SINAMICS G: Speed Control for SINAMICS G120, G120C or G120D using S7-300/400F (in STEP 7 V5) via PROFINET with Safety Integrated (via PROFIsafe)

SINAMICS G120 / G120C / G120D (with FW ≥ 4.3.2)
SIMATIC S7-300/400F

Application Description • November 2012

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SIMATIC, SINAMICS

SINAMICS G120/G120C or G120D with an S7-300/400F CPU with failsafe control of the SINAMICS G120 safety functions

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1 Task

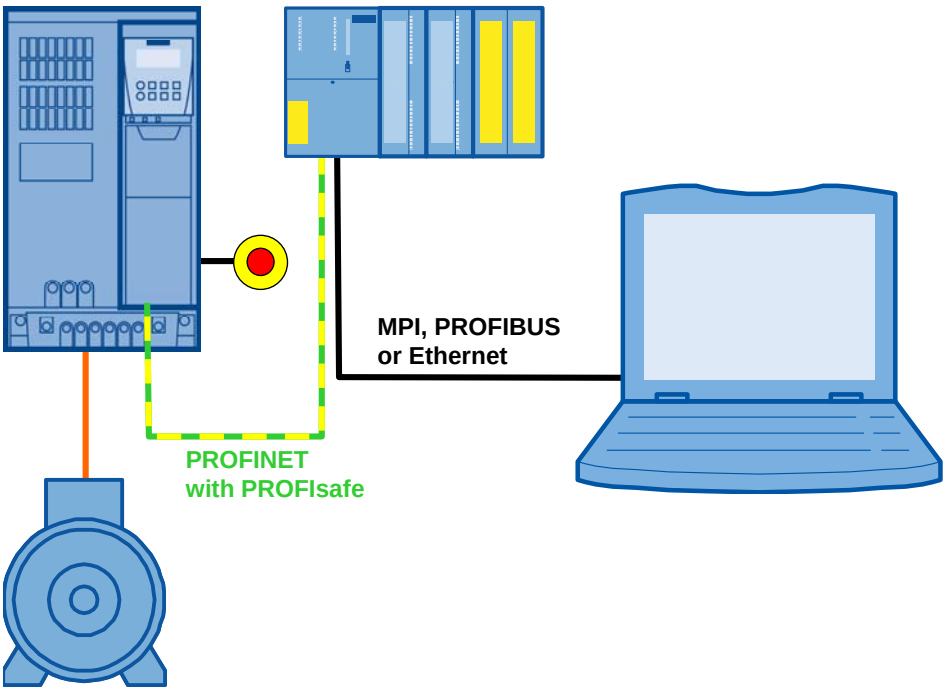
A failsafe SIMATIC S7-300/400F can be operated as a PROFINET controller. A SINAMICS drive can be used as PROFINET device and controlled by the S7-300/400F.

This application example illustrates how to configure the SINAMICS G120 and the S7-300/400F, start it up and access process data and parameters. At the same time, safety-related data can be exchanged between the S7-300/400F and the drive.

Overview of the automation task

The following figure gives an overview of the automation task:

Figure 1-1



Requirements for the automation task

Table 1-1

Requirement	Explanation
Access to process data	The drive shall be switched on and off via the control word and the speed value is to be specified as quickly as possible.
Access to parameters	Read and write access of the S7-300/400F from/to the parameters in the converter (in this example: ramp-up and ramp-down time) should be possible and be performed using as few resources as possible, i.e. small communication load.
Safety function of the SINAMICS G120	The SINAMICS G120 converters have the option of performing a fail-safe shutdown (e.g. emergency-stop, safe speed, etc.). These functions are safely triggered by the S7-300/400F.

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2 Solution

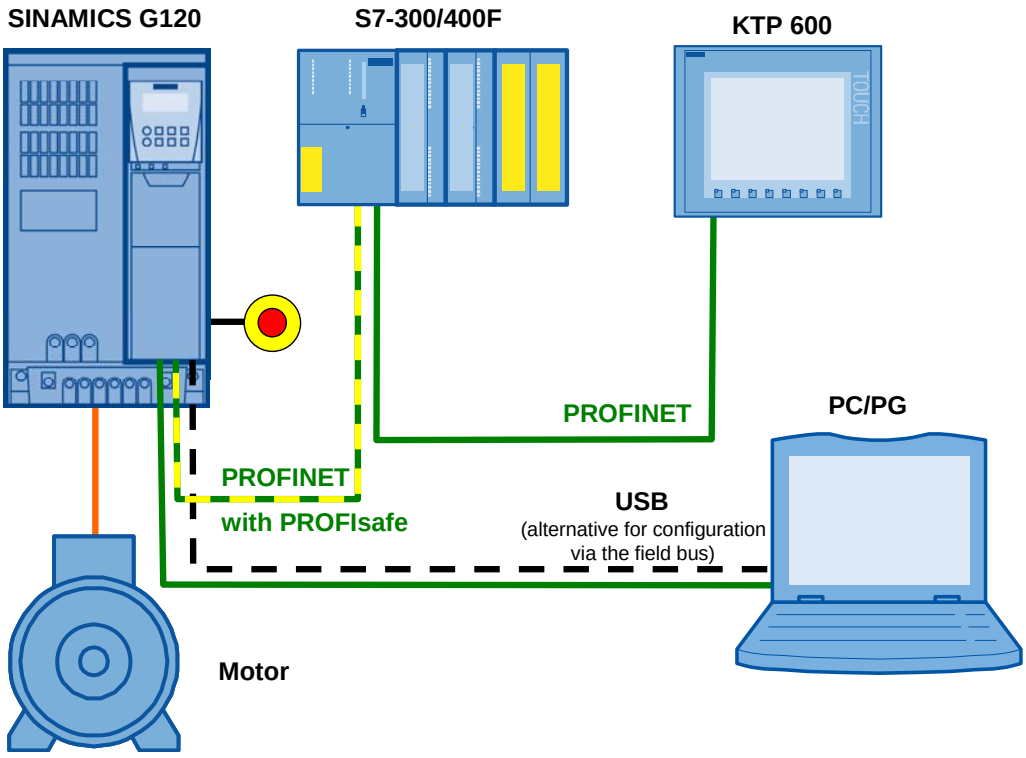
This application example gives an example of how to connect a SINAMICS G120, G120C or G120D to an S7-300F. It uses blocks which can be directly applied to your own application.

2.1 Overview of the general solution

Schematic layout

The following figure gives a schematic overview of the most important components of the solution:

Figure 2-1



The example shows you how ...

- ...the S7-300/400F controller is configured.
- ...the communication is programmed in the S7-300/400F controller.
- ...the SINAMICS G120 converter is configured using STARTER.
- ... the basic and extended safety functions of SINAMICS G120 are addressed by the S7-300/400F.
  (Extended Safety Functions not with SINAMICS G120C, SINAMICS G120 with CU240E-2 PN or SINAMICS G120D with CU240D-2 PN)
- ... the three safety-related inputs of the SINAMICS G120 are used as F-DI in the S7-300/400F.

NOTICE	**This example is only valid for frequency converter SINAMICS G120, G120C and G120D as of FW4.3.2.**

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2.2 Description of the core functionality

2.2.1 Configuring the communication

TIA (Totally Integrated Automation)

The program for SIMATIC S7-300/400F and the configuration of the SINAMICS G120 are centrally stored in a STEP 7 project. The respectively required editors are called up via the STEP 7 Manager.

SIMATIC S7-300/400F

In this example, the SIMATIC S7-300F/400F is programmed with STEP 7 V5.

In HW Config, the SIMATIC S7-300/400F the stations connected via PROFINET, such as SINAMICS G120, are configured, and the communication is defined. One of several message frame types can be selected here for the data exchange. It is important that the same message frame type is selected here as for the SINAMICS G120 configuration.

Exchanging safety-relevant data an additional PROFIsafe message frame is selected.

When inserting SINAMICS G120 into the SIMATIC project, the I/O addresses used by the S7-300F/400F for accessing the SINAMICS G120 are also specified.

SINAMICS G120

The configuration of SINAMICS G120 is performed using the STARTER commissioning tool.

For SINAMICS G120 one of several message frame types can be selected for the data exchange. This defines which data is transmitted or received in which order. It is important that the same message frame type is selected when configuring the SIMATIC S7-300/400F.

The PROFIsafe message frame for exchanging failsafe data is automatically selected upon activating the respective safety function.

2.2.2 Data exchange

Data exchange between drive and S7-300/400F occurs in two areas:

- Process data,
  i.e. control word(s) and setpoint(s), or status word(s) and real value(s)
- Parameter area,
  i.e. reading/writing of parameter values

Note The two areas, process data and parameters, are independent from each other and can also be used individually.

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Cyclic process data exchange

Process data is transferred cyclically, which means in each bus cycle, in order for it to be transferred as quickly as possible.

The S7-300/400F transmits the control word and the setpoint value to SINAMICS G120 and receives the status word and the real value.

Depending on the message frame type, two further setpoint or real values, or extended control or status words can be transferred respectively.

- In the S7-300/400F, the process data is supplied as I/O input or output words.
- In the drive, the configuration specifies which bits of the control word are used and which data is transmitted to the S7-300/400F.

The safety-related communication is also transferred cyclically.

- In the S7-300/400F, the required functions are activated by selecting an additional PROFIsafe message frame.
- The configuration of the safety functions to be used specifies in the drive whether and which PROFIsafe message frame is expected by the S7-300/400F.

Acyclic data exchange (parameter access)

To be able to transfer parameters, message frame types were defined, where four words are provided for a parameter (PIV) transfer. Since these four words, like the process data (PZD), are always transmitted, a permanent communication load is produced even though the parameters themselves are generally only rarely transferred.

Apart from the cyclic data exchange there is also the option to use an acyclical data exchange which is only used if necessary. This makes it possible to transfer the parameter area acyclically on demand, without creating a permanent communication load. The acyclic transfer takes clearly longer than the cyclic transfer of the process data.

In the example, acyclic data exchange is used to access the parameters.

- In the S7-300/400F, parameter jobs are sent to the drive by writing data record 47, and the response of the drive is read in by reading data record 47.
- No particular action is required on the drive side.

Note When using a CP341-1, the parameters of the drive cannot be accessed and no fail-safe communication can be transferred.

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2.3 Hardware and software components used

The application document was generated using the following components:

Hardware components

Table 2-1

Component	Qty.	Order number	Note
CPU 315F-2 DN/DP	1	6ES7315-2FJ14-0AB0	or other S7-300/400F CPU with PFOFINET, which supports data record routing, see /10/
MMC 128kB	1	6ES7 953-8LG20-0AA0	or larger MMC
SM 323	1	6ES7323-1BH01-0AA0	or another module with DIs
SM 326	1	6ES7326-1BK02-0AB0	or another module with F-DIs
SIMATIC Panel KTP600 Basic color PN	1	6AV6647-0AD11-3AX0	This panel is optional.
SINAMICS G120 PC converter connection kit 2m	1	6SL3255-0AA00-2CA0	Includes STARTER on DVD and USB cable. As an alternative, the SW can be downloaded and a standard micro USB cable may be used.
SINAMICS IOP or SINAMICS BOP-2	1	6SL3255-0AA00-4JA0 6SL3255-0AA00-4CA1	optional
PROFINET connector plug	6	6GK1901-1BB10-2AA0	The number is already taken into account for the connection with the PG/PC
PROFINET line		6XV1840-2AH10	
Motor	1	1LA7083-4AA60	

Hardware components when using a G120

Table 2-2 Hardware components

Component	Qty.	Order number	Note
SINAMICS G120	1 1	6SL3244-0BB13-1FA0 (CU 240E-2 PN-F) and 6SL3224-0BE22-2UA0 (PM240)	or other SINAMICS G120 with CU240E-2 PN -F or CU240E-2 PN (only Basic Safety)
PROFINET connector plug	2	6GK1901-1BB10-2AA0	Two additional ones, to connect the SINAMICS G120 with S7-300/400F and HMI

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Hardware components when using a G120C

Table 2-3 Hardware components

Component	Qty.	Order number	Note
SINAMICS G120C	1	6SL3210-1KE14-3UF1	or another SINAMICS G120C with PROFINET only Basic Safety possible
PROFINET connector plug	2	6GK1901-1BB10-2AA0	Two additional ones, to connect the SINAMICS G120 with S7-300/400F and HMI

Hardware components when using a G120D

Table 2-4 Hardware components

Component	Qty.	Order number	Note
SINAMICS G120D	1 1	6SL3544-0FB21-1FA0 (CU 240D-2 PN-F) and 6SL3525-0PE21-5AA1 (PM250D)	or CU 240D-2 PN (only Basic Safety) or any other PM250D power unit
PROFINET connector plug M12	2	6GK1901-0DB20-6AA0 or 3RK1902-2DA00	straight or angled
Connector and cable for network and motor connections	Please refer to these in the operating instructions (/7/) chapter 4.2.3 Connections and cables.		

Standard software components

Table 2-5

Component	Qty.	Order number	Note
SIMATIC STEP 7 V5.5 SP2	1	Floating License 6ES7810-4CC10-0YA5	
Distributed Safety V5.4 SP5	1	6ES7833-1FC02-0YA5	
STARTER V4.3.1.2	1	6SL3072-0AA00-0AG0	Free download: see /6/

Optional software components for the visualization

Table 2-6

Component	Qty	Order number	Note
SIMATIC WinCC flexible 2008 Advanced incl. SP3	1	6AV6613-0AA51-3CA5	

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Sample files and projects

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

Table 2-7

Component	Note
60441457_SINAMICS_G120_at_S7-300400F-PN_CODE_v20.zip	This zip file contains the STEP 7 project. The password for the safety settings is “siemens”.
60441457_SINAMICS_G120C_at_S7-300400F-PN_CODE_v20.zip	This zip file contains the STEP 7 project. The password for the safety settings is “siemens”.
60441457_SINAMICS_G120D_at_S7-300400F-PN_CODE_v20.zip	This zip file contains the STEP 7 project. The password for the safety settings is “siemens”.
60441457_SINAMICS_G120_at_S7-300400F-PN_SHORT-DOKU_v20_en.pdf	Short documentation for experienced users
60441457_SINAMICS_G120_at_S7-300400F-PN_DOKU_v20_en.pdf	This document

CAUTION **The STARTER example project has been designed for usage with the example components listed in Table 2-1. Converter and/or motor can be damaged or destroyed if a SINAMICS G120 with a different output or a different motor is connected, without adjusting the respective parameters.**

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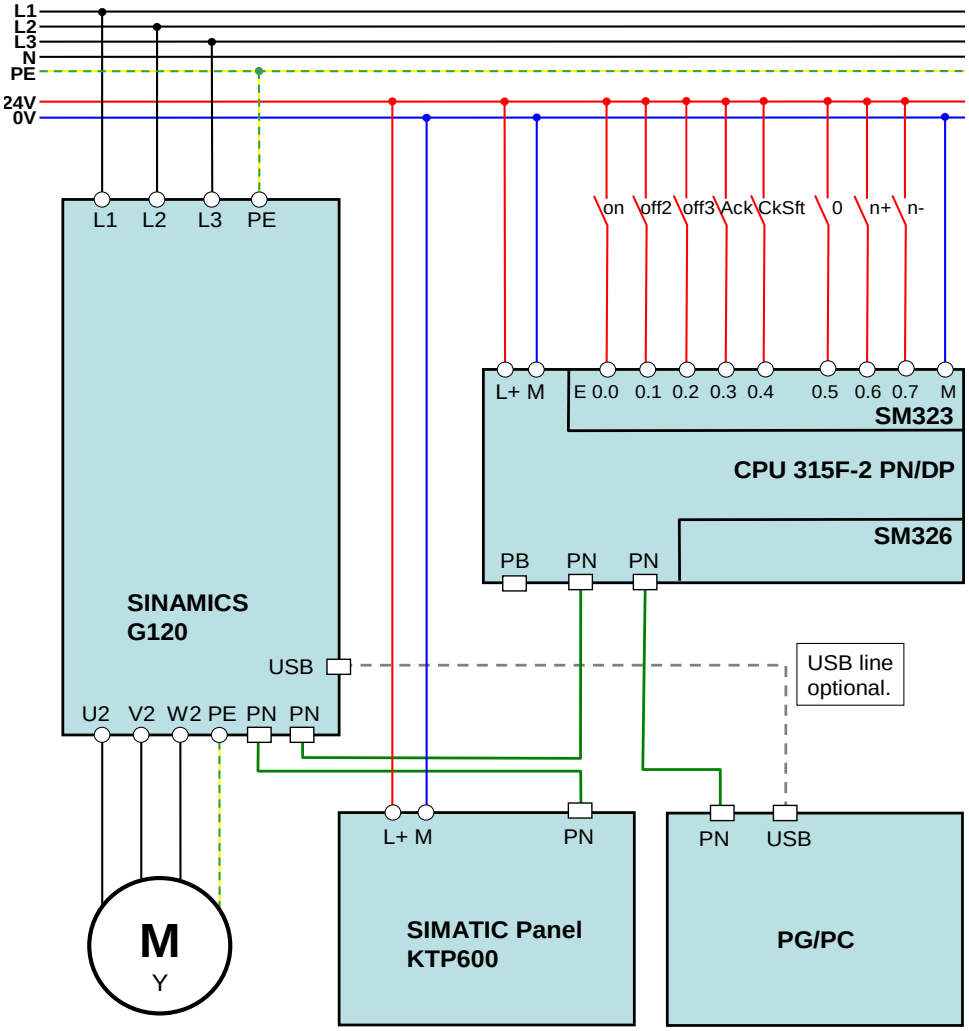
3 Setup and Commissioning

3.1 Wiring

The figures below show the hardware setup of the application:

Figure 3-1 Wiring the standard signals



The wiring of the safety signals is shown on the next page.

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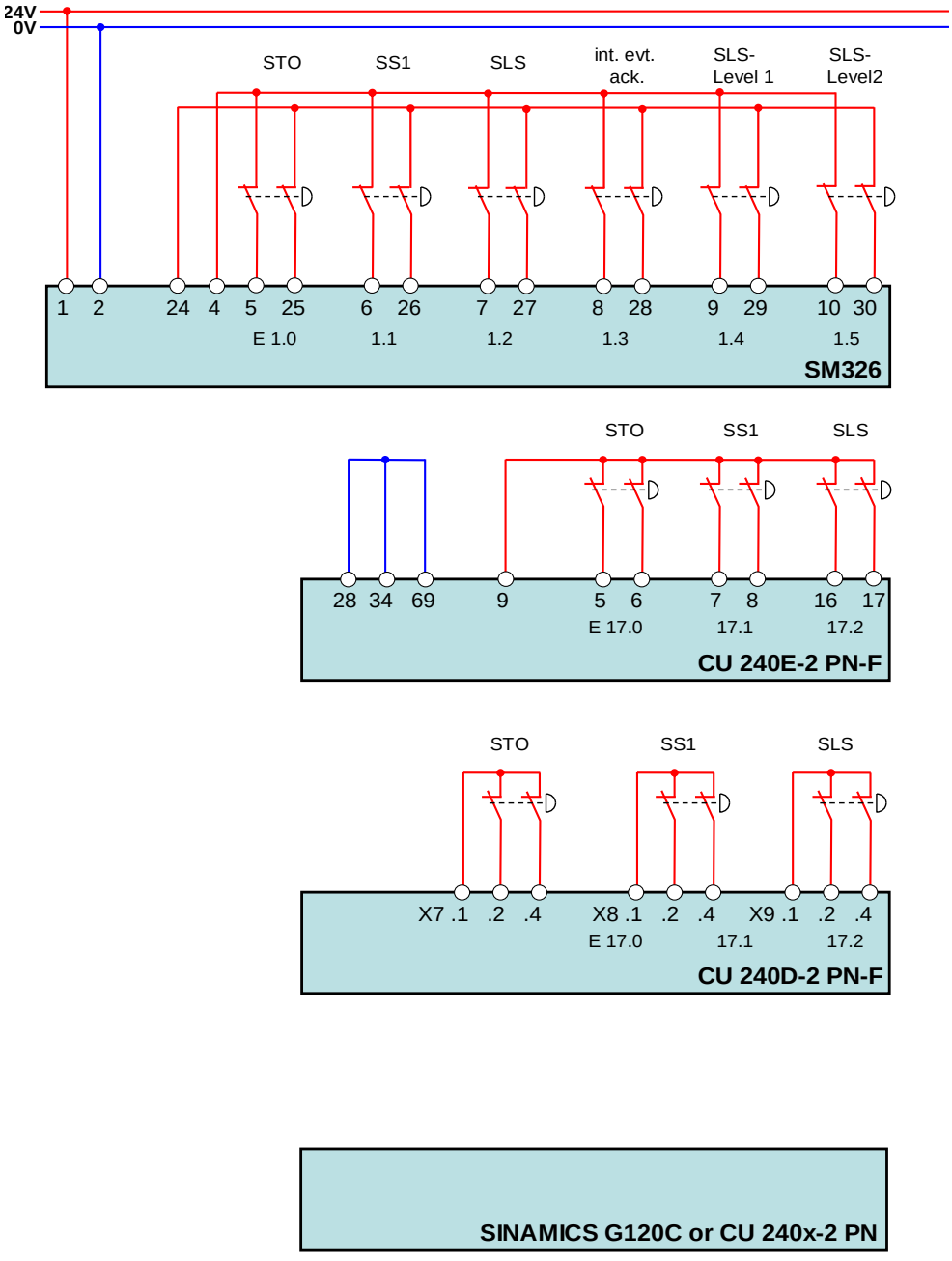
The safety wiring diagram specifies the terminals of the individual signals.

Figure 3-2 Wiring the safety signals



SINAMICS G120C, the CU240E-2 PN and the CU240D-2 PN do not have a F-DIs that can be transferred to the S7-300/400F.

Note The setup guidelines in the SINAMICS G120 manual (see (/7/) and SIMATIC S7-300/400F must be generally observed.

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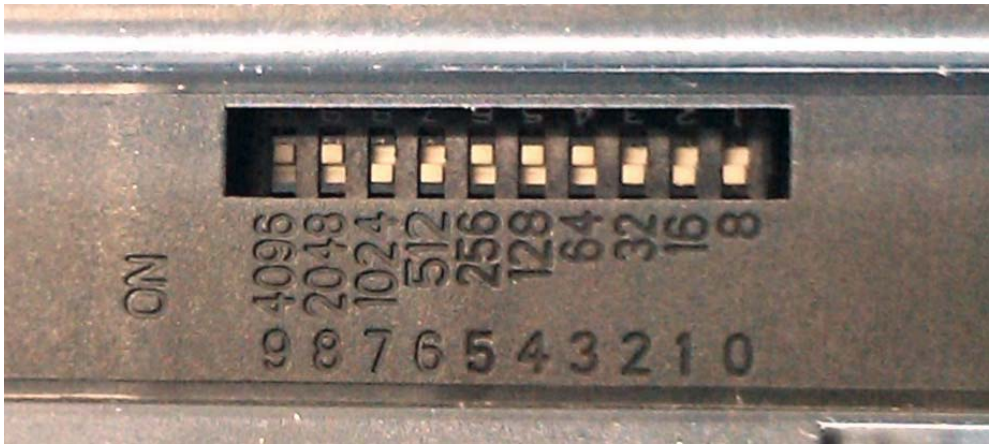
3.2 Setting the PROFIsafe address

For the F-DI module, the PROFIsafe address must be set with the DIP switches on the rear. For this example project, set switches 0, 1, 2, 6 and 7 on the rear of the F-DI module to ON.

Figure 3-3



3.3 IP addresses and PN names

The following IP addresses and device names are used in the example:

Table 3-1

IP	Component	Device Name
192.168.0.1	S7-300/400F CPU	s7-cpu
192.168.0.2	The name varies according to the used CU:	
	CU240E-2 PN CU240E-2 PN-F SINAMICS G120C PN CU240D-2 PN CU240D-2 PN -F	g120xcu240ex2 g120xcu240ex2xf g120c g120xcu240dx2 g120xcu240dx2xf
192.168.0.3	KPT600	ktp600
192.168.0.200	PG/PC	-

The network mask is always 255.255.255.0 and no router is used.

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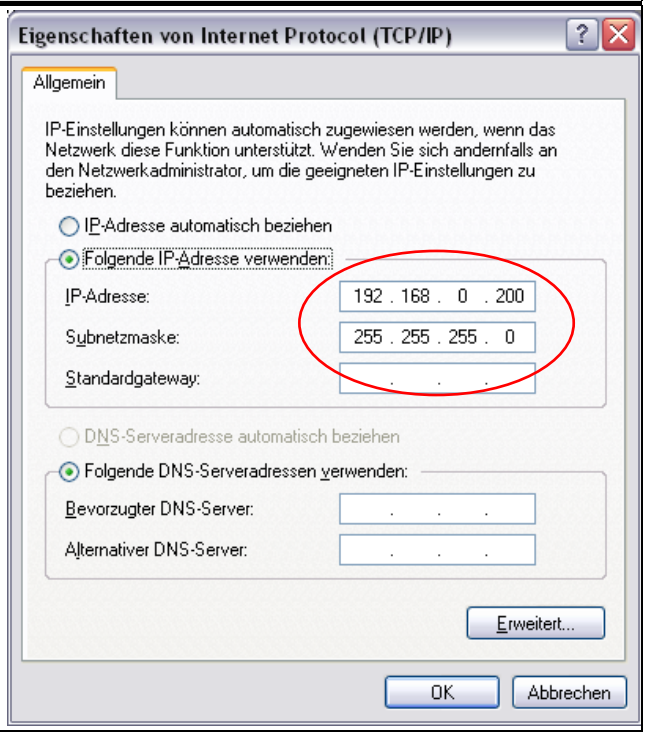
3.4 PG/PC settings

Table 3-2

Action	Remarks
Set the fixed TCP/IP address 192.168.0.200 and the subnet mask 255.255.255.0 in the Windows settings for the network card to be used. You may also enter any other IP address (192.168.0.x).	

