
# How Can You Integrate a Drive into the TIA Portal via the Device Master File (GSD)?

SIMATIC S7-1500 / TIA Portal from V12 SP1

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# Question

How can you integrate a drive into the TIA Portal via the device master file (GSD)?

# Answer

The instructions and notes listed in this document provide a detailed answer to this question.

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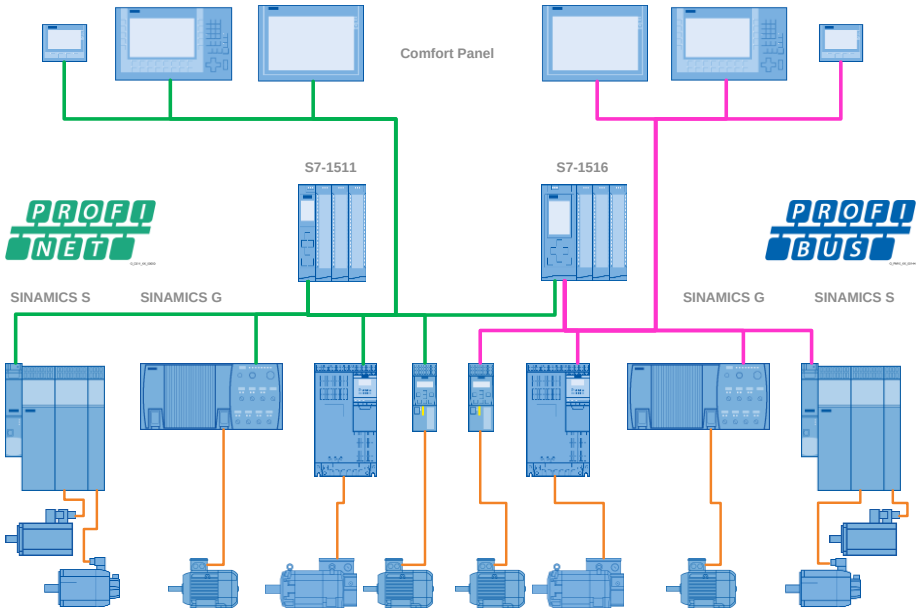
# 1 Motivation

## 1.1 Motion control with the SIMATIC S7-1500

In each CPU, the SIMATIC S7-1500 features technology functions that allow easy control of drives and therefore enable the user to implement motion control applications quickly and easily.

As shown in the figure below, all SIMATIC S7-1500 CPUs have a PROFINET port that can be used to connect drives to the controller. For some CPUs, for example the CPU 1516-3 PN/DP, you also have the option to connect PROFIBUS devices. The connection of HMI devices and drives of the SINAMICS family is shown here as an example.

Figure 1-1 Connecting drives to the SIMATIC S7-1500

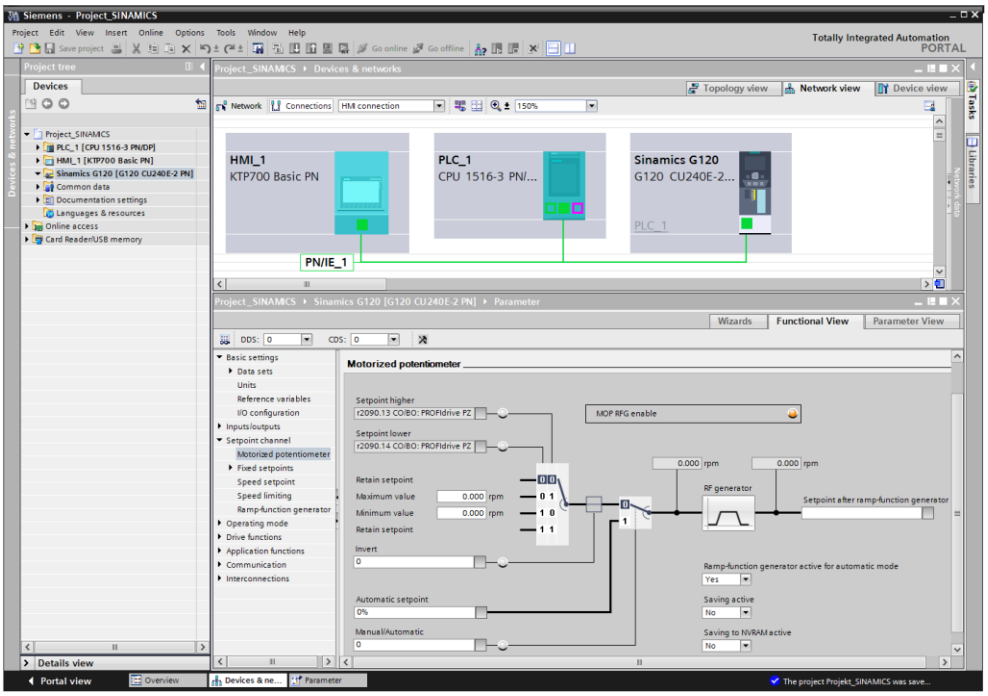



## 1.2 The SINAMICS Startdrive STEP 7 option

If the SINAMICS Startdrive STEP 7 option package has been installed in TIA Portal, SINAMICS G110 and G120 drives can be configured and commissioned directly in TIA Portal using the SINAMICS Startdrive option.

This is not possible for other drives of the SINAMICS family and third-party drives. However, these drives can still be used in TIA Portal and controlled via the SIMATIC S7-1500 user program.

Figure 1-2 SINAMICS Startdrive STEP 7 option



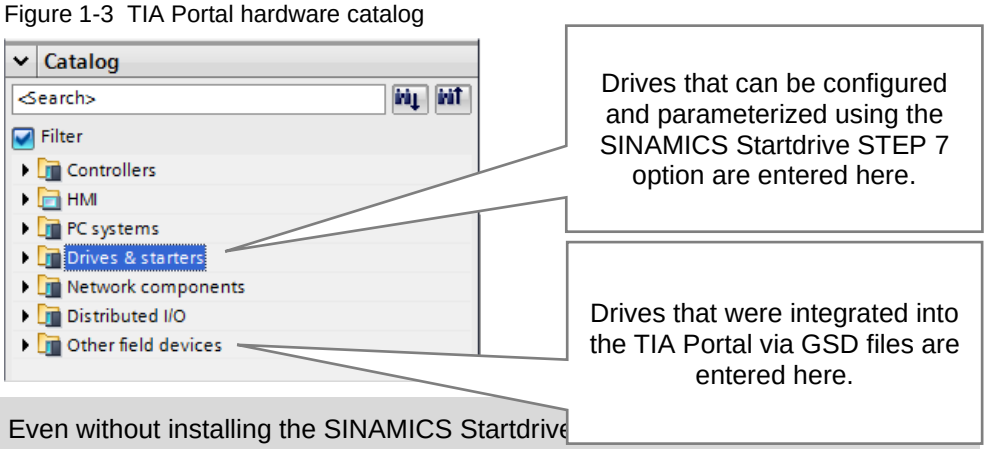

Drives that do not yet exist in the Totally Integrated Automation Portal are integrated with the aid of device master files, so-called GSD or GSDML files. The aim of this documentation is to provide a detailed explanation of the integration and use of these GSD or GSDML files.

**Note**

Throughout the rest of this document, “GSD file” is used synonymously for the terms “GSD file” for PROFIBUS and “GSDML file” for PROFINET

Depending on how the drives were integrated into the TIA Portal, drive selection in the hardware configuration must be made from different folders of the hardware catalog.

Figure 1-3 TIA Portal hardware catalog




**Note**

Even without installing the SINAMICS Startdrive, the SINAMICS S and SINAMICS G family have already been integrated into TIA Portal as device master files and can be used in projects.

## 1.3 Commissioning software for the drive

If the desired drive is integrated via the GSD file and can therefore not be configured and parameterized or commissioned using the SINAMICS Startdrive STEP 7 option, the drive must be commissioned using additional commissioning software. The same applies to the use of third-party drives.

For drives of the SINAMICS S family and drives of the SINAMICS G family that cannot be configured using the SINAMICS Startdrive STEP 7 option, the SINAMICS MICROMASTER STARTER commissioning tool can be used for commissioning.

**Note** In order to use the drive in conjunction with the SIMATIC S7-1500, the configuration in the drive made using the commissioning software must match the configuration in TIA Portal.

## 1.4 Software used for this documentation

This document was created using the software listed in the following table. However, it can also be applied to other commissioning tools and software versions – even from third-party suppliers.

Table 1-1 Software used

| Software | Version | Remark |
|---|---|---|
|  Totally Integrated Automation Portal | TIA Portal V13 with<br>• STEP 7 Professional V13<br>• WinCC Basic V13 | TIA Portal for the configuration, programming, commissioning and servicing of Siemens programmable controllers and drive systems. |
|  SINAMICS MICROMASTER STARTER | V4.4 HF3 | Commissioning software to commission all drives of the SINAMICS family for easy configuration and commissioning of drive components – menu-prompted and graphically supported. |

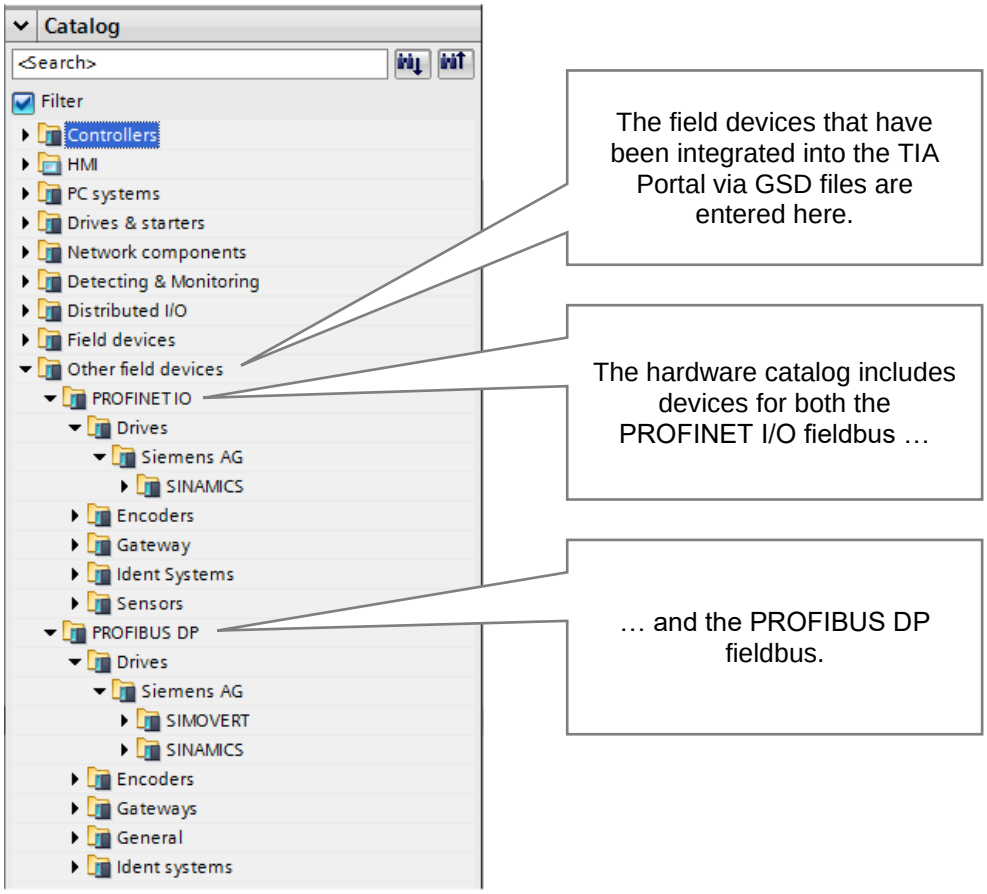
**Note** For the procedure described in this documentation, it is not necessary to install the SINAMICS Startdrive STEP 7 option in TIA Portal.

# 2 GSD Files in TIA Portal

## 2.1 Existing GSD files

The drives that have already been supplied with TIA Portal via device master files (GSD files) can be selected in the hardware catalog in “Other field devices”. This folder includes GSD files for drives of the PROFIBUS DP and PROFINET I/O fieldbus variants.

Figure 2-1 TIA Portal hardware catalog




## 2.2 Adding additional GSD files

If the desired drive unit does not exist in TIA Portal with the appropriate firmware version, the device master file (GSD file) can subsequently be installed in TIA Portal.

### 2.2.1 Obtaining the GSD files

The device master file (GSD file) required for the desired firmware version can be obtained in two different ways.

**Download from Siemens Industry Online Support**

In Siemens Industry Online Support, different download pages offer the device master files (GSD files) for the respective SINAMICS drives:

- PROFINET I/O fieldbus (GSDML files): see \7\.
- PROFIBUS DP fieldbus (GSD files): see \8\.

**Drives of the SINAMICS S family: Copying from the CF card of the Control Unit**

If the CF card required for operation already exists with the appropriate firmware version of the SINAMICS S, the necessary GSD file can also be copied directly from the CF card.


On the CF card of the Control Unit, the device master file (GSD file) can be found in the following directory:

“SIEMENS > SINAMICS > DATA > CFG”

**Note** Copy all files in this directory – including the image file (BMP) – to a folder from which you want to integrate the device master file (GSD file) into TIA Portal.

**Drives of the SINAMICS G family: Reading out of the Control Unit**

If the desired drive or the Control Unit of the drive of the SINAMICS G family already exists and if you have a SINAMICS card or a blank SIMATIC memory card of the S7-1500 to hand, the device master file (GSD file) can also be read out of the Control Unit.

For example, for the CU240E-2 Control Unit proceed as follows to read out the device master file:

- Insert the memory card into the Control Unit
- Set the p0804 parameter to the value 12
- Remove the memory card from the Control Unit
- Using the memory card, you can now transfer the device master file to the programmer for installation in TIA Portal.

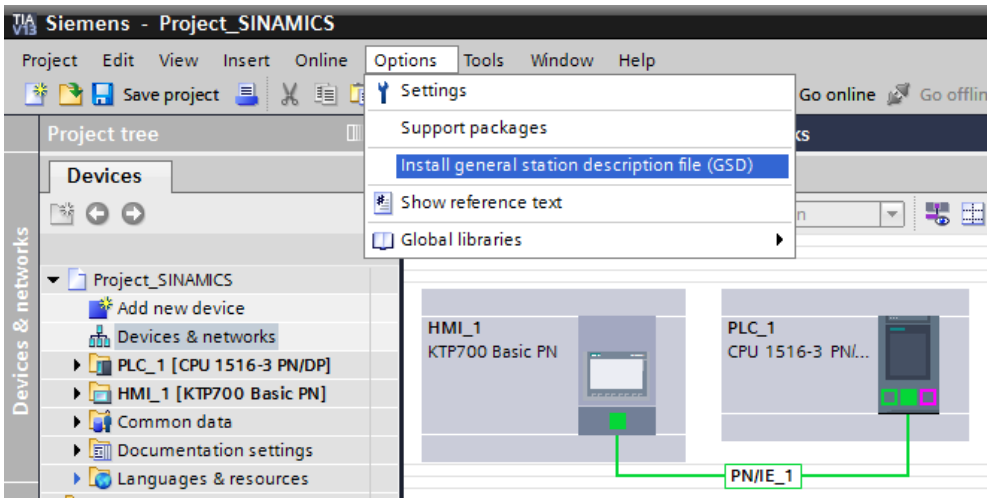
**Note** For other hardware components or firmware versions of the SINAMICS G family, the procedure may differ. Please refer to the appropriate manuals or Getting Started.

## 2.2.2 Integrating the GSD files

The device master file of the desired firmware version of the drive can be imported to TIA Portal using the “Options > Install general station description file (GSD)” menu option.

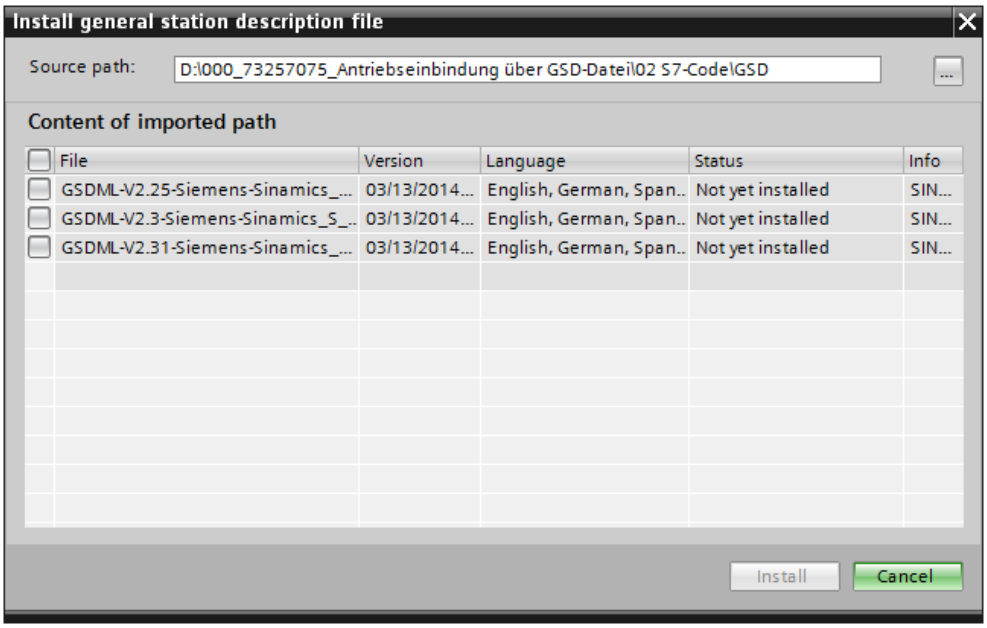
As the source path, select the folder where you have saved the GSD file(s) including the image file for device display in the hardware configuration from the download or the Control Unit.

Figure 2-2 Additionally installing the device master file




In the installation window for the GSD file, you can select the device master files for different languages and functionalities.

Figure 2-3 Selecting the GSD files to be installed




**Note**

If the desired functional scope and the necessary language is not known at this point, it is recommended to always install all files displayed in this window.

# 3 Connecting a Drive to the S7-1500

The desired drive can now be integrated into the project. The aim of this example is to show the connection of a SINAMICS S120 to the SIMATIC S7-1500.

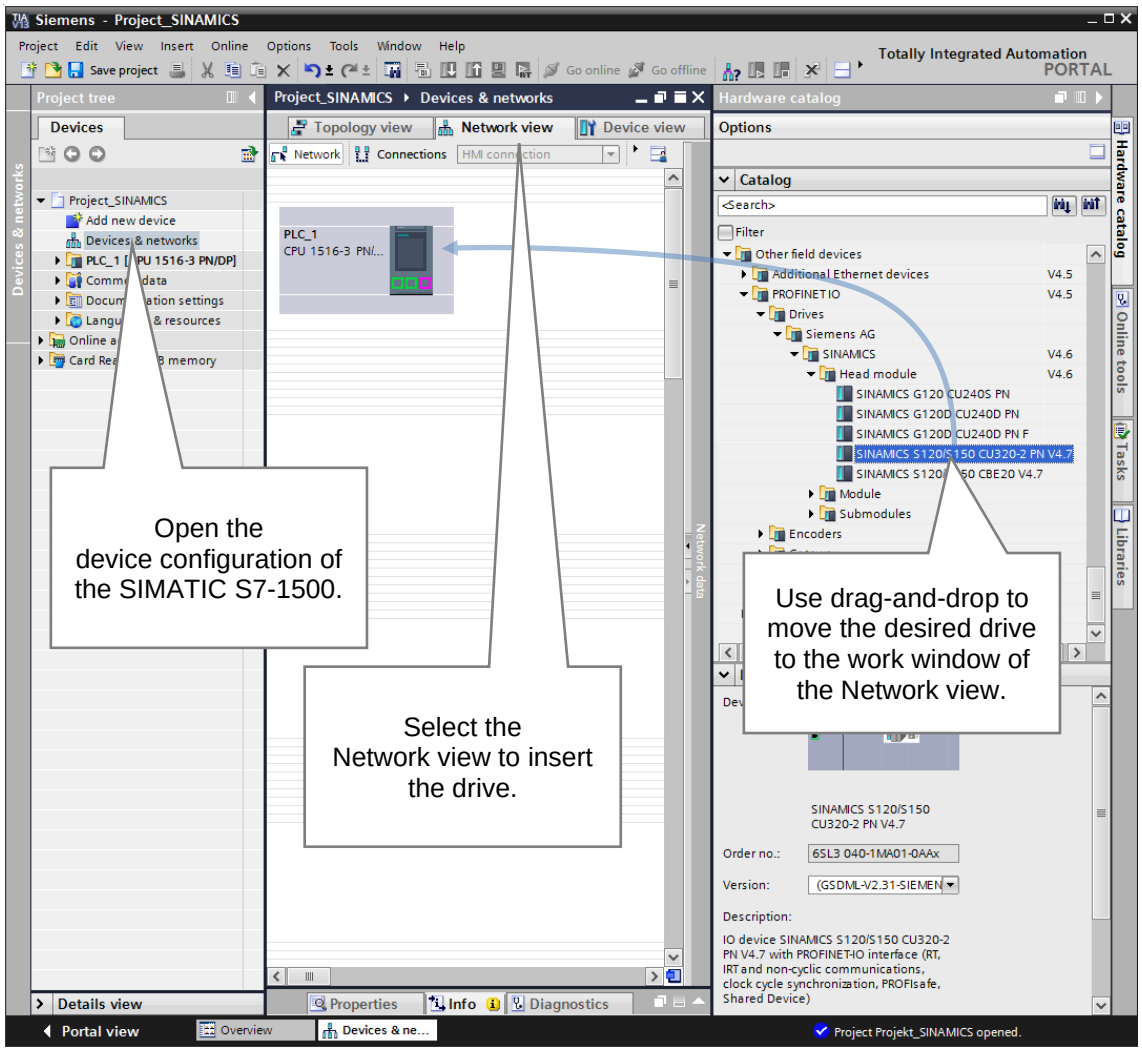
## 3.1 Selecting the drive from the hardware catalog

For the SIMATIC S7-1500 to which the SINAMICS S120 is to be connected, open the “Device configuration” and go to the “Network view”.

