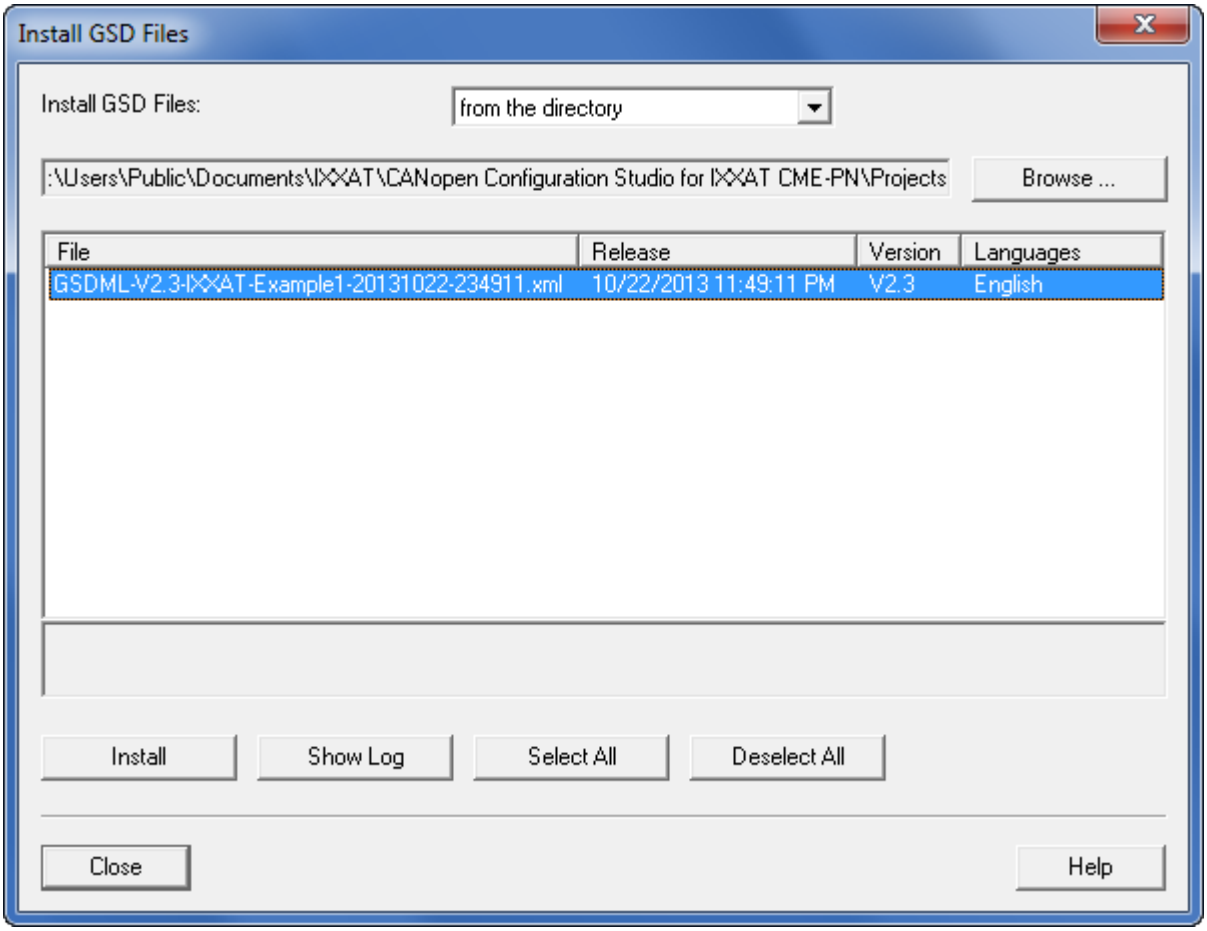

Selection of the GSD file to be inserted into the hardware catalog

Close the dialog and navigate to the hardware catalog. The IXXAT CME/PN device will be installed under the category PROFINET IO→Additional Field Devices→Gateway→IXXAT CME/PN.

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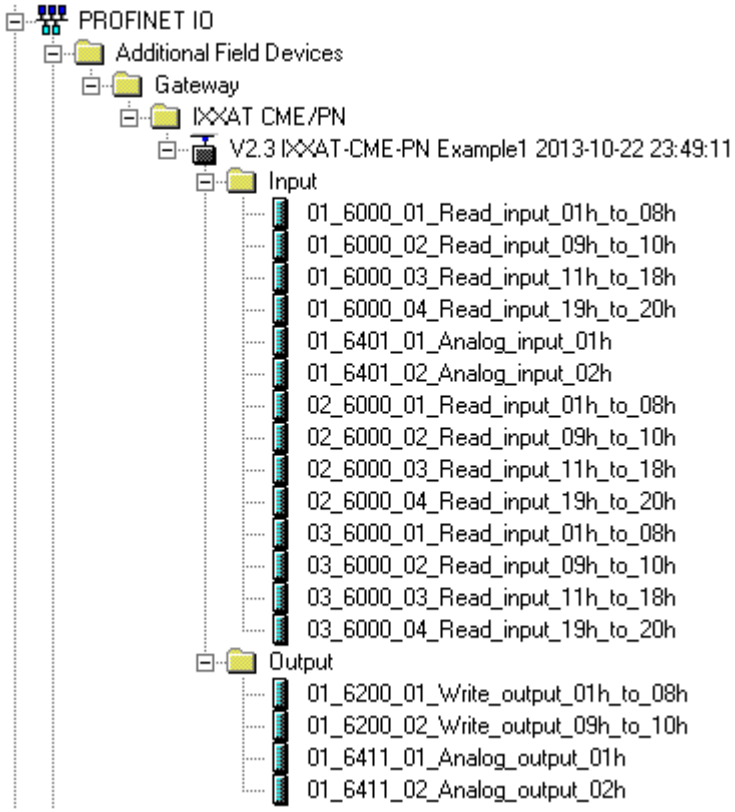

SIMATIC STEP 7 hardware catalog with the IXXAT CME/PN GSD added to the list of available devices

Under the IXXAT CME/PN device we also find categories for input and output. Opening these categories we identify exactly those application objects of the CANopen slaves devices that have been added to the process image of the CANopen manager on the IXXAT CME/PN during the prior CANopen network configuration. As naming convention CANopen Configuration Studio for IXXAT CME/PN uses a concatenation of the CANopen devices' node-ID, the object index and sub-index, and the parameter entry name.

Example:

```
01_6000_01_Read_input_01h_to_08h
```

Node-ID of the remote CANopen slave	`01`
Object index	`6000`
Object sub-index	`01`
Parameter name	`Read_input_01h_to_08h`

We continue to add the IXXAT CME/PN gateway to the PROFINET IO system in our SIMATIC STEP 7 project.

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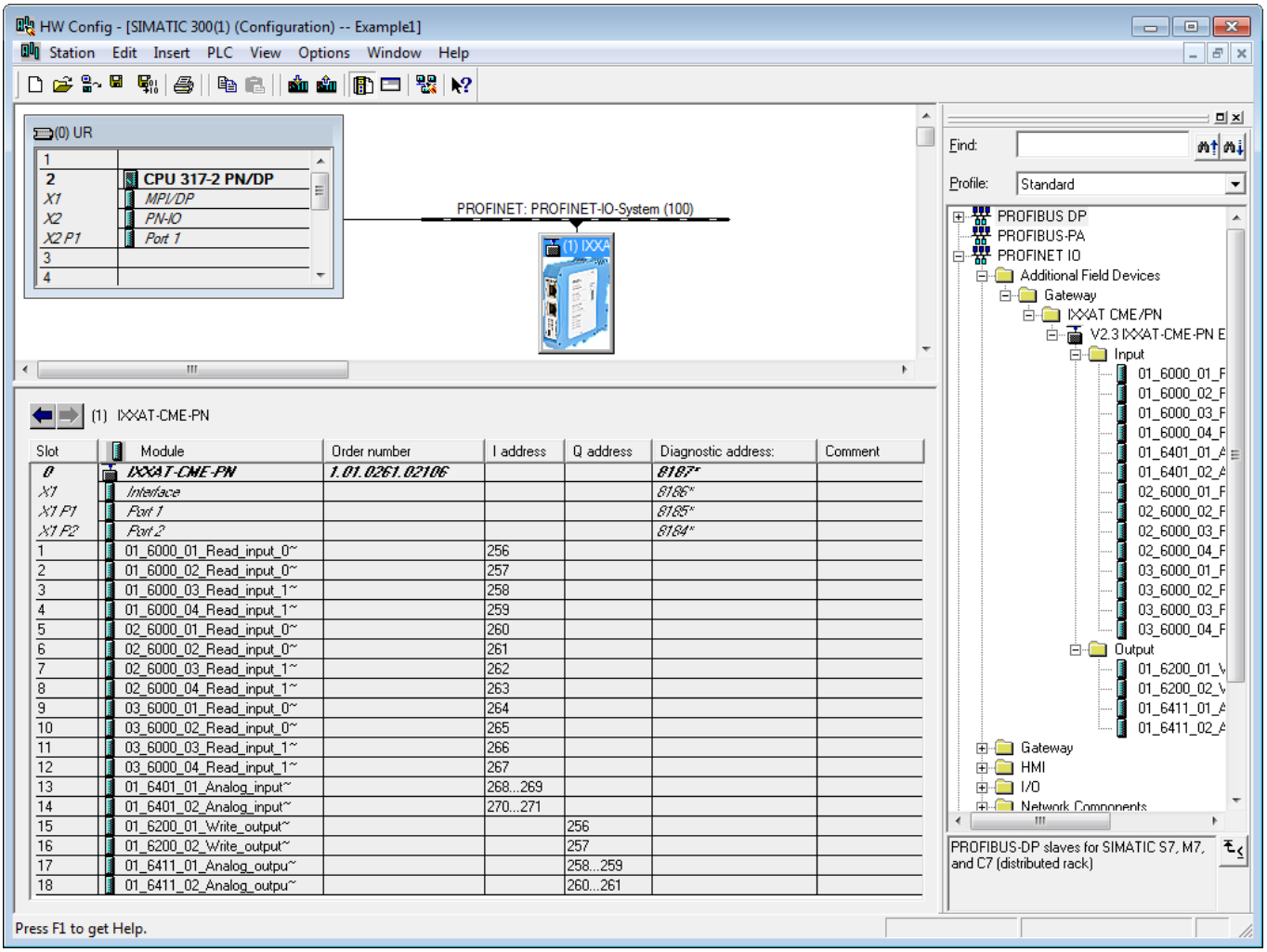
5.2.1.4 Add the IXXAT CME/PN Gateway to the PROFINET IO System

In the hardware catalog, expand the PROFINET IO→Additional Field Devices→Gateway→IXXAT CME/PN category in the device tree. Select the node corresponding to the previously created example project, drag it into your SIMATIC 300 configuration and drop it onto the PROFINET IO system.



SIMATIC 300 configuration with IXXAT CME/PN added to the PROFINET IO system. CANopen application objects are entered in slots under the IXXAT CME/PN

The gateway modules are automatically entered into the correct slots. In the slots, the module names are truncated to a total of 24 characters each.

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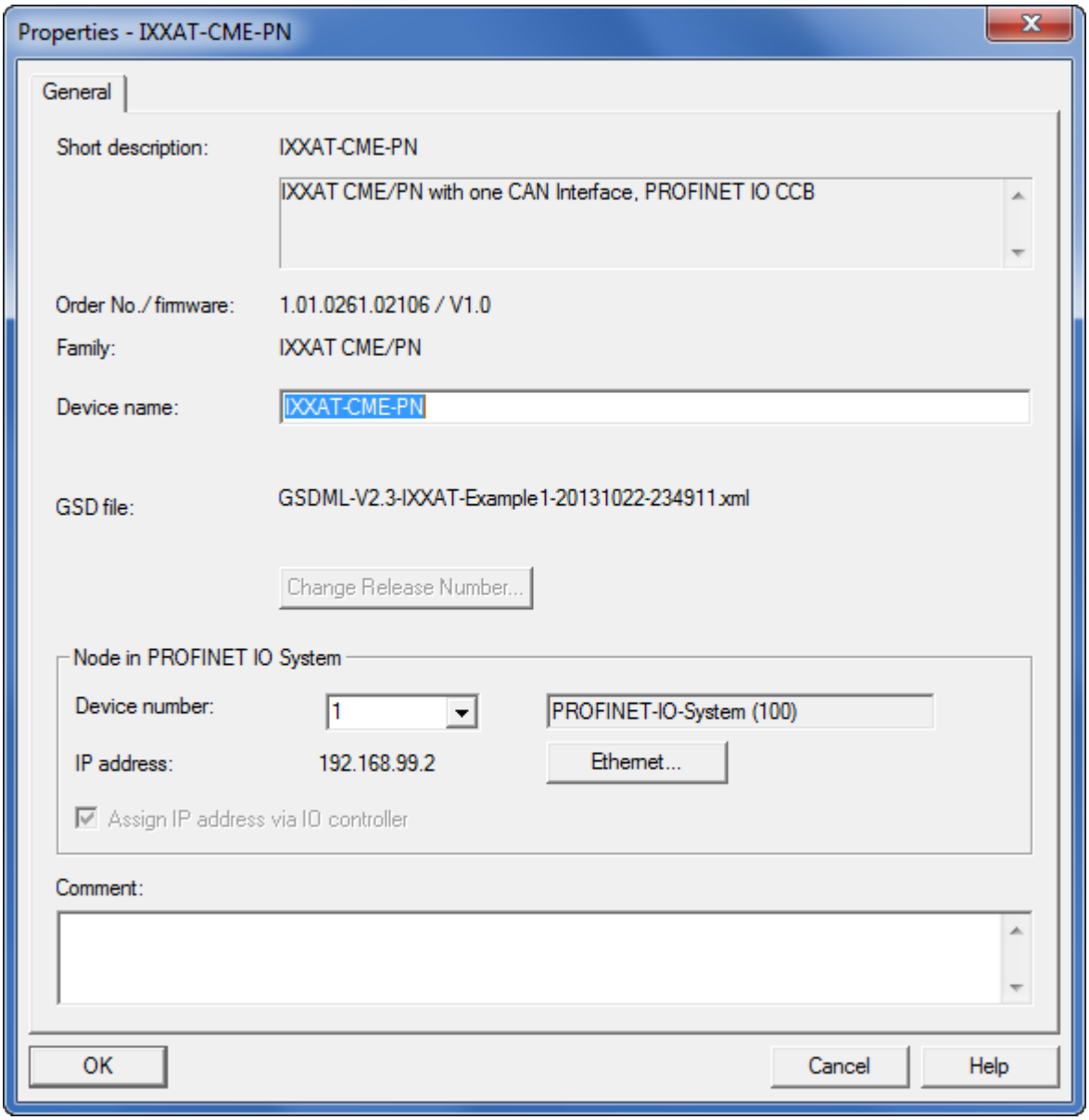
The next step verifies the configuration of the IXXAT CME/PN gateway. Double-click the CME/PN icon in the configuration window to open the IXXAT-CME-PN properties dialog. Check device name (IXXAT-CME-PN) and IP address (192.168.99.2, the next available address in the PROFINET IO subnet of the CPU) and click OK to confirm the settings.



