Application Slave-Slave Communication between two SINAMICS G120Ds

SINAMICS G120, SIMATIC S7 300/400

Application • July 2012

Applications & Tools

Answers for industry.

SIEMENS

Siemens Industry Online Support

This article is taken from the Siemens Industry Online Support. The following link takes you directly to the download page of this document:

http://support.automation.siemens.com/WW/view/en/<Item-ID>

Caution
The functions and solutions described in this article confine themselves to the realization of the automation task predominantly. Please take into account furthermore that corresponding protective measures have to be taken up in the context of Industrial Security when connecting your equipment to other parts of the plant, the enterprise network or the Internet. Further information can be found under the Item-ID 50203404.

http://support.automation.siemens.com/WW/view/en/50203404

You can also actively use our Technical Forum from the Siemens Industry Online Support regarding this subject. Add your questions, suggestions and problems and discuss them together in our strong forum community:

http://www.siemens.com/forum-applications

SIEMENS

SINAMICS
Slave-slave communication with two G120Ds

Slave-slave communication with two SINAMICS G120Ds

Warranty and liability

Note

The Application Examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The Application Examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible for ensuring that the described products are used correctly. These application examples do not relieve you of the responsibility to use safe practices in application, installation, operation and maintenance. When using these Application Examples, you recognize that we cannot be made liable for any damage/claims beyond the liability clause described. We reserve the right to make changes to these Application Examples at any time without prior notice.
If there are any deviations between the recommendations provided in these application examples and other Siemens publications – e.g. Catalogs – the contents of the other documents have priority.

We do not accept any liability for the information contained in this document.

Any claims against us – based on whatever legal reason – resulting from the use of the examples, information, programs, engineering and performance data etc., described in this Application Example shall be excluded. Such an exclusion shall not apply in the case of mandatory liability, e.g. under the German Product Liability Act (“Produkthaftungsgesetz”), in case of intent, gross negligence, or injury of life, body or health, guarantee for the quality of a product, fraudulent concealment of a deficiency or breach of a condition which goes to the root of the contract (“wesentliche Vertragspflichten”). The damages for a breach of a substantial contractual obligation are, however, limited to the foreseeable damage, typical for the type of contract, except in the event of intent or gross negligence or injury to life, body or health. The above provisions do not imply a change of the burden of proof to your detriment.

Preface

Objective of the application

This application should provide electrical application engineers and the associated commissioning engineers with guidelines to engineer and commission a simple leading/following drive for an existing SIMATIC S7 control system.

Main contents of this application note

The following main points are discussed in this application note:

- Direct communication between two DP slaves using slave-slave communication.
- Master/slave operation (leading/following drive).
- Step-by-step configuring of the SIMATIC S7 and the drives for master/slave operation.

Validity

This application has been written for a SINAMICS G120D with a CU240D-2 DP V 4.5, but is also basically possible using a SINAMICS G120 with a CU240E-2 DP / CU240B-2 DP and a PM240 / PM250 as well as a G120C.

The SINAMICS G120P with its PM230 has been developed for pump, fan and compressor applications, and is not taken into consideration in this application description.

Know-how that is required

It is assumed that readers have basic knowledge about handling SIMATIC S7, cyclic data exchange via PROFIBUS, STARTER commissioning software and drive technology.

Table of contents

1 Task

1.1 Description

For drives that are rigidly connected with one another, often one drive is operated as the leading drive (master) in speed control. The other drive or drives receive the torque setpoint from the master as setpoint and are operated as slave drive in torque control.

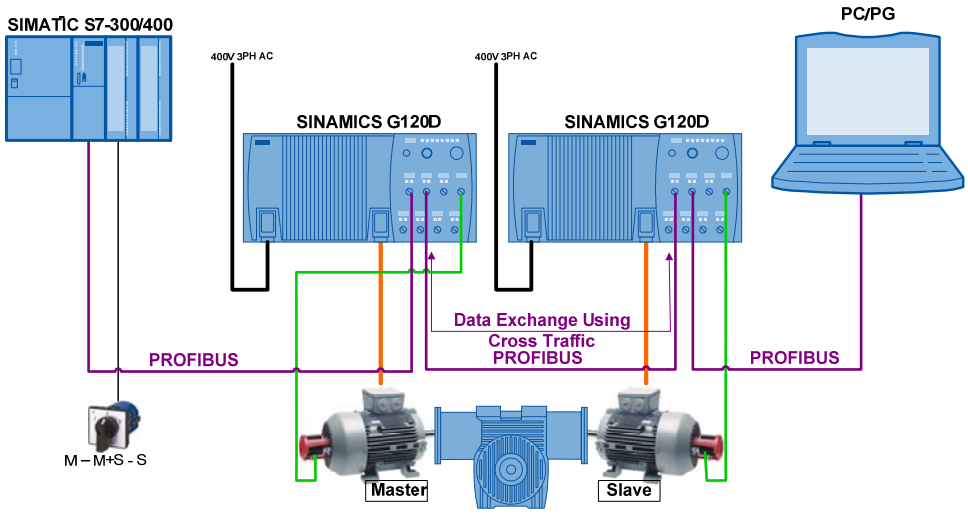
This application example shows how you can parameterize two SINAMICS G120D devices as master/slave drive, and how you can configure direct communication between the drives based on an existing SIMATIC S7-300/400 control system.

This application can also be realized using another SINAMICS G120 converter, assuming that a CU240x-2 DP is used.

Overview of the automation task

The figure below provides an overview of the automation task.

Figure 1-1 Figure 1-2 Overview of the task



Overview of the automation task

For two rigidly connected drives, one operates as master drive in closed-loop speed control. The slave drive, which is operated in closed-loop torque control, receives the setpoint torque of the master as main setpoint and is operated as a slave.

The higher-level control system identifies if one of the two drives fails. Using a selector switch, the operator deselects master/slave operation and selects the drive without fault. The load is moved with reduced velocity, e.g. with the pre-limit switch velocity or with crawl velocity to a maintenance position.

The preselection of the operating modes, master alone, slave alone, master + slave together, the velocity setpoints as well as the evaluation of the status words and the control itself is realized in the PLC.

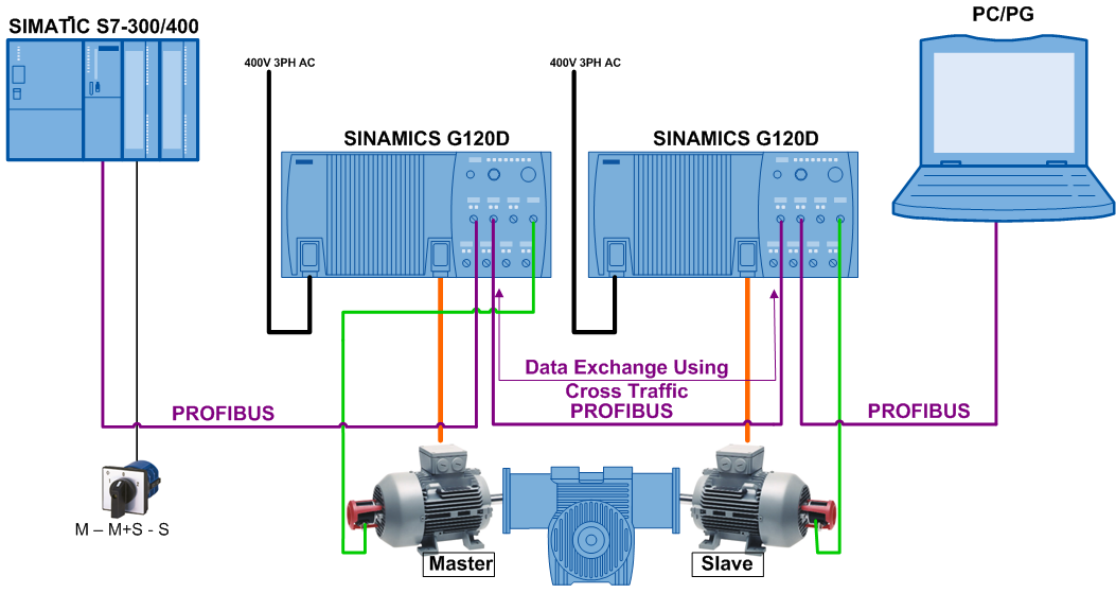
2 Solution

2.1 Overview of the total solution

Schematic

The most important components of the solution are schematically shown in the following diagram:

Fig. 2-1 Schematic representation



The example shows you

- ... the basic design, if a drive is operated as master in speed control (n control) and the slave drive in torque control (M control).
- ... where you can find the current GSD files.
- ... how a SIMATIC S7 CPU319-3 PN/DP is parameterized for simple slave-slave communication without Drive ES Basic.
- ... the most favorable drive parameterization, based on the I/O configuration 7 (macro 7).

Delimitation

This application does not include...

- ... drive dimensioning.
- ... drive commissioning.
- ... complete programming of a drive control. Only a data block and a variable table are provided, as example for data transfer and to illustrate slave-slave communication.
- ... Safety integration.

A basic knowledge of these topics is assumed.

Required know-how

It is assumed that the reader is knowledgeable about how to use SIMATIC S7, cyclic data exchange via PROFIBUS, the STARTER commissioning software as well as drive technology

2.2 Description of the core functionality

2.2.1 Parameterizing the communication

SINAMICS

SINAMICS is parameterized using the STARTER V4.3 SP1 commissioning tool.

For SINAMICS G120D V4.5, the PROFIBUS address can either be permanently set using a DIP switch, or if all of the DIP switches are set to ON or OFF, using parameter 918.

The remaining PROFIBUS parameters (e.g. baud rate) are automatically identified, or transferred from the PROFIBUS master at power-up so that these do not have to be parameterized.

For SINAMICS, a telegram type for data exchange can be selected from several telegram types. This therefore defines which data are sent and received in which sequence. When parameterizing the control it is important that the same telegram length and the same telegram type are selected.

SIMATIC S7-300/400

In this example, the SIMATIC S7-300/400 is programmed using STEP 7 V5.5 SP2. A generic station description file (GSD) must be imported in order that the SINAMICS G120D with the CU240D-2 DP (F) and the telegram type are in STEP 7 V5.5 SP2, in the hardware catalog. It is important that the same telegram length and/or the same telegram type are selected as when parameterizing the SINAMICS.

When inserting the SINAMICS in the SIMATIC project, the I/O addresses that the control should use when accessing the converter are defined.

2.2.2 Data exchange

SIMATIC S7-300/400

Data is exchanged between the drive and the PLC using cyclic process data exchange, i.e. data is transferred in every bus cycle.

To do this, as PROFIBUS master the SIMATIC S7-300/400 sends the control word and the main setpoint (e.g. n_{set}) to the SINAMICS, and from SINAMICS, receives the status word and the main actual value (e.g. n_{act}).

Depending on the telegram type, additional setpoints, actual values or extended control or status words can be transferred.

- On the control side, the process data is made available as I/O output or input words.
- The appropriate parameterization in the drive defines which bits of the control word are used, and which data is sent to the control.

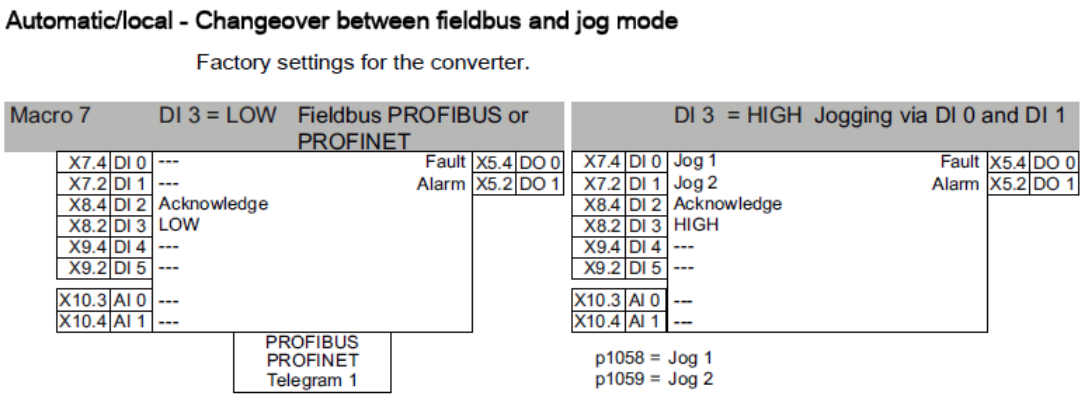
SINAMICS G120

Data exchange between the two drives is handled via an area reserved by the telegram length in the hardware configuration. This is not used for cyclic data exchange.

2.2.3 To be carefully observed when commissioning the drives

- Both drives should be initially commissioned in the speed control mode (p1300=21 / 20).
- The slave drive is not operated in pure torque control (p1300=23). The switchover to the torque setpoint is realized after the speed controller using p1501.
- The control must ensure that the slave drive cannot start in torque control without a load. This is because when a torque setpoint > break loose torque is entered, the drive would otherwise accelerate to the maximum permitted speed. Then, it is only possible to stop the drive by withdrawing OFF2 (control word 1 bit 1) or switching off the supply voltage.
- When configuring the drive I/O, the default setting 7 should be selected. The command data set is switched over, e.g. using a key-operated switch directly at DI3 of the inverter. These can then only be operated using the jog mode.