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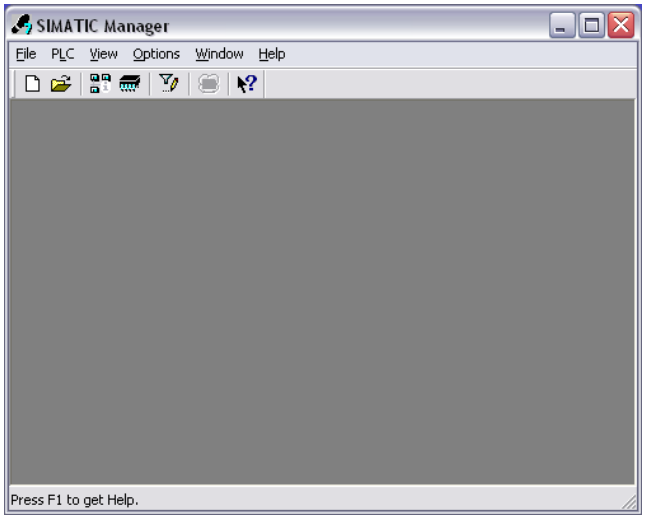
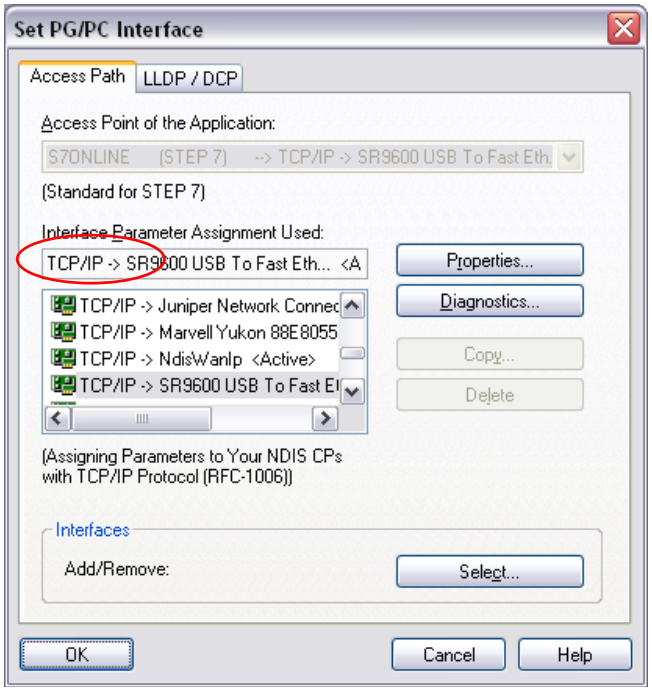
3.5 Downloading the SIMATIC S7-300/400F program

This chapter describes the steps for the installation of the example code in the S7-300/400F.

Table 3-3

No.	Action	Screenshots / Remarks
1.	Connect the PG/PC with the S7-300/400F using a network cable.	You can connect both devices directly or via a switch.
2.	Start STEP 7.	
3.	Via “Extras > Set PG/PC Interface...” you open the settings of the online interface. Select the “TCP/IP *network card*” with the network card used by you.	

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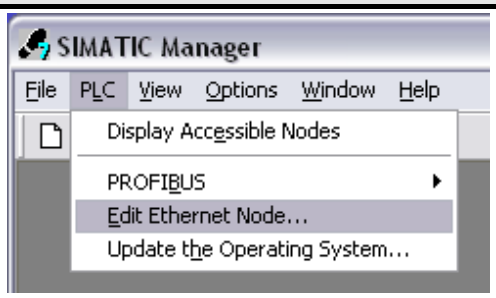
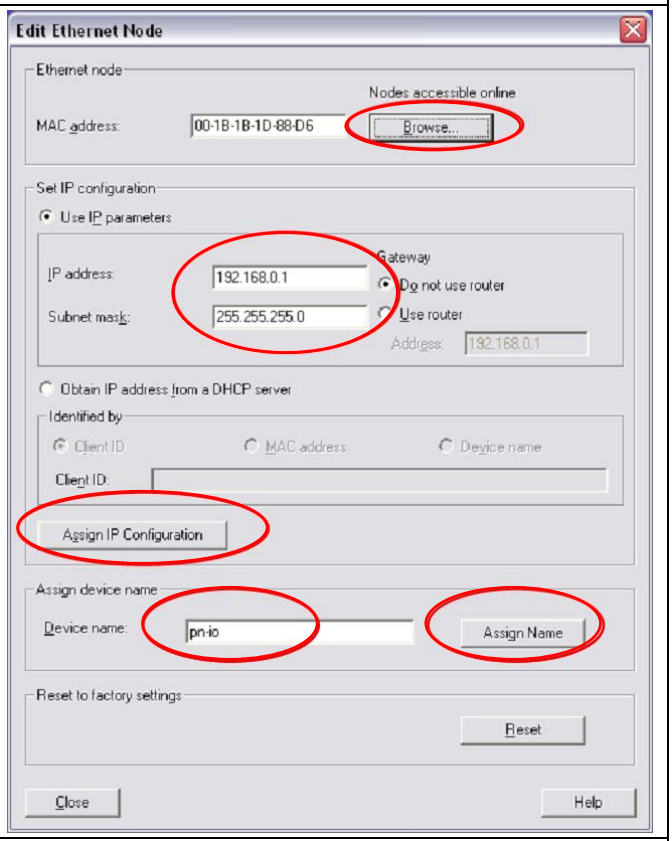
No.	Action	Screenshots / Remarks
4.	Call up the “Edit Ethernet Node…” dialog.	
5.	• Click on “Browse...” - Select the S7-300F CPU and click OK. • Enter the IP address 192.168.0.1 and the subnet mask 255.255.255.0, and click on “Assign IP Configuration”. • Enter the device name “s7-cpu” and click on “Assign Name”. Exit the dialog by clicking “Close”.	
6.	Click on “Accessible Nodes”.	

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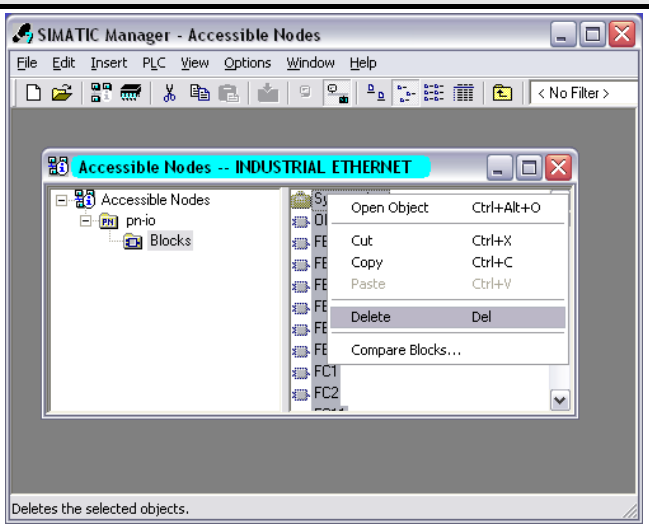
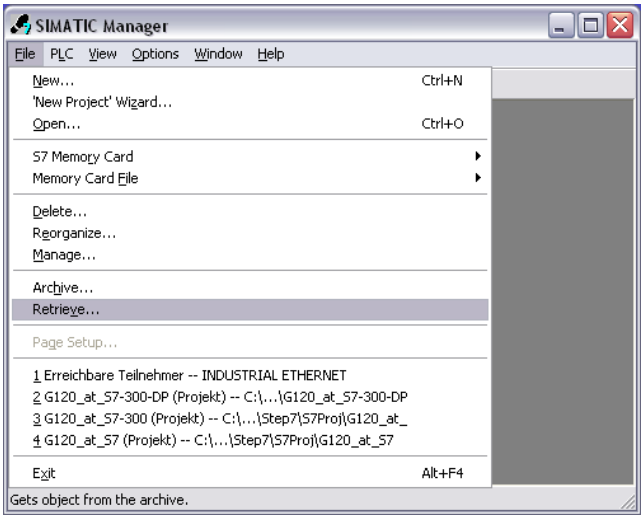
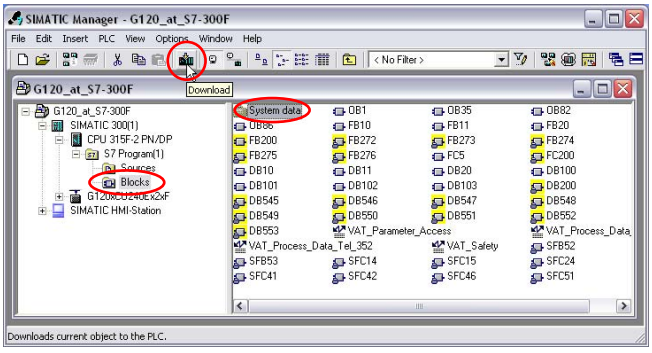
No.	Action	Screenshots / Remarks
7.	• Mark all of the blocks in the S7-300F CPU with <STRG><A> and delete them. • Acknowledge that system blocks and system data cannot be deleted.	
8.	If you have not yet dearchived the project, select a project file in “File > Retrieve...”, and dearchive it.	
9.	Open the project, select the “Blocks” folder and “System data” and click on “Download”.	

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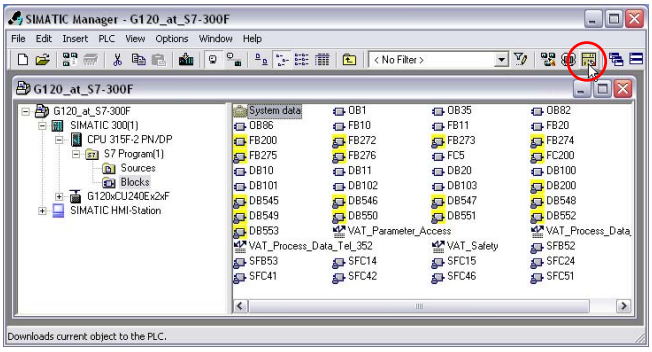
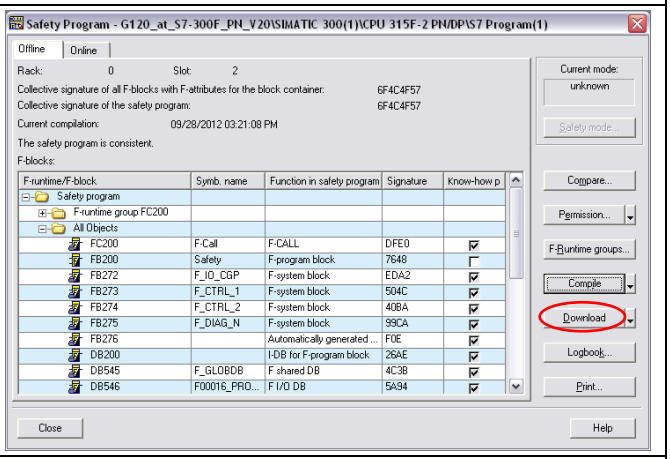
No.	Action	Screenshots / Remarks
10.	Click on “Edit safety program” Answer any query for the safety password by entering “siemens”.	
11.	Click the ”Download” button in the “Safety Program” dialog. • When asked if the standard blocks shall be downloaded as well, respond with “YES”. • Enable stopping the S7-300F CPU for a consistent download. • Let the S7-300F CPU go back to RUN mode. • Close the “Safety Program” dialog.	
12.	Restart the S7-300F CPU after downloading.	
13.	If you want to use the panel, assign the address 192.168.0.3 and load it in the HMI configuration.	

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3.6 Downloading the SINAMICS G120 configuration

This chapter describes the steps for downloading the example configuration.

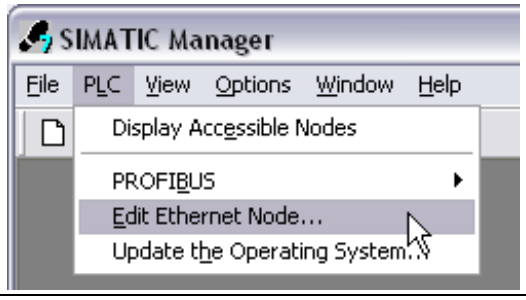
This can be performed via the network (LAN) connection, or directly via a USB connection of the PG/PC.

Note

- Should you use a different SINAMICS G120 or motor you need to perform your own configuration. Follow the instructions in chapter 6.2 "Configuring the SINAMICS G120 drive", especially steps 11 and 12.
- In the screenshots below, a SINAMICS G120 is used. In the instruction texts deviating names of the other SINAMICS G120 converter types might be mentioned.

3.6.1 Preparation for using the network connection of the PG/PC

Table 3-4

No.	Action	Remarks
1	Connect the CU 240x-2 PN-F, CU 240x-2 PN or the SINAMICS G120C with the PG/PC.	You can connect both devices directly or via a switch.
2	Unless the SIMATIC program is currently loaded, please perform steps 1 to 3 from Table 3-3.	
3	Call up the "Edit Ethernet Node…" dialog.	

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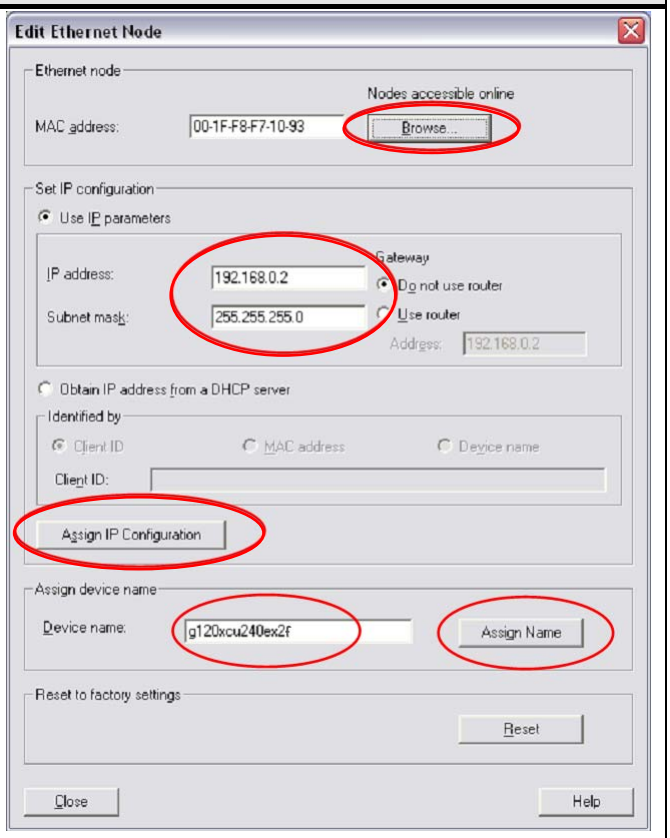
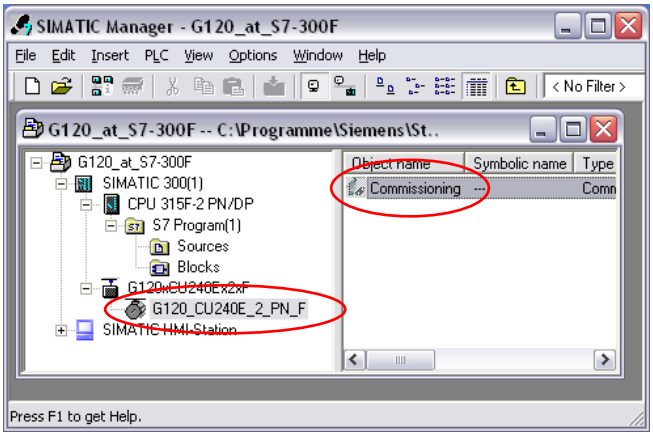
<table>
<tr><th>No.</th><th>Action</th><th>Remarks</th></tr>
<tr><td>4</td><td>

Click on “Browse...”
Select the SINAMICS G120 and click on OK.
Enter the IP address 192.168.0.2 and the subnet mask 255.255.255.0, and click on “Assign IP Configuration”.
Enter the device name of your CU and click on “Assign Name” (please observe the note).
g120xcu240ex2
g120xcu240ex2xf
g120c
g120xcu240dx2
g120xcu240dx2xf
Exit the dialog by clicking “Close”.

Note:
The device name must match the one given in the Properties of SINAMICS G120 in HW Config.
</td><td>


The picture shows the example of a SINAMICS G120 with CU 240E-2 PN-F.
</td></tr>
<tr><td>5</td><td>

Click on SINAMICS G120. Depending on the used project, the SINAMICS G120 is called
G120_CU240E-2_PN
G120_CU240E-2_PN_F
G120C_PN
G120_CU240D-2_PN
G120_CU240D-2_PN_F
Click 2x on “Commissioning”. This opens the STARTER with the project.

</td><td>


The picture shows the example of a SINAMICS G120 with CU 240E-2 PN-F.
</td></tr>
</table>

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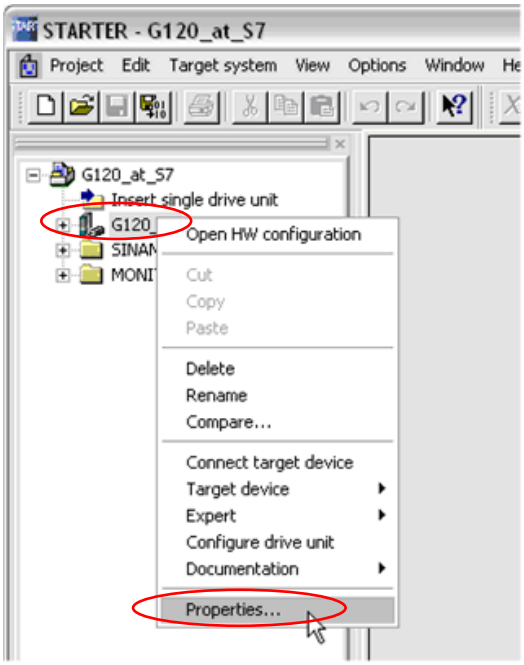
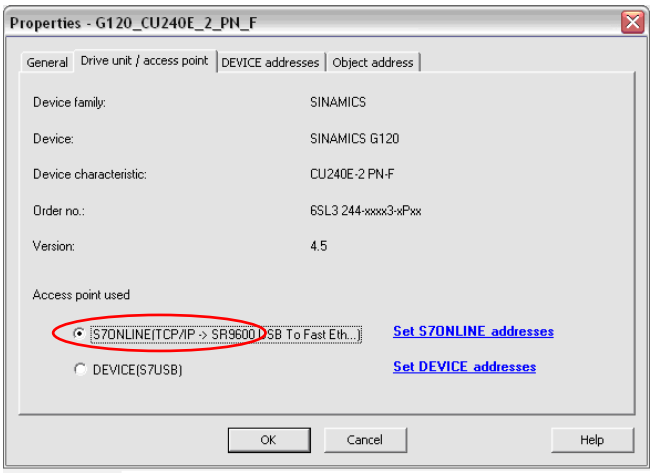
No.	Action	Remarks
6	After the STARTER has opened, select the SINAMICS G120 and open its properties by clicking on the right mouse button.	
7	Select “S7ONLINE(TCP/IP->*Network card*” and click on “OK”.	
8	Proceed with the instructions in chapter 3.6.3.	

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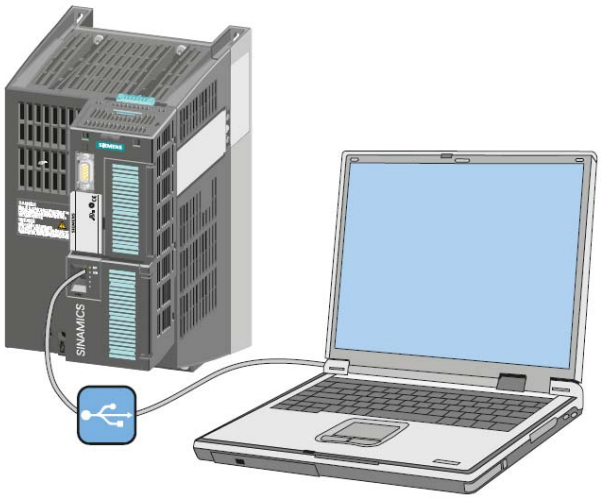
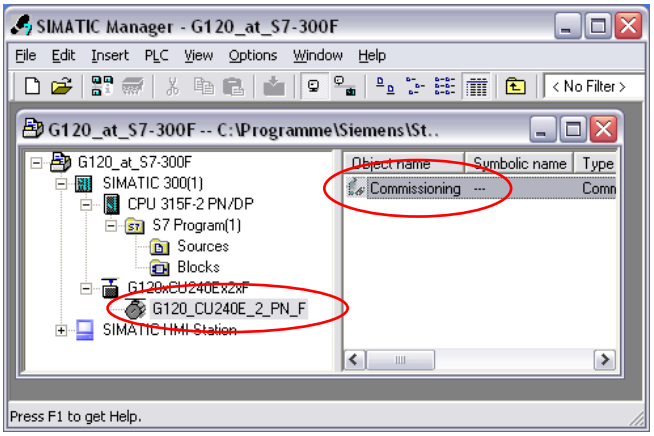
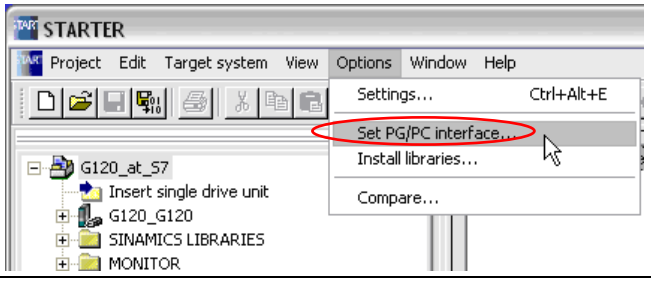
3.6.2 Preparations for using the USB connection of the PG/PC

Table 3-5

No.	Action	Remarks
1	Connect the SINAMICS G120 with the PG/PC using a USB cable. Wait until Windows has recognized the SINAMICS G120 (USB Mass Storage Device).	
2	• Click on SINAMICS G120. Depending on the used project, the SINAMICS G120 is called - G120_CU240E-2_PN - G120_CU240E-2_PN_F - G120C_PN - G120_CU240D-2_PN - G120_CU240D-2_PN_F • Click 2x on “Commissioning”. This opens the STARTER with the project.	
3	Open “Set PG/PC interface”.	

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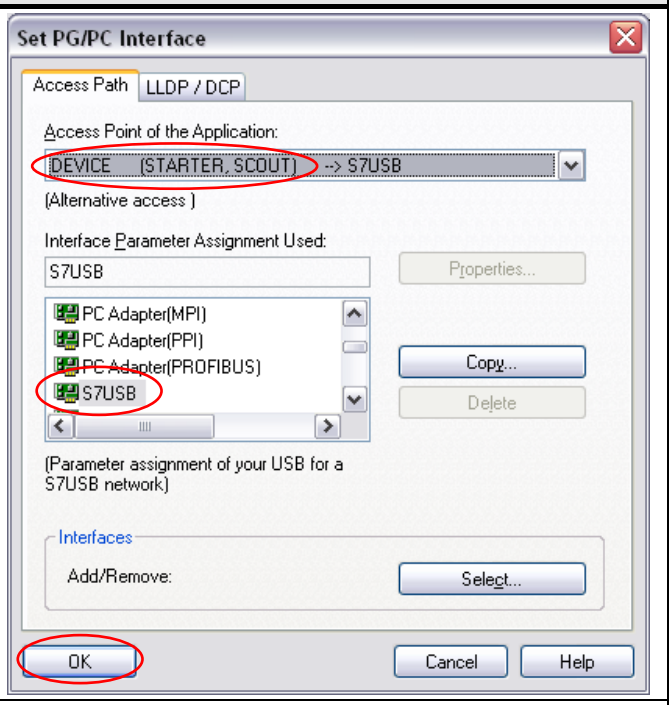
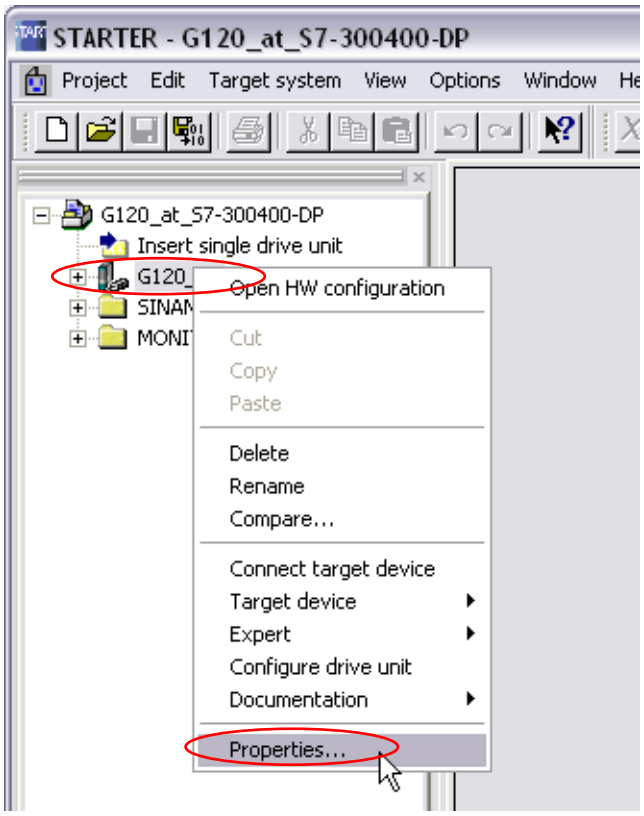
No.	Action	Remarks
3	Ensure that interface “S7USB” has been programmed for the “DEVICE (STARTER,SCOUT)” access point and acknowledge with OK.	
4	Mark the SINAMICS G120 and open its Properties with the right mouse button.	

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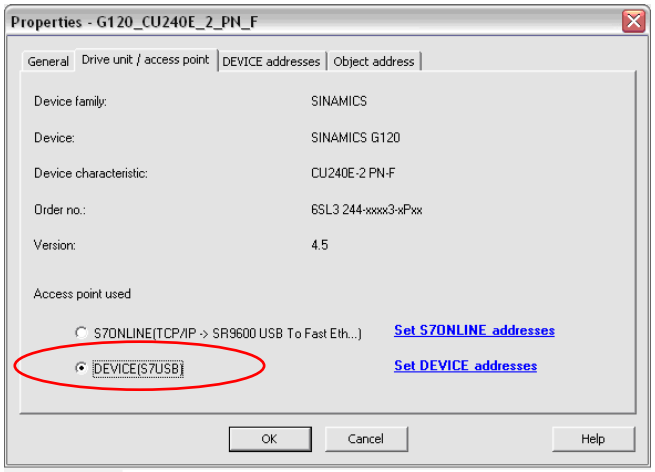
No.	Action	Remarks
5	Select “DEVICE (S7USB)” and click “OK”.	
6	Proceed with the instructions in chapter 3.6.3.	

