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Application description • 10/2014

SINAMICS V: Controlled Positioning of a V90 with S7 1200 via the Pulse/Direction Interface, with HMI

SINAMICS V90 (with FW ≥ V1.03)
SIMATIC S7-1200 (with FW ≥ V3.0 and TIA Portal ≥ V12.0)

http://support.automation.siemens.com/WW/view/en/77467940

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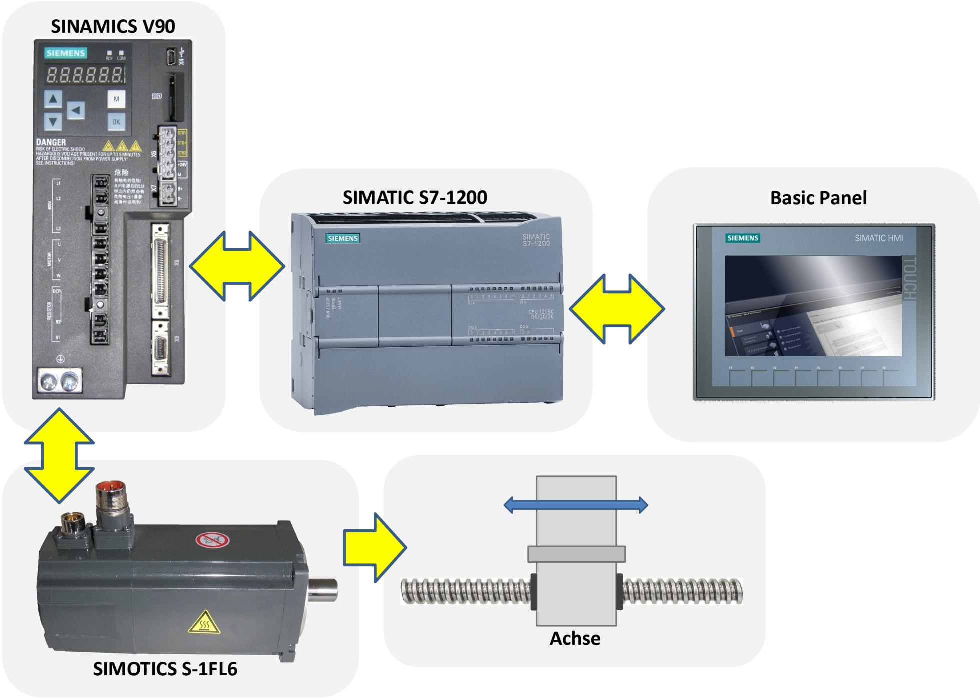
1 Task

Principle

Figure 1-1: Overview



A SINAMICS V90 servo drive shall move a SIMOTICS S-1FL6 servo motor (with integrated incremental encoder). The SINAMICS V90 shall be controlled via the pulse/direction interface (PTO) of a SIMATIC S7-1200 CPU. The move functions are realized in the SIMATIC CPU via motion control (MC) system blocks. The following move functions shall be realized in the application example:

- Moving the axis in jog mode
- Moving the axis with specified velocity
- Relative positioning of the axis
- Absolute Positioning of the axis
- Perform axis commands as a sequence of movements.

It is also demonstrated how SINAMICS V90 can be stopped in non-regular operating situations:

- Switch-off by resetting the enable signal.
- Switch-off via addressing a HW limit switch.
- Switch-off via the E-stop input of SINAMICS V90.
- Switch-off via the STO function integrated in SINAMICS V90.

Furthermore, the following shall be illustrated:

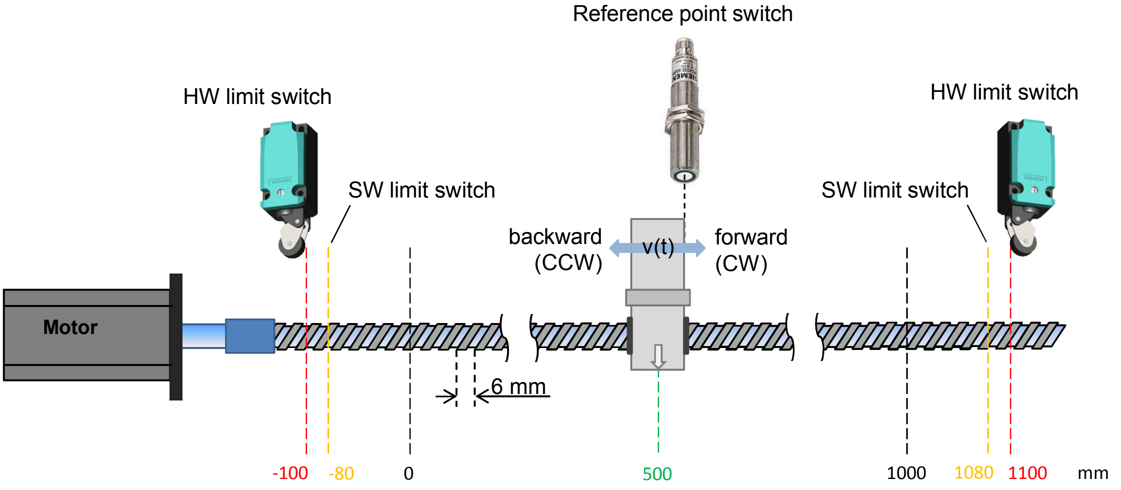
- How to support the drive parameterization, commissioning, and diagnostics via SINAMICS V90 PC TOOL V-ASSISTANT.
- How to support commissioning and diagnostics by appropriate features of technology object “Axis”.

A SIMATIC Basic Panel shall be used for operating the move function.

Moving the axis

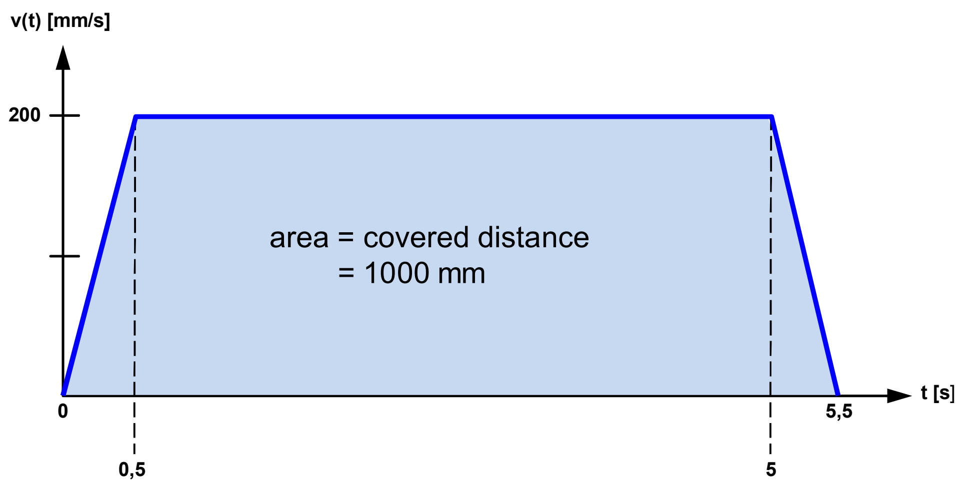
As a concrete example, the application shall be based on the following linear axis:

Figure 1-2: Linear axis



The following dynamic reference values shall be applied for the positioning process:

Figure 1-3: Motion profile



The axis shall be moved by 1000 mm. Ramp-up and ramp-down time shall be 0.5 sec each. The process shall take approx. 5.5 sec.

2 Realization

The realization is alternatively demonstrated by means of two sample projects, which are characterized as follows:

- TIA V12 project
  - CPU 1215 DC/DC/DC, FW 3.0
  - Using the 24V pulse train interface
  - Operator panel KTP600
- TIA V13 project
  - CPU 1217 DC/DC/DC, FW 4.0
  - Using the Line Drive interface
  - Operator panel KTP700

The Line Drive interface is only provided by the CPU 1217C. Compared with the 24V pulse train interface, which allows a maximum impulse generator frequency of 100 kHz, with the Line Drive interface 1 MHz is achieved. The result is – depending on drive and motor - a higher positioning accuracy and/or motor speed. In addition the electromagnetic compatibility of the Line Drive interface is higher than those of the 24V pulse train interface.

The HMI screens in both projects are identical. The CPU program difference between both sample projects is only due to the different adressing of the digital outputs.

To implement a V13 project with CPU 1215C and 24V pulse train interface you also can upgrade the attached V12 project and – if applicable – replace the CPU by a FW 4.0 type afterwards.

The following document contents refer to both projects above. Differences are pointed to separately.

3 Components and Setup

3.1 Hardware components used

The application example was set up and tested with the following components: a configuration with one SINAMICS V90 is assumed. In the case of several inverters, the number of the respective components must be adjusted.

Table 3-1: Hardware components[1]

No.	Components	Quant.	Order number	Note
1	SITOP PSU100L stabilized power supply INPUT: 120/230 V AC OUTPUT: 24V DC/5A	1	6EP1333-1LB00	For 24V power supply for SIMATIC CPU, SINAMICS V90, KTP600; you can also use a different power supply which meets the requirements of the consumer (see Technical Data in /3/, /7/, /9/)
2a	SIMATIC S7-1200 CPU1215C DC/DC/DC (FW 3.0)	1	6ES7215-1AG31-0XB0	For the TIA V12 sample project with 24V pulse train interface
2b	SIMATIC S7-1200 CPU1217C DC/DC/DC (FW 4.0)		6ES7217-1AG40-0XB0	For the TIA V13 sample project with Line Drive interface
3a	Basic Panel KTP600 (color, PN) (optional)	1	6AV6647-0AD11-3AX0	For the TIA V12 sample project. You can also let the panel run on your development system as a simulation.
3b	Basic Panel KTP700 (optional)		6AV2123-2GB03-0AX0	For the TIA V13 sample project. You can also let the panel run on your development system as a simulation.
4	Drive: SINAMICS V90 (0.75kW)	1	6SL3210-5FE10-8UA0	You can also use a SINAMICS V90 from a different performance class.
5	Network filter for drive with order number of position 4. (optional[2])	1	6SE6400-2FA00-6AD0	For network filters for other V90 performance classes see chapter 2.5 in /9/.
6	Miniature circuit breaker for drive with order number of position 4. (optional)	1	5SJ4316-7HG42	For miniature circuit breakers for other V90 performance classes see chapter 2.5 in /9/.
7	Break resistor (optional)	1		Required depending on load conditions. See chap. 2.5 and 4.6 in /9/.

[1] Small parts such as wire and other installation material are not included in this table.
[2] For sensitive power networks, the application of a network filter is recommended (e.g. PCs on the same network).

No.	Components	Quant.	Order number	Note
8	Motor: SIMOTICS S-1FL6 (0.75 kW incremental encoder no holding break)	1	1FL6044-1AF61-0AG1	Use a SIMOTICS S-1FL6, which matches the performance of the SINAMICS V90. (see chap. 2.2 in /9/.
9	Setpoint connector for connecting to SINAMICS V90 to controller, 50 poles.	1	6SL3260-2NA00-0VA0	Connector for X8 connection (interface to SIMATIC) at SINAMICS V90. Selection and preparation of the cable for SIMATIC PLC is up to the user.
	or alternatively			
	Setpoint cable preassembled for connecting to SINAMICS V90 to controller, length 1m.	1	6SL3260-4NA00-1VB0	
10	MOTION-CONNECT 300 SIGNAL INC CABLE[3] preassembled encoder cable (3m) for connecting motor and drive with ordering numbers of position 8 and 4.	1	6FX3002-2CT10-1AD0	The cable order numbers for other cable lengths are available in the Appendix of /9/.
11	MOTION CONNECT 300 SIGNAL INC CABLE[3] preassembled encoder cable (3m) for connecting motor and drive with the ordering numbers of position 8 and 4.	1	6FX3002-5CL01-1AD0	The cable order numbers for V90 of size B and C and for other cable lengths are available in the Appendix of /9/.
12	MOTION CONNECT 300 BREAK CABLE[3] preassembled break cable (3m) for connecting motor and drive (optional, only for motors with holding break)	1	6FX3002-5BL02-1AD0	The cable order numbers for other cable lengths are available in the Appendix of /9/.
13	Ethernet line with 2 RJ45 connectors	2(3)[4]	6XV1850-2Hxxx xxx = E50 → 0,5 m = H10 → 1 m = H20 → 2m = H60 → 6m = N10 → 10m	S7-1200 ⇔ KTP600 S7-1200 ⇔ PG/PC
14	USB cable (A ⇔ Mini B)	1	-	For parameterization/IBS of the drive via the PC tool
15	Axis limit switch (optional) (e.g. mechanical switch)	2	-	NC contacts (break contact)
16	Reference point switch (e.g. BERO)	1	-	NO contact (make contact)

[3] You can also configure the wire by yourself. Ordering numbers of the individual connectors, pin assignment, wire numbers and installation notes are available in /9/ in chapter 4 and in the Appendix.
[4] If you whish to connect a CPU <1215C (with only 1 Ethernet interface) and an HMI device (not only a simulation on the PG/PC), you need a switch (e.g. CSM1277) and three RJ45 patch cables.

No.	Components	Quant.	Order number	Note
17	EMERGENCY STOP MUSHROOM PUSHBUTTON	2 2	3SB3400-0E 3SB3000-1HA20	Operating element, 2 break contacts Mushroom pushbutton For application at STO and EMGS inputs of the drive.

3.2 Controller software

Standard software components

The application was generated with the following standard software:

Table 3-2: Standard software components

Component	Order number	Note
SIMATIC STEP 7 Basic V12	6ES7822-0Ax02-xxxx*)	For the TIA V12 sample project;
Updates for STEP 7 V12 SP1 and WinCC V12 SP1	Download for free see \5\	Use always the actual update!
SIMATIC STEP 7 Basic V13	6ES7822-0Ax03-xxxx*)	For the TIA V13 sample project;
Updates for STEP 7 V13 and WinCC V13	Download for free see \5\	Use always the actual update!
SINAMICS V-ASSISTANT V1.0.0 (commissioning tool for SINAMICS V90)	Download for free see \11\	Use always the actual update!
*) The order number depends on the license type (lincense contract, update service, floating license etc.). For a fully qualified order number contact your SIEMENS distribution partner or search the necessary software/license in the SIEMENS Industry Mall (https://mall.industry.siemens.com).		

User software and documentation

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

Table 3-3: Projects and documentation

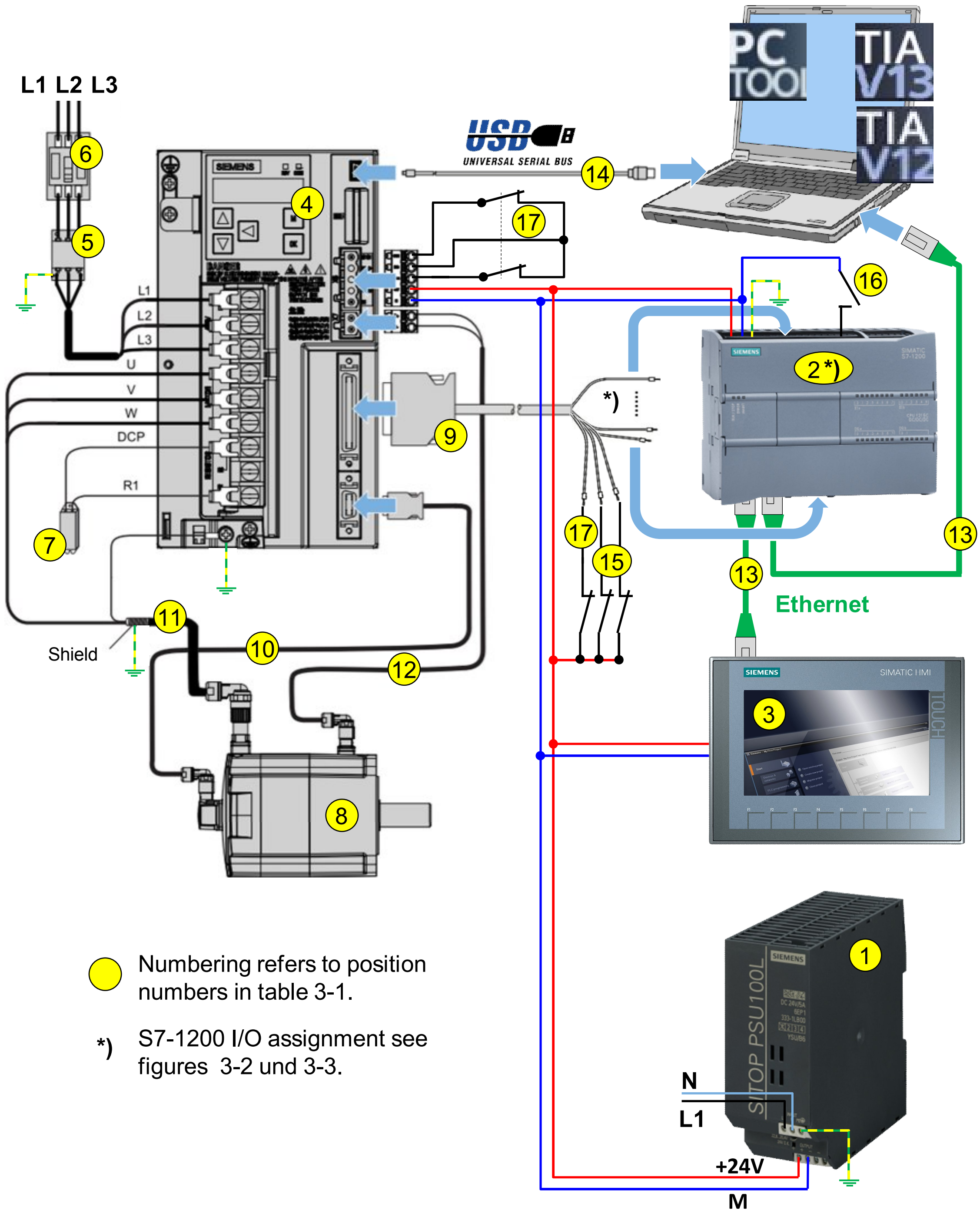
Component	Note
77467940_SINAMICS_V90_at_S7-1200_V12_Vxdy.zip[5] (archive) Name of the retrieved project: V90_at_S7-1200	STEP 7 V12 project
77467940_SINAMICS_V90_at_S7-1200_V13_Vxdy.zip[5] (archive) Name of the retrieved project: V90_at_S7-1200	STEP 7 V13 project
77467940_SINAMICS_V90_parameters_V12_Vxdy.zip[5] (archive) Name of the retrieved file: V90_parameters.prj	V-ASSISTANT parameter file for STEP 7 V12 project
77467940_SINAMICS_V90_parameters_V13_Vxdy.zip[5] (archive) Name of the retrieved file: V90_parameters.prj	V-ASSISTANT parameter file for STEP 7 V13 project
77467940_SINAMICS_V90_at_S7-1200_DOCU_Vxdy_en.pdf[5]	This document
77467940_SINAMICS_V90_at_S7-1200_FLYER_Vxdy_en.pdf[5]	Flyer

[5] Vxdy = Version ID of the application

3.3 Wiring

Wiring of the components

Figure 3-1: Wiring of the components



Numbering refers to position numbers in table 3-1.

*) S7-1200 I/O assignment see figures 3-2 und 3-3.

NOTICE	Note the setup and wiring guidelines in the manuals of the respective devices (see /3/, /7/, /9/)

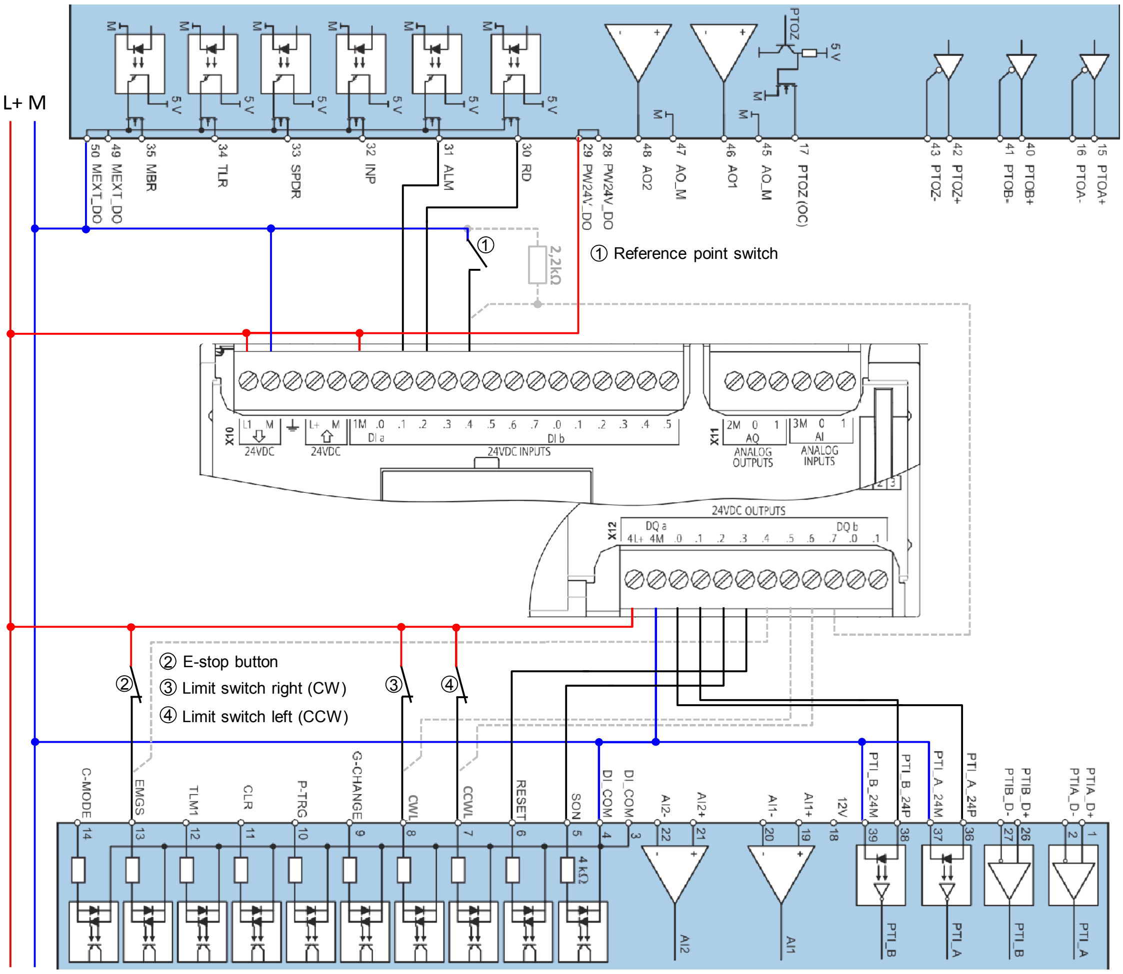
Digital interface between SINAMICS V90 and SIMATIC S7-1200

Wire the interface according to Figure 3-2 (for TIA V12 sample project) respectively Figure 3-3 (for TIA V13 sample project). Use the signal cable 9. For the application you require an emergency-stop button (break contact), two limit switches (break contact) and one reference point switch (make contact). However, the example is designed so you can simulate these contact elements via the operator panel as well[6]. In this case, you wire the digital inputs, to which the respective contact elements are connected in the real case, as displayed in the picture by the broken light gray lines.

NOTICE	**SINAMICS V90 has digital NPN outputs. Its output signals also represent current sinks.** **In order to use the digital SINAMICS output signals as input signals for the SIMATIC CPU, the 1M root at the X10 connector must be connected to L+ and not to 0V(M).** **The reference point switch ① must be connected to 0V(M). See Figure 3-2 and Figure 3-3.**

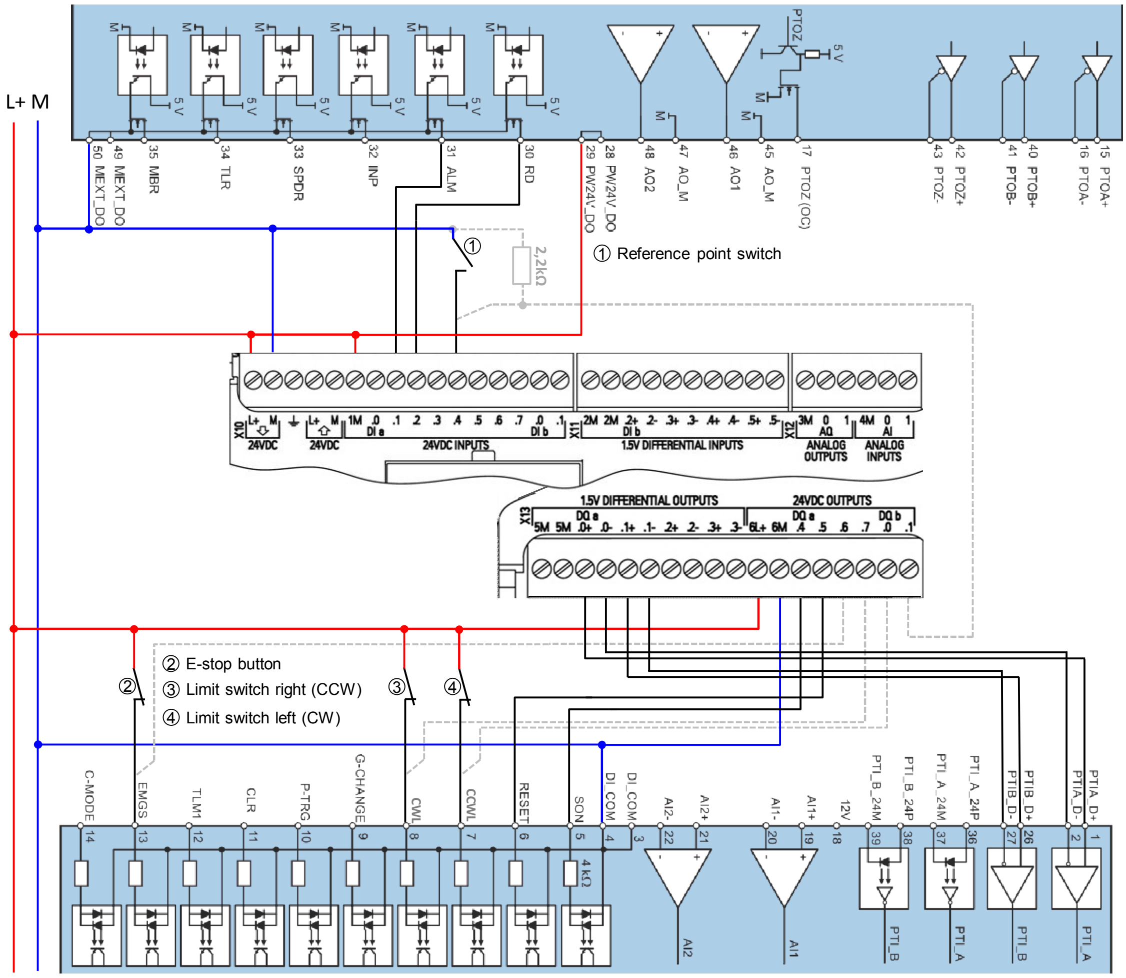
[6] Due to the limited number of digital outputs of the CPU, the full simulation scope is only possible for SIMATIC S7 CPUs 1214C/1215C/1217C or for SIMATIC S7 CPUs 1211C/1212C with DA module or DA board.

Figure 3-2: Digital interface between SINAMICS V90 (X8 contactor) and SIMATIC S7-1200 when using the 24V pulse train interface (TIA V12 sample project)



NOTICE	**Depending on composition and length of the cable used by the SIMATIC to transmit the pulse to SINAMICS V90, an additional load resistor (for at least 10% of the rated current) may be required in order to improve the quality of the pulse signals and the interference immunity.**

Figure 3-3: Digital interface between SINAMICS V90 (X8 contactor) and SIMATIC S7-1200 when using the Line Drive interface (TIA V13 sample project)



4 Commissioning

Note If you wish to inform yourself of the technical background of the pulse/direction interface and the used motion control blocks, before commissioning and operating the application example, we recommend reading chapter 6 Functional Mechanisms beforehand.

Requirements

- The hardware is wired according to Figure 3-1 and Figure 3-2 (respectively Figure 3-3).
- SINAMICS V90 is three-phase-connected to the 400V network.
- SINAMICS V90, SIMATIC S7-1200 and the panel are supplied with 24V via the SITOP power unit.
- The software according to Table 3-2 has been installed on your development system.
- State of SINAMICS V90:
  - At the display of SINAMICS V90 S oFF is displayed, alternating with alarm message *A 7585* “*Encoder 2: Position setting value activated*”. It is displayed while the SINAMICS drive has not been enabled yet; i.e. the *SON* signal (Servo on) is absent. Remove and acknowledge the pending errors (see chapter 10 in /9/).
  - The *RDY*-LED is blinking red with 1 Hz (drive not ready).
  - The *COM*-LED lights red permanently.