Fig. 2-2 From the operating instructions for the CU240D-2 p15=7



- The preferred solution is if the drives are equipped with a speed encoder. For encoderless operation, restrictions must be expected regarding dynamic performance, accuracy and at low rotating frequencies. Especially for vertical applications, additional safety measures may be required, such as interlocks, centrifugal switch, etc.

Typical application areas

- Several distributed drives acting on an annular gear, e.g. slewing gear.
- Several drives operating on a toothed rack.
- Two motors each with its own converter, which drive a gearbox.

2.3 Hardware and software components used

The application was created with the following components:

Hardware components

Table 2-1

Component	Qty.	MLFB/order number	Note
CPU 319-3 PN/DP	1	6ES7318-3EL00-0AB0	V2.4
SINAMICS G120D CU240-2DP (F)	2	6SL3544-0FB21-1PA0	V4.5
PROFIBUS M12 connection plug, pin insert	1 pack.	6GK1905-0EA00	Packing unit 5x
PROFIBUS M12 connection plug, female contact insert	1 pack.	6GK1905-0EB00	Packing unit 5x
PROFINET connection plug	2	6ES7972-0BA52-0XA0	or 6ES7972-0BA52-0XA0 (with PG socket)
PROFIBUS cable		6XV1830-0EH10	Length as required
7/8'' connector 24V pin insert (in)	1 pack.	6GK1905-0FA00	Packing unit 5x
7/8'' connector 24V female contact insert (out)	1 pack.	6GK1905-0FB00	Packing unit 5x
Cables / HAN Q4/2 plug set for power infeed	2	See D31 S8/27	2.5mm² 4mm² Length as required
Cables / HAN Q8 plug set For motor cable, shielded	2	See D31 S8/27	4x1.5mm² 2x(2x0.75mm²) 4x2.5mm² 2x(2x0.75mm²) 4x4mm² 2x1mm²+2x1.5mm² Length as required
M12 encoder plug	2	99-1487-812-08 or 99-1487-822-08	Straight connector Angled connector
Induction motor	2	1LA7080-4AA10	

Standard software components

Table 2-2

Component	Qty.	MLFB/order number	Note
SIMATIC STEP V5.5	1	STEP 7 V5.5 SP2 floating license 6ES7810-4CC10-0YA5	
STARTER V4.3.1	1	6SL3072-0AA00-0AG0	http://support.automation.siemens.com/WW/view/en/26233208
GSD file for SINAMICS G120D, CU240-2DP (F)	1	-	http://support.automation.siemens.com/WW/view/en/60292521

File examples and projects

The following list includes all files and projects that are used in this example.

Table 2-3

Component	Note
60602336_s7_code_v10.zip	This zipped file includes the STEP 7 project.
xyz_DOKU_v10_d.pdf	This document
60602336_script_slave_v10.zip	Switchover, speed/torque control in the slave drive.
60602336_script_master_v10.zip	Communication assignment for the master drive.

2.4 Alternative solutions

An alternative torque setpoint transfer from the master to the slave via analog inputs is not possible with the CU240D-2, as the CU240D-2 only has analog inputs, however, no analog outputs.

Analog data transfer is generally more sensitive to external interference and disturbances such as EMC, potential equalization etc.

3 Basics

3.1 Basics Slave-slave communication for drives

The publisher / subscriber model is used to implement slave-slave communication between the slaves. PROFIBUS slaves declared as publishers provide their input data to other slaves – the subscribers – to read this data.

Slave-slave communication allows the direct and therefore fast communication between slaves via broadcast without having to go through a master. Here, the slaves act as "publisher", i.e. the slave response is not only returned to the coordinating master, but also directly to the slaves, known as "subscribers". This means that slaves can directly track data from other slaves and use this data as their own setpoints. This opens up completely new applications. In addition, bus response times are significantly reduced.

Slave-slave communication is cyclic.

Slave-slave communication requires a PROFIBUS-DP master, which supports this data exchange function; for instance, these are all of the SIMATIC S7-CPUs with the property "Equidistance" (isochronous) in the catalog.

Sender:

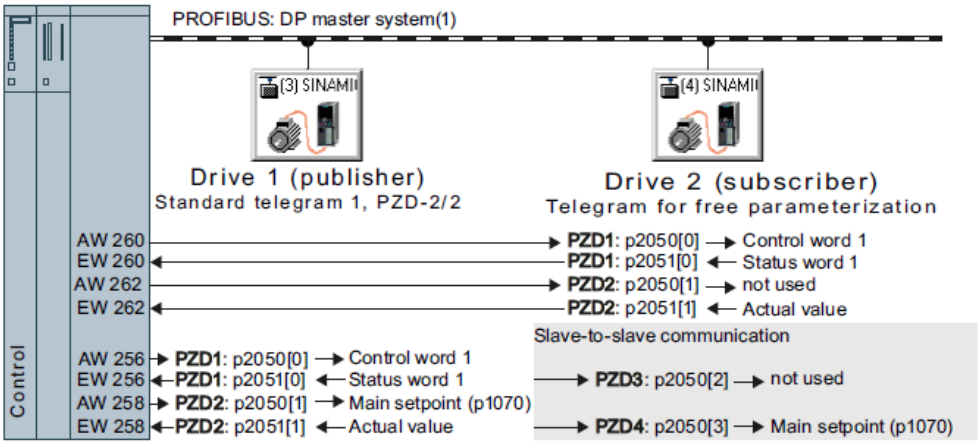
All input data of a DP slave that is capable of slave-slave communication are send data regarding data exchange. This data can be received by a DP master or DP slaves capable of slave-slave communication. ("Input data" in the sense of PROFIBUS-DP data are data that the DP slave issues in the direction of the DP master). It is not necessary to explicitly configure the data exchange sender.

Receiver:

The sources for the setpoints are appropriately configured. The following are possible as source:

- the output data of the DP master
- the input date of a DP slave as data exchange sender (for drives, their actual values)

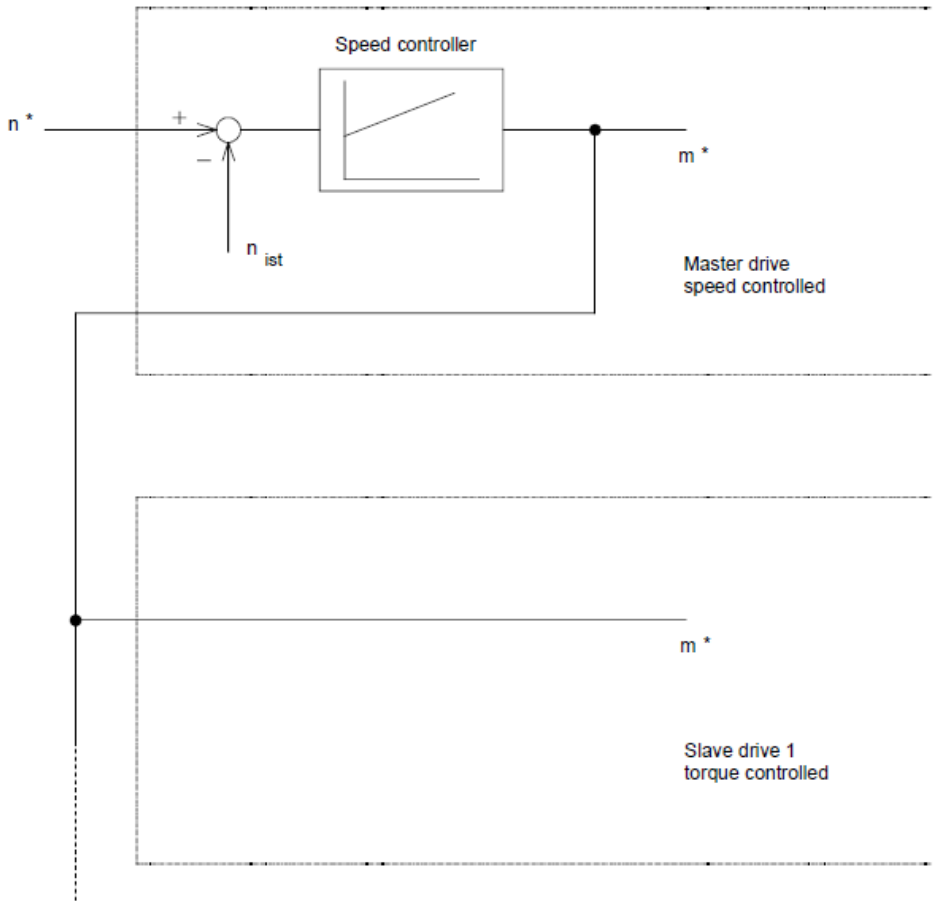
Fig. 3-1 The principle of slave-slave communication



3.2 Basics, master/slave drive

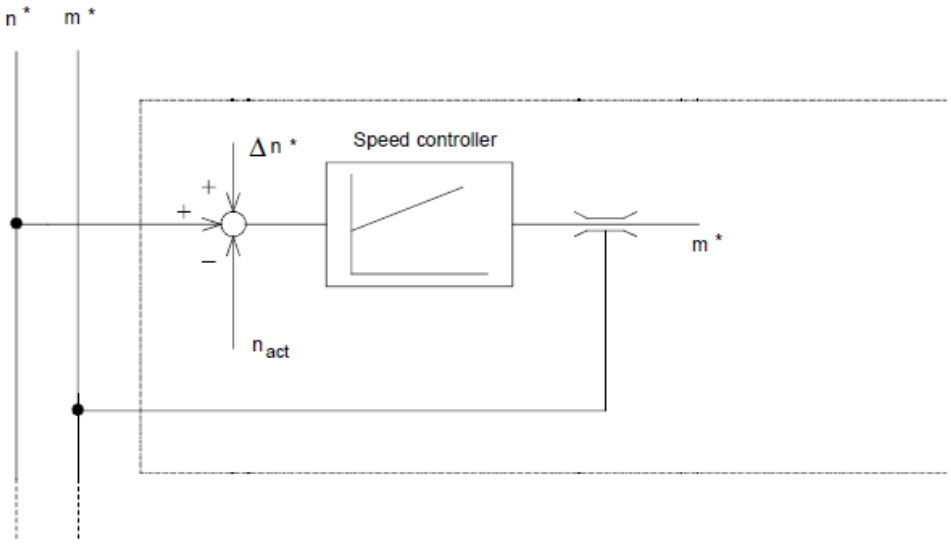
To implement master/slave drive solutions, converters must be used that are capable of speed and torque control. Every drive requires a speed encoder (incremental encoder). For master/slave drives, a uniform load distribution over the complete speed range is achieved by transferring the torque setpoint of the speed-controlled master drive to the torque-controlled slave drive(s).

Fig. 3-2 The master/slave drive principle



The slave drive(s) can be prevented from accelerating uncontrollably when unloaded (e.g. if the material breaks) in the control of the slave drives using a Δn* overdriven speed control with a corresponding torque limitation. In addition to the torque setpoint of the master drive, every slave drive also requires the speed setpoint from the master drive.

Fig. 3-3 Principle of a slave drive with overdriven speed control



The master torque setpoint must then be interconnected to the torque limits p1521 and p1523 of the slave. The lower torque limit (negative limit) must be scaled with -100% at p1525.

This method has the advantage that the drive always operates in speed control faster than the main setpoint by an amount Δn*.

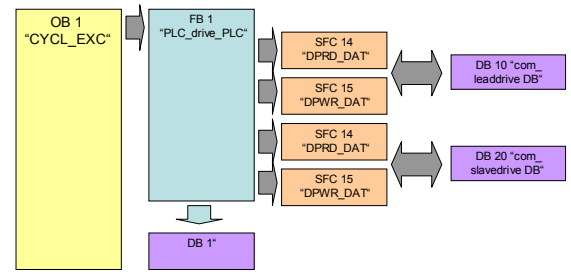
The drive can be shutdown as normal using OFF1 and a down ramp.

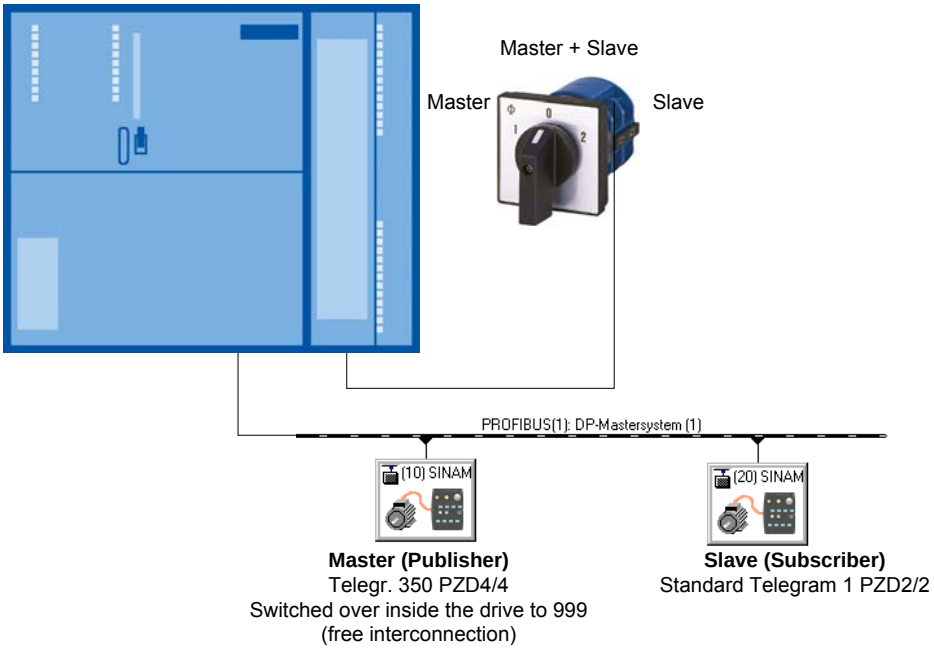
The stall and locked rotor monitoring must be adapted. (Also refer to function block diagram -8012- "Signals and monitoring functions in the Parameter Manual for version V4.5).