IXXAT CME/PN properties dialog

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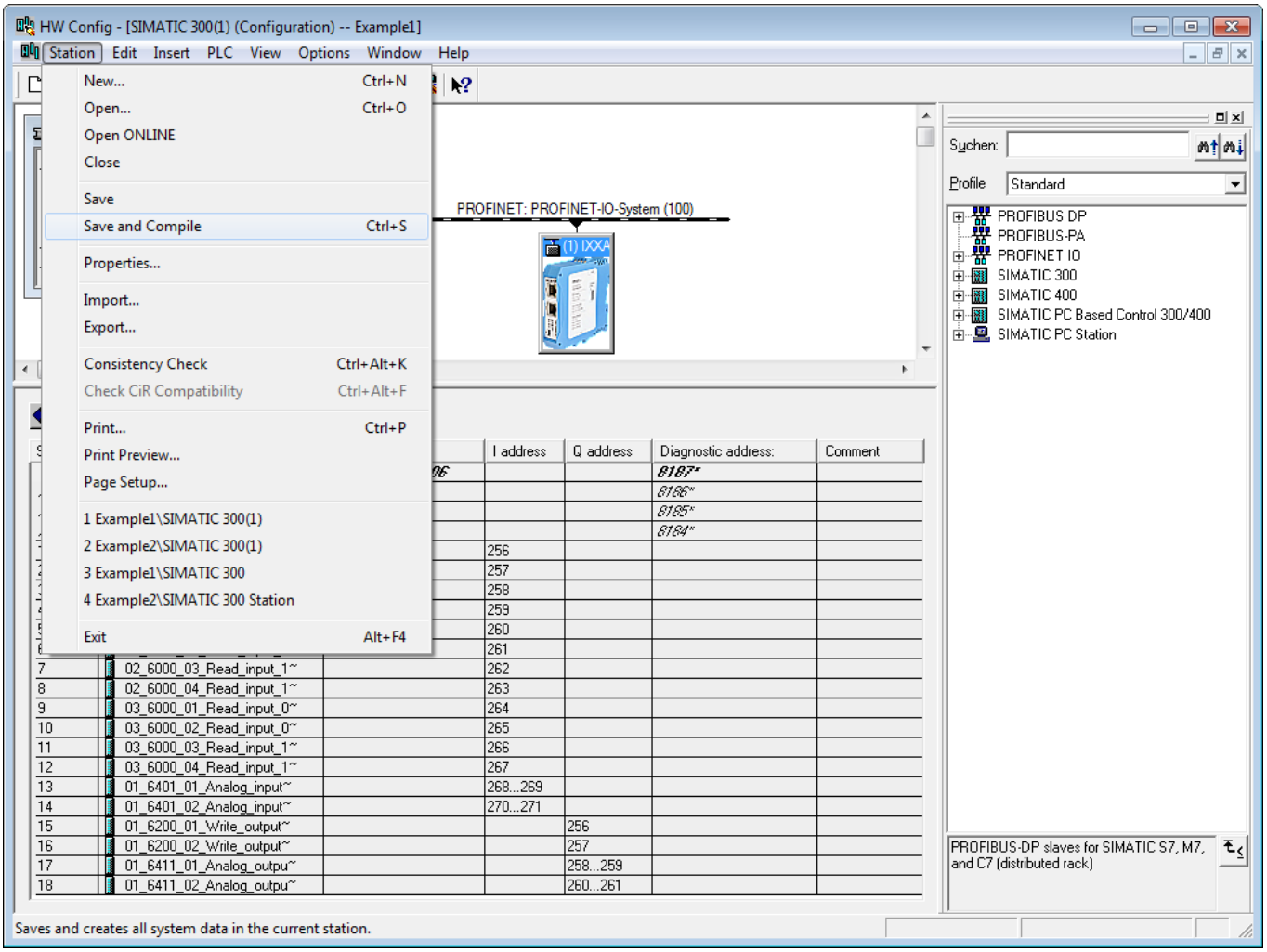
In the final step of the offline hardware configuration in the HW Config window select Station→Save and Compile.



Save and compile the hardware configuration in the HW Config window

We continue to configure the IXXAT CME/PN IP address and device name.

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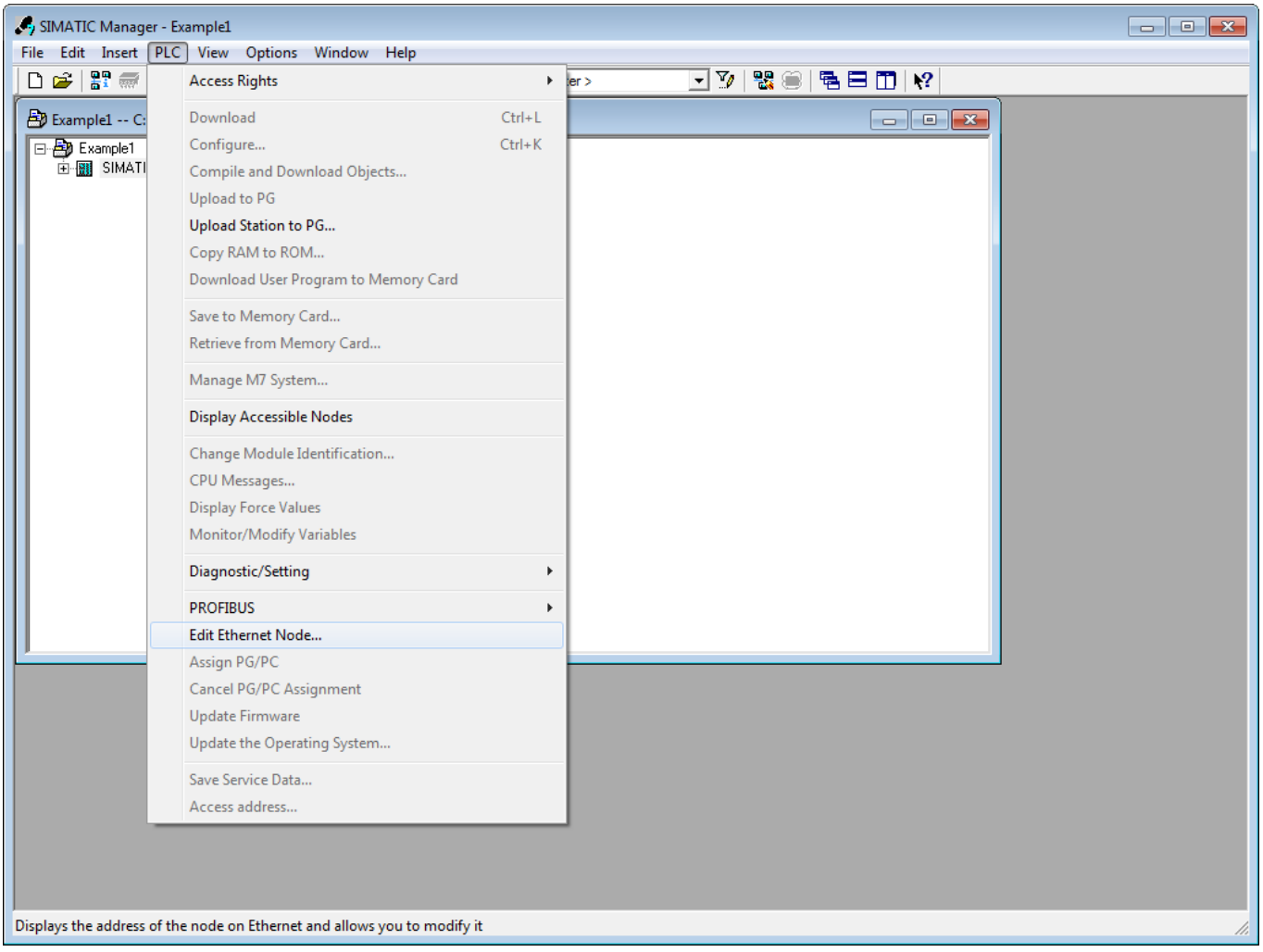
5.2.1.5 Set IP Configuration and assign Device Name to IXXAT CME/PN

We now have defined a PROFINET topology in STEP 7 consisting of SIMATIC S7-300 PLC as PROFINET IO controller and IXXAT CME/PN as PROFINET IO device. We also need to parameterize the IXXAT CME/PN device such that it corresponds to the projected STEP 7 configuration. In factory settings, IXXAT CME/PN is shipped with the IP address set to 0.0.0.0 and an empty device name. For this step, verify that SIMATIC S7-300 and IXXAT CME/PN are powered and connected as depicted in the introductory section on example 1. Return to the SIMATIC Manager and select PLC→Edit Ethernet Node... from the main menu.



Open the Edit Ethernet Node dialog to assign IP address and device name

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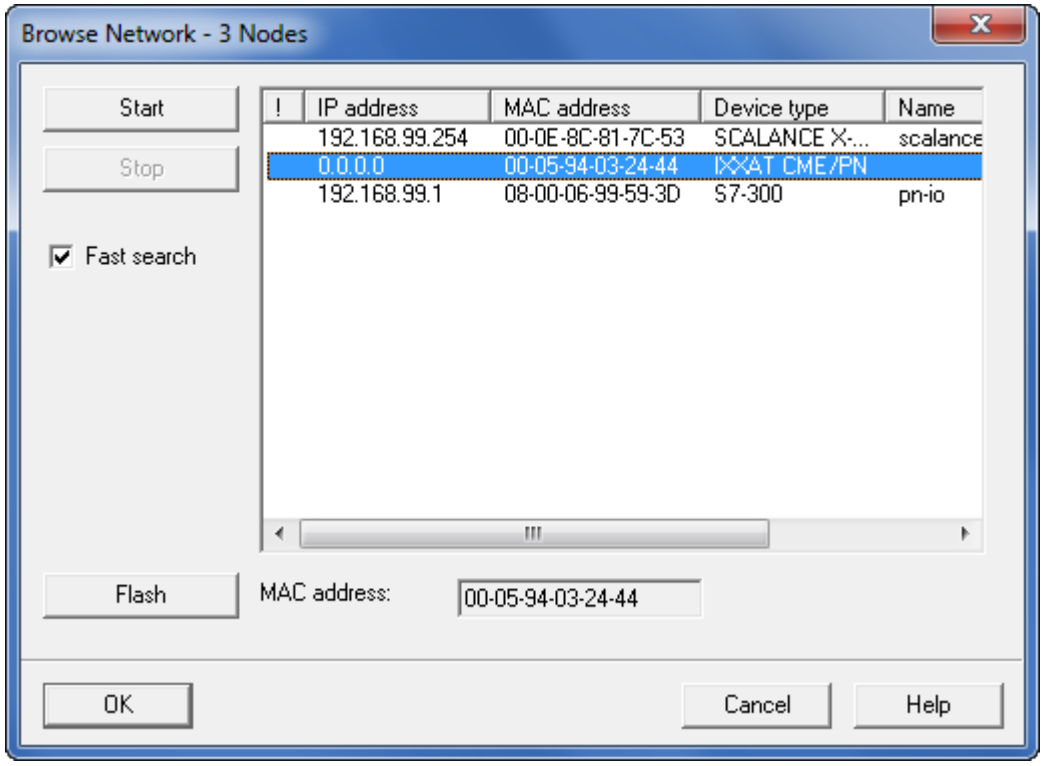
In the Browse Network dialog browse for accessible nodes and select the IXXAT CME/PN.



Browse for accessible Ethernet nodes. Select the line with the device type IXXAT CME/PN

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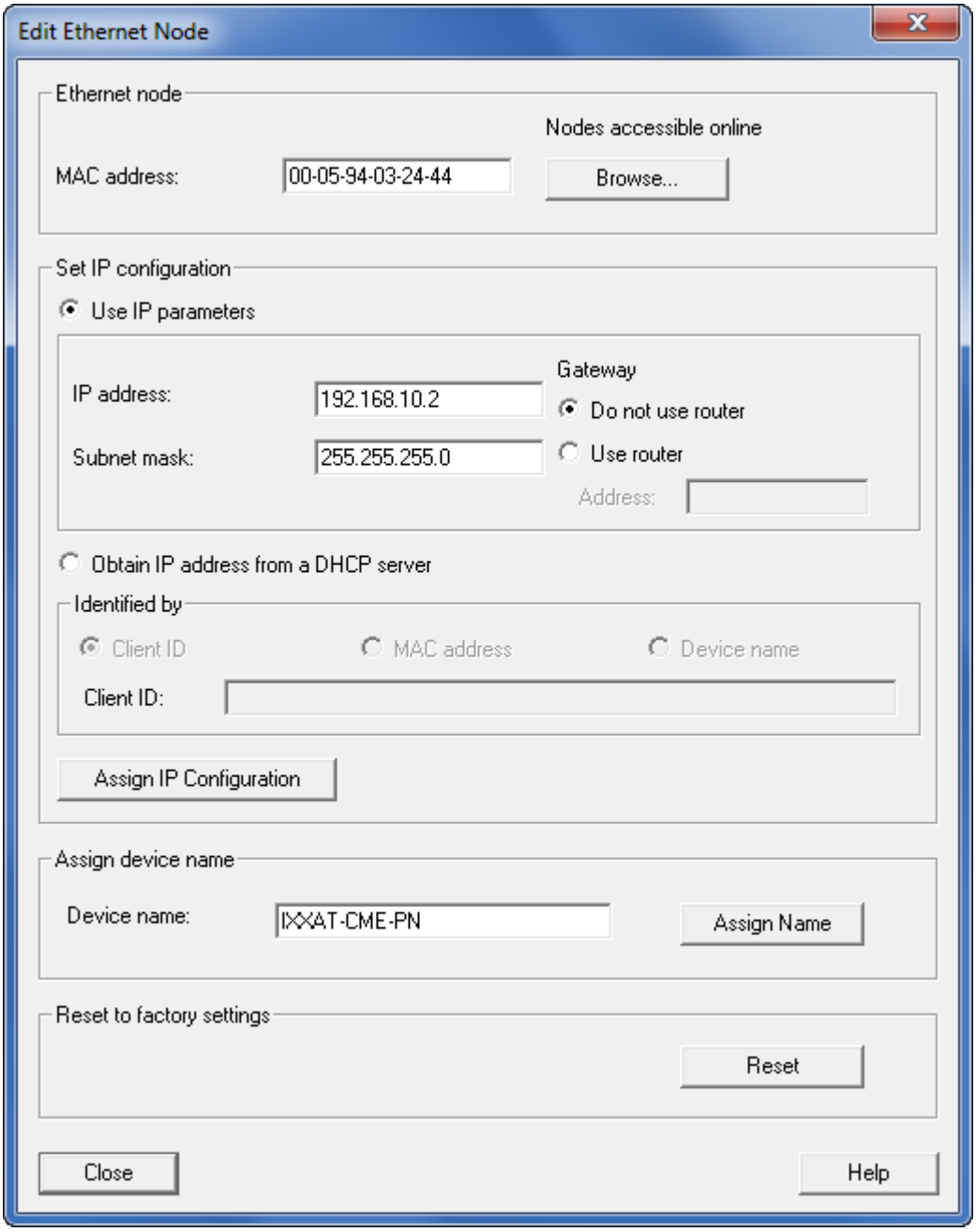
In the Edit Ethernet Node dialog enter IP address and subnet mask in the Set IP configuration group. Press Assign IP Configuration. Also assign the device name.

> ⚠ Make sure that the IP address and device name correspond exactly to IP address and device name set in the properties dialog of the hardware configuration.



Edit Ethernet Node dialog. Assign IP address, subnet mask, and device name

The basic configuration steps are now finalized. In the next section we add required S7 program blocks to the PLC program.

