Controlled Positioning of a Servo Drive Using a Pulse/Direction Interface

S7-1200 CPU 1214C, SINAMICS V60 and STEP 7 V11 SP2

Configuration Example X7 • July 2014

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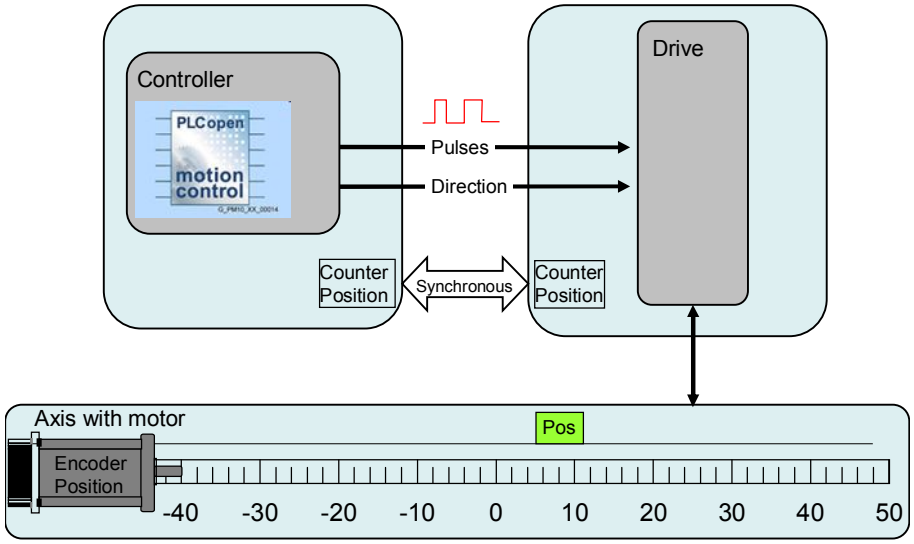
1 Automation Task

1.1 Application environment

A servo motor shall be moved by using a Sinamics V60 servo drive and with the help of the pulse interface of an S7-1200 CPU1214C. Both the servo drive and the S7-1200 CPU are provided with an internal pulse counter the count of which represents the current position. Before an absolute position can be approached, the S7-1200 CPU counter has to be synchronized with the physical position of the axis.

Figure 1-1



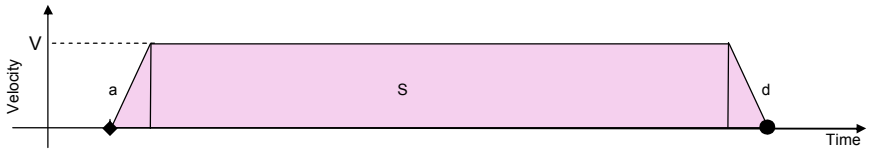
The task comprises an absolute positioning operation, irrespective of the starting position and the velocity (Figure 1-2). The required functions are provided by the S7-1200 technology object “Axis” with the associated “PLCopen – Motion Control” function blocks.

The stored values for

- acceleration “a” and deceleration “d” [mm/s^2]
- velocity in “v” [mm/s]
- target position “•” in [mm],

are taken as a basis to calculate the travel path s [mm] on the basis of the current starting position “⬧”, and to approach the target position “•”.

Figure 1-2



1.2 Components list

Products

Table 1-1

	Component	Qty.	MLFB / order number	Notes
1.	PM1207 power supply unit	1	6EP1332-1SH71	
2.	S7-1200 CPU1214C	1	6ES7214-1AE30-0XB0	DC, from Firmware V2.2 or higher
3.	Basic panel KTP1500 (color, PN) Basic panel KTP600 (color, PN)	1 1	6AV6647-0AG11-3AX0 6AV6647-0AD11-3AX0	optional optional
4.	SINAMICS V60 power module (CPM60.1)	1	6SL3210-5CC14-0UA0	4A
5.	1FL5 servo motor	1	1FL5060-0AC21-0AG0	4Nm without brake
6.	SIMATIC/SINAMICS V60 CONNECTION CABLE SUPPORTS 5V AND 24V PNP SIGNALS INCL. RESISTOR FOR SIGNALS	1	6ES7298-2DS23-0XA0	3m
7.	SIGNAL CABLE, PREASSEMBLED FOR 1FL5 WITH TTL-ENCODER 5 METER	1	6FX6002-2LE00-1AF0	
8.	POWER CABLE, PREASSEMBLED FOR 1FL5 TO 10 NM 5 METER	3m	6FX6002-5LE00-1AF0	
9.	Filter	1	6SN1111-0AA01-1BA1	optional

Note

The example project includes a KTP1500 and a KTP600 basic panel. However, these panels are not an obligatory requirement. Simulation of the user interface can also be effected with PC-Runtime of STEP 7 Basic.

The latest firmware for the S7-1200 CPU is available under:
http://support.automation.siemens.com/WW/view/en/41886031/133100

The configuration in itself is intended for industrial applications. Since the energy is supplied via industrial networks in most cases, the use of special filters/inductors with low leakage currents is usually not necessary.
If the configuration is used in sensitive electricity networks (e.g. PCs integrated in the same network), we recommend the installation of filters or inductors.

Accessorial equipment

Table 1-2

	Component	Qty.	Order number	Notes
10.	230V connection with fusing	1	Specialist dealer	L,N
11.	400V connection with fusing	1	Specialist dealer	L1, L2, L3
12.	400V/230V 3AC isolating transformer 1.0 kVA for 4Nm motor	1	Specialist dealer	3x400V primary 3x230V secondary 50/60Hz Y/Y-12
13.	Limit switch	2	Specialist dealer	Mechanically operated
14.	Reference point switch	1	Specialist dealer	Inductive

	Component	Qty.	Order number	Notes
15.	Emergency-stop circuit-breaker	1	Specialist dealer	NC contact

Note Further drive variants and the relevant motors and transformers are listed in the SINAMICS V60 manual.

http://support.automation.siemens.com/WW/view/en/44254092

Programming package

Table 1-3

	Component	Qty.	MLFB / order number	Notes
16.	STEP 7 Basic V11 SP2	1	6ES7822-0AA01-0YA0	WinCC Basic included
17.	STEP 7 Basic V11 upgrade from V10.5 to V11	1	6ES7822-0AA01-0YE0	If STEP 7 Basic V10.5 is already available

Note STEP 7 Basic V11 SP2 manual
http://support.automation.siemens.com/WW/view/en/57199536

STEP 7 WinCC Basic V11 SP2 manual
http://support.automation.siemens.com/WW/view/en/57341736

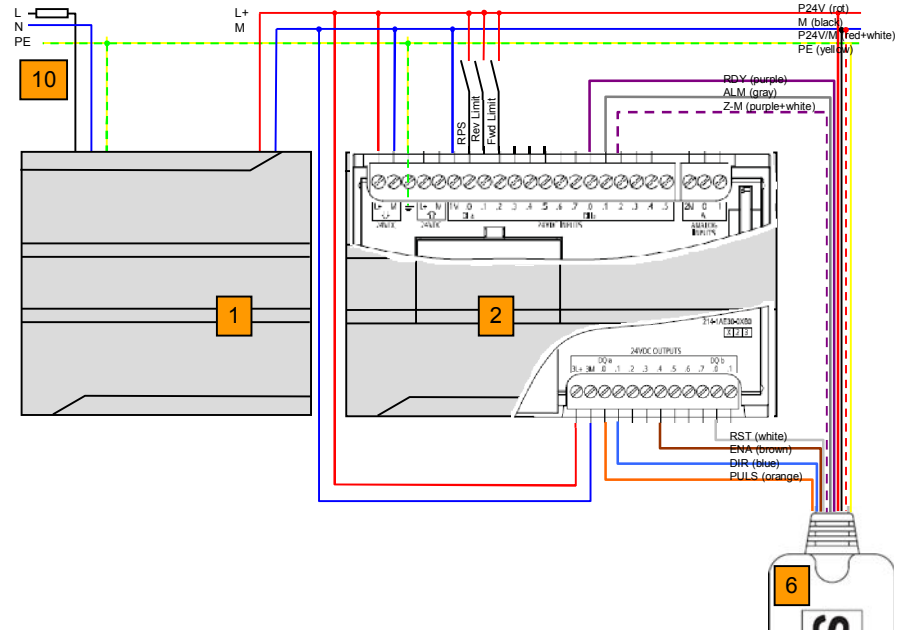
The latest updates for STEP 7 V11 and STEP 7 WinCC V11 are available at:
http://support.automation.siemens.com/WW/view/en/47071380/133100

2 Automation solution

2.1 Connection diagram

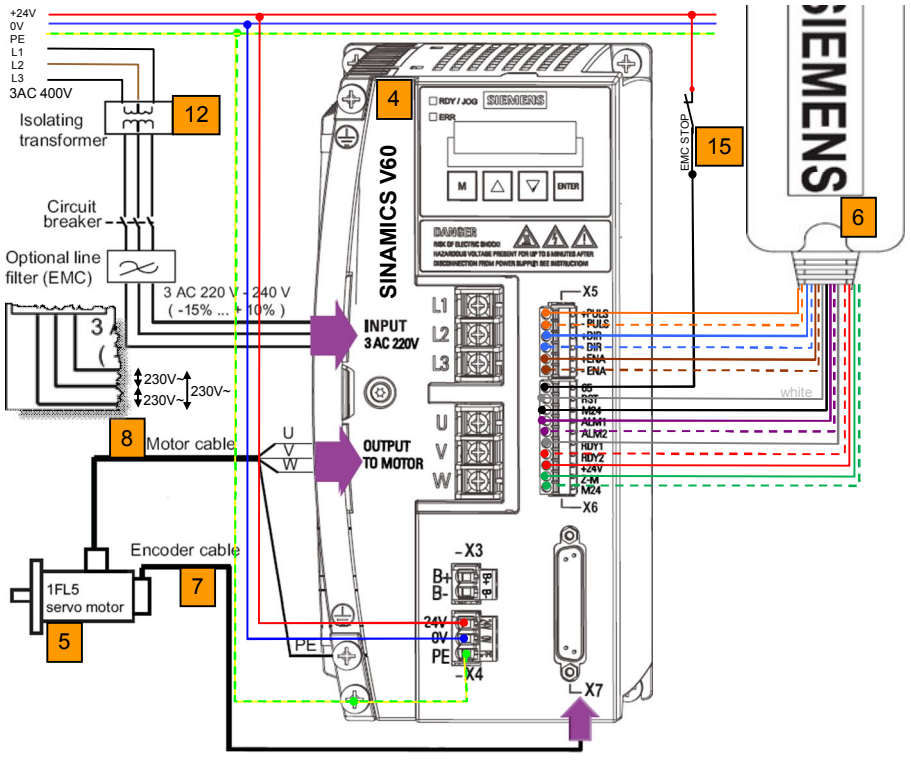
S7-1200 CPU1214C

Figure 2-1



SINAMICS V60

Figure 2-2



Note

Please make sure to connect the 3 AC 400V/230V power supply unit of the Sinamics V60 servo drive in compliance with the applicable safety regulations and the instructions listed in the manual.

http://support.automation.siemens.com/WW/view/en/44254092

ATTENTION

Notes on the prevention of electromagnetic interference:

- Make sure that a good conductive connection is provided between the servo drive and the (grounded) metal mounting plate.
- Make sure that all devices in the cabinet are suitably grounded by using short ground conductors with a large diameter which are connected to a common grounding point or grounding bus.
- Use shielded control cables.
- Where possible, run the control cables separated from power cables and in separate installation channels. Crossings between power and control lines should be at a 90° angle.
- Connect the protective conductor of the motor to the protective earth connection (PE) of the respective servo drive.
- The line ends should be properly terminated, making sure that any unshielded lines are kept as short as possible.