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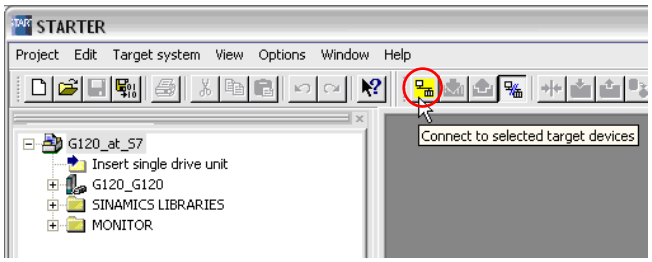
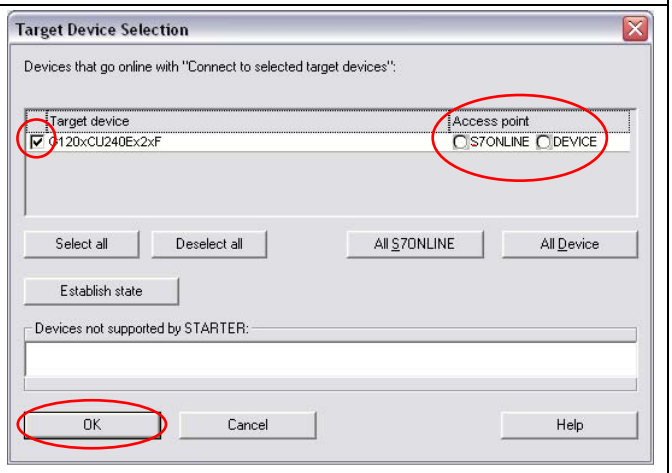
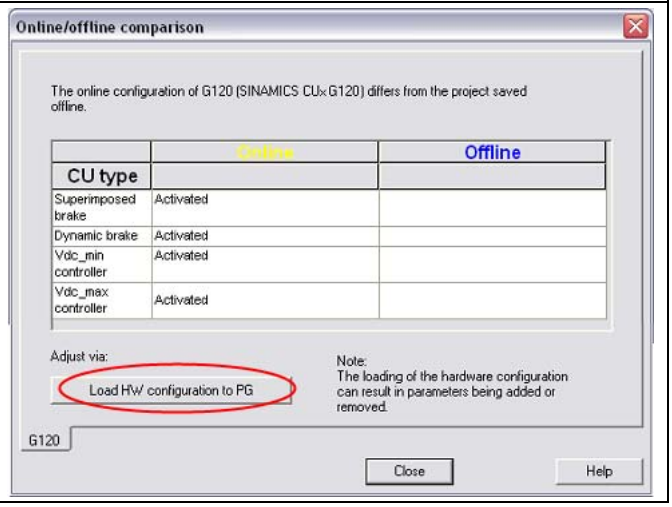
3.6.3 Downloading the configuration into the SINAMICS G120

Table 3-6

No.	Action	Remarks
14.	Go online.	
15.	If the “Target Device Selection” window opens, • set the checkmark at SINAMICS G120, • select the desired access point (S7Online for the network and DEVICE for the USB interface) and • click on “OK”.	 The picture shows the example of a SINAMICS G120 with CU 240E-2 PN-F.
16.	If the “Online/offline comparison” window opens, click on “Load HW Configuration to PG”	

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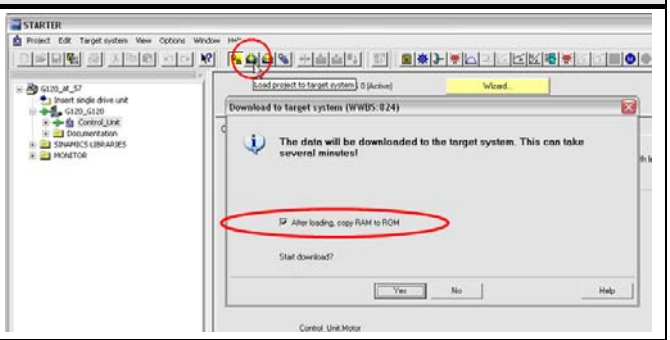
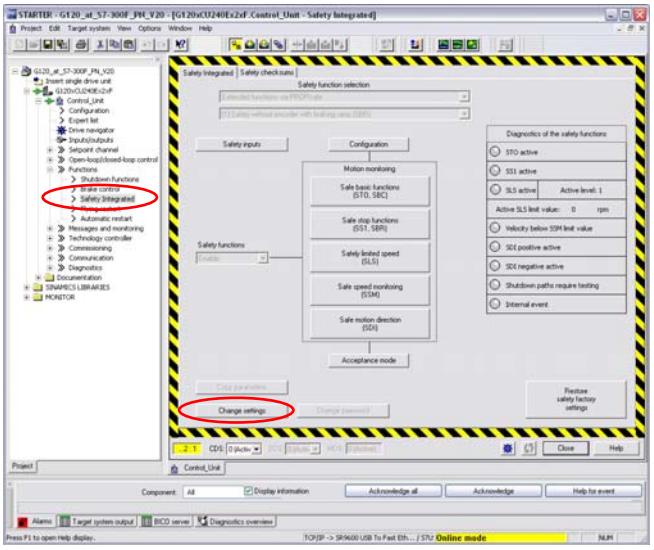
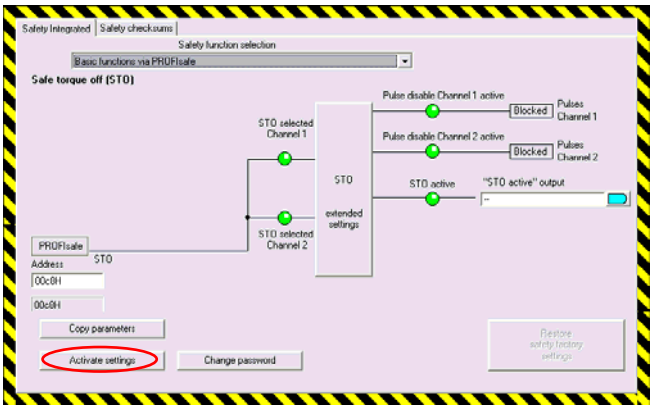
No.	Action	Remarks
17.	Start the download and tick “After loading, copy RAM to ROM”. Should you receive a note which indicates different parameters for the power unit, you need to make your own configuration. Follow the instructions in chapter 6.2 “Configuring the SINAMICS G120 drive”, especially steps 11 and 12.	
18.	• In the tree you open “Functions > Safety Integrated” Depending on the used SINAMICS G120 or the used CU, the available settings options vary. • First you click on “Change settings” and then on “Activate settings” (button name changes).	 Screenshot of CU240E-2 PN-F  Screenshot of SINAMICS G120C
19.	Enter a password (e.g. “12345”) and click on “OK”.	

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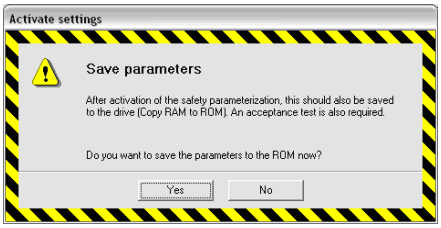
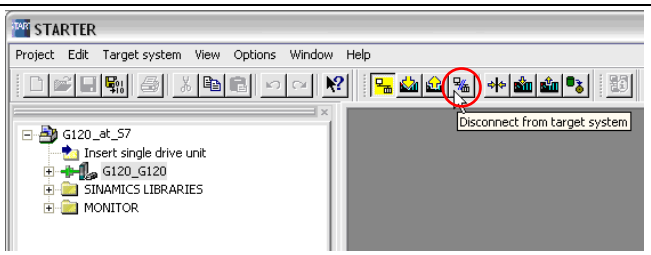
No.	Action	Remarks
20.	Choose “Yes”, to save the parameters in ROM.	
21.	Go offline.	
22.	Execute a restart / power reset	Switch off all supply voltages of SINAMICS G120, wait until all LEDs are off, and then switch back on.

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4 Operation of the Application

4.1 Requirements

To be able to switch on the drive via the digital inputs, the following points must be fulfilled:

- If the yellow “SAFE” LED is flashing on the SINAMICS G120, a safety function is active and the drive cannot be switched on (see chap. 4.2.2).
- When using an IOP, please check that the network icon ( ) is displayed on the top right. If the hand icon ( ) is displayed there, press the Hand/Auto button ( ).
- When using a BOP-2, please check whether the hand icon ( ) is displayed. If yes, press the Hand/Auto button ( ).

4.2 Operation of the Application

The drive is exclusively moved via digital inputs. The HMI is only used for monitoring.

4.2.1 Operating the standard functions

Table 4-1

Signal	Name	Function
E 0.0	On	Switching the drive on/off, (Off2 and Off3 =1 must apply for the operation)
E 0.1	Off 2	0= Motor immediately switched off, drive spins out
E 0.2	Off 3	0= Fast stop, motor is decelerated with Off3 ramp down time (P1135) until it stops
E 0.3	Ack	Rising edge acknowledges a pending error in the drive and reintegrates passivated safety modules
E 0.4	S-Test	Starts the self-test of the extended safety functions of the SINAMICS G120
E 0.5	0	The setpoint value is set to 0.
E 0.6	n+	The setpoint value is increased
E 0.7	n-	The setpoint value is decreased

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To switch on the drive, please follow the steps below:

Table 4-2

Step	Action	Note / Result
1.	Apply 24V to Off2(E0.1) and Off3(E0.2).	The further required control bits for the operation are permanently set to 1 by the program.
2.	Enter a pulse (switching on and back off) to Ack (E0.3).	This acknowledges a possibly pending error message. The reintegration of passivated safety modules is also performed.
3.	Enter a pulse (switching on and back off) to 0 (E0.5).	The setpoint is set to 0.
4.	Apply 24V to On(E0.0).	The drive switches on.
5.	Change the setpoint value with inputs n+ (E 0.6), n- (E0.7) and 0 (E0.5).	The speed of the motor changes.
6.	Remove the 24V from On(E0.0).	The drive switches back off.

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4.2.2 Operating the safety functions

The table below shows via which input what function can be triggered in the SINAMICS with the example configuration:

Table 4-3

S7-300F F-DI module Terminal	SINAMICS G120 Terminal	Function	Address in the S7-300F
5+25	5+6	STO	E1.0 or E19.0
6+16	7+8	SS1	E1.1 or E19.1
7+27	16+17	PLC	E1.2 or E19.2
8+28		Ack int event.	E1.3
9+29		PLC Level Bit 0	E1.4
10+30		PLC Level Bit 1	E1.5

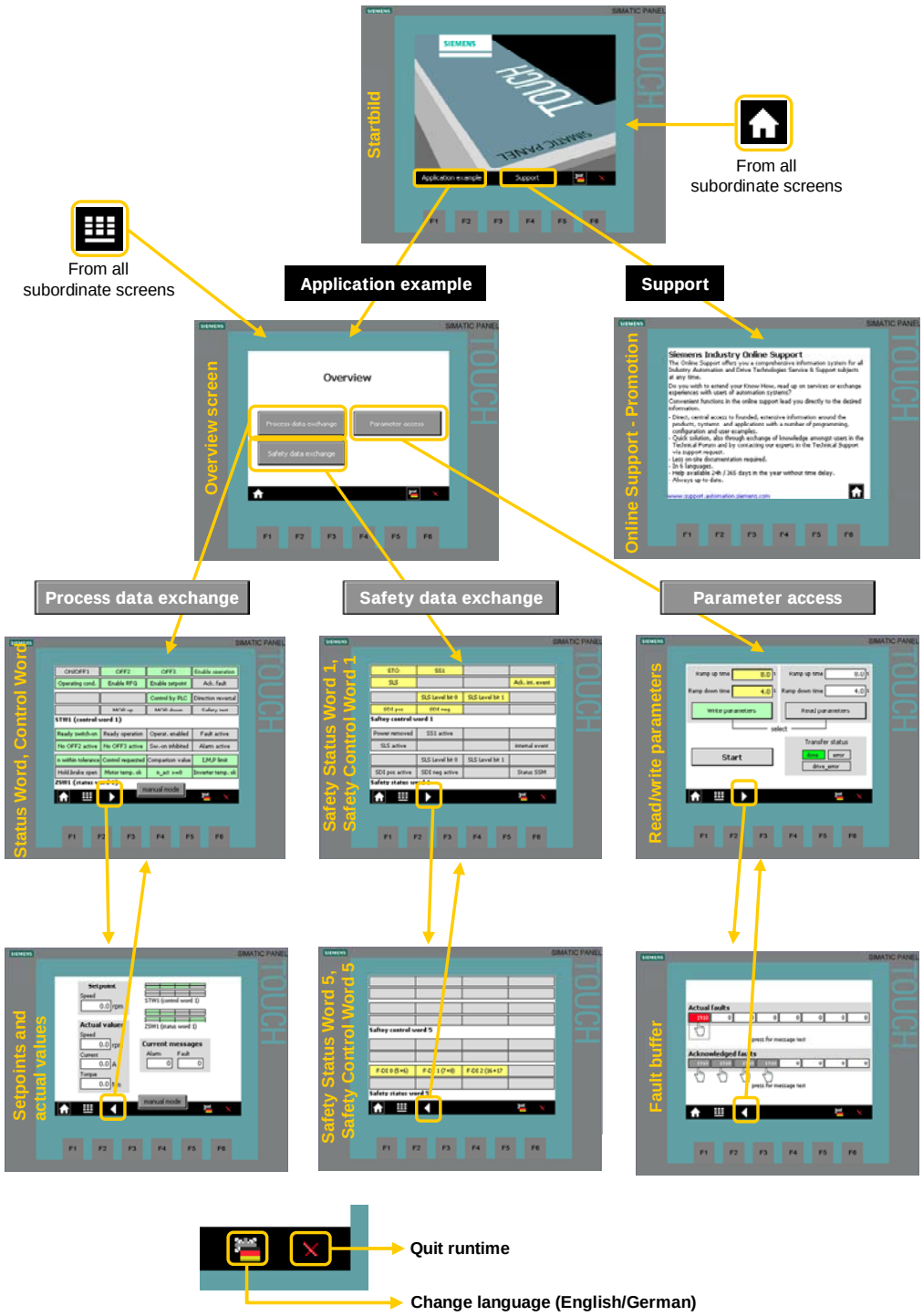
Forced dormant error detection

With input 0.4 the internal test of the shut-down method of the SINAMICS G120 can be started. Switch off the drive with E 0.0 and then activate the E 0.1 for a short moment. Further information is available in the Safety Integrated function manual (see /7/)

4.3 Monitoring and parameter access via operator panel

4.3.1 Screens and screen navigation

Figure 4-1



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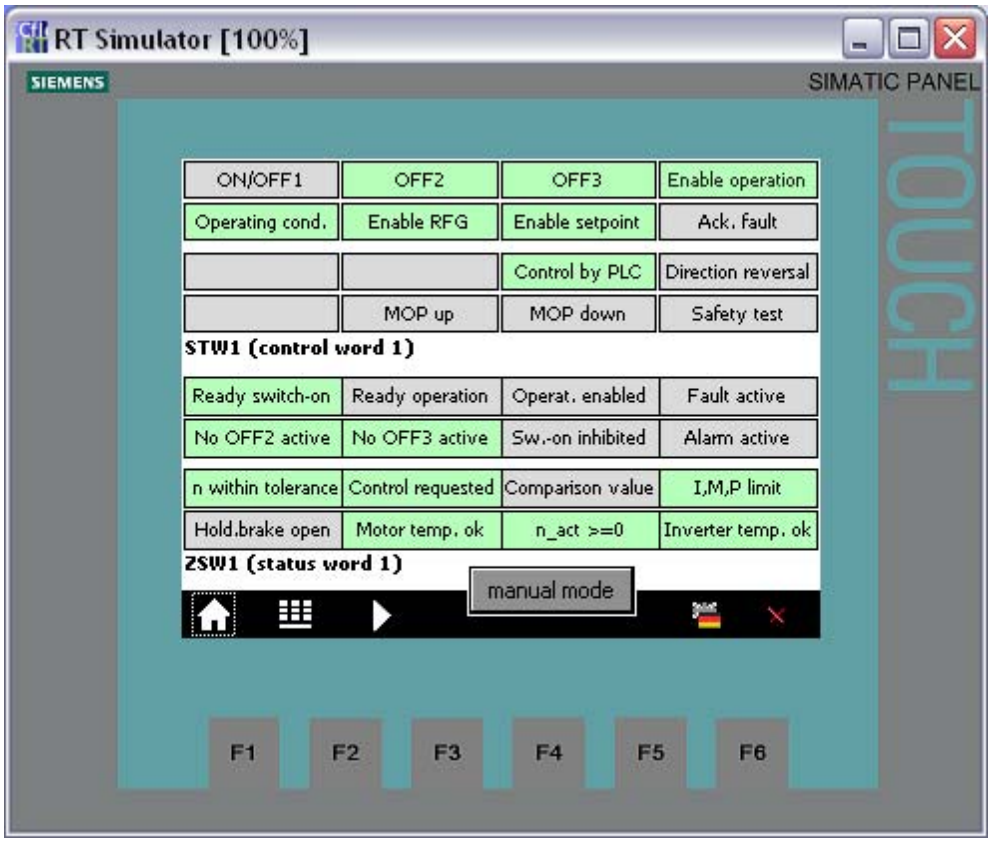
4.3.2 Process data exchange

Both screens for the process data exchange access the idb_Process_Data data block (DB11).

Control and status word

The bit commands, which you can partially specify via the digital input module, are displayed in the 16 bit wide control word.

Figure 4-2



The current state of the SINAMICS G120 is given via the also 16 bit wide status word.

Manual mode

Using the “Manual mode” button enables activating the manual mode of the block. Instead of switching to the control signals pending at the block, in this example to the digital inputs, this mode switches to an internal control word specified via HMI, for example. Also, an internal value is used instead of the pending setpoint value.

This enables a simple manual/automatic switch-over.

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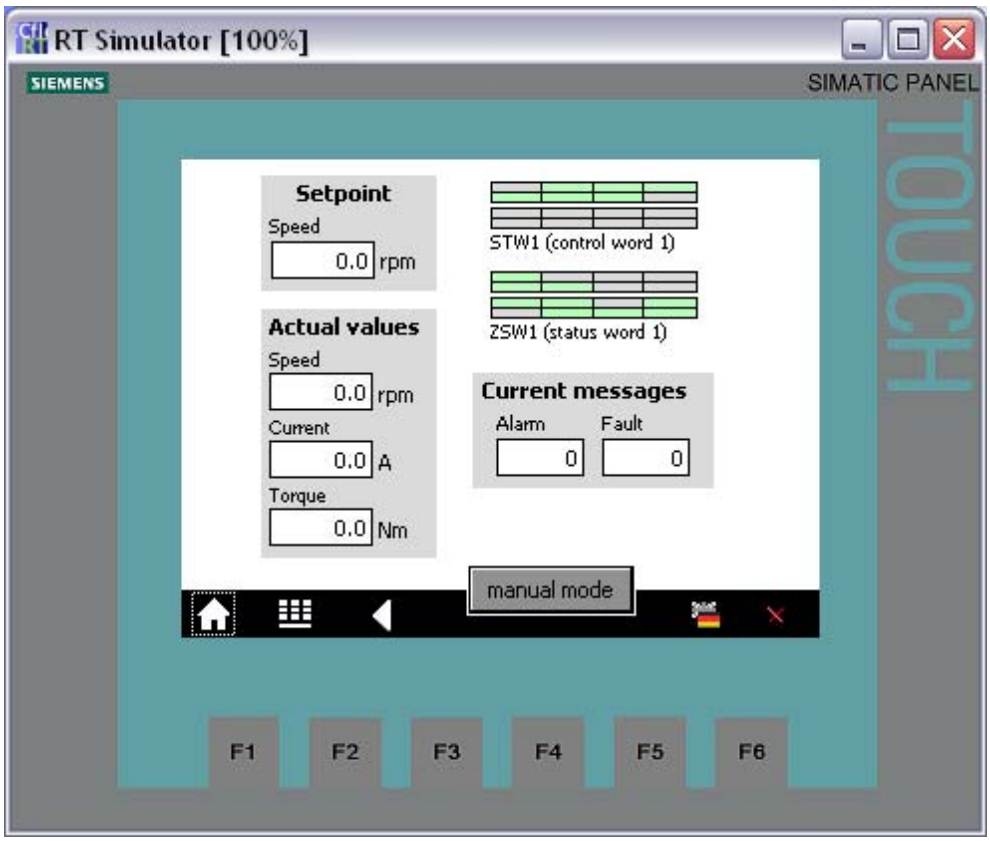
DANGER

When (de-)activating the manual mode, the control word and the setpoint value are not adjusted. It is therefore possible when switching over that SINAMICS G120 automatically starts up or changes the speed.

In this example, this enables switching from the digital inputs to manual operation via HMI. The set control word bits are then displayed yellow.

Setpoint and actual values

Figure 4-3



Setpoint speed value:
Here, the setpoint speed value is displayed which in this example, is set via the digital inputs E0.4 to E0.7 (see Table 4-1).
In manual mode, the speed setpoint value is directly specified via HMI, the input field is then shaded yellow.

DANGER

When (de-)activating the manual mode, the control word and the setpoint value are not adjusted. It is therefore possible when switching over that SINAMICS G120 automatically starts up or changes the speed.

Actual values:
The current actual values for speed, electrical current and torque are displayed below the speed setpoint value input.

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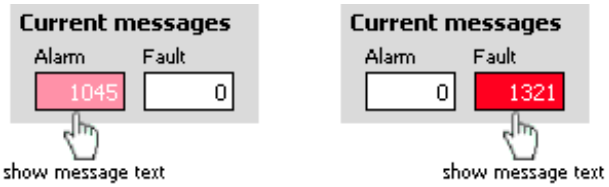
Control and status word:
To keep an eye on control word and status word, without switching to the respective screen, they are also given here as a miniature display.

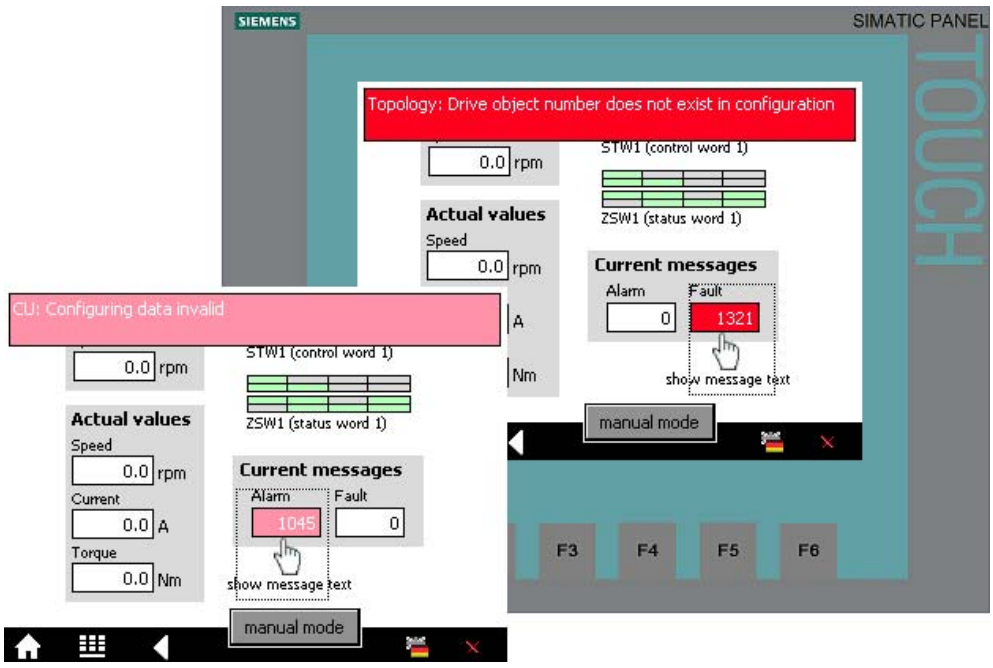
Current messages:
Current faults and warnings are displayed with a respective number. A “0” means that no fault or alarm exists. If a message is pending it is displayed according to Figure 4-4.

Figure 4-4



Tap or click on the message number to display the respective message text.

Figure 4-5



The message text is displayed as long as the message number is pressed.

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4.3.3 Safety data exchange

The two figures for the safety data exchange directly access the inputs and outputs.

The bit commands, which you can partially specify via the digital F-input module and the F-DIs of the SINAMICS G120 (see Table 4-3), are displayed in the 16 bits wide control word.
The safety control word 5 only consists of reserved bytes.
The current state of the safety functions or the F-DIs is given via both also 16 bits wide status words.

Note

Please note that the signal state “1” (depicted in color) signifies the non-active function and the signal state “0” (gray) means the active function.

The bits of the SLS threshold are only shown in the safety status word 1 if the function is also active.