4 Function mechanisms of this application

Complete overview

Fig. 4-1 Program and hardware structure





Master (Publisher)
Telegr. 350 PZD4/4
Switched over inside the drive to 999
(free interconnection)

Slave (Subscriber)
Standard Telegram 1 PZD2/2

AW 256	PZD1: r2050[0]	STW1			
EW 256	PZD1: p2051[0]	ZSW1			
AW 258	PZD2: r2050[1]	n_{set} (P1070)			
EW 258	PZD2: p2051[1]	n_{act}			
AW 260	PZD3: p2051[2]	r79M_{set}		S-to- s: r2050[2]	p1503M_{set}
EW 260	PZD3: p2051[2]	r79M_{set}			
AW 262	PZD4: p2051[3]	R52 ZSW1		S-to- s: r2050[3]	Not used
EW 262	PZD4: p2051[3]	R52 ZSW1			
AW 264				PZD1: r2050[0]	STW1
EW 264				PZD1: p2051[0]	ZSW1
AW 266				PZD2: r2050[1]	n_{set} (P1070)
EW 266				PZD2: p2051[1]	n_{act}

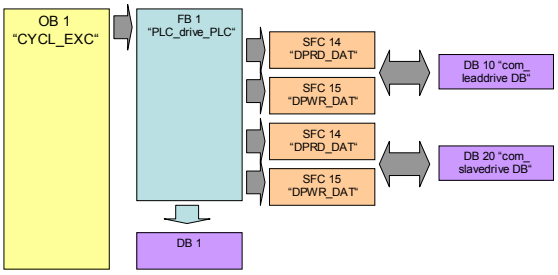
The individual mechanisms and blocks used for data exchange will not be described. These will be described in other applications.

The program example will be subsequently explained together with slave-slave communication (data exchange broadcast).

The switchover between master and slave operation is simulated in the SIMATIC

4.1 Functionality of the program provided

Fig. 4-2 Overview of the program example



The program has been deliberately kept simple and small.

The complete example is executed in FB1.

Every drive has its own data block.

The position of the rotary switch used to select the operating mode and the drive is interrogated. Depending on the position, the

- setpoints, crawl or maximum velocity

and the

- operating mode of the slave are specified.

4.1.1 Program details for block FB1

The simulated inputs of the selector switch are specified in FB1 as bit memory.

- M99.0= master/slave drive mode
- M99.1 master drive alone
- M99.2 slave drive alone

The PZD from the master and slave are read-out in networks NW1 and NW2.

In NW3, the auxiliary bit memory is set to "1", bits 1-6 and bit 10 of control word 1 of both drives in networks 7 and 8 are set to "high".

Bit memories M99.0, M99.1 and M99.2 are used to preselect the velocity in networks NW4 and NW5:

- M99.0 and M99.1 not and M99.2 not ➔ 100%
- M99.0 not and M99.1 or M99.2 ➔ 10%

In NW6, the decision is made as to whether the slave drive should be operated in speed or torque control (M99.3 -> control word 1 bit 15, DB20.DBX1.7).

An M99.7 "Dummy fault Masterside" was inserted, which is intended to act as place holder for faults from the control or the master drive. If a master fault occurs, the slave drive is switched over to the speed control mode; the torque control cannot be selected.

As the drive is pre-assigned with macro 7 (p15=7), the command data set is switched over and bit 15 of control word 1 is free for switching over between speed control and torque control.

Writing the PZD to the master and slave is realized in networks 9 and 10.

Variable table VAT_1 contains the PZD, which is transferred to and from the drives, as well as the values for the slave-slave communication.

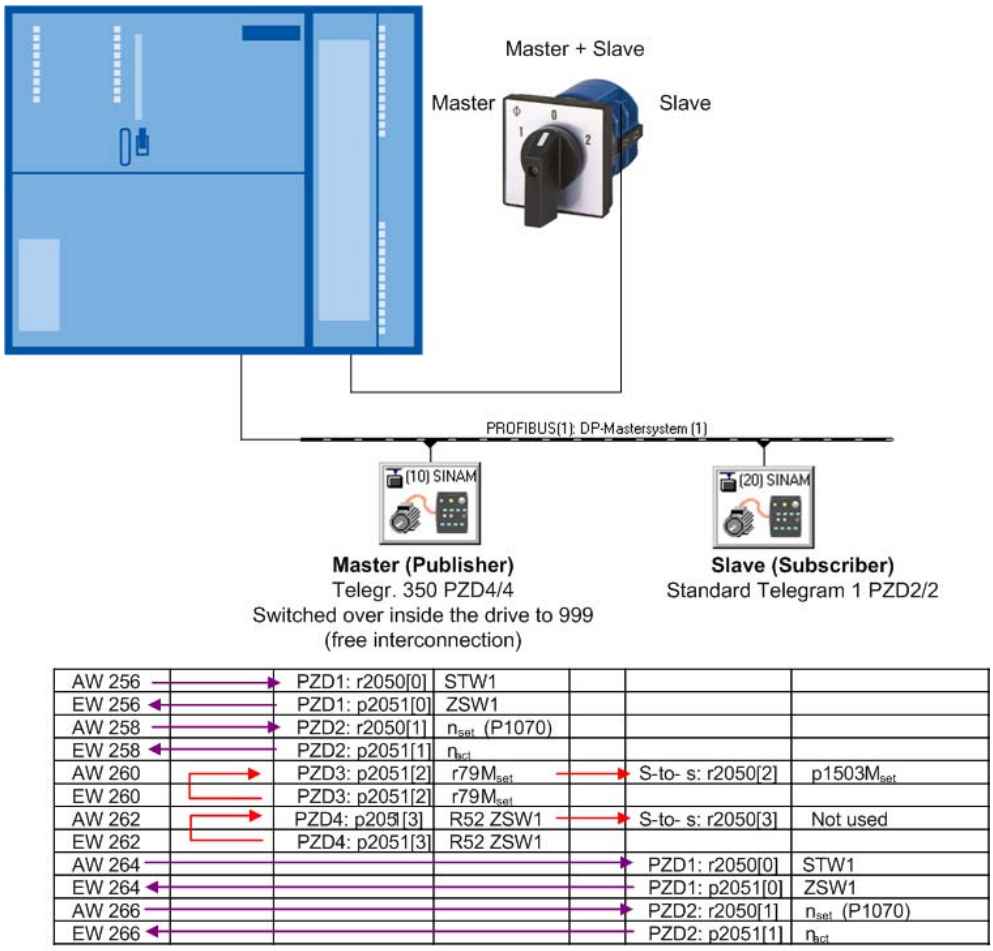
Important:

The program does not include a complete control system. It only realizes the switchover of the slave drive from speed control to torque control and the velocities.

If the selector switch is simulated, it must be ensured that the selector switch has three positions, each with one contact. Only one bit memory M99.0, M99.1 or M99.2 may be active.

4.2 Functionality of the slave-slave communication

Fig. 4-3 Slave-slave communication and the associated I/O structure



The slave-slave communication functionality is not described. This is discussed in other applications or FAQs.

Only the special features for this particular application are discussed.

4.2.1 Details for data exchange between two drives

When creating the hardware configuration, it must be ensured that in the I/O the required area is reserved for data exchange.

In the specific example, Siemens telegram 350 is selected in the DP master. It has 4/4PZD, and regarding the pre-assignment, comes closest to address the requirements of the application.

When selecting the telegram in STARTER for the master drive, Siemens telegram 350 must first be selected. The PZD in the drive is pre-assigned after Siemens telegram 350. In order that in the master drive the send data for slave-slave communication can be adapted, the telegram selection in p922 must be changed over to 999 – free telegram configuring with BICO.

The third word must be assigned torque setpoint r79 and the fourth word, status word 1, r52. The fourth word is not used in the example.

5 Configuring

5.1 Configuring slave-slave communication in the hardware configuration

A SIMATIC project with a CPU capable of slave-slave communication has already been created.

In a DP master system, the drives are inserted as GSD slaves with the corresponding PROFIBUS addresses.

For the case that the actual GSD files are still not available in the hardware catalog, these should be imported for SINAMICS G120D with the CU240D-2 via the link below and inserted.