On the right side of the TIA Portal, open the “Hardware catalog”. The drives integrated into the TIA Portal via the device master file (GSD file) can then be found in the hardware catalog in “Other field devices”.

Select the desired drive from the hardware catalog and use drag-and-drop to move the item from the editing window to the Network view. This creates the drive in the project. Detailed information on the selected drive is available at the bottom of the hardware catalog in “Information”.

Figure 3-1 Integrating the drive into the device configuration



**Note** When selecting the desired drive, make sure that you select the correct fieldbus technology. Otherwise, it is not possible to establish the bus connection between the SIMATIC S7-1500 and the drive with the desired fieldbus.

## 3.2 Establishing the bus connection

If the drive has been inserted into the project, the bus connection between the SIMATIC S7-1500 and the newly inserted drive can be established in the “Network view”.

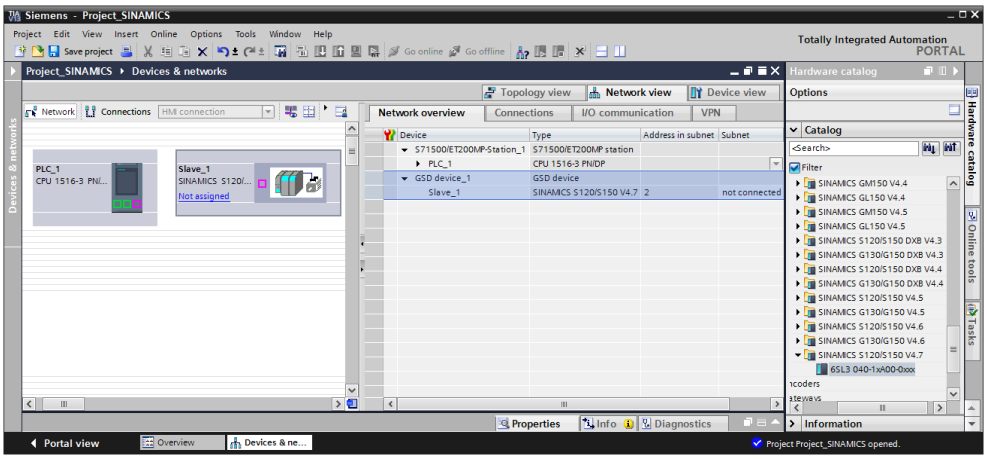
**Note** Initially, the bus connection defines the communication partner of the SIMATIC S7-1500 or the drive. At this point, the data to be exchanged between the SIMATIC S7-1500 and the drive is not yet configured. The bus connection only creates the option to exchange data and defines the physical interface.

### 3.2.1 PROFIBUS DP fieldbus

To establish the connection between the SIMATIC S7-1500 and the drive via the PROFIBUS DP fieldbus, click on the PROFIBUS port of the drive in TIA Portal and connect this port to the PROFIBUS port of the SIMATIC S7-1500 while keeping the left mouse button pressed.

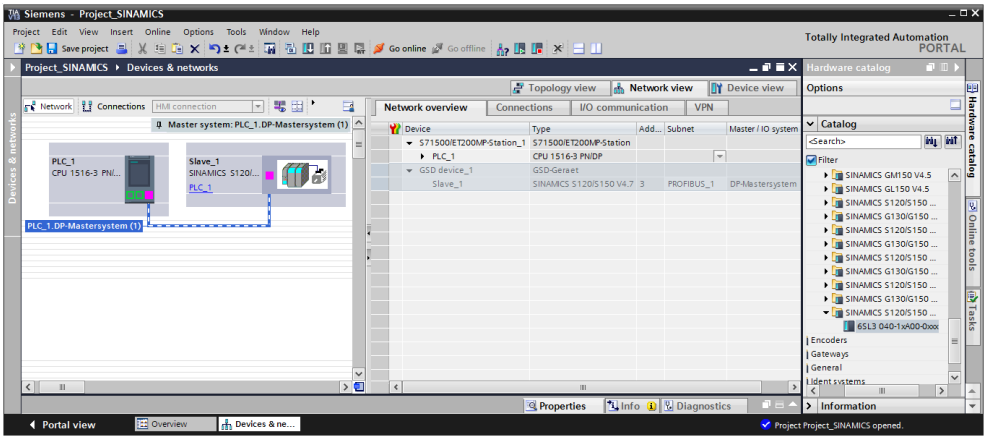
When doing so, make sure that you are in the “Network” function mode in the “Network view”.

Figure 3-2 Drive in the “Network view” display area




After configuring the networking, the drive is connected to the SIMATIC S7-1500 via a PROFIBUS DP master system.

Figure 3-3 Networking via a PROFIBUS DP master system

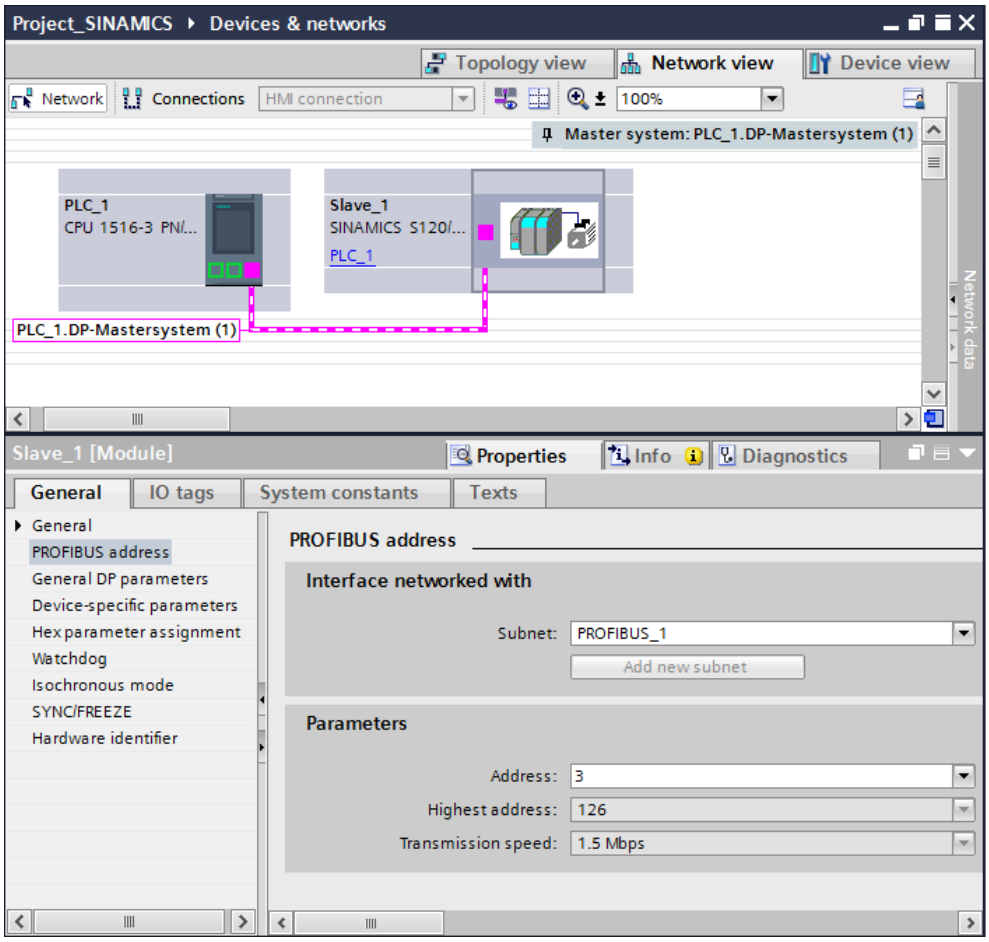



Finally, to completely establish the connection, you have to assign the PROFIBUS address of the drive or – if this has not already been done – the PROFIBUS address of the SIMATIC S7-1500. To do so, click on the image of the appropriate module in the “Network view”. In the “Properties” workspace, “General” tab, you can now use the “PROFIBUS address” menu option to set the address of the SIMATIC S7-1500 and, as shown in the figure, the PROFIBUS address of the drive.

**Note**

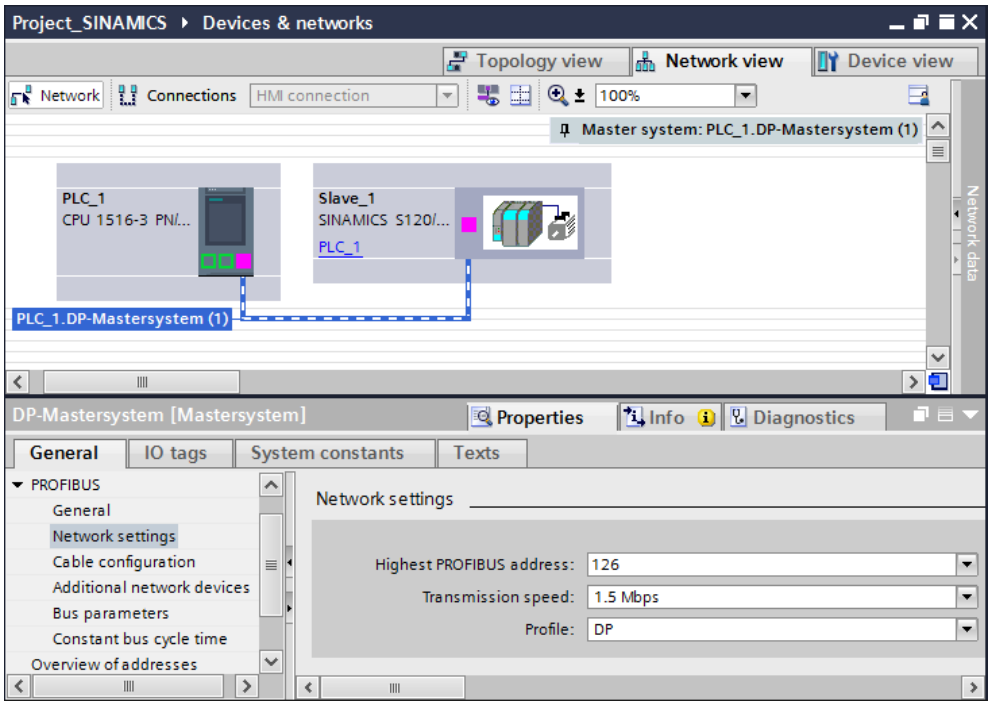
At this point, it is not possible to change the baud rate of the PROFIBUS connection as it is displayed for information only.

Figure 3-4 Assigning the PROFIBUS address on the drive




If you also want to change the baud rate of the PROFIBUS connection, e.g. for faster data exchange between the SIMATIC S7-1500 and the drive, click on the appropriate PROFIBUS DP master system in the Network view and in the “General” tab, select the “PROFIBUS > Network settings” menu option. Then you can set the baud rate.

Figure 3-5 Setting the baud rate for data transfer on the fieldbus




**Note**

For an explanation of the profiles to be selected, please refer to the TIA Portal Online Help. The “DP” setting should be selected for drives.

When the “User-defined” profile is selected, the individual parameters of the communication connection of the PROFIBUS DP master system can be set manually in the “PROFIBUS > Bus parameters” menu.

**NOTICE**

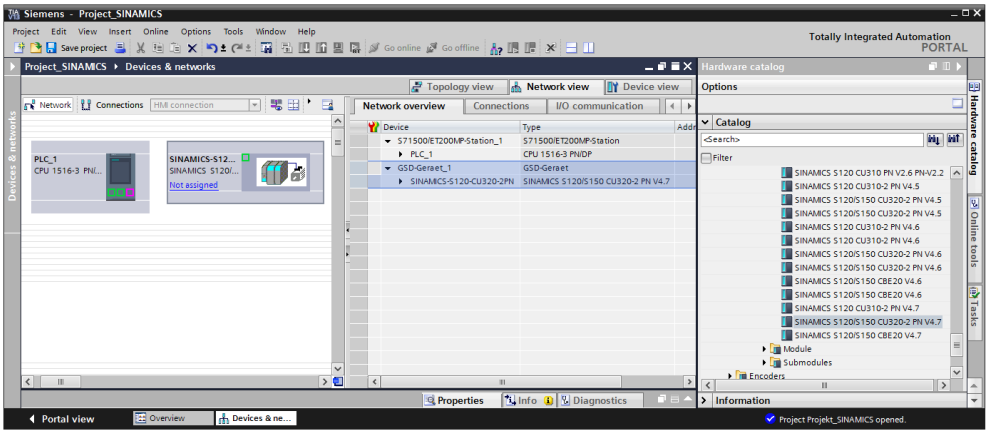
**For this configuration of the drive, please note that the settings in TIA Portal are made completely independently of the drive and that they must, of course, match the settings that already exist in the drive or that the respective settings also have to be made using the commissioning software of the drive.**

### 3.2.2 PROFINET I/O fieldbus

To establish the connection between the SIMATIC S7-1500 and the drive via the PROFINET I/O fieldbus, click on the PROFINET port of the drive in TIA Portal and connect this port to the PROFINET port of the SIMATIC S7-1500 while keeping the left mouse button pressed.

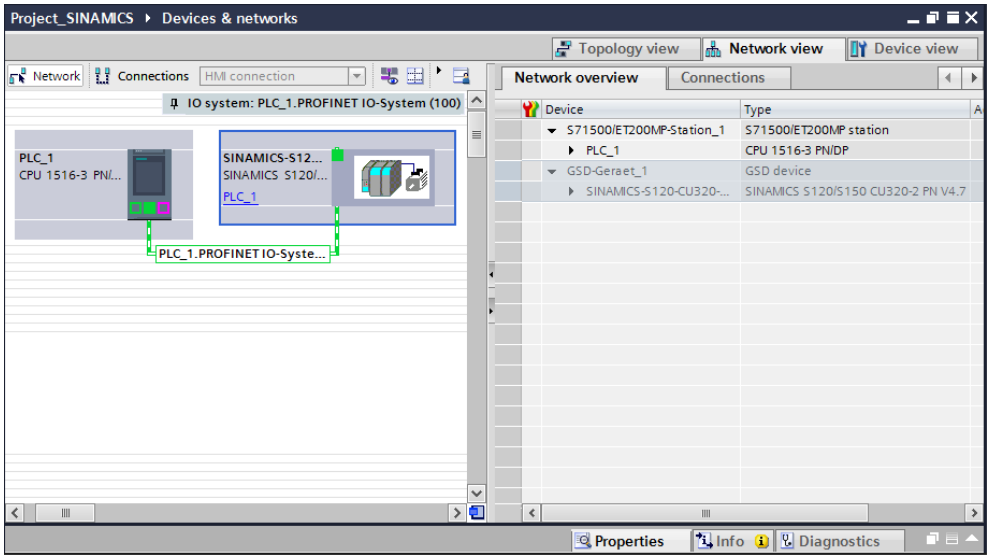
When doing so, make sure that you are in the “Network” function mode in the “Network view”.

Figure 3-6 Drive in the “Network view” display area




After configuring the networking, the drive is connected to the SIMATIC S7-1500 via a PROFINET I/O system.

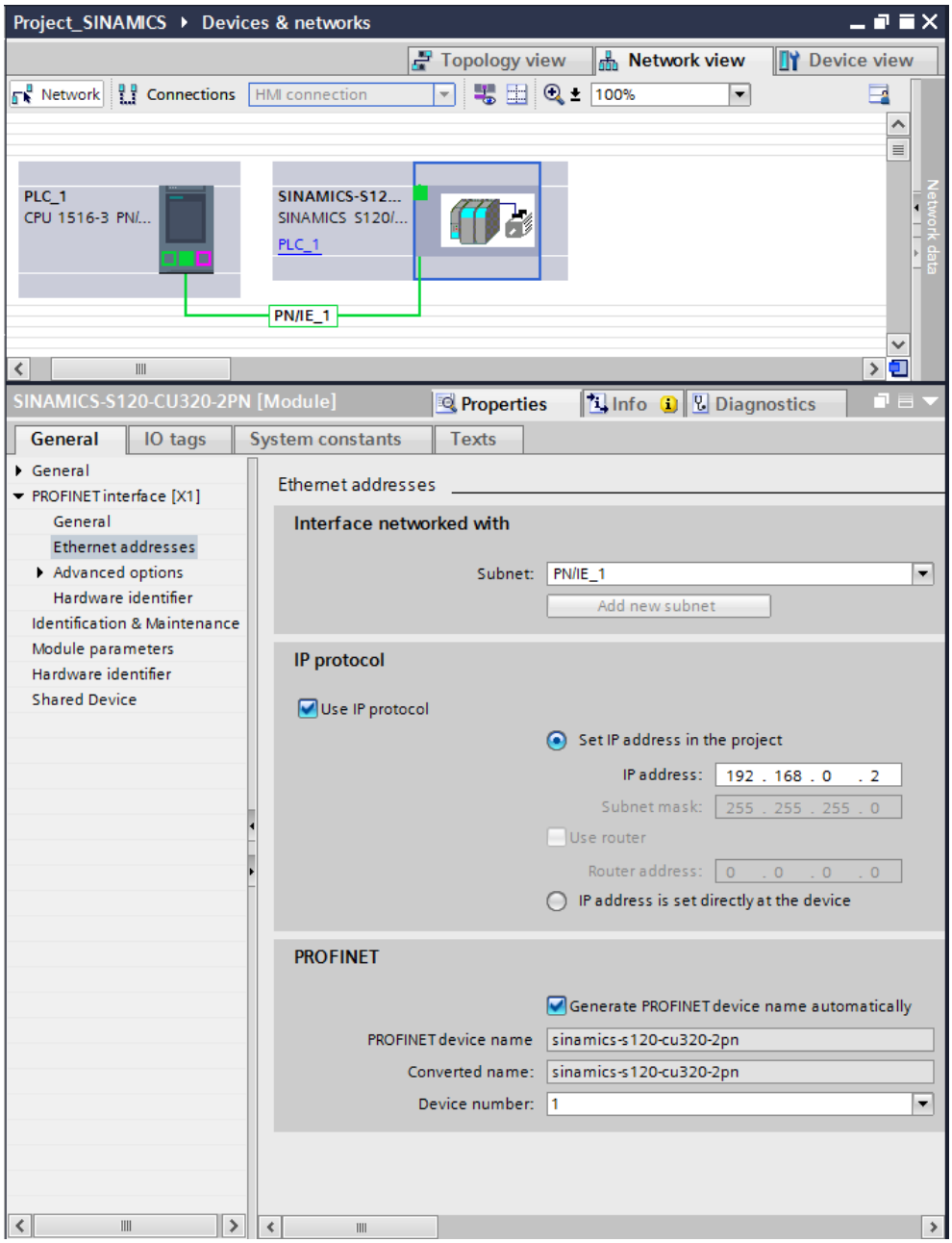
Figure 3-7 Networking via a PROFINET I/O system




Finally, to completely establish the connection, you have to assign the IP address of the drive or – if this has not already been done – the IP address of the SIMATIC S7-1500. To do so, click on the image of the module in the “Network view”. In the “Properties” workspace, “General” tab, you can now use the “Ethernet addresses” menu option to set the address of the SIMATIC S7-1500 and, as shown in the figure, the IP address of the drive.

Here you can also specify or automatically generate the PROFINET device name and, if necessary, change the device number.

Figure 3-8 Assigning the IP address on the drive




| NOTICE | **For this configuration of the drive, please note that the settings in TIA Portal are made completely independently of the drive and that they must, of course, match the settings that already exist in the drive or that the respective settings also have to be made using the commissioning software of the drive.** |
|---|---|

# 4 Establishing the Communication Connection

## 4.1 Telegram selection

Data exchange between the SIMATIC S7-1500 and the drive takes place using so-called telegrams via which the data to be exchanged is defined according to the PROFIdrive standard.