Always use shielded lines for motor connections; ground the shielding on the converter and the motor side with cable clamps.

SINAMICS V60 connection cable

Table 2-1

Supply	S7-1200	Cable		V60	Connector
		Label (color)	Label (color)		
	Q0.0	PULS (orange)	+PULS (orange)	X5.+PULS	
			-PULS (orange + white)	X5.-PULS	
	Q0.1	DIR (blue)	+DIR (blue)	X5.+DIR	
			-DIR (blue + white)	X5.-DIR	
	Q0.4	ENA (brown)	+ENA (brown)	X5.+ENA	
			-ENA (brown + white)	X5.-ENA	
				X6.65	Emergency Stop
	Q1.0	RST (white)	RST (white)	X6.RST	
M (0V)		M (black)	M24 (black)	X6.M24	
M (0V)		P24V/M (red + white)			
			ALM2 (purple)	X6.ALM1	
	I1.0	ALM (gray)	ALM2 (purple + white)	X6.ALM2	
			RDY1 (grey)	X6.RDY1	
	I1.1	RDY (purple)	RDY2 (red + white)	X6.RDY2	
L+ (24V)		P24V (red)	+24V (red)	X6.+24V	

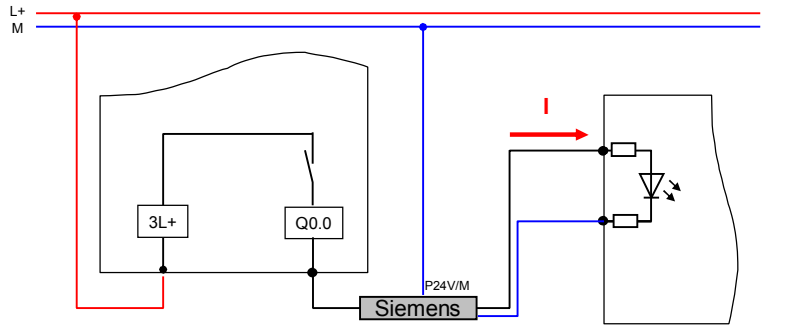
2.2 Control signals between S7-1200 CPU and servo drive

Inputs used on the servo drive unit (outputs of the S7-1200 CPU)

The drive is suitable for control with NPN and PNP signals. Via the P24V/M connection, the Sinamics V60 connection cable for servo drive control can be used for NPN and PNP.
The S7-1200 CPU1214C is equipped with PNP outputs only. For this reason, the P24V/M connection of the Sinamics V60 connection cable must be connected to ground.

If the switch, as shown symbolically in the diagram, is closed by logic “1” at the Q0.0 output of the S7-1200 CPU, current “I” is flowing. The drive identifies the flow of current as logic “1” (Figure 2-3).

Figure 2-3



Operation of the servo drive is effected with the following input signals:

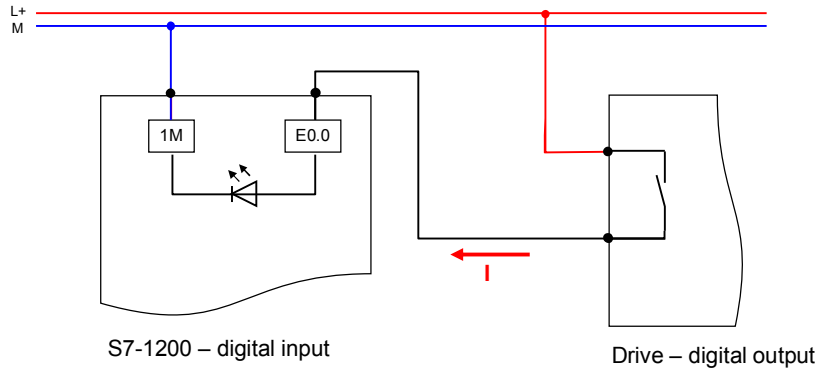
- pulse sequence
- direction of rotation
- pulse input enable
- activation/deactivation of the drive
- alarm reset

ATTENTION	**Incorrect connection of the digital outputs of the S7-1200 CPU may cause damage to the outputs.**

Outputs used on the servo drive unit (inputs of the S7-1200 CPU)

The relay outputs of the servo drive can be used as NPN or PNP outputs. In this example, the PNP variant is used.

Figure 2-4



Note All digital inputs of the S7-1200 CPU allocated to this connection to common potential can read only PNP signals. Please consider this when wiring the hardware switches.

The following output signals are used for the servo drive feedbacks:

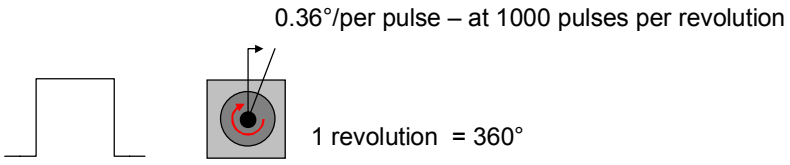
- servo ready
- alarm bit

2.3 Moving the servo motor by using the pulse interface

Depending on the servo drive settings, each pulse causes the servo motor to move by a defined angle.

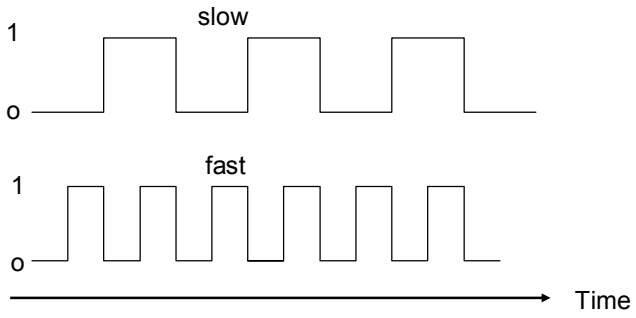
If the drive is set to 1000 pulses per revolution, for instance, the motor moves by 0.36° per pulse.

Figure 2-5



The velocity of the motor is determined by the number of pulses output per second. The S7-1200 CPU1214C allows an output of max. 100,000 pulses per second (pps).

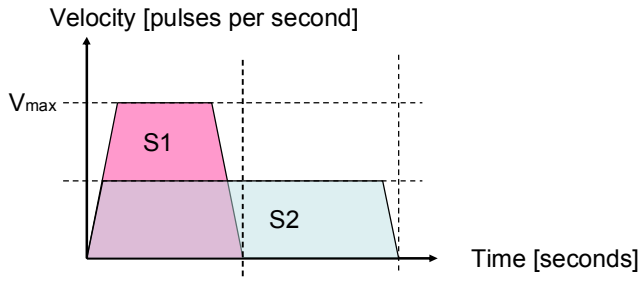
Figure 2-6



Correlation between velocity and distance

Figure 2-7 illustrates the correlation between velocity and distance. In the diagram, the travel path is represented by the enclosed area of the two curves. The area, and thus the number of output pulses, is identical in both cases. Due to the fact that the blue curve is moved more slowly than the red one, more time is needed to travel the distance.

Figure 2-7

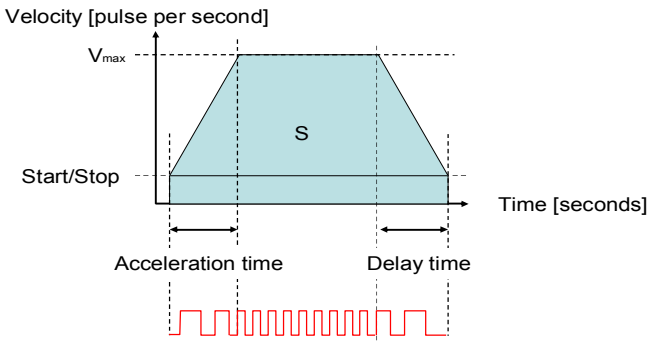


Meaning of start/stop velocity, acceleration and deceleration

Due to the inertia of the motor, it is not possible to move evenly at a velocity close to “0”. To avoid jerking of the motor, a minimum velocity (start/stop velocity) is defined.

When the pulse interface is activated, motion is initially performed at start/stop velocity. From there, the motor is accelerated to the specified velocity. Shortly before the end position, the motor is decelerated until start/stop velocity is reached. Then the pulse interface will be deactivated.

Figure 2-8



2.4 Position management in the S7-1200 CPU and the servo drive

The pulses output by the S7-1200 CPU are evaluated in the servo drive independently of the S7-1200 CPU. Internally, the S7-1200 CPU uses a high-speed counter which counts the number of output pulses, but it doesn’t receive feedback information on the actual position of the servo drive.

The servo drive used in this example identifies the current position with the help of an encoder with four-fold evaluation. A motor with 2500 pulses per revolution generates 10000 pulses.