http://support.automation.siemens.com/WW/view/en/60292521

Fig. 5-1 Starting point for the hardware configuration

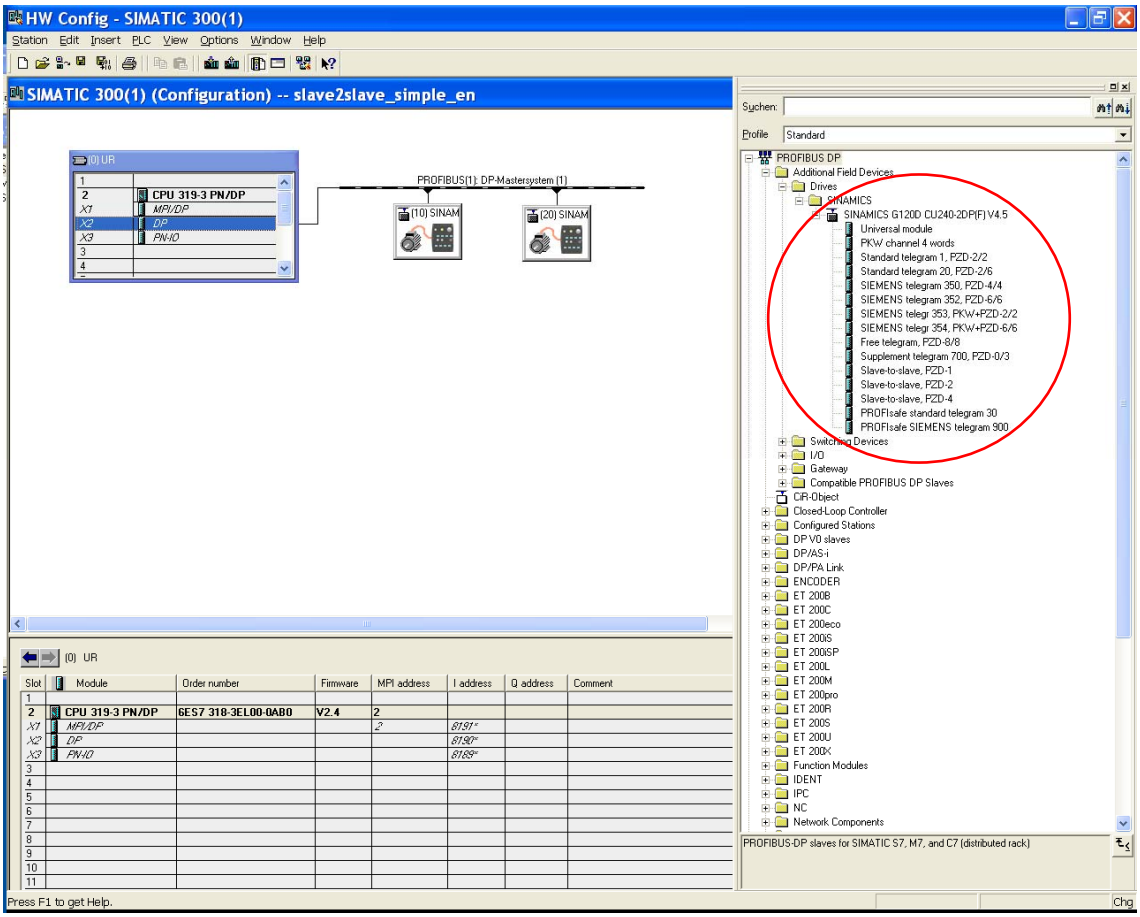
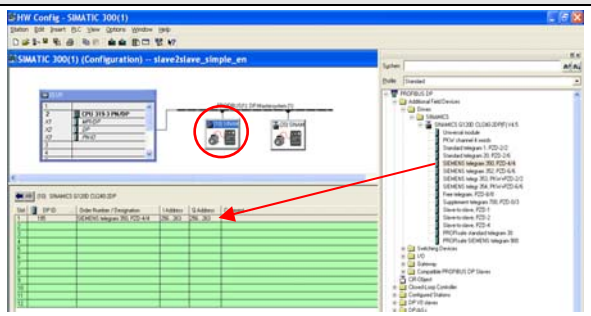
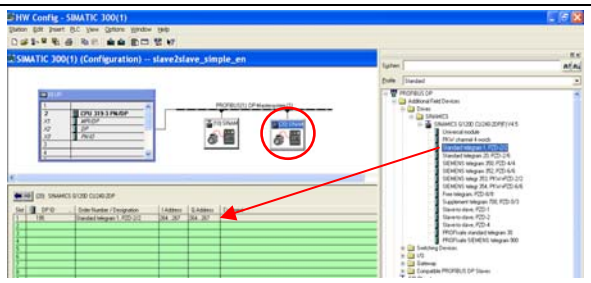
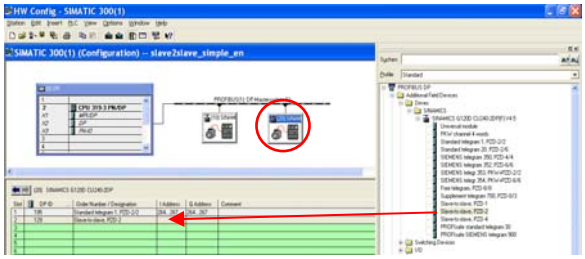
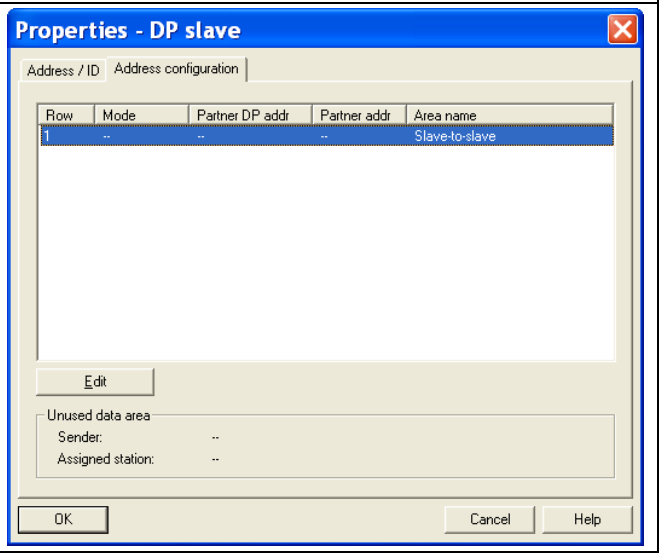
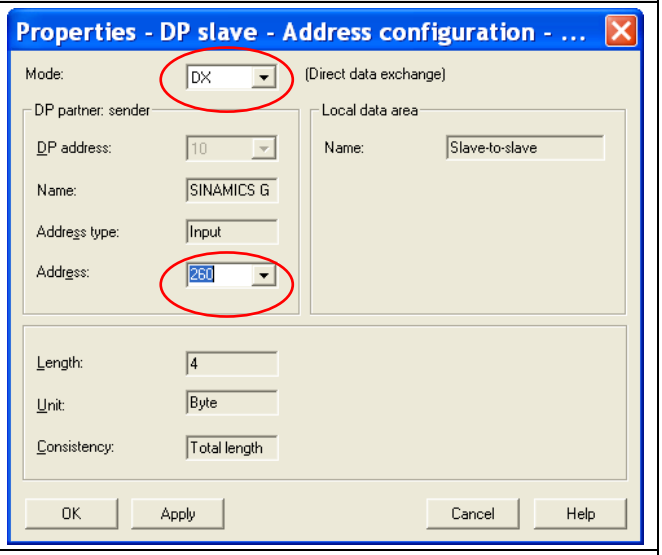
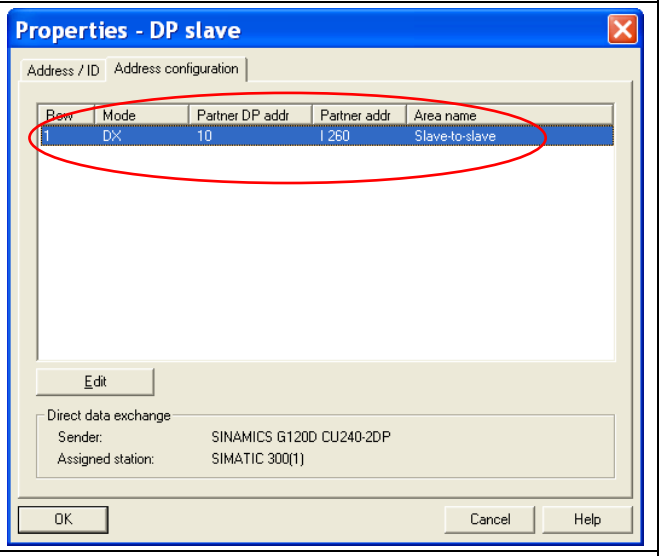


Table 5-1 Configuring slave-slave communication in HW Config

No.	Action	Comment
1.	Publisher, master drive: Drag Siemens telegram 350, PZD 4/4 into the first line of the DP slave configuration window.	
2.	Subscriber, slave drive: Drag standard telegram 1, PZD 2/2 into the first line of the DP slave configuration window.	
3.	Subscriber, slave drive: Drag the "Slave-to-slave, PZD2" object into the second line of the DP slave configuration window.	
4.	Subscriber, slave drive: Double-click on the "Slave-to-slave, PZD2" object in the second line of the DP slave configuration window, and in the Properties dialog that opens, select "Address configuration" tab and click on "Edit".	

No.	Action	Comment
5.	Subscriber, slave drive: In the new dialog 1. select the "DX" mode, 2. change the address from 256 to 260.	
6.	Subscriber, slave drive: After closing, the settings must have been accepted in the Properties dialog of the DP slave.	
7.	Compile and save the hardware configuration. HW Config can then be closed.	-

5.2 Configuring the drives in the SIMATIC project

The starting point is the SIMATIC Manager with the project opened at the topmost level.

Fig. 5-2 Starting point in the SIMATIC Manager to insert the drives

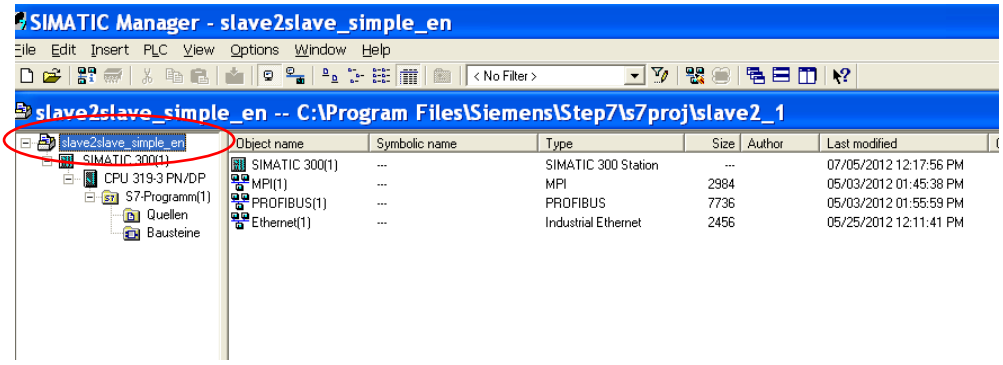
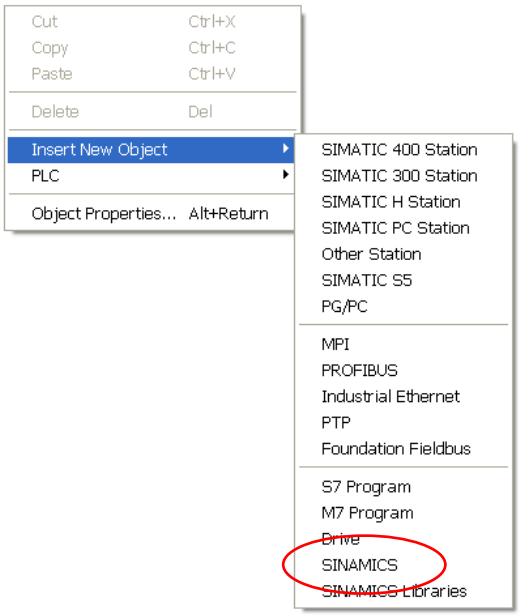
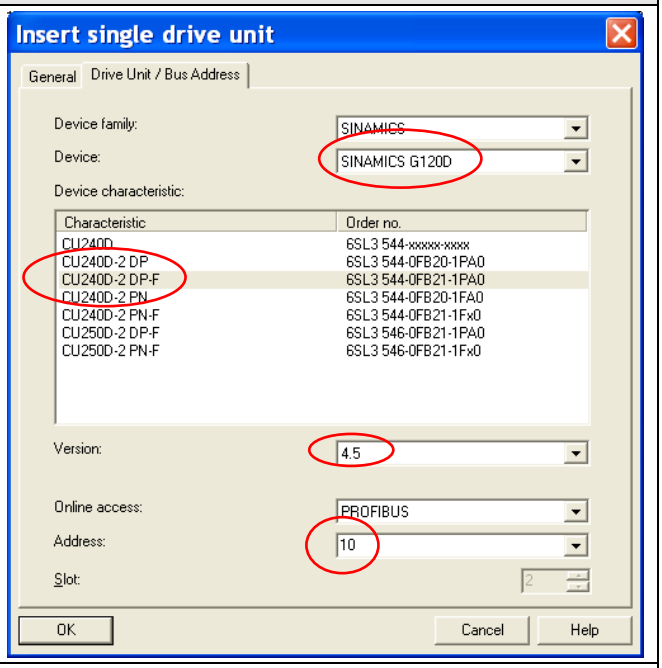
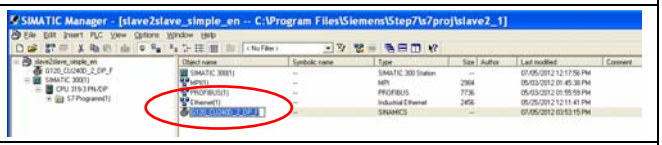
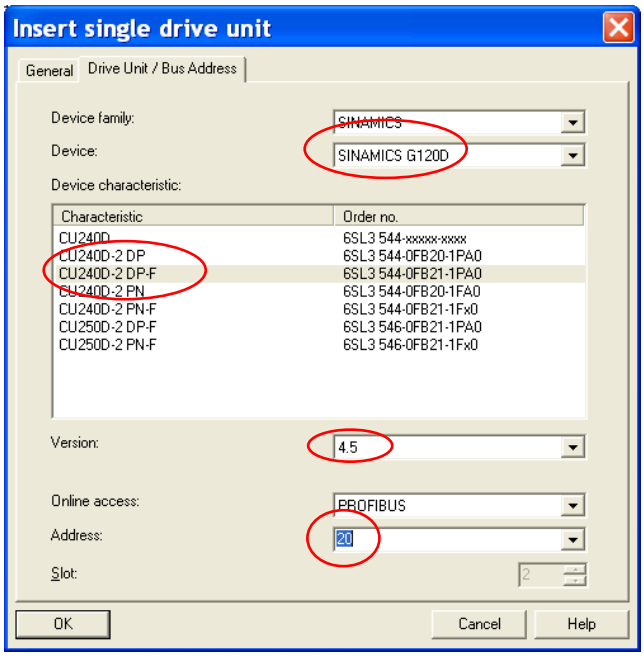


Table 5-2 Configuring the drives in the SIMATIC project

No.	Action	Comment
1.	Right click in the work area to the right of the program structure. A menu is displayed. In the next menu "SINAMICS", select "Insert New Object" using the left-hand mouse key.	

No.	Action	Comment
2.	Insert the master drive, a SINAMICS G120D with the CU240-2DP (-F) and firmware 4.5 with the PROFIBUS address 10 and acknowledge with "OK".	
3.	If required, the drive can be renamed.	
4.	Repeat step 1 for the slave drive	-
5.	Insert the slave drive, a SINAMICS G120D with the CU240-2DP (-F) and firmware 4.5 with the PROFIBUS address 20 and acknowledge with "OK".	
6.	Just the same as in the third step, the drive can be renamed.	-

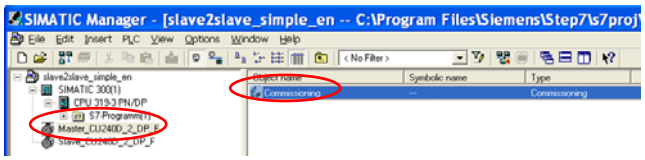
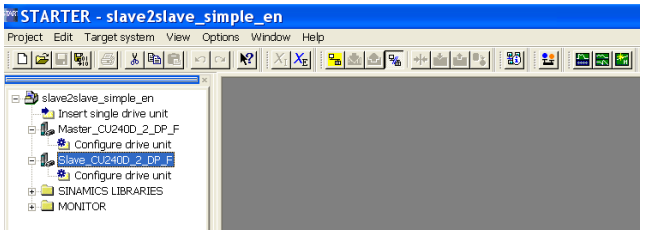
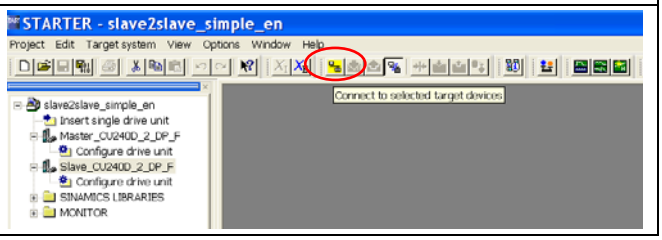
5.3 Go online with STARTER and parameterize the master drive