### 4.1.1 Drive telegrams that can be used with the SIMATIC S7-1500

The following telegrams according to the PROFIdrive standard are available for use in conjunction with the SIMATIC S7-1500 and were standardized by the PROFIBUS User Organization so that they can be used on all PROFIdrive drives:

Figure 4-1 PROFIdrive telegrams – standard telegrams

| | | PZD 1 | PZD 2 | PZD 3 | PZD 4 | PZD 5 | PZD 6 | PZD 7 | PZD 8 | PZD 9 | PZD 10 | PZD 11 | PZD 12 | PZD 13 | PZD 14 | PZD 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Telegram 1 | CPU ⇒ Drive | STW 1 | NSOLL | | | | | | | | | | | | | |
| | Drive ⇒ CPU | ZSW 1 | NIST | | | | | | | | | | | | | |
| Telegram 2 | CPU ⇒ Drive | STW 1 | NSOLL | | STW 2 | | | | | | | | | | | |
| | Drive ⇒ CPU | ZSW 1 | NIST | | ZSW 2 | | | | | | | | | | | |
| Telegram 3 | CPU ⇒ Drive | STW 1 | NSOLL | | STW 2 | G1 STW | | | | | | | | | | |
| | Drive ⇒ CPU | ZSW 1 | NIST | | ZSW 2 | G1 ZSW | e.g. G1 XIST1 | | e.g. G1 XIST2 | | | | | | | |
| Telegram 5 | CPU ⇒ Drive | STW 1 | NSOLL | | STW 2 | G1 STW | XERR | | KPC | | | | | | | |
| | Drive ⇒ CPU | ZSW 1 | NIST | | ZSW 2 | G1 ZSW | e.g. G1 XIST1 | | e.g. G1 XIST2 | | | | | | | |

| Legend | | | |
|---|---|---|---|
| STW | Control word | ZSW | Status word |
| NSOLL | Setpoint speed | NIST | Actual speed |
| XERR | Position deviation (DSC) | G1 XIST1 | Cyclic actual value (incr. encoder) |
| KPC | Position controller gain (DSC) | G1 XIST2 | Absolute actual value (abs. encoder) |
| G1 STW | Encoder control word | G1 ZSW | Encoder status word |
| PZD | Process data (type: WORD) | | |

The shown process data (PZD) is of the WORD type, which corresponds to a 16 bit data length. Therefore, the standard telegrams contain data in the WORD (16 bit) and DWORD (32 bit) form.

The maximum length of a PROFIdrive telegram is limited to 32 process data, i.e. to a data length of 512 bits or 64 bytes.

**Note**

For a detailed presentation of the bits of the control and status words for the SINAMICS S drive family, please refer, for example, to the SINAMICS S List Manual (LH 1).

### 4.1.2 Selection aid for the drive telegrams

To select the suitable telegram for data transfer between the SIMATIC S7-1500 and the drive, it is necessary to take a closer look at the main criteria of the telegrams:

- Accuracy of the transferred setpoint or actual value
  Is the 16 bit resolution transfer of the speed setpoint to the drive sufficient to achieve the desired function (speed setpoints or control response of the position control graduated)?
- Transfer of the encoder value connected to the drive
  Do you want to transfer the actual value of an encoder connected to the drive to the controller for position control in the SIMATIC S7-1500?
- Use of the DSC (Dynamic Servo Control) drive function
  Do you want to use the DSC (Dynamic Servo Control) drive function that allows quick correction of faults directly in the drive to improve the control properties of the drive?

Select the appropriate telegram depending on the desired functionality. The table below once again provides an overview of all the information.

Table 4-1 Selection aid for the drive telegrams

| Criterion for telegram selection | Telegram 1 | Telegram 2 | Telegram 3 | Telegram 5 |
|---|---|---|---|---|
| **Accuracy of the transferred setpoint and actual value** | | | | |
| 16 bit data width (WORD) | X | | | |
| 32 bit data width (DWORD) | | X | X | X |
| **Transfer of the encoder value connected to the drive** | | | | |
| No feedback of the encoder value (actual position) | X | X | | |
| Feedback of the encoder value (actual position) | | | X | X |
| **Use of the DSC (Dynamic Servo Control) drive function** | | | | |
| Use of DSC not possible | X | X | X | |
| Use of DSC possible | | | | X |

**Note**

If the drive is connected to the SIMATIC S7-1500 via PROFINET I/O and you select telegram 5, isochronous mode will be automatically activated for this axis due to the GSDML file.

In this case, isochronous mode must be parameterized accordingly for this axis in TIA Portal.

**Note**

Currently, the use of control word 2 of telegrams 2, 3 and 5 is not supported in the SIMATIC S7-1500.

### 4.1.3 Supplementary telegrams of the SINAMICS S drive family

In addition to the drive telegrams, the SINAMICS S drive family provides Siemens-specific supplementary telegrams for data exchange between the SIMATIC S7-1500 and the Control Unit or infeed (Active Infeed – Active Line Module) of the drive.

The following supplementary telegrams can be used for data exchange:

Figure 4-2 Supplementary telegrams of the SINAMICS S drive family

| | | PZD 1 | PZD 2 | PZD 3 | PZD 4 | PZD 5 | PZD 6 | PZD 7 | PZD 8 | PZD 9 | PZD 10 | PZD 11 | PZD 12 | PZD 13 | PZD 14 | PZD 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Telegram 370 (Infeed) | CPU ► INFEED | E_STW 1 | | | | | | | | | | | | | | |
| | INFEED ► CPU | E_ZSW 1 | | | | | | | | | | | | | | |
| Telegram 390 (Control Unit) | CPU ► CU | CU STW | A Digital | | | | | | | | | | | | | |
| | CU ► CPU | CU ZSW | E Digital | | | | | | | | | | | | | |
| Telegram 391 (Control Unit) | CPU ► CU | CU STW | A Digital | MT STW | | | | | | | | | | | | |
| | CU ► CPU | CU ZSW | E Digital | MT ZSW | MT1 ZS_F | MT1 ZS_S | MT2 ZS_F | MT2 ZS_S | | | | | | | | |
| Telegram 392 (Control Unit) | CPU ► CU | CU STW | A Digital | MT STW | | | | | | | | | | | | |
| | CU ► CPU | CU ZSW | E Digital | MT ZSW | MT1 ZS_F | MT1 ZS_S | MT2 ZS_F | MT2 ZS_S | MT3 ZS_F | MT3 ZS_S | MT4 ZS_F | MT4 ZS_S | MT5 ZS_F | MT5 ZS_S | MT6 ZS_F | MT6 ZS_S |

| **Legend** | | | |
|---|---|---|---|
| E_STW | Infeed control word | E_ZSW | Infeed status word |
| A Digital | Digital outputs of the CU | E Digital | Digital inputs of the CU |
| MT STW | Measuring probe control word | MT ZSW | Measuring probe status word |
| MT1 | Measuring probe 1 | MT6 | Measuring probe 6 |
| ZS_F | Measuring time, falling edge | ZS_S | Measuring time, rising edge |

The supplementary telegrams of the SINAMICS S drive family can only be accessed or evaluated via the SIMATIC S7-1500 user program. It is not possible to use these telegrams via technology objects of the motion control functions of the SIMATIC S7-1500.

These telegrams allow you to easily implement an influence on the Control Unit or the drive infeed and the use of the digital inputs and outputs of the Control Unit in the SIMATIC S7-1500, for example for limit switch signals.

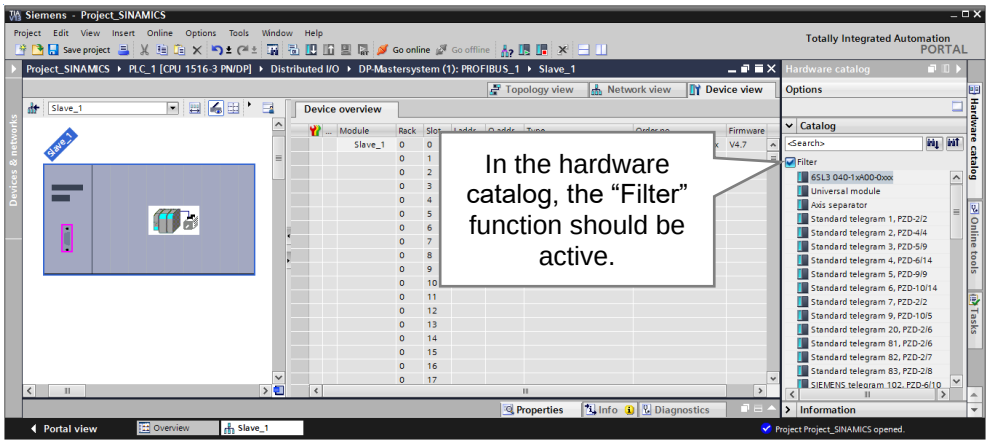
**Note**

Switch-on of an Active Infeed or Active Line Module (ALM) for use of the drive axes must be performed separately, for example using telegram 370 listed here. Automatic switch-on of the infeed via the “MC_Power” technology function is not performed.

## 4.2 Connection via PROFIBUS DP

In TIA Portal, double-click on the desired drive to go to the “Device view”. If the “Filter” function is activated in the hardware catalog, the “Device view” will automatically display the PROFIdrive telegrams available for this drive.

Figure 4-3 Drive opened in the “Device view”

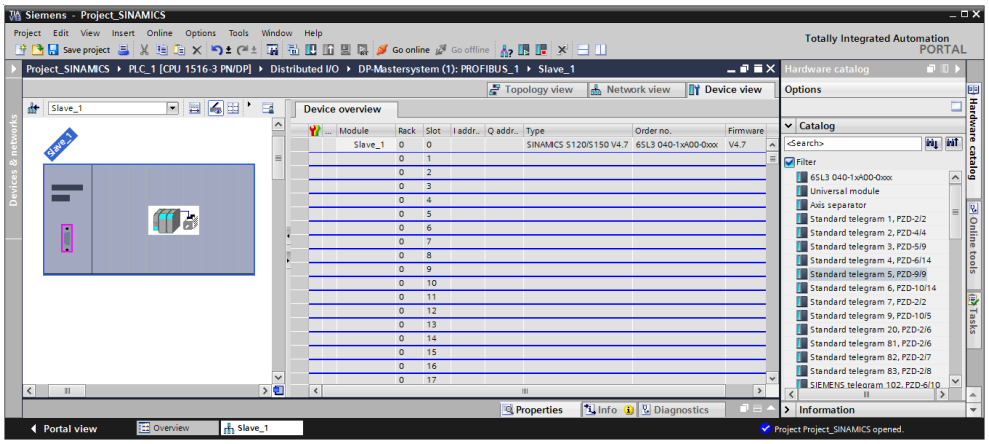



Now you can select the desired PROFIdrive telegrams from the hardware catalog and use drag-and-drop to integrate them into the device overview.

Once you select the desired telegram in the hardware catalog, possible slots for integrating the desired telegram will be marked in blue in the device overview.

This allows you to move the telegram to the respective location in the device overview using drag-and-drop.

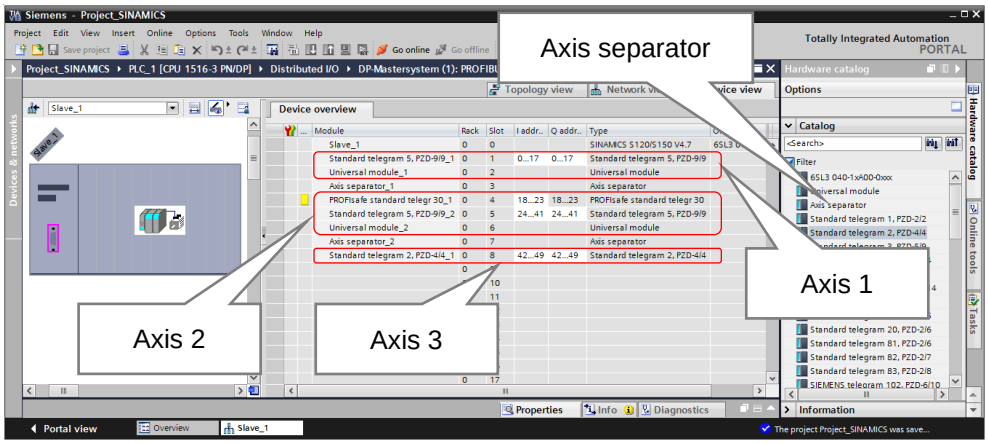
Figure 4-4 Integrating the desired telegrams into the device overview



If a drive contains multiple axes, an axis separator has to be inserted between the telegrams for the relevant axis.

This example shows the integration of telegrams for a drive unit with three axes: The first axis contains a standard telegram 5 and a telegram extension (universal module), the second axis contains a PROFIsafe extension (telegram 30), a standard telegram 5 and a telegram extension (universal module) and the third axis contains only a standard telegram 2.

Figure 4-5 Sample telegram selection for a drive unit with 3 axes




| NOTICE | **Do not forget to separate the data areas (telegram areas) of two axes by an axis separator.**<br><br>**If the axis separator is not used, an unexpected response of an axis may occur, for example for data areas that have not been completely defined, as sub-areas of telegrams could possibly be assigned to the wrong axis.**<br><br>**An axis separator must not be defined in front of the first telegram.** |
|---|---|

A telegram extension is implemented with the aid of the universal module. For this module, you can define an input range and/or an output range and a specific data length that corresponds to the desired telegram length.

Figure 4-6 Type definition of the universal module

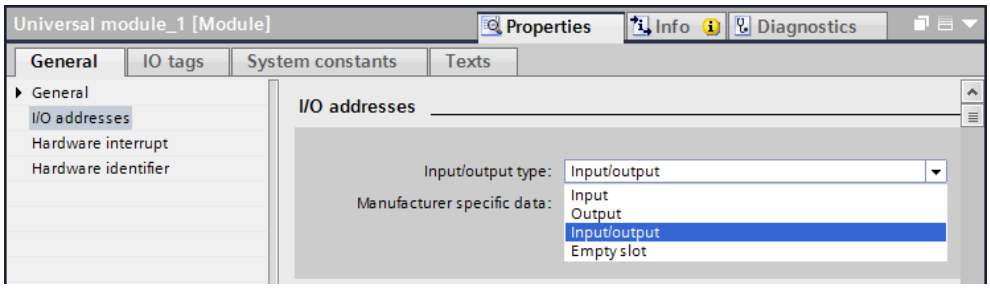
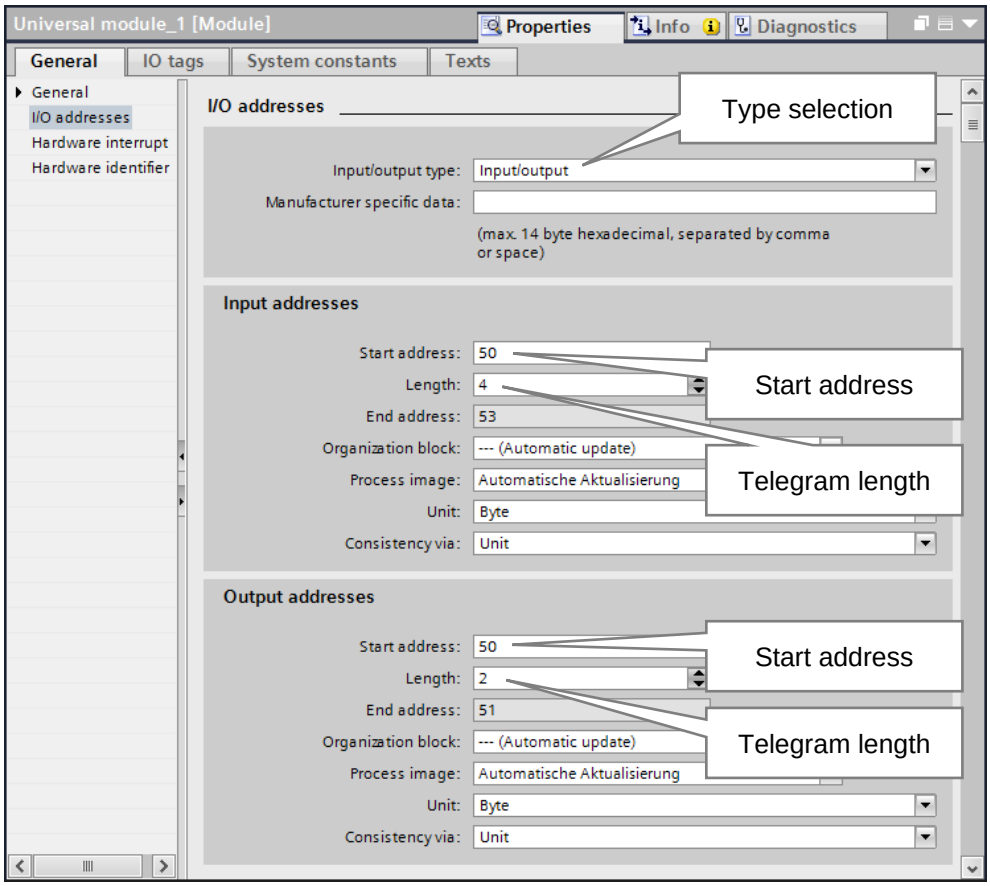


Figure 4-7 Address definition for the universal module of the “input/output” type




**Note**

In the hardware configuration (device overview), the names “Input addresses” and “Output addresses” refer to the perspective of the SIMATIC S7-1500:

- Output or O address:
  Data area for communication from the SIMATIC S7-1500 to the drive.
- Input or I address:
  Data area for communication from the drive to the SIMATIC S71500.

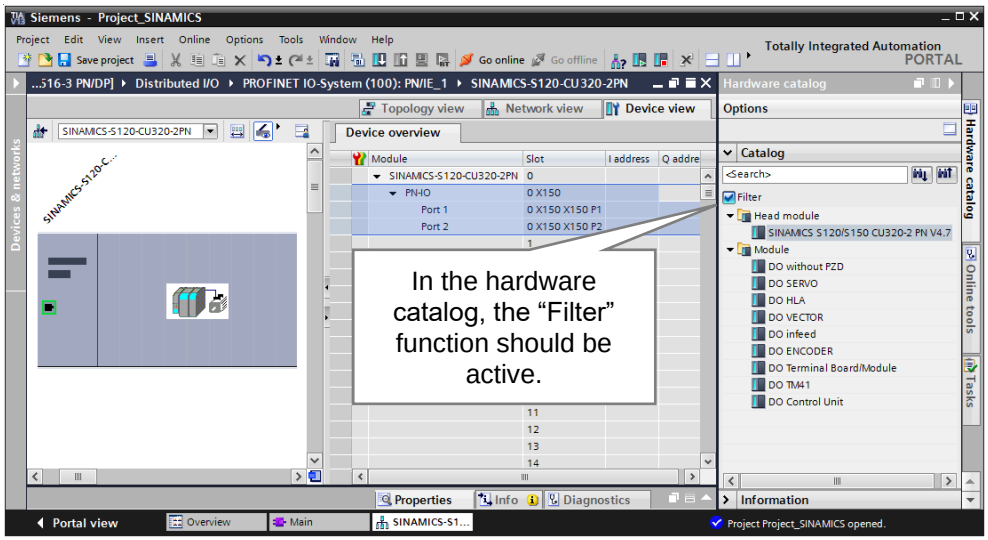
**NOTICE**

**For this configuration of the drive, please note that the settings in TIA Portal are made completely independently of the drive and that they must, of course, match the settings that already exist in the drive or that the respective settings also have to be made using the commissioning software of the drive.**

## 4.3 Connection via PROFINET I/O

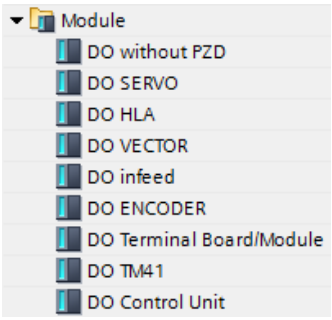
In TIA Portal, double-click on the desired drive to go to the “Device view”. If the “Filter” function is activated in the hardware catalog, the “Device view” will automatically only display the modules (drive objects “DO”) available for this drive.