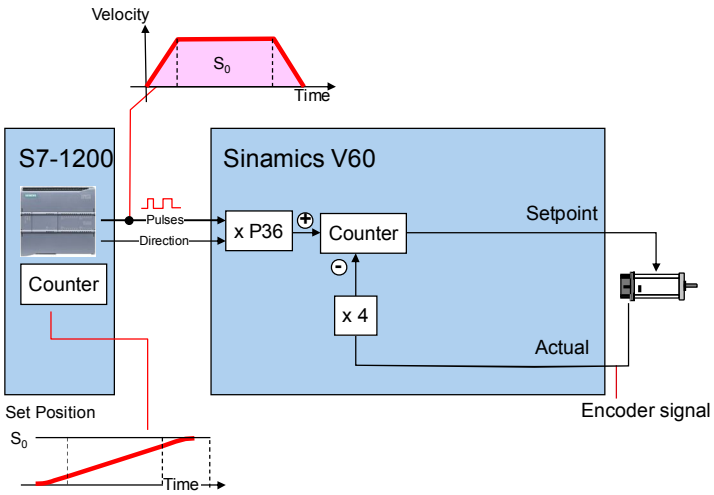
The drive SINAMICS V60 has a parameter P36.
This parameter specifies the input pulse multiplier to reach rated speed of the servo motor. It will be set to defined values and must be calculated for the maximum frequency of the chosen pulse output of the controller (see chapter 2.5).

In addition, the maximum velocity (frequency) of the technology object „Axis“ has to calculated depending on the chosen multiplier P36 (see chapter 2.5).

The servo drive then controls the motion of the servo motor.

This procedure is illustrated in Figure 2-9.

Figure 2-9



2.5 Calculation of the configuration parameters

2.5.1 Calculation of the parameter P36

The P36 specifies the input pulse multiplier to reach rated speed of the servo motor. It will be set to defined values and must be calculated for the maximum frequency of the chosen pulse output of the controller.

Example calculation

Given magnitudes:

Rated speed of the servo motor (T_{Motor})	= 2000 rpm
Number of pulses per revolution (P_{Motor}) with four-fold evaluation	= 4 x 2500 ppr
Maximum frequency of the chosen pulse output Q0.0	= 100 kHz

Calculation:

$$P36 \geq \frac{4 \times P_{Motor} \times \frac{T_{Motor}}{60s}}{f_{Output,\max}}$$

$$P36 \geq \frac{4 \times 2500\,ppr \times \frac{2000rpm}{60s}}{100kHz} \geq 3.33$$

Result:

The next possible value to set the input pulse multiplier P36 of the SINAMICS V60 is „4“.

2.5.2 Calculation of the maximum velocity of the technology object “Axis”

To ensure that the motor motion will not exceed the defined maximum speed, it is necessary to determine the maximum motor frequency that may finally be output by the pulse interface of the S7-1200 CPU.

Example calculation

Given magnitudes:

Rated speed of the servo motor (T_{Motor})	= 2000 rpm
Number of pulses per revolution (P_{Motor}) with four-fold evaluation	= 4 x 2500 ppr
Input pulse multiplier P36 of the SINAMICS V60	= 4

Calculation:

$$f_{\max} = \frac{4 \times P_{Motor} \times \frac{T_{Motor}}{60s}}{P36}$$

$$f_{\max} = \frac{4 \times 2500\,ppr \times \frac{2000rpm}{60s}}{4}$$

$$f_{\max} = 83333\,pps$$

Result:

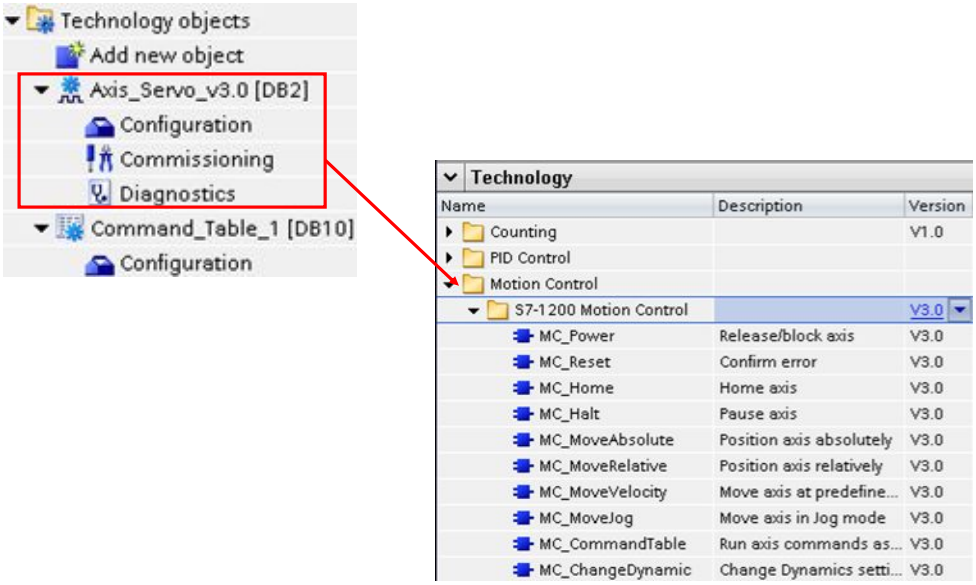
The maximum motor frequency is 83,333 pulses per second.

2.6 “Axis” technology object and “Motion Control” function blocks

The technology object “Axis” is used to map an axis in the controller, so as to facilitate servo drive control via the pulse interface of the S7-1200 CPU1214C. The “Axis” technology object is controlled by means of “Motion Control” instructions. The technology object “Axis” version 3.0 is included in the delivery of STEP 7 Basic V11 SP2. One significant extension, as compared to version 1.0, is the item “CommandTable”. This command can be used to travel the axis according to a defined sequence of movements (profile).

Configuration of the “Axis” technology object and “CommandTable” is explained in detail in chapter 3.4.

Figure 2-10



To enable the use of all functions described in this configuration example, the following program blocks are required which are to be called at cyclic intervals in the user program.

Table 2-2

No.	Program block	Function
1.	MC_Power	Activates/deactivates the axis
2.	MC_Reset	Acknowledges all pending errors
3.	MC_MoveJog	Jog mode
4.	MC_MoveVelocity	Moves the axis at the specified velocity and in the specified direction
5.	MC_Home	Homing of the axis
6.	MC_Halt	Cancels all motions, stop of the axis
7.	MC_MoveAbsolute	Absolute positioning of the axis
8.	MC_MoveRelative	Relative positioning of the axis
9.	MC_CommandTable	Perform axis commands as a sequence of movements (profile tracking)

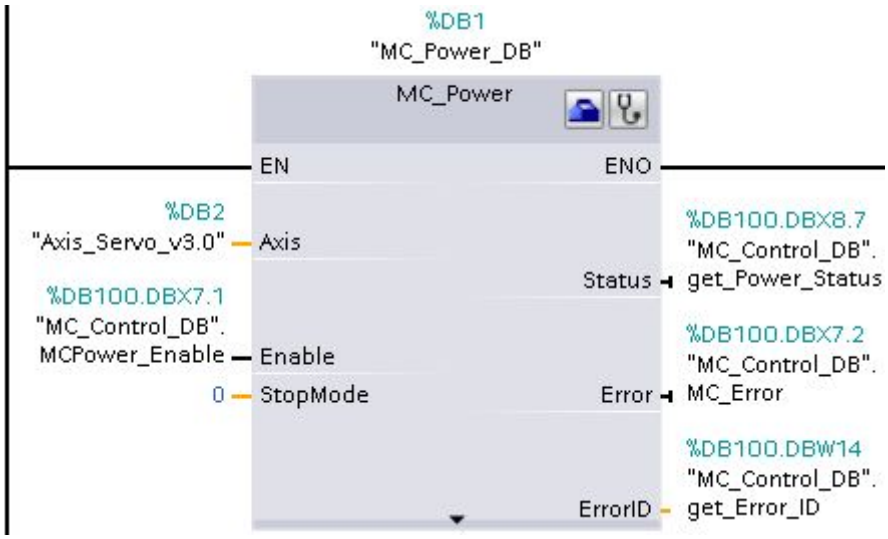
2.6.1 Enabling/disabling the axis (MC_Power)

Before the axis can be moved, it has to be activated. When the “TRUE” signal is applied to the “Enable” input of the block “MC_Power”, the output of the S7-1200 CPU parameterized in the configuration of the “Axis” technology object will be set and the servo drive will be powered up.

The “StopMode” input is used to define whether the axis, when deactivated, shall be slowed down by the configured “emergency” deceleration before being disabled (“0”), or whether the axis shall be stopped immediately (“1”).

The “Status” output of the block provides feedback from the servo drive and indicates whether the drive is ready for operation. Errors during operation are displayed at the “Error” output and the corresponding error identifier will be displayed at the “ErrorID” output. A list of ErrorIDs is available in the online help of STEP 7 Basic.

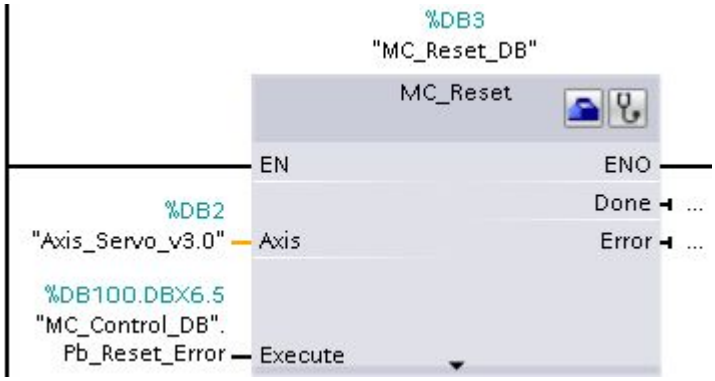
Figure 2-11



2.6.2 Error acknowledgment (MC_Reset)

If an acknowledgeable error has occurred, it has to be reset by a positive edge at the “Execute” input of the block “MC_Reset”.