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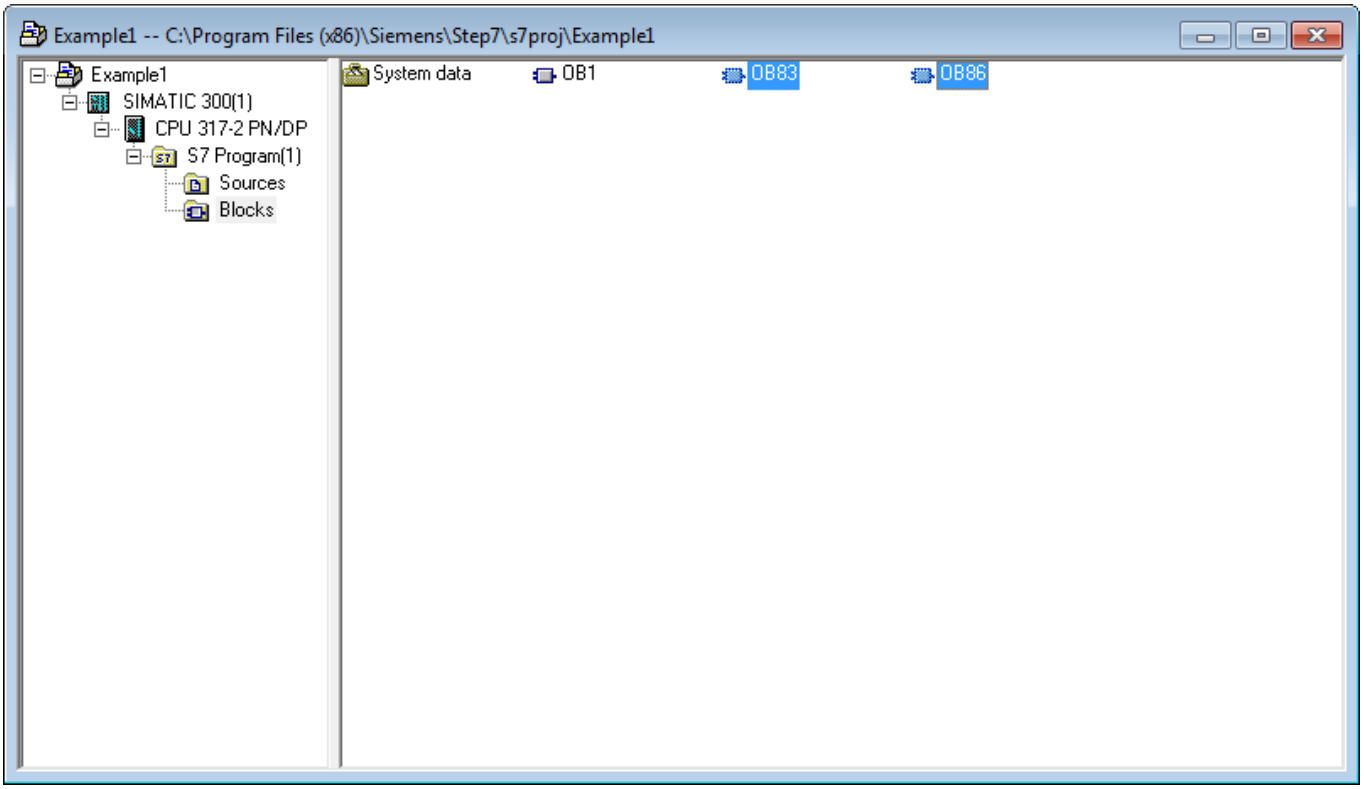
5.2.1.6 Add S7 Program Blocks

Compiling the S7-300 hardware configuration automatically creates the program cycle organization block OB1. This block is required to execute the user program in the S7 CPU. OB1 is executed periodically by the operating system of the S7 CPU.

To successfully operate IXXAT CME/PN with a SIMATIC S7 CPU, organization blocks OB83 and OB86 have to be created in addition. OB83 and OB86 are required by the `Return of submodule` alarm which is mandatory according to the PROFINET specification. For further information on OB83 and OB86 consult the SIMATIC STEP 7 documentation or the online help of the SIMATIC manager.

To create OB83 and OB86 navigate to the SIMATIC Manager window and expand the SIMATIC300(1) node. Under CPU317-2 PN/DP→S7 Program right-click on Blocks and select Insert New Object→Organization Block. In the dialog enter OB83 in the Name text field and confirm. Repeat this for OB86.



SIMATIC Manager window with required organization blocks OB83 and OB86

We continue to compile and download the hardware configuration and the STEP 7 program into the SIMATIC S7-300 PLC.

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5.2.1.7 Compile and Download to S7-300

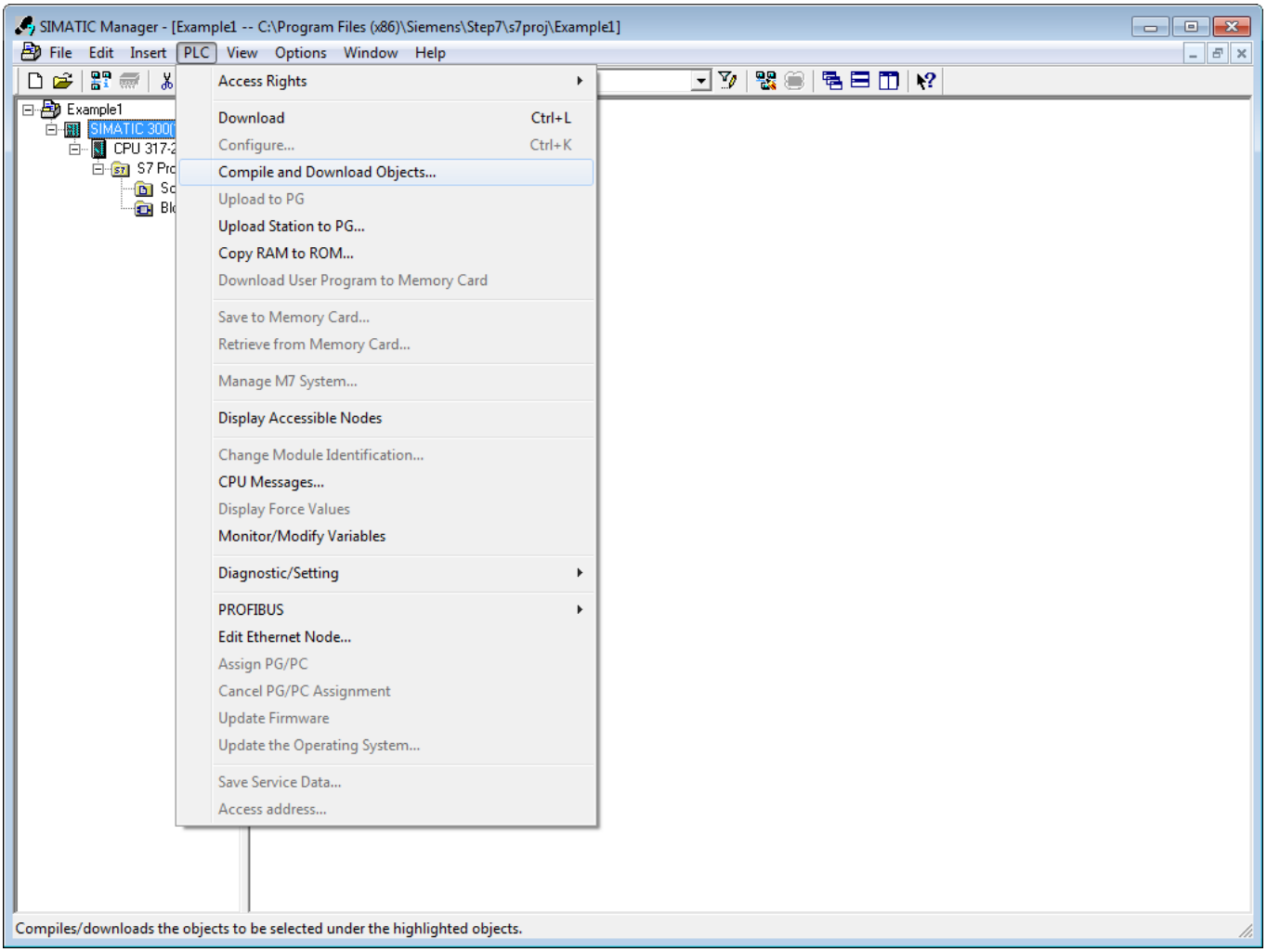
⚠ Prior to downloading the hardware configuration and the STEP 7 program the CANopen network configuration has to be downloaded into the IXXAT CME/PN device. This configuration must match the GSDML file used to implement the PROFINET configuration.

Download of the CANopen network configuration is supported via USB or via Ethernet:

USB: Download from within CANopen Configuration Studio for IXXAT CME/PN. For details on the CANopen configuration download see the sections Download of Configuration Data or Download to the IXXAT CME/PN. Then proceed with the compilation of the hardware configuration and the STEP 7 program.

Ethernet: Download from the SIMATIC HW Config window.

We continue with the compilation of the hardware configuration and the STEP 7 program. In the SIMATIC Manager window, select the SIMATIC S300(1) node in the Example1 tree and then in the menu system select PLC→Compile and Download Objects...



Compile and Download Objects

In the compile and Download Objects dialog, select the Compile only checkbox and select all objects. Start the compilation with the Start button. On completion close this dialog.

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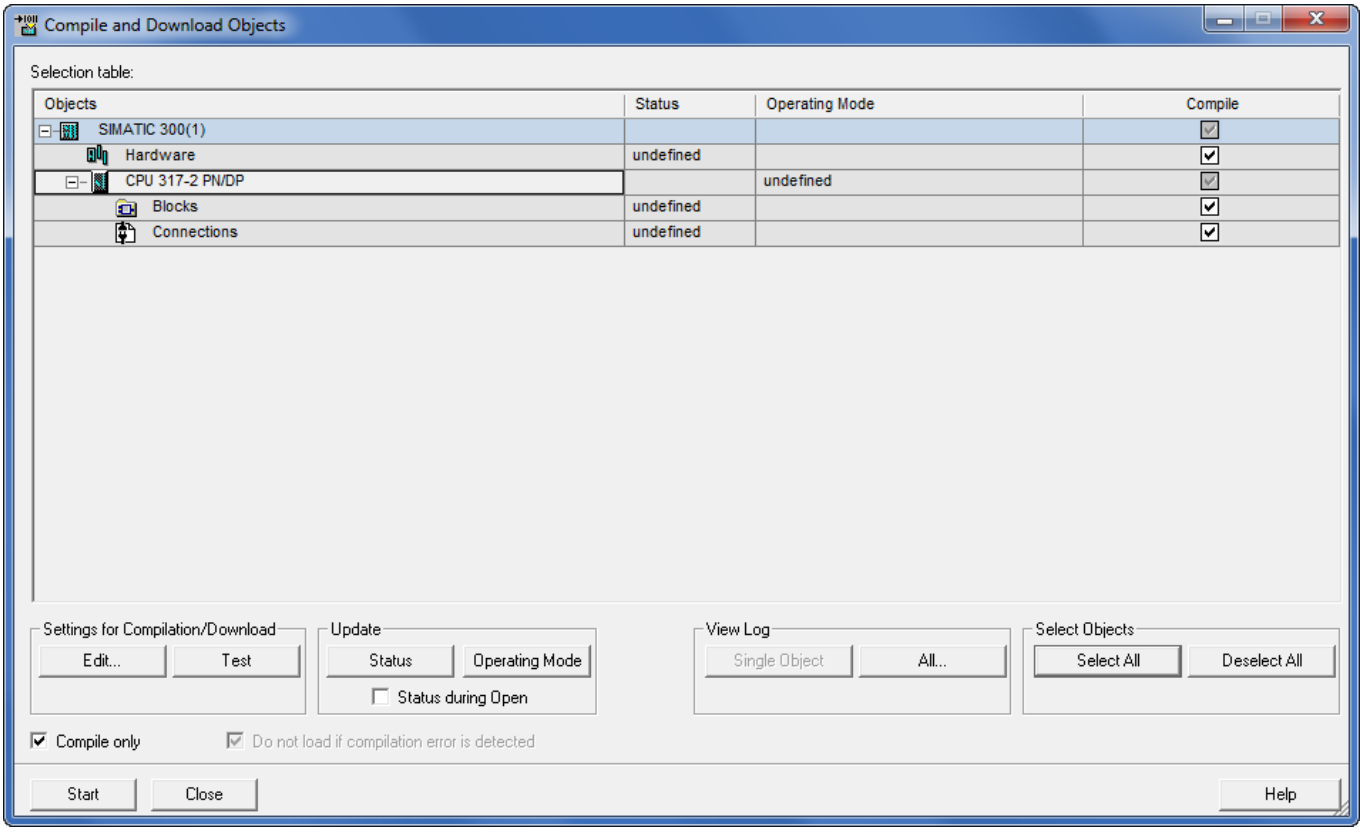

Compile and Download dialog

Finally download the hardware configuration and the STEP 7 program into the S7-300 PLC. In the SIMATIC Manager window, select the SIMATIC S300(1) node in the Example1 tree and then in the menu system select PLC→Download.

We use the menu item PLC→Download for the download. Other than the menu item PLC→Compile and Download Objects... this menu item enforces the download of all objects.

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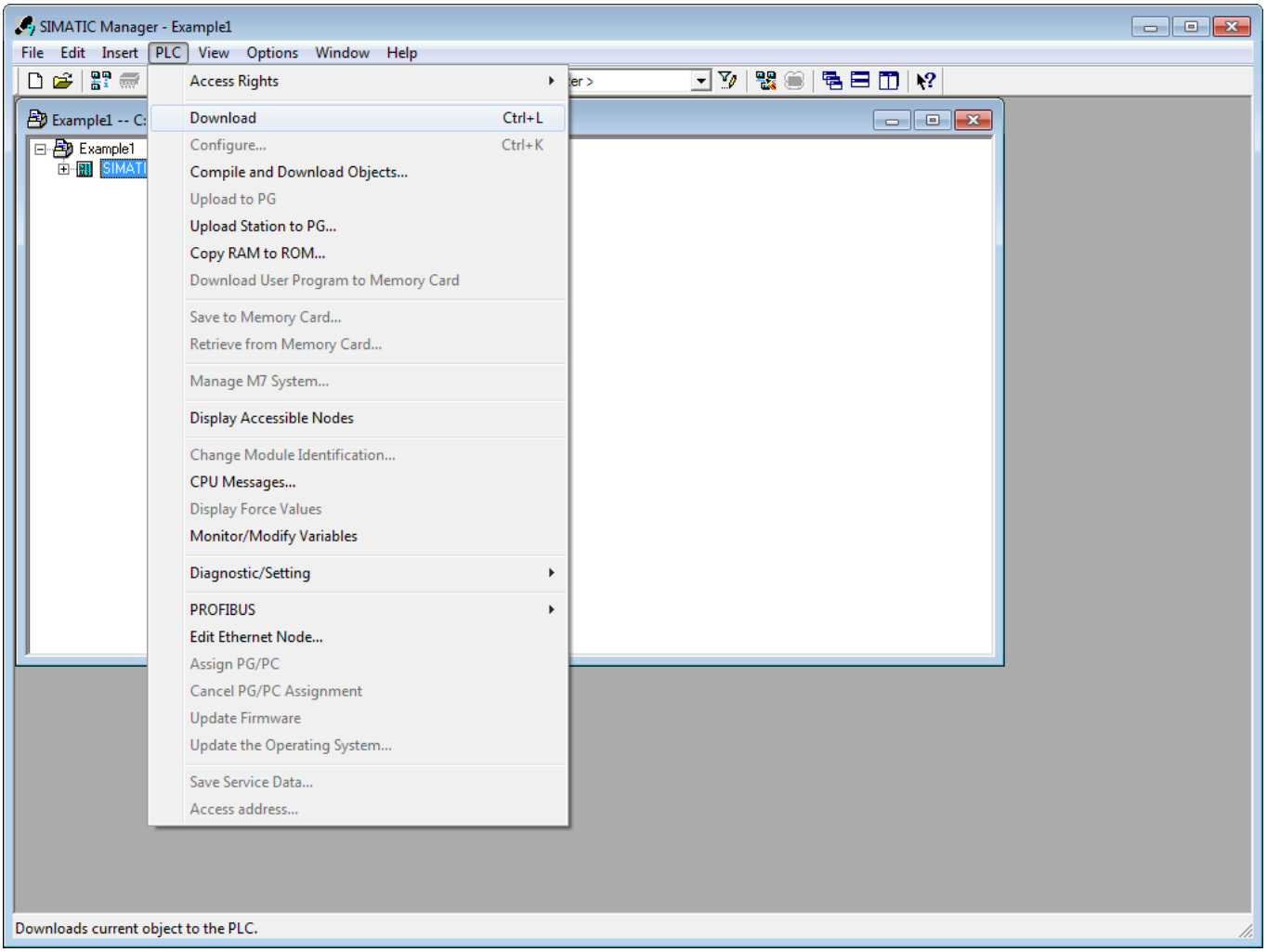

Download the compiled configuration into the S7-300 PLC from the SIMATIC Manager window

The SIMATIC Manager will request if the current system data in the programmable controller shall be deleted and replaced with the offline system data, if the target module shall be stopped, and if the blocks OB1. OB83, and OB86 shall be overwritten. Confirm with Yes.