Figure 4-8 Drive opened in the “Device view”



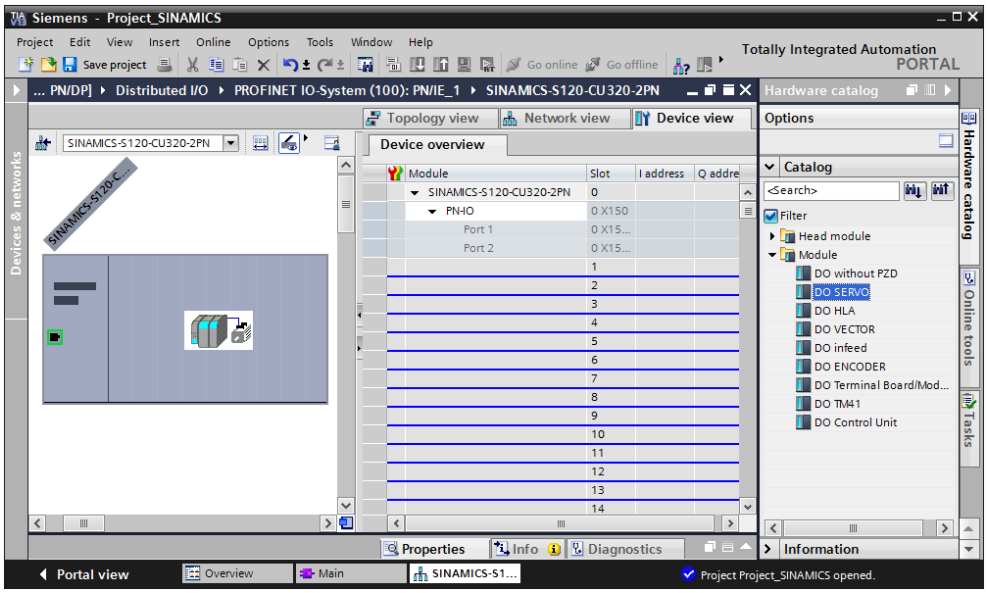

Before you can insert the desired PROFIdrive telegrams into the device overview, you have to create a drive object (DO) for each axis of the drive. For the head module SINAMICS S120 CU320 2PN, used in this example, the following DOs are available:

- without cyclic process data interchange: DO without PZD
- Axes: DO Servo, DO HLA, DO Vector, …
- Active Line Modules: DO infeed
- External encoders: DO ENCODER
- Terminal module: DO Terminal Board/Module
- Module for encoder simulation: DO TM41
- Control Unit: DO Control Unit




Drag-and-drop the Drive Object (DO) you want to address in the selected drive from the hardware catalog into one of the rows marked in blue.

Figure 4-9 Creating the axes of the drive unit as a drive object (DO)

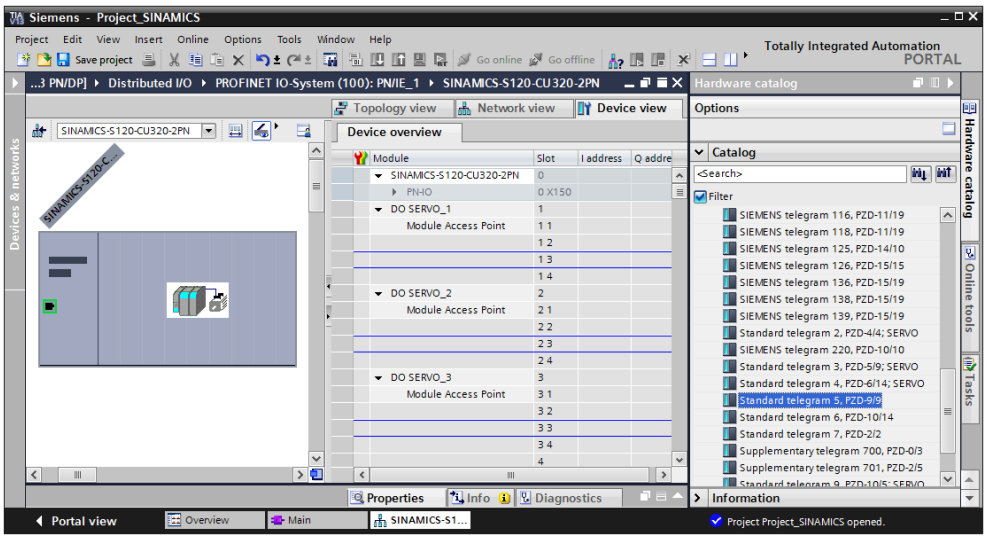



**NOTE**

Please note that, without filter (= “Filter” not checked), the respective drive objects (DOs) may be listed multiple times in the hardware catalog. To determine the correct drive object (DO) with switched-off filter, successively click on all drive objects (DOs) listed in the hardware catalog. As soon as the rows for inserting the drive object (DO) are marked in blue, you have determined the correct object and can apply it to the selected rows in the device overview using drag-and-drop.

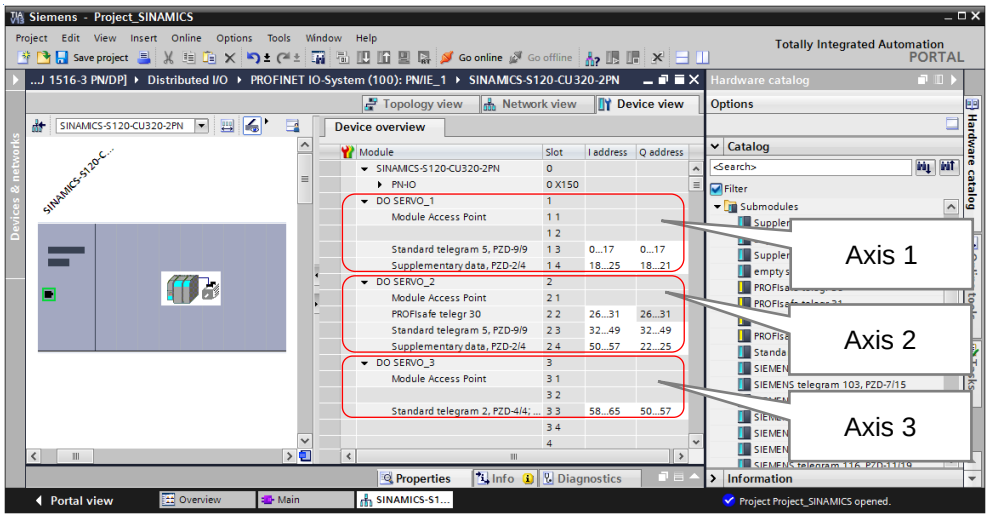
Once you have created the axes of the drive unit as drive objects (DOs), you can define the desired submodules (telegrams) below the DOs in the hardware catalog. To do so, select the required telegrams and use drag-and-drop to move them to the device overview.

Figure 4-10 Integrating the desired telegrams into the device overview

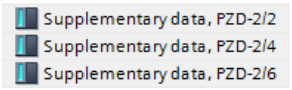


This example shows the integration of telegrams for a drive unit with three axes: The first axis contains a standard telegram 5 and a telegram extension (Supplementary data, PZD2/4), the second axis contains a PROFIsafe extension (telegram 30), a standard telegram 5 and a telegram extension (Supplementary data, PZD2/4) and the third axis contains only a standard telegram 2.

Figure 4-11 Sample telegram selection for a drive unit with 3 axes




The telegram extension is implemented with the aid of the “Supplementary data, PZD x/y” telegram. The data to be exchanged cannot be freely configured, it is defined by selecting the telegram:




- Supplementary data, PZD-2/2
  2 words from the drive to the SIMATIC S7-1500
  2 words from the SIMATIC S7-1500 to the drive
- Supplementary data, PZD-2/4
  2 words from the drive to the SIMATIC S7-1500
  4 words from the SIMATIC S7-1500 to the drive
- Supplementary data, PZD-2/6
  2 words from the drive to the SIMATIC S7-1500
  6 words from the SIMATIC S7-1500 to the drive

***Note***

*In the hardware configuration (device overview), the names “Input addresses” and “Output addresses” refer to the perspective of the SIMATIC S7-1500:*

- *Output or O address:*
  *Data area for communication from the SIMATIC S7-1500 to the drive.*
- *Input or I address:*
  *Data area for communication from the drive to the SIMATIC S7-1500.*

| NOTICE | **For this configuration of the drive, please note that the settings in TIA Portal are made completely independently of the drive and that they must, of course, match the settings that already exist in the drive or that the respective settings also have to be made using the commissioning software of the drive.** |
|---|---|

# 5 Setting Isochronous Mode

If the axes connected to the SIMATIC S7-1500 are to be used as positioning axes via the position control of the technology object of the SIMATIC S7-1500 or if the DSC (Dynamic Servo Control) function, which moves the position control to the drive for quicker compensation of disturbances, is to be used to increase axis accuracy, the drive must be connected to the automation system via an isochronous bus system.

**Note**

If the drive is connected to the SIMATIC S7-1500 via PROFINET I/O and you select telegram 5, isochronous mode will be automatically activated for this axis due to the GSDML file.

In this case, isochronous mode must be parameterized accordingly for this axis in TIA Portal.

The next chapters provide you with information on setting up an isochronous bus system for PROFIBUS DP and PROFINET I/O.

## 5.1 PROFIBUS DP

### 5.1.1 Basics and definition

**Constant bus cycle time**

Constant bus cycle time ensures that the time interval for bus cycles has exactly the same length. “Bus cycles of the same length” mean that the PROFIBUS DP master always starts the DP bus cycle after the same time interval. Therefore, the connected slaves too receive their data from the master at time intervals of the exact same length. This is also referred to as “bus cycle clocking”.

Constant bus cycle time is the prerequisite for isochronous mode.

**Isochronous mode**

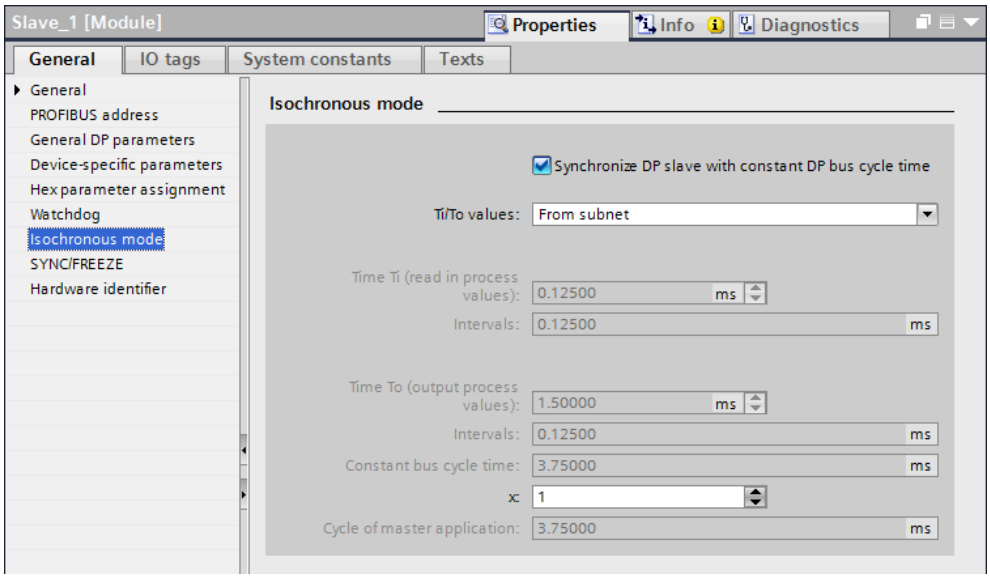
The “Isochronous mode” system property allows acquisition of measured values and process data in a fixed system cycle. Within the same system cycle, the signal is processed until it is available at the output terminal. Therefore, isochronous mode contributes to high control system quality, which results in greater manufacturing accuracy. Isochronous mode drastically reduces possible fluctuations in process reaction times. This processing stable in terms of time can be used for higher machine cycles.

Basically, isochronous mode is the choice where measured values need to be acquired synchronously, motions need to be coordinated and process reactions need to be defined and take place simultaneously.

### 5.1.2 Settings in TIA Portal

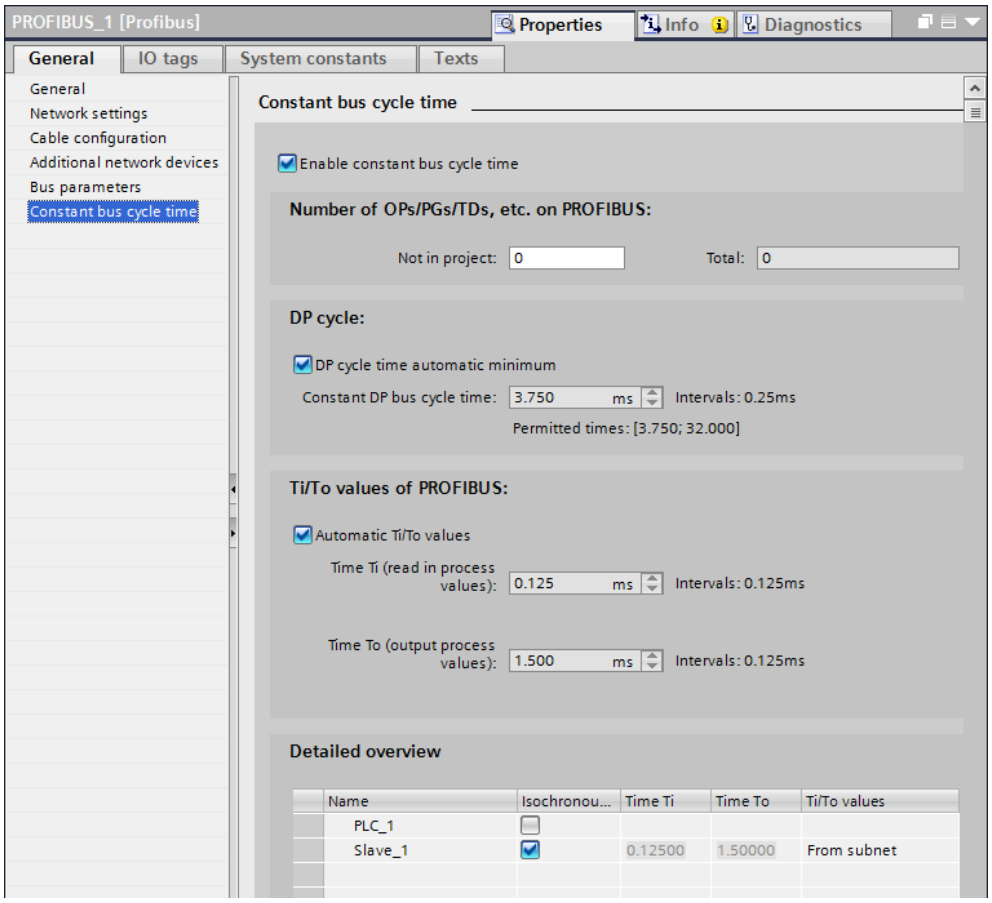
To activate isochronous operation, first activate isochronous mode in the drive’s properties.

Figure 5-1 Activating isochronous mode on the drive




Then you can activate the constant bus cycle time in the PROFIBUS properties, specify the cycle time of the equidistant DP cycle and the bias time Ti and the delay time To. In addition, you have to select the drive as an isochronous node in the detail overview.

Figure 5-2 Activating constant bus cycle time on PROFIBUS




# 5.2 PROFINET I/O

## 5.2.1 Basics and definition

### IRT Ethernet – Isochronous Real-Time Ethernet

IRT is a transmission mode where PROFINET devices are synchronized with extreme accuracy.

A sync master provides the clock, sync slaves synchronize with this clock. Both an IO controller and an IO device can act as a sync master.

Sync master and sync slaves are always nodes of a sync domain. Within the sync domain, bandwidth is reserved for IRT communication. Real-time and non-real-time communication (TCP/IP communication) is possible outside the reserved bandwidth.

### Sync domain

A sync domain is necessary to synchronize PROFINET IO devices. The sync domain ensures that all nodes of this domain can communicate in isochronous mode.

The prerequisite for IRT communication is a synchronization cycle for all PROFINET devices in a sync domain for distributing a common time base. This basic synchronization allows a synchronism of the transmission cycle of the PROFINET devices within a sync domain. The sync master (generally an IO

controller) generates the common synchronization clock and specifies the time base with which all other sync slaves (e.g., IO devices) synchronize.

If the sync master fails, the communication of the IRT devices falls back to RT quality.

**Setting up PROFINET with IRT**

When setting up and operating a PROFINET IO system in IRT mode, please follow the rules below. The aim of these rules is to ensure optimum operation of your PROFINET IO system.

- When using IRT, you must configure the topology. This ensures the exact calculation of update time, bandwidth and other parameters.
- If you want to use multiple sync domains, configure a sync domain boundary for the port connected to a PROFINET device of another sync domain.
- In a sync domain, you can only configure one sync master at a time.
- A PROFINET IO system may only belong to a single sync domain.
- If you configure PROFINET devices in a sync domain and want to synchronize them with IRT, the relevant PROFINET devices must support IRT communication.
- Where possible, use the same PROFINET device as the PROFINET IO controller and sync master.
- If only some of the PROFINET devices of a PROFINET IO system are synchronized, place PROFINET devices that are not participating in IRT communication outside the sync domain.

**Isochronous mode**

The “Isochronous mode” system property allows acquisition of measured values and process data in a fixed system cycle. Within the same system cycle, the signal is processed until it is available at the output terminal. Therefore, isochronous mode contributes to high control system quality, which results in greater manufacturing accuracy. Isochronous mode drastically reduces possible fluctuations in process reaction times. This processing stable in terms of time can be used for higher machine cycles.

Basically, isochronous mode is the choice where measured values need to be acquired synchronously, motions need to be coordinated and process reactions need to be defined and take place simultaneously.

**Time sequence of isochronous processing**

The following section explains the basic time sequence of all components involved in the synchronization from reading in the input data to outputting the output data:

- Reading in the input data in isochronous mode
- Transporting the input data to the IO controller (CPU) via the PROFINET subnet
- Processing the data in the isochronous application of the CPU
- Transporting the output data to the outputting IO device via the PROFINET subnet
- Outputting the output data in isochronous mode

**Bias time Ti**

To ensure that a consistent status of the inputs can be transferred to the IO controller at the start time of a new system cycle, the read action must be moved up by the time Ti. For a specific input module, the time Ti includes at least the

signal conditioning and conversion time on the electronic modules and the time for transfer to the interface module on the IO device backplane bus.

In a plant, the values are read in simultaneously because the bias time Ti of all input modules read in isochronous mode is set to the same value and this value is greater than or equal to the longest minimum bias time Ti of all isochronous input modules. With the default setting, STEP 7 ensures that a common bias time Ti is set that is as short as possible.

**Delay time To**

To ensure that a consistent status of the outputs can be transferred to the process at the start time of a new system cycle, the output at the terminal does not take place before the time To after the clock beat. For a specific output module, the time To includes at least the transfer time from the IO controller to the IO device (via PROFINET IO) and in the IO device, the transfer of the outputs from the interface module to the electronic module (backplane bus) with the time for digital-to-analog conversion possibly included in this module.

In the plant, these values are written simultaneously because the delay time To of all isochronous output modules is set to the same value. This value must be greater than or equal to the longest minimum delay time To of all isochronous output modules. STEP 7 automatically calculates a common delay time To that is as short as possible.

**Isochronous mode – instructions for use for components and interfaces**

When establishing isochronous communication via PROFINET, please note the following:

- Isochronous mode is only possible with the interfaces integrated in the CPU. For the SIMATIC S7-1500 with two PROFINET interfaces, only interface X1 can be configured for PROFINET IO and isochronous mode. Isochronous mode is not possible with CPs.
- Full isochronous mode from “terminal” to “terminal” is only possible if all components involved in the chain support the “Isochronous mode” system property. When selecting in the catalog, look for the “Isochronous mode” or “Isochronous processing” item in the information box of the module.
- If you are operating an IO device in isochronous mode (i.e. you have assigned it, for example, the sync slave role), the IO device must include at least one module or submodule operated in isochronous mode.

**Note**

When using PROFINET, the configured PROFINET name of the drive in TIA Portal must match the configured name in the commissioning software of the drive, e.g. SINAMICS MICROMASTER STARTER.
Please note that the name is case sensitive.

If the PROFINET name in TIA Portal differs from the one in the drive, it may not be possible to establish a connection between the SIMATIC S7-1500 and the drive.

### 5.2.2 Settings in TIA Portal

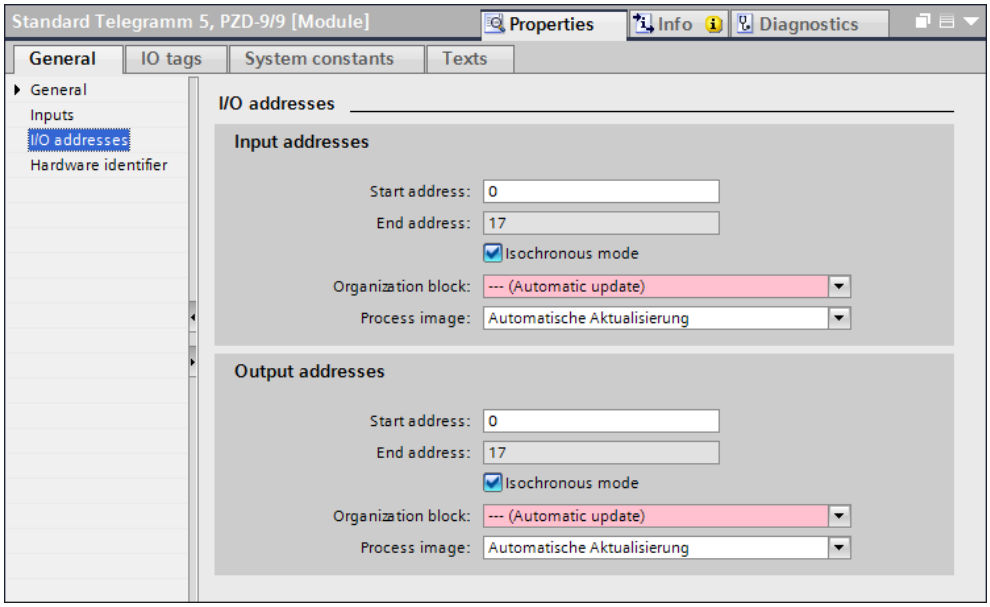
To activate isochronous mode, both the parameters for isochronous mode and the sync domain must be configured in TIA Portal.