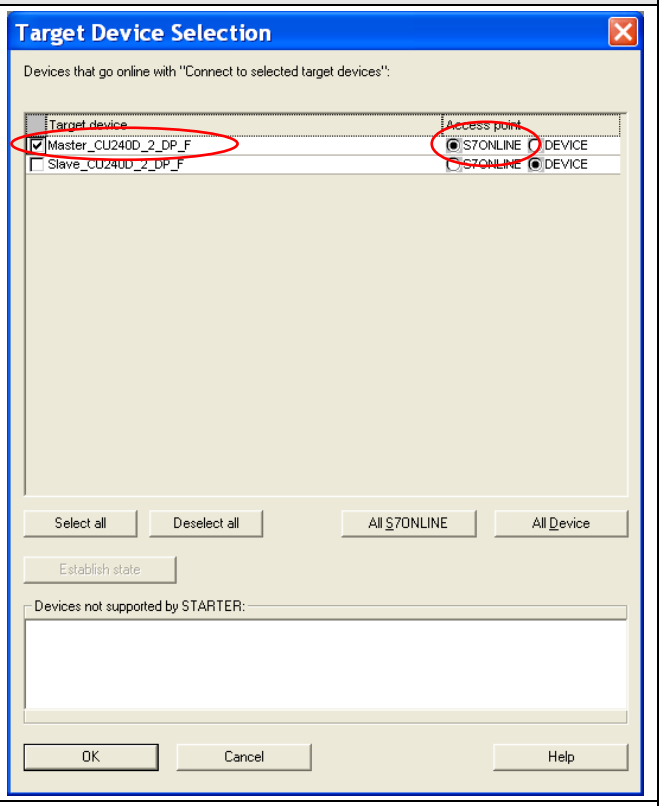
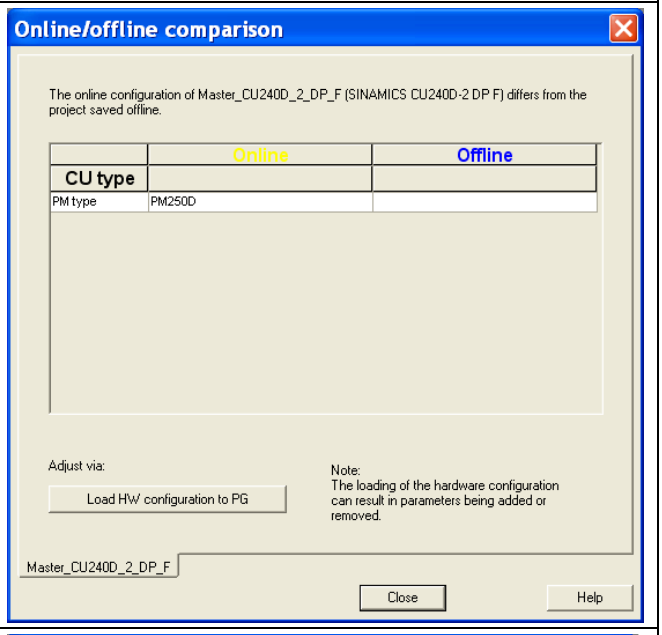
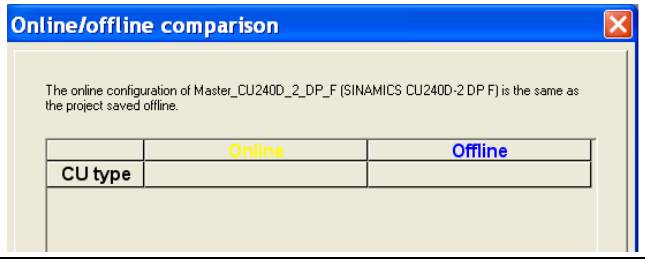
An explanation will not be given regarding the actual device configuration and basic commissioning of the drive with speed control. Reference to the basic commissioning will be given in the corresponding step in the following table.

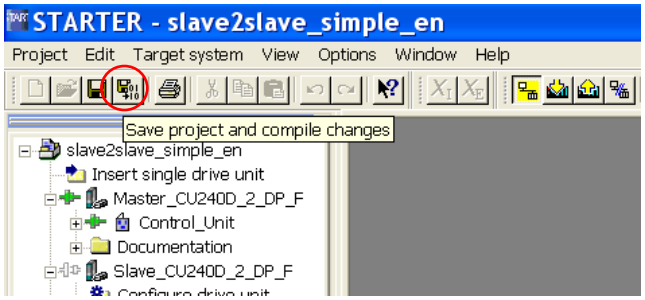
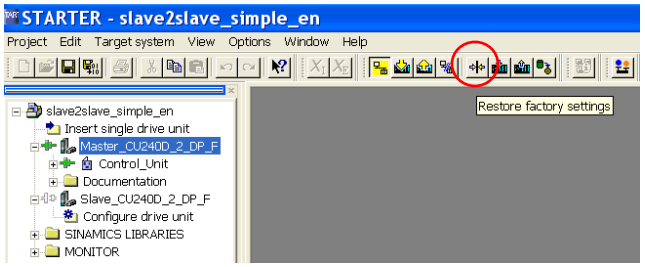
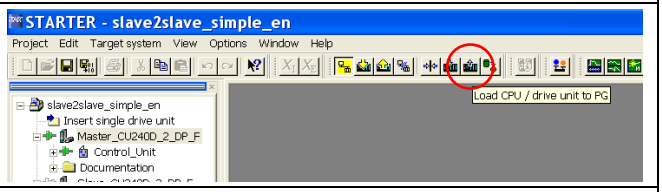
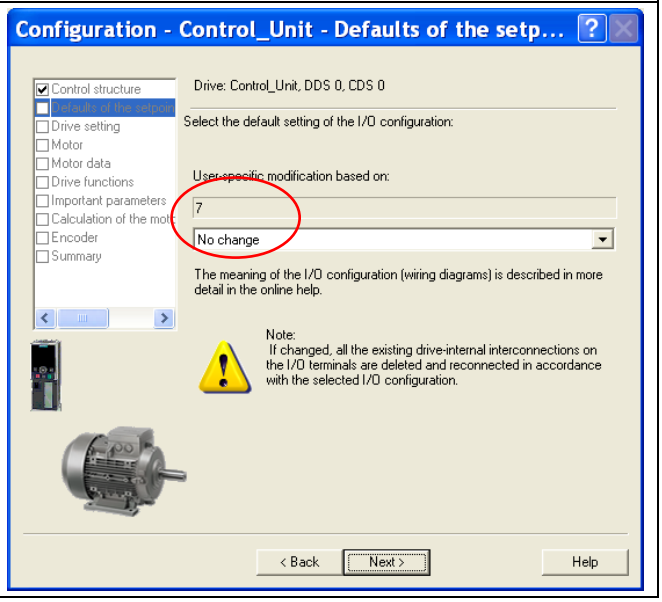
In the example, the converter is addressed and parameterized via PROFIBUS.

The starting point is step 13 in the previous section, after the drives were inserted in the SIMATIC project.

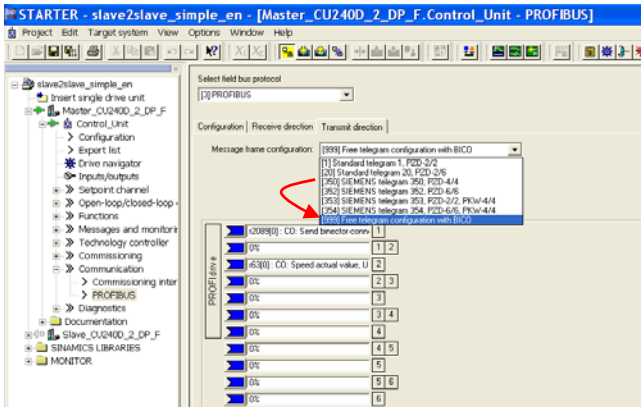
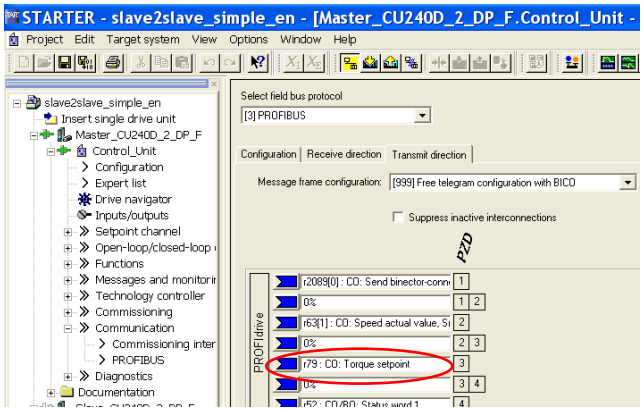
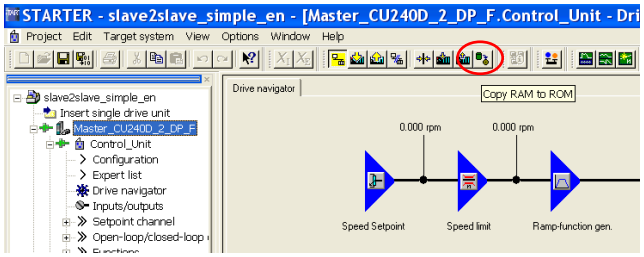
Table 5-3 Go online with STARTER and parameterize the master drive.

No.	Action	Comment
1.	Set PROFIBUS address 10 at the DIP switches of the master.	The switch to set the PROFIBUS address is located behind the inspection window at the CU240D-2 (F)
2.	Double-clicking on the master drive opens the commissioning button in the work area.	
3.	Starter with the configured drives is opened by double-clicking on the commissioning button.	
4.	In order to go online, left click on the "Connect to selected target devices" in the tool bar.	

No.	Action	Comment
5.	In the target device selection that appears, the master with the access point being used should be selected, in the example via PROFIBUS with S7ONLINE. In order to avoid confusion, only the master is selected. This setting can be subsequently modified.	
6.	After an online connection has been established with the drive, the online/offline comparison is displayed in Starter. The online configuration should be accepted in the PG/PC.	
7.	The online/offline comparison no longer shows any differences.	

No.	Action	Comment
8.	The Starter project is in the RAM memory (not retentively saved) of the PC and should now be compiled and saved.	
9.	In order to create a clear initial state, the factory setting should be restored online, and the check mark in the dialog left at RAM to ROM, in order to prevent the converter factory setting from being lost.	
10.	Fetch the factory setting back into the project.	
11.	Repeat step No. 8	-
12.	Carry out the basic commissioning for the drive speed control with the Wizard in STARTER. This will not be discussed in any more detail. (See Chapter 6 in the operating instructions for the converter with CU240D-2). Important: Leave the default setting of the I/O configuration at **7** and do not make any changes. Also refer to Chapter 2.2.3.	

5.3 Go online with STARTER and parameterize the master drive

No.	Action	Comment
13.	After the device configuration has been completed, the telegram configuration should be changed over to "(999) Free telegram configuration with BICO“. Also refer to Chapter 4.2.1.	
14.	Adapt the send data for slave-slave communication. Enter the torque setpoint into the third word r79. In the fourth word, optionally enter e.g. r52, status word1. However, in this program example, this is not evaluated in the slave.	
15.	Back up the parameter assignment RAM to ROM in the converter.	
16.	Transfer the parameter assignment into the PC, save and compile.	Analogous to the diagram in step 10, step 11 (8).

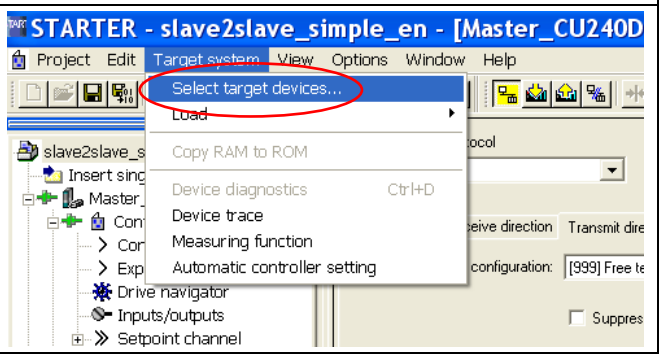
5.4 Go online with STARTER and parameterize the slave drive

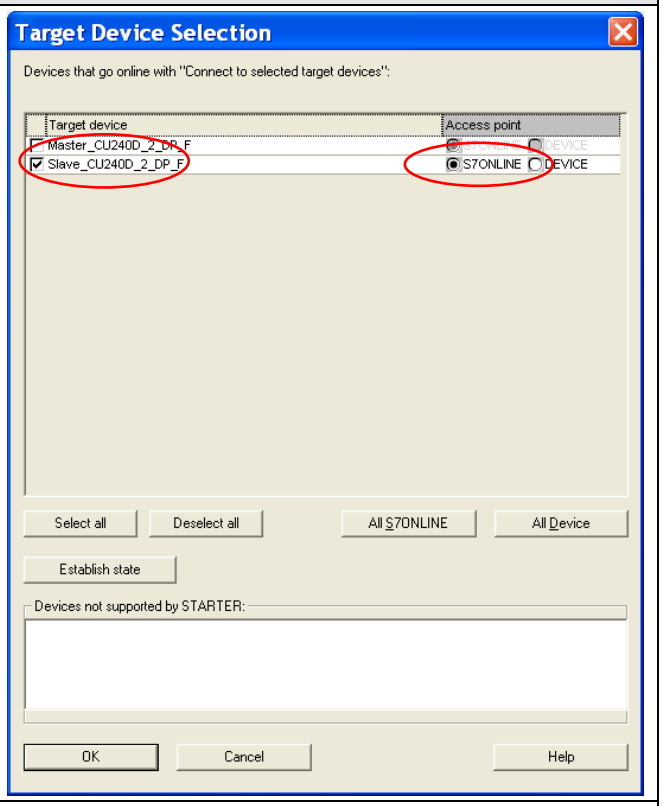
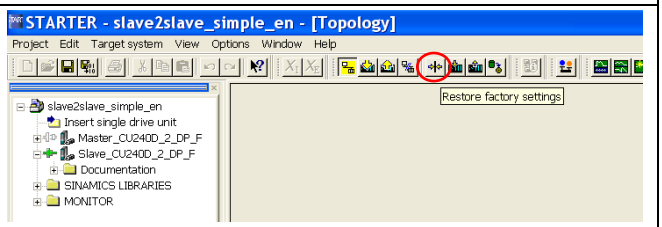
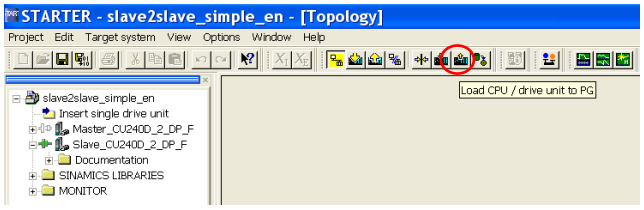
An explanation will not be given regarding the actual device configuration and the basic commissioning of the drive with speed control. Reference to the basic commissioning will be given in the corresponding step in the following table.