When the download has been completed we proceed with sending and receiving data in online mode.

5.2.1.7.1 Download from SIMATIC HW Config

In the HW Config window select the IXXAT CME/PN device that shall be configured.

> It is possible to add several IXXAT CME/PN gateways to the PROFINET IO System, see the section Add the IXXAT CME/PN Gateway to the PROFINET IO System. It has to be taken care to select the correct IXXAT CME/PN device for which the configuration has been generated.

Open the context menu of the selected IXXAT CME/PN with a right mouse click. Select Start Device Tool→Configuration Downloader. The Download dialog that will be opened supports the selection of *.profinetcdc files (for generated configuration data) and *.bin files (for firmware updates).

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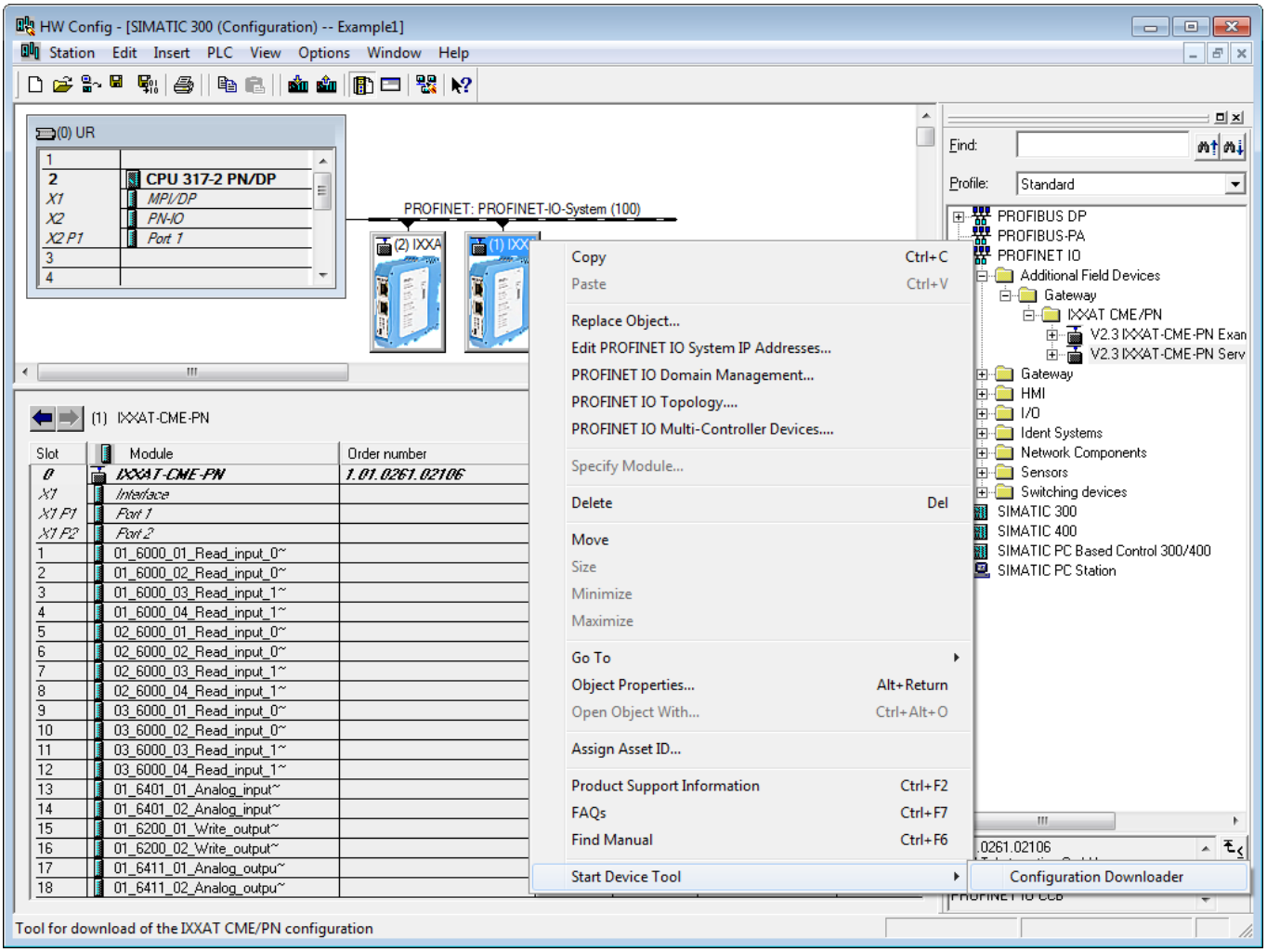

Opening the Download dialog from the SIMATIC HW Config window

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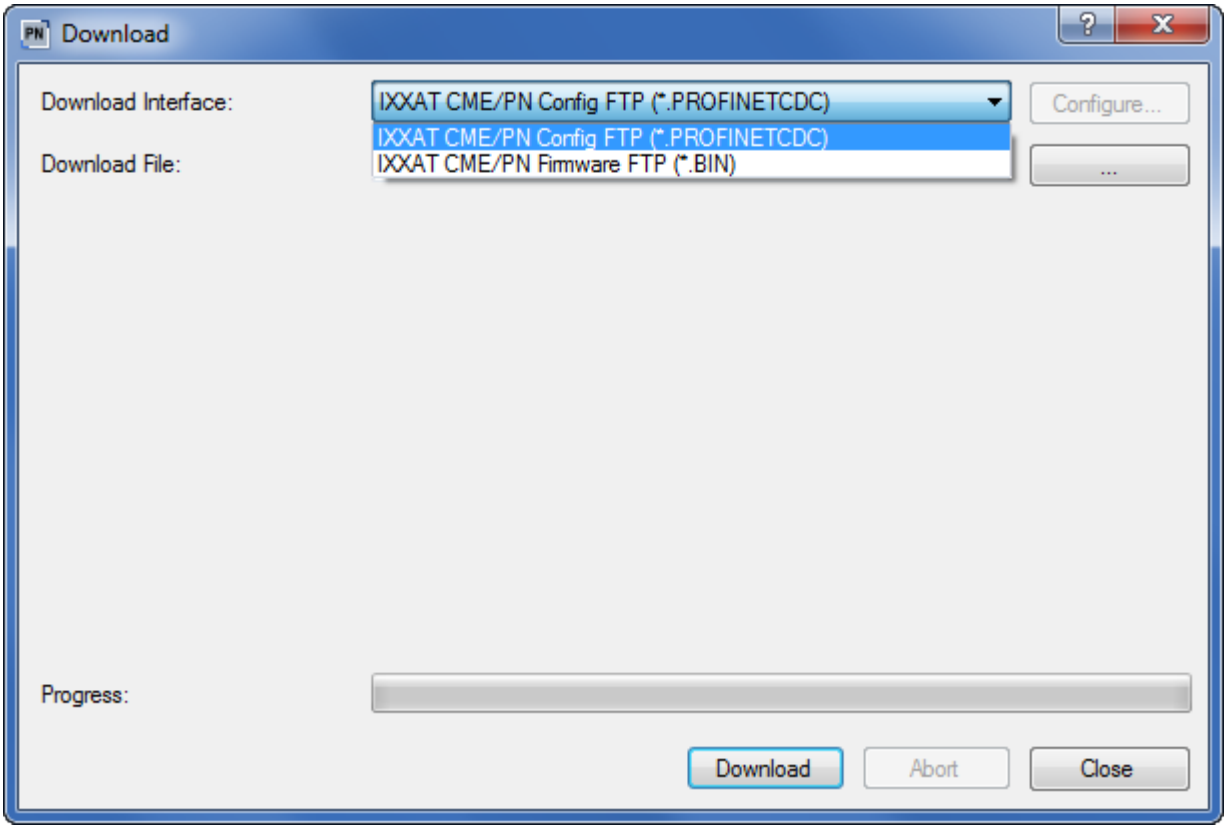

IXXAT CME/PN device tool download dialog

Only binary files supplied by IXXAT shall be selected for a firmware update. If an invalid firmware update file is loaded via Ethernet both LEDs S1 and S2 will blink red. In this case the device must be power cycled. Afterwards the device will be operational again. If a valid firmware update file is loaded the HOST LED of the IXXAT CME/PN will be permanently RED during the download process. After the download process the HOST LED will be off until the boot process is finished. A firmware update may take 1 to 2 minutes to complete. Note that the progress bar pauses some time before indicating the first update progress. Do not interrupt the IXXAT CME/PN power supply during the download process.

The download is controlled by the buttons at the bottom of the dialog. Download starts the download of the selected file to the selected IXXAT CME/PN device. While the download is running the progress bar will indicate the current status. A running download may be aborted by means of the abort button. After the download, a message box confirms the successful completion of the procedure. Click OK and then Close to close the dialog.

5.2.1.8 Working in Online Mode

If the values of bit 2 `NMT master start` and bit 3 `Start node` of object `1F80h NMT startup` are set to 0 in the CANopen configuration, the CANopen manager in the IXXAT CME/PN gateway will configure the CANopen slave devices and start the network. This implies that all devices will be set to NMT state Operational.

IXXAT CME/PN sets the network to NMT state Operational only if communication over PROFINET between the SIMATIC S7-300 and the gateway has been established. If the attached CANopen devices remain in NMT state Pre-operational (this may be monitored with a CAN bus analyzer), verify the correct configuration of both the SIMATIC S7-300 and IXXAT CME/PN devices.

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⚠ Since the download process will temporarily interrupt the connection between PLC and gateway (LED S2 switches temporarily to red on) a CANopen manager that is already in NMT state Operational will detect an error condition and set the CANopen network to NMT state Pre-operational. In this case the CANopen network has to be restarted explicitly.

Methods to restart the CANopen network:

- Power cycle the IXXAT CME/PN gateway
- Restart the CANopen network using the CANopen SDO example program

Next verify the status of the LEDs on both the PLC and the IXXAT CME/PN gateway.

⚠ As soon as the communication over PROFINET between the SIMATIC S7-300 PLC and the gateway has been established the IXXAT CME/PN sends valid data to the PLC. The valid data are set to `0` until data from the CANopen network replace it.

LEDs of the PLC

If all steps described earlier have been successfully executed, the LED on the CPU module of the PLC should exhibit the LED pattern as indicated in the nominal LED status column in the table below. For additional information, consult the documentation shipped with the SIMATIC S-7 300 PLC.

LED	Color	Status	Description	Nominal LED Status
BF 1	Red		Bus error at the first interface (X1)	Off
BF 2	Red		Bus error at the second interface (X2)	Off
SF	Red		Hardware fault or software error	Off
DC5V	Green		5 V power supply for the CPU and S7-300 bus	On
FRCE	Yellow	On	Active force job	Off
		Flashing at 2 Hz	Node flash test function	
RUN	Green	On	CPU in RUN	On
		Flashing at 2 Hz	CPU executes startup	
		Flashing at 0.5 Hz	CPU in Stop mode	
STOP	Yellow	On	CPU in STOP or HOLD, or STARTUP mode	Off
		Flashing at 2 Hz	CPU executes reset	
		Flashing at 0.5 Hz	CPU executes memory reset	

LEDs of the IXXAT CME/PN gateway

The CANopen LEDs on IXXAT CME/PN are implemented according to the specifications in CiA 303-3. If the IXXAT CME/PN has correctly started the CANopen network and all devices are in NMT state Operational, the LEDs on the IXXAT CME/PN front panel will exhibit the LED pattern as indicated in the nominal LED status column in the table below.

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LED	Name	Color	Status	Description	Nominal LED Status
ON	Power LED	-	Off	Fuse defective Voltage regulation defective Device not connected to power	Green on
		Green	On	Device fully functional	
S1	PROFINET status LED 1	-	Off	No fault	Off
		Green	-	-	
		Red	Blinking	Module identification	
		Red	On	Module fault status	
S2	PROFINET status LED 2	-	Off	Connection (AR) established to the controller	Off
		Green	On	PROFINET protocol not initialized	
		Red	On	No connection (AR) to the controller	
HOST	Host status LED	-	Off	Gateway software is not running, initialization	Green on
		Red	On	Update mode for configuration or software	
		Red	Blinking	No valid configuration found	
		Red	Flickering	Fatal error	
		Green	Single flash	Configured and initialized, but PROFINET connect frame has not yet been received	
		Green	Flashing	Normal operation, process model not valid or no transfer of the process model	
		Green	On	Normal operation, exchange of valid process data	
C1	CANopen run LED	-	Off	Gateway software is not running, initialization Fatal error if HOST LED red flickering	Green on
		Green	Blinking	NMT state Pre-operational	

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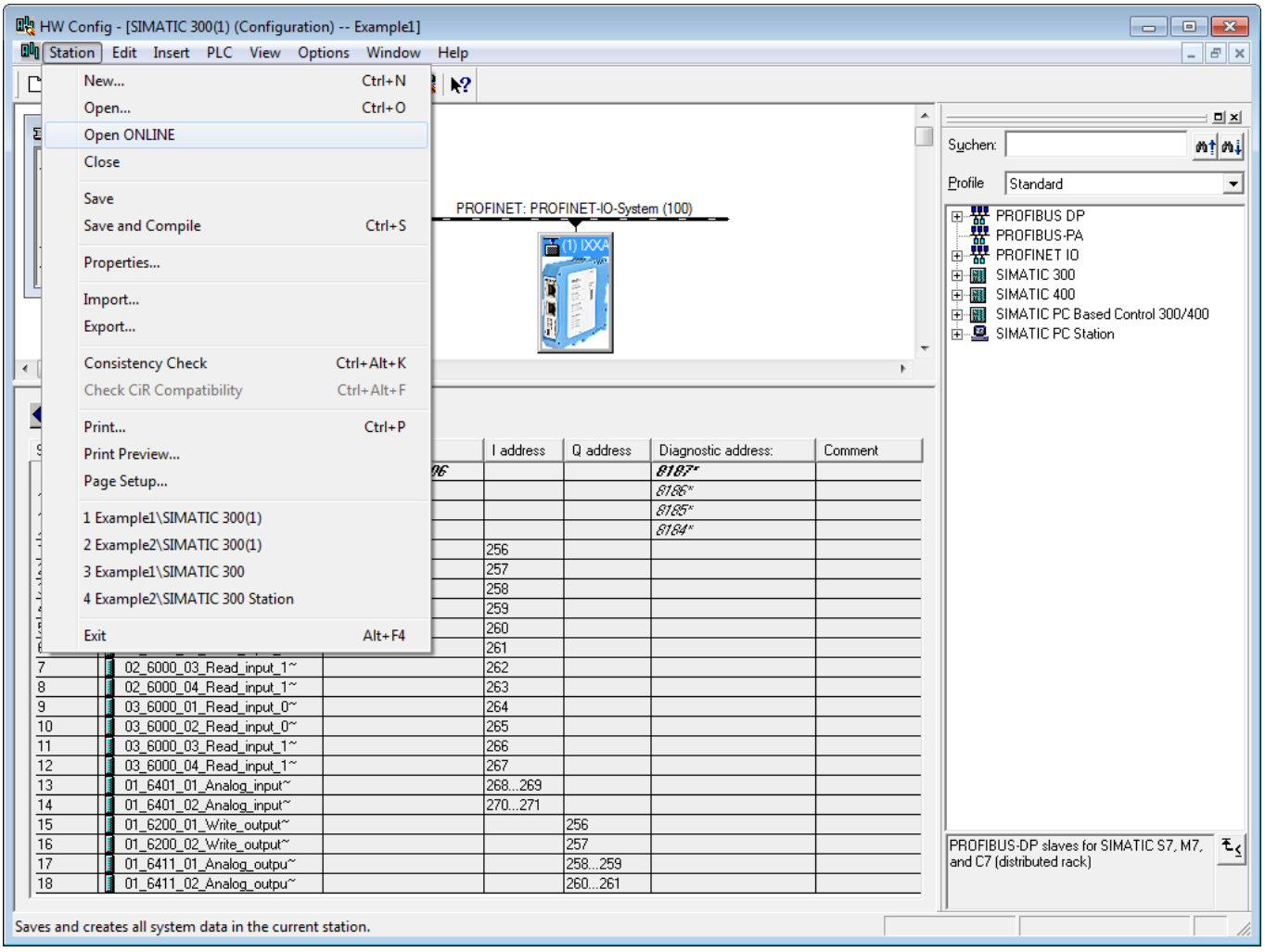
LED	Name	Color	Status	Description	Nominal LED Status
		Green	Single flash	NMT state Stopped	
		Green	On	NMT state Operational	
C2	CANopen error LED	-	Off	No fault Fatal error if HOST LED red flickering	Off
		Red	Blinking	Invalid configuration	
		Red	Single flash	CAN warning limit reached	
		Red	Double flash	Error control event occurred	
		Red	Triple flash	SYNC error event occurred	
		Red	On	CAN bus off	

Now that the CANopen network is started, we can open the station in online mode. In the HW Config window select Station→Open ONLINE.