### Isochronous mode

In the device overview of the drive on the telegram of the desired axis, select Properties > I/O addresses and activate the “Isochronous mode” function for the input and output addresses of the axis.

At this point, it is not yet necessary to assign the organization block for isochronous mode. This is done automatically when assigning the axis to a technology object in the SIMATIC S7-1500.

Figure 5-3 Activating isochronous mode




**Note**

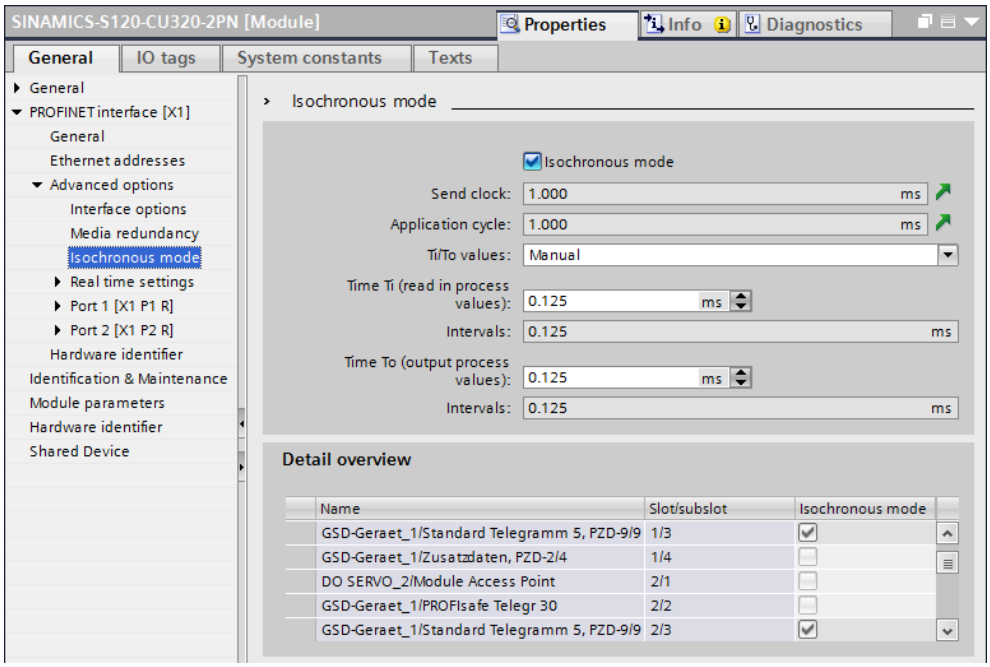
If the drive is connected to the SIMATIC S7-1500 via PROFINET I/O and you select telegram 5, isochronous mode will be automatically activated for this axis due to the GSDML file.

In this case, isochronous mode must be parameterized accordingly for this axis in TIA Portal.

On the Control Unit of the drive, select Properties > Isochronous mode and activate the “Isochronous mode” function and set the values for bias time Ti and delay time To.

When using a drive of the SINAMICS S drive family, select the manual setting of the Ti and To times and set the values of these times to a multiple of 0.375 ms.

Figure 5-4 Activating isochronous mode

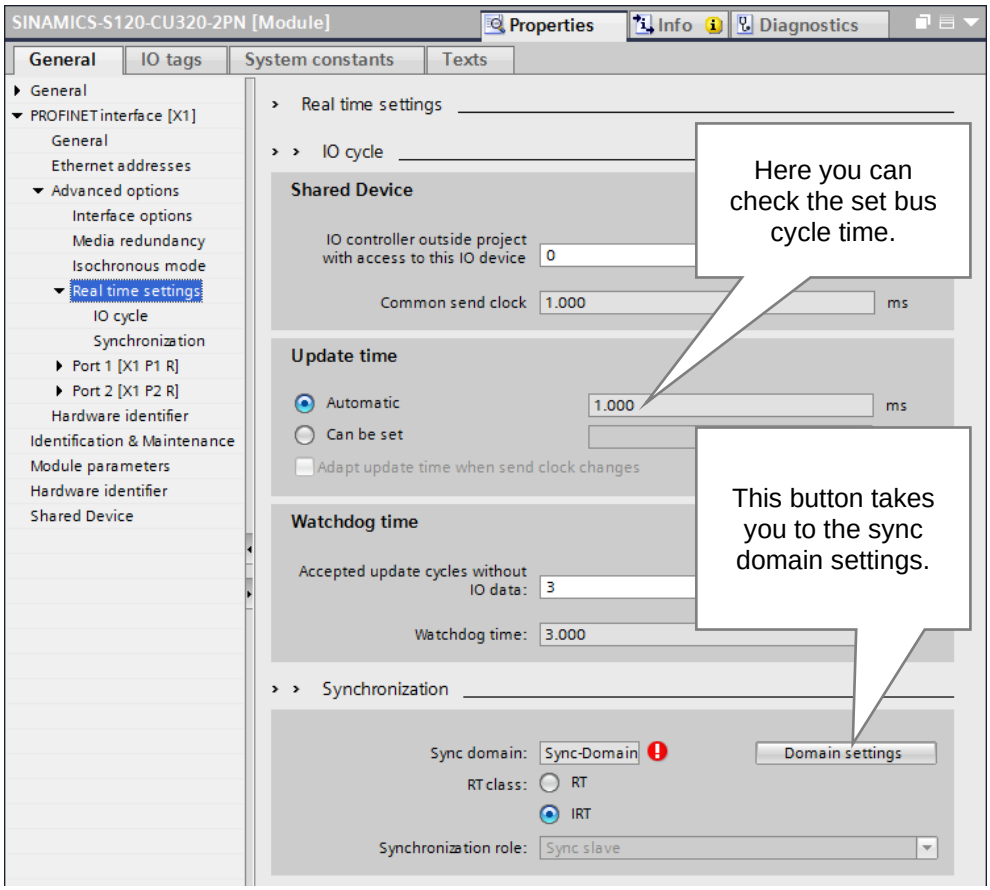



| NOTICE | **In order to use isochronous mode in conjunction with the SINAMICS S drive family, the times Ti (read in process values) and To (output process values) must be manually set to a multiple of 0.375 ms.** |
|---|---|

### Sync domain

To go to the sync domain settings, select Properties > Real time settings > Synchronization of the Control Unit of the drive. The “Domain settings” button takes you directly to the properties of the PROFINET line.

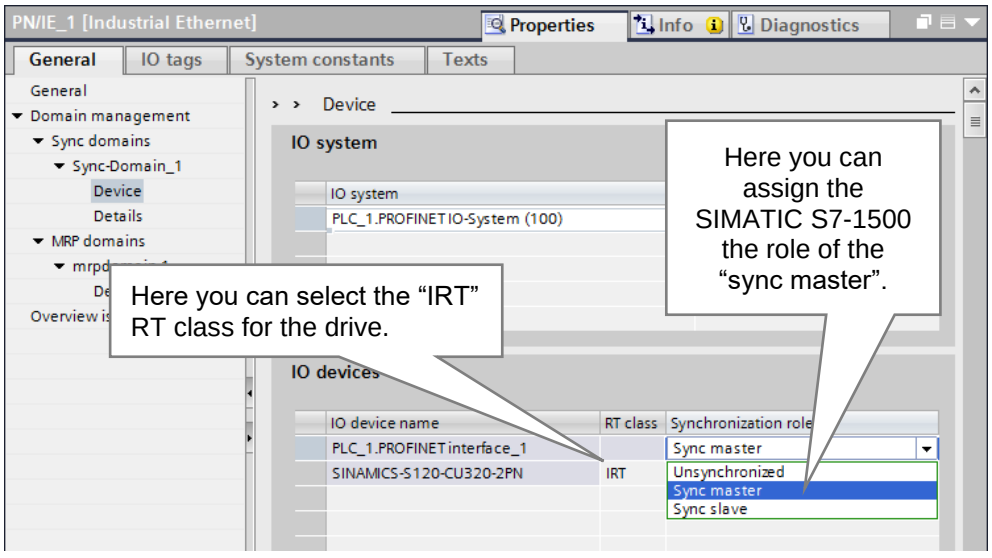
Figure 5-5 Real time settings – setting the sync domain




Here you can assign the sync domain nodes the respective roles:

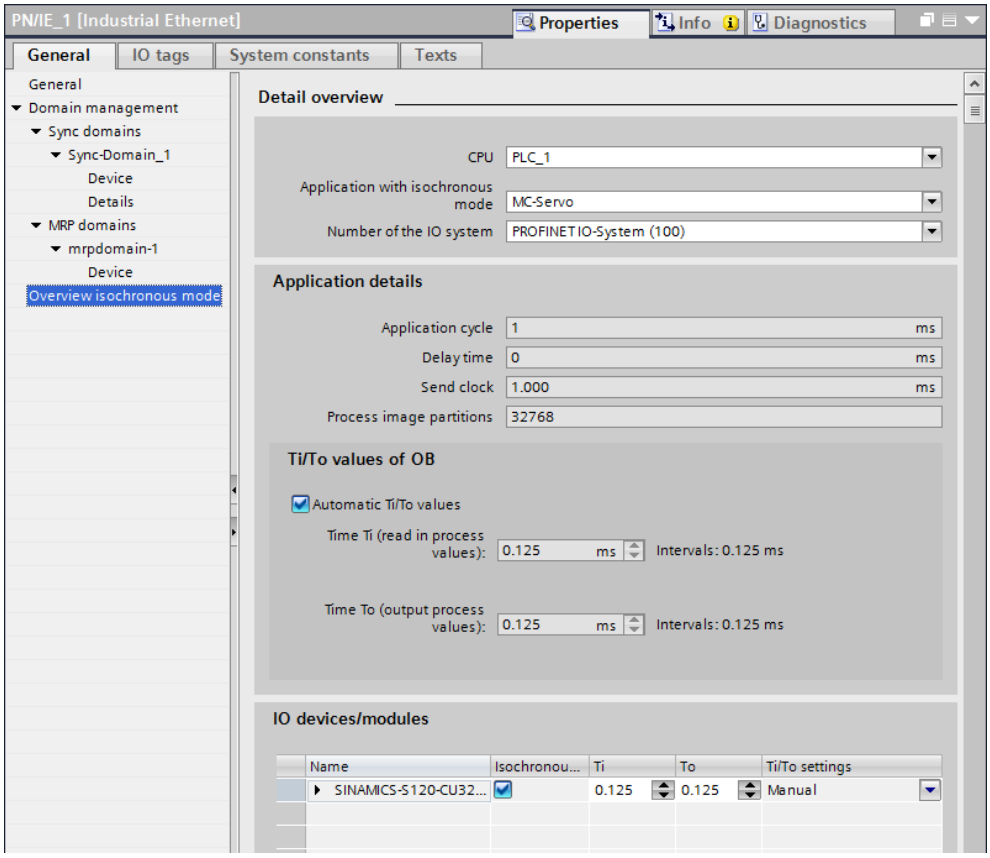
- SIMATIC S7-1500 (via PROFINET) = “sync master”
- SINAMICS S120 drive system = “sync slave” with RT class = “IRT”

Figure 5-6 Sync domain – assigning the synchronization role



Finally, you can check the settings you have made via the PROFINET line in the “Overview isochronous mode”. Once a technology object has been created, the organization block of the technology object is automatically entered in the detail overview in “Application with isochronous mode”. The shown Ti and To values of the organization block form the time base for isochronous mode of the PROFIBUS line. The values for the bias time Ti and the delay time To actually set on the drive can be read in the list of IO devices/modules.

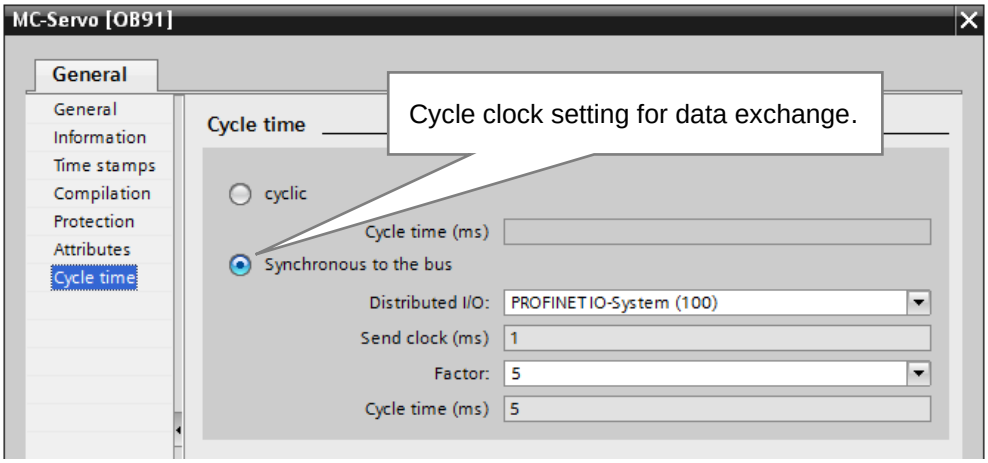
Figure 5-7 Overview isochronous mode




### Additional setting on the technology object

If a technology object is created after setting isochronous mode – as referred to in this documentation –, technology OB 91 “MC_Servo” will be created. In the properties of this organization block, the data exchange synchronization must be set in “Cycle time”. For isochronous data exchange via PROFINET I/O, select the “Synchronous to the bus” setting.

Figure 5-8 Cycle clock assignment of technology OB 91 “MC-Servo”




### Checking the isochronous mode settings on the drive

The parameter values for isochronous mode that are defined via the bus configuration in TIA Portal and transferred from the SIMATIC S7-1500 to the drive before starting isochronous mode can, for example, be checked in the SINAMICS S120 drive via the following parameters of the Control Unit:

r2064[0..7] PROFIdrive diagnostics clock synchronous mode

- [0] = Clock synchronous mode activated
- [1] = Bus cycle time (Tdp) [µs]
- [2] = Master cycle time (Tmapc) [µs]
- [3] = Instant of actual value acquisition (Ti) [ìs]
- [4] = Instant of setpoint acquisition (To) [ìs]
- [5] = Data exchange interval (Tdx) [ìs]
- [6] = PLL window (Tpll-w) [1/12 ìs]
- [7] = PLL delay time (Tpll-d) [1/12 ìs]

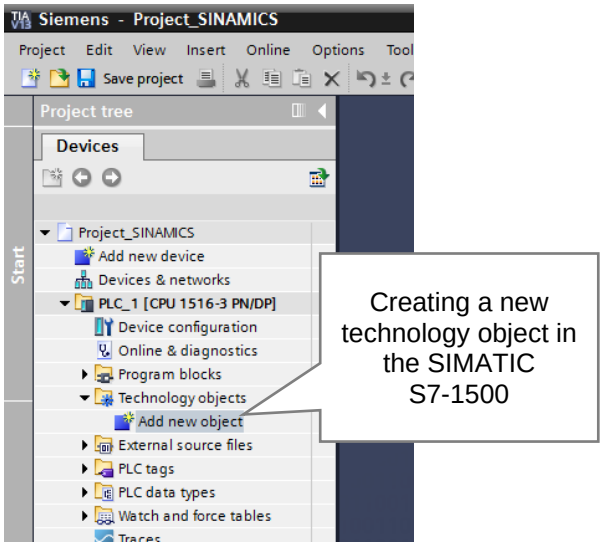
**Note** For more detailed information on this parameter, please refer to the List Manual (LH1) for the SINAMICS S120/S150 drive system.

# 6 Motion Control Functions of the S7-1500

## 6.1 Technology objects

After the axes of the drive unit have been configured and connected to the SIMATIC S7-1500, a new technology object (TO) must now be created in the SIMATIC S7-1500 for each axis to allow easy axis control.

Figure 6-1 Creating a new technology object

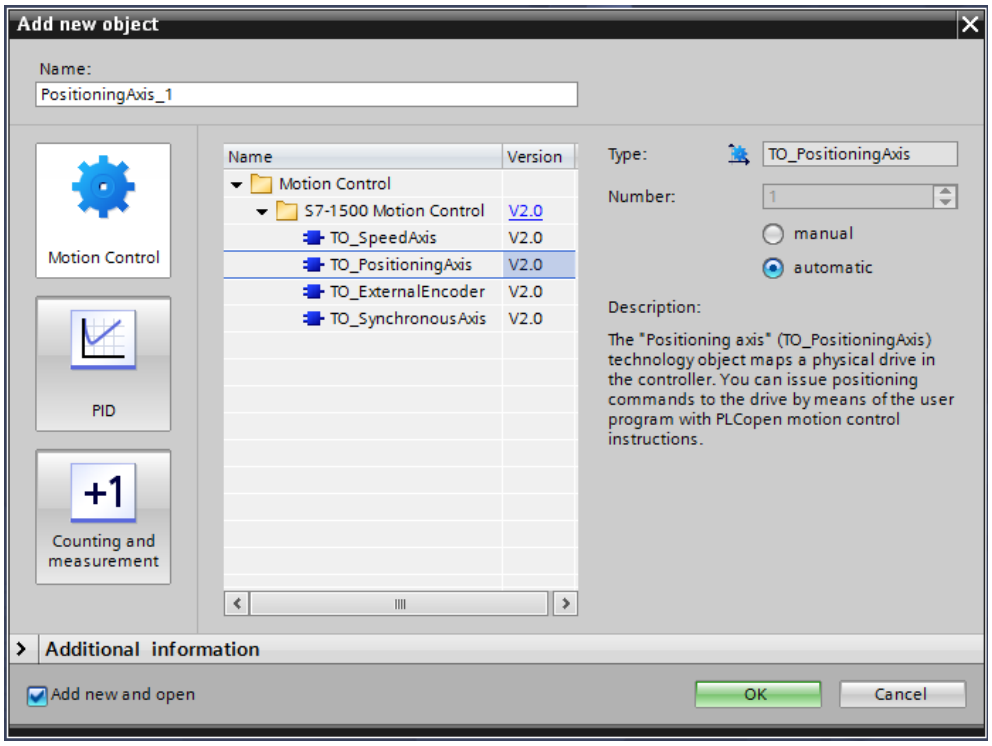



For this purpose, TIA Portal provides a dialog where different technology objects can be selected in the “Motion Control” area.

For motion control applications, the following technology objects are available:

- Axes
  - Speed axes: TO_SpeedAxis
    The “SpeedAxis” technology object is used to select the speed for a drive. The axis motion can be controlled via motion control instructions.
  - Positioning axes: TO_PositionAxis
    The “PosAxis” axis technology object is used for position-controlled positioning of a drive. Motion control instructions allow you to give the axis positioning jobs via the user program.
- Other technology objects
  - External encoders: TO_ExternalEncoder
    The “ExternalEncoder” technology object detects a position and provides it to the controller. The determined position can be evaluated in the user program.

Figure 6-2 Creating a technology object for motion control in the SIMATIC S7-1500

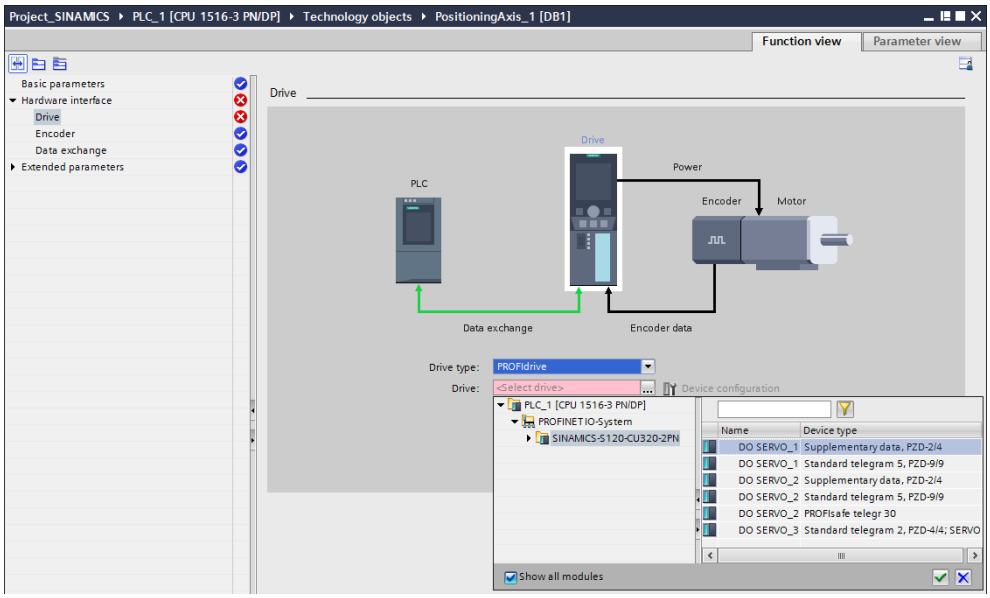



## 6.2 Selecting the drive on the technology object

After adding the desired technology object, the appropriate drive unit axis must be connected to the technology object.