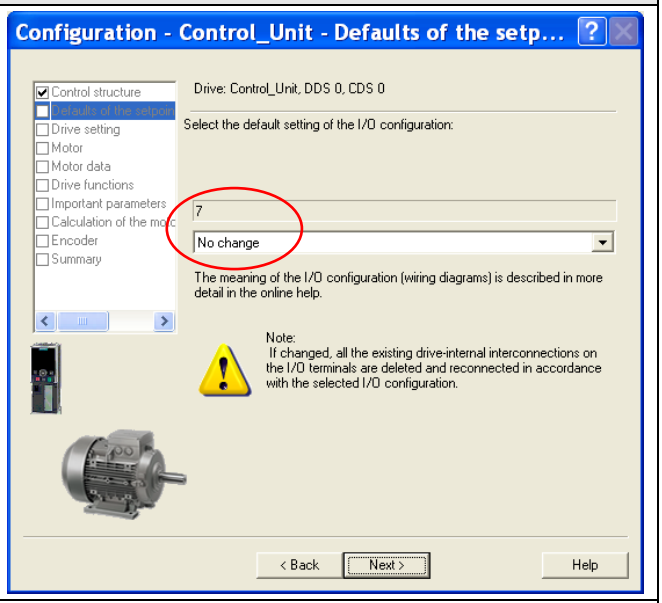
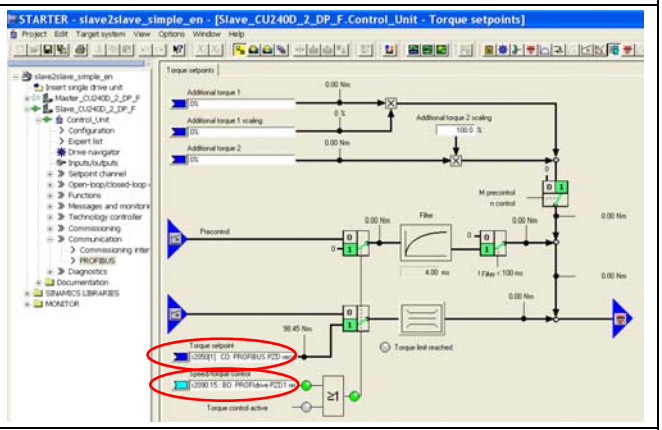
In the example, the converter is addressed and parameterized via PROFIBUS.

The starting point is step 13 in Chapter 5.2, after the drives were inserted in the SIMATIC project.

Table 5-4 Go online with STARTER and parameterize the slave drive.

No.	Action	Comment
1.	Set PROFIBUS address 20 at the DIP switches of the slave.	The switch to set the PROFIBUS address is located behind the inspection window at the CU240D-2 (F)
2.	In Starter under the menu item "Target system", with a left mouse click select "Select target devices".	

No.	Action	Comment
3.	In the target device selection that appears, the slave with the access point being used should be selected, in the example via PROFIBUS with S7ONLINE. In order to avoid confusion, only the slave is selected. This setting can be subsequently modified.	
4.	After an online connection has been established with the drive, the online/offline comparison is displayed in Starter. The online configuration should be accepted in the PG/PC.	Analogous to the diagram in step 6, in Table 5-3.
5.	The online/offline comparison no longer shows any differences.	Analogous to the diagram in step 7, in Table 5-3.
6.	The Starter project is in the RAM memory (not retentively saved) of the PC and should now be compiled and saved.	Analogous to the diagram in step 8, in Table 5-3.
7.	In order to create a clear initial state, the factory setting should be restored online, and the check mark in the dialog left at RAM to ROM, in order to prevent the converter factory setting from being lost.	
8.	Fetch the factory setting back into the project.	
9.	Save the project in the PC, repeat.	Analogous to the diagram in step 8, in Table 5-3.

No.	Action	Comment
10.	Carry out the basic commissioning for the drive speed control with the Wizard in STARTER. This will not be discussed in any more detail. (See Chapter 6 in the operating instructions for the converter with CU240D-2). Important: Leave the default setting of the I/O configuration at **7** and do not make any changes. Also refer to Chapter 2.2.3.	
11.	Parameterize the switchover of the slave drive from speed control to torque control and the source for the torque setpoint. p1501.0= r2090:15 p1503.0= r2050:2	
12.	Save the parameter assignment RAM to ROM in the converter	Analogous to the diagram in step 15, in Table 5-3.
13	Transfer the parameter assignment into the PC, save and compile.	Analogous to the diagram in step 10, step 11 (8) in Table 5-3.

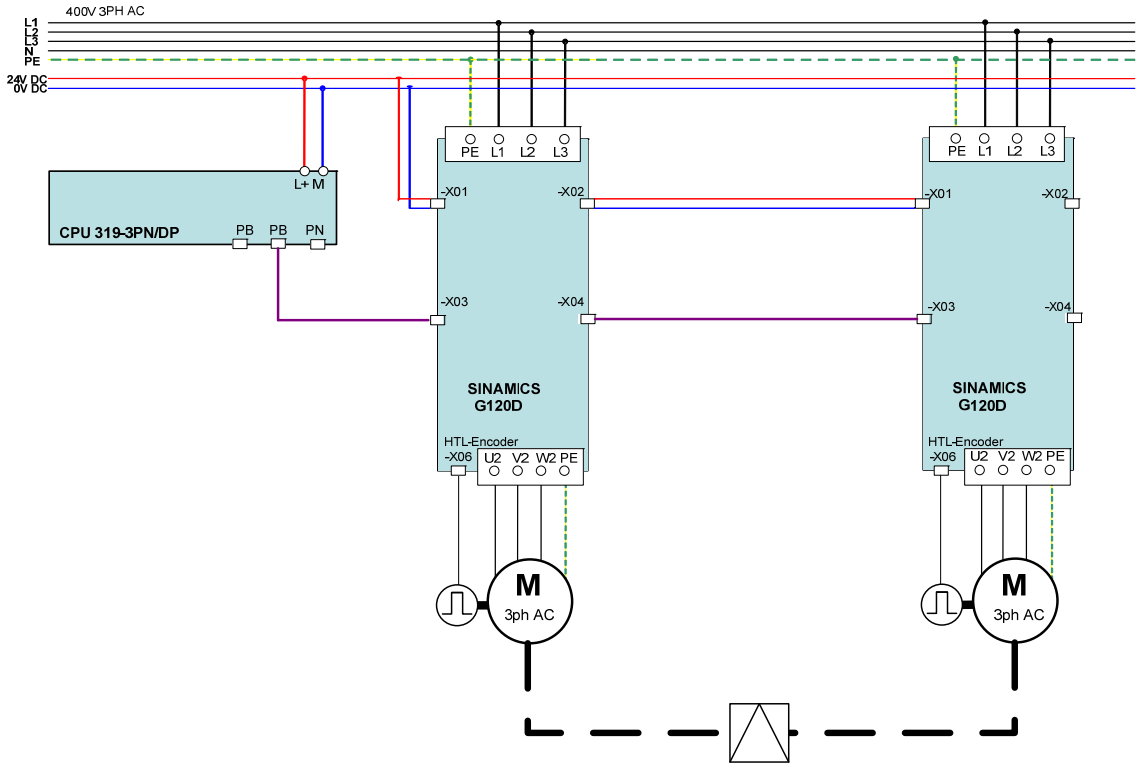
6 Installation

6.1 Installing the hardware

The hardware structure of the application example is shown in the following diagram. In the example, the switchover between master and slave operation is simulated in the SIMATIC using bit memories.

At the SINAMICS G120D with the CU240D-2, the bus terminating resistor for PROFIBUS is behind the inspection window below the USB port and the switch for the PROFIBUS address on the CU.

Fig. 6-1 Hardware structure of the application example



With the exception of a grounding screw, the SINAMICS G120D series has no terminal connections. Plug connectors are used for all of the connections.

Note The installation guidelines in the SINAMICS and SIMATIC manuals must always be carefully observed.

6.2 Installing the scripts provided

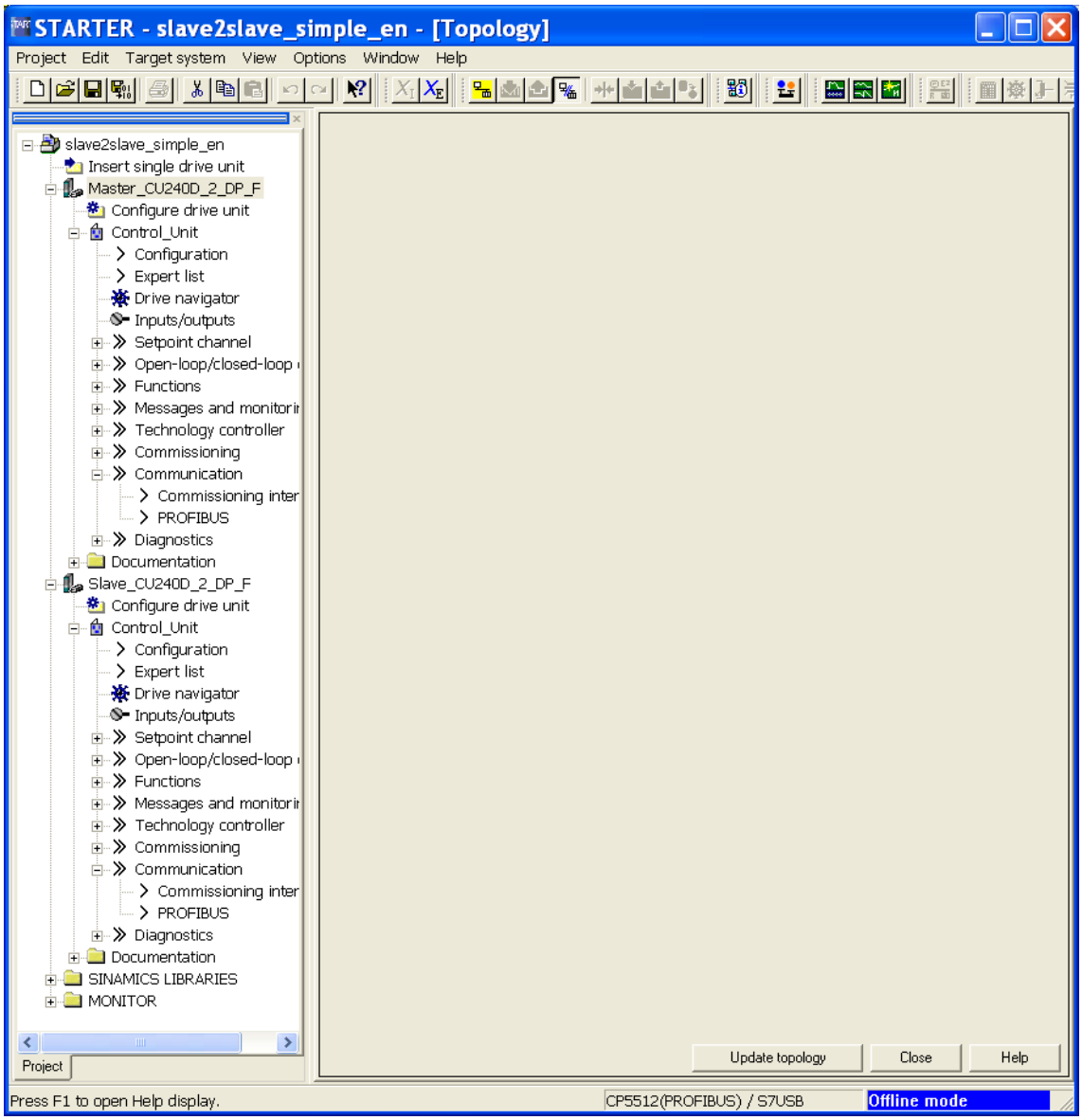
Two script files for the drives are available for the application and can be downloaded from the Internet. The script files are zipped and should be unzipped, for example, in a temporary directory.