Open the SIMATIC station in ONLINE mode

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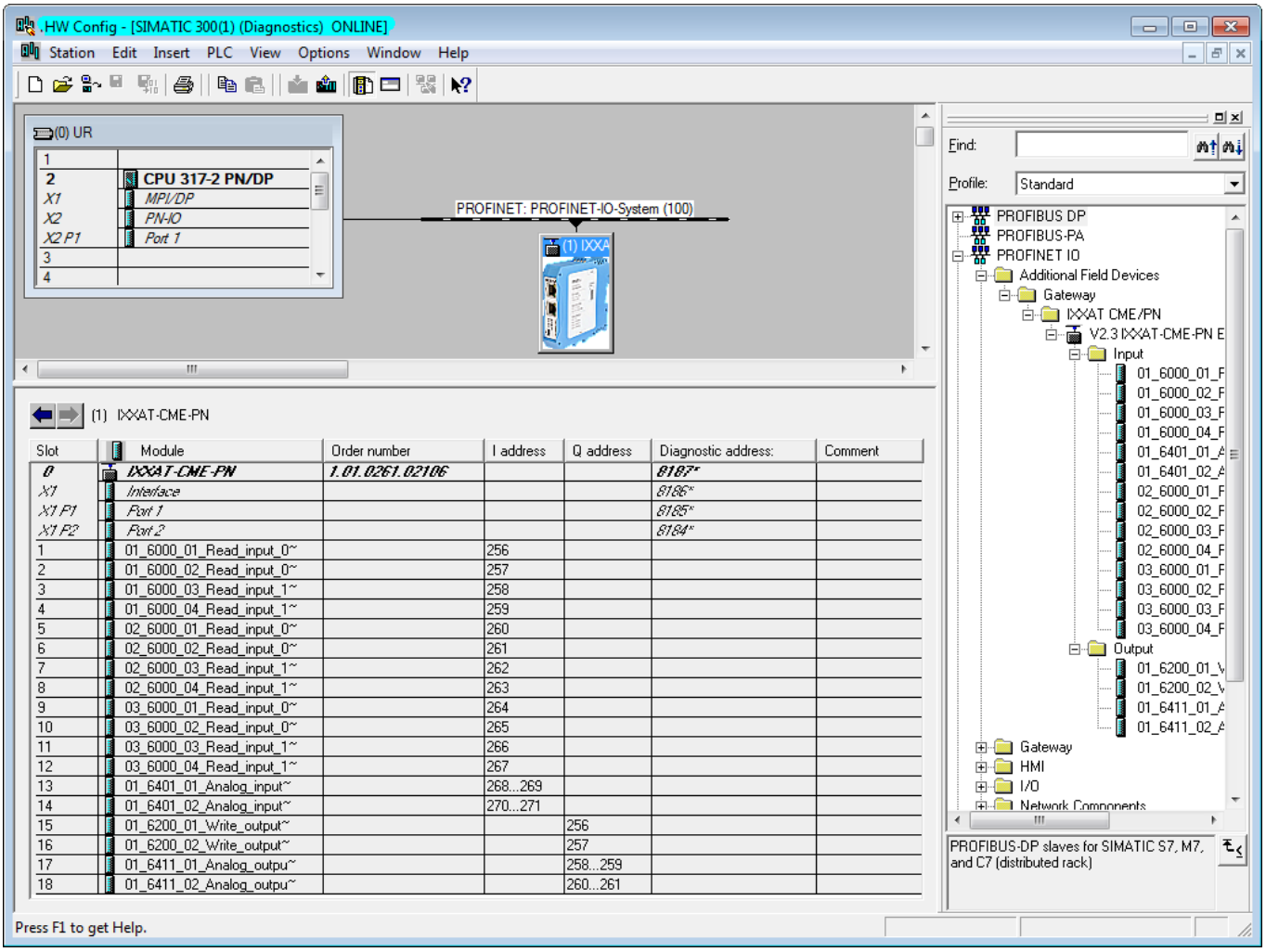
This will open the online window for the hardware configuration of the SIMATIC 300 project.



Online window to access application objects configured into the IXXAT CME/PN process image

We can now monitor or modify I/O parameters of remote CANopen devices. In the ONLINE window, select the IXXAT CME/PN device. Right-click on the module `01_6411_01_Analog_outpu~` and select select Monitor/Modify. This will display a dialog that lists the select module, its address, and the display format. In the Modify value column enter the process value that will be written from the SIMATIC S7 CPU via the IXXAT CME/PN gateway into the remote CANopen device.

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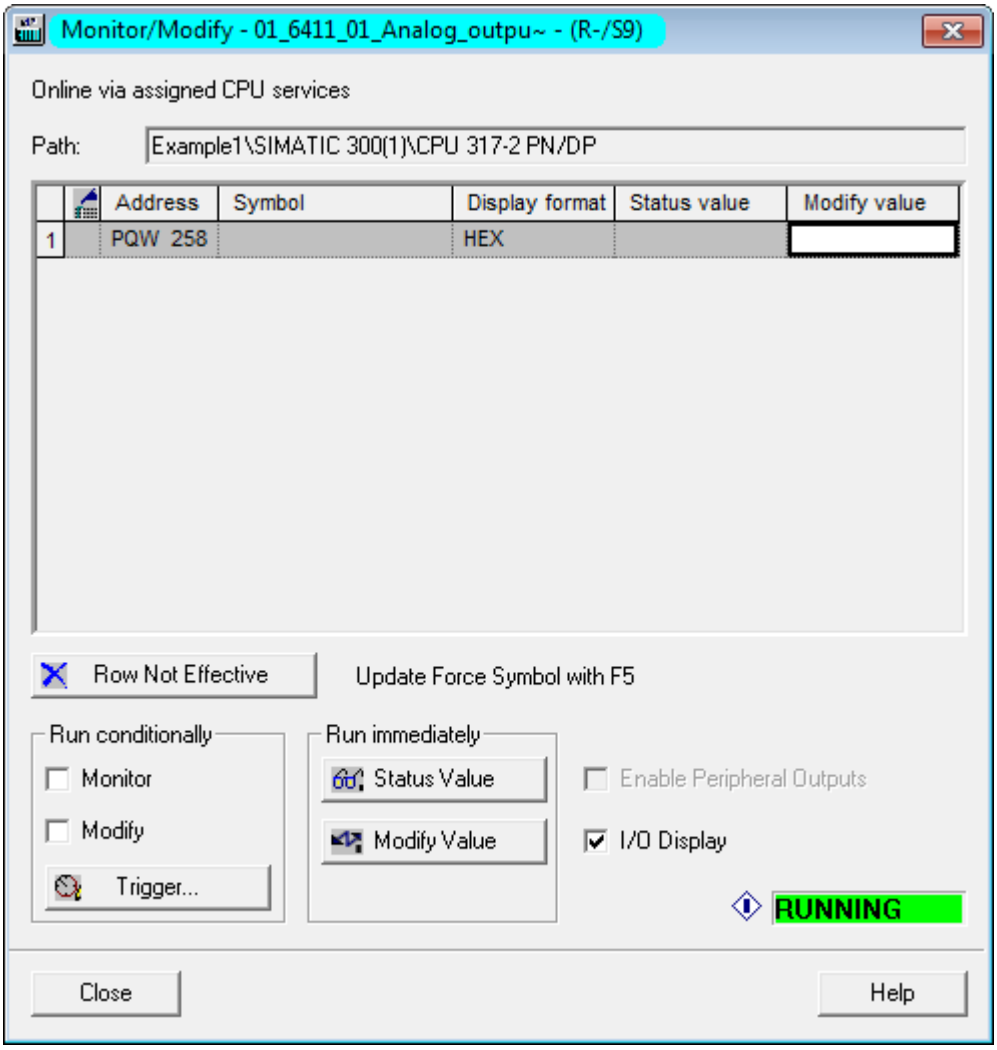

Monitor/Modify dialog in ONLINE mode for an analog output object

> ⚠ Note that in CANopen data are represented in little endian coding while PROFINET uses the big endian format. Depending on the configuration of object 4000_h `Process image byte order` to write a 16 bit process value of $7FFF_h$ into the CANopen device a value of $FF7F_h$ has to be entered in the text field. In default settings IXXAT CME/PN converts the Litte Endian data as transmitted in the CANopen network into a big endian representation in the process image, so that no byte swapping by the user is required.

Similarly input data from remote CANopen devices can be monitored. Open the context menu for the `01_6000_01_Read_input0~` module and in the Monitor/Modify dialog for module and press the Status value button. This will read the current value in the process image on IXXAT CME/PN into the SIMATIC S7 CPU and the STEP 7 software. In the image below, the current process data were 55_h.

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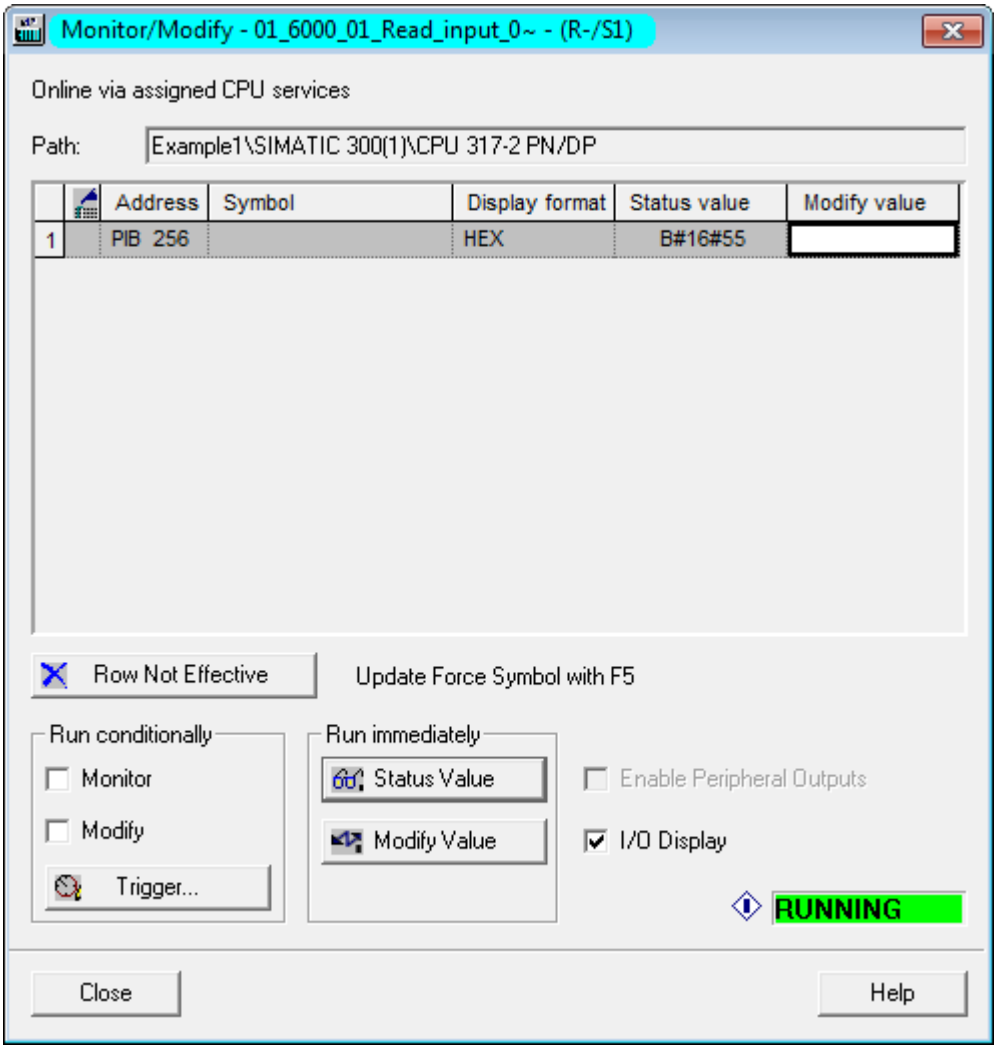

Monitor/Modify dialog in ONLINE mode for a digital input object

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5.3 Command and Diagnostics Interface

The IXXAT CME/PN gateway implements a command and diagnostics interface:

- The command interface enables the user to control the CANopen manager and the remote CANopen devices.
- The diagnostic interface enables the user to identify failed remote CANopen devices and to retrieve corresponding error information.
- The remote access interface enables the user to read and write any object dictionary entry of a remote CANopen device.

The command object and the diagnostic objects are included in the object dictionary of the CANopen manager. The user accesses the object dictionaries of both the CANopen manager and the remote CANopen devices via SDOs.

5.3.1 SDO Command Sequence

To read (SDO upload) or write (SDO download) CANopen object dictionary entries either in IXXAT CME/PN or the remote CANopen slave device the following sequences have to be executed. The data structure used to describe the requested SDO service is common for both upload and download services.