Safety control and status words

Figure 4-6 Safety control and status word 1

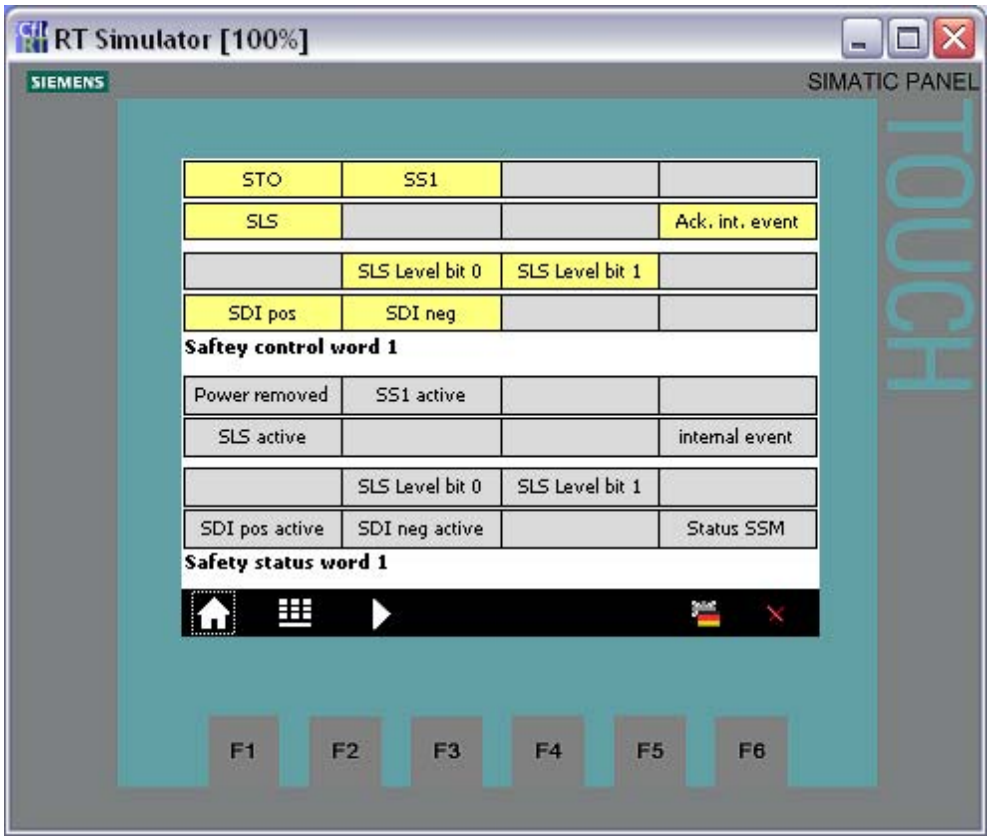

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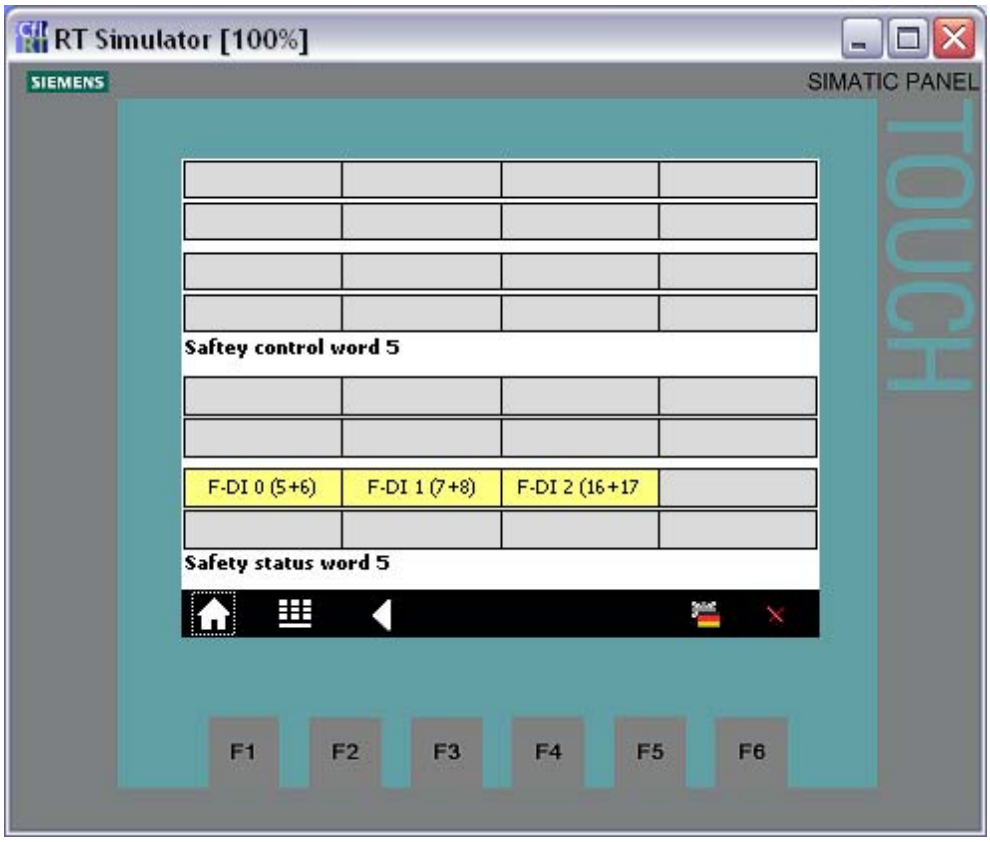
Figure 4-7 Safety control and status word 5



Safety status word 5 is only transferred if the “PROFIsafe message frame 900” is used. This is only possible with CU 240E-2 PN-F and CU 240D-2 PN-F.

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4.3.4 Parameter access

Both screens for the process data exchange access the idb_Parameter_Access data block (DB11).

Reading/writing parameters

Figure 4-8

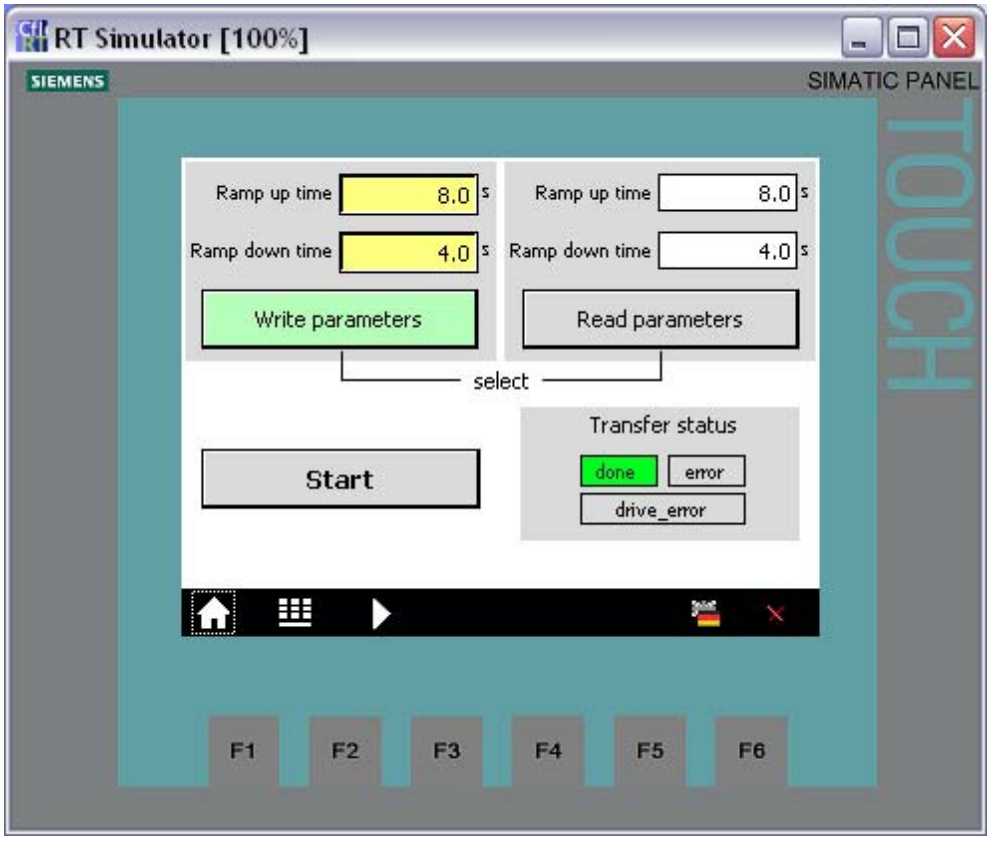

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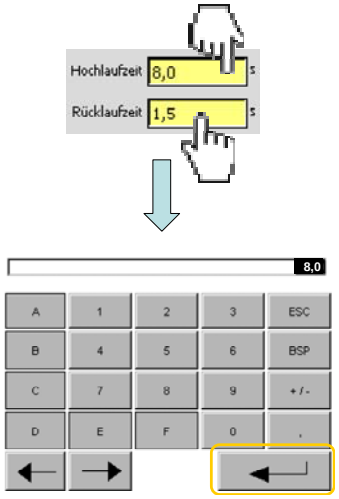
Table 4-4

	Action	Comment
1.	Select the access type with the “Read parameters” and “Write parameters” buttons.	The selected access type is displayed via a bright green button.
2.	Read parameters: Proceed with point 3 in the table. Write parameters: When tapping or clicking the yellow input field for the ramp-up/ramp-down time, a keyboard mask for the value input opens. Close your input with the Return key.	
3.	Start the write or read job with the “Start” button.	The job status specifies how the job was completed: done = completed without errors error = job cancelled with error The status refers to processing the system function blocks SFB 52 “RDREC” and SFB 53 “WRREC” in STEP7 code. For fault diagnostics see /3/. done and drive_error means that the job was transferred without error, however, SINAMICS G120 could not or only partially process the job. The error codes are available in chapter 6.1.5.1 “Configuring the fieldbus, Communication via PROFIBUS, Acyclic communication” in the operating instruction (/7/).
4.	Click “Start” again to terminate the transmission requirement.	The bits of the job status are deleted as soon as the transmission requirement is no longer pending.

Note If you wish to check the parameters after a write job, you must trigger an additional read job.

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Fault buffer

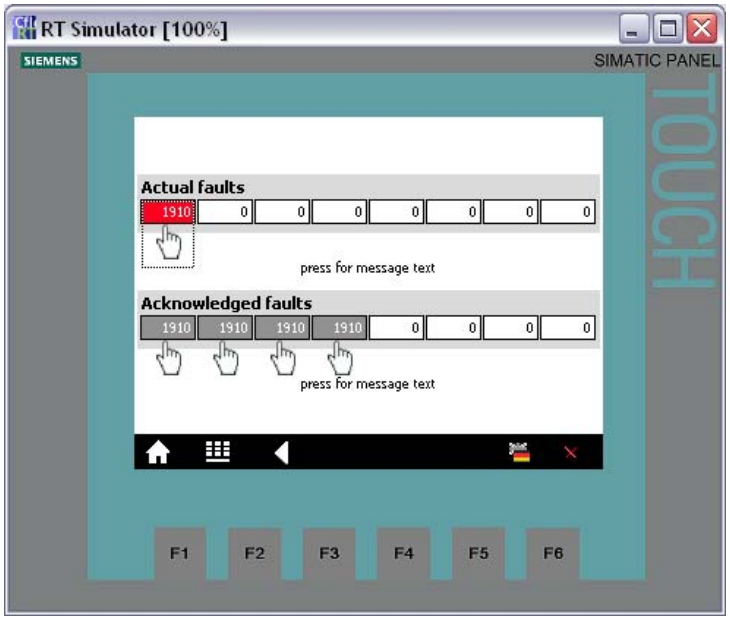
The screen displays, the fault codes of eight current and eight acknowledged faults which are saved in the SINAMICS G120.

Note

The values are read by SINAMICS G120 via the “Read parameters” function in Figure 4-8 and saved in the S7-300/400F.

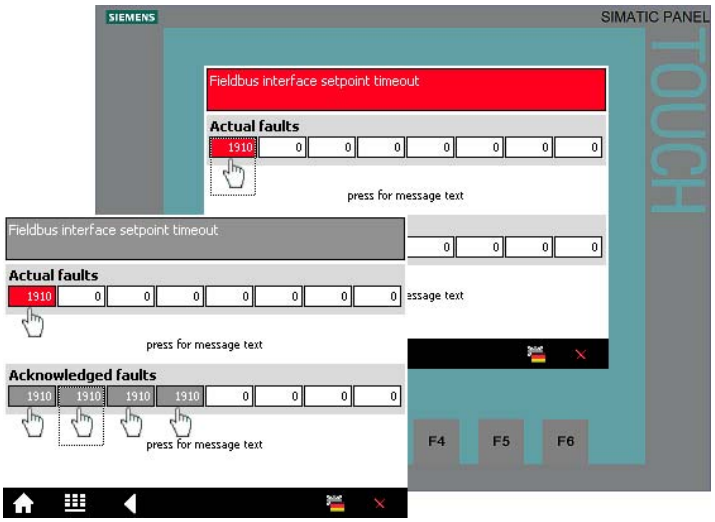
When the “Fault buffer” screen comes up, the data stored in S7300/400 is displayed and may therefore be out of date.

Figure 4-9



Tap or click on the message number to display the respective message text.

Figure 4-10



The message text is displayed as long as the message number is pressed.

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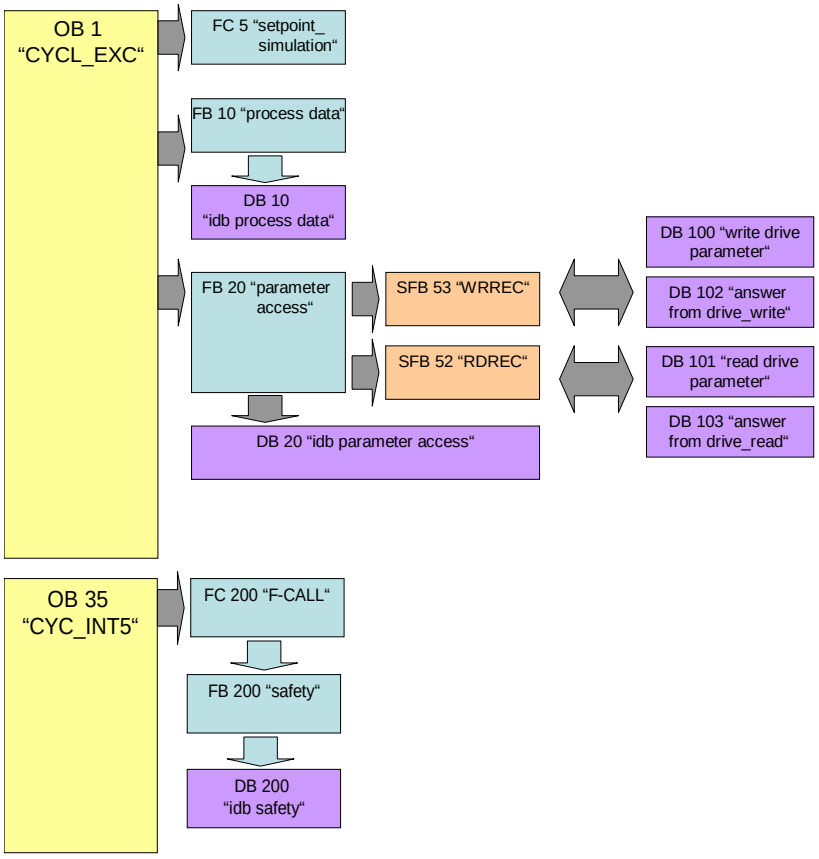
5 Functional Mechanisms of this Application

Program overview

Figure 5-1



The SIMATIC S7-300/400F program consists of four areas:

- Simulation
  In this area, the control signals are created for the SINAMICS G120, which are then transmitted as process data to the drive.
- Process data exchange
  In this area, the process data for the SINAMICS G120 is transmitted (e.g. one command and setpoint) or received (status and actual values)
- Parameter access
  In this area, the parameters from the converter are accessed.
- Safety program
  In this area the failsafe program is processed.

Note The two communication areas, process data and parameter access, are independent from each other and can each also be used individually.

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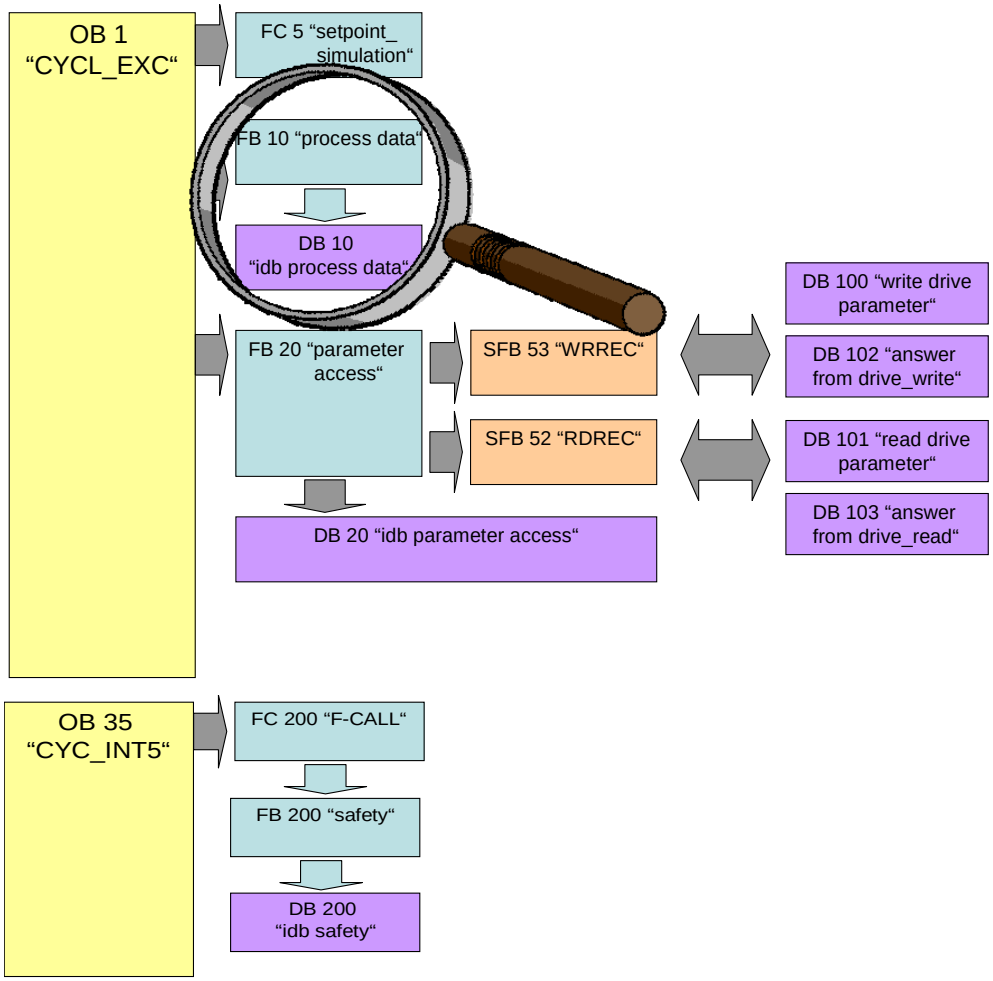
5.1 Functionality of process data exchange

Figure 5-2



The process data contains values which are regularly exchanged between S7-300/400F and SINAMICS G120. These values are at least the control and status word as well as the setpoint and actual value. Selecting the message frame type specifies the exact length and structure.

The “Siemens message frame 352, PZD 6/6” used in the example exchanges 6 words in both directions, which are:

Table 5-1 Structure of the “Siemens message frame 352, PZD 6/6”

Send direction (viewed from SIMATIC)	**Receive direction** (viewed from SIMATIC)
Control word	Status word
Setpoint speed value	Current speed (actual speed value)
(not used)	Current electrical current
(not used)	Current torque
(not used)	Current warning
(not used)	Current fault

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5.1.1 Accessing process data in the user program of the S7-300/400F

At the start of the cycle, the operating system of S7-300/400F stores the (user) data received by the SINAMICS G120 in the I/O input area of the S7-300/400F CPU and transmits the data stored in the I/O output area to the SINAMICS G120 at the end of the cycle. In the user program, the data can be accessed by reading from or writing to the I/O area. The address areas used are defined when specifying the hardware configuration. See step 9 in Table 6-1.
If the I/O is accessed with the SFC 14/15 system functions, the consistency is ensured across the entire data, hence, these functions are used in the example program.

5.1.2 Standardizing the setpoint and actual values

The setpoint and actual values are transferred as standards. The reference values are stored in parameters P2000 to P2006 of the SINAMICS G120.

FB20 “Parameter_Access” takes on entirely the conversion of setpoint and actual values. The reference values for speed current, torque stored in parameters P2000, P2003 and P2004 of SINAMICS G120 must also be entered at the block input.

16384dec = 4000hex = 100% applies here, with 100% referring to the reference value for the transferred variable.

Example:

If P2000 (reference speed or reference frequency) is 1500 1/min and if a speed of 500 1/min shall be run, then 33% or 5461dec must be transferred.

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5.1.3 Control and status word

The control and status word has already been defined. The subsequent figures illustrate the control and status word when selecting the “Siemens message frame 352, PZD 6/6”.

Figure 5-3: Control word of the “Siemens message frame 352, PZD 6/6”

Bit	Value	Significance	Comments
0	0	OFF1	Motor brakes with the ramp-down time p1121 at standstill ($f < f_{min}$) the motor is switched off.
	1	ON	With a positive edge, the inverter goes into the "ready" state, with additionally bit 3 = 1, the inverter switches on the motor.
1	0	OFF2	Switch off motor immediately, motor coasts to a standstill.
	1	No OFF2	---
2	0	Quick stop (OFF3)	Quick stop: Motor brakes with the OFF3 ramp-down time p1135 down to standstill.
	1	No quick stop (OFF3)	---
3	0	Disable operation	Immediately switch-off motor (cancel pulses).
	1	Enable operation	Switch-on motor (pulses can be enabled).
4	0	Lock ramp-function generator	The ramp-function generator output is set to 0 (quickest possible deceleration).
	1	Operating condition	Ramp-function generator can be enabled
5	0	Stop ramp-function generator	The output of the ramp-function generator is "frozen".
	1	Ramp-function generator enable	
6	0	Inhibit setpoint	Motor brakes with the ramp-down time p1121.
	1	Enable setpoint	Motor accelerates with the ramp-up time p1120 to the setpoint.
7	1	Acknowledging faults	Fault is acknowledged with a positive edge. If the ON command is still active, the inverter switches to"closing lockout" state.
8		Not used	
9		Not used	
10	0	PLC has no master control	Process data invalid, "sign of life" expected.
	1	Master control by PLC	Control via fieldbus, process data valid.
11	1	Direction reversal	Setpoint is inverted in the inverter.
12		Not used	
13	1	MOP up	The setpoint stored in the motorized potentiometer is increased.
14	1	MOP down	The setpoint stored in the motorized potentiometer is decreased.
15	1	Start forced checking procedure	Start the forced checking procedure of inverters safety functions

Note

A control word for which all bits are 0 is rejected as invalid by the SINAMICS G120. Therefore, at least bit 10 must always be set.

Normally, bit 15 is not assigned in message frame 352. However, in this example the signal for starting the safety function check was assigned to this bit.

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Figure 5-4 Status word of the “Siemens message frame 352, PZD 6/6”

Bit	Value	Significance	Comments
0	1	Ready for switching on	Power supply switched on; electronics initialized; pulses locked.
1	1	Ready for operation	Motor is switched on (ON1 command present), no active fault, motor can start as soon as "enable operation" command is issued. See control word 1, bit 0.
2	1	Operation enabled	Motor follows setpoint. See control word 1, bit 3.
3	1	Fault present	The inverter has a fault.
4	1	OFF2 inactive	Coast to standstill not activated (no OFF2)
5	1	OFF3 inactive	No fast stop active
6	1	Closing lockout active	The motor is only switched on after a further ON1 command
7	1	Alarm active	Motor remains switched on; acknowledgement is not required; see r2110.
8	1	Speed deviation within tolerance range	Setpoint/actual value deviation within tolerance range.
9	1	Control requested	The automation system is requested to assume control.
10	1	Comparison speed reached or exceeded	Speed is greater than or equal to the corresponding maximum speed.
11	0	I, M or P limit reached	Comparison value for current, torque or power has been reached or exceeded.
12	1	Holding brake open	Signal to open and close a motor holding brake.
13	0	Alarm motor overtemperature	--
14	1	Motor rotates forwards	Internal inverter actual value > 0
	0	Motor rotates backwards	Internal inverter actual value < 0
15	1	No alarm, thermal power unit overload	

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5.1.4 FB 10 “PZD_G120_Tel_352”

This FB takes on the transmission of the process data from and to the SINAMICS G120. It copies the main control and status bits and converts the setpoint and actual values. It can therefore be used as interface with SINAMICS G120 in own applications.