Figure 2-12

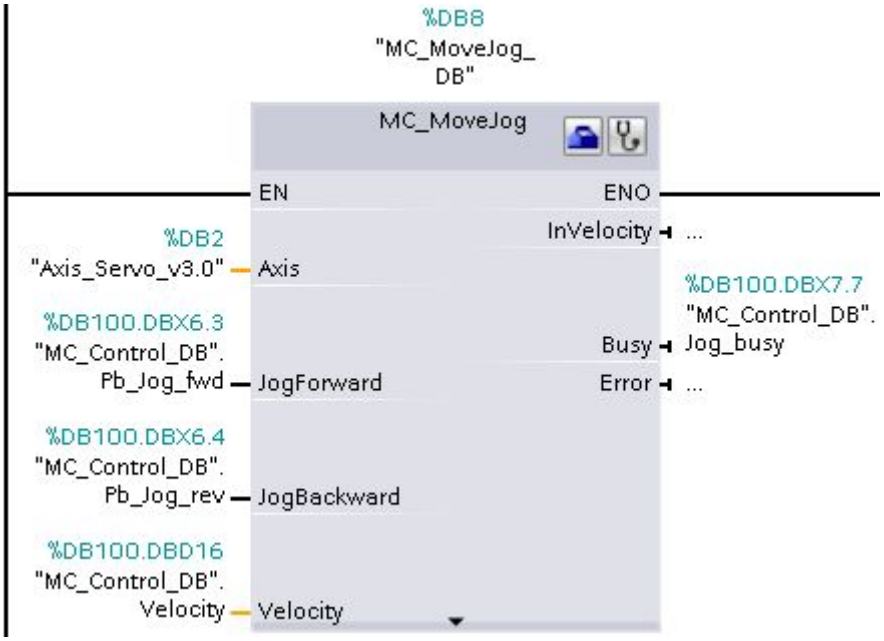


2.6.3 Manual move operation – jog mode (MC_MoveJog)

The block “MC_MoveJog” is available for moving the axis in “jog mode”. After having specified the speed at the “Velocity” input and having set the “JogForward” or “JogBackward” input, a pulse train is output at the pulse output of the controller until “JogForward” or “JogBackward” are reset.

As long as the axis is moved via this block, the “Busy” output remains active.

Figure 2-13



2.6.4 Manual move operation – at preset velocity (MC_Velocity)

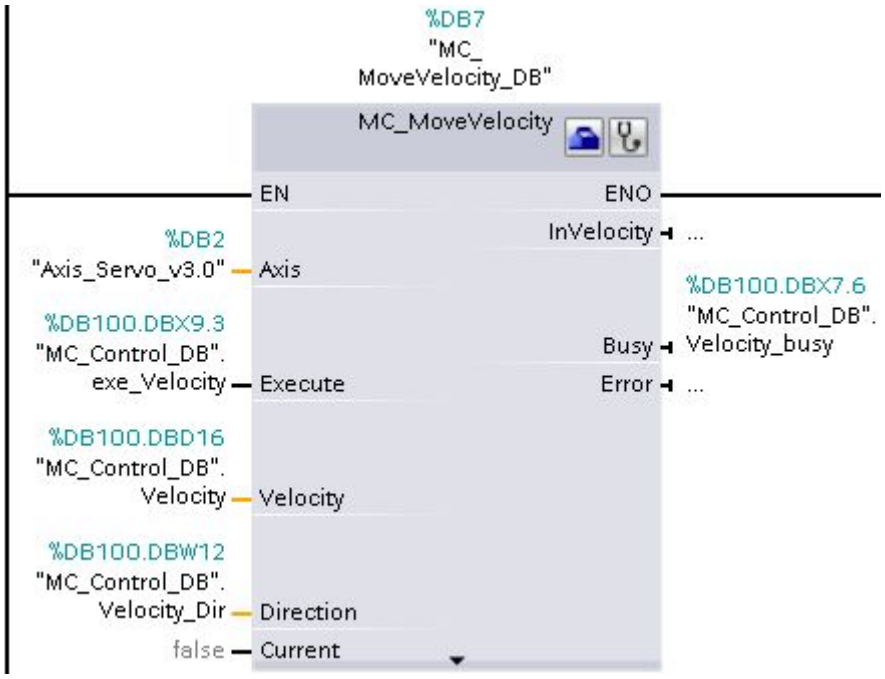
The “MC_MoveVelocity” block is available for moving the axis at a preset velocity. After having specified the speed at the “Velocity” input and by a positive edge at the “Execute” input, a pulse train is output at the pulse output of the controller until the “MC_Halt” block is executed.

The input “Direction” is used to specify the direction of rotation and may include the following three values:

- 0: The direction of rotation is controlled via the sign (+/-) of the specified velocity
- 1: Positive direction of rotation (unsigned velocity value)
- 2: Negative direction of rotation (unsigned velocity value)

As long as the axis is moved via this block, the “Busy” output remains active.

Figure 2-14

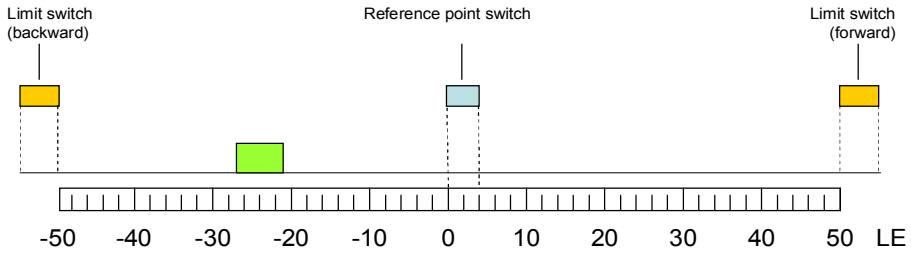


2.6.5 Homing (MC_Home)

Before the servo motor can be moved as defined via a pulse train, the physical position of the axis must be known to the controller.

How to identify the physical position (homing) shall be explained with the help of a linear axis. This axis consists, for example, of a spindle connected to the servo motor. One revolution of the motor shall correspond to 2,500 pulses and to one unit of length [LU] of the spindle.

Figure 2-15

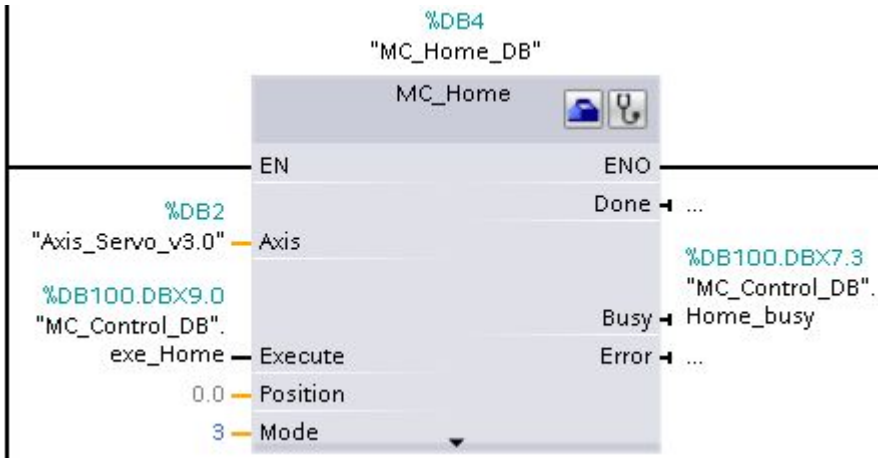


It is assumed that the standard position of the axis, shown in green in the figure, is to the left of the reference point switch displayed at position “0”.

The axis is moved at a defined velocity and in a defined direction by a positive edge at the “Execute” input of the “MC_Home” block.

The specific direction and velocity at which the axis shall be moved are defined in the technology object configuration. (Chapter 3.4, Configuration). The axis only moves as defined in this parameterized configuration when the “Mode” input of the “MC_Home” block is set to the value “3”.

Figure 2-16

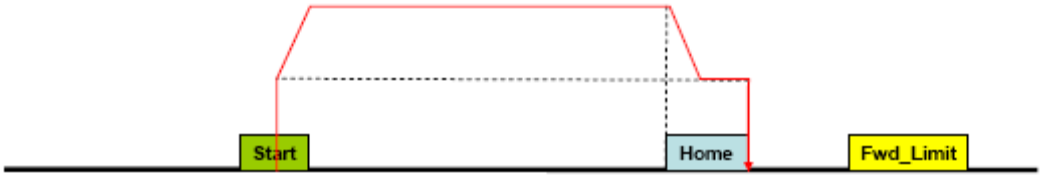


There are three different cases which may influence the homing movement of the axis.

Case 1: *Starting position to the left of the home position, deceleration to slow velocity completed before the negative edge is reached.*

A positive edge of the reference point switch decelerates the motor to a slower velocity. The axis is now moved to the falling edge of the reference point switch and then stopped. The position counter is set to the absolute value at the “Position” input.

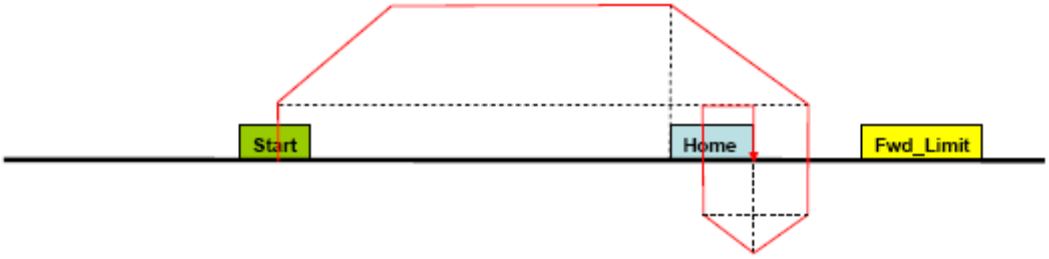
Figure 2-17



Case 2: *Starting position to the left of the home position, deceleration to slow velocity not completed before the negative edge is reached.*

If deceleration to the slower velocity is not completed before reaching the negative edge of the reference point switch, the axis will be stopped. Subsequently, the axis is moved backwards at a slow velocity until it reaches the positive edge of the reference point switch. The axis is stopped again and then moved forward at a slow velocity until it reaches the negative edge.

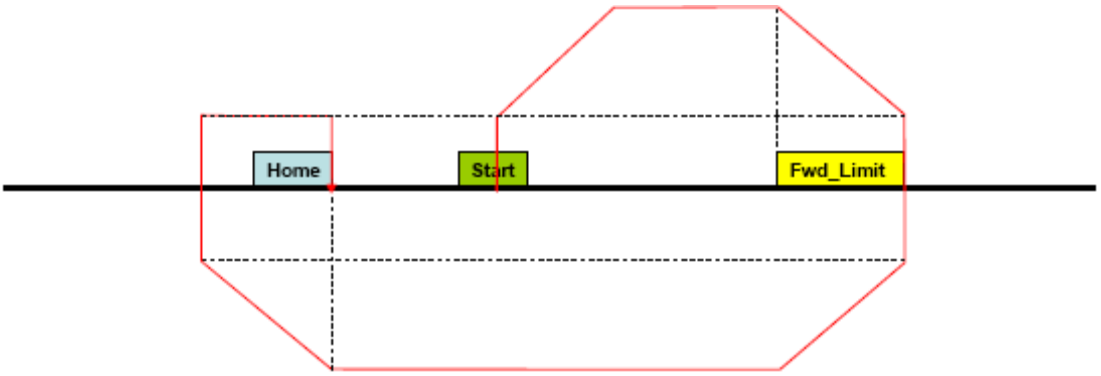
Figure 2-18



***Case 3:** Starting position to the right of the home position*

If the axis is behind or on the reference point switch, the axis is not detected by the reference point switch but by the forward limit switch. Then the axis is stopped. Once it has come to a standstill, it is moved backwards at a defined velocity until it reaches the home position. Subsequently, normal homing restarts.