In the technology object, select Hardware interface > Drive. In the “Drive” selection box, select the appropriate drive object (DO) for PROFINET or the appropriate telegram of the desired axis for PROFIBUS.

Figure 6-3 Assigning the axis to the technology object



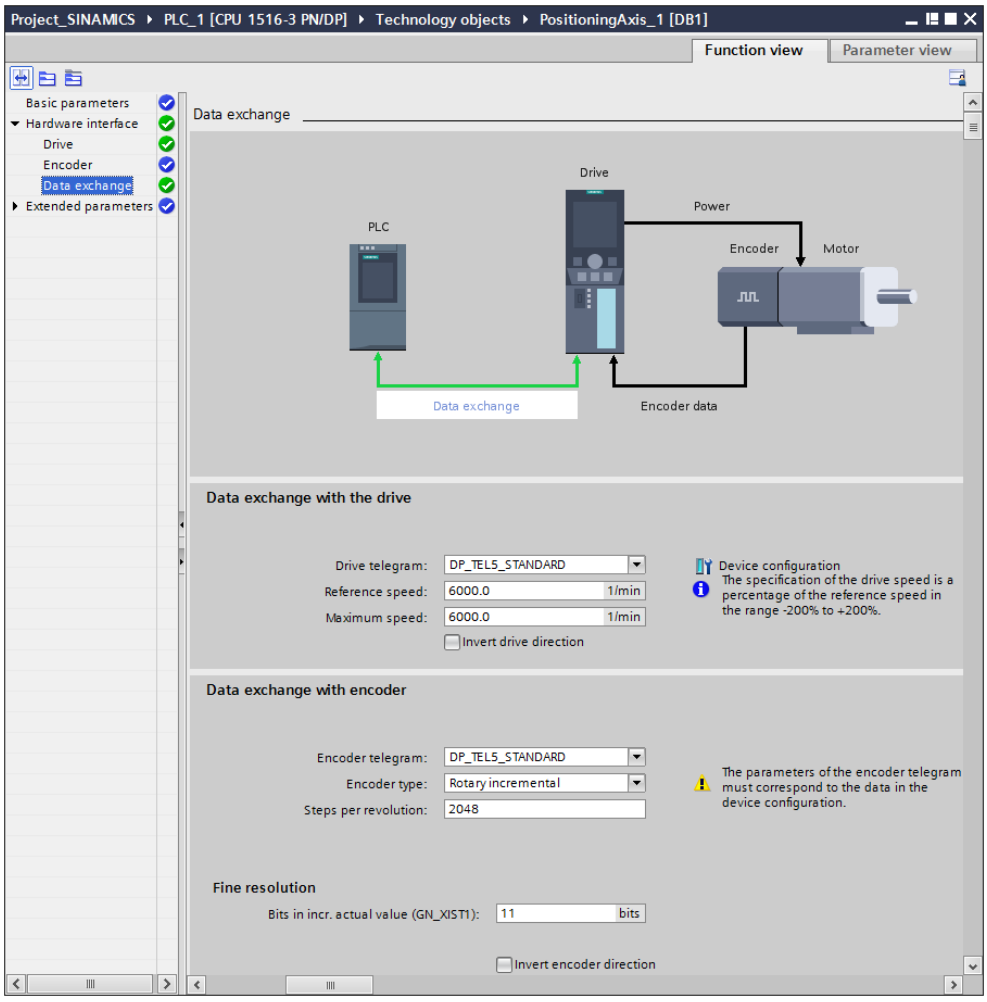
**Note**

If the desired drive object (DO) for PROFINET or the desired telegram of the axis for PROFIBUS has been configured but is not displayed in the selection dialog, activate the “Show all modules” function in the selection dialog and try again.

Occasionally, older GSD files do not contain PROFIdrive telegrams but only input/output ranges of the respective size. In these cases, select the desired drive object by explicitly selecting the associated input and output data. Chapter 9.1 describes an example with a SIMODRIVE double axis drive.

Now the desired axis is connected to the technology object of the SIMATIC S7-1500.

Figure 6-4 Technology object – Hardware interface > Data exchange




**Note**

If the data is exchanged with the selected axis via PROFIdrive telegram 5, the DSC (Dynamic Servo Control) function to move the position control to the drive is automatically enabled when creating the Positioning Axis technology object.

If you do not want to use DSC (Dynamic Servo Control), explicitly change this function in the technology object in Extended Parameters > Control loop from “Position control and speed control in drive (DSC enabled)” to “Position control and speed control in the PLC”. Axis position control is then only performed by the technology object.

## 6.3 Controlling the axis from the user program

To control the axes created as technology objects, the SIMATIC S7-1500 provides multiple technology functions that allow the user to influence the technology objects quickly and easily.

To influence the technology objects from the user program, the following functions are available:

Table 6-1 Technology functions

| Technology function | Can be used for the following technology objects | Description |
|---|---|---|
| MC_Power | Positioning axis<br>Speed axis<br>External encoder | "MC_Power" is used to enable or disable a technology object.<br>**Note:**<br>When using a drive of the SINAMICS S family with Active Infeed or Active Line Module (ALM), the infeed must be switched on separately. Automatic switch-on of the infeed via "MC_Power" is not performed. |
| MC_Reset | Positioning axis<br>Speed axis<br>External encoder | "MC_Reset" is used to acknowledge all technology alarms that can be acknowledged in the user program. The acknowledgement also resets the "Error" and "Warning" bits in the technology data block.<br>The "Restart" input of "MC_Reset" is used to start the reinitialization of technology objects. When restarting the technology object, new configuration data is applied to the technology data block. |
| MC_Home | Positioning axis<br>External encoder | "MC_Home" is used to create the reference between the position on the technology object and the mechanical position of the associated axis. The actual position value on the technology object is assigned to a reference mark. This reference mark represents a known mechanical position.<br>Homing is performed according to the mode selected on the "Mode" parameter and the configuration in "Technology object > Configuration > Extended parameters > Homing". |
| MC_Halt | Positioning axis<br>Speed axis | "MC_Halt" is used to decelerate an axis to a standstill.<br>The "Jerk" and "Deceleration" parameters are used to define the dynamic response for deceleration. |

| Technology function | Can be used for the following technology objects | Description |
|---|---|---|
| MC_MoveJog | Positioning axis<br>Speed axis | “MC_MoveJog” is used to move an axis in jog mode.<br>The “Velocity”, “Jerk”, “Acceleration” and “Deceleration” parameters are used to define the dynamic response for the motion.<br>• Positioning axis: A velocity is selected on the “Velocity” parameter.<br>• Speed axis: A speed is selected on the “Velocity” parameter. |
| MC_MoveVelocity | Positioning axis<br>Speed axis | “MC_MoveVelocity” is used to move an axis at a constant velocity.<br>The “Velocity”, “Jerk”, “Acceleration” and “Deceleration” parameters are used to define the dynamic response for the motion.<br>• Positioning axis: A velocity is selected on the “Velocity” parameter.<br>• Speed axis: A speed is selected on the “Velocity” parameter. |
| MC_MoveRelative | Positioning axis | “MC_MoveRelative” is used to move an axis relative to the position of the start of job processing.<br>The “Velocity”, “Jerk”, “Acceleration” and “Deceleration” parameters are used to define the dynamic response for the motion. |
| MC_MoveAbsolute | Positioning axis | “MC_MoveAbsolute” is used to move an axis to an absolute position.<br>The “Velocity”, “Jerk”, “Acceleration” and “Deceleration” parameters are used to define the dynamic response for the motion. |
| MC_GearIn | Start gearing V2 | With "MC_GearIn", you can start a relative gearing between a leading axis and a following axis.<br>Dynamic behavior of the following axis during synchronization is defined with the parameters"Jerk", "Acceleration", and "Deceleration" . |
| MC_MoveSuperimposed | Superimposed positioning of axes V2 | With "MC_MoveSuperimposed", you can start a relative positioning motion which is superimposed on a running basic motion.<br>Dynamic behavior during movement is defined with the parameters "VelocityDiff", "Jerk", "Acceleration" and "Deceleration". The dynamic values are added to the values of the basic motion. The duration of the basic motion is not extended by a superimposed motion. |

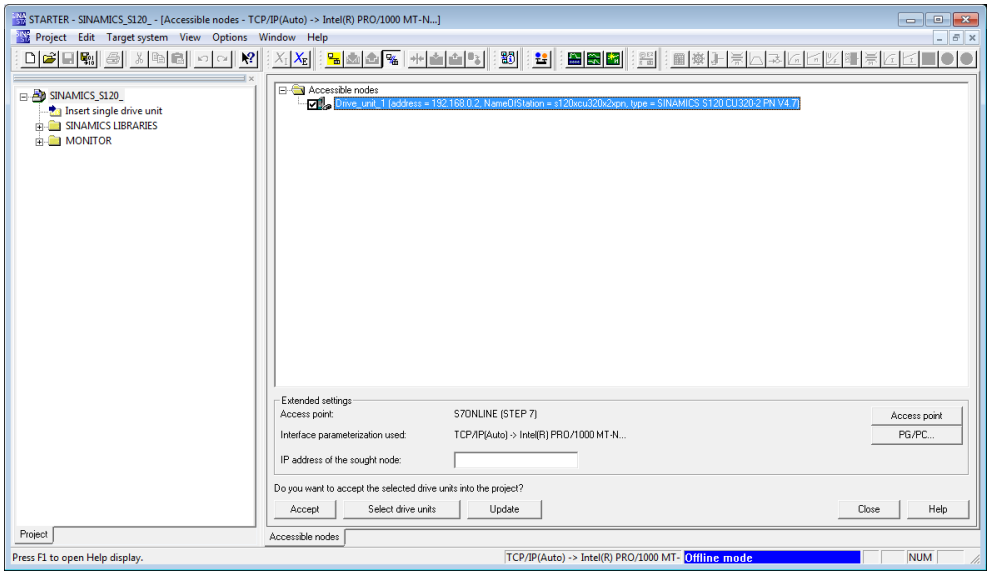
**Note** For detailed information on the use of the technology functions, please refer to the documentation for the motion control functions of the SIMATIC S7-1500 or TIA Portal documentation.

# 7 STARTER Commissioning Software

## 7.1 Working with drives

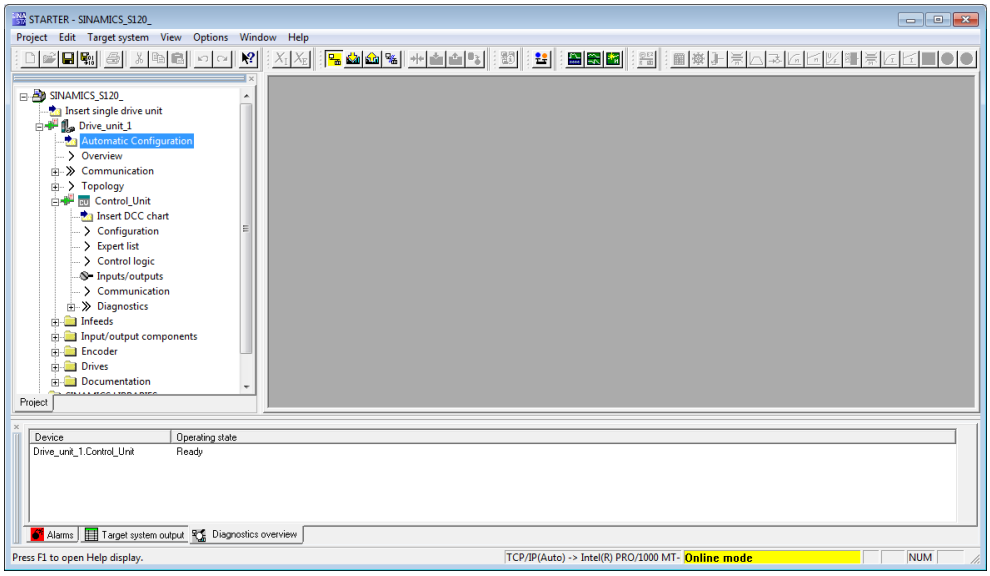
Unlike the configuration of the SIMATIC S7-1500 in TIA Portal where the controller configuration is defined offline via “Devices & Networks” and then loaded to the controller, drives of the SINAMICS G and SINAMICS S families are generally configured online.

Figure 7-1 Searching for a drive unit online using “Accessible nodes”




The drive system is set up ready for operation and the current drive configuration is then loaded to the SINAMICS MICROMASTER STARTER commissioning software via an online connection. This ensures that drives with Drive-CLiQ components can be commissioned very quickly and easily.

Figure 7-2 Automatically configuring the drive unit



**Note**

For more information on the use of the SINAMICS MICROMASTER STARTER commissioning software, please refer to the appropriate manual or the help file for SINAMICS MICROMASTER STARTER.

If not all components of the drive system feature Drive-CLiQ technology or if drive components were used that do not support automatic commissioning, the drive system can, of course, also be commissioned manually via offline configuration.

The next chapter briefly describes this procedure before it provides greater details on adapting the message frame configuration.

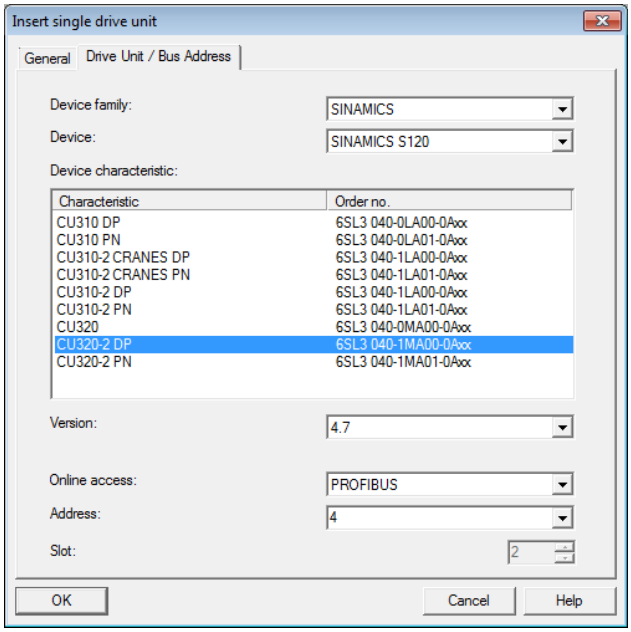
## 7.2 Creating a drive unit

The best way to commission a drive of the SINAMICS family is to create a new drive project and add a new single drive to this project.

### 7.2.1 PROFIBUS DP

To configure a PROFIBUS DP drive, select a Control Unit (CU) with PROFIBUS interface and specify the desired firmware version and PROFIBUS address of the drive.

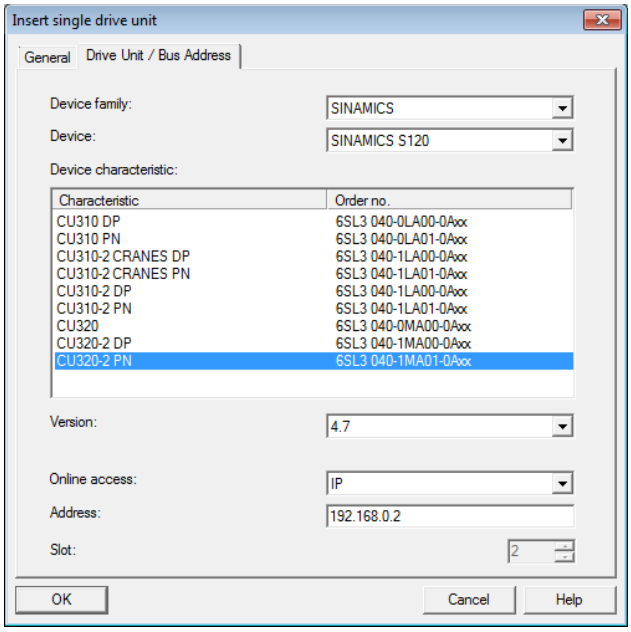
Figure 7-3 Insert single drive unit – CU 320-2 DP



### 7.2.2 PROFINET I/O

To configure a PROFINET I/O drive, select a Control Unit (CU) with PROFINET interface and specify the desired firmware version and IP address of the drive.

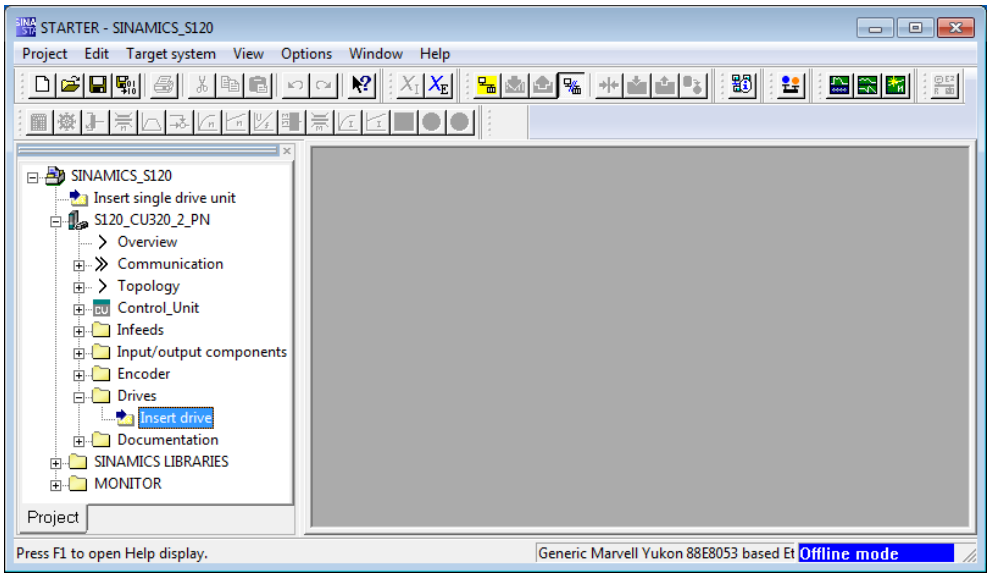
Figure 7-4 Insert single drive unit – CU 320-2 PN



## 7.3 Creating the drives

Use the “Insert drive” menu option to add the appropriate drive axes of the drive system to the drive unit you have just created.