Figure 5-5 FB 10 “ PZD_G120_Tel_352“

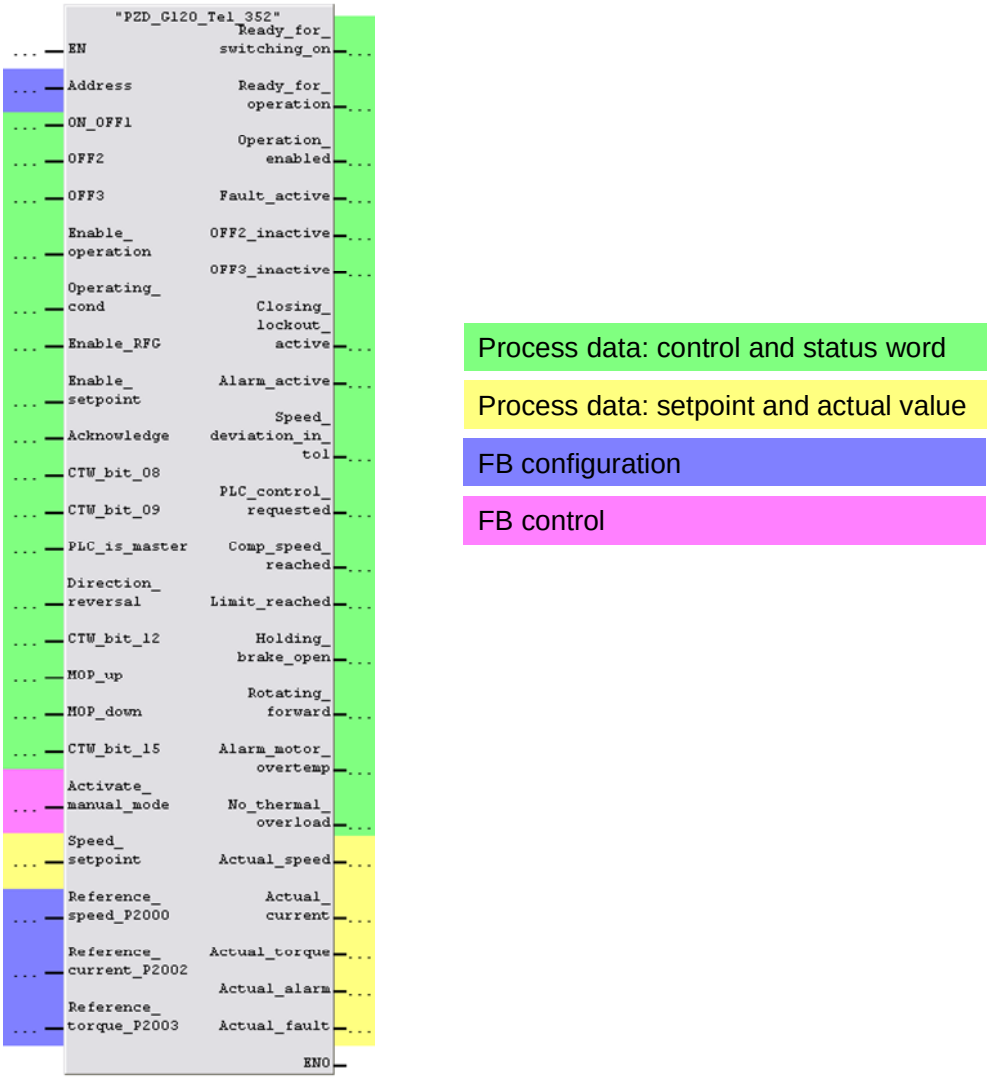

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Table 5-2 Interfaces of FB 10 “PZD_G120_Tel_352”

Parameter	Data type	Initial value	Description
Input parameters			
Address	INT	0	IO address of SINAMICS G120 Here, the IO address must be specified which was assigned for message frame “Siemens message frame 352” of SINAMICS in HW Config. Input and output address must be identical to be able to use this block.
ON_OFF1	BOOL	FALSE	If all enables have been set (marked as **bold** below) and if no errors are pending, SINAMICS G120 is switched on with a rising edge at ON_OFF1.
OFF2	BOOL	TRUE	0=Immediate STOP (motor coasts) **1=Operation enabled**
OFF3	BOOL	TRUE	0=Fast stop (with ramp down time in P1153) **1=Operation enabled**
Enable_operatiion	BOOL	TRUE	0=Pulse inhibit **1=Operation enabled**
Operating_cond	BOOL	TRUE	0=Ramp-up encoder output fixed to 0 **1=Ramp-up encoder output enabled**
Enable_RFG	BOOL	TRUE	0= Ramp-up encoder value “frozen” **1=Ramp-up encoder output enabled**
Enable_setpoint	BOOL	TRUE	0=Setpoint fixed to 0 **1=Setpoint enabled**
Acknowledge	BOOL	FALSE	Pending errors are acknowledged with rising edge.
CTW_bit 08	BOOL	FALSE	Not used
CTW_bit 09	BOOL	FALSE	Not used
PLC_is_Master	BOOL	TRUE	**1=Controlled by automation system**
Direction_reversal	BOOL	FALSE	With this input, the polarity of the setpoint value can be changed.
CTW_bit 12	BOOL	FALSE	Not used
MOP_up	BOOL	FALSE	Enlarge Motorpoti value
MOP_down	BOOL	FALSE	Reduce Motorpoti value
CTW_bit 15	BOOL	FALSE	Not used as a standard. However, in this example the forced dormant error detection is started with this bit.
Activate_manual_mode	BOOL	FALSE	Switches the block between manual and automatic mode. For FALSE, the control word and the setpoint value are formed of the signals pending at the block, for TRUE, control word and setpoint value from tags in the instance DB are used and can be specified via HMI, for example.
Speed_setpoint	REAL	0.0	Setpoint speed value in U/min Negative values change the direction

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Parameter	Data type	Initial value	Description
Reference_speed_P2000	REAL	1500.0	Reference speed Here, the same value must be specified as in parameter P2000 of SINAMICS G120.
Reference_current_P2002	REAL	0.0	Reference current Here, the same value must be specified as in parameter P2002 of SINAMICS G120.
Reference_torque_P2003	REAL	0.0	Reference torque Here, the same value must be specified as in parameter P2003 of SINAMICS G120.
Output parameters			
Ready_for_switching_on	BOOL		Drive ready for switching on
Ready_for_operation	BOOL		Drive ready for operation i.e. switched on (STW bit 0 is 1), however, operation is not enabled (STW bit 3 is 0)
Operation_enabled	BOOL		Drive is switched on and enabled Motor follows the setpoint value.
Fault_active	BOOL		The SINAMICS G120 outputs a fault.
OFF2_inactive	BOOL		OFF 2 is not set
OFF3_inactive	BOOL		OFF 3 is not set
Closing_lockout_active	BOOL		On-inhibit active. To cancel it, ON_OFF1 must be set to FALSE, all enables from 1 be set and possibly pending errors be acknowledged.
Alarm_active	BOOL		The SINAMICS G120 outputs a warning.
Speed_deviation_in_tol	BOOL		Setpoint actual value deviation within tolerance range.
PLC_control_requested	BOOL		The automation system shall control the drive.
Comp_speed_reached	BOOL		Speed => maximum speed
Limit_reached	BOOL		Comparison value for I,M or P exceeded
Holding_brake_open	BOOL		Signal for opening the motor holding break
Alarm_motor_overload	BOOL		No motor over temperature
Rotating_forward	BOOL		Rotational direction of the motor. Output is TRUE, if the motor rotates forward.
No_termal_overload	BOOL		No thermal overload of the power section
Actual_speed	REAL		Current speed in U/min. Negative values mean that the motor rotates backwards.
Actual_current	REAL		Current motor current in A

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Parameter	Data type	Initial value	Description
Actual_torque	REAL		Current motor torque in Nm Negative values mean that the motor decelerates.
Actual_alarm	REAL		Warning number of the currently pending warning
Actual_fault	REAL		Error number of the currently pending error

NOTICE	**To switch on SINAMICS G120, the enable signals** (marked bold in Table 5-2 Interfaces of FB 10 "PZD_G120_Tel_352") **should initially be set to TRUE, then it can be switched on with a positive edge (i.e. the signal changes from FALSE to TRUE) at ON/OFF1, of SINAMICS G120.**

Manual/automatic switchover (manual mode)

This function enables selecting whether SINAMICS G120 shall be controlled with the values pending at the block inputs, or whether internal values shall be used and the block inputs be ignored.
The internal values are located in the instance DB ("internal_Control_word" and "internal_Status_word") and can be specified by a visualization.

This enables realizing a switch-over between the values supplied by SIMATIC S7-300/400F (automatic) and the specification via a visualization (manual).

Independent of these settings, the bits of the status word and the actual values are always output.

DANGER	**When switching over (activating or deactivating the manual mode), the control word and the setpoint value are not adjusted. It is therefore possible when switching over that SINAMICS G120 automatically starts up or changes the speed.**

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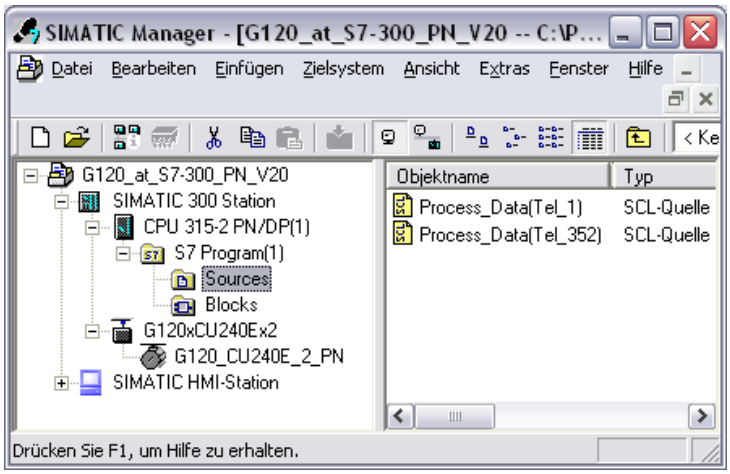
SCL language

FB 10 “PZD_G120_Tel_352” was created in SCL. During compilation in the block folder, the SCL editor generates a function block created in STL. It can be copied into your own projects and used without installed SCL.
SCL source “Process_Data(Tel_352)” is located in the “Sources” subfolder of the S7 program.
The SCL source can be exported via the context menu and then be viewed with any text editor.

Figure 5-6



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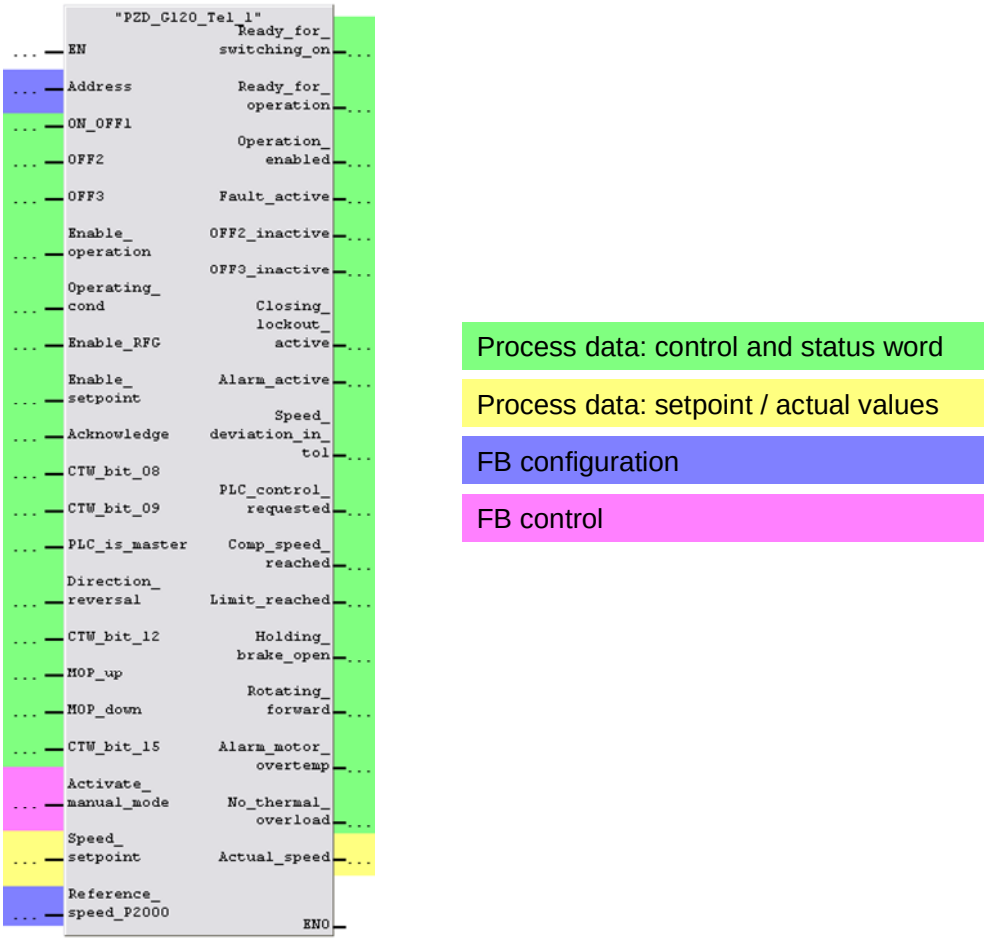
5.2 Change-over to the “Siemens message frame 1” (with FB11)

FB11 “PZD_G120_Tel_1” is, like FB10 “PZD_G120_Tel_352”, intended for transmission of process data, however, it expects message frame “Siemens message frame 1” instead of “Siemens message frame 352”.

The “message frame 1” only transfers two words in any direction: control word and setpoint value or status word and actual value.

Figure 5-7 FB 11 “ PZD_G120_Tel_1“



To switch over to message frame 1, you have to:

- select message frame1 for SINAMICS G120 in HW Config,
- call FB11“ PZD_G120_Tel_1” in OB1 instead of FB10 “PZD_G120_Tel_352”,
- load the program folder into the S7-300F CPU again (inc. system data, see Table 3-3 step 9),
- change the interface configuration of SINAMICS G120 to message frame 1 in the Starter, see Table 6-1 step 9) and
- adjust the HMI.

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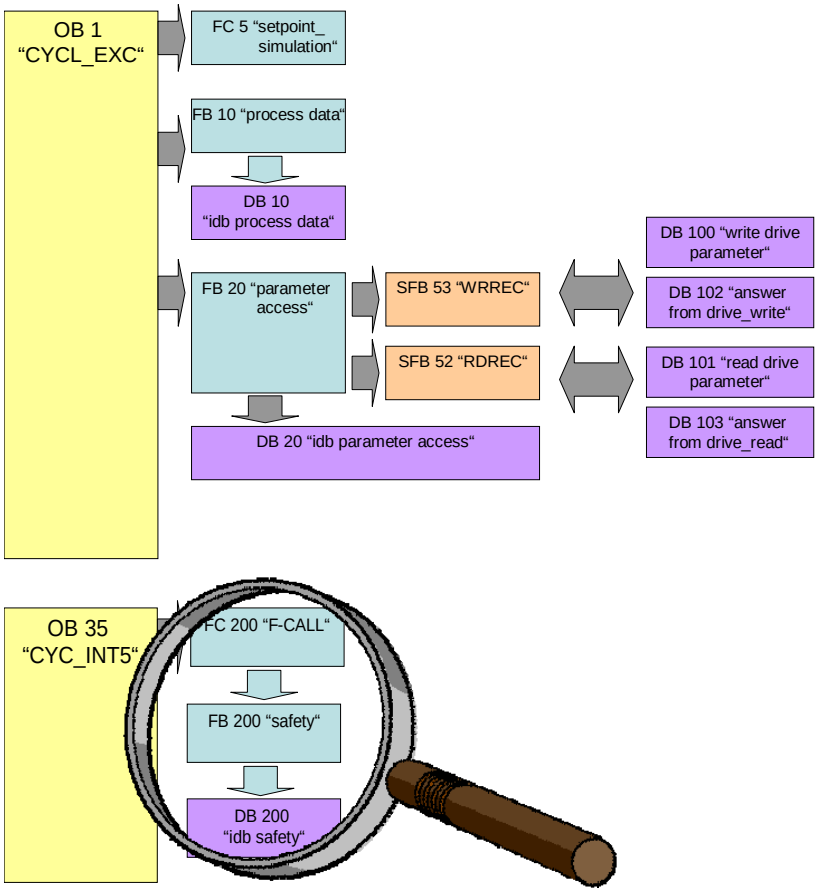
5.3 Safety functionality

Figure 5-8



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5.3.1 Configuration/settings

To be able to enable the transfer of safety-related data with PROFIsafe, two steps have to be performed.

- S7-CPU
  When configuring the message frames of SINAMICS G120 in HW Config the “PROFIsafe message frame 30 or 900” is added. The “message frame 30” enables using the standard safety functions of SINAMICS G 120; the “message frame 900” frame enables using the extended safety functions as well as transferring the failsafe inputs of SINAMICS G120.
- SINAMICS G120
  Enabling the PROFIsafe message frame is performed automatically by using the respective safety functions.
  If the PROFIsafe message frame 900 was used for the configuration of the S7-300F CPU, the transmission of the F-DI signal states has to be enabled.

5.3.2 FB 200 “Safety”

When programming the safety-related program parts, only the normal restrictions and programming rules for distributed safety have to be observed.

The F program of this example (FB200) is limited to the creation of a logic AND operation between the signal of a safe input of SINAMICS G120 and an F-DI module, using the result for the control/deactivation of a safety function.

Furthermore, the passivation bit of the F-DI and the SINAMICS G120 are read and the acknowledge signal for reintegrating both ‘modules’ is used.

The safety bits of the SINAMICS G120 can be accessed just as the bits of a SIMATIC F-DI/DO module in the safety program:

- In the example the input bytes 16 and 17 receive the PROFIsafe status word 1 and the input bytes 18 and 19 receive the PROFIsafe control word 5 of the “PROFIsafe message frame 900”.
- In the example, the PROFIsafe control word 1 of the “PROFIsafe message frame 900” is sent to the drive via the output bytes 16 and 17.

5.3.3 Safety control words and safety status words

Figure 5-9 Safety control word 1

Bit	Meaning	Comment				
0	STO	1	STO is deselected			
		0	STO is selected			
1	SS1	1	SS1 is deselected			
		0	SS1 is selected			
2, 3	*Reserved*					
4	SLS	1	SLS is deselected			
		0	SLS is selected			
5, 6	*Reserved*					
7	Internal event ack	1	Acknowledge serious safety function faults with a signal change 1 → 0			
		0	Do not acknowledge faults			
8	*Reserved*					
9	SLS-level, bit 0		Selection of the SLS level		Bit 10	Bit 9
				Level 1	0	0
10	SLS-level, bit 1			level 2	0	1
				level 3	1	0
				level 4	1	1
11	*Reserved*					
12	SDI Positive	1	SDI with positive direction of rotation is deselected			
		0	SDI with positive direction of rotation is selected			
13	SDI Negative	1	SDI with negative direction of rotation is deselected			
		0	SDI with negative direction of rotation is selected			
14, 15	*Reserved*					

Safety control word 5 only consists of reserved bits.

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Figure 5-10 Safety status word 1

Bit	Meaning	Comment				
0	Power removed	1	STO is active			
		0	STO is not active			
1	SS1 active	1	SS1 is active			
		0	SS1 is not active			
2, 3	*Reserved*					
4	SLS active	1	SLS is active			
		0	SLS is not active			
5, 6	*Reserved*					
7	Internal Event	1	The converter has detected a severe fault in the safety functions.			
		0	Fault-free operation			
8	*Reserved*					
9	SLS-level, bit 0		Active SLS level		Bit 10	Bit 9
				Level 1 level 2 level 3 level 4	0 0 1 1	0 1 0 1
10	SLS-level, bit 1					
11	*Reserved*					
12	SDI positive active	1	SDI positive direction of rotation is active			
		0	SDI positive direction of rotation is not active			
13	SDI negative active	1	SDI negative direction of rotation is active			
		0	SDI negative direction of rotation is not active			
14	*Reserved*					
15	Status SSM	1	Speed is within the SSM limit value			
		0	Speed is outside the SSM limit value			

Figure 5-11 Safety status word 5

Bit	Meaning	Comment		SINAMICS G120	SINAMICS G120D
0 … 7	*Reserved*	-			
8	Status of fail-safe inputs	0	LOW signal (0 V)	At terminals 5 and 6	At pins X7.2 and X7.4
		1	HIGH signal (24 V)		
9		0	LOW signal (0 V)	At terminals 7 and 8	At pins X8.2 and X8.4
		1	HIGH signal (24 V)		
10		0	LOW signal (0 V)	At terminals 16 and 17	At pins X9.2 and X9.4
		1	HIGH signal (24 V)		
11 … 15	*Reserved*	-			

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5.3.4 PROFIsafe addresses

F-DI module

In properties of the F-DI module you find the “F_dest_address” and the “DIP switch setting (9 to 0)”. Both lines contain the same information in different representation. The DIP switches of F-DI, must be set to this value.

Figure 5-12

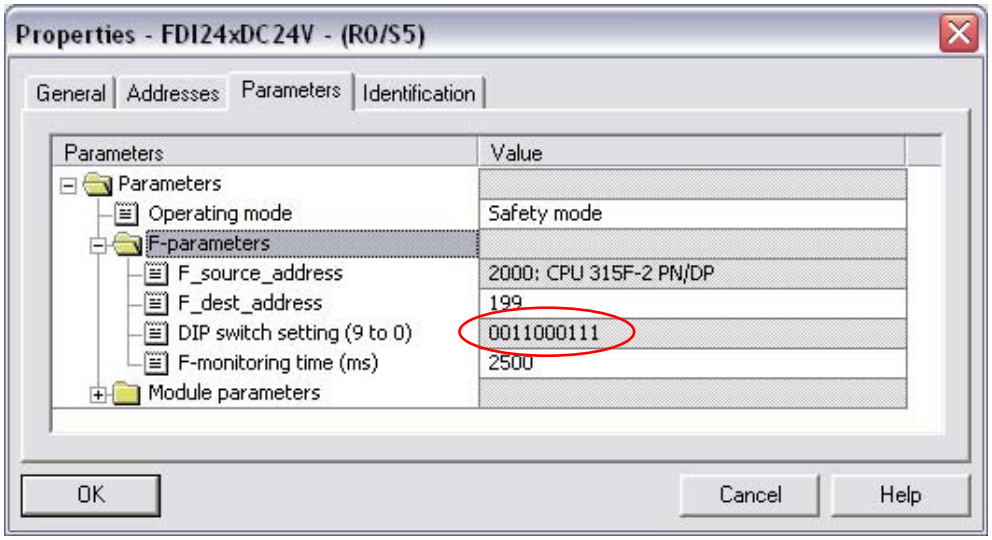
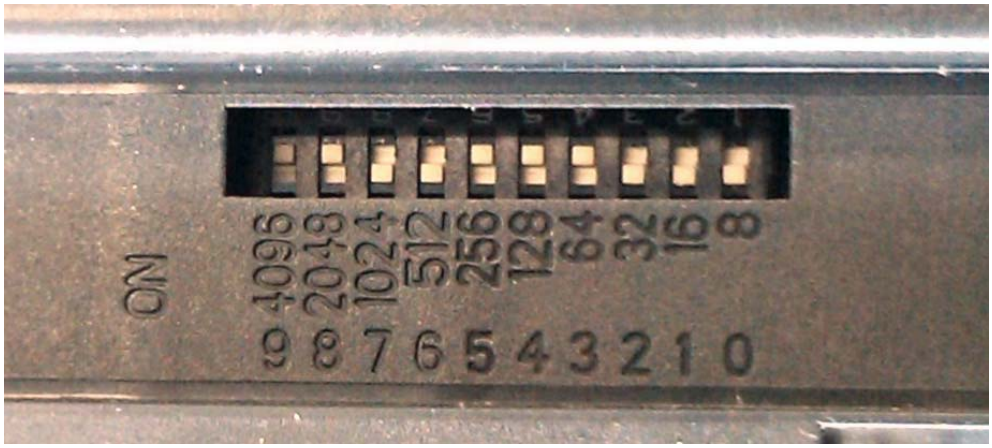


Figure 5-13



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SINAMICS G120

"F_Dest_Add" is available in the PROFIsafe tab of the Properties window for the Profisafe message frame of the SINAMICS G120 (see step 14 in Table 6-1). Enter this value when defining the configuration parameters for the safety functions of the drive.

Figure 5-14

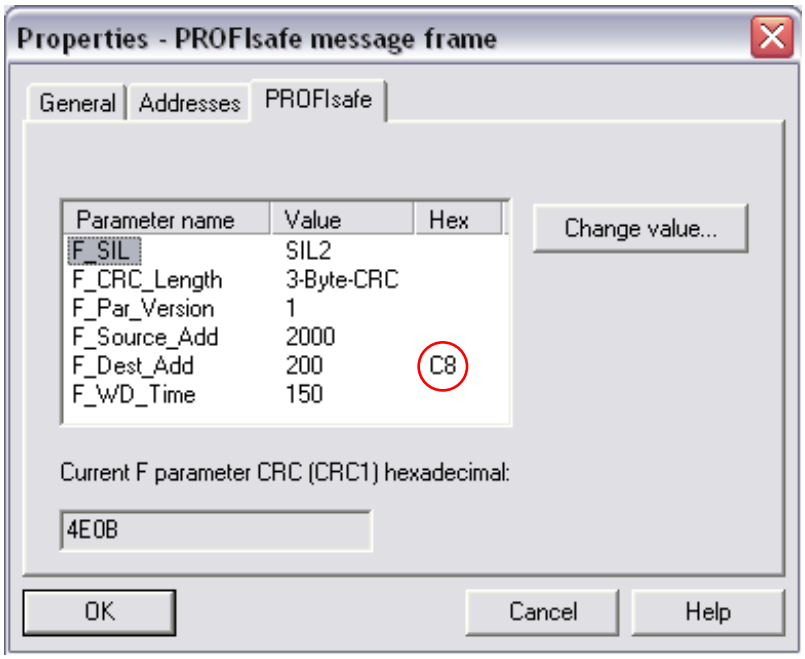
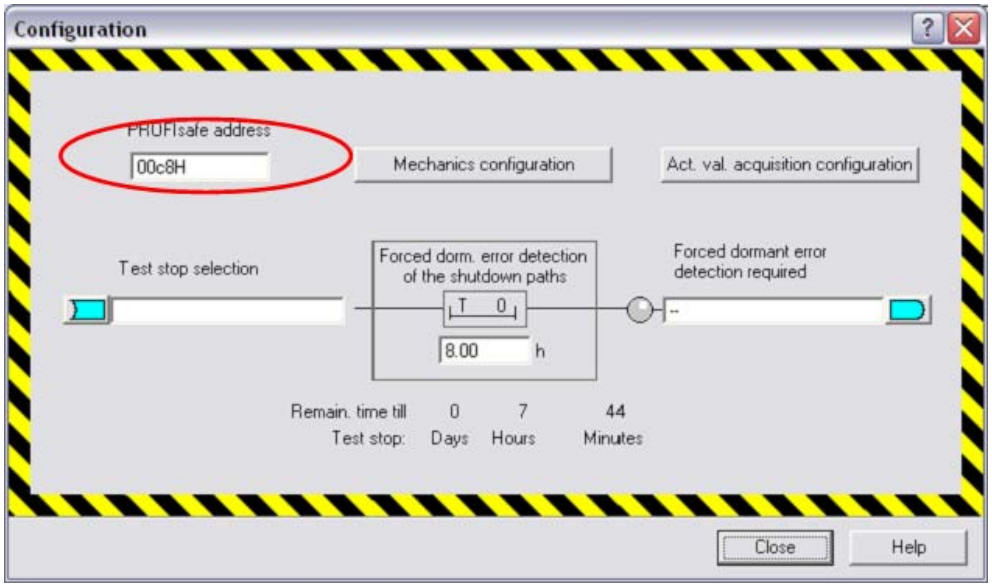


Figure 5-15



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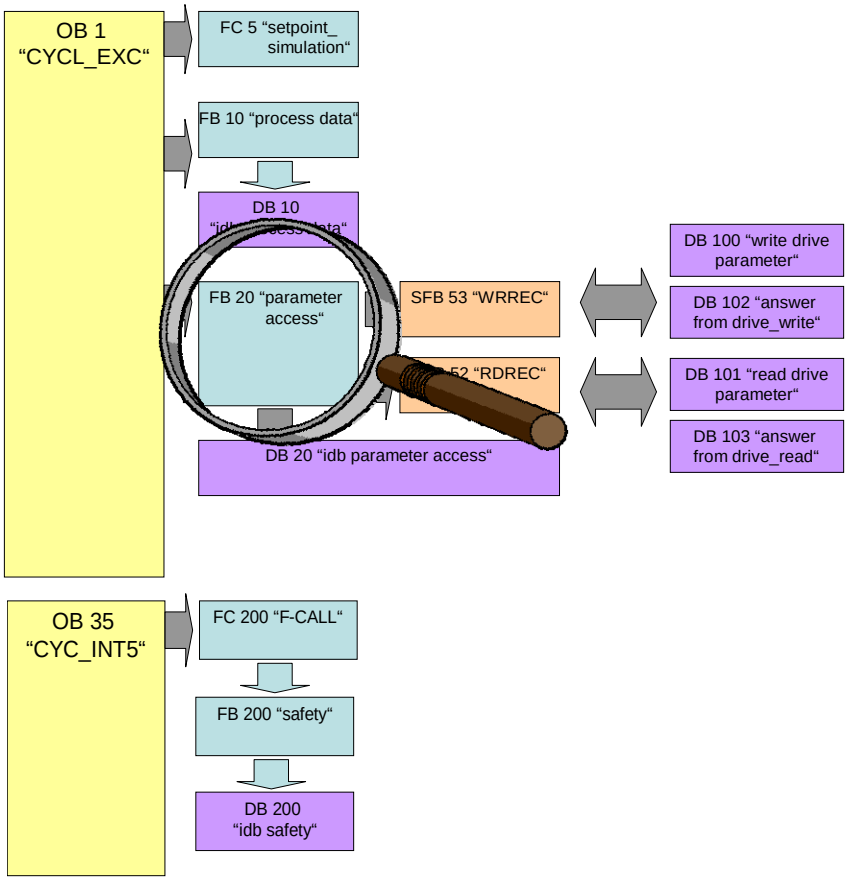
5.4 Parameter access functionality

Figure 5-16



Acyclic parameter access occurs parallel to the cyclic process data exchange. This saves resources, since this connection is only established on demand, i.e. when accessing a parameter.