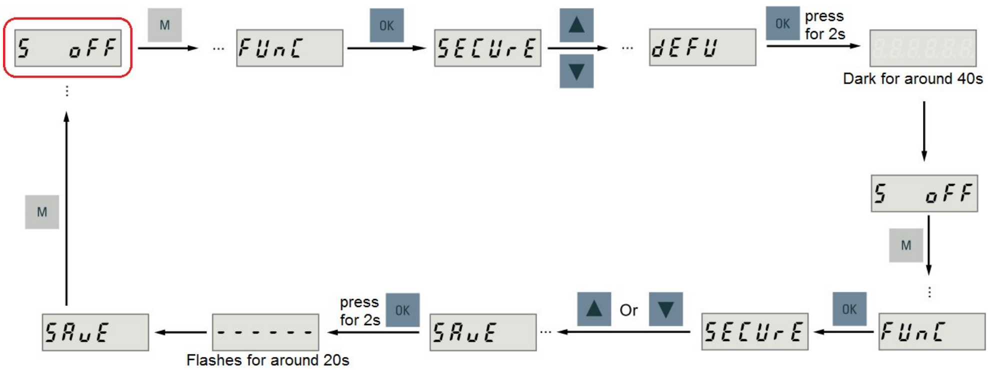
4.1 Resetting the SINAMICS V90

If the SINAMICS V90 is no longer in the delivery state, you need to reset it to its standard values.

Resetting via the BOP

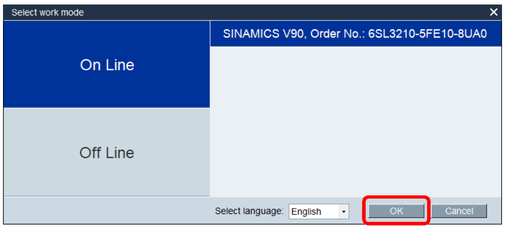
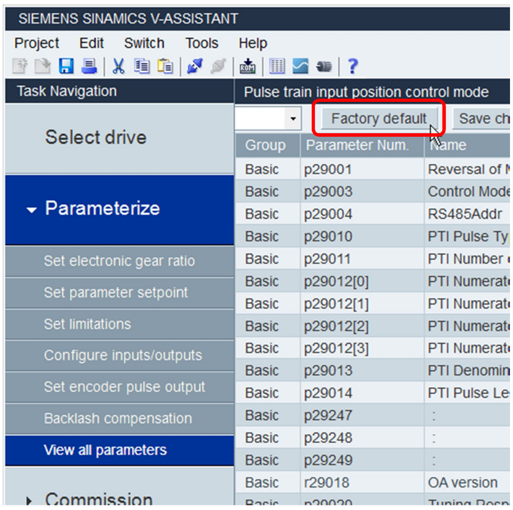
Physically separate the USB connection between the SINAMICS drive and the PG/PC. Proceed according to Figure 4-1.

Figure 4-1: Resetting the SINAMICS V90 via the BOP



Resetting via PC tool SINAMICS V-ASSISTANT

Table 4-1: Resetting the SINAMICS V90 via PC tool SINAMICS V-ASSISTANT

No.	Instruction	Note / Screen
1.	Establish the USB connection between the SINAMICS drive and the PG/PC.	Blinking at the SINAMICS V90: • *COM*-LED green with 0.5 Hz. • *RDY*-LED red with 1 Hz.
2.	3. Start the PC tool SINAMICS V-ASSISTANT 4. Confirm with “OK”.	 The tool connects to the SINAMICS V90 online and recognizes it.
5.	1. In the Task Navigation you click on *Parameterize > View all parameters* and press the *Factory default* button. 2. Press *Yes* to exit the subsequent *Question* window with the security query.	 This process takes several seconds. The progress of this process is, in the PC tool, indicated at the information windows with progress display (bar) and for the V90 at the LEDs *RDY* and *COM* and in the display. After the process has been completed, the *RDY*-LED starts blinking red again with 1 Hz and the *COM*-LED green with 0.5 Hz. S oFF is shown at the display again, alternating with alarm message *A 7585*.

4.2 Jog mode without SIMATIC controller

Check whether the motor can be moved in jog mode without SIMATIC controller via the BOP integrated in the SINAMICS drive or using PC tool SINAMICS V-ASSISTANT. This ensures that SINAMICS drive and the motor are connected correctly and voltage has been applied.

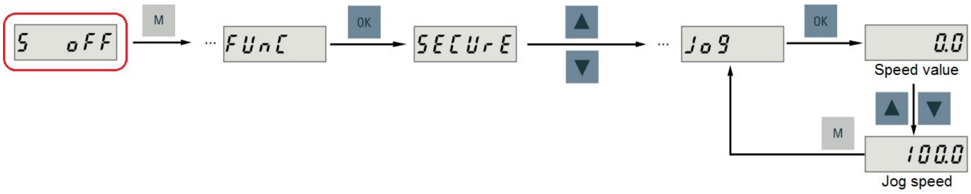
Precondition

- Motor is without load.
- SIMATIC S7-1200 is not connected to the SINAMICS V90.

Jog mode via BOP

Physically separate the USB connection between the SINAMICS drive and the PG/PC. Proceed according to Figure 4-2.

Figure 4-2: Jog mode via BOP

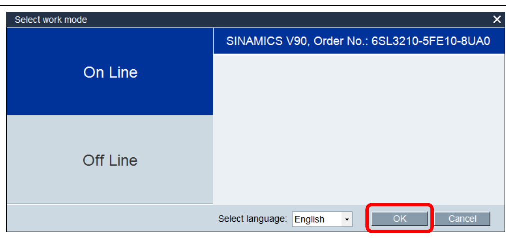


The standard jog speed is 100 min^{-1}. It can be changed via the P1058 parameter. Move the motor in both directions. If it turns the wrong way, you control the phasing at the feed[7].

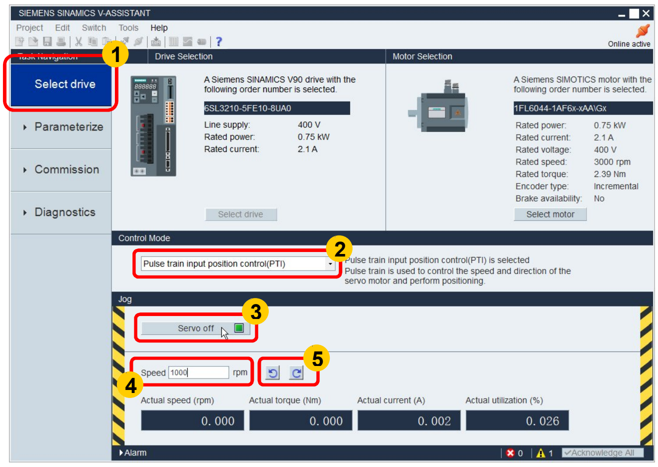
Jog mode via SINAMICS V-ASSISTANT

Establish the USB connection between the SINAMICS drive and the PG/PC.

Table 4-2: Jog mode via SINAMICS V-ASSISTANT

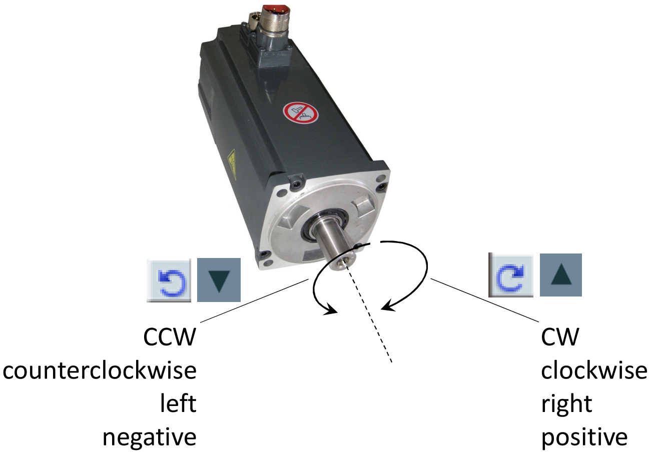
No.	Instruction	Note / Screen
1.	Establish the USB connection between the SINAMICS drive and the PG/PC.	Blinking at the SINAMICS V90: • *COM*-LED green with 0.5 Hz. • *RDY*-LED red with 1 Hz.
2.	1. Start the PC tool SINAMICS V-ASSISTANT 2. Confirm with “OK”.	 The tool connects to the SINAMICS V90 online and recognizes it.

[7] The rotation direction can also be changed with Boolean parameter P29001 (standard value = 0). For changing parameters please refer to chapter 6.4.1 in \9\.

No.	Instruction	Note / Screen
3.	1. Select Select drive.[8] 2. Make sure that operating mode *PTI* has been selected: 3. Release the drive with the *Servo on* button (button subsequently changes the key label to *Servo off*). Consider the notes in the *Warning* that opens, and close it with *OK*. 4. Enter a jog speed. 5. Move the motor in jog mode.	
4.	For terminating the jog mode, press the *Servo off* button; its label will then change back to *Servo on*.	
5.	Terminate the SINAMICS V-ASSISTANT via *Project > Exit* in the menu bar.	Answer possible questions after saving parameters to the ROM of V90 or after storing the current project data with *No*.

Changing direction of rotation

Figure 4-3: Definition of the rotation direction



For defining the rotation direction of motors you can also refer to \13\.

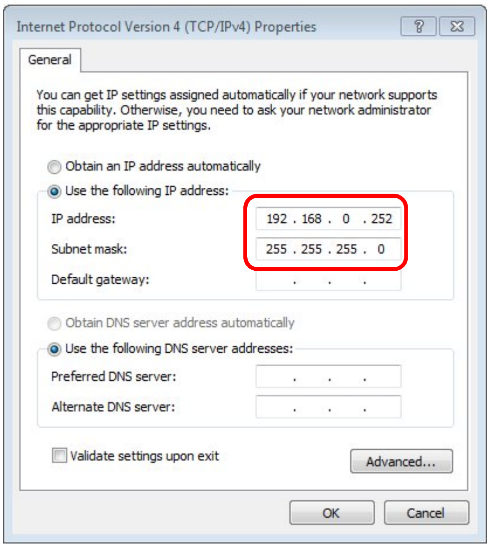
When a positive speed value is given, the motor shall rotate clockwise. If the rotation direction of the motor does not fit the pressed button, you change the phasing at the feed. However, the rotation direction can also be changed with Boolean parameter P29001 (standard value = 0). For changing parameters please refer to chapter 6.4.1 in /9/. All parameters can also be changed online via the V90 PC tool.

[8] The user interface for the jog mode also becomes available when selecting *Commission > Test motor* in the task navigation.

4.3 IP and subnet addresses

The following data is used in the example. The user can make changes at any time.

Table 4-3: IP addresses

Component	IP address	Note
S7-CPU	IP 192.168.0.1 Sub 255.255.255.0	Standard setting when configuring the CPU in TIA Portal.
KTP600	IP 192.168.0.2 Sub 255.255.255.0	Standard setting when configuring the KTP600 in TIA Portal. The addresses must also be set at the device itself. (This is handled in point 2 of Table 4-6). For KTP600 as simulation in TIA Portal no action is necessary.
PG/PC	IP 192.168.0.xxx Sub 255.255.255.0	For the network card in the PG/PC used for the application you assign a free IP address located in the same subnet as the addresses of CPU and HMI device. In Windows 7, for example, you navigate as follows: Start > Control Panel >Networks and Release Center >Change adapter settings >Right-click to the used network card >Properties >Internet protocol version 4 (TCP/IPv4) >Properties 

4.4 Parameters of SINAMICS V90 for the application example

Based on the factory settings, only the following drive parameters must be changed for the application example:

Table 4-4: Drive parameters to be changed

Parameter	Value		Explanation
	Application example	**Factory setting**	
p29011 Setpoint pulses per motor revolution	3000	0	For calculation see chapter 7.1.
p29014 Selection of pulse train interface	1: 24V 0: RS485	1: 24V	with TIA V12 sample project
p1120 Ramp-up time [s]	0.000	1.000	The ramps shall alone be determined via the *MC* blocks.
p1120 Ramp-down time [s]	0.000	1.000	

The configuration can alternatively be performed in three ways:

1. Entering parameters via the integrated BOP of SINAMICS V90.
2. Entering parameters via SW tool SINAMICS V-ASSISTANT and downloading it to SINAMICS V90.
3. Open the project file V90_parameters.prj appended in the application example with PC tool SINAMICS V-ASSISTANT, and load the parameters differing from the factory settings into SINAMICS V90.

Proceed according to the third type, which is described in the subsequent chapter 4.5. The standard procedure for the first two types is discussed in chapter 7.

4.5 Loading the software

NOTICE	If, regarding the order numbers, the used SINAMICS V90 drive or SIMOTICS S-1FL6 motor should differ from the specification in Table 3-1, you need to perform your own parameterization. In this case, follow the instruction in chapter 7.2 before loading the software into the device. Otherwise, this may cause damage.

This chapter describes how to…

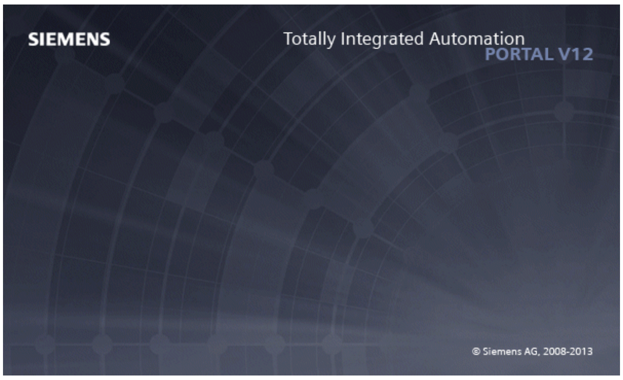
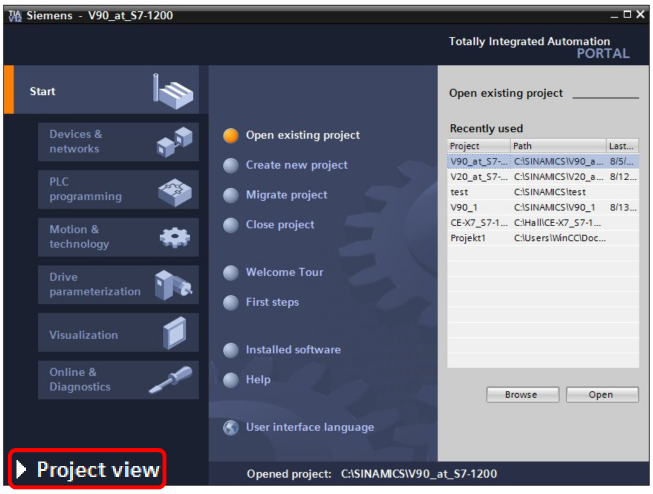
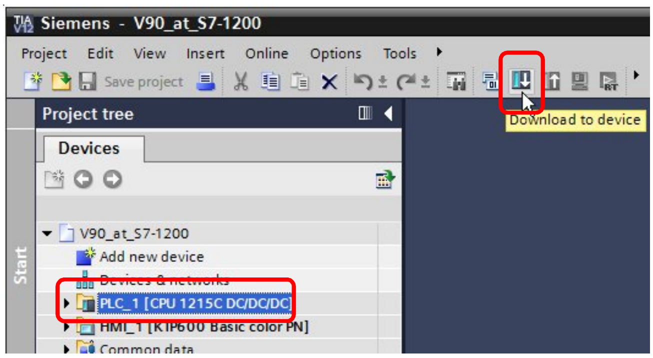
- …load the STEP 7 program into the SIMATIC S7-1200.
- …simulate the panel in the TIA Portal or load the operator panel configuration to the HMI device (if existing).
- …load the drive parameterization into the SINAMICS V90.

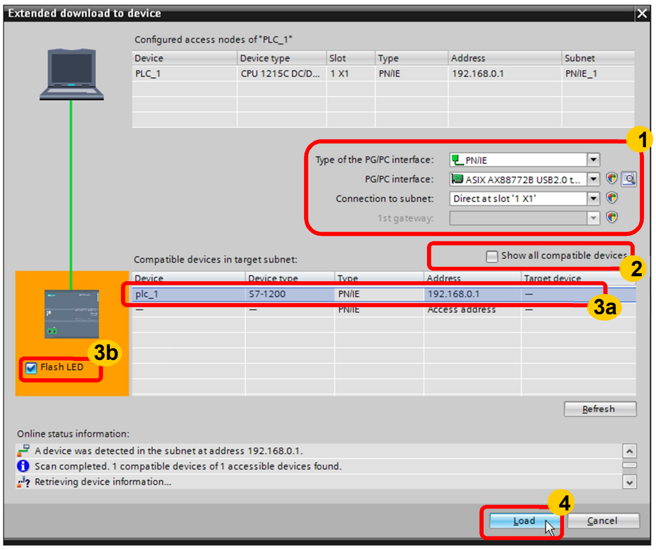
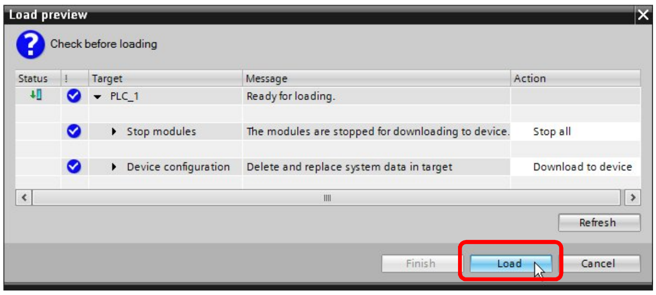
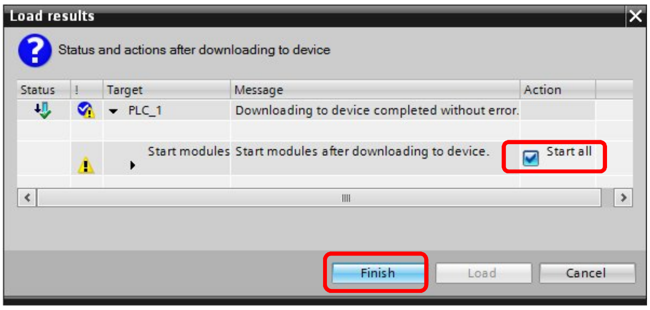
It is assumed, that the software has been installed on your PG/PC according to Table 3-2.

Load the STEP 7 project into the SIMATIC CPU

The following procedure table for TIA V12 equally applies to TIA V13. Minimal deviations are possible.

Table 4-5: Load the STEP 7 project into the SIMATIC CPU

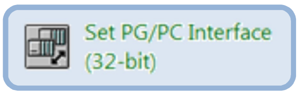
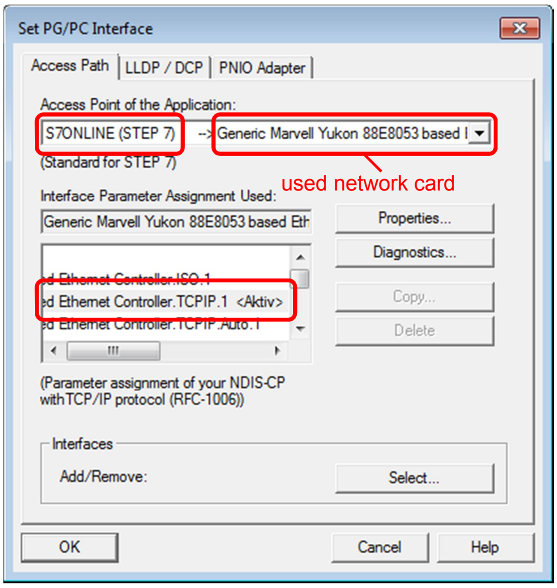
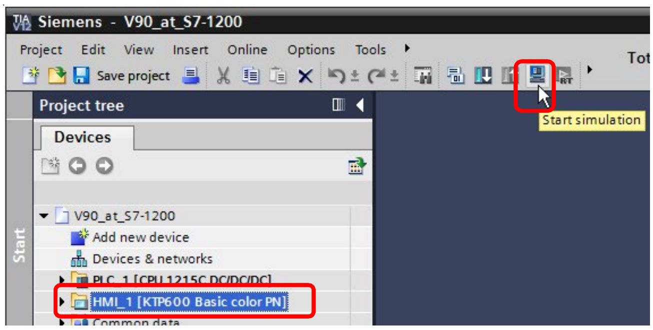
No.	Action	Note
1.	Retrieve the project on hand as zip file named *77467940_SINAMICS_V90_at_S7-1200_Vxdy.zip"* on Windows level. The project folder *"V90_at_S7-1200"* is created.	
2.	Double click on the ap12 file in the project folder just retrieved in order to open the project in TIA Portal.	
3.	If TIA Portal opens in the Portal view, go to the bottom left to switch to the Project view.	
4.	Load the program into the SIMATIC controller.	

No.	Action	Note
5.	If the “Extended download” window appears, proceed as follows: 1. Select the PG/PC interface used to connect with the Ethernet subnet. 2. Checkmark “Show all compatible devices” when receiving a respective online status information in the lower part of the window 3. Select the SIMATIC controller to be used in the target subnet. If necessary, identify it by “Flash LED”. 4. Acknowledge with the “Load” button.	
6.	Start the download process. If actions necessary for loading are requested in the “Action” column (shaded red), you select their execution.	
7.	Exit the download with the “Start all” option.	

Simulation of the HMI panel at the PG/PC

(not applicable when HMI device exists)

Table 4-6: Simulating or loading the KTP600

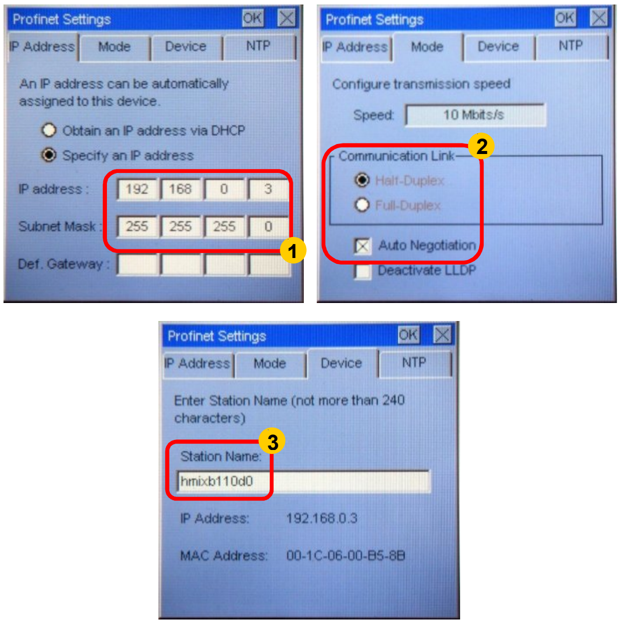
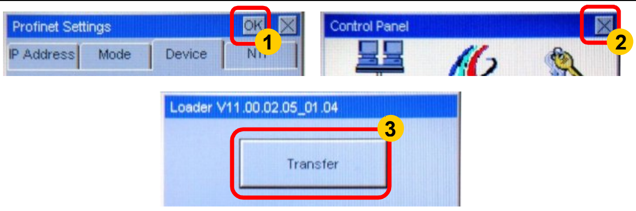
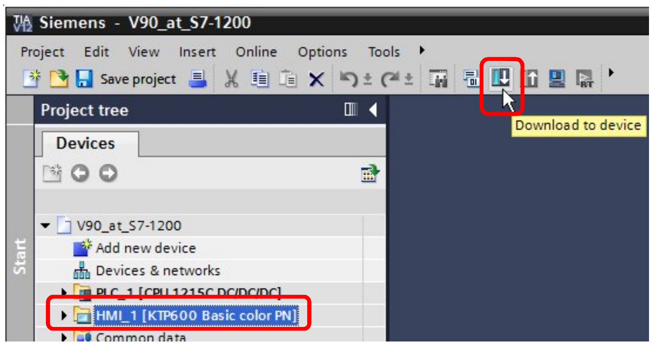
No.	Action	Note
1.	Set the PG/PC interface on Windows level. Select “S7ONLINE (STEP7)” as *access point* of the application and your used network card parameterized for TCP/IP as *Interface Parameter Assignment Used*. Navigate in Windows as follows: >Start >Control Panel -> Set PG/PC Interface 	
2.	Start the simulation of the HMI control panel in the TIA Portal project.	

Preparation & loading of the KTP600 in the TIA V12 sample project

(not applicable for simulation at the PG/PC)

Table 4-7: Preparation and loading of the KTP600 in the TIA V12 sample project

No.	Action	Note
1.	Connect the HMI KTP600 to the supply voltage. 1. Open the “Control Panel”. 2. Open the PROFINET settings.	

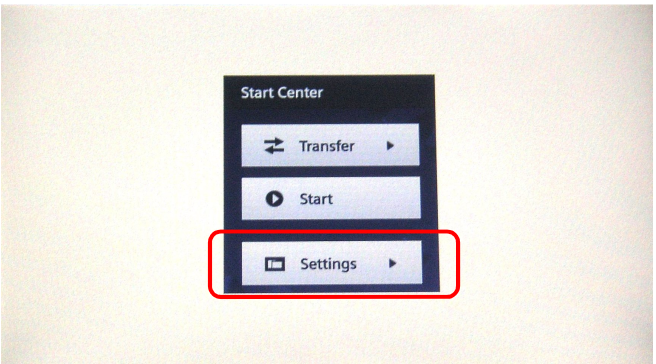
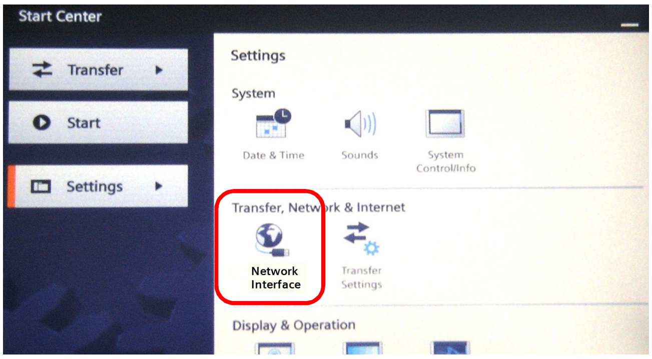
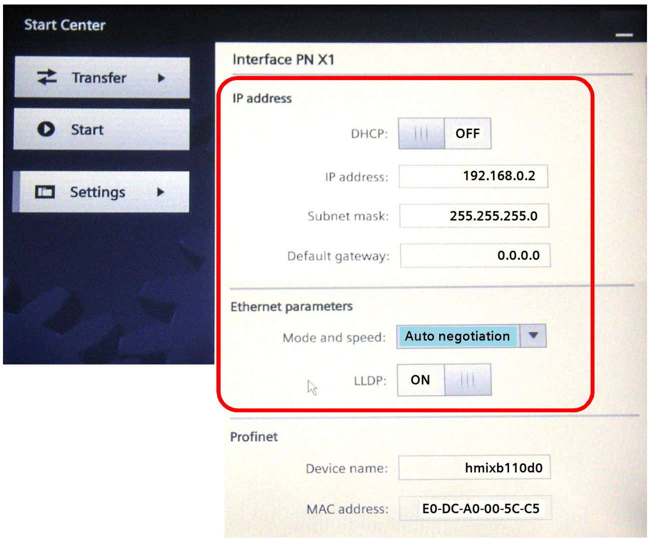
No.	Action	Note
2.	Make the entries according to the screens on the right. 1. Enter the value for the IP address configured in STEP 7. (It is available in the “devices and networks” editor in the device view of the HMI control panel under Properties and “Ethernet addresses”.) 2. Adopt (check) the standard settings on the “Mode” tab according to the right-hand screenshot. 3. The PROFINET device names themselves need not be edited. It is automatically entered when loading the HMI project into the control panel.	
3.	1. Exit the PROFINET settings with OK. 2. Exit the Control Panel. 3. Prepare the loading process by clicking the “Transfer” button.	
4.	Unless already performed, connect the HMI KTP600 with an Ethernet patch cable to the PG/PC directly or via a switch and start the data transfer. The HMI control panel will then start automatically. When working without switch, connect the control panel to the Ethernet port of the SIMATIC CPU.	