SDO read access sequence (read diagnostic data)

1. Fill the structure with:
    a. Command = 0 (SDO read)
    b. CANopen node-ID
    c. Object dictionary index and sub-index
    d. Number of data bytes = 0
2. Send a PROFINET record with the structure to the IXXAT CME/PN
3. Receive a PROFINET record with the structure from the IXXAT CME/PN
4. Check the error code
5. Read the data contents

SDO write access sequence (write command data)

1. Fill the structure with:
    a. Command = 1 (SDO write)
    b. CANopen node-ID
    c. Object dictionary index and sub-index
    d. Data
    e. Number of data bytes
2. Send a PROFINET record with the structure to the IXXAT CME/PN
3. Receive a PROFINET record with the structure from the IXXAT CME/PN
4. Check the error code

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5.3.2 SDO Command Data Structure

Byte Number	Content	Description
0	SDO service type	SDO read (upload) = 0, SDO write (download) = 1
1	CANopen node-ID	Valid range 01_h to $7F_h$
2	Object dictionary index, low byte	
3	Object dictionary index, high byte	
4	Object dictionary sub-index	
5	Data[0]	Least significant byte
...	...	
249	Data[244]	Most significant byte
250	Number of data bytes	0 .. 245
251	reserved	Always 00
252	Error code, least significant byte	SDO abort code, for details see CiA 301 $0000\ 0000_h$ if no error occurred $FFFF\ FFFF_h$ if SDO command interface is busy
253	Error code	
254	Error code	
255	Error code, most significant byte	

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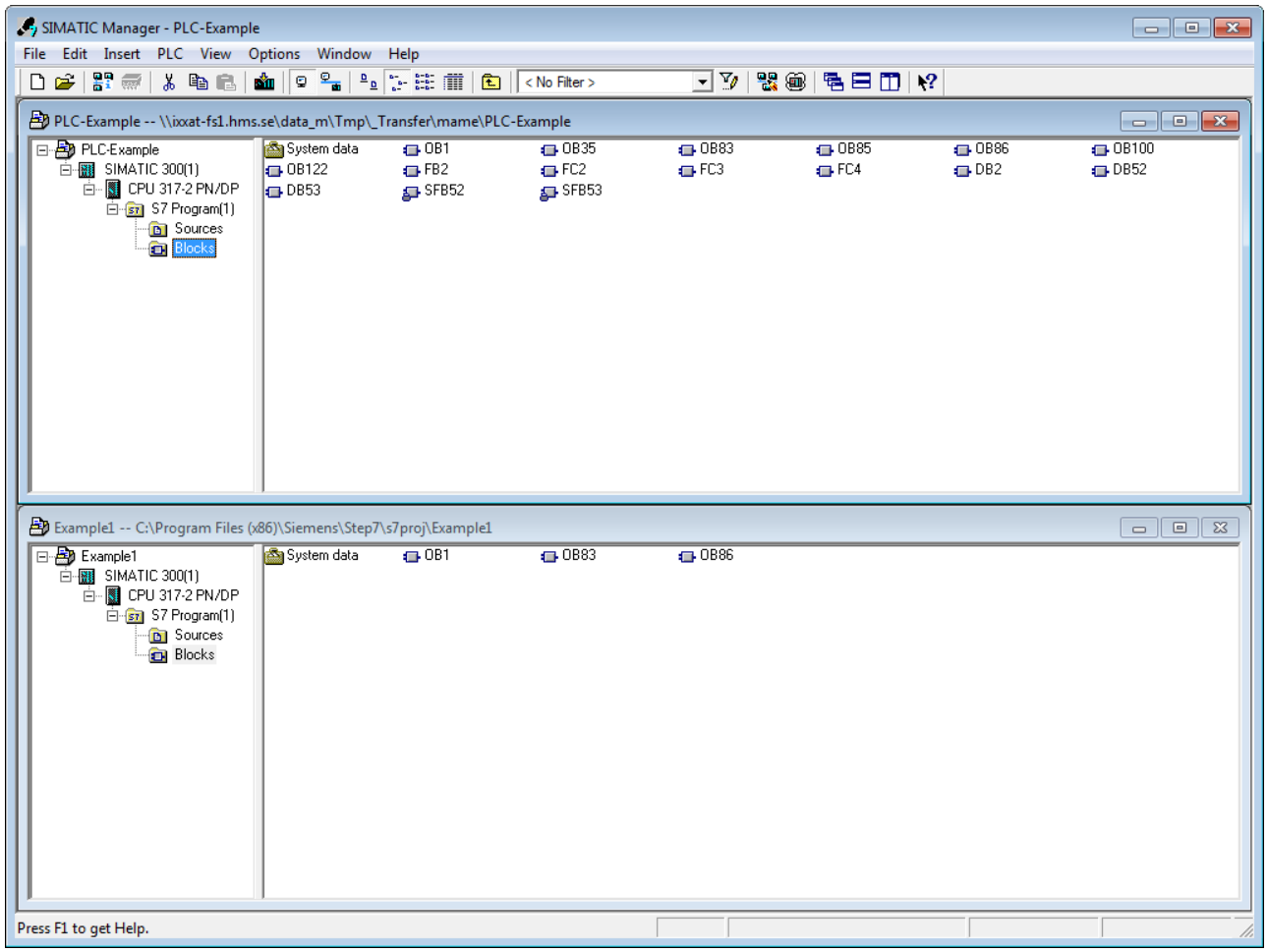
5.3.3 CANopen SDO Example Program

Use a PLC program to transmit PROFINET records that encapsulate SDO commands. The execution sequence and format the of these PROFINET records are defined in the sections SDO command sequence and SDO command data structure.

The IXXAT CME/PN gateway will extract the SDO commands from the PROFINET records and access the corresponding object dictionary entries. SDO accesses to the object dictionary of the CANopen manager are handled locally on the IXXAT CME/PN gateway. SDO accesses to object dictionaries of remote CANopen devices are transported via the CANopen network.

The installation of CANopen Configuration Studio for IXXAT CME/PN copies a sample project "PLC-Example" into `C:\Program Files (x86)\IXXAT\CANopen Configuration Studio for IXXAT CME-PN\Step7\PLC-Exam` folder on your PC (path name for an English locale system). Follow the procedure below to insert the blocks and symbols of the "PLC-Example" into your project:

1. Start SIMATIC manager
2. Select File→Open to open "PLC-Example"
3. Browse to the folder of the example PLC program
4. Select "PLC-Example" and press OK
5. Select File→Open to open your project e. g. "Example1"
6. Expand "PLC-Example" and select Blocks
7. Select all blocks of "PLC-Example"
8. Expand "Example1" and select Blocks



S7 Program Blocks of PLC Example project

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9. Drag all blocks of “PLC-Example” and drop them in “Example1”
10. Confirm overwriting of all blocks
11. Select S7 Program→Symbols in the “PLC-Example” window
12. Select S7 Program→Symbols in the “Example1” window
13. Drag Symbols of “PLC-Example” and drop them in “Example1”
14. Confirm replacing of symbols
15. Close “PLC-Example”

You may now repeat the tests of the section Working in Online Mode.

5.3.4 CANopen SDO Example Blocks

The following table gives an overview of the blocks and symbols of the project PLC-Example. The logic block OB1 internally calls first the logic block FC2 which implements SDO_START_NETWORK and then the block FC4 (SDO_GET_DEVICETYPE) for both node-ID $7F_h$ (CANopen manager) and 01_h (I/O device). FC2 demonstrates how to start the network by writing to object $1F82_h$, Request NMT, FC4 how to read object 1000_h, Device type. Alternatively you may read one of the IXXAT specific diagnostics objects in IXXAT CME/PN similar to the program code of FC4.

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Block	Symbol	Description
OB1	CYCL_EXC	Cyclic execution of of the startup statemachine: • STATE0: Call SDO_GET_MANAGER_STATE • STATE1: Call SDO_START_NETWORK • STATE2: Call SDO_GET_DEVICETYPE • STATE3: Wait for GATEWAY_IO_READY • STATE4: Process Data IO
OB35	CYC_INT5	Cyclic interrupt • Modifies IO data every 100ms (for demonstration only)
OB83	I/O_FLT2	Monitors the presence of modules in the central rack. This block is executed for each module when it becomes operational and its process data are valid
OB85	OBNL_FLT	The operating system of the CPU calls OB85 when the following event occurs: • I/O access error during update of the process image by the system
OB86	RACK_FLT	Detects a rack failure. This block is called when a PROFINET IO device fails or when the error is eliminated. This is the case when the gateway is available again (for example after disconnect)
OB100	COMPLETE RESTART	Clear execution control flags and initialize process IO data
OB122	MOD_ERR	The operating system of the CPU calls OB122 whenever an error occurs while accessing data on the module
FC2	SDO_START_NETWORK	Uses the command interface to start the CANopen network by calling FB2 (SDO_REQUEST) to write 05_h (NMT state operational) to object $1F82_h$, sub-index $7F_h$ (Request NMT)
FC3	SDO_GET_MANAGER_STATE	Uses the diagnostic interface to query the CANopen manager state by calling FB2 (SDO_REQUEST) to read object 5000_h, sub-index 02_h (State of the CANopen manager)
FC4	SDO_GET_DEVICETYPE	Uses the diagnostic interface to query device type of a device by calling FB2 (SDO_REQUEST) to read object 1000_h, sub-index 00_h (Device type)
FB2	SDO_REQUEST	State machine to perform a generic SDO read/write request States: • STATE0: init – fill the structure • STATE1: write record • STATE2: read record • STATE3: check result Static data: • current state • record

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Block	Symbol	Description
DB2	SDO_ACCESS_INSTANCE	Data block of FB2
SFB52	RDREC	System Function Block. Read a data record from a PROFINET IO device
DB52		Data block of SFB52
SFB53	WRREC	System Function Block. Transfer a data record to a PROFINET IO device
DB53		Data block of SFB53

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6 Object Dictionary Entries

CANopen Configuration Studio for IXXAT CME/PN and the example configurations and programs described in the previous chapters refer to a number of standardized CANopen objects as well as manufacturer specific objects that are described in more detail in the following sections.

- Standardized communication profile objects
- Manufacturer specific objects
- Standardized device profile objects

6.1 Standardized Communication Profile Objects

CANopen Configuration Studio for IXXAT CME/PN and IXXAT CME/PN devices refer to, respectively implement, communication objects that are standardized in the CANopen specifications published by CiA. The table below contains a selection of those objects that can be addressed in the communication profile area of the object dictionary.

In the `Implemented on device category` column of the summary table below it is indicated if the corresponding object is typically implemented on CANopen manager or CANopen slave devices or on both.

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Index	Object type	Name	Data type	Implemented on device category	CiA specification
1000_h	VAR	Device type	UNSIGNED32	Manager, Slave	CiA 301 and device or application profiles
1001_h	VAR	Error register	UNSIGNED8	Manager, Slave	CiA 301 and device or application profiles
1008_h	VAR	Manufacturer device name	VISIBLE_STRING	Manager, Slave	CiA 301
1018_h	RECORD	Identity object	IDENTITY	Manager, Slave	CiA 301
$1F80_h$	VAR	NMT startup	UNSIGNED32	Manager, Slave	CiA 302-2
$1F81_h$	ARRAY	NMT slave assignment	UNSIGNED32	Manager	CiA 302-2
$1F82_h$	ARRAY	Request NMT	UNSIGNED8	Manager	CiA 302-2
$1F84_h$	ARRAY	Device type identification	UNSIGNED32	Manager	CiA 302-2
$1F85_h$	ARRAY	Vendor identification	UNSIGNED32	Manager	CiA 302-2
$1F86_h$	ARRAY	Product code	UNSIGNED32	Manager	CiA 302-2
$1F87_h$	ARRAY	Revision number	UNSIGNED32	Manager	CiA 302-2
$1F88_h$	ARRAY	Serial number	UNSIGNED32	Manager	CiA 302-2
$1F89_h$	VAR	Boot time	UNSIGNED32	Manager	CiA 302-2

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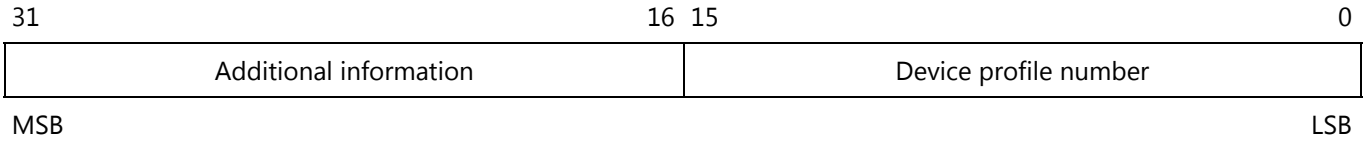
6.1.1 Object 1000_h: Device Type

This object contains information about the device type describing the type of the logical device and its functionality. It is composed of a 16-bit field indicating the implemented device or application profile and a second 16-bit field, which provides additional information about specific functionality of the logical device. The additional information parameter is device or application profile specific. It is defined in the corresponding device profile and application profile specification.

The value 0000_h for the device profile number indicates a logical device that does not implement a standardized device or application profile. In this case the additional information is 0000_h if no further logical device is implemented. For multiple logical device modules the additional information parameter is set to $FFFF_h$ and the device profile number referenced by object 1000_h indicates the profile of the first logical device in the object dictionary. All other profiles of a multiple logical device module indicate their profiles at objects $67FF_h + n \times 800_h$ with n = internal number of the logical device (from 1 to 8) minus 1. These objects describe the device type of the preceding logical device, having the very same value definition as object 1000_h.



Structure of the device type parameter

Object description

Attribute	Value
Index	1000_h
Object name	Device type
Object code	VAR
Data type	UNSIGNED32
Category	mandatory

Entry description

Attribute	Value
Sub-index	00_h
Access	ro
PDO mapping	no
Value range	see value definition
Default value	0000 0000_h

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6.1.2 Object 1001_h: Error Register

This object provide error information. The CANopen device maps internal errors into this object. The content of the error register is transmitted in byte 2 of an emergency object.

Value definition of the error register

Bit	Mandatory/Optional	Description
0	mandatory	Generic error
1	optional	Current
2	optional	Voltage
3	optional	Temperature
4	optional	Communication error (overrun, error state)
6	optional	Device profile specific
6	optional	reserved (always 0_b)
7	optional	Manufacturer specific

If a specific error occurs the corresponding bit is set to 1_b. The generic error bit is always supported. The other bits may be supported. The generic error is set to 1 at any error situation.

Object description

Attribute	Value
Index	1001_h
Object name	Error register
Object code	VAR
Data type	UNSIGNED8
Category	mandatory

Entry description

Attribute	Value
Sub-index	00_h
Access	ro
PDO mapping	TPDO
Value range	see value definition
Default value	no

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6.1.3 Object 1008_h: Manufacturer Device Name

This object contains a manufacturer assigned device name.

Object description

Attribute	Value
Index	1008_h
Object name	Manufacturer device name
Object code	VAR
Data type	VISIBLE_STRING
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Access	const
PDO mapping	no
Value range	VISIBLE_STRING
Default value	Manufacturer specific

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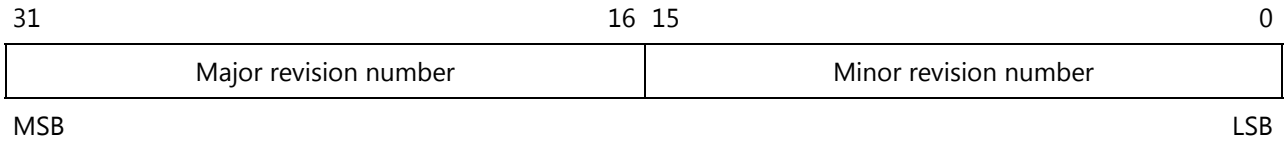
6.1.4 Object 1018_h: Identity Object

This object provides general identification information of the CANopen device.

- Sub-index 01_h contains a value that is allocated uniquely to each vendor of a CANopen device. The value 0000 0000_h indicates an invalid vendor-ID. The value is assigned exclusively by CAN in Automation.
- Sub-index 02_h contains a value that identifies a specific type of CANopen devices. The value of 0000 0000_h is reserved.
- Sub-index 03_h contains the major and the minor revision numbers of the CANopen device. The major revision number identifies a specific CANopen behavior. That implies that if the CANopen functionality is different, the major revision number is incremented. The minor revision number identifies different versions of a CANopen device with the same CANopen behavior. The value of 0000 0000_h is reserved.



Structure of the pre-defined error field

- Sub-index 04_h contains a serial number that uniquely identifies a CANopen device within a product group and a specific revision. The value of 0000 0000_h is reserved.