In S7-300/400F, the “Write data record” and “Read data record” functions must be used. Data record 47 must always be used.

Writing data record 47 sends a job to the SINAMICS G120 which performs the job and provides a response. Reading data record 47 makes the response of SINAMICS G120 available in S7-300/400F and can be evaluated.

For reading and writing data records, the system function blocks SFB 53 “WRREC” and SFB 52 “RDREC” are used in S7-300/400F.

The structure of data record 47 is available in chapter 6.1.5.1 “Configuring the fieldbus, PROFIdrive profile for PROFIBUS and PROFINET, acyclic communication” in the operating instruction (/7/)

Note Since SFB 53 “WRREC” and SFB 52 “RDREC” are not used with CP341-1, the parameter access is not possible when using this CP.

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5.4.1 FB 20 “Parameter_Access”

The parameters are accessed in FB 20 “Parameter_Access”. It is called cyclically in OB 1. The block was created so they can simply be used in own applications.

Figure 5-17

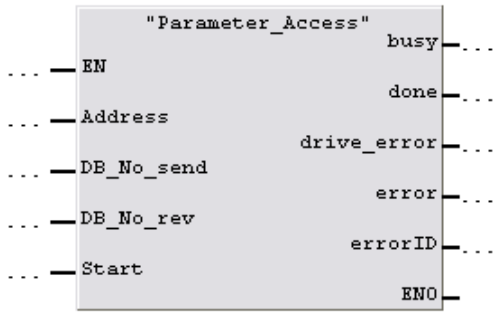

Table 5-3 Interfaces of FB 20 “Parameter_Access”

Parameter	Data type	Initial value	Description
Input parameters			
Address	INT	0	IO address of SINAMICS G120. Here, the IO address must be specified which was assigned for message frame “Siemens message frame 352” of SINAMICS G120 in HW Config. Input and output address must be identical to be able to use this block.
DB_No_send	INT	0	Number of the DB in which the data record to be sent is stored.
DB_No_rev	INT	0	Number of the DB in which the response of SINAMICS G120 is to be stored.
START	BOOL	FALSE	The transmission is started with a rising edge at START.
Output parameters			
Busy	BOOL		Transmission active
Done	BOOL		Job successfully transferred.
Drive_Error	BOOL		Job successfully transferred, however, the job could not or only partially be completed by SINAMICS G120. The response contains the error detection.
Error	BOOL		Access aborted with transmission error
ErrorID	WORD		Cause of the abort (see subsequent error list)

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Error list

The FB 20 “Parameter_Access” can output the following error codes:

Table 5-4

Error number	Description	Note
0	No error	☺
8000	DB_No_send and DB_No_rev are identical.	Check the parameters of FB 20 “Parameter_Access”.
8001	DB_No_rev or DB_No_send is zero.	
8002	SFC53 “WEREC” outputs errors	In the instance DB, the error code of the SFC is stored in #WD_REC_STATUS.
8003	SFC53 “WEREC” outputs errors	In the instance DB, the error code of the SFC is stored in #RD_REC_STATUS.
8004	Send DB is empty (length 0), non existent or faulty.	In the instance DB, the error code of the SFC24 “TEST_DB” is stored in #TEST_DB_1_STATUS. If the code is 0, the DB is empty or write protected.
8005	Receive DB is empty (length 0), non existent or faulty.	In the instance DB, the error code of the SFC24 “TEST_DB” is stored in #TEST_DB_2_STATUS. If the code is 0, the DB is empty or write protected.

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Drive error

If during processing a job in SINAMICS G120 an error occurred, and the error detection was set in the response, the response DB must be analyzed to find out the cause of the error.

Function

FB 20 “Parameter_Accesss” only transfers the selected DBs to or from SINAMICS G120 and checks, whether the transmission was successful. It is also checked, whether the error detection was set in the response of the SINAMICS G120.

The structure of the error detection is available in chapter 6.1.5.1 “Configuring the fieldbus, PROFIdrive profile for PROFIBUS and PROFINET, acyclic communication” in the operating instruction (/7/)

Structure

The “Parameter” FB consists of three parts:

- Checking the DB_No_xx input parameters
  Network 1
- A step chain which controls the sequence of the parameter access.
  Networks 2 to 10
- Call of the system functions “Read data record” or “Write data record”.
  Network 11

Checking the DB_No_xx input parameters

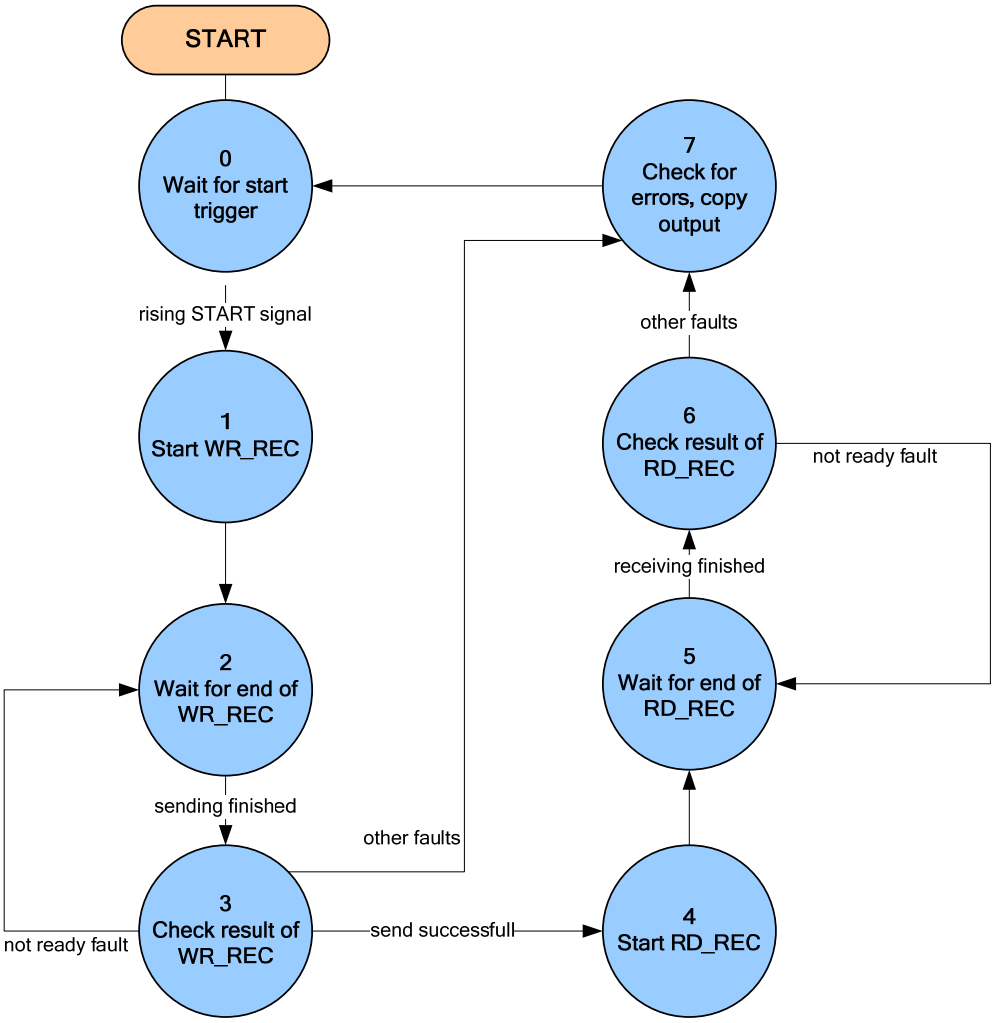
It is checked, whether input parameters DB_No_send and DB_No_rev are equal or if they were parameterized with “0”. One respective error message is output.

Note Network 1 with checking the DB_No_xx input parameters can be deleted to save computing time and storage space without affecting the other functions of the block.

Step chain

The step chain of FB 20 “Parameter_access” is represented in the following graphic. The possible transitions between the individual steps are also displayed there.

Figure 5-18 Step chain



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In the individual states of the step chain, the following functions are executed:

Table **5**-5: Function of the states of FB 20 “Parameter_access”

State		Function
0	Wait for start trigger	Waiting for a rising edge of the “START” signal. If it is detected, all output signals will be deleted, “BUSY” will be set and step 1 will be activated.
1	Start WR_REC	The “REQ” signal of SFB 53 “WRREC” is set and step 2 is activated.
2	Wait for end of WR_REC	Waiting until the “busy” signal of SFB 53 “WRREC” becomes 0 again. Then step 3 is activated.
3	Check result of WR_REC	It is checked whether the data record was written successfully. If so, the “REQ” signal of SFB 53 “WRREC” will be deleted again and step 4 will be activated. If SFB 53 “WRREC” reports the error 16#DF80_B500 (peer not ready), step 3 will be activated again and SFB 53 “WRREC” will repeat the job. If a different error has occurred, the “REQ” signal of SFB 53 “WRREC” will be deleted, an internal error bit will be set and step 7 will be activated.
4	Start RD_REC	The “REQ” signal of FB “RDREC” is set and step 5 is activated.
5	Wait for end of RD_REC	It is waited until the “busy” signal of FB “RDREC” becomes 0 again. Then step 6 is activated.
6	Check result of RD_REC	Check whether the data record has been read successfully. If so, the “REQ” signal of SFB 52 “RDREC” will be deleted again and step 7 will be activated. If SFB 52 “RDREC” reports the error 16#DE80_B500 (peer not ready), step 5 will be activated again and FB “RDREC” will repeat the job. If a different error has occurred, the “REQ” signal of SFB 52 “RDREC” will be deleted, an internal error bit will be set and step 7 will be activated.
7	Check for errors, copy outputs	It is checked whether one of the internal error bits has been set. If an error bit has been set, - the “ERROR” signal will be set, - the “BUSY” signal deleted, - step 0 activated. If no error bit has been set, the read times will be output, the “BUSY” will be deleted, the “DONE” will be set and step 0 will be activated.

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Call of the “Read data record” or “Write data record” system functions

After the currently required control bits were set in the sequence chart of FB 20 “Parameter_access”, the “Write data record” and “Read data record” system functions (SFB 53 “WRREC” and SFB 52 “RDREC”) are called in network 10.

It is initially checked, whether the DB to be used exists in the S7-300/400F CPU and how long it is. This creates an ANY pointer, which references the data to be send/received, and calls the SFC.

5.4.2 The DBs “read/write_drive_parameters” and “answer_from_drive”

To access the parameters, a given job structure must be kept. The response of SINAMICS G120 also contains a given response structure.

Job and response structure

The structure of the jobs and responses are available in chapter 7.3.2.1 “Configuring the fieldbus, PROFIdrive profile for PROFIBUS and PROFINET, acyclic communication” in the operating instruction (/7/)

Note

Since the structure of the data record to be sent or received depends on the number of jobs and their number format, a generally valid structure cannot be used.

FB 20 “Parameter_Access” is therefore limited to sending and receiving the data record. The DBs for the data record to be send and received must be set by the user.

The job to access a parameter consists of at least 10 words. Therefore, the job should be assembled in a DB. The response by the SINAMICS G120 also consists of several words.

A job may contain the access to several parameters. Since the length of the data to be transferred per job depends on the number and data types of the SINAMICS G120 parameters, no generally valid structure can be devised.

In this example, only the ramp up and ramp down times (P1120 and P1121) and a part of the fault memory (P945.x) is accessed. The job of writing the parameters is stored in DB 100 “write_drive_parameters” and the job to read the parameters in DB 101 “read_drive_parameters”.

The response of the SINAMICS G120 is copied to DB 102 “answer_from_drive_write” or DB 103 “answer_from_drive_write_read”. The structure contained therein corresponds to the structure for a successful writing/reading of the parameters.

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Figure 5-19 DB 100 for writing the ramp up and ramp down time (in the picture: 10s and 15 s)

DB100 -- "write_drive_parameters" -- G120_at_S7\SIMATIC 300 Station\CPU 315-2 PN/DP(1)\...\DB100

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	H_Reference	BYTE	B#16#0	HEAD: Reference number
+1.0	H_Request_ID	BYTE	B#16#2	HEAD: Request ID: 1=read, 2=write
+2.0	H_Axis	BYTE	B#16#1	HEAD: Always 1 for SINAMICS G120
+3.0	H_Number_of_parameters	BYTE	B#16#2	HEAD: Number of parameters to transfer
+4.0	A_1_Attribute	BYTE	B#16#10	Address: 16#10= parameter value
+5.0	A_1_Number_of_indices	BYTE	B#16#0	Address: Number of elements (0 to 234)
+6.0	A_1_Parameter_number	INT	1120	Address: Parameter number
+8.0	A_1_Index	INT	0	Address: Index number
+10.0	A_2_Attribute	BYTE	B#16#10	Address: 16#10= parameter value
+11.0	A_2_Number_of_indices	BYTE	B#16#0	Address: Number of elements (0 to 234)
+12.0	A_2_Parameter_number	INT	1121	Address: Parameter number
+14.0	A_2_Index	INT	0	Address: Index number
+16.0	V_1_Format	BYTE	B#16#8	Value: Format of parametr value
+17.0	V_1_Number_of_index_valu	BYTE	B#16#1	Value: Number of index values
+18.0	V_1_Value	REAL	1.000000e+001	Value: Parameter value
+22.0	V_2_Format	BYTE	B#16#8	Value: Format of parametr value
+23.0	V_2_Number_of_index_valu	BYTE	B#16#1	Value: Number of index values
+24.0	V_2_Value	REAL	1.500000e+001	Value: Parameter value
=28.0		END_STRUCT		

Figure 5-20 DB 102 for the response to the write job

DB102 -- "answer_from_drive_write" -- G120_at_S7\SIMATIC 300 Station\CPU 315-2 PN/DP(1)\...\DB102

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	H_Reference	BYTE	B#16#0	HEAD: Reference number (mirrored)
+1.0	H_Response_ID	BYTE	B#16#0	HEAD: Response ID: 8xh=error, 0xh=ok
+2.0	H_Axis	BYTE	B#16#0	HEAD: Always 1 for SINAMICS G120
+3.0	H_Number_of_parameters	BYTE	B#16#0	HEAD: Number of parameters to transfer
+4.0	Value_01	BYTE	B#16#0	
+5.0	Value_02	BYTE	B#16#0	
+6.0	Value_03	BYTE	B#16#0	
+7.0	Value_04	BYTE	B#16#0	
+8.0	Value_05	BYTE	B#16#0	
+9.0	Value_06	BYTE	B#16#0	
+10.0	Value_07	BYTE	B#16#0	
+11.0	Value_08	BYTE	B#16#0	
+12.0	Value_09	BYTE	B#16#0	
+13.0	Value_010	BYTE	B#16#0	
+14.0	Value_011	BYTE	B#16#0	
+15.0	Value_012	BYTE	B#16#0	
+16.0	Value_013	BYTE	B#16#0	
+17.0	Value_014	BYTE	B#16#0	
+18.0	Value_015	BYTE	B#16#0	
+19.0	Value_016	BYTE	B#16#0	
=20.0		END_STRUCT		

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Figure 5-21 DB 101 for reading the ramp up and ramp down time and 16 values of the fault memory

DB101 -- "read_drive_parameters" -- G120_at_S7\SIMATIC 300 Station\CPU 315-2 PN/DP(1)\...\DB101

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	H_Reference	BYTE	B#16#0	HEAD: Reference number
+1.0	H_Request_ID	BYTE	B#16#1	HEAD: Request ID: 1=read, 2=write
+2.0	H_Axis	BYTE	B#16#1	HEAD: Always 1 for SINAMICS G120
+3.0	H_Number_of_parameters	BYTE	B#16#3	HEAD: Number of parameters to transfer
+4.0	A_1_Attribute	BYTE	B#16#10	Address: 16#10= parameter value
+5.0	A_1_Number_of_indices	BYTE	B#16#0	Address: Number of elements (0 to 234)
+6.0	A_1_Parameter_number	INT	1120	Address: Parameter number
+8.0	A_1_Index	INT	0	Address: Index number
+10.0	A_2_Attribute	BYTE	B#16#10	Address: 16#10= parameter value
+11.0	A_2_Number_of_indices	BYTE	B#16#0	Address: Number of elements (0 to 234)
+12.0	A_2_Parameter_number	INT	1121	Address: Parameter number
+14.0	A_2_Index	INT	0	Address: Index number
+16.0	A_3_Attribute	BYTE	B#16#10	Address: 16#10= parameter value
+17.0	A_3_Number_of_indices	BYTE	B#16#16	Address: Number of elements (0 to 234)
+18.0	A_3_Parameter_number	INT	945	Address: Parameter number
+20.0	A_3_Index	INT	0	Address: Index number
=22.0		END_STRUCT		

Figure 5-22: DB 103 for the response of the read job

DB103 -- "answer_from_drive_read" -- G120_at_S7\SIMATIC 300 Station\CPU 315-2 PN/DP(1)\...\DB103

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	H_Reference	BYTE	B#16#0	HEAD: Reference number (mirrored)
+1.0	H_Response_ID	BYTE	B#16#0	HEAD: Response ID: 8xh=error, 0xh=ok
+2.0	H_Axis	BYTE	B#16#0	HEAD: Always 1 for SINAMICS G120
+3.0	H_Number_of_parameters	BYTE	B#16#0	HEAD: Number of parameters to transfer
+4.0	V_1_Format	BYTE	B#16#0	Value: Format of parameter value (44h=error)
+5.0	V_1_Number_of_index_valu	BYTE	B#16#0	Value: Number of index values
+6.0	V_1_Value	REAL	0.000000e+000	Value: Parameter value
+10.0	V_2_Format	BYTE	B#16#0	Value: Format of parameter value
+11.0	V_2_Number_of_index_valu	BYTE	B#16#0	Value: Number of index values
+12.0	V_2_Value	REAL	0.000000e+000	Value: Parameter value
+16.0	V_3_Format	BYTE	B#16#0	Value: Format of parameter value
+17.0	V_3_Number_of_index_valu	BYTE	B#16#0	Value: Number of index values
+18.0	V_3_Value_00	WORD	W#16#0	Value: Parameter value
+20.0	V_3_Value_01	WORD	W#16#0	Value: Parameter value
+22.0	V_3_Value_02	WORD	W#16#0	Value: Parameter value
+24.0	V_3_Value_03	WORD	W#16#0	Value: Parameter value
+26.0	V_3_Value_04	WORD	W#16#0	Value: Parameter value
+28.0	V_3_Value_05	WORD	W#16#0	Value: Parameter value
+30.0	V_3_Value_06	WORD	W#16#0	Value: Parameter value
+32.0	V_3_Value_07	WORD	W#16#0	Value: Parameter value
+34.0	V_3_Value_08	WORD	W#16#0	Value: Parameter value
+36.0	V_3_Value_09	WORD	W#16#0	Value: Parameter value
+38.0	V_3_Value_10	WORD	W#16#0	Value: Parameter value
+40.0	V_3_Value_11	WORD	W#16#0	Value: Parameter value
+42.0	V_3_Value_12	WORD	W#16#0	Value: Parameter value
+44.0	V_3_Value_13	WORD	W#16#0	Value: Parameter value
+46.0	V_3_Value_14	WORD	W#16#0	Value: Parameter value
+48.0	V_3_Value_15	WORD	W#16#0	Value: Parameter value
=50.0		END_STRUCT		

Note Since the structure of the data record to be sent or received depends on the number of jobs and their number format, a generally valid structure cannot be used.

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5.5 Function of the further blocks in the example projects

Apart from FB10 and FB20 further blocks are contained in the example projects which are necessary to make the examples runnable.

These tables are:

Table 5-6

Block	Function
OB86	If the connection to a PROFIBUS station is interrupted or restored, the S7-300/400F CPU calls these error organization blocks. If this OB does not exist in the S7-300/400F CPU, it goes to STOP instead. In this OB, the user can program a reaction to a failed or restored station, in this example it is empty.
FC5	Function for generating a speed setpoint value using the digital inputs. The setpoint value is stored in MD0. This block is not intended for use in your own projects.
VAT_Process_Data_Tel_x	Value tables for monitoring and control of FB10, FB11 and FB20.
VAT_Parameter_Access	
VAT_Safety	Value table for monitoring the F-DI/O and the data of the PROFIsafe message frame.

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6 Configuration and Settings

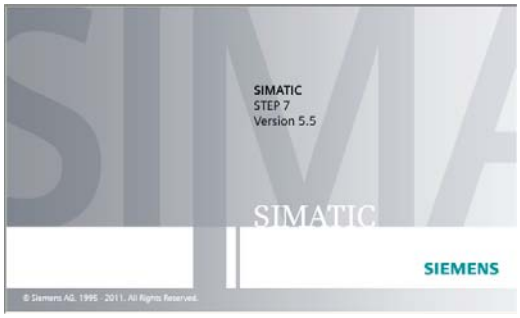
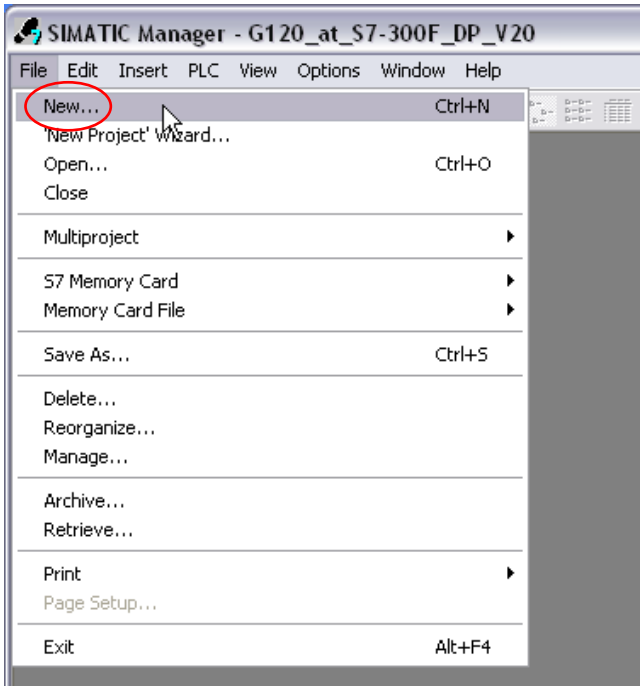
Note If you only wish to download and commission the example program, please follow the instructions in chapter 3 “Setup and Commissioning”.

The step tables below describe what you have to do if you do not want to or cannot use the sample code and you want to or have to configure SINAMICS G120 and SIMATIC S7-300/400F CPU yourself.

6.1 Configuring the S7-300/400F controller

This chapter describes how the S7-300/400F must be configured for the example program. Integrating the operator panel and programming of the S7-300/400F is not discussed here.