Preparation & loading of the KTP700 in the TIA V13 sample project

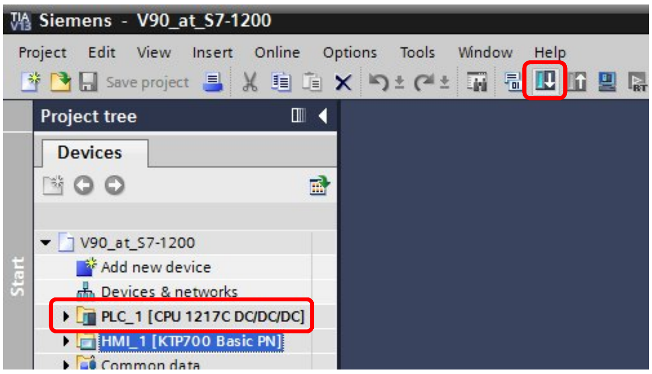
(not applicable for simulation at the PG/PC)

Table 4-8: Preparation and loading of the KTP700 in the TIA V13 sample project

Nr.	Aktion	Anmerkung
1.	If the panel is not in the as-delivered state, reset it to the factory setting.	For resetting into the delivery status see the operating instructions „HMI devices Basic Panels 2nd Generation“ (\7\).

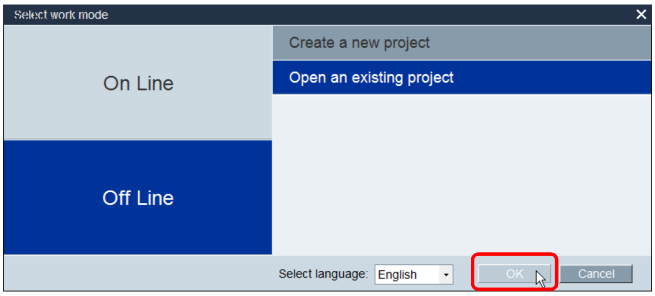
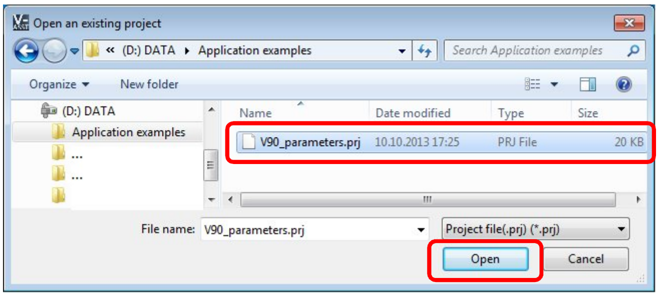
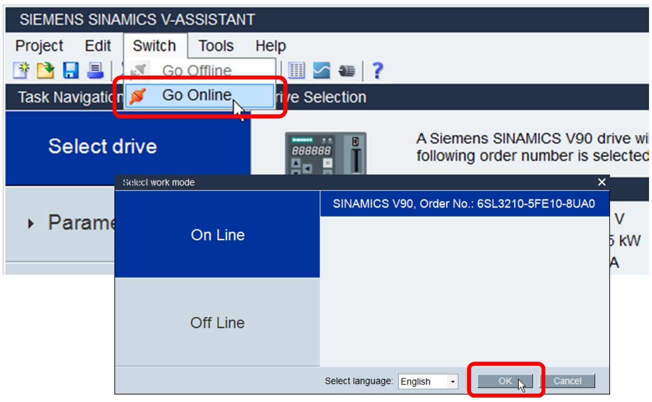
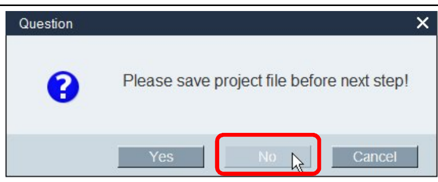
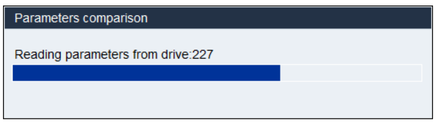
<table>
<tr><th>Nr.</th><th>Aktion</th><th>Anmerkung</th></tr>
<tr><td>2.</td><td>1. Apply power supply to the KTP700.
2. Press button Settings.</td><td>
</td></tr>
<tr><td>3.</td><td>Open dialogue Interface PN X1 by touching Network Interface</td><td>
</td></tr>
<tr><td>4.</td><td>1. Make entries according to the figure on the right.
You need not to edit the PROFINET device name. It is automatically entered with loading the HMI project into the panel.
2. Press Transfer button.</td><td>
</td></tr>
<tr><td>3.</td><td>If you have not done so already, connect the HMI KTP700 directly or via the CPU or via a switch to the PG/PC and start the data transfer.

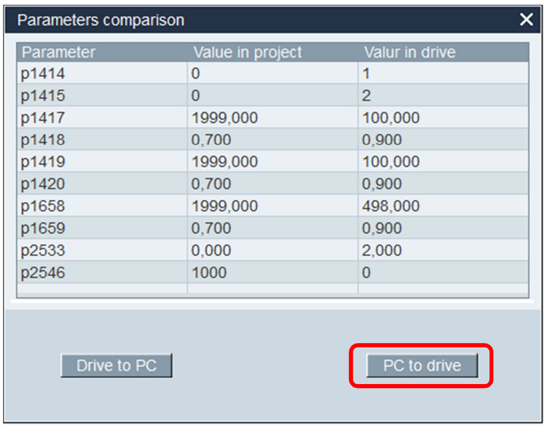
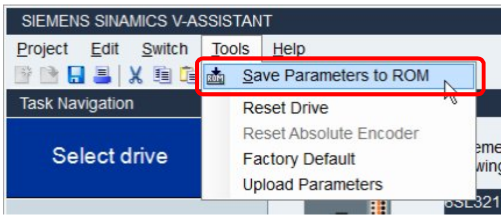
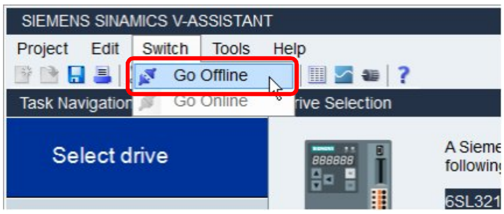
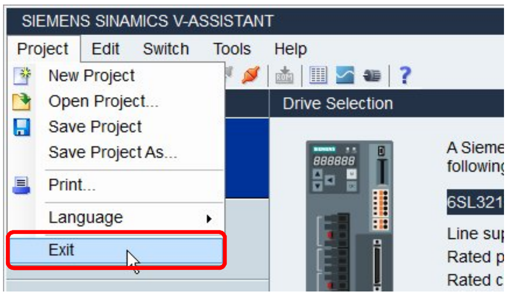
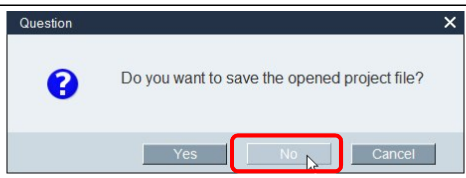
The HMI panel starts automatically afterwards.

If you do not use a switch, now connect your panel to an Ethernet port of the SIMATIC CPU.</td><td>
</td></tr>
</table>

Downloading the drive parameterization into the SINAMICS V90

Table 4-9: Downloading the drive parameterization into the SINAMICS V90

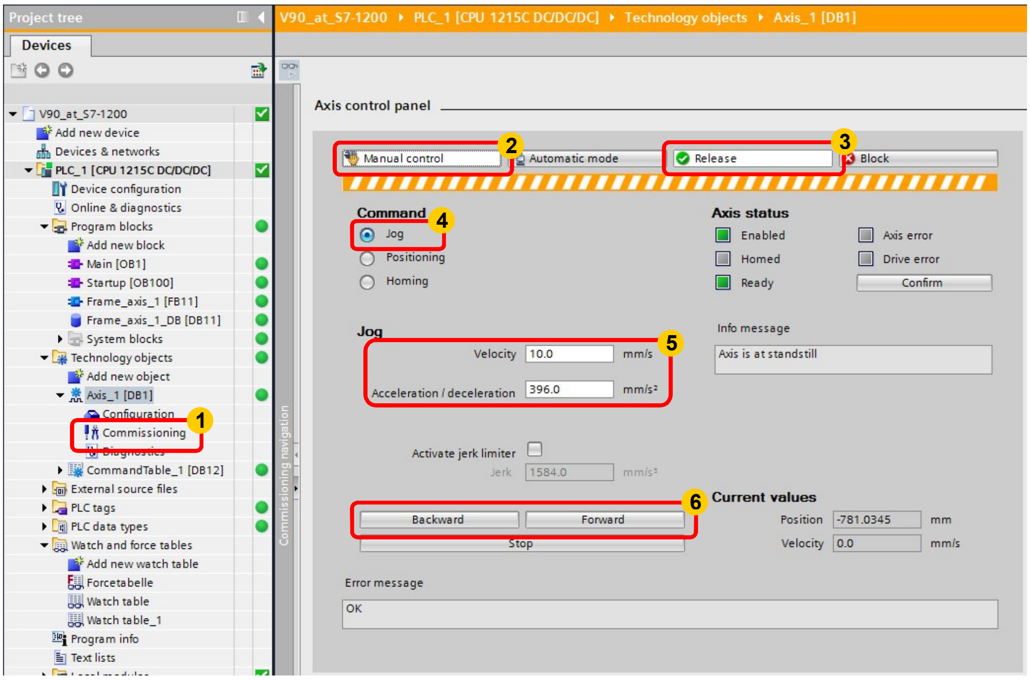
No.	Action	Note
1.	Unzip the “77467940_SINAMICS_V90_parameters_V*nn*_Vxdy.zip” archive supplied with the application into a directory on the hard drive of your PG/PC. It contains the “V90_parameters.prj” file. (*nn* = 12 or 13, see Table 3-3)	
2.	1. Start the PC tool SINAMICS V-ASSISTANT Select “Off Line” and “Open an existing project”. 2. Confirm with “OK”.	
3.	In the pane for opening the file you select the unzipped V-ASSISTANT project “V90_parameters.prj” and exit the window with “Open”.	
4.	1. Make sure that the USB connection between the SINAMICS V90 and your PG/PC has been physically established. 2. Go to the opened project. 3. Your SINAMICS V90 answers. Confirm with “OK”.	The *COM* LED at the SINAMICS V90 needs to blink green at 0.5 Hz. 
5.	1. The subsequent prompt to save the project file needs not be followed. 2. An offline/online comparison follows.	

No.	Action	Note
6.	Any existing differences between the project file and the settings in SINAMICS V90 will be displayed. You can now choose between an upload and a download. Select the download. If there are no differences between the project file and the settings in SINAMICS V90, the comparison window on the right does not appear and the download is void. In this case you proceed with step 0.	
7.	If you have performed a download, save the parameters to the ROM of the SINAMICS V90.	 The saving progress is indicated in a window.
8.	Go offline.	
9.	Exit the tool.	
10.	Since you have not changed the project file, exit the window on the right with “No”.	
11.	Physically separate the USB connection between the PG/PC and SINAMICS.	A red permanent *COM* LED light at the SINAMICS V90 shows again.

4.6 Commissioning via the axis control panel in the TIA Portal

Within the framework of your commissioning process, you can, via the TIA Portal, move the axis for an already parameterized SINAMICS V90 without *MC* function blocks and without HMI for test purposes. However, the STEP 7 program needs to already contain your configured *Axis_1* technology object. Proceed according to Table 4-10:

Table 4-10: Commissioning the axis with the axis control panel

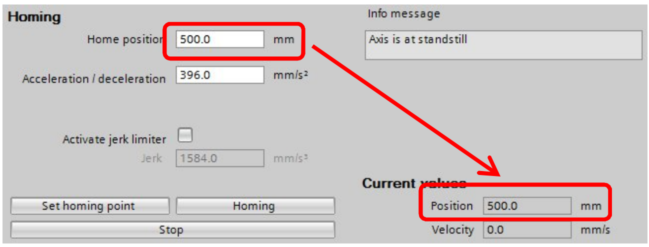
No.	Action
1.	Make sure that the SIMATIC controller does not output the *SON* (A0.2) signal to the SINAMICS V90 through the user program or via the watch table. *SON* must carry a 0-signal.
2.	Moving in jog mode: 1. In the project navigation you double-clock on the *Commissioning* menu item of the *Axis_1* axis control panel. 2. Activate the *Manual control*. The SIMATIC controller then goes online. 3. Now activate the release. The axis status indicates *Enabled* and *Ready* (green). 4. Select the *Jog* command. 5. Enter the desired values for *Velocity* and *Acceleration/deceleration*. 6. Move the drive with the *Backward* and *Forward* buttons in jog mode. 
3.	Relative positioning: Analog to the above jog mode, relative positioning is also possible. 1. Select the *Positioning* command. 2. Enter the desired values for *Position, Velocity* and *Acceleration/deceleration*. The sign for *Position* defines the motion direction. 3. Start the positioning process with the *Relative* button. 4. The axis can be stopped prematurely and the positioning command be cancelled with the *Stop* button.

<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>4.</td><td>
<u>Homing:</u>
The axis can be homed via the axis control panel.

In jog mode you move the axis to a position on right of the RPS.
Select the Homing command.
Enter the desired values for Home position and Acceleration/deceleration.
Start the homing process with the Homing button. The axis starts moving to the left. Homing is performed “actively”; i.e. the entire homing motion runs automatically according to the specifications in the axis configuration (step 21 in Table 7-2)[9].
The axis can be stopped prematurely and the homing process be cancelled with the Stop button.
Wait for the end of the homing process.

<u>Reference point switch exists physically:</u>
wait until the axis slide reaches the homing switch and the positioning process has been terminated.
<u>Reference point switch simulated:</u>
if you have already loaded FB Frame_axis_1 and the RPS digital input E0.4 is wired for the RPS simulation (broken line for connection in Figure 3-2), you can recreate and operate the RPS via the KTP600 or the respective Runtime simulation. To do this, click on the grayed Home button in the Function menu screen. This takes you to the RPS Simulation screen, which only contains the reference point switch. In order to create the necessary switching ramps for the simulation of reaching the RPS, press the RPS Simulation twice in brief succession.

After completing the process, the given home position has been assigned to the right edge of the axis slide, and the axis slide is positioned physically on this position. The current position is displayed at the axis control panel.



The homing method[10] to be performed with the Set homing point button is not further pursued in this application.
</td></tr>
<tr><td>5.</td><td>
<u>Absolute positioning:</u>
Analog to relative positioning, absolute positioning can be performed – after the axis has been referenced.

Select the Positioning command.
Enter the desired values for Home position, Velocity and Acceleration/deceleration.
Start the positioning process with the Absolute button.

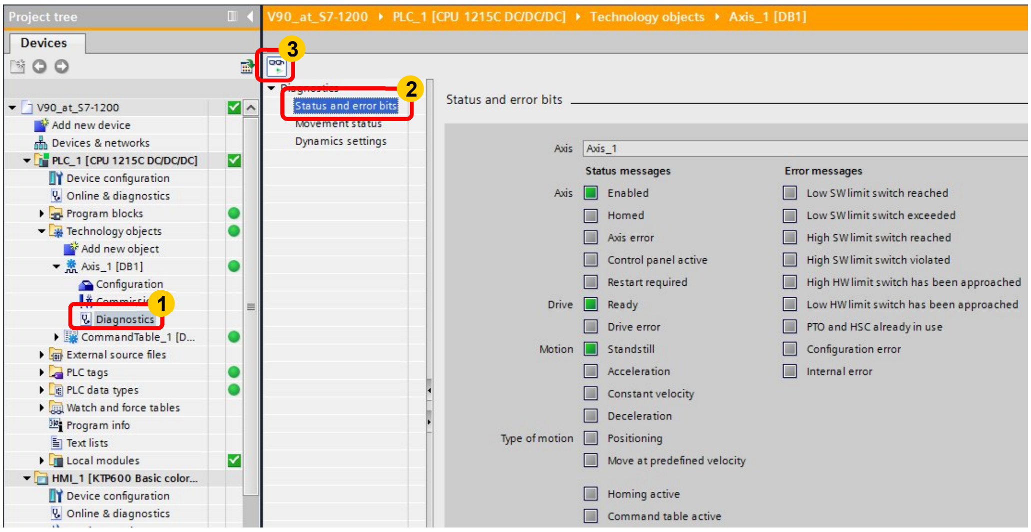
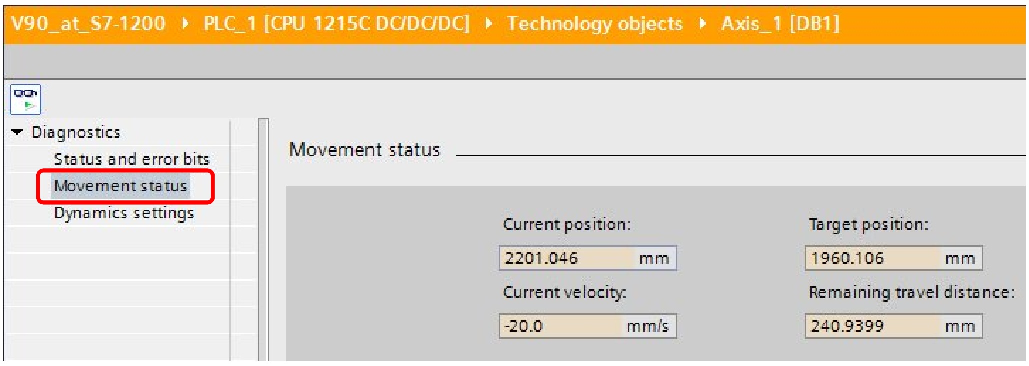
The axis can be stopped prematurely and the positioning command be cancelled with the Stop button.
</td></tr>
</table>

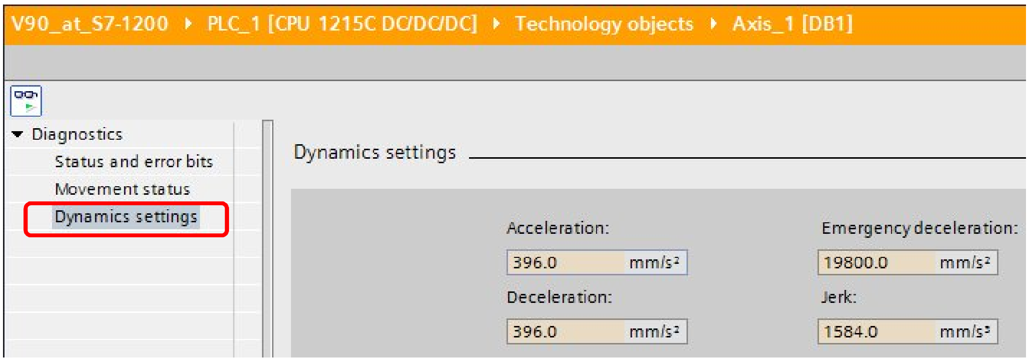
[9] The sequence corresponds to referencing with FB *MC_Home* using input parameter *Mode* = 3, as also described in chapter 5.5.2 in the “*Home* screen”. Explanations on the various referencing types are available, for example, in the Step 7 Online Help.
[10] The sequence corresponds to referencing with FB *MC_Home* using input parameter *Mode* = 0.

4.7 Axis diagnostics in the TIA Portal

Within the framework of your commissioning process, you can, via the TIA Portal, diagnose the axis in menu item *Diagnostics* of the technology object for an already configured SINAMICS V90 and configured *Axis_1* technology object. It is not important whether you move the axis via the axis control panel or – if already configured before this point – via user program using the *MC* blocks and the operator panel. Proceed as explained in table below.

Table 4-11: Diagnosis of the axis

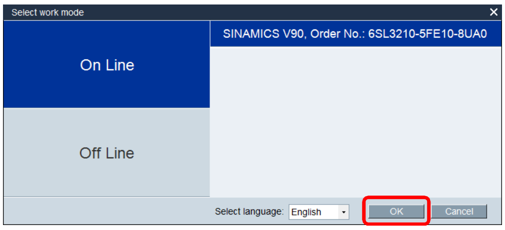
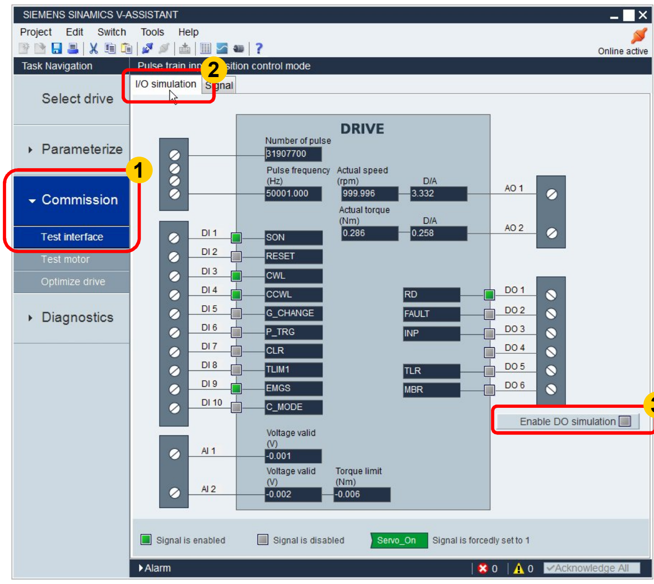
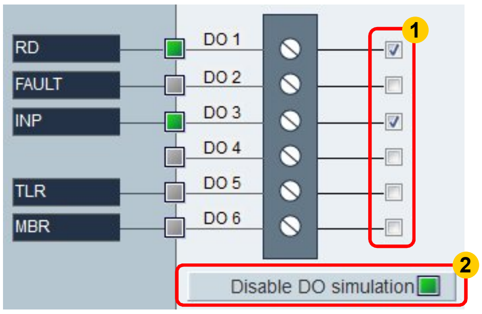
No.	Action
1.	<u>Status and error bits:</u> 1. In the project navigation you double-click on menu item *Diagnostics* of the *Axis_1* technology object to open Diagnostics. 2. Select the *Status and error bit*. 3. In the Diagnostics window you click on . 
2.	<u>Movement status:</u> Based on step 1, select the *Movement status*. 

<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>3.</td><td>Dynamics settings:
Based on step 1, select the Dynamics settings.

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

4.8 Interface test with PC tool SINAMICS V-ASSISTANT

The PC Tool enables you, from the point of view of SINAMICS V90, to view its digital (and analog) interfaces and simulate its digital output signals.

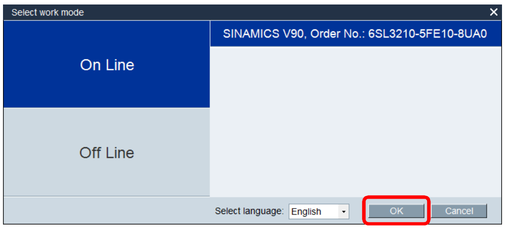
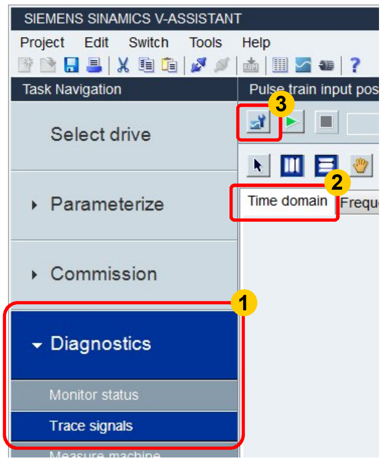
Table 4-12: Interface test with PC Tool SINAMICS V-ASSISTANT

No.	Instruction	Note / Screen
1.	Establish the USB connection between the SINAMICS drive and the PG/PC.	At the SINAMICS V90 the *COM* LED blinks green at 0.5 Hz.
2.	1. Start the PC tool SINAMICS V-ASSISTANT 2. Confirm with "OK".	 The tool connects to the SINAMICS V90 online and recognizes it.
3.	1. In the Task Navigation you click on *Commission > Test interface*. 2. Select the *I/O simulation* tab. You can now monitor the interface signals. 3. Allow the simulation of the digital outputs.	
4.	1. Force digital outputs for test purposes. (only possible if no *SON* signal (Servo_On) is pending) 2. Terminate forcing.	
5.	Terminate the PC Tool via *Project > Exit* in the menu bar.	Answer the query whether to save the project file with *No*.

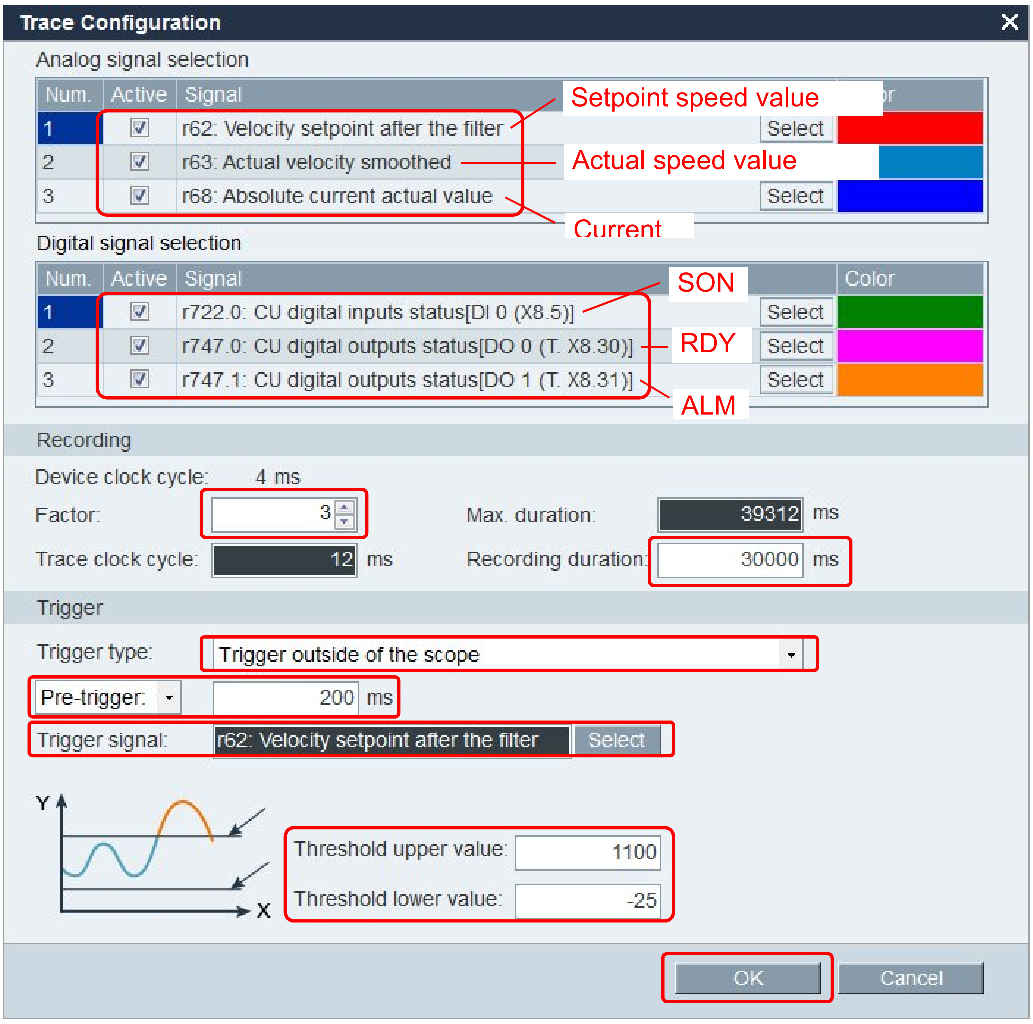
4.9 Trace function of PC Tool SINAMICS V-ASSISTANT

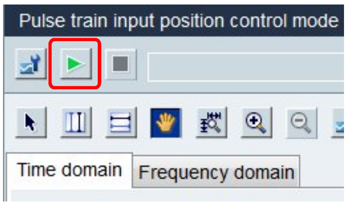
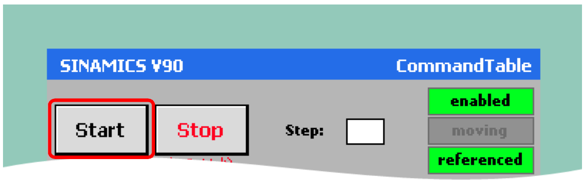
For optimization or trouble-shooting purposes you can use SINAMICS V ASSISTANT to record various analog and digital signals over a certain period of time and represent them in a graphical curve. This shall be demonstrated using the example of the material processing sequence (Table 5-1) realized via the command table.