Figure 2-19

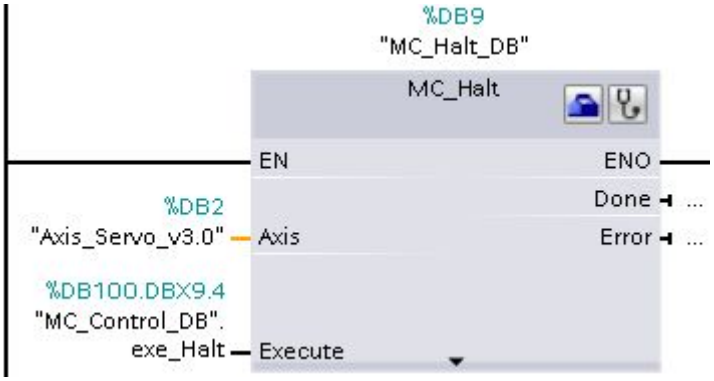


While the axis is moved via this block, the “Busy” output is active. Once the block has been executed successfully, the “Done” status bit is set to “TRUE” in the data block of the “Axis” technology object.

2.6.6 Interruption of motion jobs (MC_Halt)

Each active job, i.e. each active motion of the axis, can be stopped by the “MC_Halt” block. A positive edge at the “Execute” input decelerates the axis to a standstill. The position at which the axis stops is not defined.

Figure 2-20



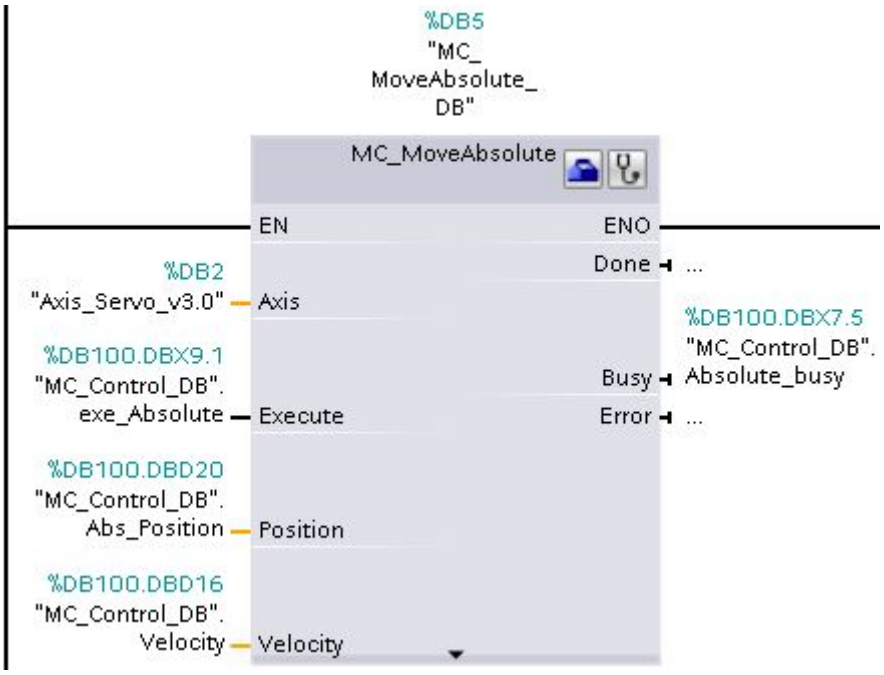
In addition, every active job can be interrupted by triggering a new job. Only the last triggered job is always active.

Example: The axis is moved at the preset velocity. When the jog mode is activated, the job with the preset velocity will be deleted and the jog mode will become active.

2.6.7 Absolute Positioning (MC_MoveAbsolute)

Due to the homing operation, the current axis position is known. With the aid of the “MC_MoveAbsolute” block, any position within the mechanical limits can be approached by specifying the real position in [mm]. In addition, the velocity of travel has to be specified.

Figure 2-21

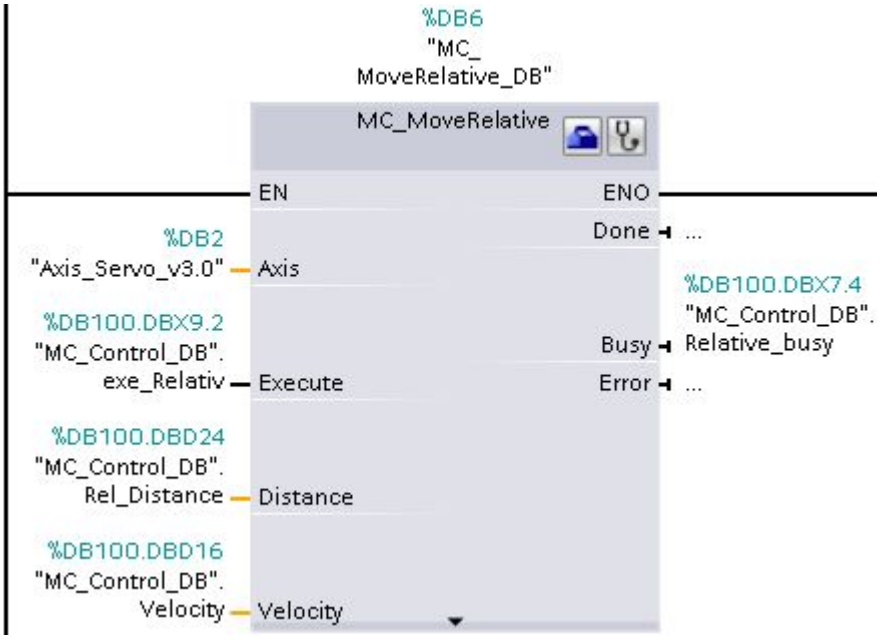


When the block is started by a positive edge at the “EXECUTE” input, the number of pulses required to reach the target position is calculated on the basis of the current position and the target position. If possible, the motor is then accelerated to the specified velocity and a decelerated stop is performed at the target position.

2.6.8 Relative Positioning (MC_MoveRelative)

Aside from absolute positioning, a relative motion with any distance, direction and velocity can be performed with the aid of the “MC_MoveRelative” block.

Figure 2-22



When the block is started by a positive edge at the “EXECUTE” input, the axis is moved by the set distance at the selected velocity. The sign (+/-) of the distance indicates the direction.

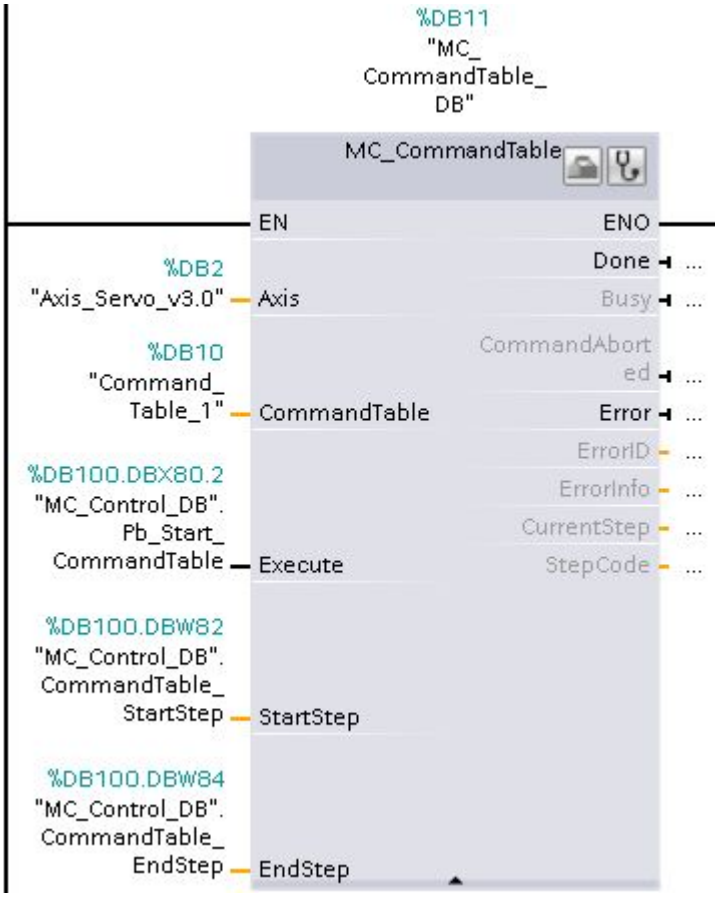
DANGER

To make sure that positioning is performed only within the permissible limits, the axis must have been homed beforehand.

2.6.9 Sequence of movements (MC_CommandTable)

This block offers the option of moving along a defined profile (sequence of movements). Precondition is that the axis has been started and homed. A positive edge at the “EXECUTE” input starts the moving sequence at the specified “Start Step”. The sequence ends at the specified “End Step”. Movement can also be interrupted by a STOP command or by starting another positioning job.

Figure 2-23



2.7 Program Structure

This chapter provides information on the realized program structure and describes the sequential control of the automatic process of the application example.