Table 6-1

No.	Action	Remarks
1.	Start STEP 7 V5.	
2.	• Create a new project: - Add an S7-300 station. - Enter a CPU 315F-2PN/DP (6ES7315-2FJ14-0AB0) in the hardware configuration of the new station or another S7-300/400F CPU which supports the data record routing, see /10/. - Assign the IP 192.168.0.1 with subnet mask 255.255.255.0 - Create a new Ethernet network	

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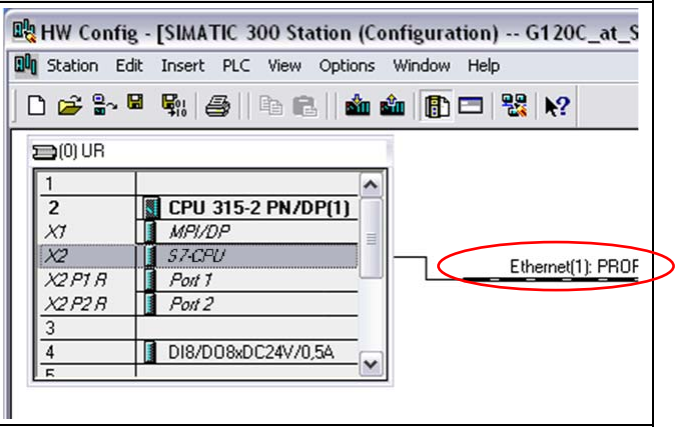
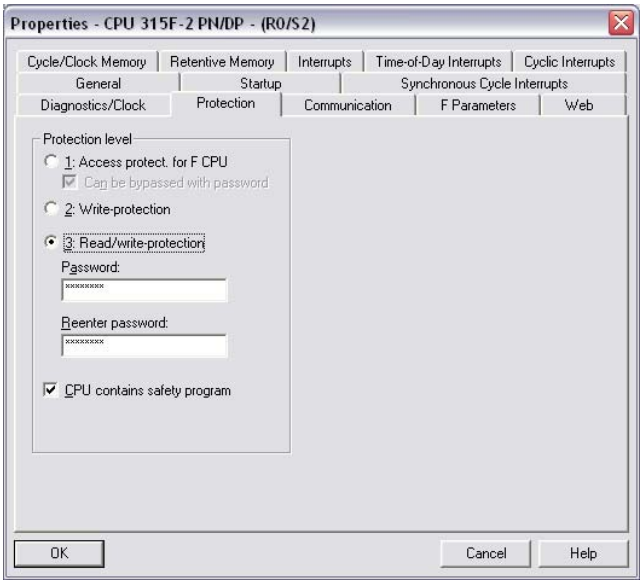
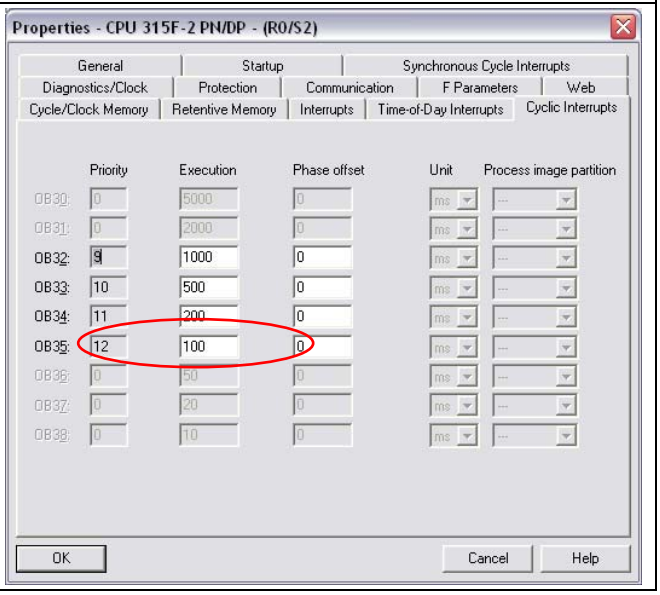
No.	Action	Remarks
3.	Ensure that the PROFINET network is displayed.	
4.	Call up the properties of the S7-300/400F CPU • Select level 3 in the “Protection” tab and assign a password (e.g. “siemens”) • Checkmark “CPU contains safety program”.	
5.	Select the Cyclic Interrupts tab • Make sure that the time for OB35 is set to 100ms. • Close the Properties of the S7-300/400F CPU with OK	

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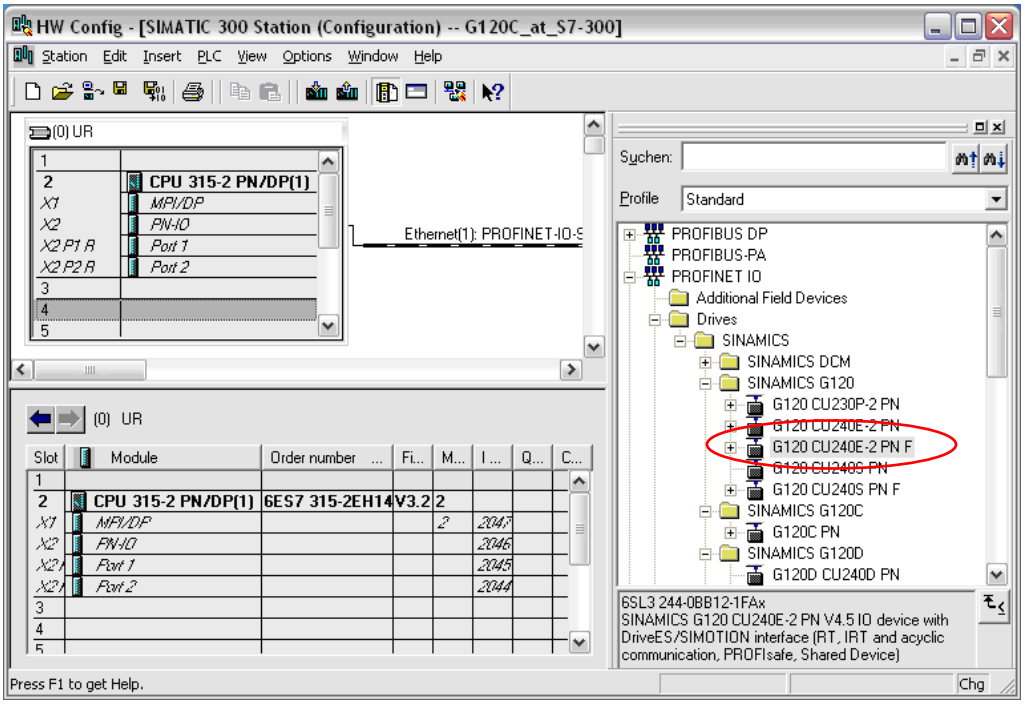
No.	Action	Remarks
6.	• Search your SINAMICS G120 in the catalog: The path in the catalog is: > PROFINET IO > Drives > SINAMICS > SINAMICS G120x • Then select your CU (Control Unit). Depending on which SINAMICS G120 you have, you must use one of the following entries: **SINAMICS G120 :** - G120 CU240E-2 PN - G120 CU240E-2 PN F **SINAMICS G120C**: - G120C PN **SINAMICS G120D**: - G120D CU 240D-2 PN - G120D CU 240D-2 PN F  The picture shows the example of a selected SINAMICS G120 with CU 240E-2 PN-F.	

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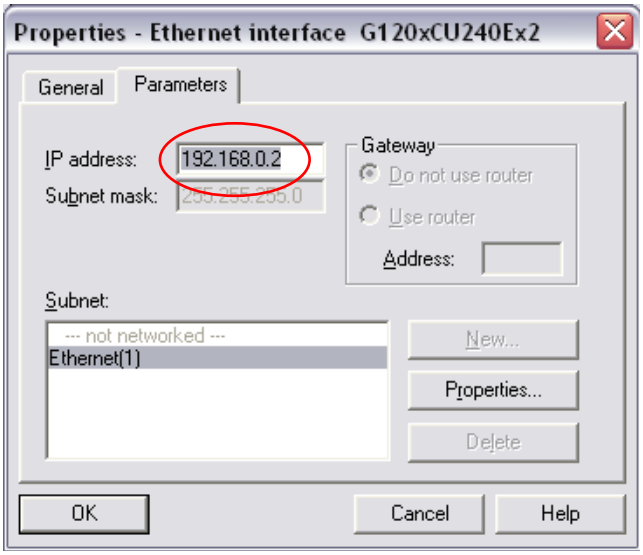
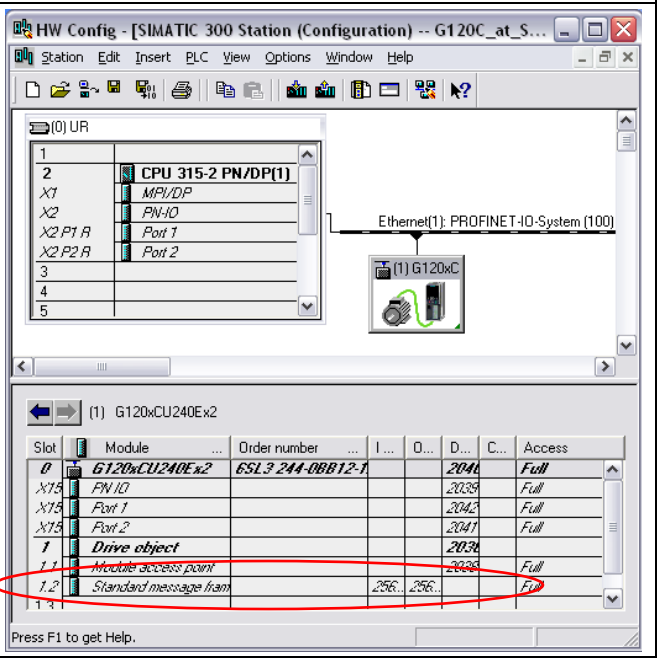
No.	Action	Remarks
7.	• Drag the selected CU **onto** the PROFINET line and release the mouse button. The window for selecting the Ethernet interface opens automatically: • Select address 192.168.0.2 for SINAMICS G120. • Click the OK button.	
8.	Double-click slot 1.2 of SINAMICS G120, so its properties are displayed.	

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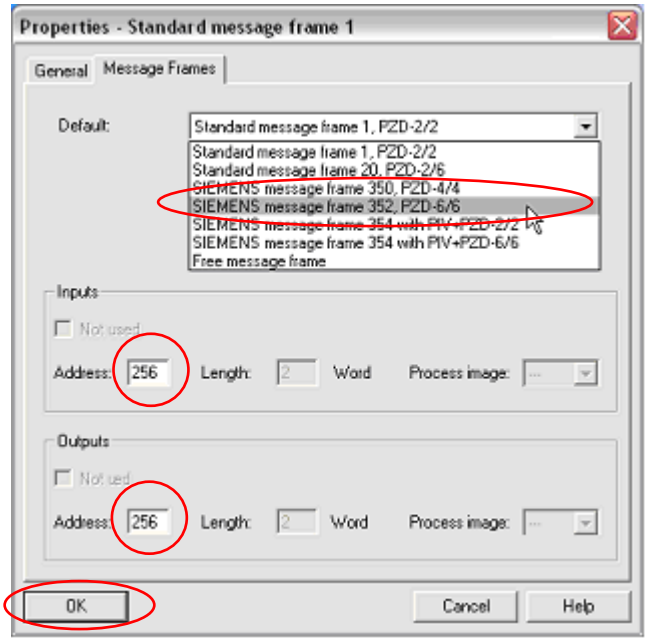
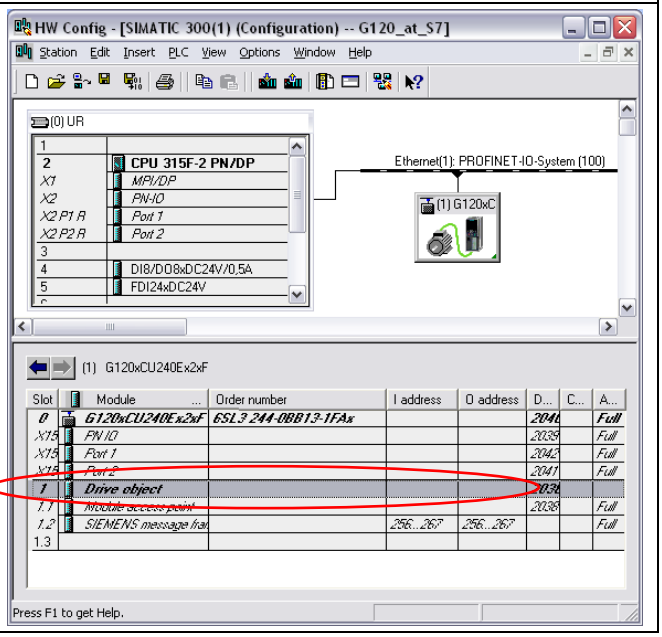
No.	Action	Remarks
9.	• Go to the “Message Frames” tab. • Select the “Siemens message frame 352, PZD 6/6” • Ensure that the I-address and the Q-address are both 256 respectively. • Click OK to close the dialog box	
10.	Double-click slot 1 (drive object) of SINAMICS G120, so its properties are displayed.	

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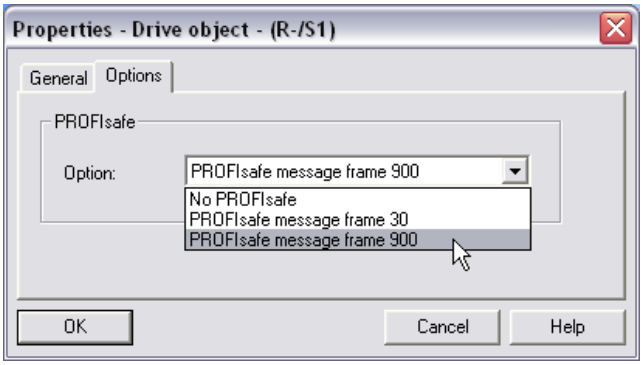
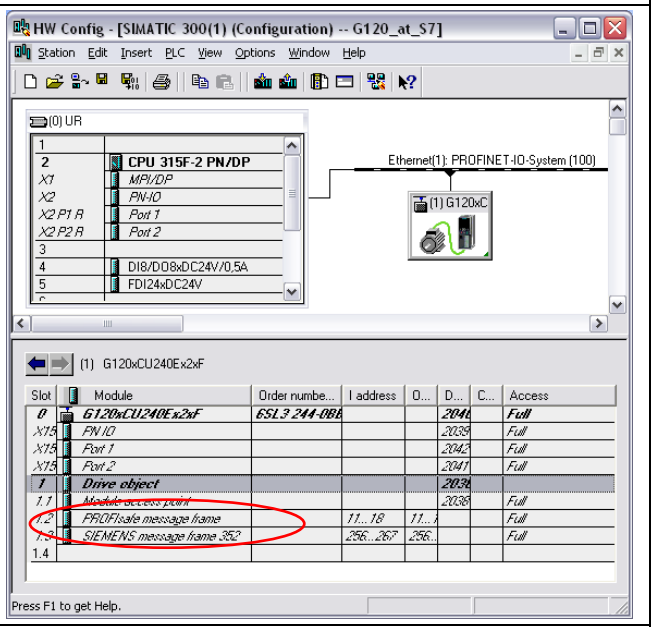
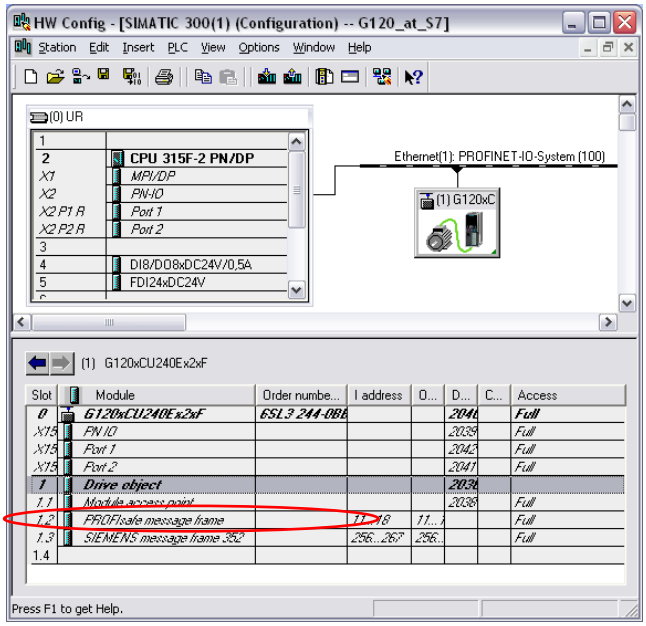
No.	Action	Remarks
11.	• Select the PROFIsafe message frame to be used. The “message frame 30” only transfers safety control word 1, The “message frame 900” also transfers safety control word 5 (with the information on the F-DI of SINAMICS G120) For CU240x-2 PN and the SINAMICS G120C only the “message frame 30” is available.	
12.	Check that now • a “PROFIsafe message frame **and** • the “Siemens message frame 352 frame” are displayed.	
13.	Double-click slot 1.2 of SINAMICS G120 (PROFIsafe message frame), so its properties are displayed.	

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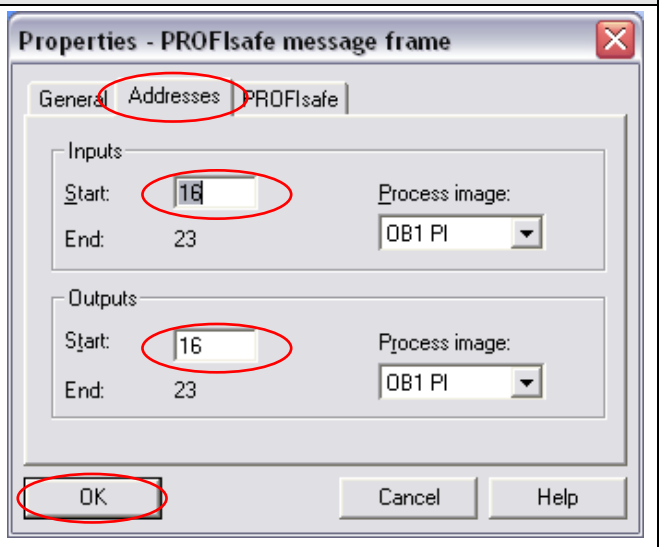
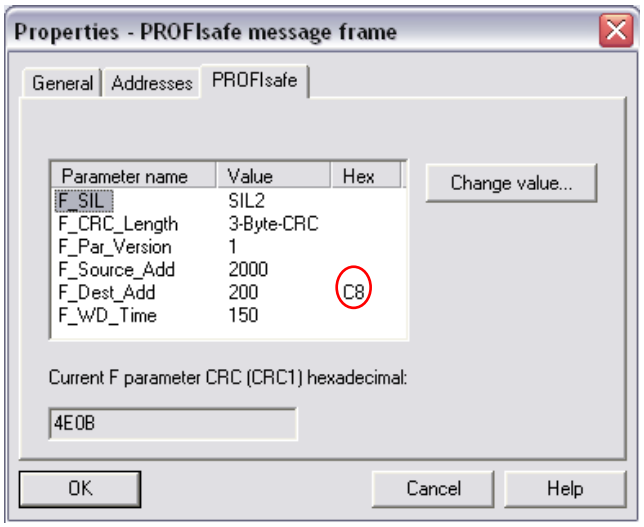
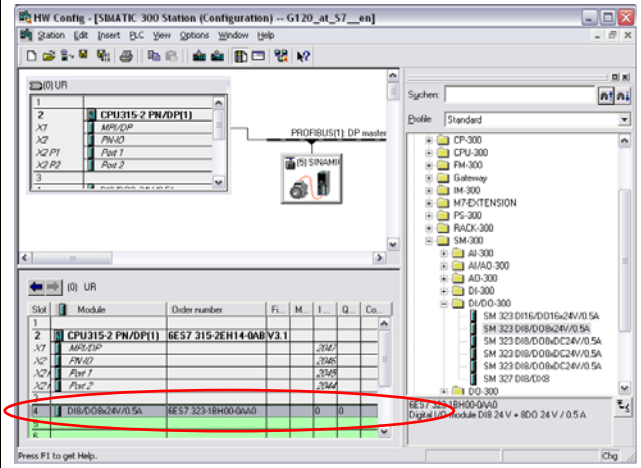
No.	Action	Remarks
14.	• If asked for a safety password, enter “siemens”, for example. • Change the I and Q address in the Addresses tab to 16. The safety functions of the drive are addressed via this address. • Note the “F_Dest_Add” in the PROFIsafe tab in Hex. You will need this value when configuring the SINAMICS G120 safety functions (step 20 in Table 6-2). • Click “OK” to close the Properties dialog.	 
15.	Enter a DI or DI/DO module (e.g. 6ES323-1BH01-0AA0) on slot 4 of the central rack. Please ensure that the I-address is 0.	

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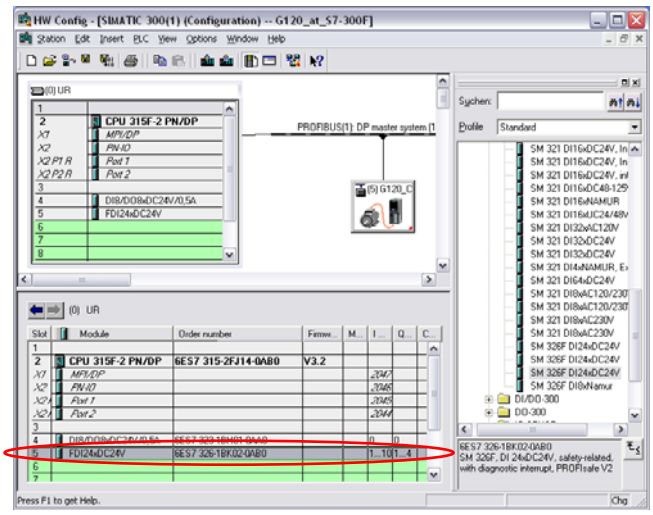
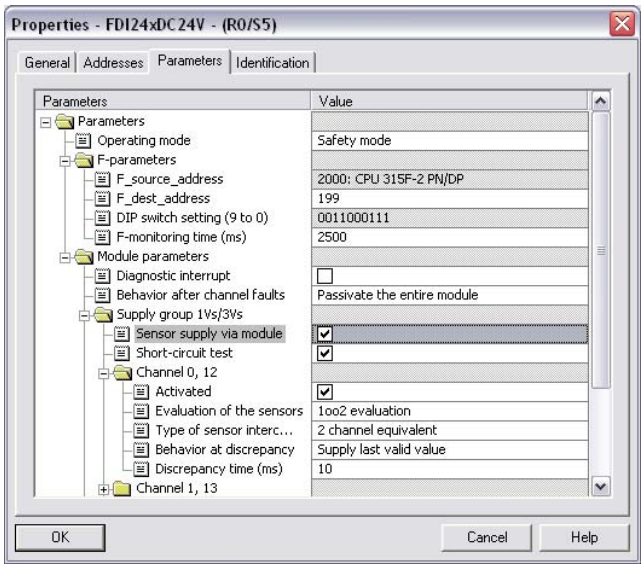
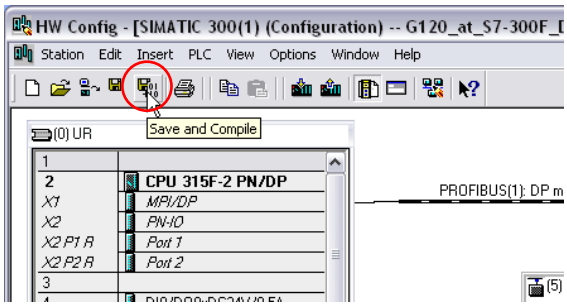
No.	Action	Remarks
16.	Please enter an F-DO module on slot 5 of the central rack (e.g. 6ES323-1BH00-0AA0). Make sure that the I/Q-address is set to1.	
17.	Open the Properties of the F-DI module and go to the “Parameter” tab • Set the DIP switches on the rear of the F-DI according to the details in “F parameter > DIL switch position (9...0)” (see chap. 3.2) • Activate “Sensor supply via module” in the module parameters in the tree. • Quit the dialog box with “OK”.	
18.	Click “Save and compile”	

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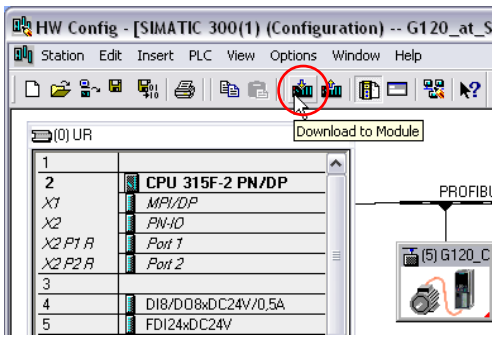
No.	Action	Remarks
19.	Download the configuration to the S7-300/400F CPU. Thus, the hardware configuration is completed.	

Note

To be able to use the safety data of the drive in the safety program, the following must be created according to the programming regulations of Distributed Safety. At least

- one F-runtime group
- one F-CALL block and
- one safety FB

Further information is available in the “S7 Distributed Safety – Configuration and programming” manual, see /9/

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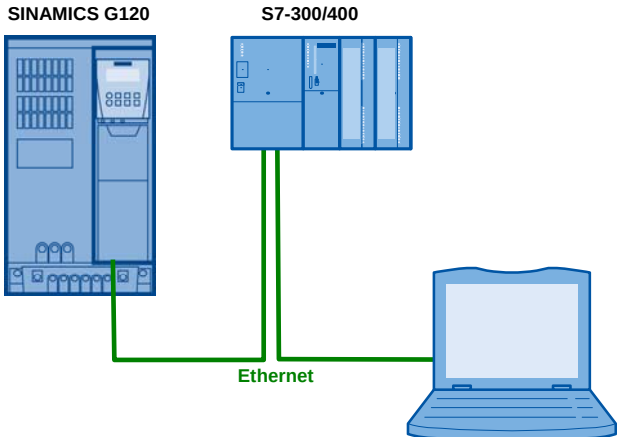
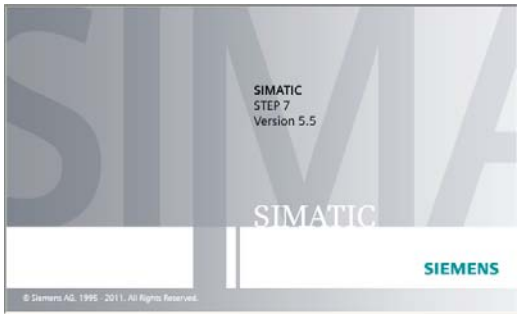
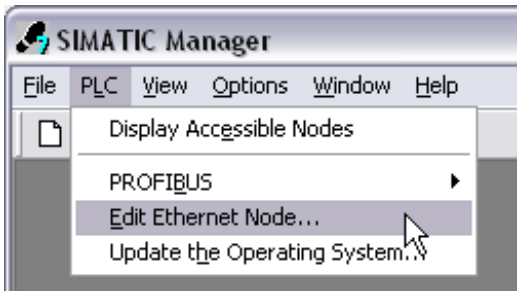
6.2 Configuring the SINAMICS G120 drive

The subsequent configuration instruction assumes that the SINAMIC G120 is to be accessed via routing.

Table 6-3

No.	Action	Remarks
1.	If still unsuccessful, install the STARTER commissioning software (see /6/).	
2.	Connect SINAMICS G120 and S7-300 via network cables.	
3.	Start the SIMATIC Manager and open the project created in chapter 6.1 "Configuring the S7-300F/400F controller".	
4.	Call up the "Edit Ethernet Node…" dialog.	

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<table>
<tr>
<td>4</td>
<td>

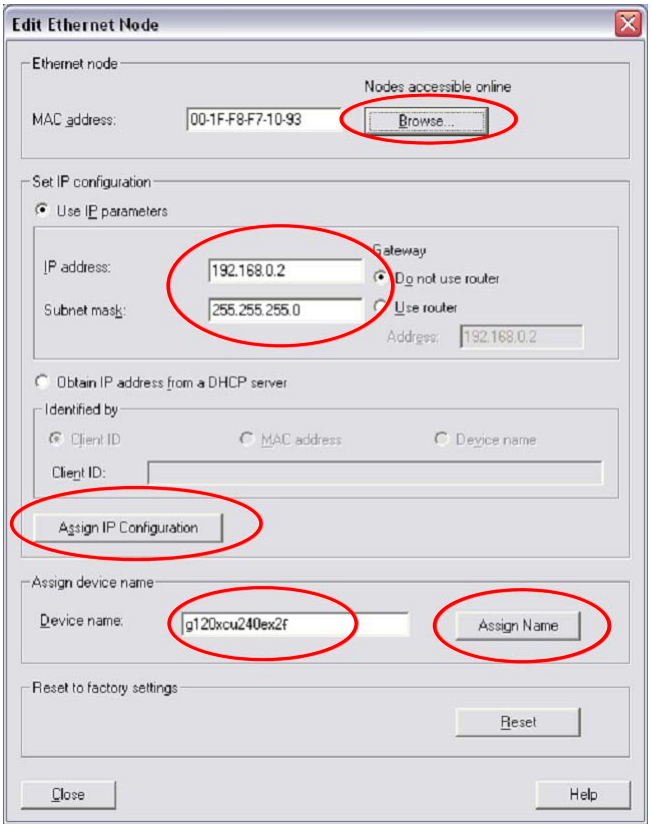
Click on “Browse...”