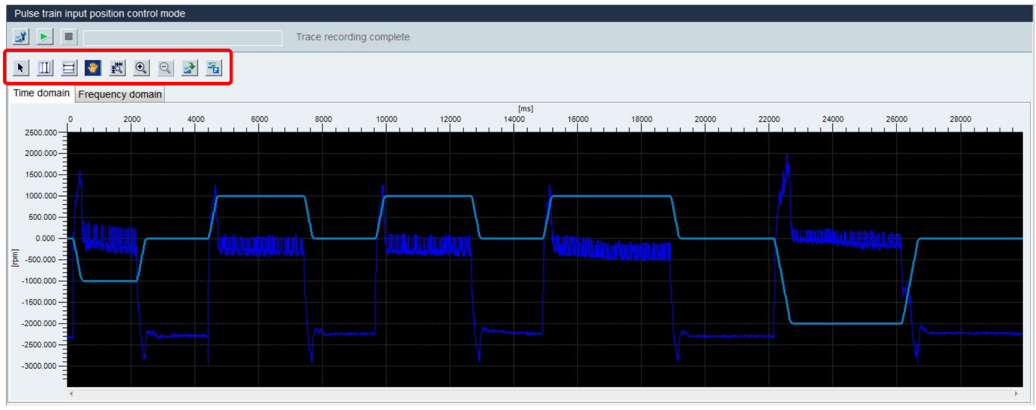
Table 4-13: Recording signals with the SINAMICS V ASSISTANT trace function

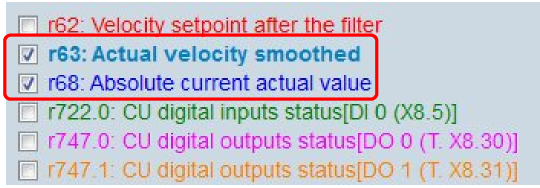
No.	Instruction	Note / Screen
1.	Establish the USB connection between the drive and the PG/PC.	At the SINAMICS V90 the *COM* LED blinks green at 0.5 Hz.
2.	1. Start the PC tool SINAMICS V-ASSISTANT 2. Confirm with “OK”.	 The tool connects to the SINAMICS V90 online and recognizes it.
3.	1. In the Task Navigation you click on *Diagnostics > Trace signals*. 2. Select the *Time domain* tab. 3. Open the trace configuration.	

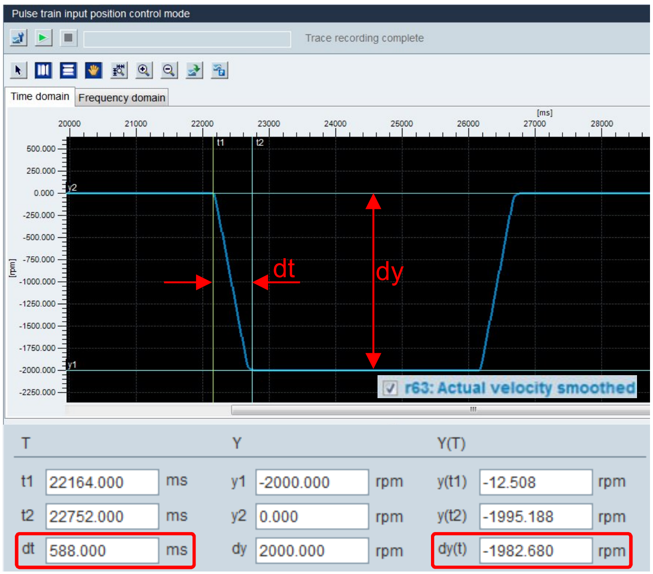
<table>
<tr><td>4.</td><td colspan="2">Configure your trace according to the figure.



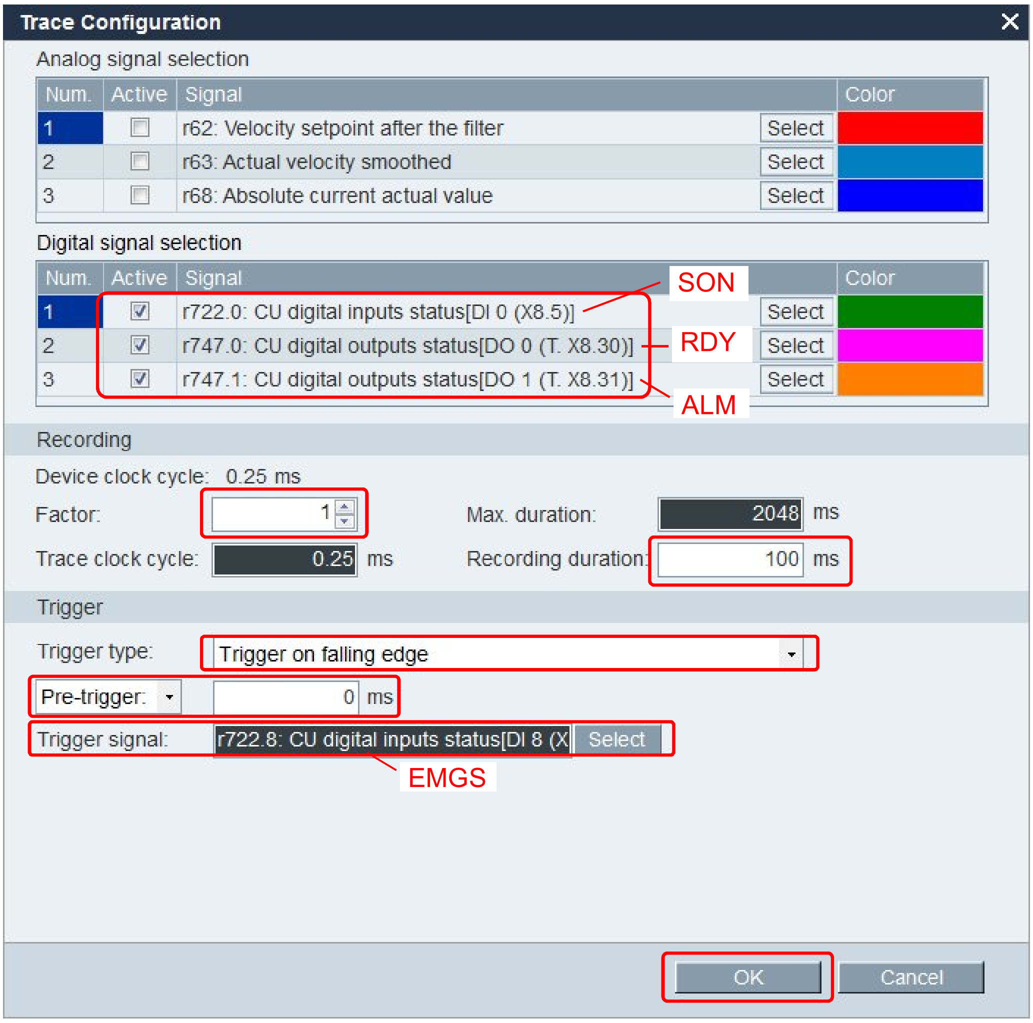
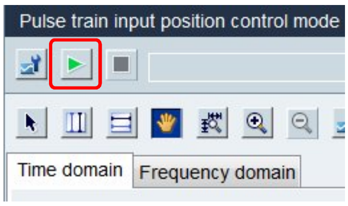
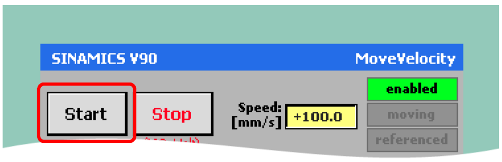
Fetch the signals from the drop-down menu with the respective *Select* button. The color of the graphs can also be selected from a drop-down list.</td></tr>
<tr><td>5.</td><td colspan="2">Reference the axis in HMI screen *Home* and then switch to HMI screen *CommandTable* (see chapter 5.6.2, Home screen and CommandTable screen).</td></tr>
<tr><td>6.</td><td>Start recording in the SINAMICS V-ASSISTANT</td><td>
</td></tr>
<tr><td>7.</td><td>Start the command chain in HMI screen *CommandTable*.</td><td>
</td></tr>
</table>

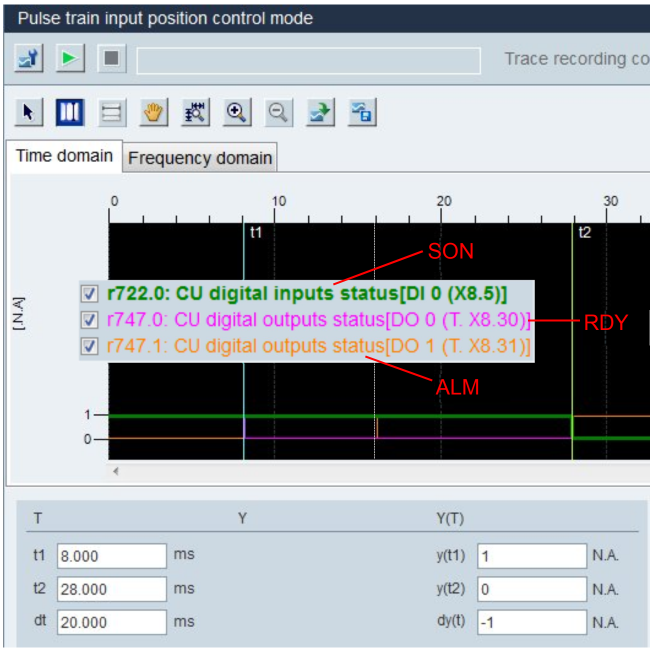
<table>
<tr><td>8.</td><td colspan="2">After the end of recording and data transmission to the PG/PC, the time curves of the selected signals are displayed.


Select the curves you wish to see via the checkboxes.


Clicking on transforms the cursor pad into a cursor arrow which you use to select one of the displayed curves. This curve is represented in bold and the measurement cursors can be applied to it. The dimension of the ordinate of the diagram is also that of the selected curve.</td></tr>
<tr><td>9.</td><td>For the curve analysis the graphs can be measured. can be used here to alter the display size and to shift the display. The measured data of the curves measured with are displayed below the diagram.</td><td>

Example:
In the application, the ramp-up time was, in the configuration of the technology object, configured to the maximal speed of 200 mm/s with 0.5 s.
It can be graphically determined from the above curve that from the state after 588 ms a speed of 1982.68 rpm (198.268 mm/s) was reached.</td></tr>
</table>

<table>
<tr><td>10.</td><td colspan="2">The timing of the digital signals can also be analyzed.
If you trigger an emergency stop via EMGS → 0 at the SINAMICS V90 while the axis is moving, you can, for example, record the time behavior of the RDY, ALM and SON signals.
Leave only the digital signals activated. Make the recordings and trigger settings as shown in the screen below.

</td></tr>
<tr><td>11.</td><td>Start recording in the SINAMICS V-ASSISTANT</td><td>
</td></tr>
<tr><td>12.</td><td>Start, for example, a Move_Velocity command and then trigger an emergency stop with EMGS → 0.</td><td>
</td></tr>
</table>

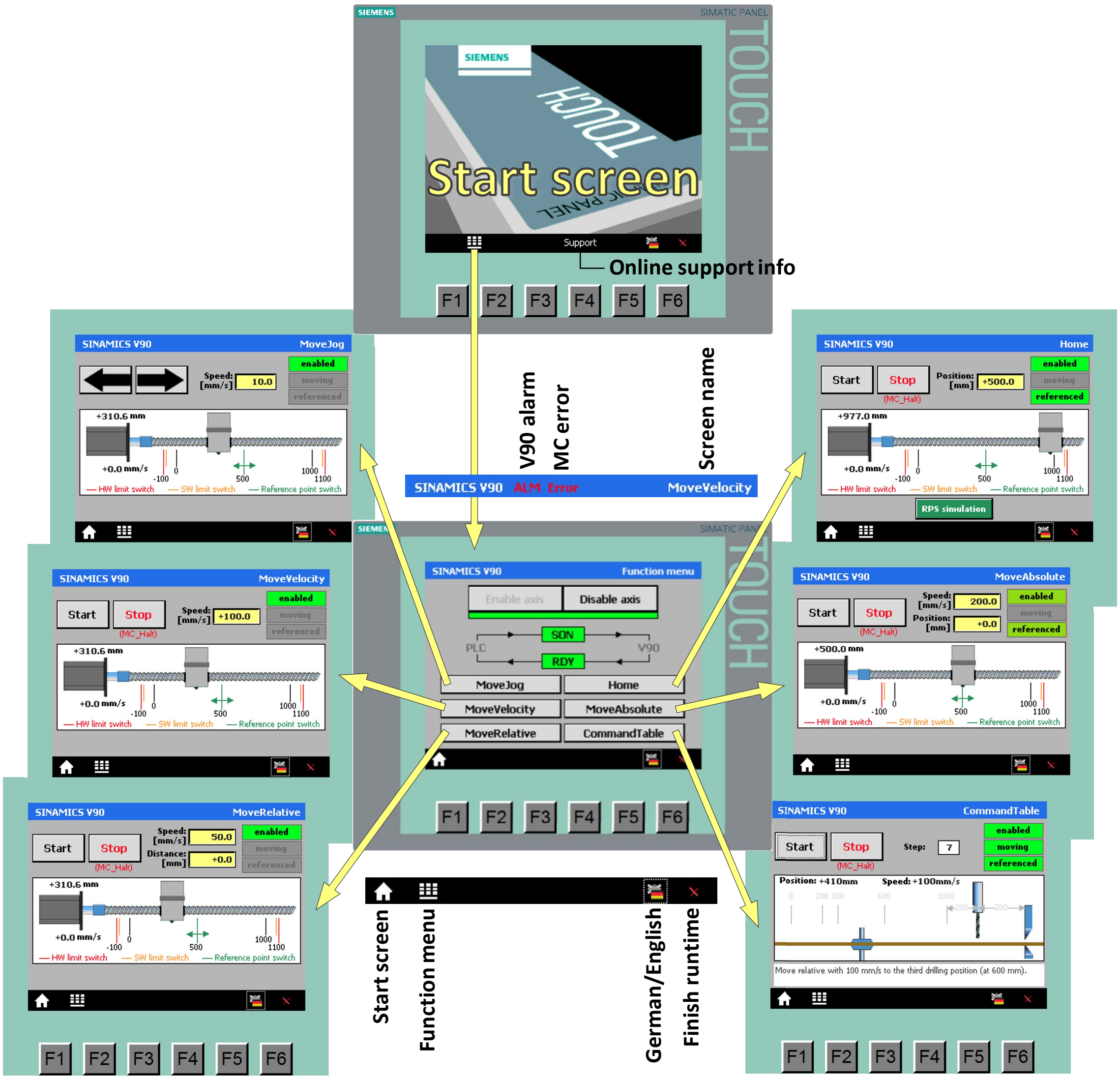
13.	After the end of recording and data transmission to the PG/PC, the time curves of the selected signals are displayed.	 From the diagram it can be seen that the SINAMICS V90 resets its *RDY* signal after approx. 8 ms after triggering the emergency stop and the SIMATIC cancels the *SON* signal after another 20 ms. Approx. 16 ms after the emergency stop event, the SINAMICS V90 outputs the *ALM* alarm message.
14.	You can save or reload your recorded trace curves with the and buttons.	The files are stored with file extension "*.trc*". The specified default names correspond to date and time: *traceyyyymmddhhmmss.trc* (e.g. *trace20131014125616.trc*)

5 Operation

5.1 Screen navigation

The screens in TIA V12 project (KTP600) and TIA V13 (KTP700) are identical.

Figure 5-1: Screen navigation



Function keys are not assigned.

5.2 Header with error display

All function-relevant screens have a blue header. It contains the picture name which reveals the function of the screen. Furthermore, errors are indicated here:

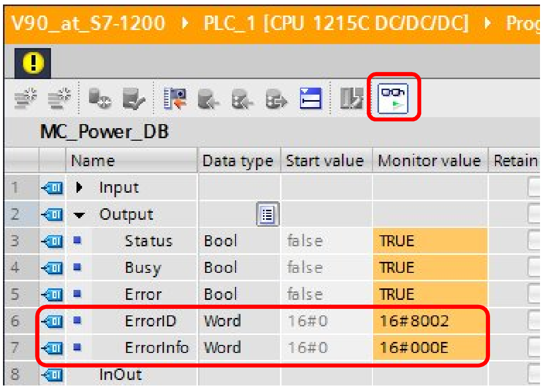
Error displays

- *ALM*
  Error reported via digital output *ALM* of SINAMICS V90. Identify the error by

means of the display at the V90. An error description is available in chapter 11.2 of the V90 operating instruction /9/.

- *Error*
  Error detected by the *MC* block. Identify the error by means of *MC* FB parameter *ErrorID* and *ErrorInfo*. Open the *MC_Power_DB* in the TIA Portal.

Figure 5-2: Error messages *ErrorID* and *ErrorInfo*



Error acknowledgment

To acknowledge the error you click on one of the errors in the header. The acknowledgement pulse always affects both errors *ALM* and *Error*.

- *ALM*
  The acknowledgement causes a pulse at V90 digital input *RESET*.
- *Error*
  The acknowledgement causes the execution of FBs *MC_Reset*.

5.3 Menu bar

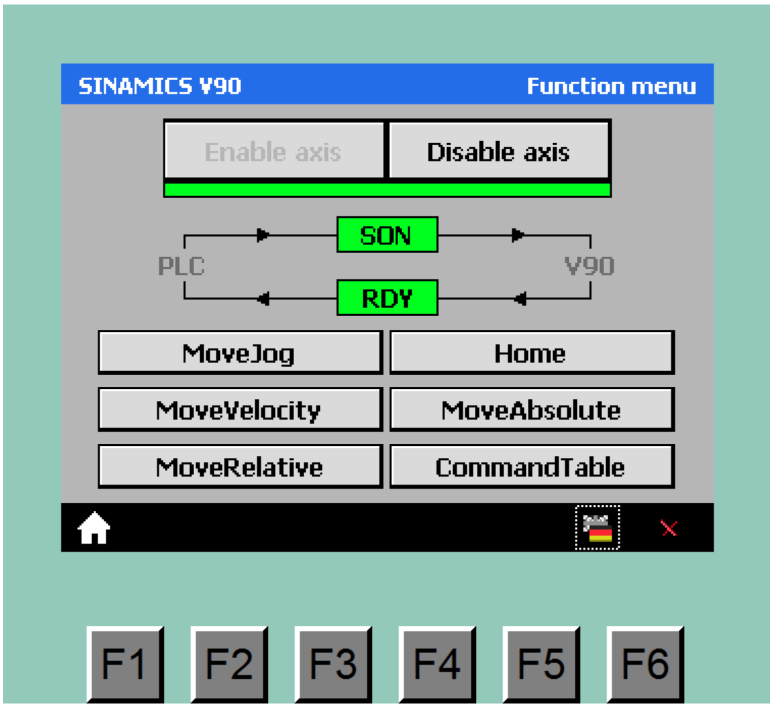
All screens have a blue header. The following functions can be executed:

- 
  This takes you to the *Function menu* screen.
- 

  (only exists in the start screen)
  This screen informs you of the Siemens Industry online support.
- 
  Change language (German / English).
- 
  Exit runtime
-  (does not exist in the start screen)
  This takes you to the start screen.

5.4 *Function menu* screen

Figure 5-3: *Function menu* screen



After restarting the controller – as, for example, after commissioning has been completed according to chapter 4.5 – the axis is disabled. The decisive digital signals *SON* (Servo on) from the controller to the drive and *RDY* (Ready) from drive to controller are 0. In the screen, the respective displays are gray.

Unless an error is pending[11] (no display in the header blinking red), you can set the *Enable* parameter of FB *MC_Power* to 1 using the *Enable axis* button. "*Enable* = 1" is indicated by a green bar underneath the enable/disable buttons. As a reaction to "*Enable* = 1", FB MC_Power sets the *SON* signal. SINAMICS V90 reacts to this by setting the *RDY* signal. This releases the axis and makes it ready to execute MC commands. The above screen is displayed for an enabled axis (green indicators).

If the axis is ready, you can call up the screen of the desired MC command.

5.5 Moving the axis with the MC blocks

The move command screens *MoveJog, MoveVelocity, MoveRelative, Home, MoveAbsolute* and *CommandTable* start the *MC* move command (FBs) of the same name. FB *MC_Halt* is used for the (premature) termination of a command. This is triggered by means of the stop button which exists in any move commend screen (with the exception of *MoveJog*).

The inclinations of the acceleration and deceleration ramps of all move processes controlled with the *MC* blocks, are default in the axis configuration. When stopping via the *MC* blocks, it is differentiated between **General** and **Emergency stop**. Both deceleration delays are defined in the axis configuration:

- **General**
  If a move command is terminated by FB *MC_Halt*, or the respective switch-

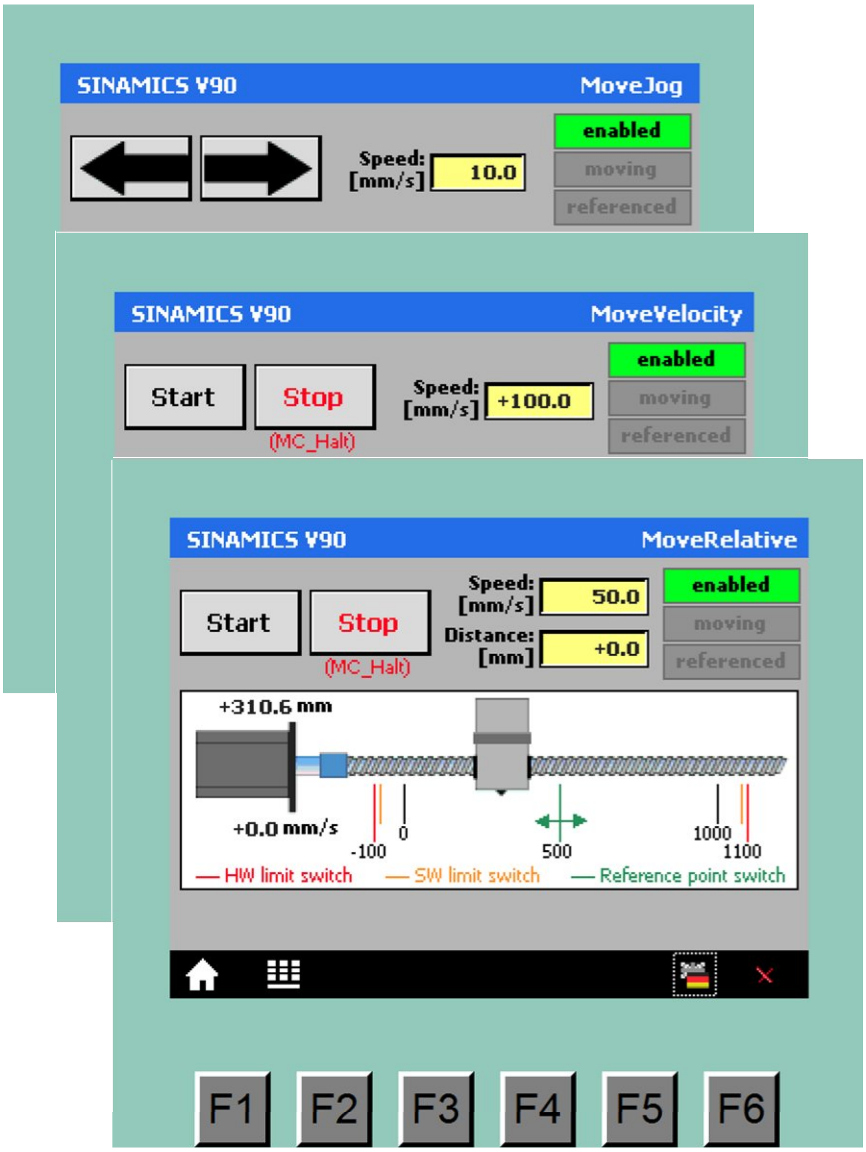
[11] Remove any possibly pending errors. See chapter 5.2 for error acknowledgement.

on command (*MC_MoveJog*: *JogForward, JogBackward* → 0 or, releasing the respective arrow key in the *MoveJog* screen) is cancelled, the motor ramps down with the general ramp.

- **Emergency stop**
  If – as in the application example – the *StopMode* parameter in *MC_Power* has been configured as 0 (default value), and a move command is terminated by disabling the enable (*MC_Power*: *Enable* → 0 or pressing the *Disable axis* button in HMI screen *Function menu*), the motor ramps down with the emergency-stop ramp.

5.5.1 Moving the non-referenced axis

Figure 5-4: Moving the non-referenced axis



After restarting the controller, the slide of the axis in the graphic is in the 0 mm position. Using the FBs *MC_MoveJog*, *MC_MoveVelocity* or *MC_MoveRelative* you can move the axis over any distance in both directions (in the graphic, the slide position is restricted to the HW limit-switch positions), until…

- the axis is enabled (**enabled** , axis DB *Axis_1*: *Enable* → 1),
- the axis is not referenced
(**referenced** , axis DB *Axis_1*: *HomingDone* → 0) and
- the HW limit-switches are not actuated (V90 digital inputs CWL or CCWL both supply a 1 signal).

MoveJog screen

Moving the axis left or right in command mode using the arrow keys. After a controller restart, 10 mm/s are entered by *MC_MoveJog* as the default velocity. You can define values up to ±200 mm/s (= maximal value entered in the axis configuration) via the input field. Higher values may be entered; however, the respective command is not executed by the MC blocks. When specifying a negative velocity, the direction of motion is inverted.

MoveVelocity screen

Moves the axis at a constant velocity. Start the motion with the start button. After a controller restart, FB *Frame_axis_1* enters +100 mm/s as the user default velocity into the *MC_MoveVelocity_DB*[12]. You can define values up to ±200 mm/s (= value entered in the axis configuration) via the input field. Values of higher amounts may be entered, however, the respective command is not executed by the MC blocks. When specifying a negative velocity, the direction of motion is inverted.

Press the stop button for stopping the axis. It starts FB *MC_Halt* via its input parameter *Execute*.

MoveRelative screen

Position the axis relative to the output position by a certain distance. Start the motion with the start button.

After a controller restart, FB *Frame_axis_1* enters +50 mm/s as the user default velocity into the *Velocity* input parameter of *MC_MoveRelative_DB*[13]. You can, via the respective input field, write values up to +200 mm/s (= maximal value entered in the axis configuration) into the *Velocity* parameter. Higher values may be entered; however, the respective command is not executed by the MC blocks.

After the controller restart, a distance to be moved of 0 mm has been entered as the default value into input the *Distance* parameter des *MC_MoveRelative_DB*. You can, via the respective input field, write values up to ±9,999.9 mm/s into the *Distance* parameter. The sign of the entered value decides the direction of motion. The maximal value range of the *Distance* parameter is ±1.0*e^{12}. For larger values, the move command cannot be executed.

---

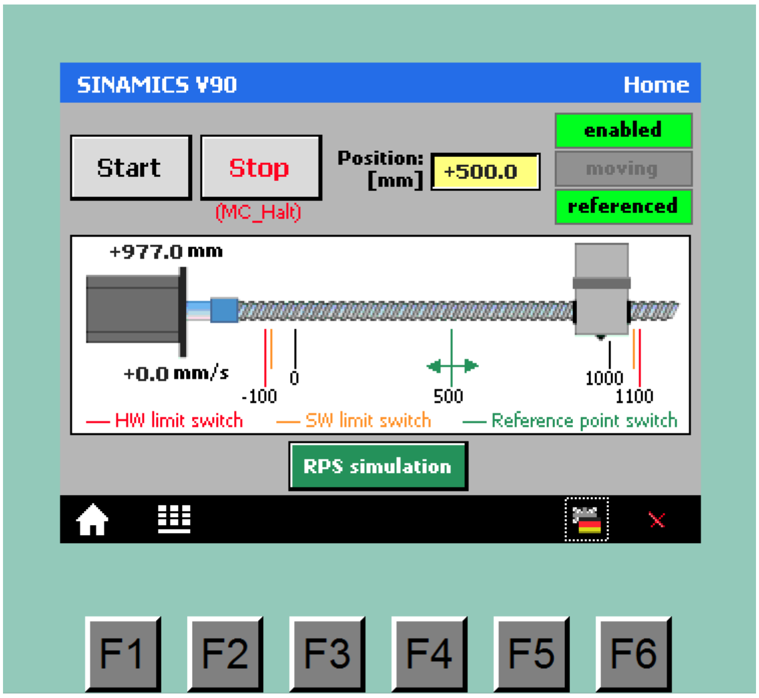
[12] At a restart, FB *Frame_axis_1* overwrites the default value 10 mm/s of *MC_MoveVelocity*.

[13] At a restart, FB *Frame_axis_1* overwrites the default value 10 mm/s of *MC_MoveRelative*.

5.5.2 Moving the referenced axis

Home screen

Figure 5-5: *Home* screen



Reference the axis before starting the *MC_MoveAbsolute* or *MC_CommandTable* commands.