2.7.1 List of used blocks

The STEP 7 V11 project of this application example includes the following blocks:

Table 2-3 List of used blocks

Block	Symbolic name	Function
Blocks of the control program		
OB 1	Main	Cyclic call of the blocks of the application example.
FC 1	MC_Call_Motion-Blocks	Call of the motion control blocks for the technology object „Axis_Servo_v3.0“
FC 2	MC_Copy_to_Contol_DB	Mirroring the technology object „Axis_Servo_v3.0“ to DB 100
FC 3	MC_Errors	Converting the parameter „ErrorID“ of the block „MC_Power“ into HMI alarms
FC 4	MC_Call_Command_Table	Call of the motion control blocks for the technology object „Command_Table_1“
DB 100	MC_Control_DB	Tag access to the technology objects for displaying in the HMIs
Motion Control Blocks		
FB 1100	MC_Halt	Halt axis
FB 1101	MC_Home	Home axes, set home position
FB 1102	MC_MoveAbsolute	Absolute positioning of axes
FB 1103	MC_MoveJog	Move axes in jogging mode
FB 1104	MC_MoveRelative	Relative positioning of axes
FB 1105	MC_MoveVelocity	Move axes at preset rotational speed
FB 1107	MC_Power	Enable, disable axis
FB 1108	MC_Reset	Acknowledge error
FB 1112	MC_CommandTable	Run axis jobs as movement sequence

Motion Control Blocks		
DB 9	MC_Halt_DB	Instance data block for FB 1100
DB 4	MC_Home_DB	Instance data block for FB 1101
DB 5	MC_MoveAbsolute_DB	Instance data block for FB 1102
DB 8	MC_MoveJog_DB	Instance data block for FB 1103
DB 6	MC_MoveRelative_DB	Instance data block for FB 1104
DB 7	MC_MoveVelocity_DB	Instance data block for FB 1105
DB 1	MC_Power_DB	Instance data block for FB 1107
DB 3	MC_Reset_DB	Instance data block for FB 1108
DB 11	MC_CommandTable_DB	Instance data block for FB 1112
Technology objects		
DB 2	Axis_Servo_v3.0	Technology object „Axis“
DB 10	Command_Table_1	Technology object „Command table“

2.7.2 Overview of the program structure

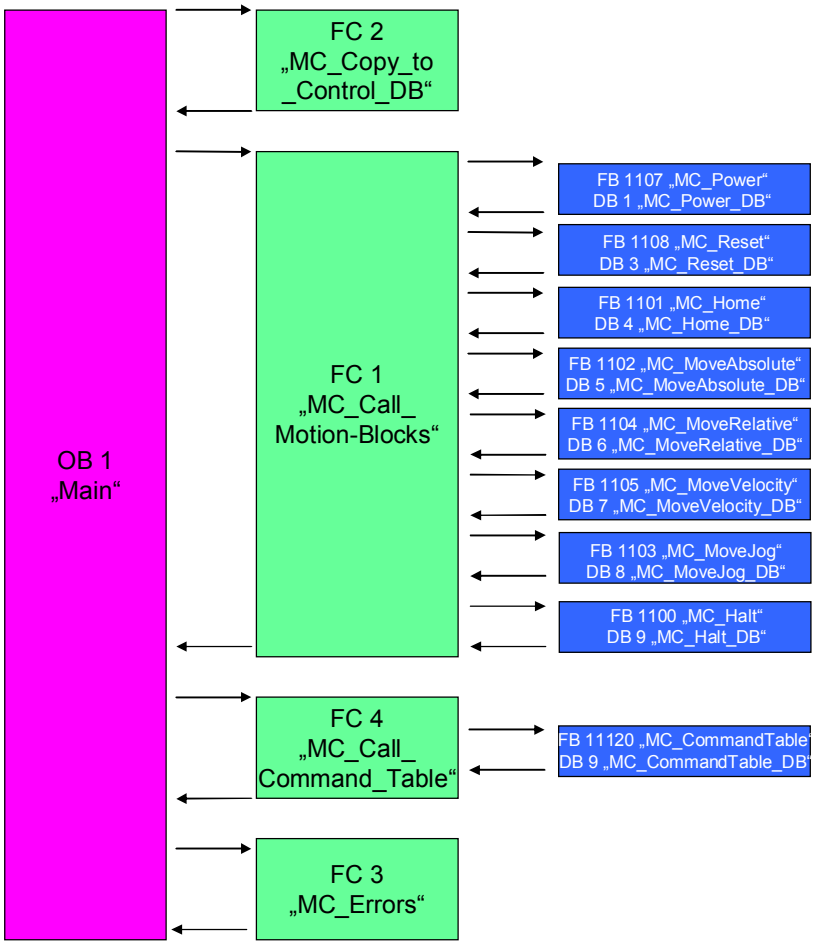
The figure provides an overview of the call structure of the blocks of the application example’s overall control program.

The program is divided into four function calls:

- **MC_Copy_to_Control_DB:**
  This function call filters the required tags of the technology object for the HMI access.
- **MC_Call_Motion-Blocks:**
  This section takes the control of the axes of the application. The real axes, i.e. the inverters and motors, are connected to the control program via the “Axis” technology objects.
- **MC_Call_Command_Table:**
  This will run axis jobs as movement sequence.
- **MC_Errors**
  The parameter „ErrorID“ of the block „MC_Power“ will be translated in the information text displayed on the HMI.

The used technology function blocks will be explained in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**

Figure 2-24 Overview of the program structure



3 Configuration

3.1 Hardware installation and wiring

Table 3-1

No.	Instruction	Note / screen
1.	Mount the fuse, PM1207, S7-1200 CPU1214C and servo drive onto a top-hat rail.	
2.	Connect the controller to the 24 V DC supply voltage of the PM1207.	See chapter “Connection diagram”
3.	Use terminal X3 to connect the Sinamics V60 to the 24 V DC supply voltage.	See chapter “Connection diagram”
4.	Connect the isolating transformer to the 3AC 400V supply voltage.	
5.	Connect the isolating transformer to the 3AC 230V supply voltage of the isolating transformer.	
6.	Use the motor cable and the encoder cable to connect the servo drive to the servo motor.	
7.	Connect the signal cable to the inputs and outputs of the S7-1200 and 24 V DC.	See chapter “Connection diagram”
8.	Connect all ground connections to earth.	

3.2 Configuration and commissioning of SINAMCS V60

The configurations defined in the following enable the servo drive to be moved via pulse/direction signals and with consideration to its maximum dynamic range.

All further parameters with regard to the motor fine settings are not described here. Further details on these settings are described in the SINAMICS V60 manual.

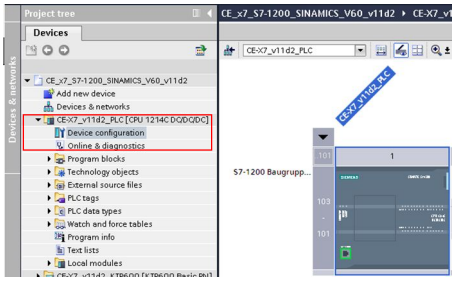
Table 3-2

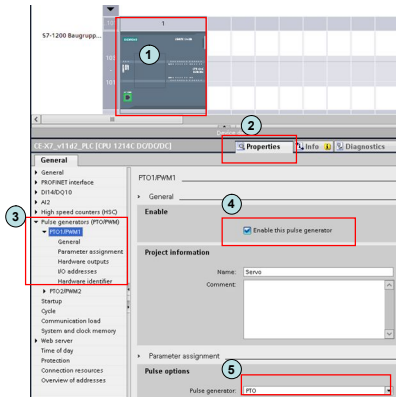
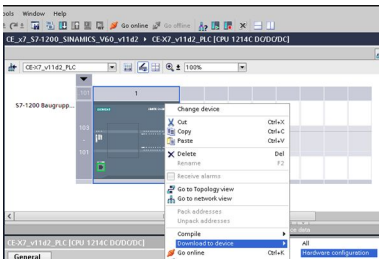
No.	Instruction	Note / screen
1.	Switch on the servo drive.	
2.	Press the “M” button.	The display shows: **Para**
3.	Press the “Enter” button.	The display shows: **P01**
4.	Press the “Enter” button.	The display shows: **0**
5.	**Parameter: Remove write protection** Use the arrow buttons to set the parameter to **1**	The display shows: **1**
6.	Press “Enter” to confirm your selection.	The display shows: **P01**
7.	Use the arrow buttons to select the parameter P36.	The display shows: **P36**
8.	Press the “Enter” key.	The display shows: **1**
9.	**Parameter: Input Pulse Multiplier** Use the arrow buttons to set this parameter to **4 (**see chapter 2.5).	The display shows: **4**

No.	Instruction	Note / screen
10.	Press the “Enter” key to confirm your settings.	The display shows: **P36**
11.	Press the “M” button 3 times.	The display shows: **Func**
12.	Press the “Enter” key.	The display shows: **Jog**
13.	**Save your settings** Use the arrow buttons to select the value: **Store**	The display shows: **Store**
14.	Press the “Enter” key.	The display shows: **no**
15.	Use the arrow buttons to select: **yes**	The display shows: **yes**
16.	Press “Enter” to confirm your settings.	The display briefly shows: **finish**
17.	Switch off the servo drive.	
18.	Switch the servo drive on again shortly afterwards.	
19.	Perform first commissioning as described in the manual.	

3.3 S7-1200 CPU configuration and hardware download

Table 3-3

No.	Instruction	Note / screen
18.	Unzip the file from Table 4-1 No. 1	
19.	Open the unzipped project in STEP7 Basic V11 SP2.	*.ap11
20.	Select “CE-x7_v11d2d5_PLC” from the Project Tree and open the device configuration window.	
21.	Check the device configuration and adjust the hardware, if necessary.	

No.	Instruction	Note / screen
22.	Check whether the pulse generator “PTO1” is activated. • Click the CPU (1) and select Properties (2). • Select the “Pulse Generator” (PTO/PWM) from (3). • Check the settings for PTO1/PMW1 (4-5) ○ activated ○ pulse generator PTO	
23.	Download the hardware to the CPU • Select the CPU and click the “Download to Device” icon, or • Click the CPU with your right mouse button and select “Download to Device” → “Hardware Configuration” • After downloading, set the CPU to “RUN”.	

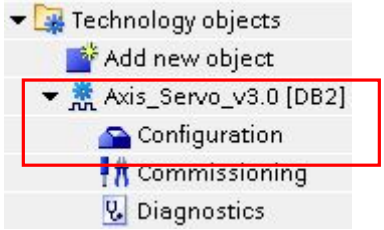
3.4 Parameterizing the technology object “Axis”

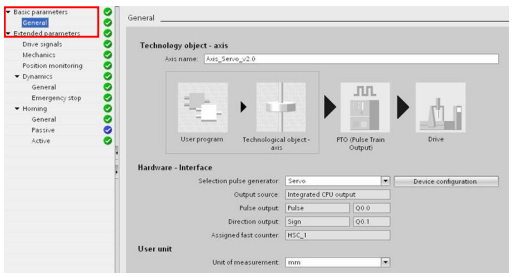
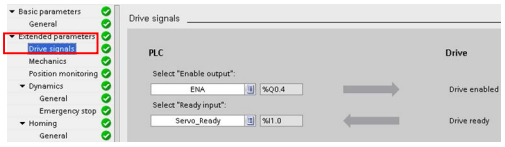
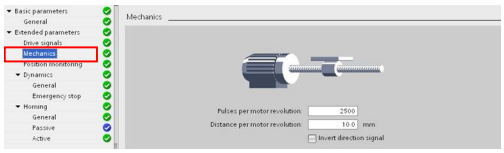
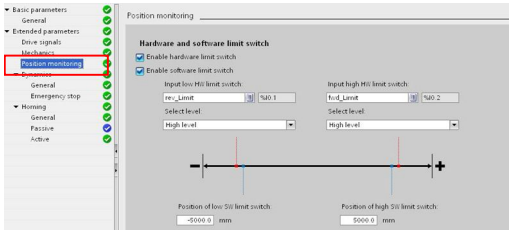
In this project, all parameters for the technology object “Axis” are already defined. For better understanding, the table below provides more detailed information on the configuration of this object.