Object description

Attribute	Value
Index	1018_h
Object name	Identity object
Object code	RECORD
Data type	IDENTITY
Category	mandatory

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	ro
PDO mapping	no
Value range	01_h - 04_h
Default value	Profile- or manufacturer-specific

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Attribute	Value
Sub-index	01_h
Description	Vendor-ID
Entry category	mandatory
Access	ro
PDO mapping	no
Value range	UNSIGNED32
Default value	Assigned uniquely to manufacturers by CiA

Attribute	Value
Sub-index	02_h
Description	Product code
Entry category	optional
Access	ro
PDO mapping	no
Value range	UNSIGNED32
Default value	Profile- or manufacturer-specific

Attribute	Value
Sub-index	03_h
Description	Revision number
Entry category	optional
Access	ro
PDO mapping	no
Value range	UNSIGNED32
Default value	Profile- or manufacturer-specific

Attribute	Value
Sub-index	04_h
Description	Serial number
Entry category	optional
Access	ro
Access	no
Value range	UNSIGNED32
Default value	Profile- or manufacturer-specific

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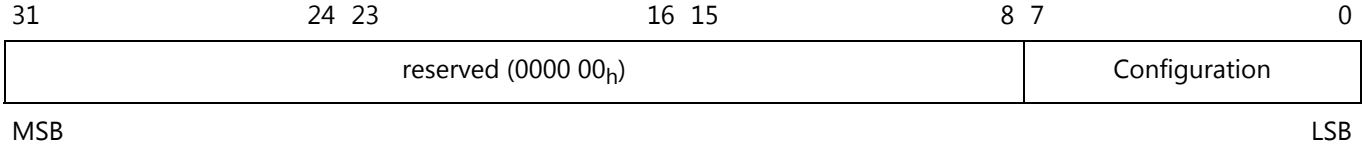
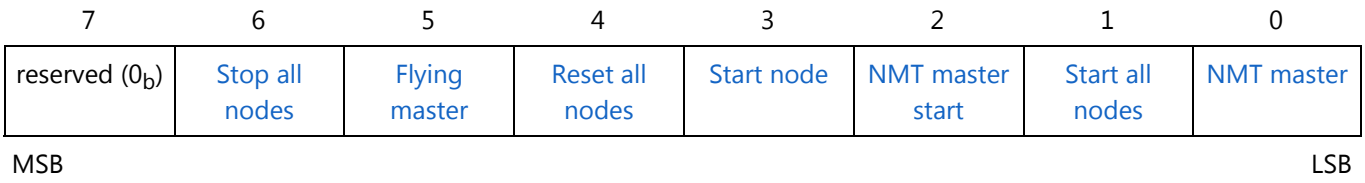
6.1.5 Object $1F80_h$: NMT Startup

This object configures the startup behavior of a CANopen device. Internal state transitions do not result in changes the value of this object. An attempt to change a bit of a functionality that is not supported by the CANopen device is responded with an abort message (abort code: 0609 0030_h). The first figure below describes the overall structure of the NMT startup object, the second figure the bit oriented structure of the configuration value. The subsequent tables describe the allowed values.



Object $1F80_h$ – bit structure of the value



Object $1F80_h$ – bit structure of the configuration value

Value NMT master (bit 0)

Value	Description
0_b	CANopen device is not NMT master The entries of the object $1F81_h$ are ignored. All other bits of object $1F80_h$ are ignored
1_b	CANopen device is the NMT master

Value Start all nodes (bit 1)

Value	Description
0_b	NMT service start remote node is requested individually for each node-ID
1_b	NMT service start remote node is requested for all nodes with node-ID = 0

Value NMT master start (bit 2)

Value	Description
0_b	The NMT master switches into NMT state Operational in the process NMT startup
1_b	The NMT master does not switch into the NMT state Operational by itself and wait for an application to request the state transition into NMT state Operational

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Value Start node (bit 3)

Value	Description
0_b	The NMT master starts the NMT slaves
1_b	The NMT master does not start the NMT slaves and waits for an application to request that the NMT slaves are started

Reset all nodes (bit 4)

Value	Description
0_b	In case of error control event of a CANopen device defined as mandatory (see object $1F81_h$) the NMT service reset node with node-ID of the CANopen device that caused the error control event is executed
1_b	In case of error control event of a CANopen device defined as mandatory (see object $1F81_h$) the NMT service reset node with node-ID = 0 is executed

⚠ Note that Flying master functionality (bit 5) is not supported by IXXAT CME/PN

Flying master (bit 5)

Value	Description
0_b	CANopen device shall not participate the NMT flying master negotiation
1_b	CANopen device shall participate the NMT flying master negotiation

Stop all nodes (bit 6)

Value	Description
0_b	In case of error control event of a CANopen device defined as mandatory (see object $1F81_h$) the action as defined by bit 4 is executed
1_b	In case of error control event of a CANopen device defined as mandatory (see object $1F81_h$) the NMT service Stop remote node with node-ID = 0 is executed. Bit 4 is ignored

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Object description

Attribute	Value
Index	$1F80_h$
Object name	NMT startup
Object code	VAR
Data type	UNSIGNED32
Category	conditional mandatory if the CANopen device is a CANopen manager or a start-up capable CANopen device

Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	no
Value range	see value definition
Default value	$5F_h$

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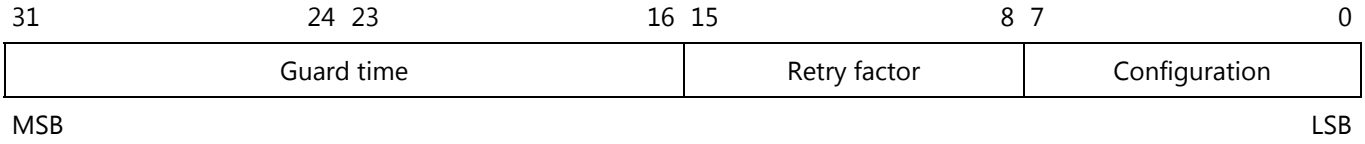
6.1.6 Object $1F81_h$: NMT Slave Assignment

This object assigns CANopen devices to the NMT master, the device that implements this object. Each sub-index of this object corresponds to the node-ID of the corresponding CANopen device in the network. The sub-index corresponding to its own node-ID is ignored. An attempt to change a bit of a functionality that is not supported by the CANopen device is aborted with code 0609 0030_h (invalid value for parameter). The two figures below describe the structure of the value. The subsequent tables describe the value contents.

The value for the retry factor indicates the number of retries the NMT master issues in case of a node guarding event (see CiA 301). The value 0 shall disable node guarding for the CANopen device.

The value for the guard time indicates the cycle time for the node guarding of the CANopen device. The value is indicated in multiples of 1 ms. The value 0 disables node guarding for the CANopen device.

> If the heartbeat consumer object is configured to a value unequal 0, then the heartbeat mechanism will have priority over node guarding.



Object $1F81_h$ – structure of the value

Object $1F81_h$ – bit structure of the configuration value

Value NMT slave (bit 0)

Value	Description
0_b	NMT master or not available in the network
1_b	NMT slave and available in the network

NMT boot slave (bit 2)

Value	Description
0_b	Configuration and NMT service Start remote node shall not be allowed in case of error control event or NMT service Bootup Note: The application is responsible for the NMT slave startup
1_b	Configuration and NMT service Start remote node shall be performed in case of error control event or NMT service Bootup

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Mandatory (bit 3)

Value	Description
0_b	CANopen device may be present prior to network startup (CANopen device is optional)
1_b	CANopen device shall be present prior to network startup (CANopen device is mandatory)

Reset communication (bit 4)

Value	Description
0_b	NMT service Reset communication may be executed for the CANopen device at any time
1_b	NMT service Reset communication shall not be executed for the CANopen device in case the CANopen device is in NMT state Operational

Software version (bit 5)

Value	Description
0_b	Software version verification shall not be performed for the CANopen device
1_b	Software version verification shall be performed for the CANopen device

Software update (bit 6)

Value	Description
0_b	Software update shall not be performed for the CANopen device
1_b	Software update shall be performed for the CANopen device

Restore (bit 7)

Value	Description
0_b	CANopen device may be used without prior resetting
1_b	CANopen device shall be reset to factory defaults by issuing a restore to defaults (object 1011_h)

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Object description

Attribute	Value
Index	$1F81_h$
Object name	NMT slave assignment
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h to $7F_h$
Default value	$7F_h$

Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional mandatory if node-ID 1 is supported
Access	rw
PDO mapping	no
Value range	see value definition
Default value	$0000\ 0000_h$

to

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Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional mandatory if node-ID 127 is supported
Access	rw
PDO mapping	no
Value range	see value definition
Default value	$0000\ 0000_h$

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6.1.7 Object $1F82_h$: Request NMT

This object allows to request a specific NMT service for a unique CANopen device in the network or for all CANopen devices in the network in case the CANopen device implementing this object is in NMT master mode. Normally, the request is issued by another CANopen device in the network or by the application on the very same CANopen device, for example an IEC 61131 environment.

This object additionally indicates the current NMT state of a unique CANopen device in the network in case the CANopen device implementing this object is in NMT master mode.

The sub-index corresponds to the node-ID of the CANopen devices in the network. Sub-index 80_h addressed all nodes. Requests may apply for the NMT master itself. The value definition is provided in the table below.

An attempt to download a value that is reserved is responded with abort code 0609 0030_h.

The values from 00_h to $7F_h$ have to be applied carefully to not unintentionally affect the NMT master or the requesting CANopen device itself.

Value definition

Value	Description	
	on upload (read)	**on download (write)**
00_h	NMT state unknown	reserved
01_h	CANopen device missing	reserved
02_h	reserved	
03_h	reserved	
04_h	NMT state Stopped	NMT service Stop remote node Note that an attempt to request this service for node-ID 0 or the node-ID of the CANopen manager is aborted by the IXXAT CME/PN to prevent the network from becoming non-operable.
05_h	NMT state Operational	NMT service Start remote node
06_h	reserved	NMT service Reset node
07_h	reserved	NMT service Reset communication
08_h	reserved	
:::	:::	
$7E_h$	reserved	
$7F_h$	NMT state Pre-operational	NMT service Enter pre-operational
80_h	reserved	
:::	:::	
FF_h	reserved	

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Object description

Attribute	Value
Index	$1F82_h$
Name	Request NMT
Object code	ARRAY
Data type	UNSIGNED8
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	80_h
Default value	80_h

Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional
Access	rw
PDO mapping	no
Value range	see value description
Default value	00_h

to

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Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional
Access	rw
PDO mapping	no
Value range	see value description
Default value	00_h

Attribute	Value
Sub-index	80_h
Description	All nodes
Entry category	mandatory
Access	wo
PDO mapping	no
Value range	see value description
Default value	00_h

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6.1.8 Object $1F84_h$: Device Type Identification

This object is used for verification of the device type of the CANopen devices in the network. The device type (object 1000_h – see CiA 301) of the CANopen device in the network is matched against the value of this object in case the value is unequal to 0000 0000_h. An error event is generated if the values mismatch. The sub-index corresponds to the node-ID of the CANopen devices in the network. The sub-index corresponding to the own node-ID is ignored.

Object description

Attribute	Value
Index	$1F84_h$
Name	Device type identification
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - $7F_h$
Default value	$7F_h$

Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional mandatory if node-ID 1 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1000_h – see CiA 301
Default value	0000 0000_h

to

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Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional mandatory if node-ID 127 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1000_h – see CiA 301
Default value	0000 0000_h

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6.1.9 Object $1F85_h$: Vendor Identification

This object is used for verification of the vendor-ID of the CANopen devices in the network.

The vendor-ID (object 1018_h sub-index 01_h – see CiA 301) of the CANopen device in the network is matched against the value of this object in case the value is not equal 0000 0000_h. An error event is generated if the values mismatch.

The sub-index corresponds to the node-ID of the CANopen devices in the network. The sub-index corresponding to its own node-ID is ignored.

Object description

Attribute	Value
Index	$1F85_h$
Name	Vendor identification
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - $7F_h$
Default value	$7F_h$

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Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional mandatory if node-ID 1 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 01_h – see CiA 301
Default value	0000 0000_h

to

Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional mandatory if node-ID 127 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 01_h – see CiA 301
Default value	0000 0000_h

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6.1.10 Object $1F86_h$: Product Code

This object is used for verification of the product code of the CANopen devices in the network.

The product code (object 1018_h sub-index 02_h – see CiA 301) of the CANopen device in the network is matched against the value of this object in case the value is not equal 0000 0000_h. An error event is generated if the values mismatch.

The sub-index corresponds to the node-ID of the CANopen devices in the network. The sub-index corresponding to its own node-ID is ignored.

Object description

Attribute	Value
Index	$1F86_h$
Name	Product code
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - $7F_h$
Default value	$7F_h$

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Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional mandatory if node-ID 1 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 02_h – see CiA 301
Default value	0000 0000_h

to

Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional mandatory if node-ID 127 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 02_h – see CiA 301
Default value	0000 0000_h

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6.1.11 Object $1F87_h$: Revision Number

This object is used for verification of the revision number of the CANopen devices in the network.

The revision number (object 1018_h sub-index 03_h – see CiA 301) of the CANopen device in the network is matched against the value of this object in case the value is not equal 0000 0000_h. An error event is generated if the values mismatch. A mismatch is defined as

- the major revision number is unequal to the expected major revision number, or
- the minor revision number is less than the expected minor revision number

The sub-index corresponds to the node-ID of the CANopen devices in the network. The sub-index corresponding to its own node-ID is ignored.

Object description

Attribute	Value
Index	$1F87_h$
Name	Revision number
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - $7F_h$
Default value	$7F_h$

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Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional mandatory if node-ID 1 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 03_h – see CiA 301
Default value	0000 0000_h

to

Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional mandatory if node-ID 127 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 03_h – see CiA 301
Default value	0000 0000_h

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6.1.12 Object $1F88_h$: Serial Number

This object is used for verification of the serial number of the CANopen devices in the network.

The serial number (object 1018_h sub-index 04_h – see CiA 301) of the CANopen device in the network is matched against the value of this object in case the value is not equal 0000 0000_h. An error event is generated if the values mismatch.

The sub-index corresponds to the node-ID of the CANopen devices in the network. The sub-index corresponding to its own node-ID is ignored.

Object description

Attribute	Value
Index	$1F87_h$
Name	Serial number
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - $7F_h$
Default value	$7F_h$

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Attribute	Value
Sub-index	01_h
Description	Node-ID 1
Entry category	conditional mandatory if node-ID 1 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 04_h – see CiA 301
Default value	0000 0000_h

to

Attribute	Value
Sub-index	$7F_h$
Description	Node-ID 127
Entry category	conditional mandatory if node-ID 127 is supported
Access	rw
PDO mapping	no
Value range	see value definition for object 1018_h sub-index 04_h – see CiA 301
Default value	0000 0000_h

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6.1.13 Object $1F89_h$: Boot Time

The object defines the time out between start of the process Start process boot NMT slave and the signaling of the successful boot of all mandatory NMT slaves. The value is given in multiples of 1 ms. The value $0000\ 0000_h$ disables the timer.

Object description

Attribute	Value
Index	$1F89_h$
Object name	Boot time
Object code	VAR
Data type	UNSINGED32
Category	optional

Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	no
Value range	UNSIGNED32
Default value	$0000\ 0000_h$

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6.2 Manufacturer Specific Objects

IXXAT CME/PN implements manufacturer specific objects to enable access to additional configuration options and to diagnostics and status information. These objects are described below:

- Process Image Byte Order Configuration
- General CANopen Diagnostics Objects
- CANopen Network Diagnostics Object

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6.2.1 Object 4000_h: Process Image Byte Order Configuration

This object allows to configure the byte order representation of the process image on IXXAT CME/PN to be either little endian (the network byte order for CANopen networks) or big endian format (the default network byte order for PROFINET networks). The default is big endian format, enabling the user to work with process data in the default byte order for PROFINET systems. The object is only accessible from CANopen Configuration Studio for IXXAT CME/PN. The parameterized value is included in the concise device configuration file that is downloaded into the IXXAT CME/PN gateway. Any attempt to write this object from the CANopen network is aborted with error code 0800 0021_h: Data cannot be transferred or stored to the application because of local control.

Value definition Process Image Endianness Configuration

Value	Description
00_h	Process data of IXXAT CME/PN represented in little endian format
01_h	Process data of IXXAT CME/PN represented in big endian format

Object description

Attribute	Value
Index	4000_h
Name	Process Image Byte Order Configuration
Object code	VAR
Data type	UNSIGNED8
Category	Manufacturer specific

Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	no
Value range	see value definition
Default value	01_h

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6.2.2 General CANopen Diagnostics Objects

The IXXAT CME/PN gateway implements manufacturer specific diagnostic objects that enable the user to identify a failed remote CANopen device and to read the corresponding error information. You can access the diagnostic objects via PROFINET using a PLC program.