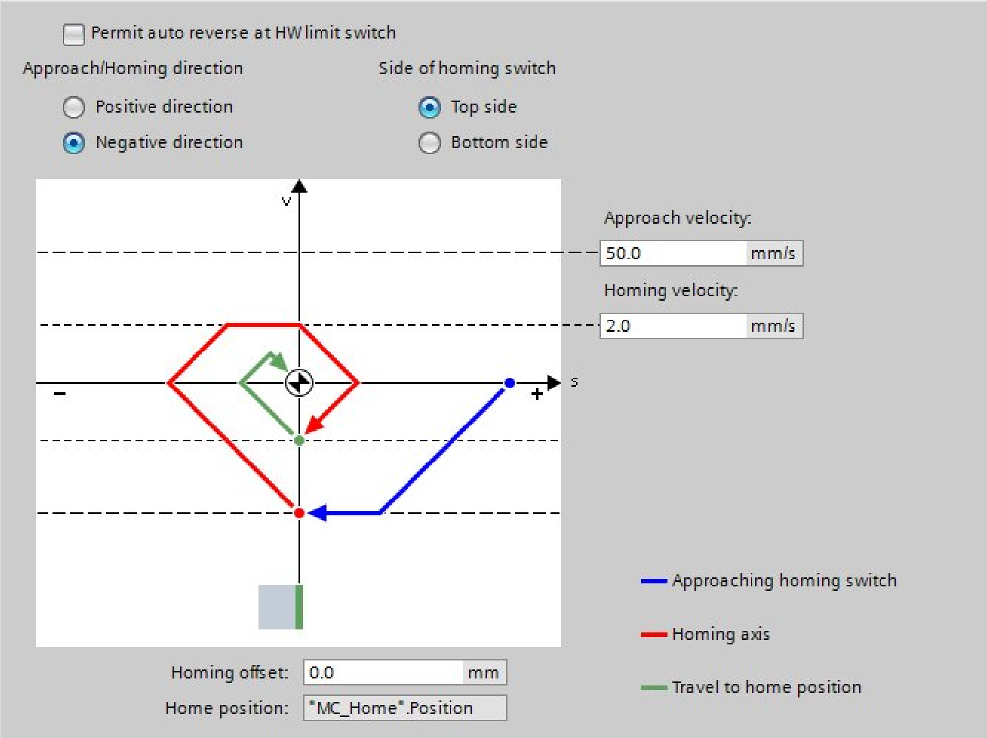
After a controller restart, FB *Frame_axis_1* enters +500 mm/s as the user default value for the reference point switch position into *MC_Home_DB*[14]. You can, via the respective input field, write values up to ±9,999.9 mm/s into the *Position* parameter. The maximal value range of the *Position* parameter is ±1.0*e[12]. For larger values, the command cannot be executed.

To be able to use the application without real reference point switch (RPS) as well, it is simulated in the HMI screen by the 

button. In the application example, homing is performed "actively" by means of FB *MC_Home*; i.e., *MC_Home* performs the entire reference-point search motion automatically (input parameter of *MC_Home*: *Mode* = 3). Explanations on the various referencing types are available, for example, in the Step 7 Online Help. In the axis configuration, homing was defined as follows:

[14] At a restart, FB *Frame_axis_1* overwrites the default value 0 mm of *MC_Home*.

Figure 5-6: Active homing



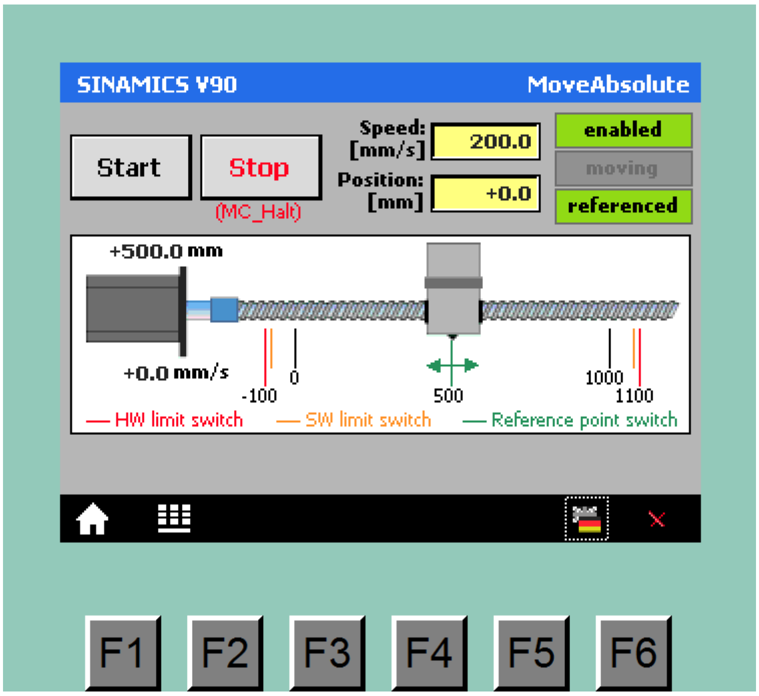
If – as in the application example – the HW limit-switches are connected directly at the SINAMICS V90, a change of direction at the HW limit-switch must not be permitted, since, upon reaching it, the drive would generate an error message requiring acknowledgement and stop with OFF3.

For the homing process, please proceed as follows:

1. Move the axis to a position on right of the RPS using *MC-MoveJog*, *MC_MoveVelocity* or *MC_MoveRelative*.
2. Start the homing process with the *Start* button.
   - In order to create the necessary switching ramps to simulate reaching the RPS, press the *RPS Simulation* button twice in brief succession after starting the process.
3. After completing the process, the value of the *Position* parameter has been assigned to the right edge of the axis slide, and the axis slide is positioned physically on this position.

MoveAbsolute screen

Figure 5-7: *MoveAbsolute* screen



Position the axis to an absolute position. Start the motion with the start button. The command is only processed at referenced axis (referenced).

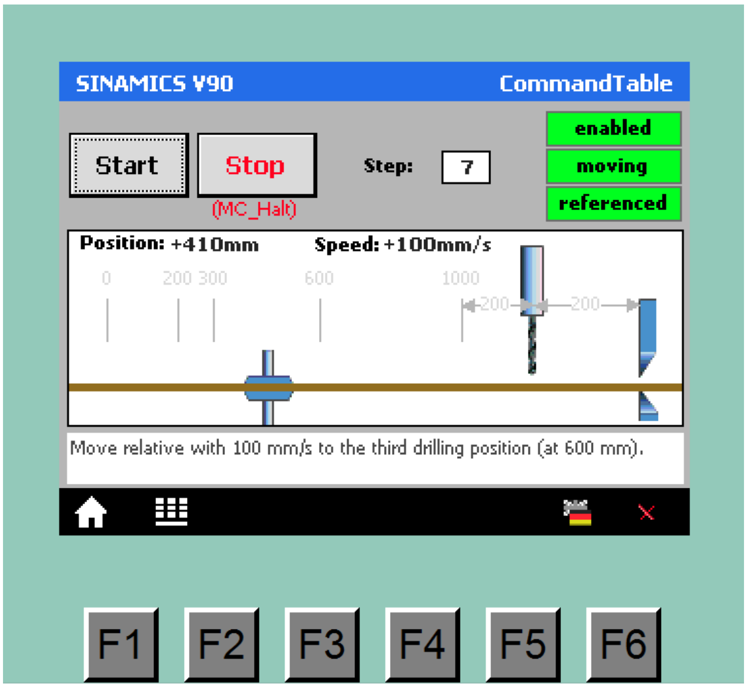
After a controller restart, FB *Frame_axis_1* enters +200 mm/s as the default velocity into the *Velocity* input parameter of *MC_ MoveAbsolute_DB*[15]. You can, via the respective input field, write values up to +200 mm/s (= maximal value entered in the axis configuration) into the *Velocity* parameter. Higher values may be entered, however, the respective command is not executed by the MC blocks.

After the controller restart, the approached 0 mm position has been entered as the default value into input the *Position* parameter des *MC_ MoveAbsolute_DB*. You can, via the respective input field, write values up to ±9,999.9 mm/s into the *Position* parameter. The maximal value range of the *Position* parameter is ±1.0*e[12]. For larger values, the move command cannot be executed.

[15] At a restart, FB *Frame_axis_1* overwrites the default value 10 mm/s of *MC_MoveAbsolute*.

CommandTable screen

Figure 5-8: *CommandTable* screen



Process a command table consisting of *MC* single move commands and wait times. FB *MC_CommandTable* is only processed at referenced axis (**referenced**). Creating a command table required inserting a *CommandTable* technology object into the STEP 7 project In the application on hand, a command table was created for the following example:

Three holes shall be drilled in succession into a band material. Subsequently, the band shall be cut off.

Figure 5-9: Appliance for material processing

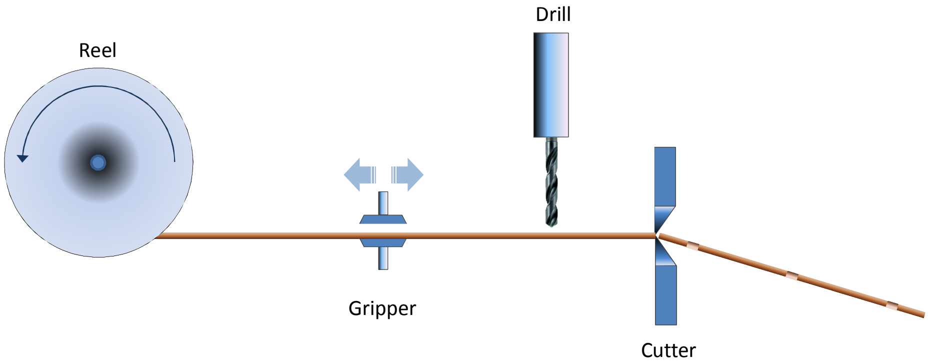
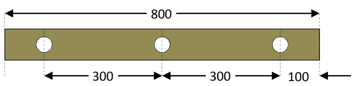
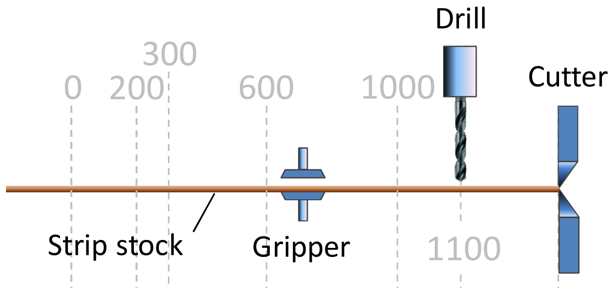
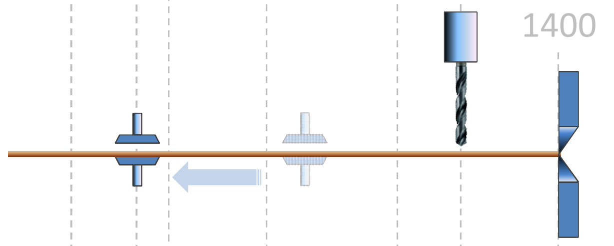
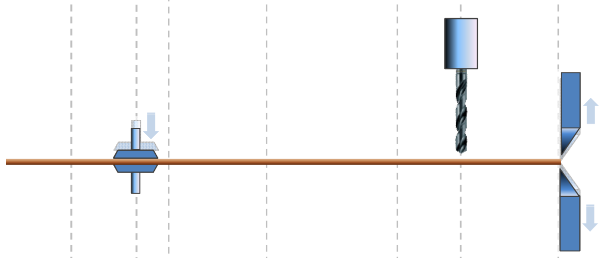
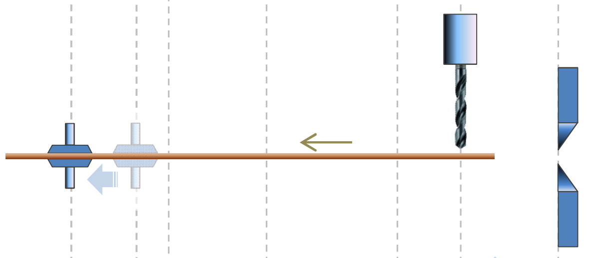
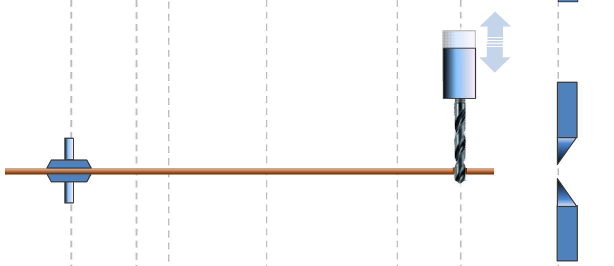
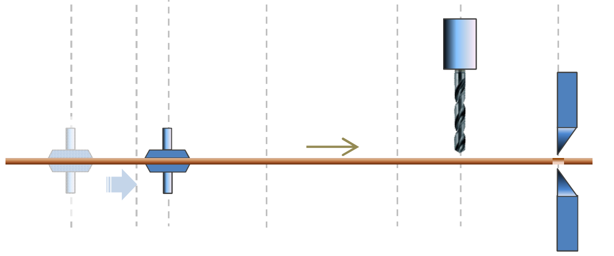


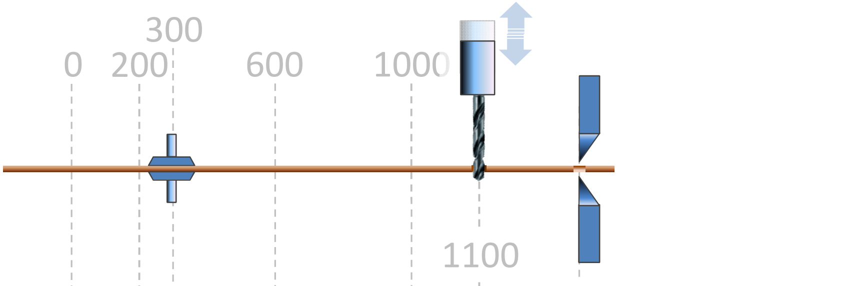
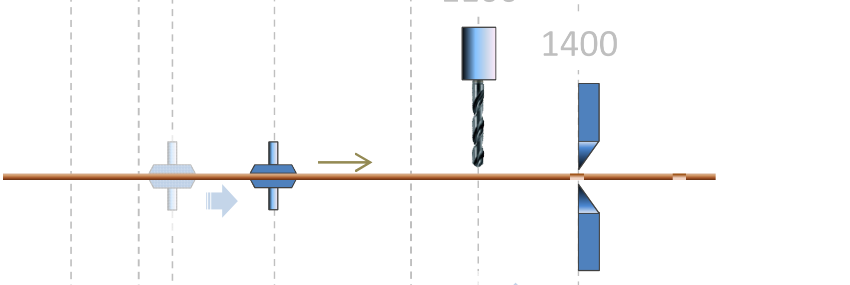
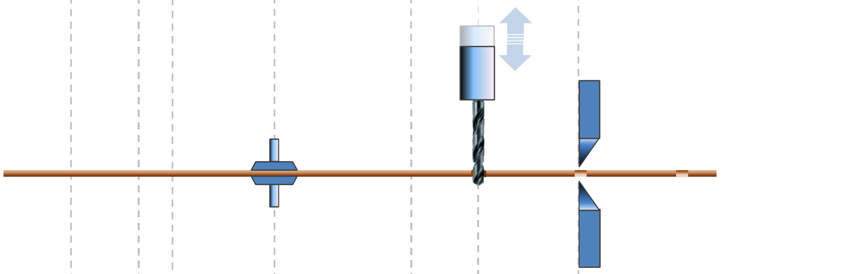
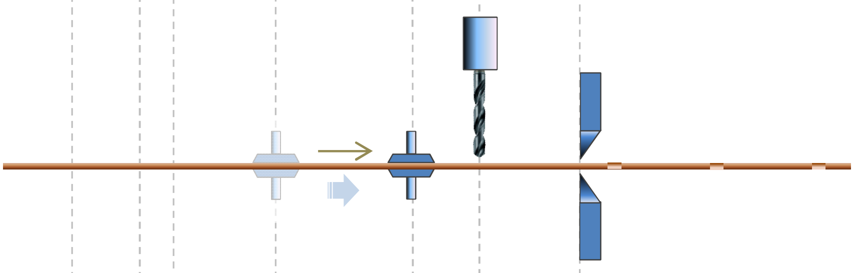
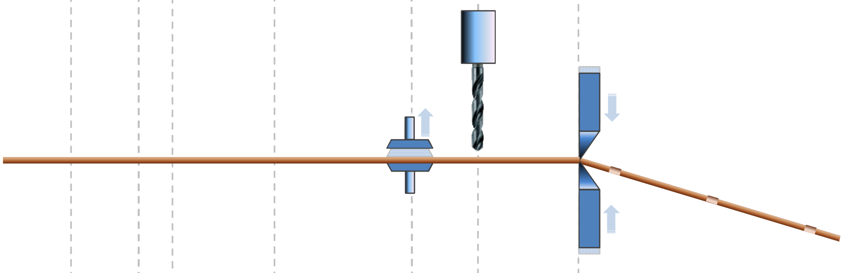
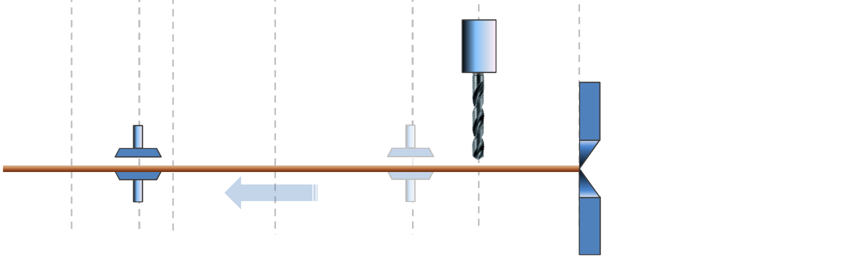
Figure 5-10: Finished work piece



In this application example, a horizontally movable gripper, controlled by the SINAMICS V90 and SIMATIC S7-1200, shall transport the band to the drilling positions and to the cutting position. The sequence is explained in Table 5-1.

Table 5-1: Sequence of material processing

Graphics	Explanation
	**Initial state:** The gripper is opened and the band material resting on the closed cutter. The gripper position has not been determined.
	**Step 1:** The opened gripper moves to the absolute starting position (200 mm) at 200 mm/s.
	**Step 2:** The band waits for the gripper to close and the cutter to open.
	**Step 3:** The first drilling position (0 mm) is approached absolutely at 100 mm/s.
	**Step 4:** The band waits for end of the drilling process.
	**Step 5:** The second drilling position (300 mm) is approached relatively at 100 mm/s.

Graphics	Explanation
	**Step 6:** The band waits for end of the drilling process.
	**Step 7:** The third drilling position (600 mm) is approached relatively at 100 mm/s.
	**Step 8:** The band waits for end of the drilling process.
	**Step 9:** The cutter (0 mm) is approached absolutely at 100 mm/s.
	**Step 10:** The band waits for the end of the cutting process (cutter closed) and the subsequent opening of the gripper.
	**Step 11:** The starting position (200 mm) is returned to absolutely at 200 mm/s.

Start processing the command table with the start button. The individual processing steps are displayed in the HMI screen. They agree with the step numbering in Table 5-1. Step 1 does not apply unless the gripper is already in start position (200 mm) when starting the command table.

Addressing an SW limit-switch

If – as it is the case in this application – the SW limit-switches were activated in the axis configuration and the axis referenced, search motions are stopped upon reaching a SW limit. When reaching an SW limit switch, the following happens:

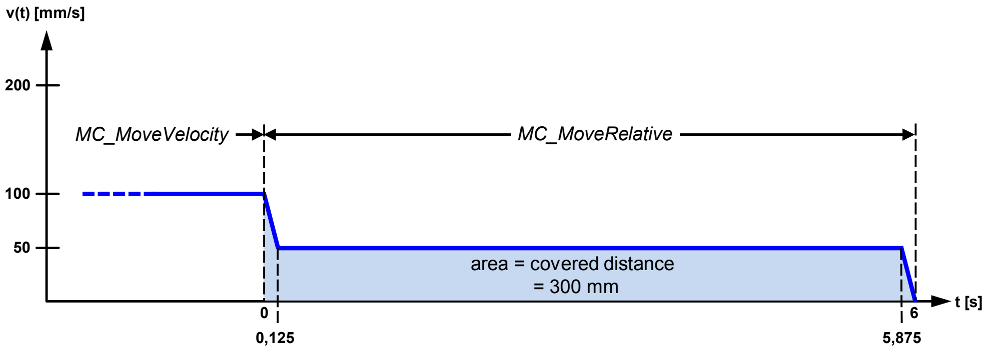
- The drive is stopped with the general deceleration ramp.
- The drive remains enabled (enabled) and the *SON* signal pending.
- The SINAMICS V90 is not informed of the event.
- The SIMATIC goes into error state, which is marked as follows:
  - the respective error bits and error words are set in axis DB *Axis_1* and FC *MC_Power*.
  - an *MC* error (Error) is displayed in the header of the HMI screen.

Acknowledge the error recovery by clicking the error display in the HMI header. Subsequently, a new *MC* command can be started.

5.5.3 Replacement behavior

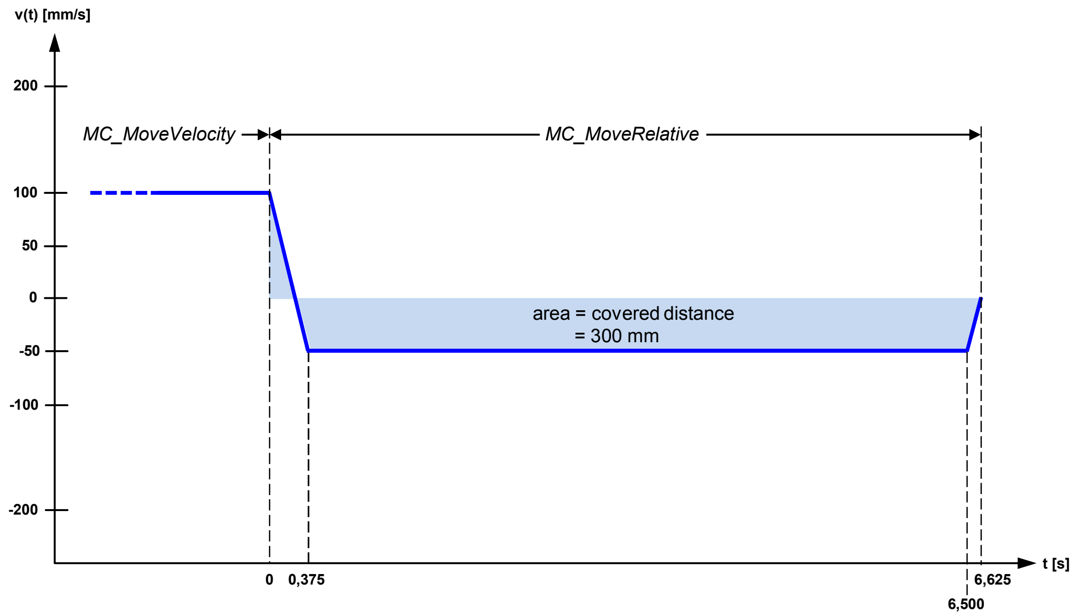
MC commands can replace each other. If, for example, *MC_MoveVelocity* is active at 100 mm/s and motion direction to the right, and you are starting *MC_MoveRelative* at 50 mm/s and 300 mm distance in the same direction, the axis will decelerate from 100 to 50 mm/s at the deceleration specified in the axis configuration (396 mm/s^2), continue at this velocity, and stop after 300 mm.

Figure 5-11: *MC_MoveRelative* replaces *MC_MoveVelocity* (without change of direction)



If *MC_MoveVelocity* was replaced by an *MC_MoveRelative* in the opposite direction, the behavior displayed in Figure 5-12 would result. The direction change would slightly increase the traversing time of *MC_MoveRelative*.

Figure 5-12: *MC_MoveRelative* replaces *MC_MoveVelocity* (with change of direction)



You can test the above example by starting FB *MC_MoveVelocity* in the *MoveVelocity* screen, changing to the *MoveRelative* screen and starting FB *MC_Move Relative*.

Information on which *MC* command you can use to replace another *MC* command with, and which *MC* command can be replaced by another, is available, for example, in the online help at the description of the respective *MC* move command.

5.6 Stopping the motor in non-regular operating situations

In emergency situations, the motor can be stopped in the following ways:

- E-stop via resetting the enable
- E-stop via the EMGS input of SINAMICS V90
- Addressing a HW limit-switch
- Safety function STO (Safe Torque Off)

WARNING	**With all four of the following methods, the pulses of the motor are switched off. Unless the motor has an emergency break, the pending loads will not be halted.**

5.6.1 E-stop via resetting the enable

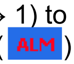
Triggering the E-stop

An E-stop can be triggered at running motor via resetting the enable (FB *MC_Power*, parameter *Enable* → 0) or by pressing the *Disable axis* button in the *Function menu* screen. The following happens then:

- SINAMICS V90 stops actively taking into consideration the ramp-down times:
  - Deceleration time set in the drive with parameter P1121.
  - Deceleration time set in the axis configuration of the technology object at *Extended parameters > Dynamics > Emergency stop*.

  In order to yield a determined deceleration time, one of the above times should be configured as 0.0 s[16]. In the application example, drive parameter P1121 was set to 0.0 s (see chapter 4.4).

CAUTION	**The emergency-stop deceleration time must be adjusted to the mechanism of your application. A deceleration time selected too small may cause material damage.**

- SIMATIC disables the SINAMICS drive (*SON* signal → 0)
- As a reaction to the cancelled *SON* signal at running motor, SINAMICS V90 goes to an error state, which is marked as follows:
  - The SINAMICS drive resets the ready message to the SIMATIC (signal *RDY* → 0).
  - The drive shows the respective error number (*F7490)* in the display.
  - The drive outputs an alarm message (signal *ALM* → 1) to the SIMATIC, which is displayed in the header of the HMI screen ().

Error recovery and acknowledge

1. Acknowledge the error by clicking on the error display in the HMI header. The error disappears
2. Enable the axis again by pressing the *Enable axis* button in the *Function menu* screen. The *RDY* and *SON* signals have a 1 signal again (green).

[16] In the axis configuration, only a very small value ≠ 0 can be entered. Use this minimal value if you which to define the deceleration ramp via the drive parameters.

5.6.2 E-stop via the EMGS input of SINAMICS V90

Triggering the E-stop

Since in this application example the emergency-stop button is directly wired to a digital input *(EMGS)* of SINAMICS 90, it is on a higher level than the *MC* commands. If the emergency-stop button is pressed, i.e. *EMGS* set to 0, the following happens:

- SINAMICS V90 stops actively at maximum torque *(OFF3)*, which is set with the parameters P1520 (default value = 11.0 Nm) and P1521 (default value = -11.0 Nm).
- SINAMICS V90 shows the respective error number (*F7490)* in the display.
- SINAMICS V90 outputs an alarm message (signal *ALM* → 1) to the SIMATIC, which is displayed in the header of the HMI screen (ALM).
- SINAMICS V90 resets the ready message to the SIMATIC (signal *RDY* → 0).
- As a reaction to the cancelled *RDY* signal while an *MC* command is running, the SINAMIC goes to an error state, which is marked as follows:
  - The SINAMICS drive is disabled (signal *SON* → 0)
  - The drive is declared not enabled in the axis DB of SIMATIC (enabled , *"Axis_1".StatusBits.Enable* → 0)
  - The respective error bits and error words are set in axis DB *Axis_1* and FC *MC_Power*.
  - An *MC* error (Error) is displayed in the header of the HMI screen.

Error recovery and acknowledge

1. Set the *EMGS* signal by unlocking the respective emergency-stop button to 1.
4. Acknowledge the error by clicking on the error display in the HMI header. Both error displays disappear, and the axis is enabled again (enabled). The *RDY* and *SON* signals carry a 1 signal again.

5.6.3 Addressing a HW limit-switch

Normally, the HW limit-switches are only approached in non-referenced operation. If the axis is referenced, the SW limit-switches stop the motion before the slide has reached a HW limit-switch.

Approaching a limit-switch

Since in this application example the HW limit-switches are directly wired to the digital inputs *CWL* and *CCWL* of SINAMICS 90, they are on a higher level than the *MC* commands. When reaching a HW limit-switch, i.e. *CWL* or *CCWL* reset, the following happens:

- SINAMICS V90 stops actively at maximum torque *(OFF3)*, which is set with the parameters P1520 (default value = 11.0 Nm) and P1521 (default value = -11.0 Nm).
- SINAMICS V90 shows the respective error number (*F7491* or *F7492)* in the display.