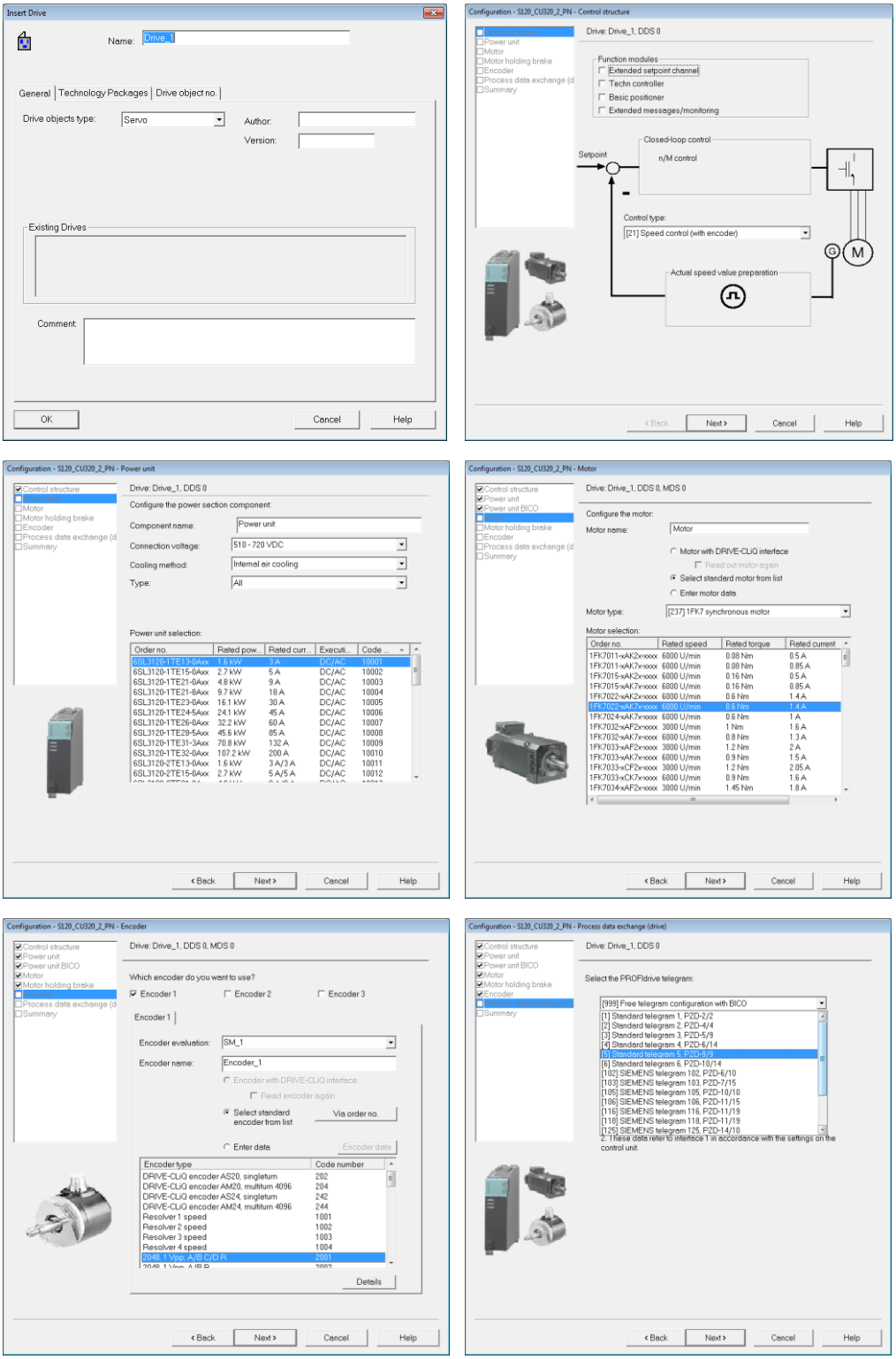
Figure 7-5 Insert drive




The wizard prompts you to enter the following drive parameters:

- Drive name
- Parameterization of the control structure
- Selection of the power unit
- Selection of the motor and a possibly existing motor holding brake
- Selection of the encoder system
- Basic configuration of the communication message frame of the drive

Figure 7-6 Creating and parameterizing a drive

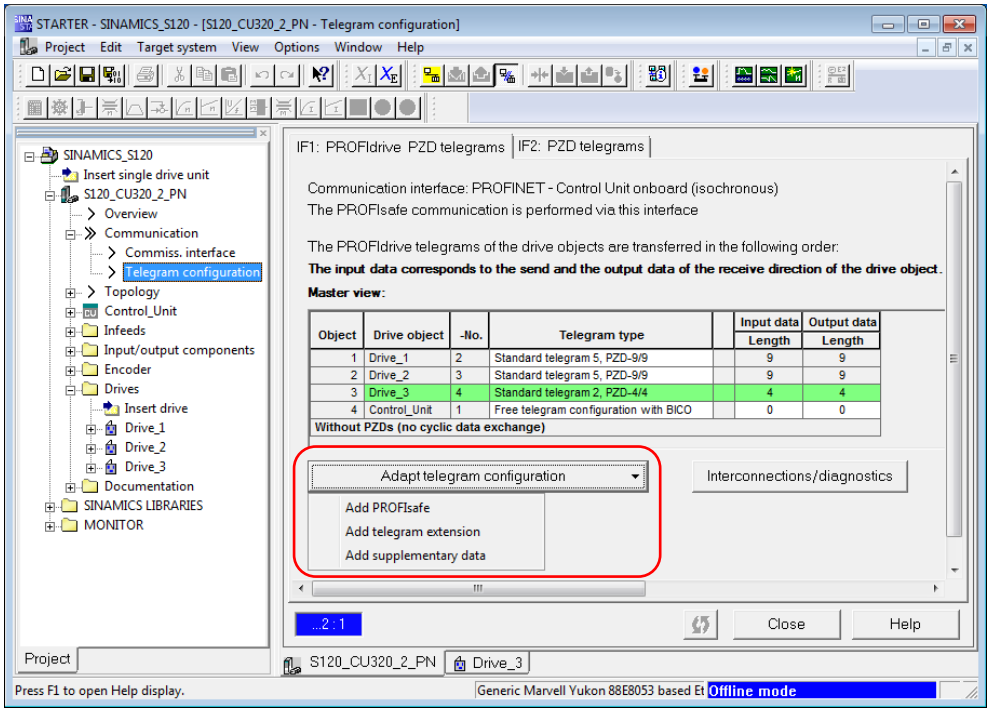


### 7.3.1 Adapting the communication message frames

After you have created all required drives with a basic selection of communication message frames, you can adapt the individual message frames so that they correspond to the settings in TIA Portal.

To do so, select the message frame to be adapted and select the “Adapt message frame configuration” button.

Figure 7-7 Adapt message frame configuration




A message frame extension or supplementary data is inserted after the standard communication message frame. Adapt the quantity of the send and receive data according to the settings in TIA Portal.

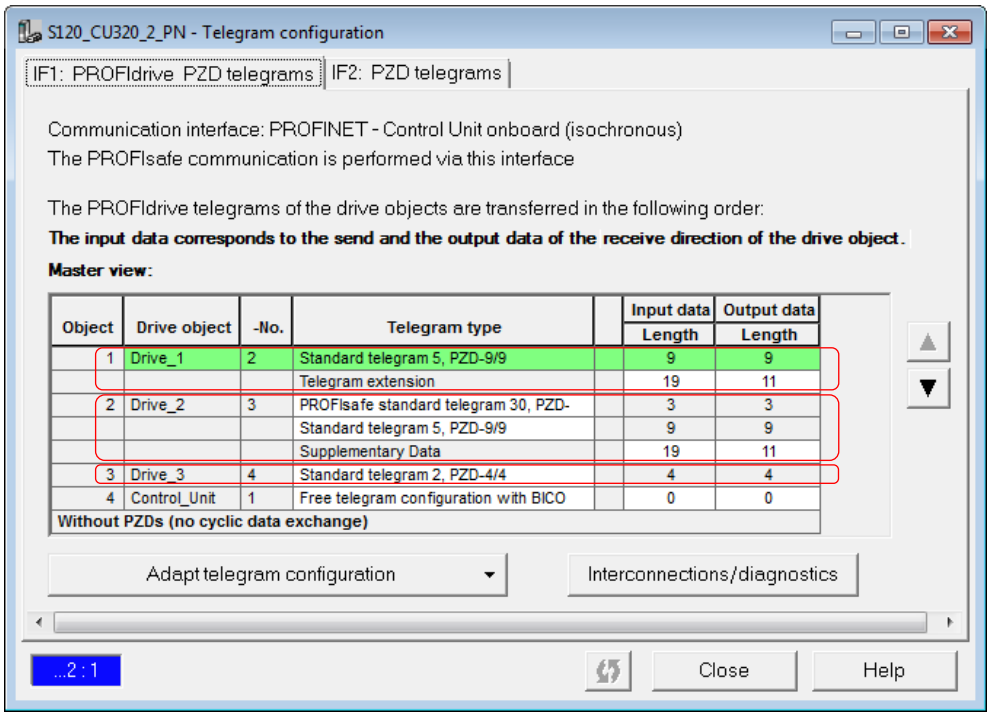
The PROFIsafe extension is inserted before the standard communication message frame and does not require further editing.

**Note**

Please note that a PROFIsafe extension cannot be added in the message frame configuration for the SINAMICS S120 with PROFIBUS DP interface or PROFINET I/O interface with firmware revision level V4.4.

In the overview, you can now check all message frame adaptations. They must exactly correspond to the settings in TIA Portal.

Figure 7-8 Adapted telegrams




**Note**

Please note the send and receive data assignment. In TIA Portal and in the SINAMICS MICROMASTER STARTER commissioning software, this data is always assigned from the perspective of the controller, for example the SIMATIC S7-1500.

# 8 Glossary

This chapter provides a brief explanation of special terms and abbreviations used in this documentation.

**Constant bus cycle time for PROFIBUS DP**

Constant bus cycle time ensures that the time interval for bus cycles has exactly the same length. “Bus cycles of the same length” mean that the PROFIBUS DP master always starts the DP bus cycle after the same time interval. Therefore, the connected slaves too receive their data from the master at time intervals of the exact same length. This is also referred to as “bus cycle clocking”.

Constant bus cycle time is the prerequisite for isochronous mode.

**Note**

For PROFIBUS DP, the maximum permissible cycle time for operating isochronous drives is 8 ms.

This affects the maximum number of isochronous axes that can be operated on the SIMATIC S7-1500. Please consider this when designing your automation concept.

**Drive object (DO) – general**

A drive object (DO) is an independent, self-contained software functionality with its own parameters and, if necessary, its own fault and alarm messages. Drive objects (DOs) can be provided by default (e.g., evaluation of inputs/outputs) or you can add a single drive object (e.g., terminal board) or multiple drive objects (e.g., drive control).

Drive objects (DOs) processed by the Control Unit are set up via configuration parameters during first commissioning in STARTER. Various drive objects (DOs) can be created within a Control Unit. Drive objects (DOs) are configurable function blocks that are used to execute specific drive functions. If you want to configure or delete additional drive objects (DOs) after first commissioning, this must be done using configuration mode of the drive system. The parameters of a drive object (DO) cannot be accessed until the drive object has been configured and you have changed from configuration mode to parameterization mode.

**Drive object (DO) – drive control**

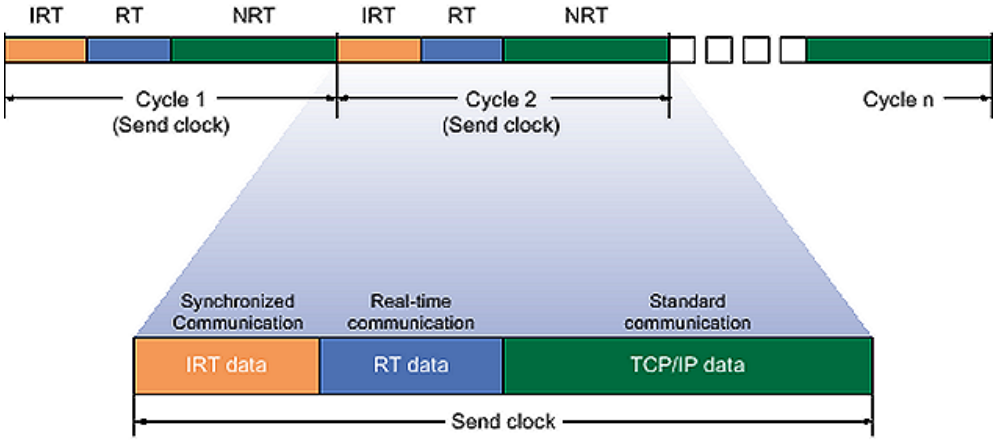
A drive object (DO) for drive control has four slots on each port. The first slot is permanently linked to the module access point and cannot be changed by the user. The second slot is reserved for the optional integration of a PROFIsafe telegram. The standard telegram of the drive for data exchange can be integrated into the third slot. The fourth slot is reserved for the optional integration of a telegram extension.

### IRT Ethernet (Isochronous Real-Time Ethernet) for PROFINET I/O

IRT is a transmission mode where PROFINET devices are synchronized with extreme accuracy. A sync master provides the clock, sync slaves synchronize with this clock. Both an IO controller and an IO device can act as a sync master. Sync master and sync slaves are always nodes of a sync domain. Within the sync domain, bandwidth is reserved for IRT communication. Real-time and non-real-time communication (TCP/IP communication) is possible outside the reserved bandwidth.

The communication cycle for IRT Ethernet (Isochronous Real-Time Ethernet) is subdivided into the three time ranges shown in the figure below:

Figure 8-1 IRT Ethernet (Isochronous Real-Time Ethernet)




The individual communication time ranges have the following function:

- IRT data (synchronized communication)
  Depending on the send clock, you can reserve this time range in specific steps. Only IRT data is transmitted during this time range.
- RT data (real-time communication)
  The cyclic RT data is transmitted during this time range. RT data is prioritized over “normal” TCP/IP data. TCP/IP data or Ethernet message frames can have a priority between 1 and 7. RT data has a priority of 6.
- TCP/IP data (standard communication)
  Standard communication (TCP/IP, etc.) is transmitted in the remaining interval of the communication cycle.

PROFINET with IRT is particularly suitable for:

- High performance and deterministics for large quantity frameworks in terms of user data communication (productive data).
- High performance even with many nodes in line topology in terms of user data communication (productive data).
- Parallel transmission of productive and TCP/IP data via one line, even with high traffic volumes while ensuring productive data forwarding by reserving the transmission bandwidth.

### NRT Ethernet (Non-Real-Time Ethernet) for PROFINET I/O

NRT Ethernet (Non-Real-Time Ethernet) corresponds to the standard communication via Ethernet using TCP/IP, etc.

**RT Ethernet (Real-Time Ethernet) for PROFINET I/O**

RT Ethernet (Real-Time Ethernet) corresponds to NRT Ethernet with prioritized handling of the data packets to be transmitted.

**RT classes for PROFINET I/O**

PROFINET IO is a scalable real-time communication system based on Ethernet technology. This scalable approach is expressed in different real-time classes:

- RT (Real-Time Ethernet):
  Transmission of data in prioritized Ethernet message frames, not isochronously. The required bandwidth is in the free bandwidth for TCP/IP communication.
- IRT (Isochronous Real-Time Ethernet):
  Isochronous transmission of data with high stability for time-critical applications (e.g., motion control). The required bandwidth is in the bandwidth reserved for cyclic data.

Depending on the device, not all real-time classes are supported.

**Sync domain for PROFINET I/O**

A sync domain is a group of PROFINET devices that are synchronized to a common clock. Exactly one device has the role of the sync master (clock generator), all other devices have the role of a sync slave. In most cases, the sync master is an IO controller or switch.

Non-synchronized PROFINET devices are not part of a sync domain.

**Synchronization clock for PROFINET I/O**

The synchronization clock is the clock setting of the sync master for its role as the sync master (clock generator) for data exchange within a group of PROFINET devices of a sync domain.

**Note**

For PROFINET I/O, the maximum permissible cycle time for operating isochronous drives is 4 ms.

This affects the maximum number of isochronous axes that can be operated on the SIMATIC S7-1500. Please consider this when designing your automation concept.

**Sync master for PROFINET I/O**

Exactly one device in a sync domain has the role of the sync master and is the clock generator for clock synchronization of a group of PROFINET devices of a sync domain.

**Sync slave for PROFINET I/O**

All devices of a sync domain that do not have the role of the sync master are sync slaves. These devices synchronize with the clock specified by the sync master (clock generator) for data exchange within this sync domain.

**Isochronous mode for PROFIBUS DP**

The “Isochronous mode” system property allows acquisition of measured values and process data in a fixed system cycle. Within the same system cycle, the signal is processed until it is available at the output terminal. Therefore, isochronous mode contributes to high control system quality, which results in greater manufacturing accuracy. Isochronous mode drastically reduces possible fluctuations in process reaction times. This processing stable in terms of time can be used for higher machine cycles.
Basically, isochronous mode is the choice where measured values need to be acquired synchronously, motions need to be coordinated and process reactions need to be defined and take place simultaneously.

The equidistant (isochronous) PROFIBUS forms the fundamental basis for synchronized processing cycles. It provides a basic clock as a basis. The “Isochronous mode” system property connects an automation solution to the equidistant PROFIBUS.

This means:

- Reading in the input data is synchronized with the DP cycle; all input data is read in at the same time.
- The user program for processing the I/O data is synchronized with the DP cycle using the isochronous interrupt OBs OB 61 to OB 64.
- Outputting output data is synchronized with the DP cycle; all output data becomes effective at the same time.
- All input and output data is transferred consistently. This means that all the data from the process image belongs together, both logically and with respect to timing.

**Delay time To of isochronous mode for PROFIBUS DP**

To ensure that a consistent status of the outputs can be transferred to the process at the start time of a new system cycle, the output at the terminal does not take place before the time To after the clock beat. For a specific output module, the time To includes at least the transfer time from the IO controller to the IO device (via PROFINET IO) and in the IO device, the transfer of the outputs from the interface module to the electronic module (backplane bus) with the time for digital-to-analog conversion possibly included in this module.

In the plant, these values are written simultaneously because the delay time To of all isochronous output modules is set to the same value. This value must be greater than or equal to the longest minimum delay time To of all isochronous output modules. STEP 7 automatically calculates a common delay time To that is as short as possible.

**Bias time Ti of isochronous mode for PROFIBUS DP**

To ensure that a consistent status of the inputs can be transferred to the IO controller at the start time of a new system cycle, the read action must be moved up by the time Ti. For a specific input module, the time Ti includes at least the

signal conditioning and conversion time on the electronic modules and the time for transfer to the interface module on the IO device backplane bus.

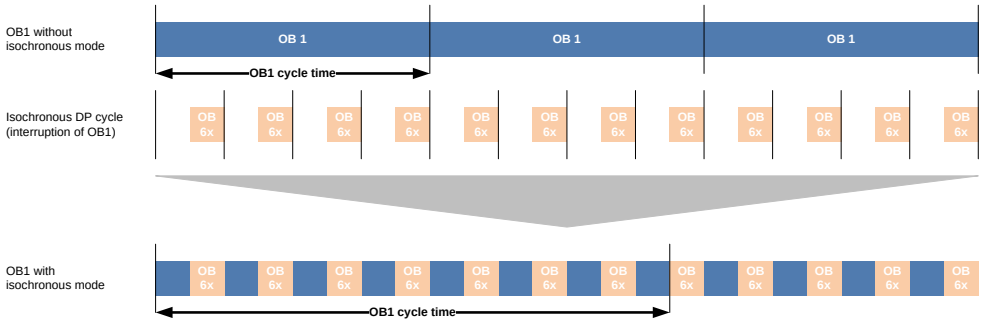
In the plant, the values are read in simultaneously because the bias time Ti of all input modules read in isochronous mode is set to the same value and this value is greater than or equal to the longest minimum bias time Ti of all isochronous input modules. With the default setting, STEP 7 ensures that a common bias time Ti is set that is as short as possible.

### Cycle time of the OB 1 cycle when using isochronous mode for PROFIBUS DP

It is possible to combine isochronous mode distributed I/O with non-isochronous mode distributed I/O on one DP master system. For improved performance, it is recommended to use different DP master systems for isochronous mode distributed I/O and non-isochronous mode distributed I/O.
When using HMI devices or PGs, they should not be operated in the isochronous mode DP master system.

When planning isochronous mode, please note that the isochronous interrupt OBs are executed with high priority and that cyclic execution and alarms are interrupted during this time.

Figure 8-2 Extension of the OB1 cycle through isochronous mode



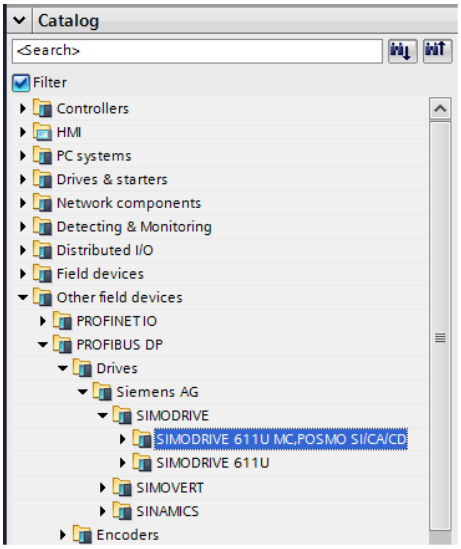

If the execution time of the isochronous user program (OB 6x) is half as long as the DP cycle time, the cycle time of OB 1 will double. If the execution of OB 6x accounts for 66 %, the cycle time of OB 1 will triple, etc.
If a cyclic user program is to be used in addition to the isochronous user program, it has to be ensured that the percentage the isochronous user program accounts for in the DP cycle is not too large.

# 9 Appendix

## 9.1 Characteristic feature of SIMODRIVE drives

### 9.1.1 Basic information

Basically, SIMODRIVE drives behave in exactly the same way as the SINAMICS drives with PROFIBUS connection shown in this documentation.




The integration of the device master file (GSD file) of the SIMODRIVE corresponds to the procedure for the SINAMICS drives shown in Chapter 2.2.2. The integrated SIMODRIVE drive, too, can then be found in Other field devices > PROFIBUS DP > Drives > Siemens AG > SIMODRIVE.

Here you can select the installed SIMODRIVE drives and integrate them into the hardware configuration of the project in TIA Portal.