The supported diagnostic objects are listed in the table below:

Index	Sub-index	Name	Type	Description
5000_h		Status CANopen manager	RECORD	
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Event indication	UNSIGNED16	Equal to object 5020_h byte 4 and 5 00_h = OK
	02_h	State of the CANopen manager	UNSIGNED8	High nibble 00_h INIT 40_h MASTER_STATE_RESET 60_h PREPARE_NET_INIT 61_h NTW_RESET 62_h NTW_WAIT 64_h BOOT_CONF 70_h BOOT_END_MISSING_MAND $8x_h$ CLEAR Ax_h RUN Cx_h STOP Ex_h PREOPERATIONAL 90_h FATAL_ERROR Low nibble Bit 0: 0 No error; 1 At least one optional or unexpected CANopen module does not correspond to the expected network configuration Bit 1: 0 No error; 1 At least one mandatory CANopen module does not correspond to the

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Index	Sub-index	Name	Type	Description
				expected network configuration Bit 2: 0 No CANopen device, including the CANopen manager is in NMT state Operational 1 At least one CANopen device is in NMT state Operational (not including the CANopen manager) Bit 3: 0 The CANopen manager is not in NMT state Operational 1 The CANopen manager is in NMT state Operational
	03_h	Communication status of the CANopen manager	UNSIGNED8	0 = OK 10_h = OK, if CANopen diagnostic device is “Tx passive”
5001_h		Assigned slaves bit list	ARRAY	Bit flag list of CANopen slave devices for which bit 0 in object $1F81_h$ is set to 1. Device with this configuration are assigned to the CANopen manager and present in the network
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5002_h		Configured slaves bit list	ARRAY	Bit flag list of CANopen devices for which the boot slave process has been successfully completed and which are fully configured based on the concise DCF data for the particular device
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)

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Index	Sub-index	Name	Type	Description
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5003_h		Fault slaves bit list	ARRAY	Bit list that flags all attached CANopen slave devices for which an error has been detected. Errors reasons may include: • CANopen devices that were detected in the CANopen network, but are not declared in object $1F81_h$ • CANopen devices that reuse the CANopen node-ID used by the CANopen manager itself
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5004_h		Operational slaves bit list	ARRAY	Bit flag list of CANopen slave devices with expected NMT state Operational. The bit list is populated based on NMT node control commands issued by the CANopen manager. The operational slave bit list is not directly synchronized with information from NMT error control services (heartbeat or node guarding). On error control events such as heartbeat or node guarding errors, or on detected boot-up messages, the bit flag for the particular CANopen slave is cleared
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)

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Index	Sub-index	Name	Type	Description
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5005_h		Stopped slaves bit list	ARRAY	Bit flag list of CANopen slave devices with expected NMT state Stopped. The bit list is populated based on NMT node control commands issued by the CANopen manager. The stopped slave bit list is not directly synchronized with information from NMT error control services (heartbeat or node guarding). On error control events such as heartbeat or node guarding errors, or on detected boot-up messages, the bit flag for the particular CANopen slave is cleared. Devices that have been detected in the network but are not declared as CANopen slave devices assigned to the CANopen manager will be set into NMT state Pre-operational by default to prevent network disruption. The application may set these devices alternatively into NMT state Stopped. The bit flag for these devices is then set to 1 in the stopped slaves bit list.
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5006_h		Pre-operational slaves bit list	ARRAY	Bit flag list of CANopen slave devices with expected NMT state Pre-operational. The bit list is populated based on NMT node control commands issued by the CANopen manager. The pre-operational slave bit list is not directly synchronized with information from NMT error control services (heartbeat or node guarding). On error control events

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Index	Sub-index	Name	Type	Description
				such as heartbeat or node guarding errors, or on detected boot-up messages, the bit flag for the particular CANopen slave is cleared. Devices that have been detected in the network but are not declared as CANopen slave devices assigned to the CANopen manager will be set into NMT state Pre-operational by default to prevent network disruption. The bit flag for these devices is set to 1 in the pre-operational slaves bit list.
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5007_h		Emergency slaves bit list	ARRAY	Slave has transmitted at least one emergency message, the corresponding device is not error free
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5008_h		Inconsistent concise DCF bit list	ARRAY	Bit flag list of CANopen slave devices for which a format error has been detected in the concise DCF data containing the configuration information for the slave device
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)

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Index	Sub-index	Name	Type	Description
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5009_h		Mismatching concise DCF bit list	ARRAY	Bit flag list of CANopen devices for which the internal structure in the concise DCF data does not correspond to the object dictionary layout of the connected CANopen slave device. This case is detected if the download of configuration data to the CANopen slave device is terminated by means of a SDO abort protocol
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
$500A_h$		Identity error bit list	ARRAY	Bit flag list of CANopen slave devices for which the identity information in the arrays $1F84_h$ to $1F88_h$ does not correspond to the identity information retrieved from objects 1000_h and 1018_h, sub-index 01_h to 04_h of the CANopen slave device
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h - 20_h	UNSIGNED32	Bit n represents node-ID (n+1)
	02_h	Node-ID 21_h - 40_h	UNSIGNED32	Bit n represents node-ID (n+33)
	03_h	Node-ID 41_h - 60_h	UNSIGNED32	Bit n represents node-ID (n+65)
	04_h	Node-ID 61_h - $7F_h$	UNSIGNED32	Bit n represents node-ID (n+97). Bit 31 is always 0
5010_h		Node error count	ARRAY	The CANopen manager counts the emergency messages received from each of the CANopen slave devices starting with the NMT startup process. Emergency messages indicating an error free condition are counted as well. If

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Index	Sub-index	Name	Type	Description
				the counter has reached the limit of 255, the counter is not incremented further.
	00h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h	UNSIGNED8	Emergency counter for node-ID 01_h
	::			
	$7F_h$	Node-ID $7F_h$	UNSIGNED8	Emergency counter for node-ID $7F_h$
5011_h	00_h	Generic error count	UNSIGNED8	The CANopen manager counts and categorizes emergency messages received from any CANopen slave according to the most important error types. If a counter has reached the value 255, it is not incremented further. Error code $10xx_h$
5012_h	00_h	Device hardware error count	UNSIGNED8	see description for object 5011_h Error code $50xx_h$
5013_h	00_h	Device software error count	UNSIGNED8	see description for object 5011_h Error code $60xx_h$
5014_h	00_h	Communication error count	UNSIGNED8	see description for object 5011_h Error code $81xx_h$
5015_h	00_h	Protocol error count	UNSIGNED8	see description for object 5011_h Error code $82xx_h$
5016_h	00_h	External error count	UNSIGNED8	see description for object 5011_h Error code $90xx_h$
5017_h	00_h	Device specific error count	UNSIGNED8	see description for object 5011_h Error code $FFxx_h$
5018_h		CANopen slave emergency history	ARRAY	If no emergency message has yet been received by a CANopen slave that is part of the CANopen network, byte 0 returns the value zero. The size of the domain is one. Else the value of byte 0 specifies the number of the last emergency message received.

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Index	Sub-index	Name	Type	Description
				The data of the emergency messages are copied into the queue in the same order as they were received (LSB first). Every emergency message consists of exactly 8 bytes.
	00h	Highest sub-index supported	UNSIGNED8	
	01_h	Node-ID 01_h	DOMAIN	Emergency history for node-ID 01_h
	::			
	$7F_h$	Node-ID $7F_h$	DOMAIN	Emergency history for node-ID $7F_h$
5020_h	00_h	CANopen network diagnostics	UNSIGNED48	see CANopen network diagnostics object description
5030_h		Fatal error log	RECORD	
	00_h	Highest sub-index supported	UNSIGNED8	
	01_h	Number of fatal errors	UNSIGNED16	
	02_h	Fatal error log	DOMAIN	Contact Technical Support for details

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6.2.3 Object 5020_h: CANopen Network Diagnostics Object

General summary of state of CANopen manager, CANopen slave devices, and the CAN network.

Value definition CANopen network diagnostics

Byte(s) number	Name	Description
0	CANopen manager state machine	Value coded: 0. Waiting for CANopen initialization or CANopen initialization is running 1. IXXAT CME/PN is configured as CANopen slave **Only valid if IXXAT CME/PN is configured as NMT master** 2. Process NMT startup has not been started 3. Process NMT startup in state reset network 4. Process NMT startup scanning the network and booting the CANopen slave devices 5. Reserved, always 0 6. Reserved, always 0 7. Process NMT startup mandatory slave error: boot time not elapsed 8. Process NMT startup: CANopen manager is allowed to start itself and the network 9. Process NMT startup: CANopen manager is allowed to start itself but not the network 10. Process NMT startup: CANopen manager is not allowed to start itself but may start the network 11. Process NMT startup: CANopen manager is neither allowed to start itself nor the network 12. Process NMT startup finished: CANopen manager is allowed to start a booted slave autonomously 13. Process NMT startup finished: CANopen manager is allowed to start a booted slave if the CANopen manager is in NMT state Operational 14. Process NMT startup finished: CANopen manager is not allowed to start a booted slave autonomously **Fatal error** 15. Severe software error has been detected
1	CANopen state of the CANopen manager	Value coded: 0. NMT state Operational 1. NMT state Stopped 2. NMT state Pre-operational 3. Waiting for initialization or CANopen initialization is running

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Value definition CANopen network diagnostics

Byte(s) number	Name	Description
2	CAN status	Bit coded: 0. Bus off 1. CAN receive message lost 2. CAN transmit message 3. Warning level reached 4. Transition warning level reached to warning level left occurred 5. Cable break
3	CANopen slave status	Bit coded: 0. Mandatory slave missing, identity error, or concise DCF error 1. Optional slave missing, identity error, concise DCF error, or unexpected device(s) present in the network 2. At least one operational slave that has been booted successfully 3. At least one pre-operational slave that has been booted successfully 4. At least one stopped slave that has been booted successfully
4 - 5	Event indication	Byte 4, bit coded: 0. Fatal error 1. Another device uses the node id of the CANopen manager 2. Error control event of a mandatory slave 3. Identity error of a mandatory slave 4. Identity error of an optional slave 5. No communication with the PROFINET IO controller 6. Communication status with the PROFINET IO controller has changed 7. General indication: network management event Byte 5, bit coded: 0. NMT slave assignment configuration error 1. Reception of a RPDO with less data than expected 2. Mismatching concise DCF 3. Inconsistent concise DCF 4. Failed save configuration 5. Cable break detected 6. The state of the CANopen network has been changed by a request NMT command (see object $1F82_h$) via a CAN message 7. The state of a single CANopen slave has been changed by request NMT command (see object $1F82_h$) via a CAN message

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Object description

Attribute	Value
Index	5020_h
Name	CANopen network diagnostics
Object code	VAR
Data type	UNSIGNED48
Category	Manufacturer specific

Entry description

Attribute	Value
Sub-index	00_h
Access	ro
PDO mapping	no
Value range	see value definition
Default value	no

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6.3 Device Profile Objects

The configuration examples discussed in earlier sections are based on generic device description files according to CiA 401 CANopen device profile for generic I/O modules. The objects used in those example configurations are:

Index	Object type	Name	Data type	CiA specification
6000_h	ARRAY	Read input 8 bit	UNSIGNED8	CiA 401
6200_h	ARRAY	Write output 8 bit	UNSIGNED8	CiA 401
6401_h	ARRAY	Read analog input 16 bit	INTEGER16	CiA 401
6411_h	ARRAY	Write analog output 16 bit	INTEGER16	CiA 401

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6.3.1 Object 6000_h: Read Input 8 bit

This object reads groups of 8 input lines as 8 bit information. The object is mandatory for digital input modules.

Object description

Attribute	Value
Index	6000_h
Object name	Read input 8 bit
Object code	ARRAY
Data type	UNSINGED8
Category	conditional mandatory if the device supports digital inputs

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - FE_h
Default value	Device specific

Attribute	Value
Sub-index	01_h
Description	Read input 01_h to 08_h
Entry category	mandatory
Access	ro
PDO mapping	TPDO
Value range	UNSIGNED8
Default value	no

to

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Attribute	Value
Sub-index	FE_h
Description	Read input $7E8_h$ to $7F0_h$
Entry category	optional
Access	ro
PDO mapping	TPDO
Value range	UNSIGNED8
Default value	no

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6.3.2 Object 6200_h: Write Output 8 bit

This object sets groups of 8 output lines as 8 bit information. The object is mandatory for digital output modules.

Object description

Attribute	Value
Index	6200_h
Object name	Write output 8 bit
Object code	ARRAY
Data type	UNSINGED8
Category	conditional mandatory if the device supports digital outputs

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - FE_h
Default value	Device specific

Attribute	Value
Sub-index	01_h
Description	Write output 01_h to 08_h
Entry category	mandatory
Access	rw
PDO mapping	RPDO
Value range	UNSIGNED8
Default value	00_h

to

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Attribute	Value
Sub-index	FE_h
Description	Write output $7E8_h$ to $7F0_h$
Entry category	optional
Access	rw
PDO mapping	RPDO
Value range	UNSIGNED8
Default value	00_h

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6.3.3 Object 6401_h: Read Analog Input 16 bit

This object reads the value of one input channel per sub-index. The object is mandatory for analog input modules.

Object description

Attribute	Value
Index	6401_h
Object name	Read analog input 16 bit
Object code	ARRAY
Data type	INTEGER16
Category	conditional mandatory if the device supports analog inputs

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - FE_h
Default value	Device specific

Attribute	Value
Sub-index	01_h
Description	Analog input 01_h
Entry category	mandatory
Access	ro
PDO mapping	TPDO
Value range	INTEGER16
Default value	no

to

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Attribute	Value
Sub-index	FE_h
Description	Analog input FE_h
Entry category	optional
Access	ro
PDO mapping	TPDO
Value range	INTEGER16
Default value	no

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6.3.4 Object 6411_h: Write Analog Output 16 bit

This object writes an unsigned 16 bit value to an analog output channel. The object is mandatory for analog output modules.

Object description

Attribute	Value
Index	6411_h
Object name	Write analog output 16 bit
Object code	ARRAY
Data type	INTEGER16
Category	conditional mandatory if the device supports analog outputs

Entry description

Attribute	Value
Sub-index	00_h
Description	Highest sub-index supported
Entry category	mandatory
Access	const
PDO mapping	no
Value range	01_h - FE_h
Default value	Device specific

Attribute	Value
Sub-index	01_h
Description	Analog output 01_h
Entry category	mandatory
Access	rw
PDO mapping	RPDO
Value range	INTEGER16
Default value	0000_h

to

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Attribute	Value
Sub-index	FE_h
Description	Analog output FE_h
Entry category	optional
Access	rw
PDO mapping	RPDO
Value range	INTEGER16
Default value	0000_h

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7 Glossary

C

CAN
Controller Area Network

CAN-ID
CAN identifier

CiA
CAN in Automation e.V.

COB
Communication Object

COB-ID
COB identifier

Concise DCF
Concise DCF. Specified in CiA 302-3

D

DCF
Device Configuration File. Specified in CiA 306

E

EDS
Electronic Data Sheet
Electronic device description format as specified in CiA 306

F

FSA
Finite state automaton

G

GSD
General Station Description

GSDML
General station description markup language. XML based markup language to describe PROFINET devices. Specified in PNO Order No: 2.352

L

LSB
Least significant bit/byte

M

MPDO

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Multiplexed-PDO

MSB
Most significant bit/byte

N

NMT
Network Management

NMT error control
Node guarding, heartbeat

NMT node control

Node-ID
Unique node identifier with a valid range from 1 to 127.

P

PDO
Process Data Object

PLC
Programmable Logic Controller

Process data duration
Time interval for which process data retain their current values

PROFINET Update Time
The update time is the time interval within which an IO device in the PROFINET IO system is supplied cyclically with new data from the IO controller. The update time may be configured separately for each IO device and determines the interval at which data is sent from the IO controller to the IO device (output module) as well as from the IO device to the IO controller (input module).

R

RPDO
Receive PDO

S

SDO
Service Data Object

SYNC
Synchronization object

T

TPDO
Transmit PDO

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PNO Order No: 2.352 - GSDML - Technical specification for PROFINET IO, version 2.3

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