- SINAMICS V90 outputs an alarm message (signal *ALM* → 1) to the SIMATIC, which is displayed in the header of the HMI screen (ALM).
- SINAMICS V90 resets the ready message to the SIMATIC (signal *RDY* → 0).
- As a reaction to the cancelled *RDY* signal while an *MC* command is running, the SINAMIC goes to an error state, which is marked as follows:
  - The drive is disabled (signal *SON* → 0)
  - The drive is declared not enabled in the axis DB of SIMATIC (enabled , *"Axis_1".StatusBits.Enable* → 0)
  - The respective error bits and error words are set in axis DB *Axis_1* and FC *MC_Power*.
  - An *MC* error (Error) is displayed in the header of the HMI screen.

Error recovery and acknowledge

1. Acknowledge the error by clicking on the error display in the HMI header. Both error displays disappear and the axis is enabled again (enabled). The *RDY* and *SON* signals have a 1 signal again.
2. Override the limit-switch with an *MC* command in opposite direction.

NOTICE	**After a stop by simulating CWL=0 or CCWL=0, the axis must also be relieved by "override". It is <u>not</u> sufficient to reset the respective limit-switch signal back to 1 without moving the axis in opposite direction. After the error acknowledgement, proceed as follows for the simulated override:** **1. Start MC_MoveVelocity, for example, in opposite direction via the HMI.** **2. Go online in the TIA Portal and set the respective limit-switch signal CWL/CCWL in in the *Watch table* back to 1, while the axis is in motion.** 3. **Stop the axis with MC_Halt via the HMI.**

5.6.4 Safety function STO (Safe Torque Off)

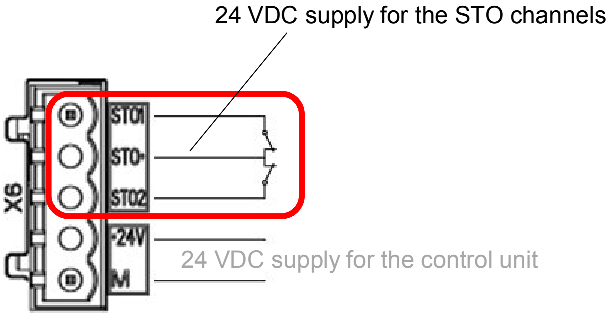
Function

This function is used for unexpected ramp-up according to EN 60204-1 chapter 5.4. The Safe Torque Off function disables the pulses of the drive and cuts the power supply to the motor (corresponds to stop category 0 according to EN 60204-1). The SINAMICS drive is torque-free and safe. This drive state is monitored internally.

Connection

SINAMICS V90 has two STO channels with an own 24 VDC supply. The connection to your system is performed via interface X6.

Figure 5-13: STO connection



Triggering the STO

The function is activated as soon as at least one STO channel is without voltage, i.e., if in the application example the respective mushroom pushbutton has been actuated. The following happens:

- SINAMICS V90 deletes the pulses and disconnects the power supply to the motor (no electrical isolation). The deceleration delay of the motor solely depends on the mass inertia and the friction forces of the load.
- SINAMICS V90 shows the respective error number (F1611) at the display.
- SINAMICS V90 outputs an alarm message (signal *ALM* → 1) to the SIMATIC, which is displayed in the header of the HMI screen (ALM).
- SINAMICS V90 resets the ready message to the SIMATIC (signal *RDY* → 0).
- As a reaction to the cancelled *RDY* signal while an *MC* command is running, the SINAMIC goes to an error state, which is marked as follows:
  - The drive is disabled (signal *SON* → 0)
  - The drive is declared not enabled in the axis DB of SIMATIC (enabled , *"Axis_1".StatusBits.Enable* → 0)
  - The respective error bits and error words are set in axis DB *Axis_1* and FC *MC_Power*.
  - An *MC* error (Error) is displayed in the header of the HMI screen.

Error recovery and acknowledge

1. Close the break contacts of both STO channels. Unlock the mushroom pushbutton in the application example.
2. Acknowledge the error message at the operator panel by clicking on *ALM* or *Error* in the header. *Error* disappears. *ALM* cannot be acknowledged and is pending again. The SIMATIC sets the *SON* switch-on signal again.
3. Perform a POWER ON at the SINAMICS V90 (short interruption of the 24 VDC supply). After ramping up, it sets its ready signal *RDY*. The drive is now ready again to execute MC commands.

6 Functional Mechanisms

This chapter takes a closer look at the pulse/direction interface and the digital signals to be exchanged between the SIMATIC and SINAMICS V90. Technology object *Axis* will be introduced and the tasks and configurations of the individual STEP 7 motion control blocks discussed. Furthermore, the STEP 7 user program will be explained. The chapter is to help you to deepen your knowledge on the functionality of the SINAMICS V90 ⇔ SIMATIC S7-1200 interface.

The content of this section is not necessarily required for commissioning (chapter 4) and operating (chapter 5) the application example.

6.1 Pulse/direction interface

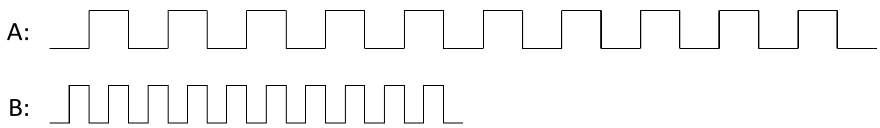
The pulse/direction interface for controlling a servo drive, as provided by SIMATIC S7-1200, principally consists of two digital signals:

- **Pulse train**

  The *Number of pulses* defines the distance travelled by the axis. Each pulse output by the SIMATIC corresponds to a travel or angle increment, or respectively, an angular step of the motor axis. The transmission (pulses/Δs or pulses/Δφ) depends on the resolution of the shaft angle encoder integrated in SIMOTICS S-1FL6 and of factors and parameters of SINAMICS V90.

  The *Pulse frequency* defines the velocity at which the axis is moved or specifies the motor speed.

  Figure 6-1: Pulse trains

  For the above pulse trains, the axis moves equally far. Case B requires only half of the time for the same distance (= double velocity).

- **Direction signal**
  Specifies the travel and rotation direction. 1-signal means “forward” (see Figure 4-3).

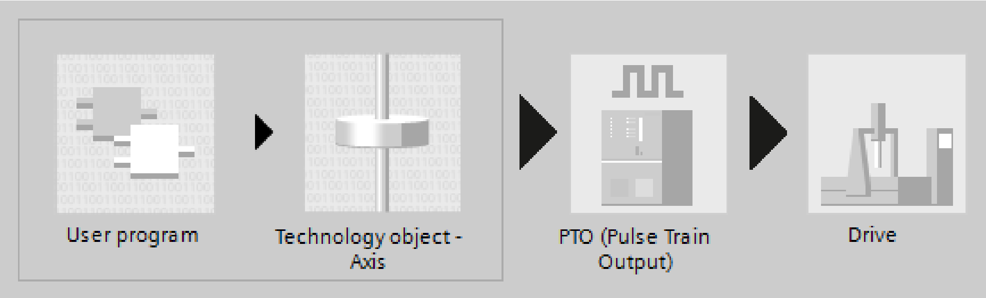
All of the motion processes realized with the Motion Control instruction in this application are traversed with two digital signals according to the above principle.

6.2 Technology objects

Within the STEP 7 project, the *Technology objects* are located in the project navigation on the same level as, for example, the *Program blocks* or the *PLC tags*. The masks they supply serve the user as configuration, commissioning and diagnostics as for certain objects. The result of the configuration of a technology object is a data block which is accessed from the user program – e.g. from the Motion Control blocks.

6.2.1 Technology object “Axis”

Figure 6-2: Technology object “Axis”



The "Axis" technology object used in the application ("TO_Axis_PTO") maps a physical drive in the controller. This supplies the functions for controlling stepper motors and servo motors with pulse interface. The motion of the SINAMICS drive can be programmed via PLCopen Motion Control blocks. The configuration of technology object “Axis” is described in Table 7-2: Creating the project configuration. Further information is available, for example, in the STEP 7 Online Help or in the STEP 7 Basic V13.0 System Manual (/4/), chap. 11.2.5 Positioning axis technology object.

6.2.2 Technology object “Command table”

Technology object "Command table" ("TO_CommandTable_PTO") enables creating motion profiles in a table using PLCopen Motion Control commands. The created profiles are applied to a physical drive using the "Axis" technology object. The motion sequences defined in the command table are programmed via PLCopen Motion Control function block *MC_CommandTable*. The configuration of technology object “Command table” is described in Table 7-2: Creating the project configuration. Further information on command tables is available, for example, in the STEP 7 Online Help or in the STEP 7 Basic V13.0 System Manual (/4/), chap. 11.2.6 Technology object command table.

6.3 Motion Control system blocks

The Motion Control instructions are available on the *Instructions* task card at

Technology > *Motion Control* > *S7-1200 Motion Control*.

When dragging an *MC* instruction into your program, the respective system function block is automatically created with the respective instance DB and filed in *Project navigation* at

Program blocks > *System blocks* > *Program resources*.

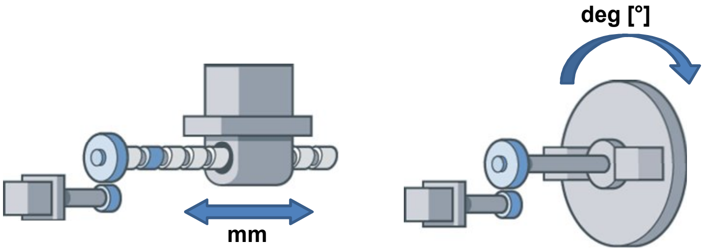
The *MC* system blocks are described in detail in the STEP 7 Online Help. Enter *Overview of the Motion Control statements (S7-1200)* as search text.

The following section only mentions those Motion Control system blocks used in the application example. The chapter should only provide the user with an overview and, if necessary, point out facts not covered by the online help.

User units

The *MC* blocks use dimensionful interface parameters for travel and velocity. The used time unit is always seconds. The user unit of the travel depends on the used axis model and must be specified in the configuration of *Technology object “Axis”* when defining the basic parameters. Available are mm, m, in, ft, pulses and °. Also use the unit selected there for the interface parameters of the *MC* blocks

Figure 6-3: User units for various axis models



Motion dynamics

The parameterization of the *MC* blocks only specifies the desired velocity for the move functions regarding the dynamics. The basic data decisively determining the motion behavior, such as start/stop velocity, maximal velocity, ramp-up/ramp-down time or acceleration/deceleration must be set in the configuration of *Technology object - Axis* under the *Dynamics* point and apply equally for all move functions initiated with the *MC* blocks.

Identical block parameters of all *MC* blocks

Table 6-1: Identical block parameters of all MC blocks

Parameter	IN/OUT	Data type	Description
Axis	IN	TO_Axis_1	Name of the technology object given in the project navigation. STEP 7 assigns the standard name *Axis_n*[17] (n = 1,2,3,…) when creating the object.
Busy	OUT	BOOL	The acyclic working block is currently executed.
Error	OUT	BOOL	This block has detected an error. Identification via ErrorID and ErrorInfo
ErrorID	OUT	WORD	The parameters specify the error in greater detail and can be evaluated for Error = TRUE (see links in the online help on the respective *MC* block).
ErrorInfo	OUT	WORD	

Note For all *MC* blocks started with a positive edge at parameter *Execute*, unacknowledged errors are displayed through their output parameters *Error*, *ErrorID* and *ErrorInfo* only for *Execute* = 1. If you only start the respective commands with a (cycle) pulse, the errors cannot be evaluated. Since, however, the error parameters are internally copied to the instance DB of FB *MC_Power* who has no *Execute*, they are available there to the user as output parameter *Error*, *ErrorID* and *ErrorInfo* for evaluation until error acknowledgement.

MC_Power instruction

Before an axis can be moved, it must be enabled which must always be performed with FB *MC_Power*.

[17] The name assignment is language-dependent.

Figure 6-4: *MC_Power*

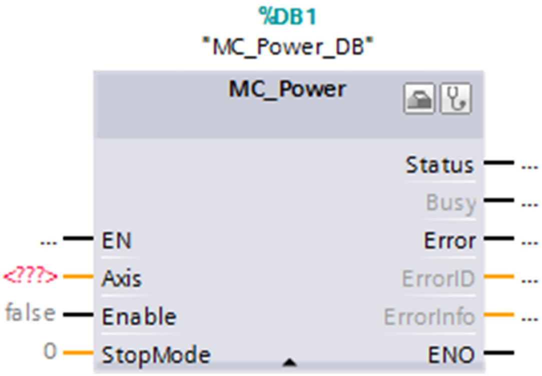


Table 6-2: Parameters of MC_Power

Parameter	IN/OUT	Data type	Description
Enable	IN	BOOL	Enable *Enable* = TRUE sets the digital output of the S7-1200 CPU configured in the respective *Technology object Axis_n* and enables the SINAMICS V90. In the application example, this is output A0.5, wired to input *SON* (X8/5) of V90 (see Figure 3-2).
StopMode	IN	INT	Stop mode 0: with emergency-stop deceleration ramp 1: immediate off (without deceleration ramp) 2: with emergency-stop deceleration ramp and jerk limitation 1: The application stops with mode 0. The emergency-stop delay is configured in the respective *Technology Axis _n* under *Dynamics > Emergency stop*.
Status	OUT	BOOL	Status of axis enable For *Status* = TRUE, the axis is ready to execute MC commands. If the feedback message *RDY* of V90 (X8/30) is wired to input E0.2 of the S7-1200 CPU (see Figure 3-2), and this is configured accordingly in the *Technology object Axis_n* as well, *Status* is only set with the *RDY* signal.
Further parameters see Table 6-1.			

***MC_Reset* instruction**

This axis enables acknowledging “operating errors with axis stop” and “configuration errors”. These respective errors are available in the STEP 7 Online Help on the parameters *ErrorID* and *ErrorInfo* of the MC blocks.

Figure 6-5: *MC_Reset*

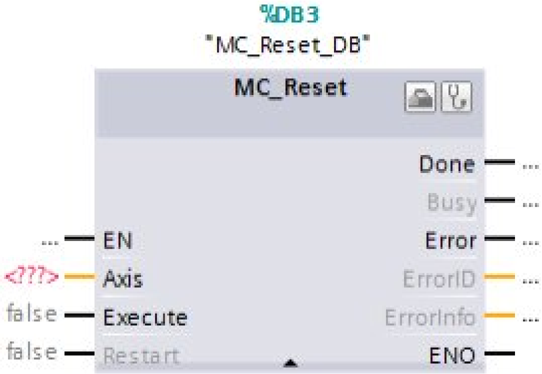


Table 6-3: Parameters of MC_Reset

Parameter	IN/ OUT	Data type	Description
Execute	IN	BOOL	Starting the command with rising edge
Restart (available as of V3.0)	IN	BOOL	FALSE: acknowledges pending errors TRUE: Loads the configuration of the axis from the load memory to the work memory. The command can only be executed at disabled axis In the application example, only the error acknowledgement is used:
Done	OUT	BOOL	Error was acknowledged.
Further parameters see Table 6-1			

MC_MoveJog instruction

The Motion Control instruction "MC_MoveJog" moves the axis constant at the specified velocity in jog mode.

Figure 6-6: *MC_MoveJog*

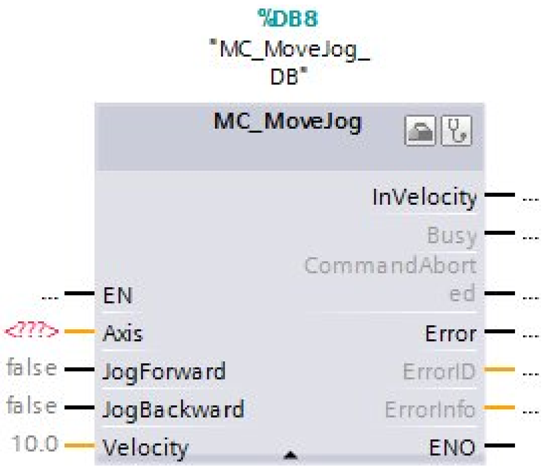


Table 6-4: Parameters of *MC_MoveJog*

Parameter	IN/OUT	Data type	Description
JogForward	IN	BOOL	Axis moves in positive direction until *JogForward* = TRUE.
JogBackward	IN	BOOL	Axis moves in negative direction until *JogForward* = TRUE.
Velocity	IN	REAL	Specified velocity for jog mode
InVelocity	OUT	BOOL	The velocity output at the *Velocity* parameter was reached.
CommandAborted	OUT	BOOL	The command was cancelled with another command during processing.
Further parameters see Table 6-1			

***MC_MoveVelocity* instruction**

The Motion Control instruction "MC_MoveVelocity" moves the axis constant at the specified velocity.

Figure 6-7: *MC_MoveVelocity*

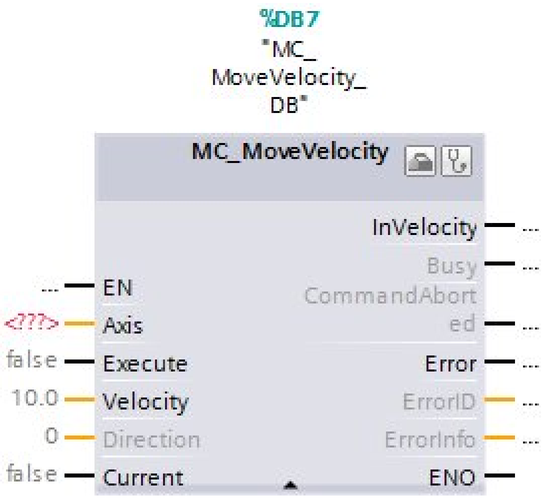


Table 6-5: Parameters of *MC_MoveVelocity*

Parameter	IN/OUT	Data type	Description
Execute	IN	BOOL	Starting the command with rising edge. The axis moves until the MC_Halt instruction is executed.
Velocity	IN	REAL	Specified velocity for moving the axis
Direction	IN	INT	Specified direction 0: rotation direction according to the *Velocity* sign 1: rotation direction positive 2: rotation direction negative

Parameter	IN/OUT	Data type	Description
Current	IN	BOOL	Behavior when MC_Velocity cancels a preceding command. FALSE: axis takes on velocity and direction according to the parameters *Velocity* and *Direction*. TRUE: Axis adopts the current values velocity and direction from the preceding command.
InVelocity	OUT	BOOL	The velocity specified in the *Velocity* parameter was reached (for *Current* = FALSE), or the axis has adopted the current velocity of the preceding command (for *Current* = TRUE).
CommandAborted	OUT	BOOL	The command was cancelled with another command during processing.
Further parameters see Table 6-1			

MC_MoveRelative instruction

The Motion Control instruction MC_MoveRelative starts a positioning motion relative to the starting position; i.e., the axis is moved by a defined positive or negative distance starting from the current position.

Figure 6-8: *MC_MoveRelative*

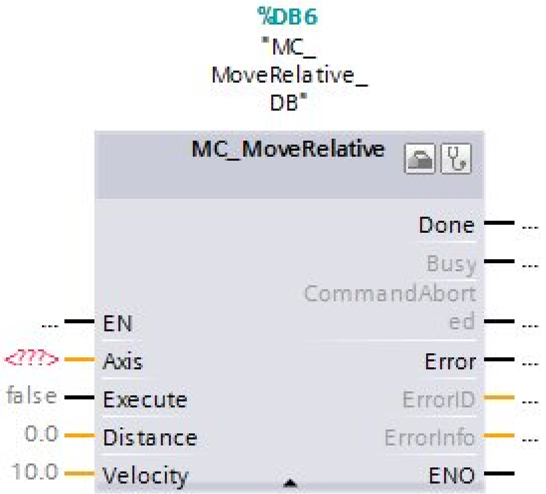


Table 6-6: Parameters of *MC_ MoveRelative*

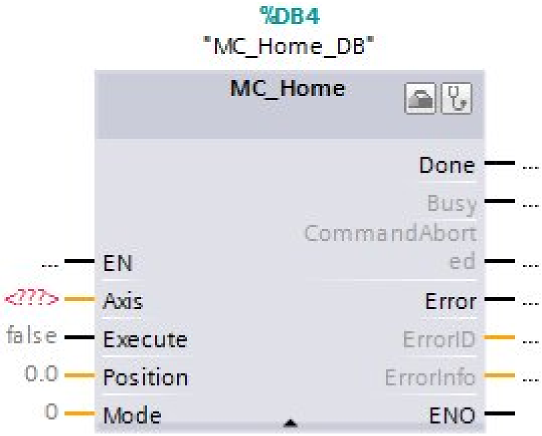
Parameter	IN/OUT	Data type	Description
Execute	IN	BOOL	Starting the command with rising edge.
Distance	IN	REAL	Distance moved. Can be positive or negative.
Velocity	IN	REAL	Specified velocity for moving the axis (May not be reached due to the acceleration and deceleration and the distance to the target position configured in *Technology object - Axis*.)
Done	IN	INT	Target position reached
CommandAborted	OUT	BOOL	The command was cancelled with another command during processing.

Parameter	IN/OUT	Data type	Description
Further parameters see Table 6-1			

MC_Home instruction

To approach a position absolutely, the axis coordinate must be matched with the real, physical position of the drive. This process is referred to as "Homing" (referencing). It needs to be performed once with the *MC_Home* block before a position is approached absolutely with *MC_Absolute*.

Figure 6-9: *MC_Home*



The *MC_Home* block provides four different types of homing (*Mode* parameter):

- **Direct homing absolute** (*mode* = 0)
When starting the command with *Execute*, only the absolute position value pending at the *Position* parameter is assigned to the axis. *MC_Home* does not start a travel motion. This method is used when no reference point switch exists, and the axis is moved to the position to be homed in jog mode.
- **Direct homing relative** (*mode* = 1)
When starting the command with *Execute*, the position value of the *Position* parameter is added to the current absolute position value for an already homed axis. *MC_Home* does not start a travel motion. This method is used, for example, when you have already homed your axis with *Mode = 0* and wish to move the reference point afterwards.
- **Passive homing** (*Mode* = 2)
Passive homing assumes the existence of a reference point switch (RPS). Homing occurs upon detection of the RPS. What approach direction to be referenced with which respective edge of the RPS is specified in the configuration of the *Technology object - Axis* at *Referencing* > *Passive*. *MC_Home* does not start a travel motion. The travel motions necessary for homing must otherwise be realized via other MC instructions. This method is applied if an RPS is available to you for homing, however, you do not wish to or cannot use automatic homing (see following point).
- **Active homing** (*Mode* = 3)
Active homing assumes the existence of a reference point switch (RPS). Homing occurs upon detection of the RPS. The travel motions necessary for approaching the RPS are started with the *Execute* parameter. The RPS approach procedure including the travel speed is defined at the configuration of the *Technology object Axis* in *Homing* > *active*.

This method is applied if an RPS is available to you for homing, and your application enables automatic homing. The application example uses this homing method.

Table 6-7: Parameters of *MC_Home*

Parameter	IN/OUT	Data type	Description
Execute	IN	BOOL	Starting the command with rising edge.
Position	IN	REAL	For *Mode* = 0, 2, 3: absolute position, which the axis shall have after the homing process. For Mode = 1: correction value for the current axis position.
Mode	IN	INT	Homing mode: 0: Direct homing absolute 1: Direct homing relative 2: Passive homing 3: Active homing
Done	OUT	BOOL	Job completed
CommandAborted	OUT	BOOL	The command was cancelled with another command during processing.
Further parameters see Table 6-1			

MC_MoveAbsolute instruction

The Motion Control instruction *MC_MoveAbsolute* starts a positioning motion of the axis to an absolute position; to be able to use the block, the axis must previously have been homed with the *MC_Home* instruction.

Figure 6-10: *MC_MoveAbsolute*

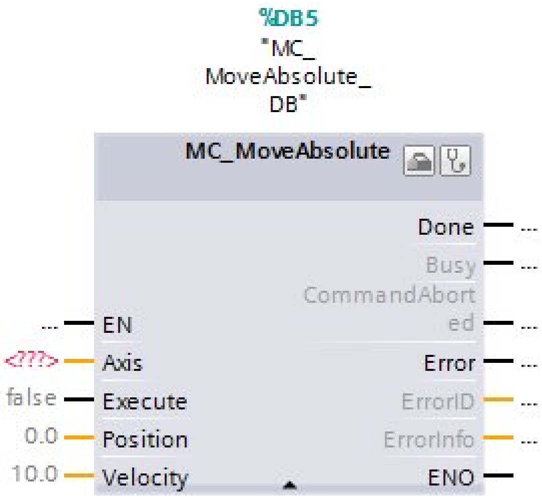


Table 6-8: Parameters of *MC_MoveAbsolute*

Parameter	IN/OUT	Data type	Description
Execute	IN	BOOL	Starting the command with rising edge.
Position	IN	REAL	Absolute target position
Velocity	IN	INT	Specified velocity for moving the axis (May not be reached due to the acceleration and deceleration and the distance to the target position configured in *Technology object - Axis*.)
Done	OUT	BOOL	Job completed; target position was reached.
CommandAborted	OUT	BOOL	The command was cancelled with another command during processing.
Further parameters see Table 6-1			

MC_CommandTable instruction

Start the sequential processing of a command list with the MC_Command_Table instruction. It may consist of up to 32 individual commands. The following commands are possible:

- ***Positioning Relative***
  Positioning the axis relative
- ***Positioning Absolute***
  Positioning the axis absolute
- ***Velocity setpoint***
  Moving the axis with specified velocity
- ***Halt***
  Stop the axis (the command only becomes effective after a *Velocity setpoint* command)
- ***Wait***
  Wait until the given duration has elapsed. Wait does not stop any running travel motions.
- ***Empty***
  The command serves as a wildcard for possibly added commands in the list. When processing the command table, it is ignored.
- ***Separator***
  Adds a separator line above the marked line.
- The separator line serves as an area limit for the graphic representation of the curve diagram in TIA Portal. Use separator lines if you wish to process sections of the command table.

A requirement for the application of FB *MC_CommandTable* is the existence of a *CommandTable* technology object. A description of how to integrate this into your project is given in Table 7-2, from step 22 on.

Figure 6-11: *MC_CommandTable*

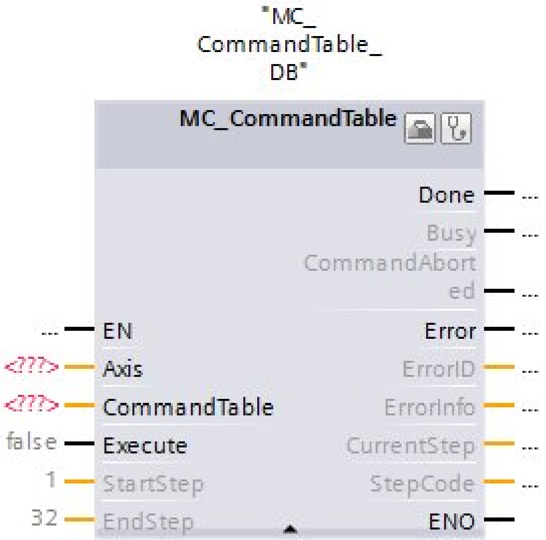


Table 6-9: Parameters of *MC_CommandTable*

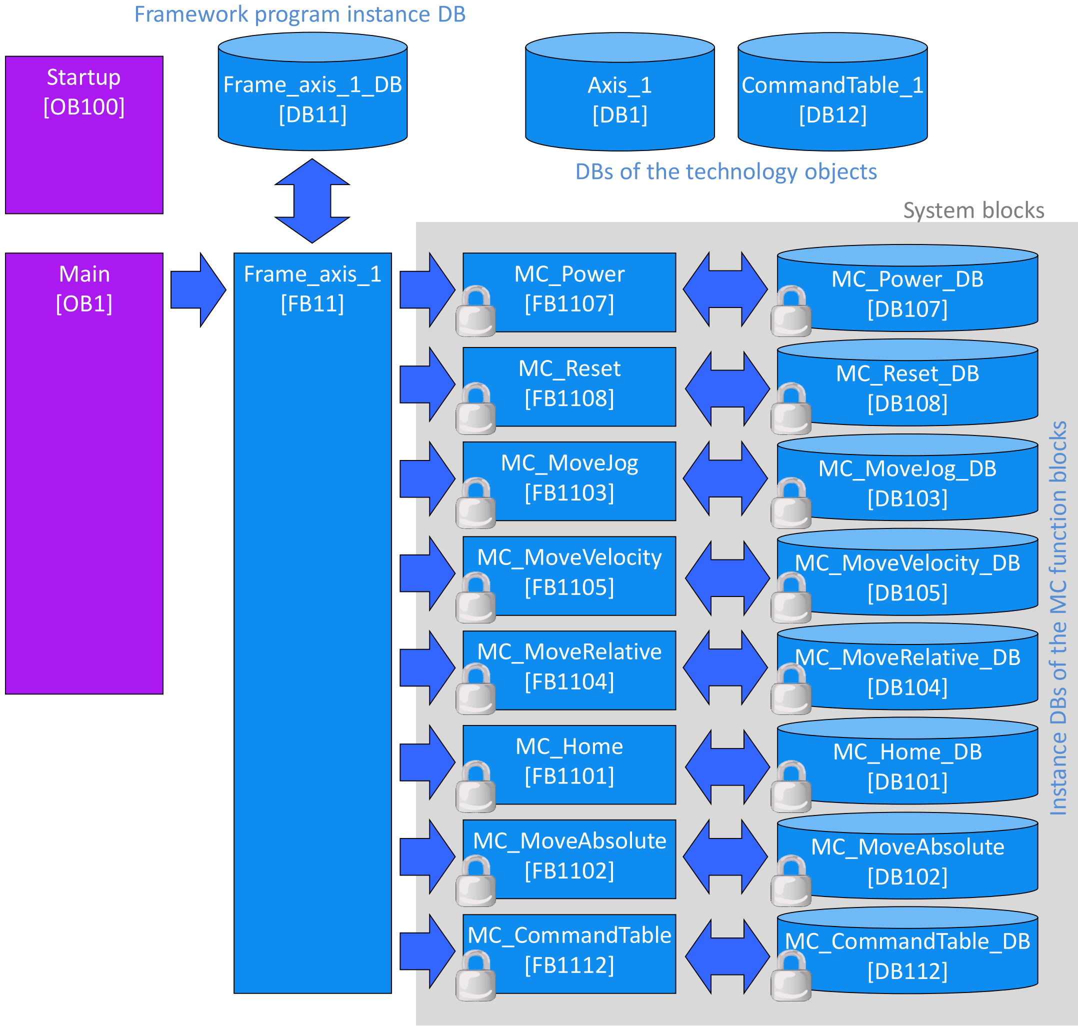
Parameter	IN/OUT	Data type	Description
CommandTable	IN	TO_CommandTable_1	Technology object of the command table
Execute	IN	BOOL	Starting the command with rising edge.
StartStep	IN	INT	The individual commands are automatically numbered consecutively (1-32). Processing starts with *StartStep* and ends with *EndStep*.
EndStep	IN	INT	
Done	OUT	BOOL	The command table was processed successfully.
CommandAborted	OUT	BOOL	The command was cancelled with another command during processing.
Further parameters see Table 6-1			

6.4 The STEP 7 program code

6.4.1 Block diagram

The STEP 7 program mainly consists of the calls of the *MC* system function blocks. These are summarized in the user FB *Frame_axis_1* without parameters.