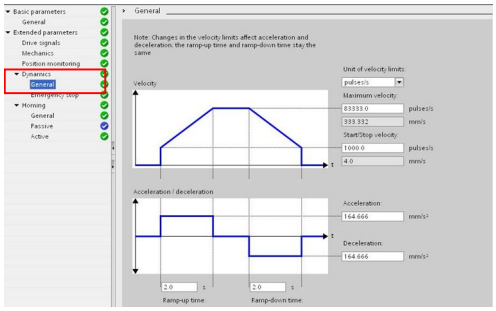
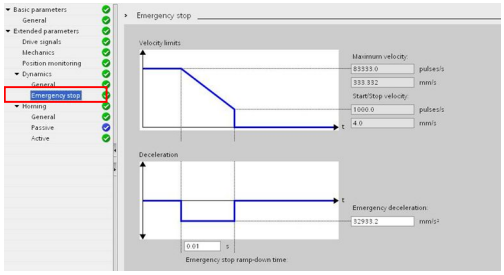
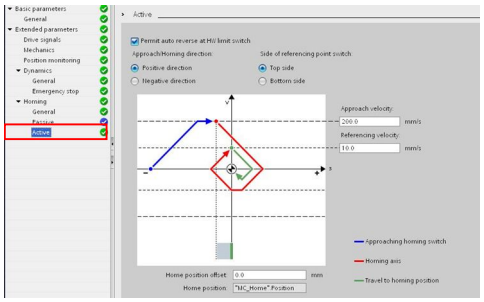
ATTENTION If necessary, the parameters “Pulses per revolution”, “Max. velocity” and “Start/stop velocity” have to be adapted individually, depending on the servo drive or motor used (see chapter 2.5).

Depending on the real axis used, the mechanical limits of the axis must also be adjusted.

Table 3-4

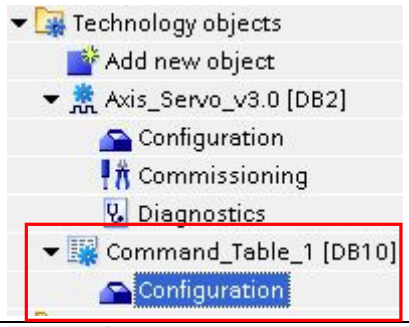
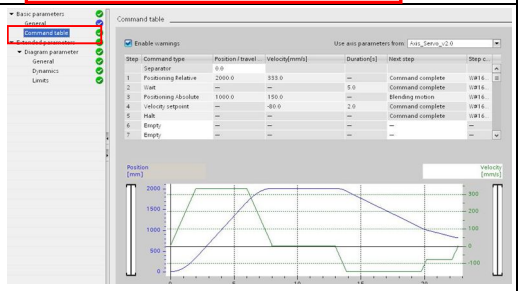
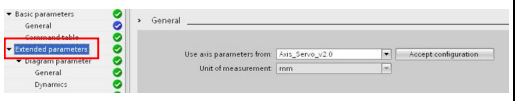
No.	Instructions	Note / screen
1.	In the Project Tree, select the technology object „Axis_Servo_v3.0“ and double-click “Configuration”.	

No.	Instructions	Note / screen
2.	Click “Basic Parameters” → “General” • Define the name of the axis: **Axis_Servo** • Select the pulse interface according to the device configuration: **Servo** • Select the unit of measurement: **mm**	
3.	“Extended Parameters” → Drive signals Used to enable/disable the servo drive and managed by “MC_Power” • Select the enable output according to the connection diagram: **Q0.4 ENA** • Select the ready input according to the connection diagram: **I1.0 Servo_Ready** If the servo drive does not supply a “Ready” signal, the value **TRUE** has to be entered here.	
4.	“Extended parameters” → Mechanics Define the motor limits and conversion of pulses into a length unit • pulses per motor revolution: **2500** • Distance per motor revolution: Enter a distance to be traveled per motor revolution, e.g. with a slide on a spindle **(e.g. 10mm)**. • Invert direction signal: Exchanges “forward” by “backward”.	
5.	“Extended parameters” → Position monitoring Definition of hardware and software limit switches, their position and switching performance • Enable both hardware and software limit switches. • Define the hardware limit switches according to the connection diagram and define whether they are used as NC contacts or as NO contacts (e.g. **I0.1 and I0.2, Active level → High)** • Define the position of the software limit switches according to the mechanical limits of your axis (e.g. **-5000 mm to 5000mm)**	 When the axis is homed, it is moved within the limits of the software limit switches. When the software limit switches are reached, the axis will be decelerated to a standstill. In case of overtravel and when the axis is not homed, the hardware limit switches bring the axis to a standstill at emergency deceleration.

No.	Instructions	Note / screen
6.	“Extended parameters” → Dynamics General Setting of velocity limits, acceleration, deceleration (see chapter 2.3) • Enter the maximum velocity in pulses/second: **83,333 pps** • Enter a permissible start/stop velocity (pulses/second): **1000 pps** • Enter the acceleration and deceleration in mm/s²; as an alternative you may also enter the ramp-up and ramp-down time in seconds: **e.g. 2s → 164.6mm/s²** Automatic conversion to mm/s².	
7.	“Extended parameters” → Dynamics Emergency stop • Enter an emergency deceleration or a ramp-down time to stop the axis the hardware limit switches have been overtraveled or to stop the axis when disabled by “MC_Power” (e.g. **0.01s → 32933mm/s²)**	
8.	“Extended parameters” → Homing General • Define the reference point switch according to the connection diagram (**I0.0 RPS**) • Level selection: **High level**	
9.	“Extended parameters” → Homing Active • Enable the permit for auto reverse at the HW limit switch (see chapter 2.6.5 – case 3) • Select the approach direction: **positive** • Select the **top side** of the referencing point switch as detection point. • Define the approach velocity (fast velocity for reference point switch search): **200 mm/s** • Define the referencing velocity (slow velocity for the falling edge of the referencing point): **10 mm/s** • Define the home position offset: **0.0 mm** The home position coordinate (position to be applied in case of successful homing) is parameterized in the “MC_Home” block.	

3.5 Parameterizing the Technology Object “CommandTable”

Table 3-5

No.	Instructions	Note / Screen
1.	Select the technology object “Command_Table_1” in the Project Tree and double-click “Configuration”	
2.	Click “Basic parameters” → “Command table” • Enable warnings • Use axis parameters from: **Axis_Servo_v3.0** • Define the sequence of move operations in the table	
3.	“Extended parameters” Accept the configuration settings for the technology object **Axis_Servo_v3.0**	

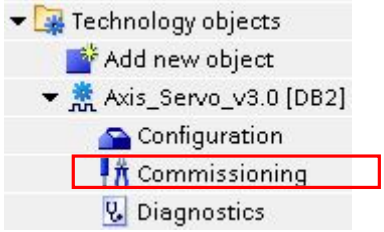
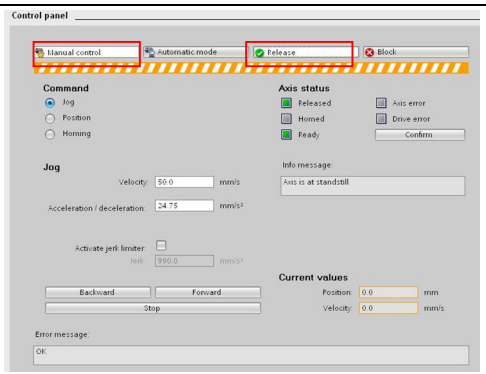
3.6 Software download

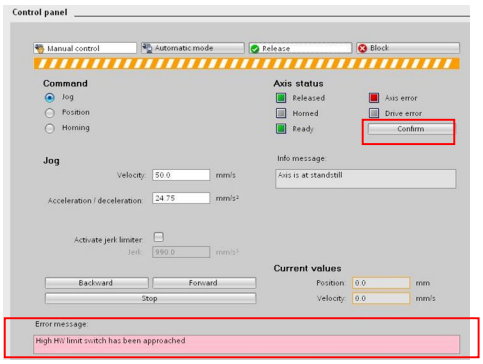
No.	Instructions	Note / screen
1.	Download the fully parameterized project to the controller. • Select the program blocks and click the “Download to Device” icon or • Click “CE-X7_v11d2d5_PLC” with your right mouse button and select “Download to device” → “Software” • After downloading, set the CPU to “RUN”	

3.7 Commissioning and diagnosis of the axis with the technology object

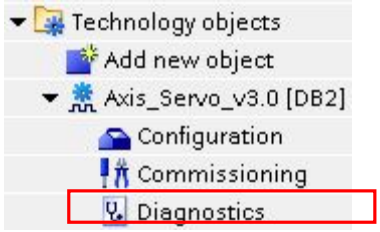
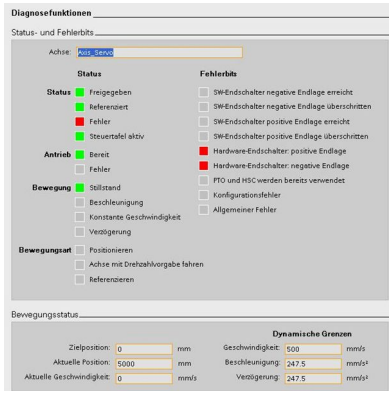
This chapter describes how you can test and diagnose the proper functioning of the servo drive by using the online function of the “Axis” technology object.

Commissioning

No.	Instructions	Note / screen
1.	Double-click “Technology objects” → “Axis_Servo_v3.0” → “Commissioning”	
2.	• Select “**Manual control**” → the CPU will automatically be set to online mode • Then select “Release” to enable the servo drive	
3.	You are now in **jog mode** • Define the velocity and the acceleration/deceleration • Click “Backward” or “Forward”	The axis accelerates at the specified acceleration speed and moves at the specified velocity as long as the button is kept pressed. Then, the axis will be brought to a standstill at the specified deceleration.
4.	Change over to “**Positioning**” mode • Define the velocity and the acceleration/deceleration • Define a “distance” (+/-) for “relative” motion of the axis • Define a “destination” (+/-) for “absolute” motion of the axis Please note: Absolute motion of the axis is possible only if it has been homed.	From the current position, the axis moves along the specified distance. The axis moves to the specified position.