Select the SINAMICS G120 and click on OK.

Enter the IP address 192.168.0.2 and the subnet mask 255.255.255.0, and click on “Assign IP Configuration”.
Enter the device name of your CU and click on “Assign Name” (please observe the note).

g120xcu240ex2
g120xcu240ex2xf
g120c
g120xcu240dx2
g120xcu240dx2xf

Exit the dialog by clicking “Close”.

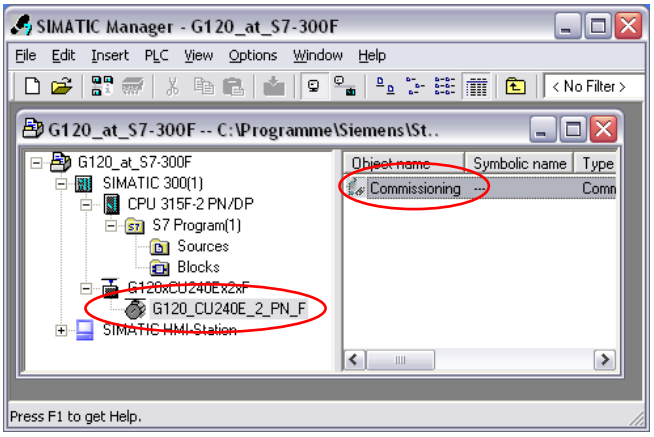
Note:
The device name must match the one given in the Properties of SINAMICS G120 in HW Config.
</td>
<td>


</td>
</tr>
<tr>
<td>5</td>
<td>

Click on SINAMICS G120. Depending on the used project, the SINAMICS G120 is called

G120_CU240E-2_PN
G120_CU240E-2_PN_F
G120C_PN
G120_CU240D-2_PN
G120_CU240D-2_PN_F

Click 2x on “Commissioning”. This opens the STARTER with the project.

</td>
<td>


The picture shows the example of a SINAMICS G120 with CU 240E-2 PN-F.
</td>
</tr>
</table>

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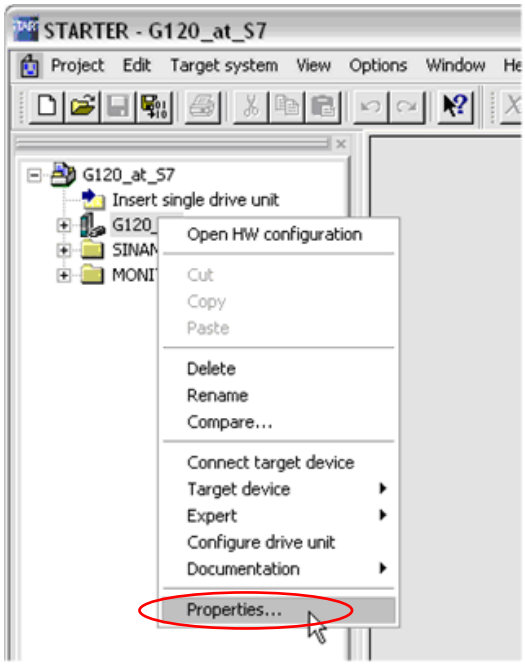
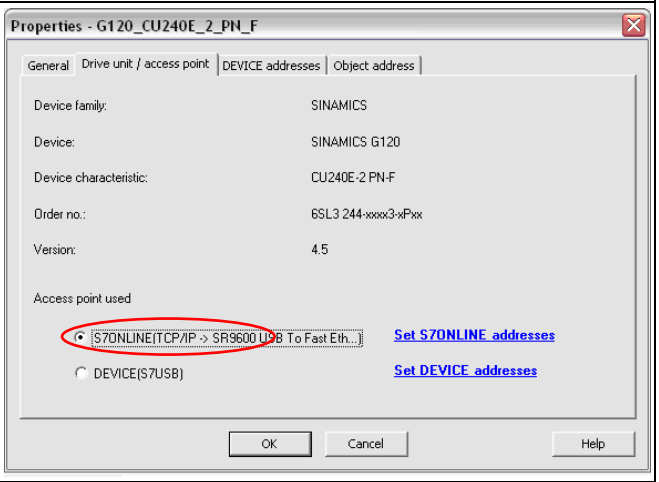
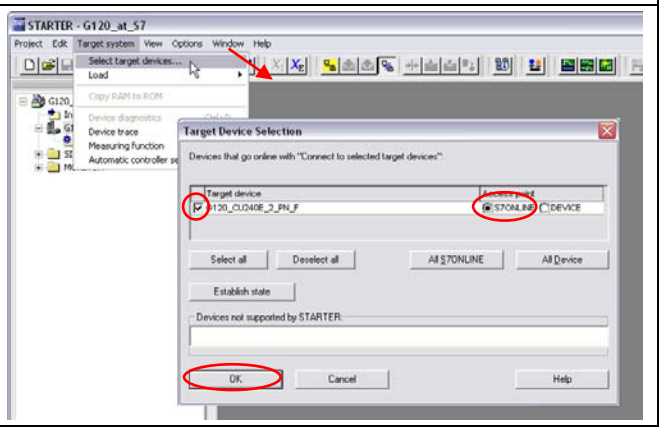
5.	After the STARTER has opened, select the SINAMICS G120 and open its properties by clicking on the right mouse button.	
6.	Select “S7ONLINE(TCP/IP->*Network card*” and click on “OK”.	
7.	Call up the “Target Device Selection” dialog in the STARTER via “Target system > Select target device...”. Select the CU and the “S7ONLINE” access point and then click on OK.	

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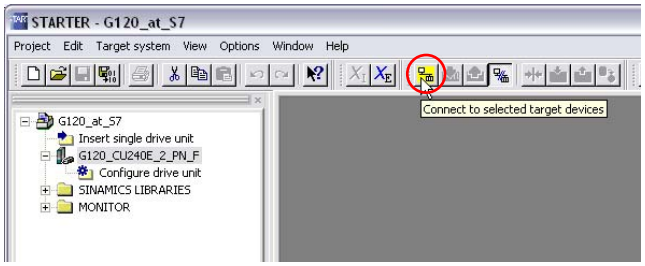
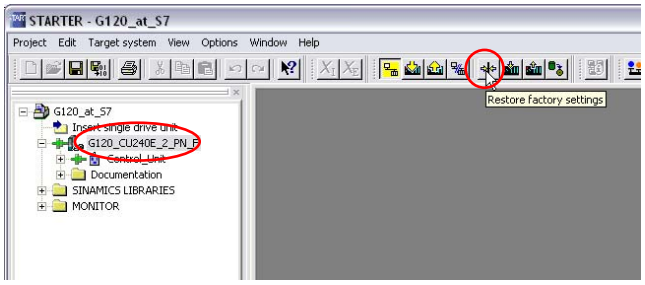
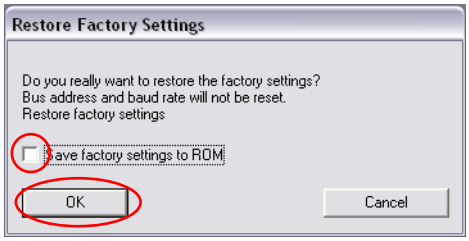
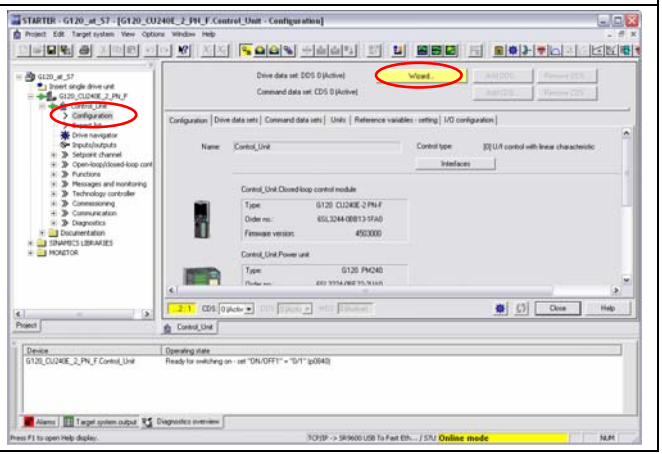
8.	Go online.	
9.	Select the SINAMICS G120 in the tree and then press “Restore factory settings”.	
10.	Remove the checkmark for “Save factory settings to ROM” and then click “OK”.	
11.	Expand the tree and click on “Configuration”. Then call up the wizard.	

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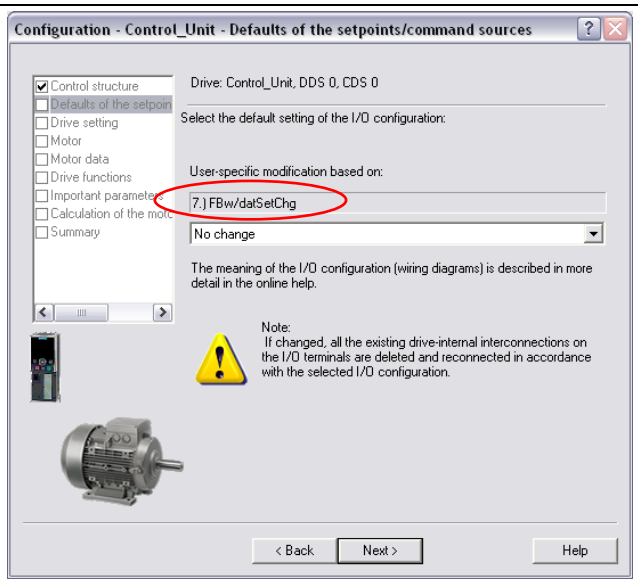
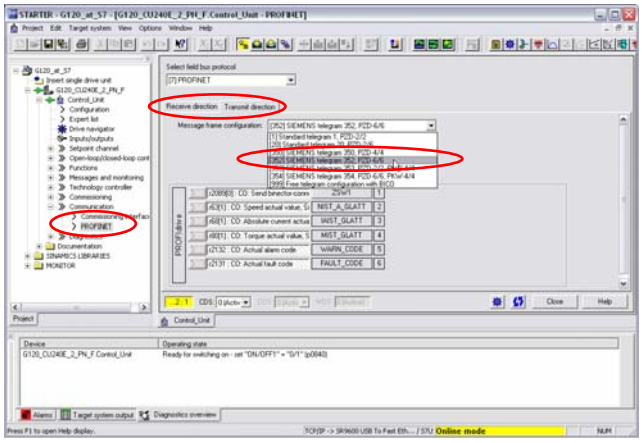
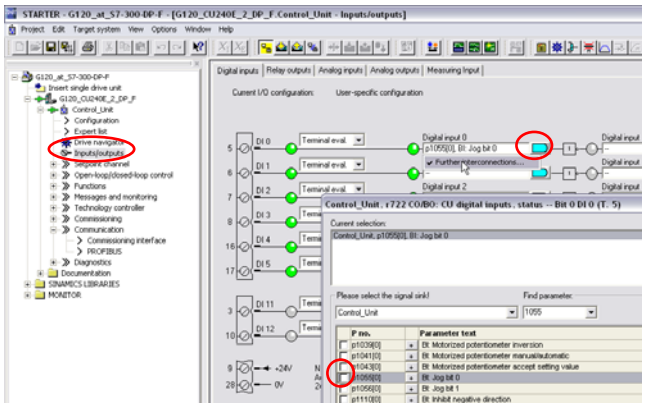
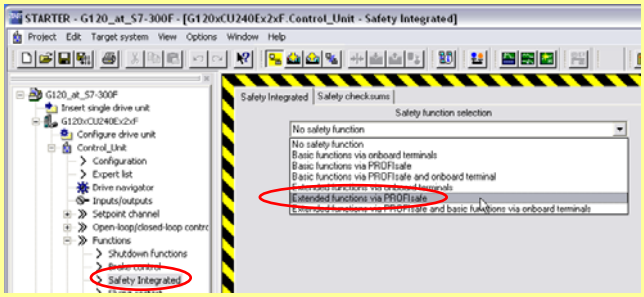
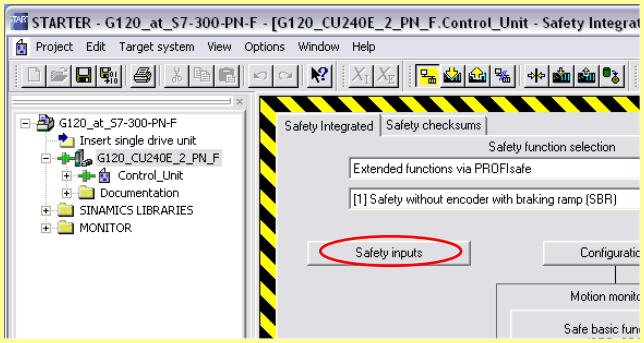
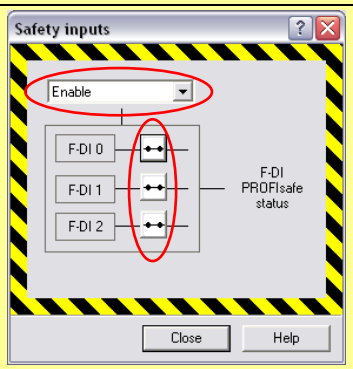
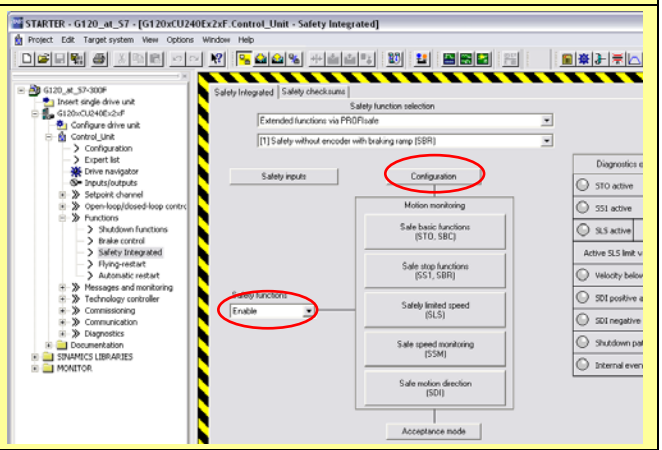
12.	Run the wizard and enter the data you need. If you have no specific requirements, use the respective default values, apart from the following exceptions • Ensure that the field bus (FieldBus With data Set Change) is selected in the "Defaults of the setpoint/command sources" step. • In the "Motor" step you enter the data of the connected motor.	
13.	After the wizard has been run through completely, double-click on "Communication > PROFINET" in the tree, select one of the "Receive" or "Send direction" tabs, and select "Siemens message frame 352, PZD 6/6)". Note: It is decisive here that the same message frame and the same address are selected as for the hardware configuration in STEP 7.	
14.	• Open "Inputs/outputs" in the tree • Click on the magenta colored field next to digital input 0 • Remove all checkmarks in the "Control_Unit, ...D0 (Kl.5)" window and then close this window with OK • Repeat this for DI1 to DI5	 DI 0 to 5 shall be used as fail-safe inputs, however, they retain their function as standard inputs. Controlling FDI 0 (Kl. 5+6) would therefore also trigger those functions which were configured on DI0 (Kl. 5) and DI1 (Kl. 6) (Jog Bit 0/1). To prevent this, the functions of the standard inputs are deleted.

15.	If the “PROFIsafe message frame 900” is configured, please proceed with step 16. If the “PROFIsafe message frame 30” is configured, please proceed with step 24.	
16.	• Open “Safety Integrated” in the tree. • Select “Extended functions via PROFIsafe”. • Confirm that a PROFIsafe message frame has been created.	
17.	Open the “Safety inputs” dialog.	
18.	• Enable the transfer of the inputs This activates the “PROFIsafe message frame 900” frame in the SINAMICS G120, without enable the “PROFIsafe message frame 30” frame is used. • Select the inputs to be transferred by closing the connection	
19.	• Set the enable of the safety functions • Open the “Configuration” dialog	

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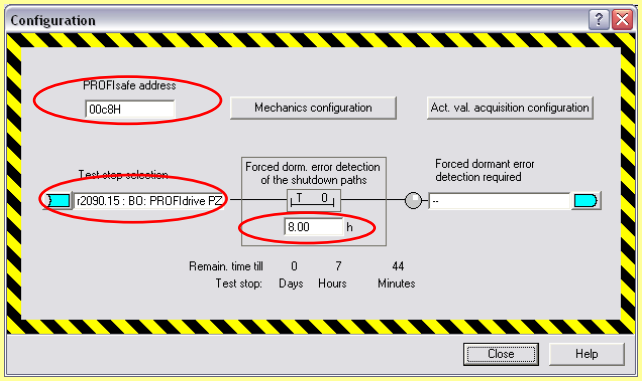
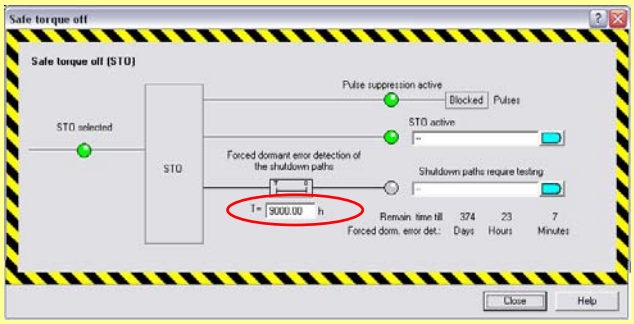
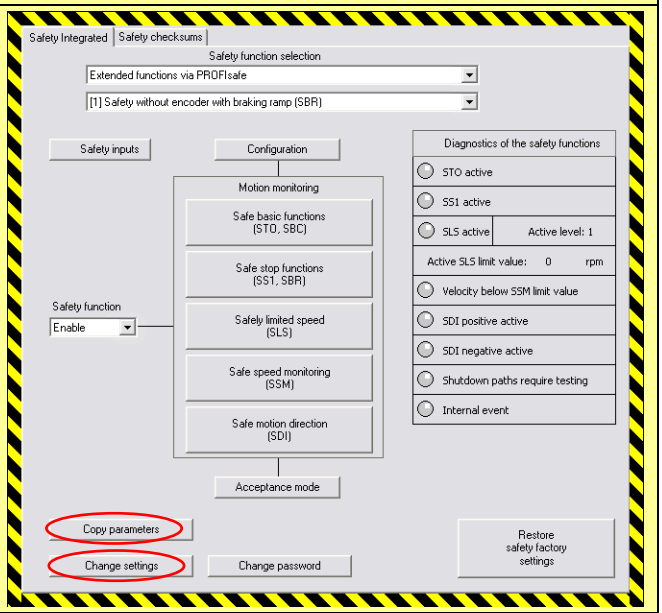
20.	• In the “PROFIsafe address” field you enter the value you noted down during the S7-300/400F configuration (step 14 in Table 6-1) • Select bit 15 of the control word (i.e. “P2090.15”) as the “Test stop selection” • Set the monitoring of the forced dormant error detection for the expanded functions to 8h. • Press “Close” to close the dialog box.	
21.	• Open the “Safe torque off (STO)” dialog by clicking on the button “Safe basic functions (STO, SBC)” and deactivate the monitoring of the “Forced dormant error detection” for the basic functions by setting the monitoring time to the maximal value (9000 h). • Press “Close” to close the dialog box.	 Monitoring the “Forced dormant error detection” of the basic functions is not necessary when using the extended functions, since the test of the extended functions contains the test for the basic functions.
22.	Click “Copy parameters” and then “Activate settings“.	
23.	Proceed with step 26.	

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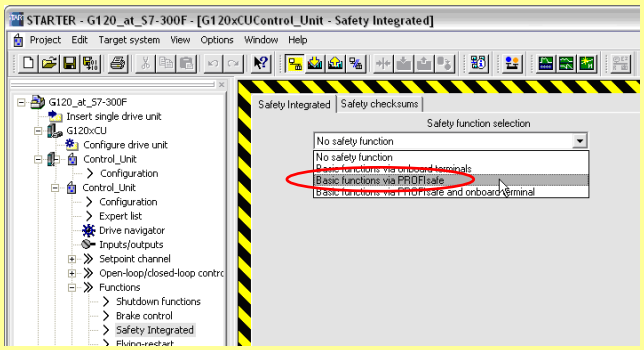
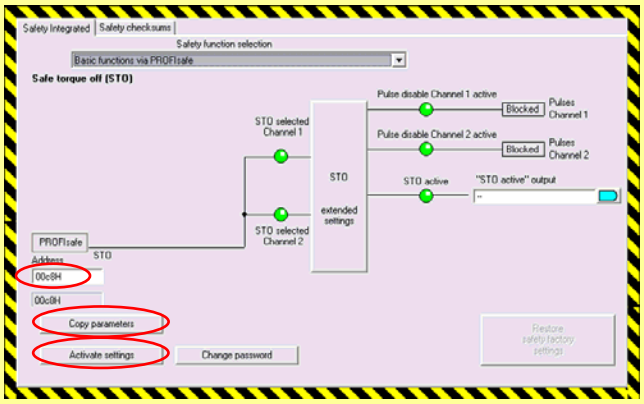
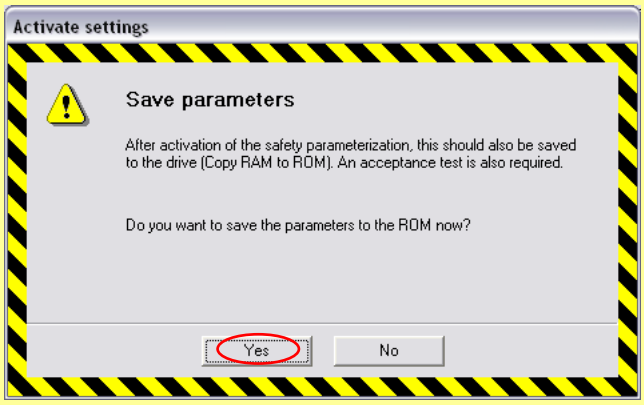
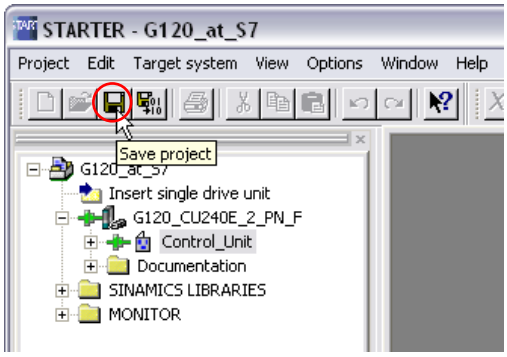
24.	• Select “Basic functions via PROFIsafe”. • Confirm that a PROFIsafe message frame has been created.	
25.	• In the “Address” field you enter the value you noted down during the S7-300/400F configuration (step 14 in Table 6-1) • Click on “Copy parameters” • Then click “Activate settings”.	
26.	Enter a password and then click on “Activate settings again”. (The password used in this example is “12345”)	
27.	Choose “Yes”, to save the parameters in ROM.	
28.	Save the project on your hard disc.	

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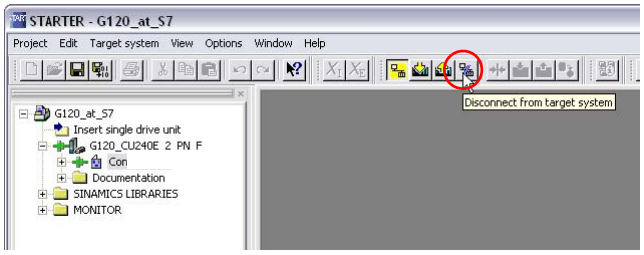
29.	Go offline.	
30.	Activating the modified safety programming requires performing a power reset.	

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7 Links & Literature

The following list is by no means complete and only provides a selection of appropriate sources.

Table 7-1

	Topic	Title / link
/1/	STEP7 SIMATIC S7-300/400	Automating with STEP7 in STL and SCL Author: Hans Berger Publicis Verlag ISBN: 978-3-89578-397-5
/2/		Automating with STEP 7 in LAD and FBD Author: Hans Berger Publicis Verlag ISBN: 978-3-89578-296-1
/3/		Reference Manual System and Standard Functions for S7-300 and S7400 Vol. 1/2 http://support.automation.siemens.com/WW/view/en/44240604
/4/	Link to this document	http://support.automation.siemens.com/WW/view/en/60441457
/5/	Siemens Industry Online Support	http://support.automation.siemens.com
/6/	STARTER	http://support.automation.siemens.com/WW/view/en/26233208
/7/	SINAMICS G120 Manuals	Operating instruction (V4.5): http://support.automation.siemens.com/WW/view/en/61618946 List manual (V4.5) (parameters and error list): http://support.automation.siemens.com/WW/view/en/49383082 Function manual Safety Integrated (V4.5): http://support.automation.siemens.com/WW/view/en/63035886
	SINAMICS G120C Manuals	Operating instruction (V4.5): http://support.automation.siemens.com/WW/view/en/61462568 List manual (V4.5) (parameters and error list): http://support.automation.siemens.com/WW/view/en/59745599 Function manual Safety Integrated (V4.5): http://support.automation.siemens.com/WW/view/en/63035886
	SINAMICS G120D Manuals	Operating instruction CU240D-2 (V4.5): http://support.automation.siemens.com/WW/view/en/60448591 Operating instruction CU250D-2 (V4.5): http://support.automation.siemens.com/WW/view/en/60443897 List manual (V4.5) (parameters and error list): http://support.automation.siemens.com/WW/view/en/59745958 Function manual Safety Integrated (V4.5): http://support.automation.siemens.com/WW/view/en/63035886
/8/	Application example without PROFIsafe	Speed control of a SINAMICS G120, G120C, G120D or G120P – drive using an S7-300/400 CPU via PROFINET or PROFIBUS-DP in STEP 7 V5 http://support.automation.siemens.com/WW/view/en/58820849
/9/	Distributed Safety Manual	S7 Distributed Safety, configuring and programming http://support.automation.siemens.com/WW/view/en/22099875
/10/	FAQ for data record routing	http://support.automation.siemens.com/WW/view/en/7000978 http://support.automation.siemens.com/WW/view/en/50037141

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8 History

Table 8-1

Version	Date	Revisions
V1.0	05/2012	First issue
V2.0	11/2012	Complete revision with focus on easy usability of the blocks in own projects Expansion by SINAMICS G120C and G120D

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