Figure 6-12: Program structure



6.4.2 Block description

For a better understanding of the block description, open the block editor in the TIA Portal to look at the program code.

Startup [OB100]

If the digital input signals EMGS (emergency-stop), CWL (right HW limit switch actuated) and CCWL (left HW limit switch actuated) of the SINAMICS V90 are not wired to physically present switches, but supplied by the SIMATIC S7-1200 for a simple demonstration of the application example (see Figure 3-2, broken line for wiring), they need to be preassigned when restarting the controller. In network 1 of the block, all three of the digital outputs A0.4. A0.5 and A0.6 of the controller are placed on 1 signal in order to prevent the SINAMICS V90 from detecting any respective errors. For testing, the three signals can be reset via the command table during runtime.

Main [OB1]

Here, only the axis controller is called in network 1 of user FB *Frame_axis_1*.

Frame_axis_1 [FB11]

This is the user block for controlling the axis. It does not have any parameters.

Table 6-10: Net works of FB *Frame_axis_1*

NW	Explanation
1.	Calling FB *MC_Power* Only the *Axis* parameter was supplied at the block interface of the *MC* block. To enable the axis, the operator panel directly accesses input parameter *Enable* in the respective instance DB. For parameter *StopMode*, the default value 0 is retained, which means that the axis will break with the configured emergency-stop deceleration and be disabled at standstill if a request for blocking the axis is pending.
2.	Calling FB *MC_Reset* Only parameters *Axis* and *Execute* were supplied at the block interface of the *MC* block. Between resetting the SINAMICS V90 via its digital input *RESET* (wired to controller output *Axis_1_RESET*, A0.3) and resetting the error state in the technology object of the controller, a temporal delay must be integrated. Otherwise, the SIMATIC would set the *SON* signal for V90 too early, which would cause the drive to no longer output a *RDY* signal. The required timer *IEC_Timer_0_Instance* and the edge trigger flag *reset_pulse_edge_flag* are stored as static tags in *Frame_axis_1_DB* (instance DB). For the *Restart* parameter, the default value 0 is kept, which means that *MC_Reset* in is used in “Error acknowledgement” mode[18].
3.	Calling FB *MC__MoveJog* Only the *Axis* parameter was supplied at the block interface of the *MC* block. For the jog operation, the operator panel directly accesses input parameters *JogForward* and *JogBackward* in the respective instance DB. For parameter *Velocity*, the default value 10.0 mm/s is kept. After a restart, it is displayed in the *MoveJog* screen of the operator panel and can be modified there.
4.	Calling FB *MC__MoveVelocity* Only the *Axis* parameter was supplied at the block interface of the *MC* block. To start the command job, the operator panel directly accesses input parameter *Enable* in the instance DB of the *MC* block. Parameter *Velocity* is preassigned directly in the instance DB of the *MC* block at 100.0 mm/s. After a restart, this value is displayed in the *MoveVelocity* screen of the operator panel and can be modified there. *Velocity* is not supplied via the block interface of the *MC* block.
5.	Calling FB *MC__MoveRelative* Only the *Axis* parameter was supplied at the block interface of the *MC* block. To start the command job, the operator panel directly accesses input parameter *Enable* in the instance DB of the *MC* block. Parameter *Velocity* is preassigned directly in the instance DB of the *MC* block at 50.0 mm/s. After a restart, this value is displayed in the *MoveRelative* screen of the operator panel and can be modified there. *Velocity* is not supplied via the block interface of the *MC* block. Since the *Distance* input parameter is also not supplied at the block interface of the *MC* block, the default value 0.0 mm is displayed in the *MoveRelative* screen of the operator panel and can be modified from there.
6.	Calling FB *MC_Home* Only parameters *Axis* and *Mode* were supplied at the block interface of the *MC* block. To start the command job, the operator panel directly accesses input parameter *Enable* in the instance DB of the *MC* block. Parameter *Position* is preassigned directly in the instance DB of the *MC* block at 500.0 mm. After a restart, this value is displayed in the *Home* screen of the operator panel and can be modified there. The *Mode* value was parameterized default at 3, so the entire homing process runs automatically.

[18] With FB *MC_Reset*, the axis configuration can also be downloaded from the load memory into the work memory (see online help).

NW	Explanation
7.	Calling FB *MC_ MoveAbsolute* Only the *Axis* parameter was supplied at the block interface of the *MC* block. To start the command job, the operator panel directly accesses input parameter *Enable* in the instance DB of the *MC* block. Parameter *Velocity* is preassigned directly in the instance DB of the *MC* block at 200.0 mm/s. After a restart, this value is displayed in the *MoveAbsolute* screen of the operator panel and can be modified there. *Velocity* is not supplied via the block interface of the *MC* block. Since the *Position* input parameter is also not supplied at the block interface of the *MC* block, the default value 0.0 mm is displayed in the *MoveAbsolute* screen of the operator panel and can be modified from there.
8.	Calling FB *MC_CommandTable* Only the parameters *Axis* and *Execute* were supplied at the block interface of the *MC* block. To start the command job, the operator panel directly accesses input parameter *Enable* in the instance DB of the *MC* block. Since all 11 steps of the command table shall be processed, the input parameters *StartStep* and *EndStep* remain unswitched at the block interface of the *MC* block.
9.	Calling FB *MC_Halt* Only the *Axis* parameter was supplied at the block interface of the *MC* block. To start the command job, the operator panel directly accesses input parameter *Enable* in the instance DB of the *MC* block.
10.	Simulation of the reference point switch When simulating the RPS designed as a break contact (broken line of respective wiring in Figure 3-2), the control output of *Axis_1_RPS_Sim* (A0.7) recreates its zero switching signal. Triggering the RPS via the respective button at the operator panel is configured as "SetBitWhileKeyPressed" event and stored as static *RPS_Sim_neg* tag in *Frame_axis_1_DB* (instance DB). The different logic requires a negation.
11.	INT tags for axis motion in HMI The animated motion of the axis slide in the HMI screens requires an integer tag. Therefore, the format of the *MotionStatus.Position* real tag from axis DB *Axis_1* is converted to the *MotionStatus_Position_Int* integer tag, created in *Frame_axis_1_DB* (instance DB).
12.	Animation in HMI screen *Command table* Boolean tags are created for the animated display of the states of gripper (open/close), driller (up/down) and cutter (open/close) and for the visualization of the material feeder.

Networks 11 and 12 are exclusively used for screen representation at the KTP600 and have no impact on the control of the axis.

Frame_axis_1_DB [DB11]

This instance data block is part of FB *Frame_axis_1* [FB11].

Axis_1 [DB1]

Axis DB automatically generated with the configuration of technology object *Axis_1*.

CommandTable_1 [DB12]

Data block of the command table automatically generated with the configuration of technology object *CommandTable_1*.

7 Configuration

Note

- If you only wish to download and commission the example program, please follow the instructions in chapter 4 “Commissioning”.

7.1 Number of setpoint pulses per motor revolution

The number of setpoint pulses per motor revolution must be entered for the configuration of the SINAMICS V90 as well as for the axis configuration in the TIA Portal. This value is determined as follows:

According to Figure 1-3: Motion profile (page 6) the axis shall be moved at a maximal velocity v_{max} = 200 mm/s. For a landscrew pitch of m = 6 mm pro per revolution (Figure 1-2: Linear axis, page 6) and a gear ratio i = n_{drive}/n_{drive} = 1 (no gear between motor and spindle) yields a maximal motor speed.

$$\mathrm{n_{max}} = \frac{\mathrm{v_{max}}}{\mathrm{m}} \cdot i = \frac{200}{6} \cdot 1 = 33{,}\overline{3333}\ \mathrm{s}^{-1} = 2000\ \mathrm{min}^{-1}.$$

The maximal pulse frequency of the onboard pulse generator of the CPU 1215C in the TIA V12 project (with 24V pulse train interface) is f_{max} = 100kHz. Applying this value to the maximal speed n_{max} guarantees the highest-possible resolution (positioning precision). For the maximal number of setpoint pulses ppr_{max}, this yields the following values:

$$ppr_{max} = \frac{f_{max}}{n_{max}} = \frac{100000}{33{,}\overline{3333}} = 3000.$$

This above value is used for the TIA V12 application example. However, you can also choose a smaller value for f_{max} – e.g. for EMV problems.

The Line Drive interface of the CPU 1217C in the TIA V13 project allows a maximum pulse frequency of 1MHz. By means of the calculation above a maximum number of setpoint pulses ppr_{max} = 30000 can be achieved. The V13 project however also uses ppr_{max} = 3000. It is the task of the user to modify the values in the drive (*p29011*) and in the technology object (*Configuration* > *Extended parameters* > *Mechanics*).

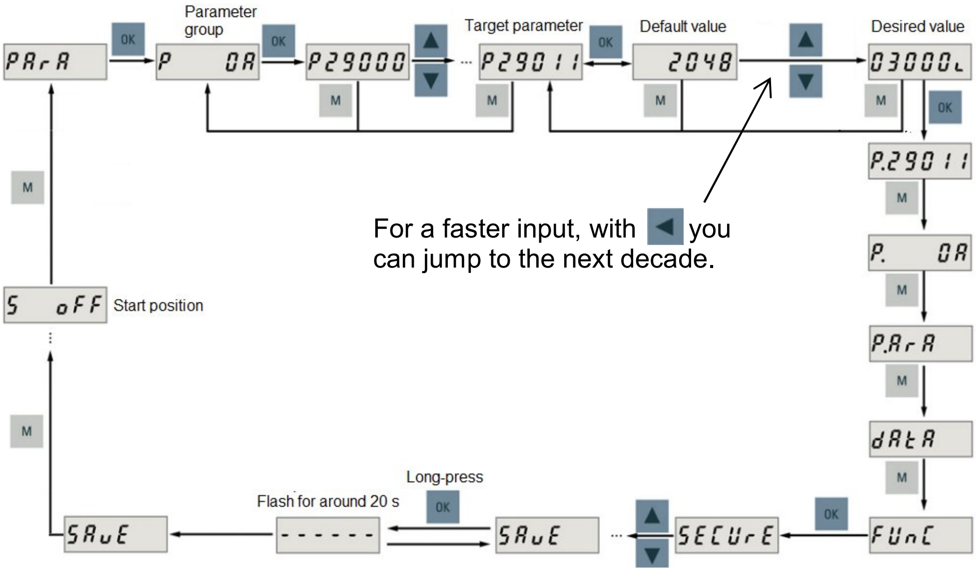
NOTICE	**Changing axis data in the TIA Portal in the configuration of the technology object is only possible offline. The axis must not be enabled at this time. Furthermore, the subsequent download of the axis via the “Load PLC program in the device and reset” command must be performed in the “Online” menu.**

7.2 Configuration of the SINAMICS V90

7.2.1 Configuration via the installed BOP

Ensure that SINAMICS V90 has no USB connection with the PG/PC. Proceed according to Figure 7-1.

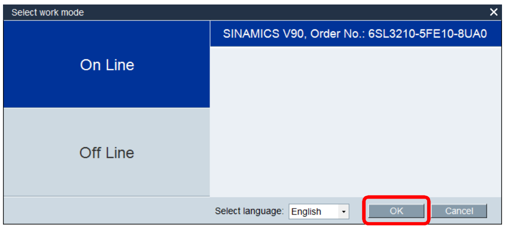
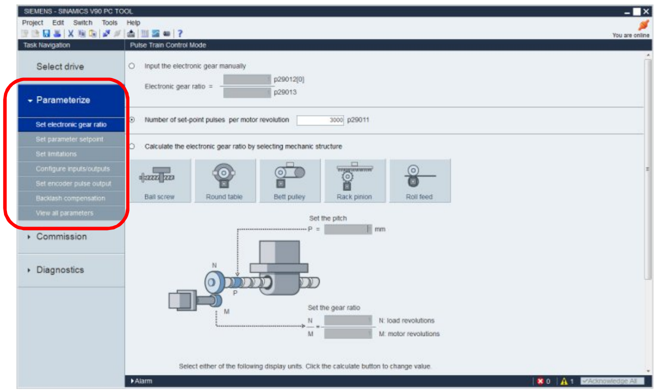
Figure 7-1: Set parameter p29011 to 3000 via the installed BOP

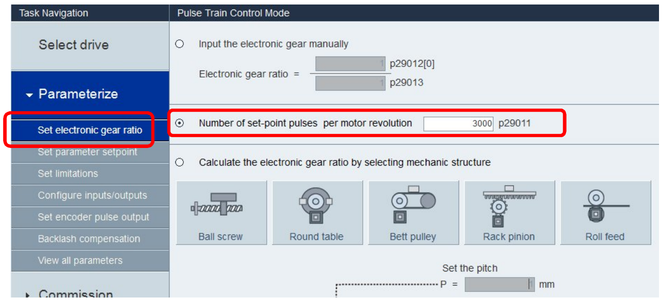
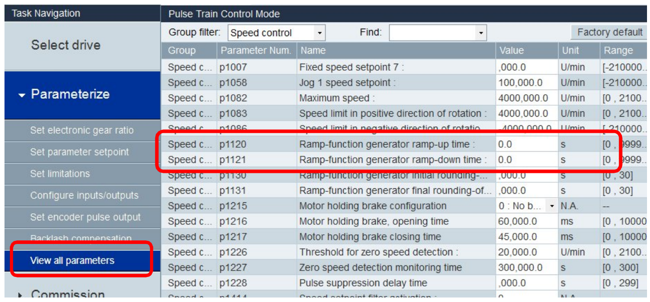
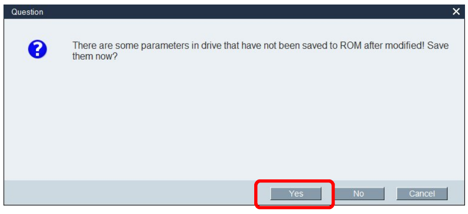
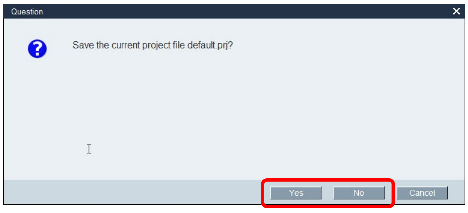


To set parameters p1120 and p1121 for the ramp-up and ramp-down time, select parameter group P0C. However, you can also set the parameter group to ALL.

7.2.2 Configuration via SINAMICS V-ASSISTANT

Table 7-1: Jog mode via SINAMICS V-ASSISTANT

No.	Instruction	Note / Screen
1.	Establish the USB connection between the SINAMICS drive and the PG/PC.	Blinking at the SINAMICS V90: • *COM*-LED green with 0.5 Hz. • *RDY*-LED red with 1 Hz.
2.	1. Start the PC tool SINAMICS V-ASSISTANT 2. Confirm with “OK”.	 The tool connects to the SINAMICS V90 online and recognizes it.
3.	Go into the *Parameterize* menu. There you can perform the most important configurations in the individual sub-items. Further parameters can be changed in submenu *View all parameters*.	

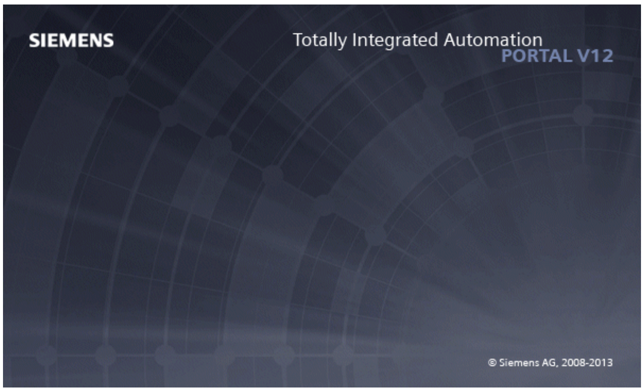
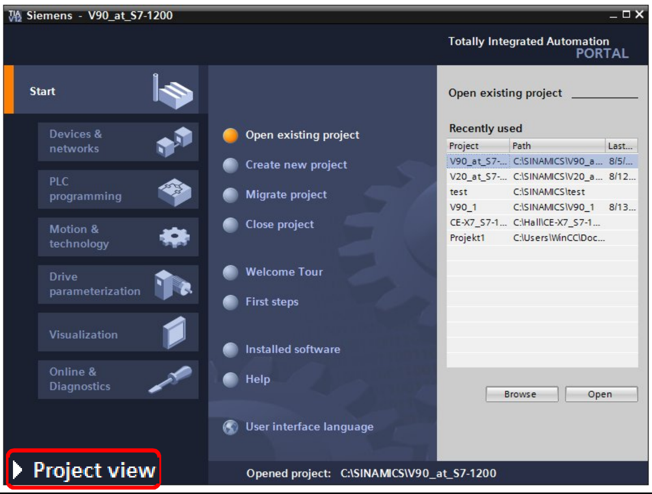
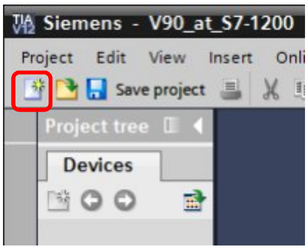
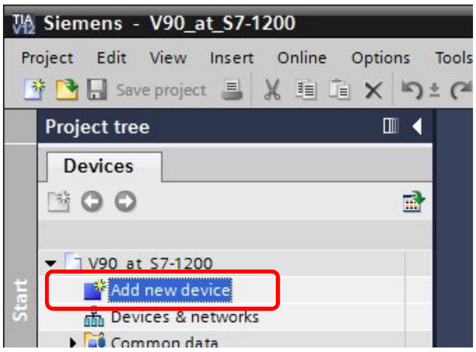
No.	Instruction	Note / Screen
4.	For the application example, you select *Number of set-point pulses per motor revolution* at *Set electronic gear ratio* and enter the value 3000. It is immediately transferred into the SINAMICS V90.	
5.	For the application example, go to sub-item *View all parameters* and change the ramp-up and ramp-down times (p1120, p1121) to 0. Each value entered and acknowledged with the Enter key is immediately transferred to the SINAMICS V90.	
6.	1. Terminate the PC Tool via *Project > Exit*. 2. Answer the query after saving the changed parameters to the ROM of the SINAMICS V90 with "Yes". 3. If necessary, save the current project file *default.prj*.	 The saving process in the SINAMICS V90 is terminated when the progress indication "-------" in the display of the SINAMICS V90 is replaced by "S oFF".  When answering the query with "Yes", you are on Windows level requested to enter the desired storage location.

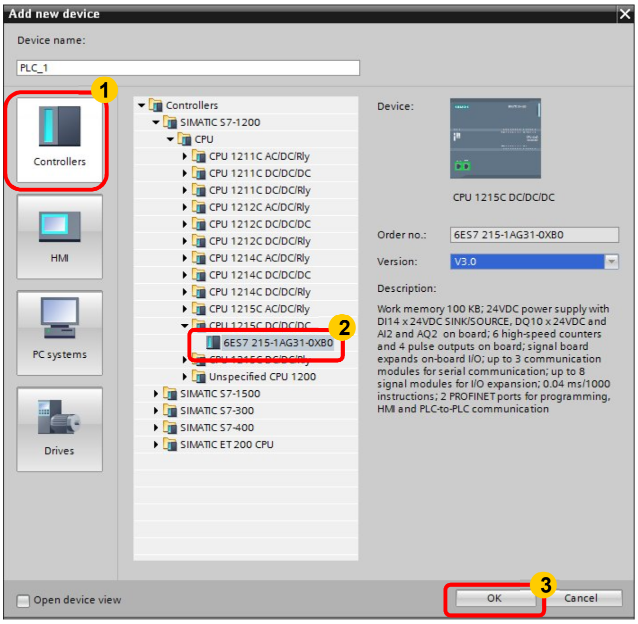
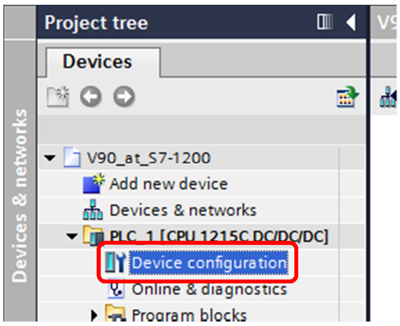
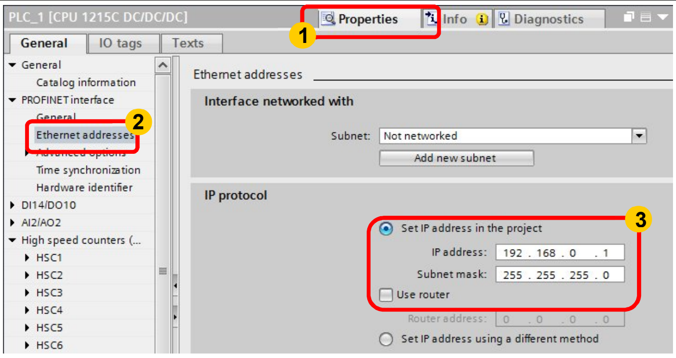
7.3 Creating the STEP 7 project configuration

The step tables below shall apply to both TIA V12 as well as TIA V13 projects. They describe what to do if you do not want to use the example code, but wish to configure the SIMATIC S7 CPU and the HMI device yourself. The configuration of the SIMATIC S7-1200 and the configuration of the control panel are not subject of this chapter.

It is assumed, that the software has been installed on your PG/PC according to Table 3-2.

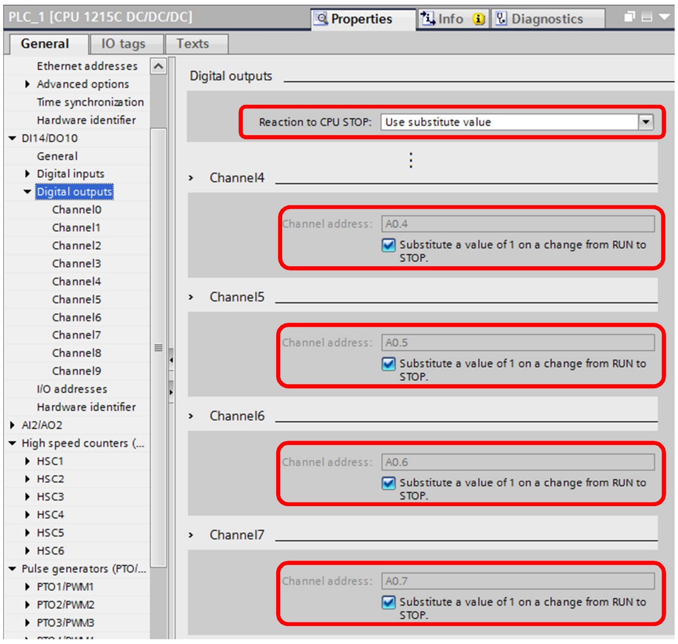
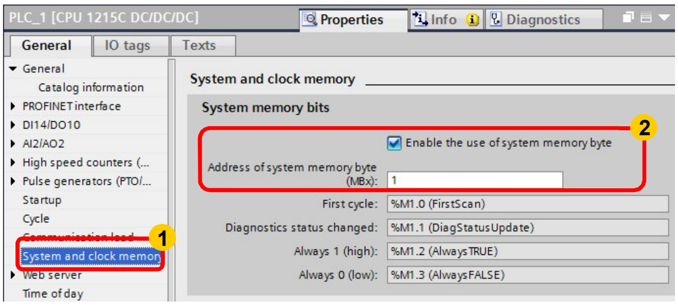
Table 7-2: Creating the project configuration

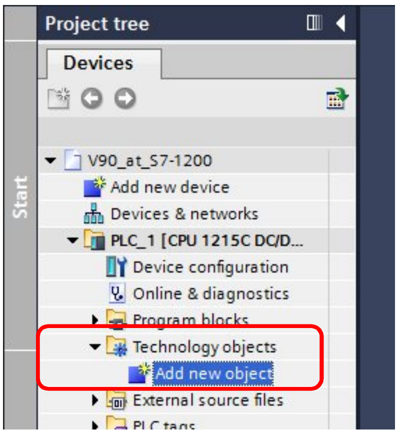
No.	Action	Note
	Creating the project	
1.	Open TIA Portal.	
2.	If TIA Portal opens in the Portal view, go to the bottom left to switch to the Project view.	
3.	Create a new project and assign a name (e.g."V90_at_S7-1200")	
	Inserting the SIMATIC S7-1200	
4.	Double-click on "Add new device".	