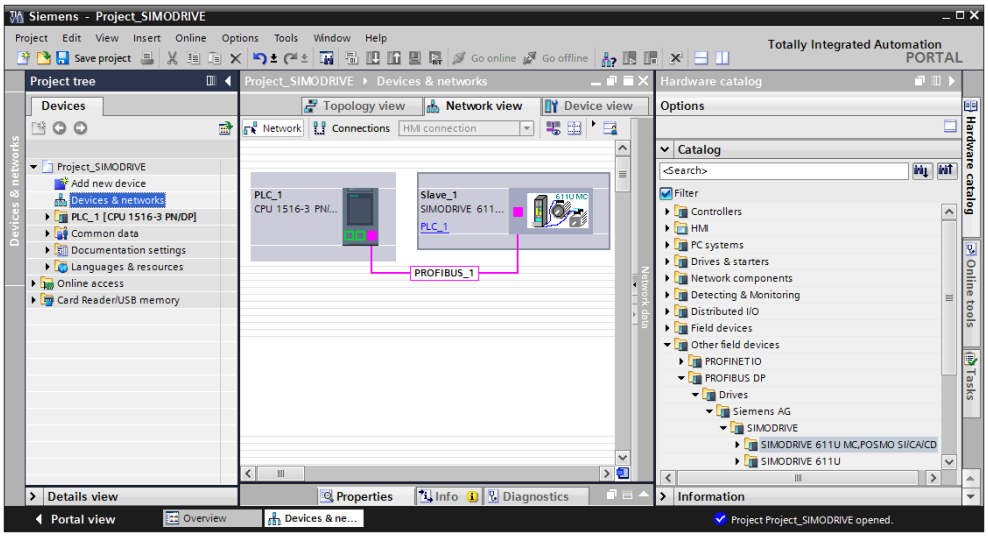
The example used in this documentation is a 2-axis SIMODRIVE 611U.

Differences arise only when integrating communication message frames for two and more axes, which will be shown in the following chapters.

### 9.1.2 Connecting the drive to the S7-1500

The SIMODRIVE drive is integrated into the project and connected to the SIMATIC S7-1500 as shown in Chapter 3.

Figure 9-1 Connecting the drive to the SIMATIC S7-1500

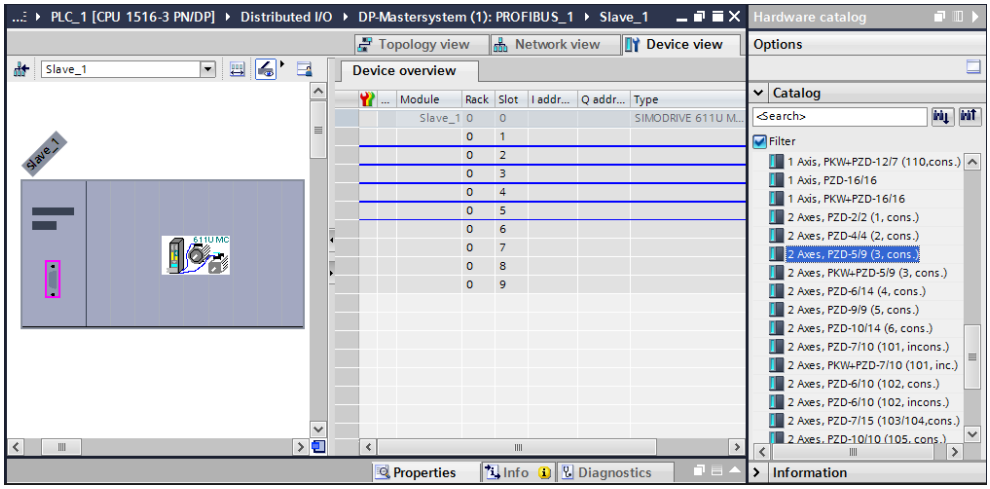


### 9.1.3 Establishing the communication connection

To establish the communication connection, use drag-and-drop to select the telegram from the catalog and integrate it into the first slot of the drive.

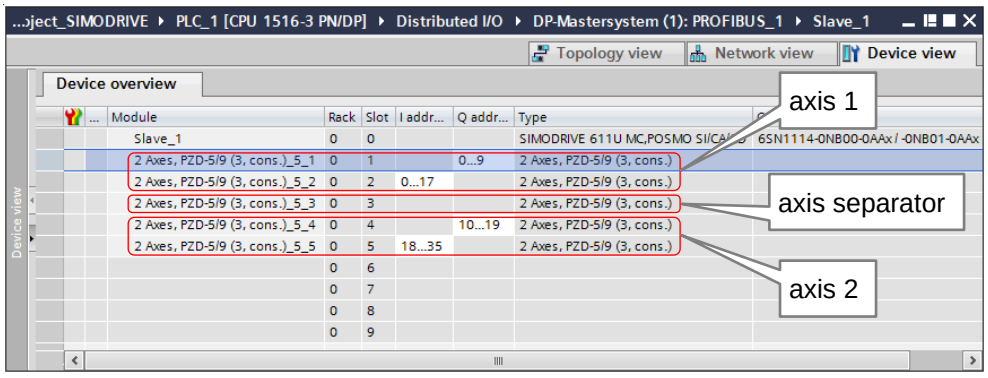
For the procedure shown here, the 2-axis telegram PZD-5/9 (3, cons.) is to be used.

Figure 9-2 Integrating the desired telegram




This process occupies five slots in the SIMODRIVE drive for the selected 2-axis telegram PZD-5/9 (3, cons.).

Figure 9-3 2-axis telegram PZD-5/9 (3, cons.)




The first two slots represent the input and output data of the first axis of the SIMODRIVE drive. The third slot represents an axis separator between the two axes of the SIMODRIVE drive and therefore has no input and output data. Slots four and five then represent the input and output data of the second axis of the SIMODRIVE drive.

With this setting, standard telegram 3 according to the PROFIdrive standard is used for data exchange between the SIMODRIVE drive and the SIMATIC S7-1500 as explained in the figure below.

Figure 9-4 Data of the 2-axis telegram PZD-5/9 (3, cons.)

| | | PZD 1 | PZD 2 | PZD 3 | PZD 4 | PZD 5 | PZD 6 | PZD 7 | PZD 8 | PZD 9 | PZD 10 | PZD 11 | PZD 12 | PZD 13 | PZD 14 | PZD 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Telegram 3 PZD-5/9 | CPU ⇒ Drive | STW 1 | NSOLL | | STW 2 | G1 STW | | | | | | | | | | |
| | Drive ⇒ CPU | ZSW 1 | NIST | | ZSW 2 | G1 ZSW | e.g. G1 XIST1 | | e.g. G1 XIST2 | | | | | | | |

| Legend | | | |
|---|---|---|---|
| STW | Control word | ZSW | Status word |
| NSOLL | Setpoint speed | NIST | Actual speed |
| G1 STW | Encoder 1 control word | G1 XIST1 | Cyclic actual value (incr. encoder) |
| G1 ZSW | Encoder 1 status word | G1 XIST2 | Absolute actual value (abs. encoder) |
| PZD | Process data (type: WORD) | | |

**Note**

In the hardware configuration (device overview), the names “Input addresses” and “Output addresses” refer to the perspective of the SIMATIC S7-1500:

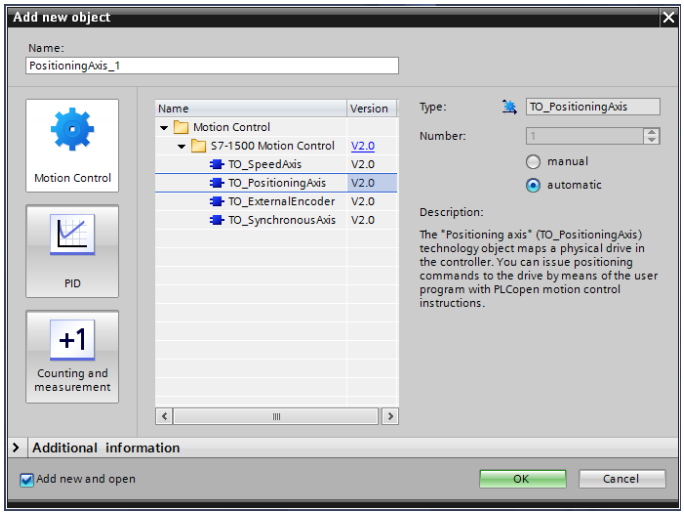
- Output or O address:
  Data area for communication from the SIMATIC S7-1500 to the drive.
- Input or I address:
  Data area for communication from the drive to the SIMATIC S7-1500.

### 9.1.4 Selecting the drive on the technology object

For easy control of the axes of the SIMODRIVE drive, a new technology object (TO) must be created in the SIMATIC S7-1500 for each axis.

The example used here is a positioning axis that is to control axis 2 of the SIMODRIVE drive via telegram 3 (PZD-5/9 (3, cons.)).

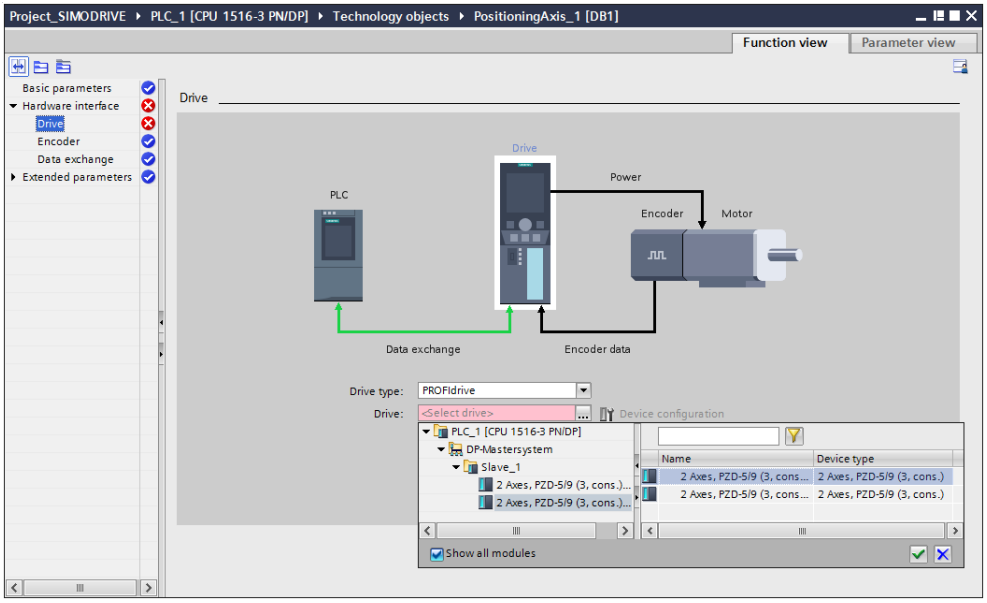
Figure 9-5 Creating a technology object for motion control in the SIMATIC S7-1500




After selecting the axis technology in the SIMATIC S7-1500, the appropriate hardware (axis) of the SIMODRIVE drive must be assigned to the newly created technology object (TO).

In the technology object, select Hardware interface > Drive. In the “Drive” selection box, select the selection dialog for the desired axis.

Figure 9-6 Assigning the drive hardware to the technology object (TO)




**Note**

For the axes of the SIMODRIVE drive to be displayed in the selection dialog for the drive hardware of the technology object, the “Show all modules” function must be activated in the selection dialog.

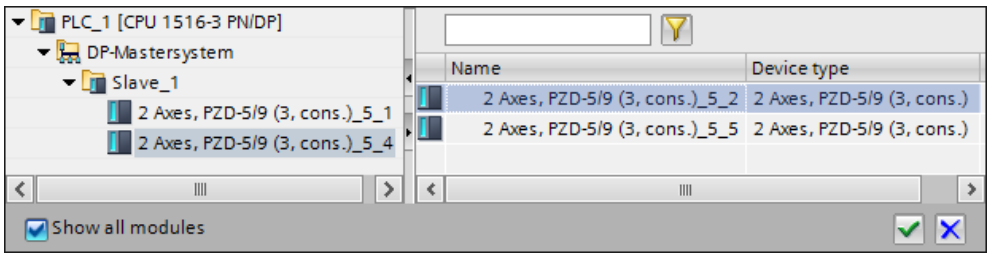
The selection dialog for the drive hardware displays the output data of the telegrams for all axes of the SIMODRIVE drive. The input data of all axes of the SIMODRIVE drive is displayed below the output data.

To connect axis 2 of the SIMODRIVE drive to the technology object (TO) of the SIMATIC S7-1500, both the output data of axis 2 and the input data of axis 2 of the SIMODRIVE drive must be selected in this dialog.

In the selection dialog of the example, the data has the following name:

- Output data of axis 2 (slot 4): “2-axis, PZD-5/9 (3, cons.)_5_4”
- Input data of axis 2 (slot 5): “2-axis, PZD-5/9 (3, cons.)_5_5”

Figure 9-7 Selection dialog for the drive hardware of the technology object (TO)




**NOTICE**

**Make sure that the selection of output and input data (slots) of the relevant axis is consistent.**

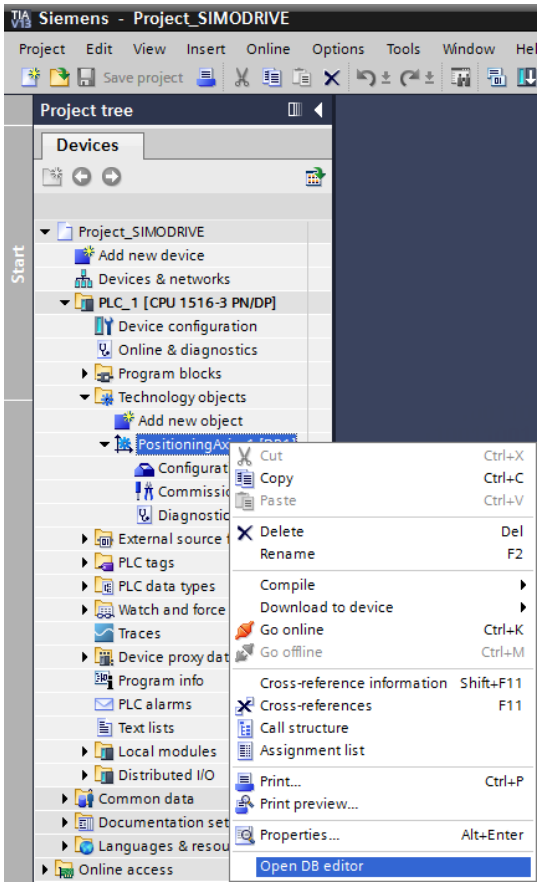
**Otherwise, an unexpected response of the axis may occur due to erroneous data transfer between the technology object (TO) and the drive.**

### 9.1.5 Checking the drive connection via the technology object

After assigning the drive hardware to the respective technology object (TO), the addresses for data exchange parameterized in the technology object should always be checked via the selected telegram.

In the context menu of the technology object (TO), open the object in the block view in the DB editor of TIA Portal.

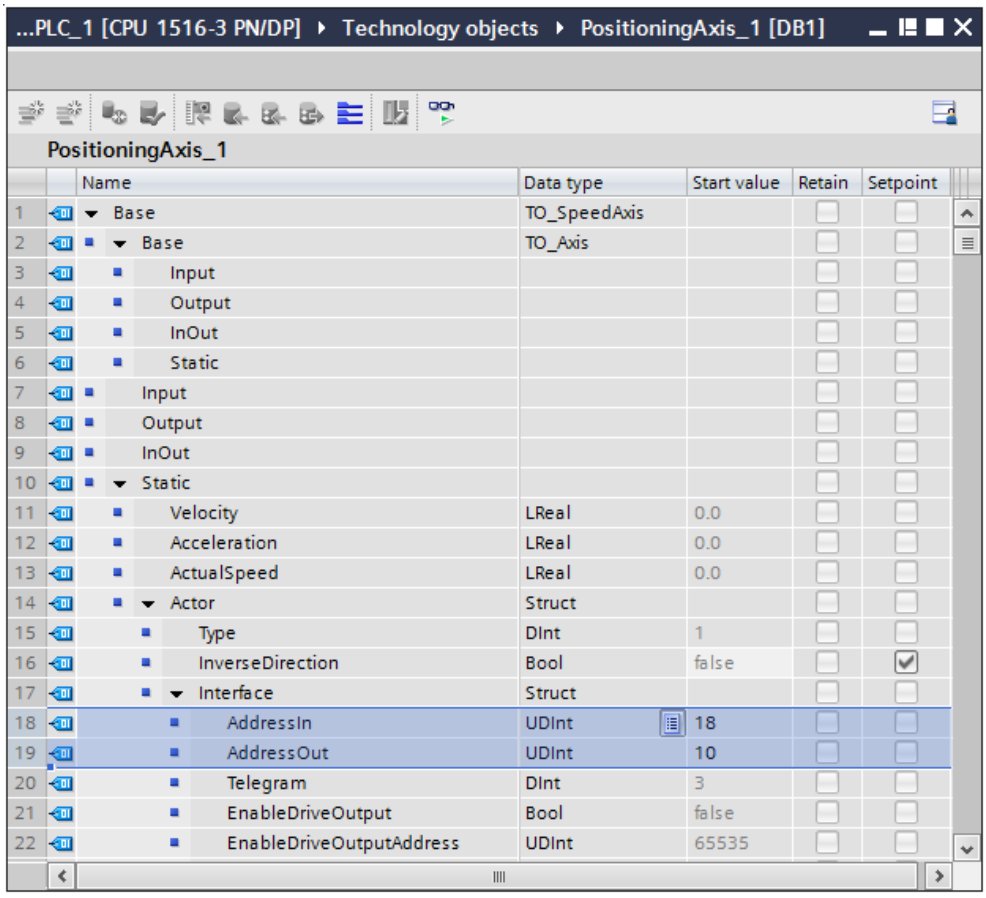
Figure 9-8 Opening the technology object (TO) in the block view in the DB editor



The data block structure of the technology object (TO) lists the parameterized addresses for the input and output data of the telegram connection for the SIMODRIVE drive in the Base > Static > Actor > Interface path:

- The address entered in “AdressOut” must match the start address of the output data area of the telegram of the desired axis.
  In the example shown here, this means for axis 2:
  - Entered address “AdressOut” = **10**
  - Start address of the output data area of the telegram = **10**…19
- The address entered in “AdressIn” must match the start address of the input data area of the telegram of the desired axis.
  In the example shown here, this means for axis 2:
  - Entered address “AdressIn” = **18**
  - Start address of the input data area of the telegram = **18**…35

Figure 9-9 Addresses for the output and input data in the technology object (TO)



# 10 References

This list is by no means complete and only provides a selection of useful information.

Table 10-1

| | Topic | Title |
|---|---|---|
| \1\ | Reference to the entry | https://support.industry.siemens.com/cs/ww/en/view/73257075 |
| \2\ | Siemens Industry Online Support | https://support.industry.siemens.com |
| \3\ | Information on TIA Portal | TIA Portal<br>http://www.industry.siemens.com/topics/global/en/tia-portal/Pages/default.aspx<br><br>Controller Software in TIA Portal – SIMATIC STEP 7<br>http://www.industry.siemens.com/topics/global/en/tia-portal/controller-sw-tia-portal/Pages/Default.aspx |
| \4\ | Information on the SIMATIC S7-1500 | SIMATIC S7-1500<br>http://www.automation.siemens.com/mcms/programmable-logic-controller/en/advanced-controller/s7-1500/Pages/default.aspx |
| \5\ | STARTER commissioning tool | SINAMICS MICROMASTER STARTER (Download)<br>https://support.industry.siemens.com/cs/ww/en/view/26233208 |
| \6\ | SINAMICS Startdrive STEP 7 option | SINAMICS STARTDRIVE<br>http://www.automation.siemens.com/mcms/mc-solutions/en/engineering-software/startdrive/Pages/startdrive.aspx |
| \7\ | GSDML files for PROFINET - download | SINAMICS S120<br>https://support.industry.siemens.com/cs/ww/en/view/49217480<br>SINAMICS S150, G130/G150, GM150/GL150/SL150/SM120, DCM, DCP<br>https://support.industry.siemens.com/cs/ww/en/view/98207877<br>SINAMICS G120<br>https://support.industry.siemens.com/cs/ww/en/view/26641490 |
| \8\ | GSD files for PROFIBUS – download | SINAMICS S120<br>https://support.industry.siemens.com/cs/ww/en/view/49216293<br>SINAMICS S150, G130/G150, GM150/GL150/SL150/SM120, DCM, DCP<br>https://support.industry.siemens.com/cs/ww/en/view/98206128<br>SINAMICS S110<br>https://support.industry.siemens.com/cs/ww/en/view/42705323<br>SINAMICS G120 / G120P<br>https://support.industry.siemens.com/cs/ww/en/view/23450835<br>SINAMICS G120C<br>https://support.industry.siemens.com/cs/ww/en/view/60292416<br>SINAMICS G120D<br>https://support.industry.siemens.com/cs/ww/en/view/60292521<br><br>Paket SIMODRIVE 611U V14.2<br>https://support.industry.siemens.com/cs/ww/en/view/103498340<br>(The GSD files are in the toolbox) |