No.	Instructions	Note / screen
5.	Change over to “**Homing**” mode • Define a home position and an acceleration/deceleration. • Start homing.	The axis moves in the defined direction until the reference point switch or hardware limit switch is detected. When the negative edge of the reference point switch is detected, the axis will be stopped and the specified home position will be applied as the current position.
6.	**Error** If an error is pending, you can perform a reset by clicking the “Confirm” button. You may, for example, simulate an error by actuating a hardware limit switch. The respective last error message will be displayed in the bottom line.	

Diagnosis

No.	Instructions	Note / Screen
1.	Double-click “Technology objects” → “Axis_Servo_v3.0” → “Diagnostics”.	
2.	When the CPU is in online mode, all currently pending status and error messages are displayed here. After recovery, “MC_RESET” can be used to acknowledge **software errors**. For a list of possible software errors, please refer to the STEP7 Basic online help.	
3.	**Drive alarm** After an emergency stop or another fault event identified by the servo drive, a reset is necessary.	The display of the servo drive shows Axx (see the V60 manual for more details) The servo drive is disabled and an alarm message bit is set.
4.	Eliminate the fault. • Reset the alarm • Reactivate the servo drive	

No.	Instructions	Note / Screen
5.	Some fatal faults can only be eliminated by “power off reset”. To do this, switch the servo drive off and restart it after a short time.	

Note The “Axis” technology object creates a global data block in which all parameters and the current axis status is stored.

In the user program, these values can be accessed during runtime by specifying the symbolic name of the axis.

3.8 Operation with WinCC Runtime Simulation

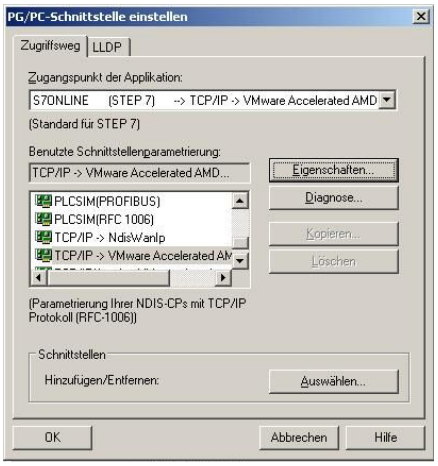
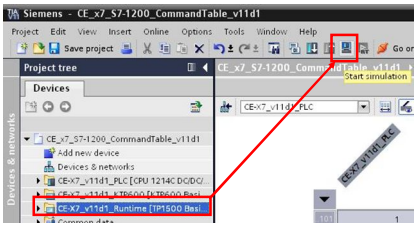
Apart from the controller programming functions, STEP 7 Basic V11 also offers functions for the visualization of a project. The software supports all basic panels with Ethernet interface presently available.

If no panel is at hand, it can be simulated by the integrated PC Runtime program.

For convenient operation of the project, an HMI project has been integrated which can also be simulated with PC Runtime.

To make the simulation executable, proceed as follows:

Table 3-6

No.	Action	Note / screen
1.	Change over to the control panel of your programming unit and set the PG/PC interface as follows: • Access point: S7Online • Interface: TCP/IP -> “Your network adapter”	
2.	Return to the STEP 7 Basic project	*.al11
3.	• Select “CE-X7_v11d2d5_Runtime” in the Project Tree • Then click the “Start simulation” icon	

PC Runtime enables you to test all features described in this documentation. All important status messages are displayed. If an error occurs, a message text will be displayed.

I/O fields highlighted in blue are read-only fields. The I/O fields highlighted in yellow are available for data entry.

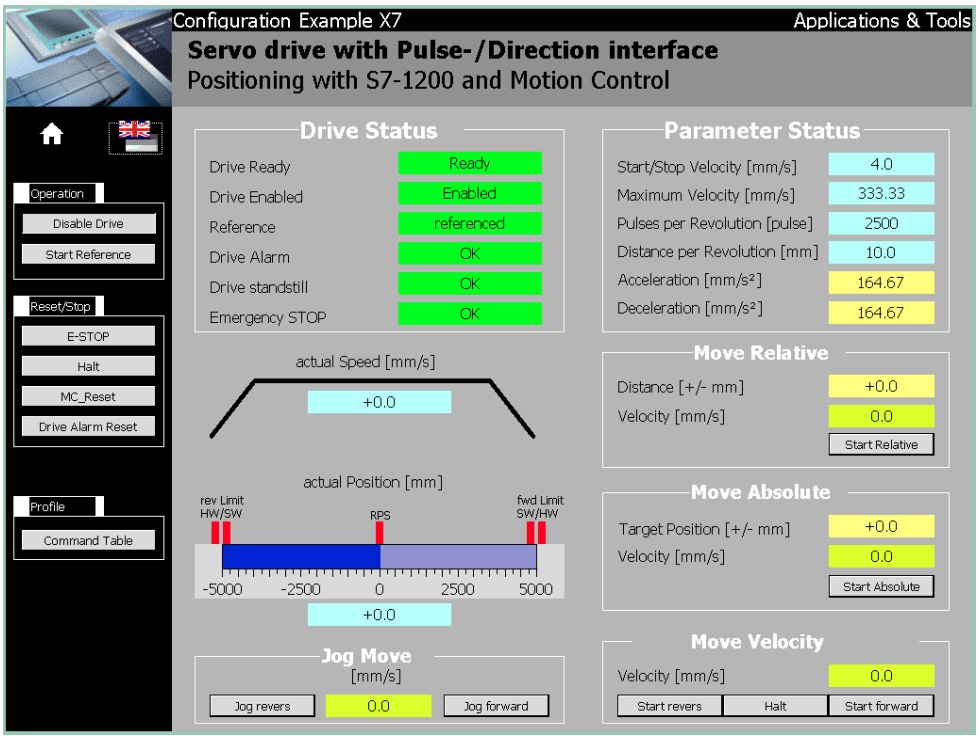
The bar chart indicates the position of the axis. The displayed ramp shows whether the axis is accelerating, decelerating or if it is moving at a constant velocity.

Flashing buttons indicate that an action must be performed.

At the beginning of visualization, the start-up screen of the application appears (Figure 3-1). Here you can choose between German or English language. Click the “?” symbol to open the quick help function for the application. Click “Start application” to open the user interface (Figure 3-2).

Figure 3-1

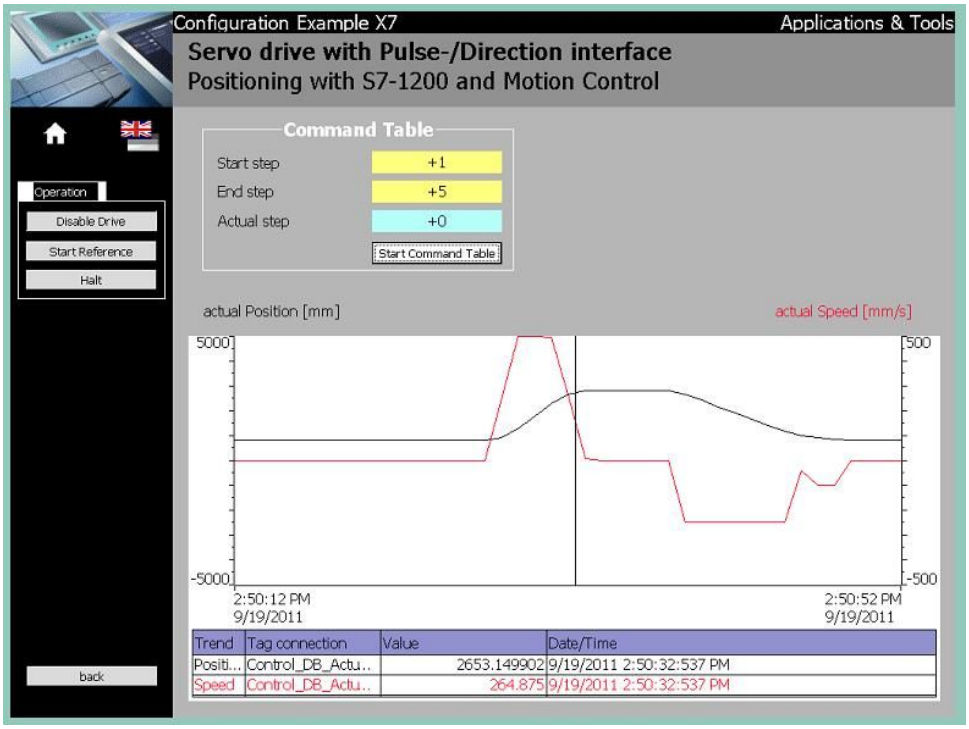
Figure 3-2



Click “Command Table” to start positioning along the configured sequence of movements as shown in Figure 3-2. When having entered the start step and end

step, the profile can be tracked (Figure 3-3). The curve diagram shows the current position and the actual velocity.

Figure 3-3



Note There is also a configuration for a KTP600 basic panel available.

4 Code Elements

The following software examples are also available via the HTML page from which you have downloaded this document.

Table 4-1

No.	File name	Content
1.	CE_x7_S7-1200_SINAMICS_V60_v11d2d5.zip	STEP 7 Basic V11 SP2 Upd5 project with CPU firmware V2.2 and Motion Control V3
2.	CE_x7_S7-1200_SINAMICS_V60_v12d1d4.zip	STEP 7 Basic V12 SP1 Upd4 project with CPU firmware V3 and Motion Control V3
3.	CE_x7_S7-1200_SINAMICS_V60_v13d0d2.zip	STEP 7 Basic V12 SP1 Upd4 project with CPU firmware V4 and Motion Control V4

5 History

Version	Date	Revisions
V11.2	23.01.2012	First issue for STEP 7 Basic V11 SP2 and SINAMICS V60
V11.2.5	18.07.2014	• Revision of chapter 2.1, 2.2, 2.4, 2.5 • Revision of STEP 7 Basic V11 SP2 project (minimizing the acquisition cycle of the HMI tags) • Addition of STEP 7 Basic V12 SP1 Upd4 project with CPU firmware V3 and Motion Control V3 • Addition of STEP 7 Basic V13 Upd2 project with CPU firmware V4 and Motion Control V4