<table>
<tr><th>No.</th><th>Action</th><th>Note</th></tr>
<tr><td>5.</td><td>1. Select “Controller”.
2. Select the desired SIMATIC CPU.
It must be a DC/DC/DC type. Using the Line Drive interface you need a CPU 1217C.
3. Then click on “OK”.</td><td>
</td></tr>
<tr><td colspan="3">Configuring the SIMATIC S7-1200</td></tr>
<tr><td>6.</td><td>In the device configuration you go to the SIMATIC CPU.</td><td>
</td></tr>
<tr><td>7.</td><td>Open the PROFINET interface:
1. In the device configuration you open the “Properties” of the SIMATIC CPU.
2. Go to “Ethernet addresses” in the navigation tree.
3. Select “Set IP address in the project” and enter the desired IP address.</td><td>

In the application example – as in the above screen – the default values are used.</td></tr>
</table>

<table>
<tr><th>No.</th><th>Action</th><th>Note</th></tr>
<tr><td>8.</td><td>Define 1 as substitute value for the following digital outputs:
Axis_1_EMGS (A0.4)
Axis_1_CWL (A0.5)
Axis_1_CCWL (A0.6)
Axis_1_RPS_Sim (A0.7)

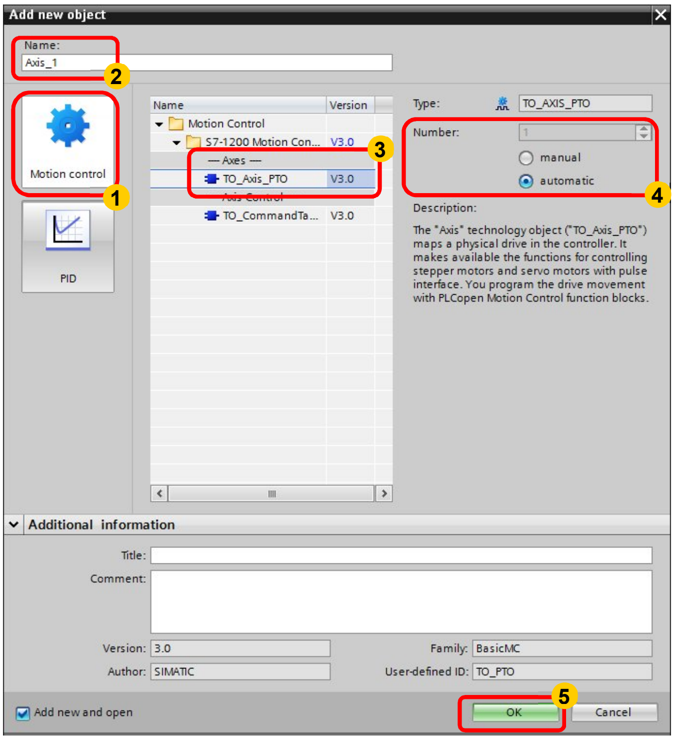
With this measure, when simulating the above signals (broken-line for wiring in Figure 3-2), the respective digital outputs of the PLC are, for a controller restart, switched to the inactive state (=1).</td><td>
</td></tr>
<tr><td>9.</td><td colspan="2">For the application, one of the pulse generators must be activated in the properties of the CPU at Pulse generators (PTO/PWM). However, this is adopted from technology object Axis_1 when configuring it (see step 13). They need not be activated here.</td></tr>
<tr><td>10.</td><td>Enable the use of the system memory bits, since they are used in the control program of the application.
1. In the tree you go to System and clock memory.
2. Checkmark Enable the use of system memory byte and enter the desired byte address.</td><td>

The program in the application example uses MB1 (default setting)</td></tr>
<tr><td colspan="3">Configure the Axis_1 technology object</td></tr>
<tr><td>11.</td><td>Insert a technology object.</td><td>
</td></tr>
</table>

<table>
<tr><th>No.</th><th>Action</th><th>Note</th></tr>
<tr><td>12.</td><td>

1. Select Motion Control.
2. Assign a name.
3. Select technology object *TO_Axis_PTO*.
4. Assign the number of the axis DB, which is generated automatically or manually.
5. Close the window with OK.

</td><td>



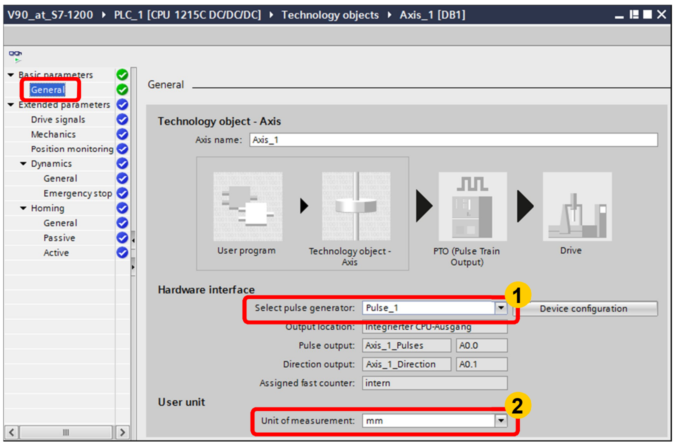
The axis in the application example is named *Axis_1*. DB number 1 is assigned to the axis-DB of the same name.

</td></tr>
<tr><td>13.</td><td>

The configuration window of the technology object opens. At menu item *Basic parameters* > *General* you make the following settings:

1. Select the generator. It is automatically marked as *activated* in the properties of the CPU.[19]
2. Select the user unit of the axis.

</td><td>



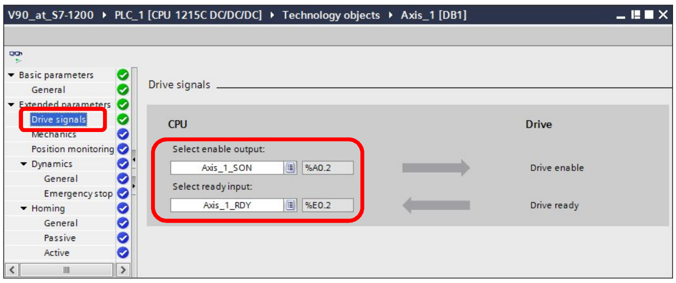
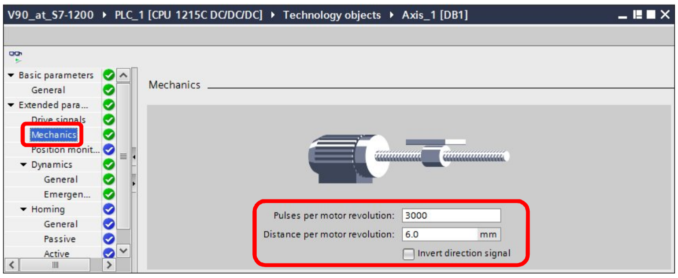
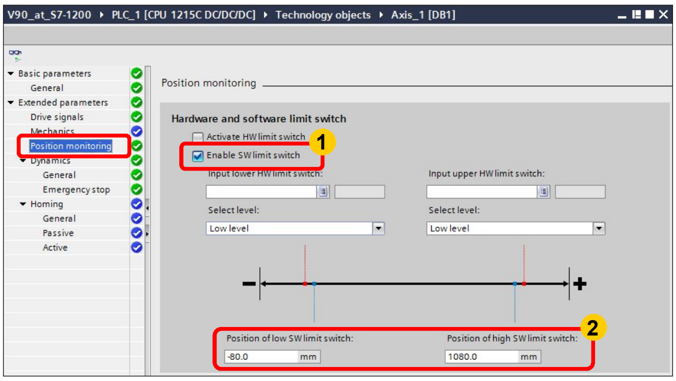
Which and how many pulse generators appear in the dropdown list depends on the used SIMATIC CPU and of the possibly used signal boards. In the application, the *Pulse_1* pulse generator is used.

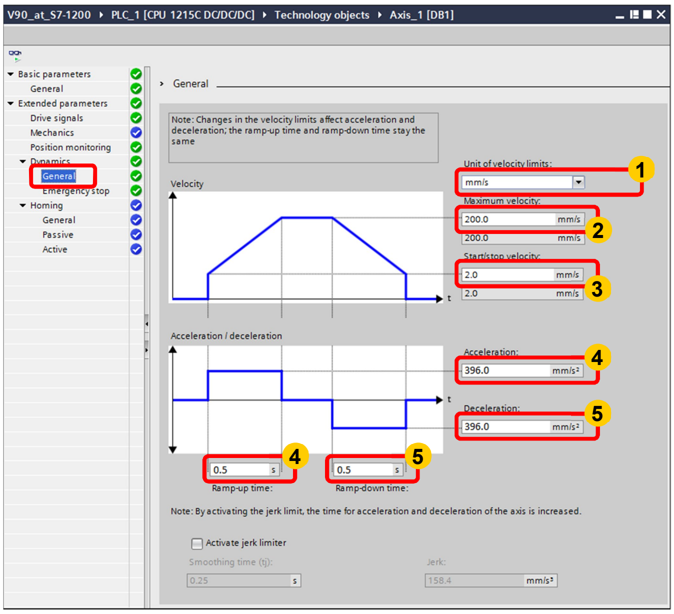
The grayed objects cannot be changed. They are determined by the device configuration and the selection of the pulse generator. If you have not yet created any symbolism for the pulse and direction output, default names will be used for the symbolic names and written to the tag table.

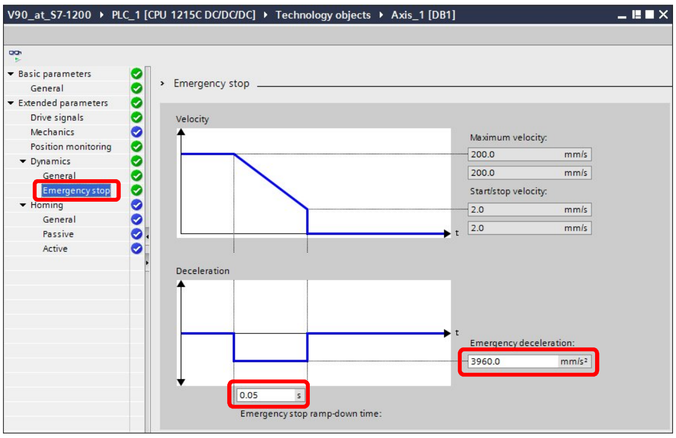
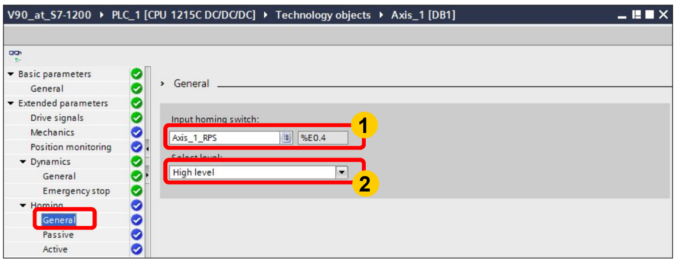
In the application, "*mm*" is used as the unit.

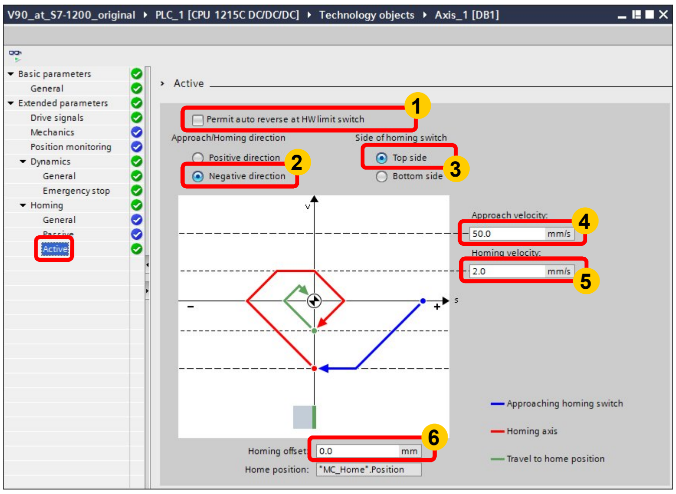
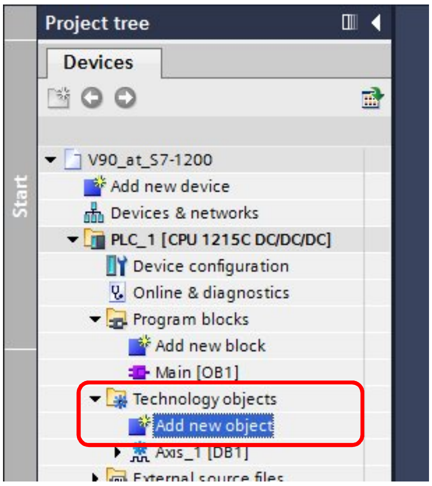
</td></tr>
</table>

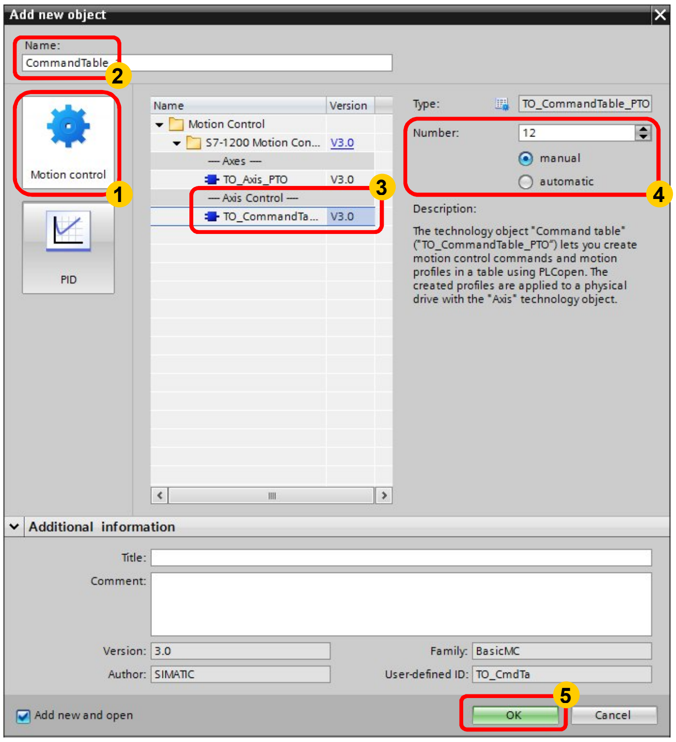
[19] You can verify this by opening the CPU properties with the *Device configuration* button.

No.	Action	Note
14.	At *Extended parameters > Drive signals* you enter the address of the interface signals *SON* and *RDY*.	 In the application, the respective data signals have the symbolic names *Axis_1_SON* (A0.2) and *Axis_1_RDY* (E0.2).
15.	In *Extended parameters > Mechanics…* …you enter the pulses per motor revolution which the SIMATIC outputs at digital output *Axis_1_Pulses* (A0.0) and …the travel per motor revolution. In the screen, this would be the landscrew pitch, if no drive exists.	 For the application example, 3000 ppr (**p**ulses **p**er **r**evolution) is entered (calculation see chapter. 7.1). The travel per motor revolution is in the application example set to 6 mm. The direction signal is not inverted in the application example. Inverting has the same effect as, for example, exchanging the motor phases.
16.	Define the limit switch at *Extended parameters > Position monitoring*. 1. Activate the SW limit switch. 2. Enter the position of the bottom (left) and the top (right) SW limit switch.	 In the application, only the SW limit switches are activated. In the example, the HW limit switches must not be activated, since they are directly connected to the SINAMICS V90 (see Figure 3-2). *Select level* refers to the HW limit switch and is therefore irrelevant here. For this application example, the positions -80 mm (bottom) and 1080 mm (top) were entered for the SW limit switch.

No.	Action	Note
17.	In *Dynamics > General* you make the following settings for the regular move commands (not emergency stop): 1. Unit of the velocity settings 2. Maximal velocity moved at in your application 3. Minimal velocity moved at in your application 4. Acceleration or ramp-up time between start/stop velocity and maximal velocity 5. Deceleration or ramp-down time between maximal velocity and start/stop velocity	 For this application, *mm/s* was always selected for the application. In the application example, the axis shall move at a maximum of 200 mm/s. Since the pulse output was optimized for this maximum according to chapter 7.1, no higher value can be entered either. The smallest velocity (start/stop velocity), should always be measured to still enable a movement without jerks. For example, when starting a motion, the SIMATIC immediately outputs a pulse frequency which corresponds to this velocity. For this application example, 2 mm/s were entered. The smallest pulse frequency which the CPU permits is 1Hz. In the application, this would correspond to 0.002 mm/s. There is an alternative input of acceleration or ramp-up time. The respectively not entered parameter will be calculated automatically. In the application example, a ramp-up time of 0.5 s is entered, which corresponds to an acceleration of 396 mm/s^2. There is an alternative input of deceleration or ramp-down time. The respectively not entered parameter will be calculated automatically. In the application example, a ramp-down time of 0.5 s is entered, which corresponds to a deceleration of 396 mm/s^2. A jerk limitation is not used in this application example. Further information is available, for example, in the STEP 7 Online Help at *Axis behavior when using the jerk limit*.

No.	Action	Note
18.	In *Dynamics > Emergency stop* you enter the *Emergency stop deceleration* and *Emergency stop ramp-down time*.	 There is an alternative input of deceleration or ramp-down time. The respectively not entered parameter will be calculated automatically. In the application example, a ramp-down time of 0.05 s is entered, which corresponds to a deceleration of 3,960 mm/s^2. The motor ramps-down with the emergency stop ramp, if – as in the application example – parameter *StopMode* of *MC_Power* has been parameterized as 0, and a move command terminated by blocking the enable (*MC_Power*: *Enable* → 0 or pressing the *Disable axis* button in HMI screen *Function menu*).
19.	At *Homing > General* you make the following settings: 1. Enter the bit address of the digital input to which the reference point is connected. 2. In the dropdown list you select the signal level pending at the CPU when the reference point switch is approached.	 In the application, the respective digital input has the symbolic names *Axis_1_ RPS* (E0.2). For the application, the level selection *Higher level* (equal to "logic 1-signal") must be selected from the dropdown list. Since in this application, the inputs of the SIMATIC CPU supply voltage (terminal 1M at +24V), the 1-signal – which corresponds to a closed RPS contact (see Figure 3-2) – carries a voltage of approx. 0V against M .
20.	Passive homing	In the application example, homing occurs actively (FB *MC_Home*, parameter *Mode*=3). Therefore, no entries are required at *Homing > passive*.

No.	Action	Note
21.	At *Homing* > *Active*, you make the following settings: 1. Permit or refuse a direction reversal at the HW limit switch during homing. 2. Specify the move direction in which you approach the reference point switch. 3. Specify whether the right (top) or left (bottom) edge of the axis slide is ruling for homing. 4. Specify the approach velocity (= velocity up to the first contact with the RPS). 5. Specify the homing velocity (= velocity from the first RPS contact). 6. If necessary, specify a homing offset towards the axis slide.	 The graphic displayed in TIA Portal illustrates the homing process according to your specifications. In the application example, the direction reversal at the HW limit switch is not permitted, since the HW limit switches are connected directly at the SINAMICS V90 and trigger an emergency stop (OFF3) when actuated. In the application example, *Negative direction* has been selected as in Approach/Homing direction. Prior to the start of the homing process, the axis slide must be positioned right of the RPS or be brought to this position (see Figure 1-2). Decisive for the homing in this application example is the right side (*Top side*) of the axis slide. In the application example, 50 or 2 mm/s have been entered as the approach and homing velocity. A homing offset has not been defined in the example on hand (entry 0.0 m). The ruling virtual homing point in this application corresponds to the physical position of the reference point switch here.
Configuring the technology object *CommandTable_1*		
22.	Insert a technology object.	

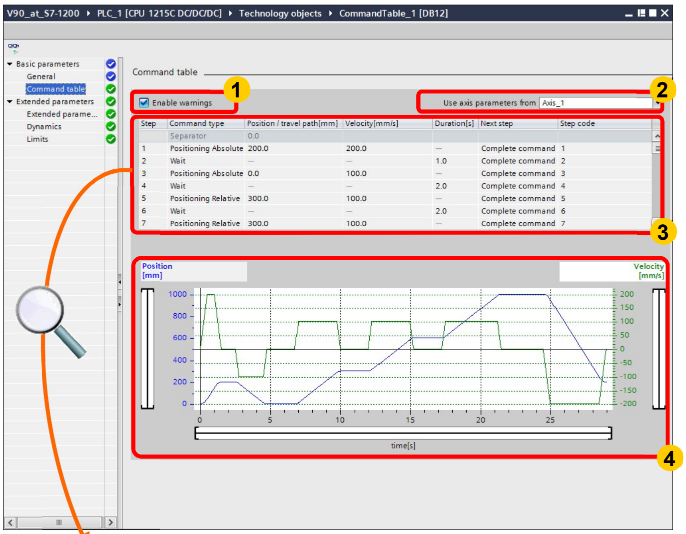
<table>
<tr><th>No.</th><th>Action</th><th>Note</th></tr>
<tr><td>23.</td><td>1. Select Motion Control.
2. Assign a name.
3. Select technology object TO_CommandTable_PTO.
4. Assign the number of the axis DB, which is generated automatically or manually.
5. Close the window with OK.</td><td>
The command table in the application example is referred to as CommandTable_1. DB number 12 is assigned to the DB of the same name.</td></tr>
</table>

No.	Action	Note

24.

The configuration window of the technology object opens. Go straight to menu item *Basic parameters > Command table*. (In *General*, only the name of the command table you have already assigned can be edited.)

1. When activating *Enable warnings*, you will be informed of any faulty entries when editing the table.
2. Use the axis parameters of the already configured *Axis_1*.
3. Edit your individual commands.
4. In the bottom part of the configuration window, you can check the curve shapes of position and velocity of your command compilation.



Step	Command type	Position / travel path[mm]	Velocity[mm/s]	Duration[s]	Next step	Step code
	Separator	0.0				
1	Positioning Absolute	200.0	200.0	—	Complete command	1
2	Wait	—	—	1.0	Complete command	2
3	Positioning Absolute	0.0	100.0	—	Complete command	3
4	Wait	—	—	2.0	Complete command	4
5	Positioning Relative	300.0	100.0	—	Complete command	5
6	Wait	—	—	2.0	Complete command	6
7	Positioning Relative	300.0	100.0	—	Complete command	7
8	Wait	—	—	2.0	Complete command	8
9	Positioning Absolute	1000.0	100.0	—	Complete command	9
10	Wait	—	—	3.0	Complete command	10
11	Positioning Absolute	200.0	200.0	—	Complete command	11
12	Empty	—	—	—	—	—
13	Empty	—	—	—	—	—
14	Empty	—	—	—	—	—

The table can comprise up to 32 commands preassigned with *Empty* commands. Apart from the already known *MC* commands *Velocity setpoint, Halt, Positioning Relative* and *Positioning Absolute*, a *Wait* command is available with configurable time duration.

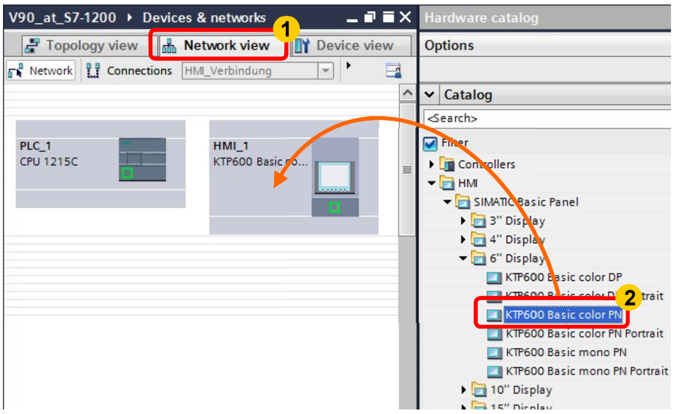
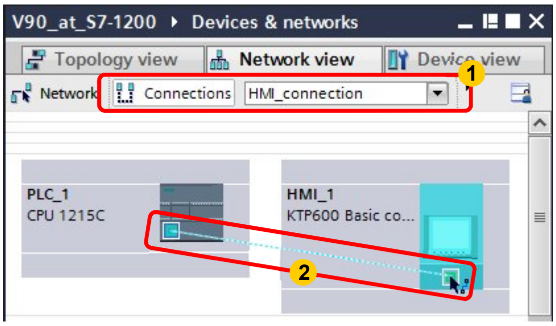
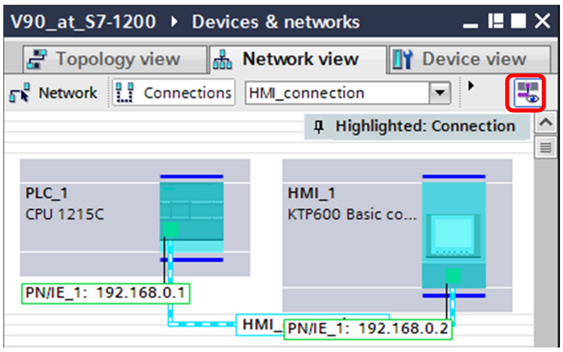
In *Next step*, if this is a positioning command, you select whether the respective single command is terminated regular or blended with the consecutive command.

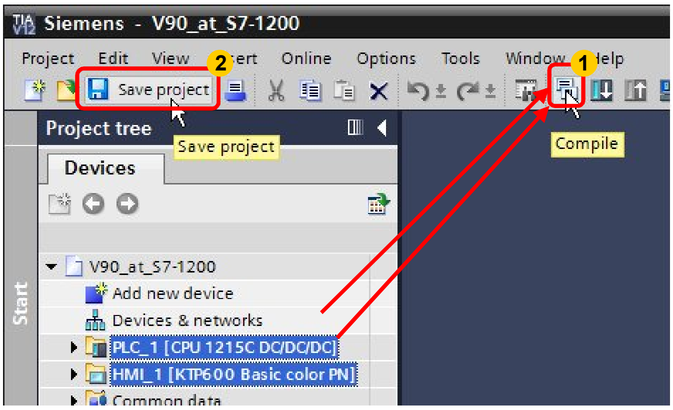
The *Step code* is a value (data type WORD) to be selected by the user for each single command which can be evaluated in the user program.

The steps of the command table correspond to those in Table 5-1: Sequence of material processing.

25.

Dynamics and limits of the axis for which the command table is determined, must be defined in menu item *Extended parameters*. Since they assume an already configured axis (*Axis_1*), the editor enters their data here by default. For menu item *Extended parameters*, you do not need to make any entries at its sub-items.

No.	Action	Note
	Add and network the HMI KTP600	
26.	Select the desired HMI operator panel: 1. In the Devices & networks editor, go to the Network view. 2. Then use drag and drop to move the required HMI from the catalog to the graphic area.	 In the application, HMI panel KTP600 was used. It is available at… *>HMI* *>SIMATIC Basic Panels* *>6“ Display*
27.	Connect the HMI operator panel to the SIMATIC controller: 1. Activate connection mode and from the drop-down list, select *HMI connection*. 2. Create a connection graphically between the Ethernet connections of the HMI KTP600 and the PLC by dragging the mouse.	
28.	Show the addresses. The KTP600 HMI is automatically assigned to the next free the IP address 192.168.0.3.	
	Creating the STEP 7 program, configuring the HMI operator panel	
29.	Now you create the STEP 7 program (programming the OBs, FCs, FBs, DBs) and also configure the HMI control panel (creating pictures, assigning HMI tags etc.). The step-by-step explanation of these two points is not subject of the application example on hand.	

No.	Action	Note
Compile and save		
30.	1. Successively compile the *PLC_1* and *HMI_1* devices. 2. Save the project.	

8 Related Literature

This list is not complete and only represents a selection of relevant information.

Table 8-1: Literature

	Subject	Title / link
\1\	Siemens Industry Online Support	http://support.automation.siemens.com
\2\	This entry	http://support.automation.siemens.com/WW/view/en/77467940
\3\	SIMATIC S7-1200 STEP 7 Basic	SIMATIC S7-1200 System Manual http://support.automation.siemens.com/WW/view/en/91696622 Update to the System Manual, edition 03/2014 http://support.automation.siemens.com/WW/view/en/89851659 S7-1200 Motion Control V12 SP1 – Function Manual http://support.automation.siemens.com/WW/view/en/80384402 S7-1200 Motion Control V13 – Function Manual http://support.automation.siemens.com/WW/view/en/90075651
\4\		STEP 7 Basic V12.0 System Manual http://support.automation.siemens.com/WW/view/en/68113678 STEP 7 Basic V13.0 System Manual http://support.automation.siemens.com/WW/view/en/89336297
\5\		Updates for STEP 7 V12 SP1 and WinCC V12 SP1 http://support.automation.siemens.com/WW/view/en/78683919 Updates for STEP 7 V13 and WinCC V13 http://support.automation.siemens.com/WW/view/en/90466591
\6\		Automating with SIMATIC S7-1200 Author: Hans Berger Publisher: Publicis Publishing ISBN: 978-3-89578-385-2
\7\	SIMATIC Basic Panels	HMI devices Basic Panels 1st Generation – Operating Instructions (with KTP600) http://support.automation.siemens.com/WW/view/en/31032678 HMI devices Basic Panels 2nd Generation – Operating Instructions (with KTP700) http://support.automation.siemens.com/WW/view/en/90114350
\8\		WinCC Basic V12.0 System manual http://support.automation.siemens.com/WW/view/en/68074843 WinCC Basic V13.0 System Manual http://support.automation.siemens.com/WW/view/en/91379840
\9\	SINAMICS V90 Manuals	Operating Instructions http://support.automation.siemens.com/WW/view/en/80007808
\10\		V90/SIMOTICS S-1FL6 Getting Started Compact Operating Instructions http://support.automation.siemens.com/WW/view/en/80007847
\11\	Commissioning Tool SINAMICS V-ASSISTANT	SINAMICS V-ASSISTANT http://support.automation.siemens.com/WW/view/en/81550014
\12\		SINAMICS V-ASSISTANT Online Help – Operating Manual http://support.automation.siemens.com/WW/view/en/82569200
\13\	Other	Defining the direction of motor rotation (FAQ) http://support.automation.siemens.com/WW/view/en/60605536

9 History

Version	Date	Change
V1.0	10/2013	First version
V1.1	10/2014	Extended by an analogue TIA V13 project • with CPU 1217C, where the Line-Drive interface is used. • with Basic Panel KTP700 instead of KTP600.