The script for the master includes the setting for cross traffic described in Chapter 5.3.

The script for the slave includes the parameterization for the cross traffic and the switchover between closed-loop speed and torque control described in Chapter 5.4.

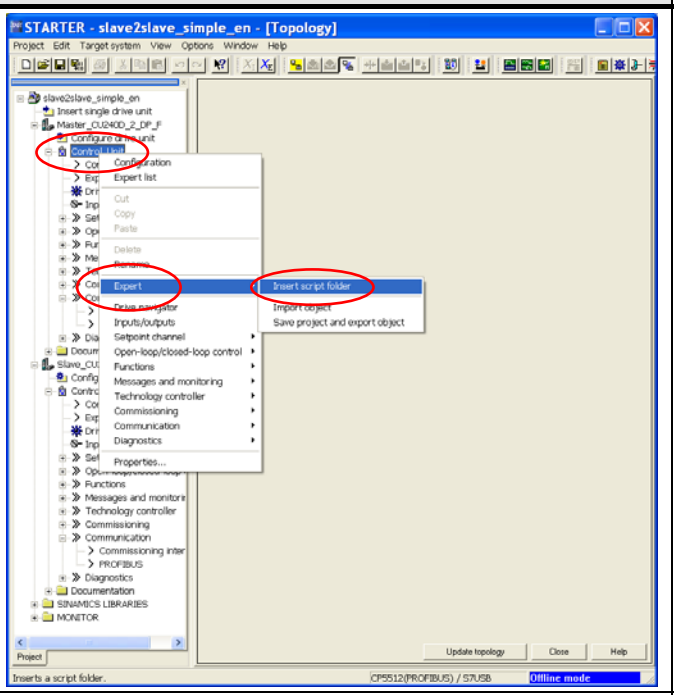
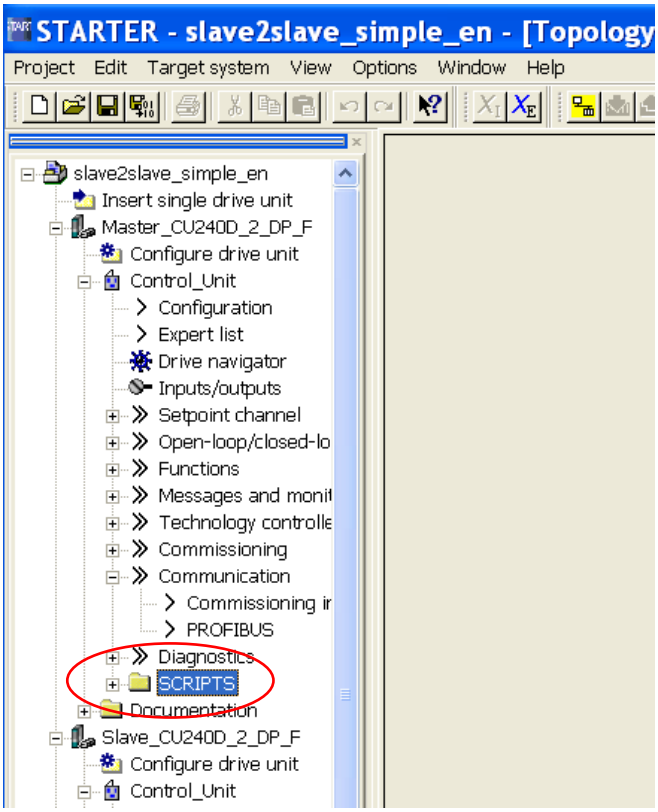
The starting point is the STARTER project opened offline.

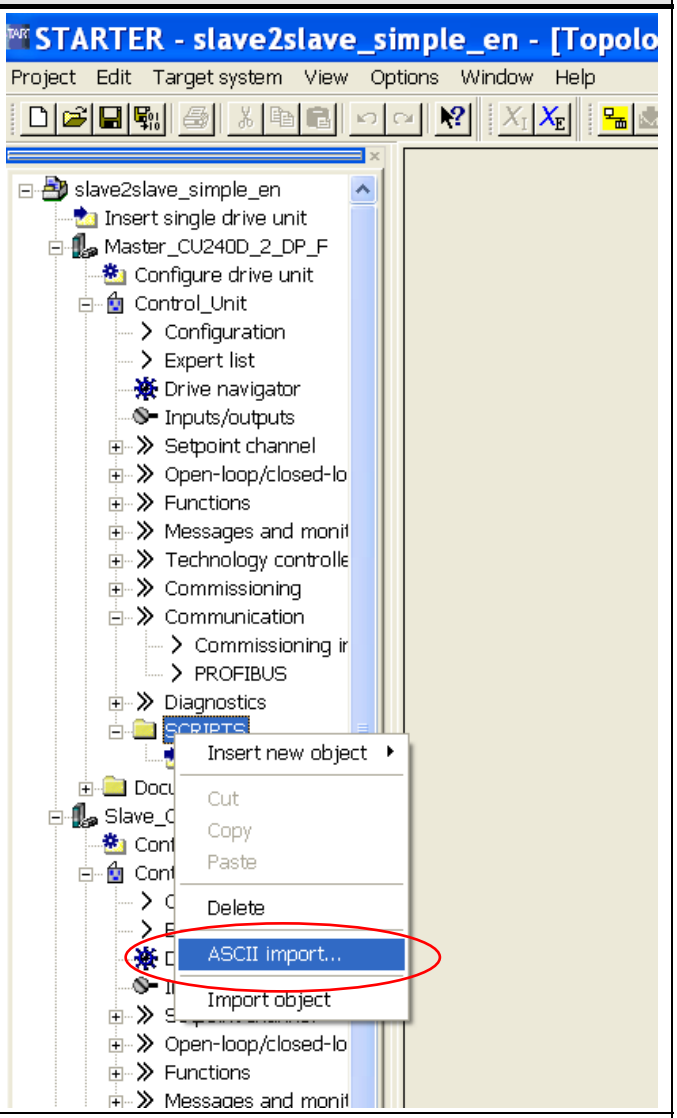
Fig. 6-2 The STARTER project opened offline

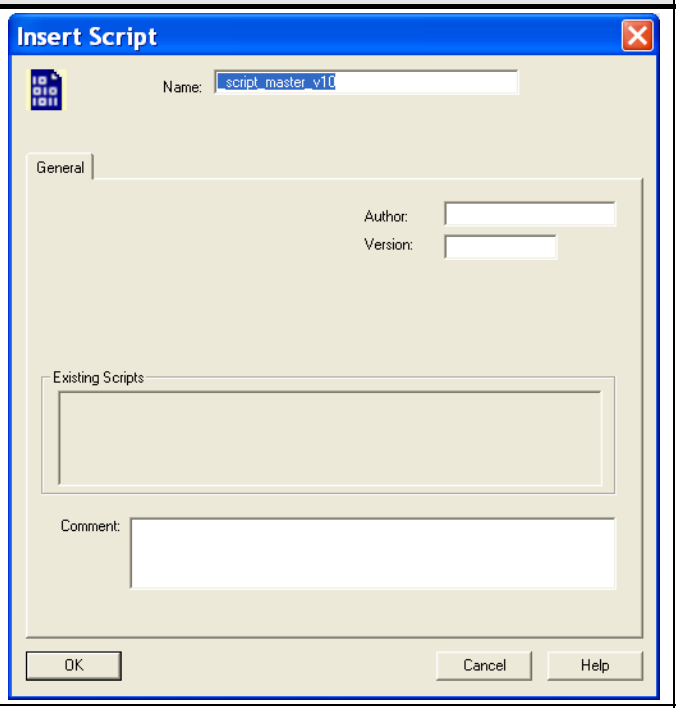
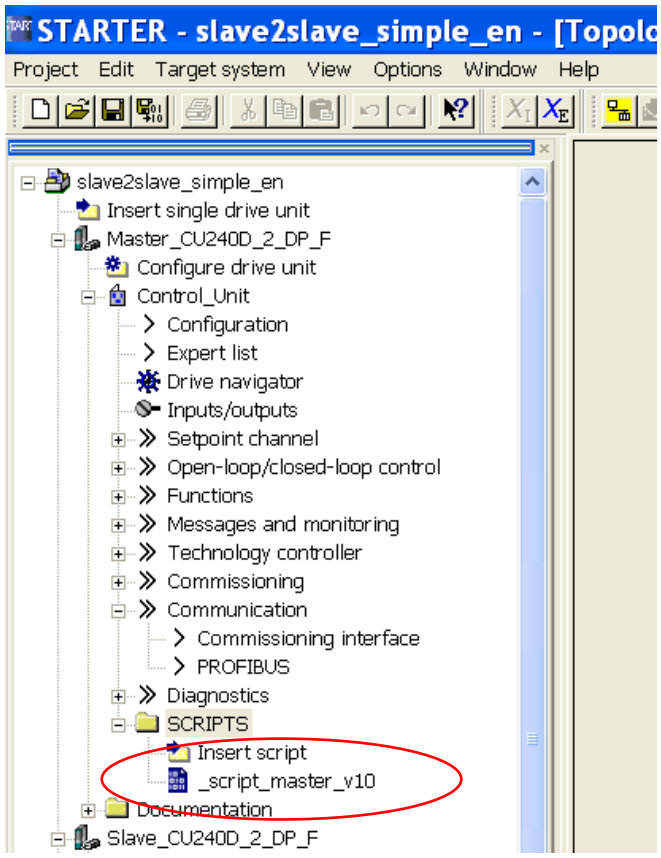


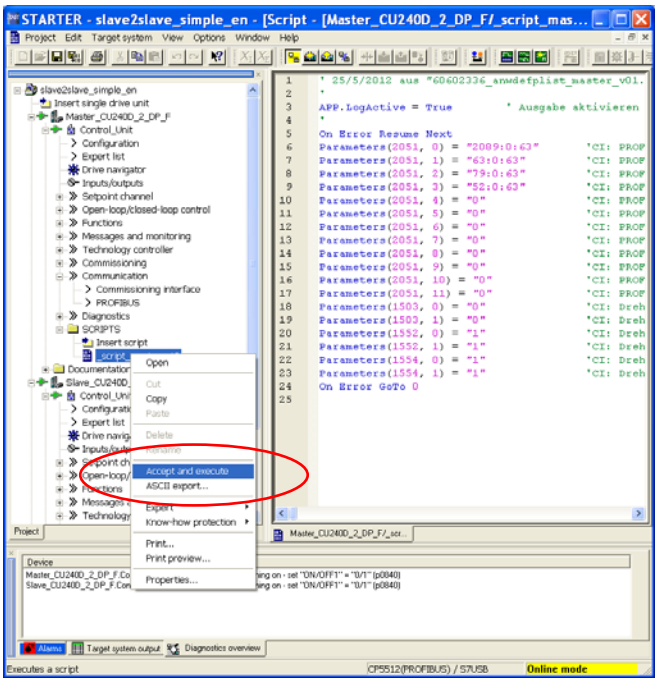
6.2 Installing the scripts provided

Table 6-1 Installing the STARTER scripts provided

No.	Action	Comment
1.	Select the Control Unit of the master drive with a right click. In the menu that now opens, under "Expert", left click on the submenu item "Insert script folder".	
2.	A new "SCRIPTS" folder is created.	

No.	Action	Comment
3.	With a right mouse click, select the "SCRIPTS" folder of the master drive. In the menu that now opens, select "ASCII import".	
4.	Navigate to where the unzipped script is located "**_60602336_script_master_v01.txt**" and select.	STARTER accepts the file.

No.	Action	Comment
5.	In the "Insert script" window, confirm the script name with "OK"	
6.	The ASCII file is now inserted as script.	
7.	The same procedure should be applied when creating the script for the slave drive.	The "**_60602336_script_slave_v01.txt**" file should be selected

No.	Action	Comment
8.	Then go online, carefully ensure that the drive cannot rotate, i.e. check that no enable signals are available	-
9.	Using the right-hand mouse key, select the appropriate script and select in the menu "Accept and execute" that has just opened.	
10.	If required, transfer the change to the drive and save in a non-volatile fashion with Ram to Rom.	-
11.	If required, transfer the change into the PC and save in the project.	-

6.3 Installing the SIMATIC project provided

Table 6-1 installing the SIMATIC project provided

No.	Action	Comment
1.	Open SIMATIC Manager	-
2.	Dearchive the project example.	If you created your own project as explained in Chapter 5, then the project example should be dearchived, and the blocks from the block folder copied into the block folder of your own project.
3.	If required, adapt the SIMATIC project to the existing hardware (CPU, possibly I/O addresses and drives).	If you created your own project as explained in Chapter 5, then it would be necessary to adapt the I/O addresses in FB1 for calling SFC14/15.
4.	Save and compile.	-
5.	Transfer the configuration to the target device.	-
6.	Carry out RAM to ROM on the SIMATIC CPU.	-

7 Commissioning the application

7.1 Preparation

Table 7-1 Preparation

No.	Action	Comment
1.	To start, ensure that all of the relevant safety measures have been maintained, so that nobody can be injured for example by live, moving or rotating parts.	-
2.	Decouple the drive from the load for the basic commissioning and no-load measurement.	-
3.	Ensure that the Emergency Off is functioning correctly.	-

7.2 Commissioning

Only qualified personnel should commission the application.

For the purpose of the documentation and warning information on the product itself, qualified personnel are familiar with the installation, mounting, start-up, operation and maintenance of the product, and have the appropriate qualifications for the activities they perform, for example:

- Trained and authorized to energize and de-energize, ground and tag circuits and equipment according to applicable safety standards.
- Trained or instructed according to the latest safety standards in the care and use of the appropriate safety equipment.
- Trained in rendering first aid.

The starting point for commissioning the master/slave drive is, ...

... that the basic commissioning of the converter speed control has been completed.

... that the directions of rotation match the control sense.

... that both drives are again coupled to the load connection point (e.g. annular gear or similar).

... that no load is being moved.

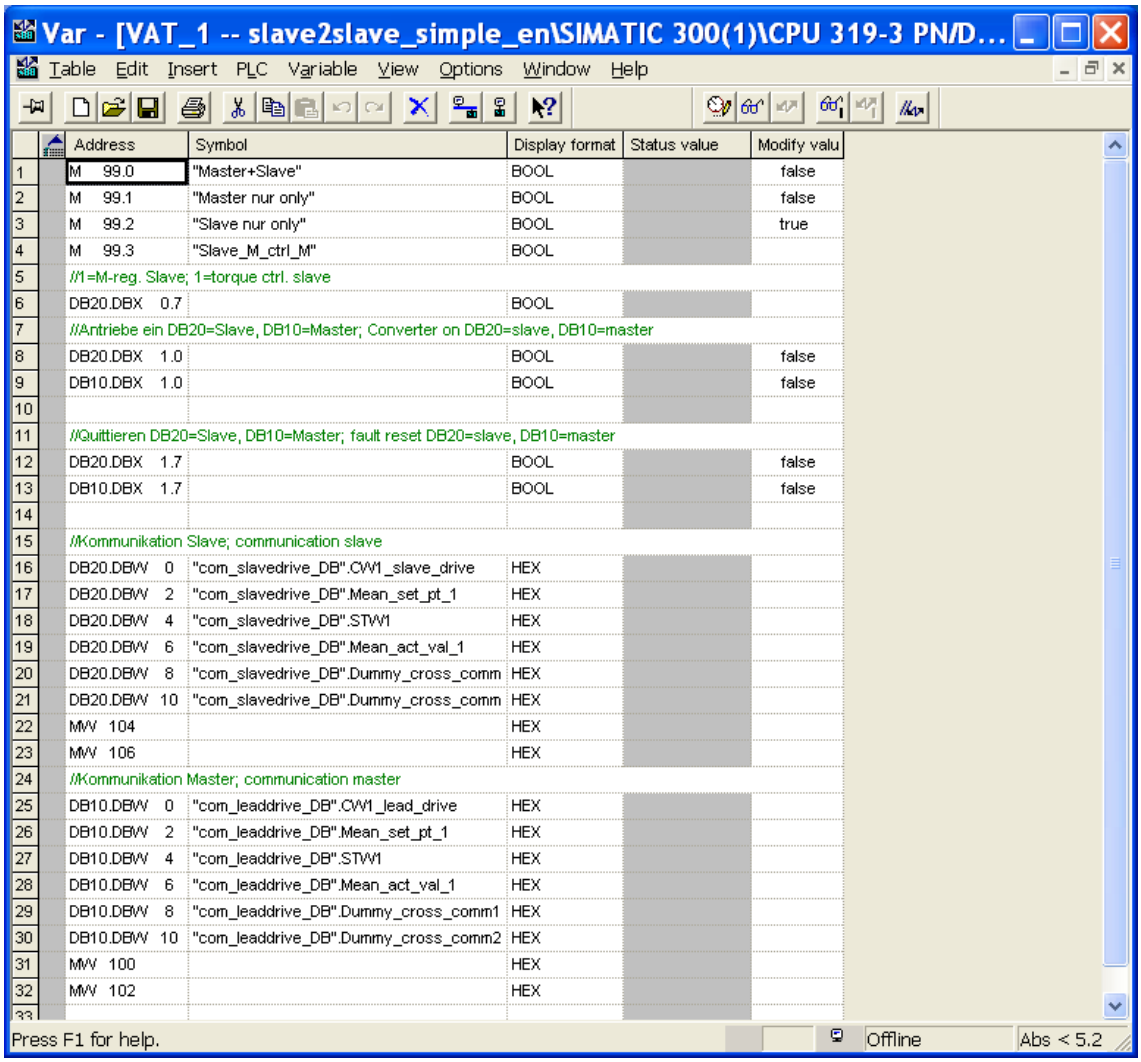
... safety mechanisms on the system side, for instance Emergency Off, limit switches, centrifugal switches etc. have been tested and are functioning correctly.

Table 7-2

No.	Action	Comment
1.	Check that the control words and setpoints are received at the correct locations.	-
2.	Test the master and the slave by operating them individually at a low velocity.	-
3.	Switch over to master/slave operation and operate at low speeds.	-
4.	Monitor the output currents to check the load distribution.	-
5.	Under certain circumstances, approach various operating points of the machine without applying a load.	-

8 Operation of the application

Fig. 8-1 Overview of the variable table



	Address	Symbol	Display format	Status value	Modify valu
1	M 99.0	"Master+Slave"	BOOL		false
2	M 99.1	"Master nur only"	BOOL		false
3	M 99.2	"Slave nur only"	BOOL		true
4	M 99.3	"Slave_M_ctrl_M"	BOOL		
5	//1=M-reg. Slave; 1=torque ctrl. slave				
6	DB20.DBX 0.7		BOOL		
7	//Antriebe ein DB20=Slave, DB10=Master; Converter on DB20=slave, DB10=master				
8	DB20.DBX 1.0		BOOL		false
9	DB10.DBX 1.0		BOOL		false
10					
11	//Quittieren DB20=Slave, DB10=Master; fault reset DB20=slave, DB10=master				
12	DB20.DBX 1.7		BOOL		false
13	DB10.DBX 1.7		BOOL		false
14					
15	//Kommunikation Slave; communication slave				
16	DB20.DBW 0	"com_slavedrive_DB".CW1_slave_drive	HEX		
17	DB20.DBW 2	"com_slavedrive_DB".Mean_set_pt_1	HEX		
18	DB20.DBW 4	"com_slavedrive_DB".STW1	HEX		
19	DB20.DBW 6	"com_slavedrive_DB".Mean_act_val_1	HEX		
20	DB20.DBW 8	"com_slavedrive_DB".Dummy_cross_comm	HEX		
21	DB20.DBW 10	"com_slavedrive_DB".Dummy_cross_comm	HEX		
22	MW 104		HEX		
23	MW 106		HEX		
24	//Kommunikation Master; communication master				
25	DB10.DBW 0	"com_leaddrive_DB".CW1_lead_drive	HEX		
26	DB10.DBW 2	"com_leaddrive_DB".Mean_set_pt_1	HEX		
27	DB10.DBW 4	"com_leaddrive_DB".STW1	HEX		
28	DB10.DBW 6	"com_leaddrive_DB".Mean_act_val_1	HEX		
29	DB10.DBW 8	"com_leaddrive_DB".Dummy_cross_comm1	HEX		
30	DB10.DBW 10	"com_leaddrive_DB".Dummy_cross_comm2	HEX		
31	MW 100		HEX		
32	MW 102		HEX		

Variable table VAT_1 contains the PZD, which is transferred to and from the drives, as well as the values for the slave-slave communication. The inputs/bit memory of the selector switch can be activated.

If the selector switch is simulated, it must be ensured that the selector switch has three positions, each with one contact. Only one bit memory M99.0, M99.1 or M99.2 may be active (activated mdyfied value).

In the example, the drives are switched-on and switched-off using the boolean operands DB20.DBX0.0 and DB10.DBX0.0 via the variable table with "control".

Drive faults can be reset using "control" via DB20.DBX1.7 and DB10.DBX1.7.

8.1 Scenario, only the master drive

The inputs of the selector switch are specified in the FB1 as bit memory.

- M99.0= master/slave drive mode
- M99.1 master drive alone
- M99.2 slave drive alone M99.3 (DB20.DBX1.7)= switchover, speed/torque control for the slave

Further, the bit memories are used to preselect the velocity (NW1 and NW2):

- M99.0 and M99.1 not and M99.2 not ➔ 100%
- M99.0 not and M99.1 or M99.2 ➔ 10%

The master drive is always operated in speed control.

Table 8-1

No.	Action	Comment
1	In the variable table, set M99.1 to "1" and "activate modyfied value" M99.0 and M99.2 have the "0" state.	The master drive receives a low speed setpoint from FB1.
2	In the variable table, set bit DB10.DBX0.0 to "1" and "activate modyfied value".	The master drive is switched on and starts to rotate with a slow speed.
3	Reset DB10.DBX0.0 using "0" and "activate modyfied value" in the variable table.	The drive decelerates along a ramp and switches off.

8.2 Scenario, only the slave drive

The inputs of the selector switch are specified in the FB1 as bit memory.

- M99.0= master/slave drive mode
- M99.1= master drive alone
- M99.2= slave drive alone
- M99.3 (DB20.DBX1.7)= switchover, speed/torque control for slave

Further, the bit memories are used to preselect the velocity (NW1 and NW2):

- M99.0 and M99.1 not and M99.2 not ➔ 100%
- M99.0 not and M99.1 or M99.2 ➔ 10%

If the slave drive is operated without a master, then the speed control is always active.

Table 8-2

No.	Action	Comment
1	In the variable table, set M99.2 to "1" and "activate modyfied value". M99.0 and M99.1 have the "0" state.	The slave drive receives a low speed setpoint from FB1.
2	In the variable table, set bit DB20.DBX0.0 to "1" and "activate modyfied value ".	The slave drive is switched on and starts to rotate with a slow speed.
3	Reset DB20.DBX0.0 using "0" and "activate modyfied value" in the variable table.	The drive decelerates along a ramp and switches off.

8.3 Scenario, the master and slave drive together

The inputs of the selector switch are specified in the FB1 as bit memory.

- M99.0= master/slave drive mode
- M99.1 master drive alone
- M99.2 slave drive alone

Further, the bit memories are used to preselect the velocity (NW1 and NW2):

- M99.0 and M99.1 not and M99.2 not ➔ 100%
- M99.0 not and M99.1 or M99.2 ➔ 10%

In NW3 the decision is made as to whether the slave drive should be operated in speed or torque control (M99.3 -> control word 1 bit 15, DB20.DBX1.7).

An M99.7 "Dummy fault Masterside" was inserted, which is intended to act as place holder for faults from the control or the master drive. If a master fault occurs, the slave drive is switched over to speed control; torque control cannot be selected.

As the drive is pre-assigned with the I/O configuration 7 (p15=7), the command data set is switched over using the digital inputs of the converter and bit 15 of control word 1 is free for switching over between speed control and torque control.

If the rotary switch is set to master/slave operation, then the master drive operates with speed control and the slave drive with torque control.

Table 8-3

No.	Action	Comment
1	In the variable table, set M99.0 to "1" and "activate modyfied value" M99.1 and M99.2 have the "0" state.	The slave drive and the master drive receive the high speed setpoint from FB1.
2	In the variable table, set bit DB20.DBX0.0 and bit DB10.DBX0.0 to "1" and "activate modyfied value".	The slave drive and master drive are switched on and accelerate up to the rated speed.
3	Reset DB20.DBX0.0 and DB10.DBX0.0 to "0" and activate modyfied value" in the variable table.	The drives decelerate along the down ramp and switch off.

9 Further notes

For the master/slave drive, the converter control can be made even more direct as follows. After the operating mode preselection for master/slave operation, the drives are switched on using bit 0 in the control word and the converter is enabled using bit 3.

The motors are magnetized and kept at zero speed.

The command for the drives to rotate can be issued with the setpoint enable. Delays as a result of different magnetization times or similar effects are eliminated.

This application can also be used on a SINAMICS G120, CU240E-2 DP / CU240B-2 DP with the PM240 / PM250 as well as a G120C.

The preferred solution is if the drives are equipped with a speed encoder. For encoderless operation, restrictions must be expected regarding dynamic performance, accuracy and at low rotating frequencies. Especially for vertical applications, additional safety measures may be required, such as interlocks, centrifugal switch, etc.

The SINAMICS G120P with its PM230 has been developed for pump, fan and compressor applications, and is not taken into consideration in this application description.

10 Internet links - data

This list is in no way complete and only reflects a selection of suitable information.

Table 10-1

	Subject area	Title
\1\	Reference to the article	http://support.automation.siemens.com/WW/view/en/60602336
\2\	Siemens Industry Online Support	http://support.automation.siemens.com
\3\	Siemens Industry Online Support G120D	http://support.automation.siemens.com/WW/view/en/25021636/130000

11 Contact person

Siemens AG

Industry Sector
I DT MC PMA APC
Frauenauracher Strasse 80
D - 91056 Erlangen
mailto: tech.team.motioncontrol@siemens.com

12 History

Table 12-1

Version	Date	Change
V1.0	07/2012	First Edition