HMK Automation & Drives

Setup Guide

SINAMICS V90 and S7-1200 PLC with Pulse Train Control

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Contents

1 Introduction

1.1 HMK Automation & Drives

HMK Automation & Drives is the largest Integrated Drive Systems provider in the UK. We offer a diverse range of general and high performance variable speed drives, motors, gearboxes and other mechanical components as well as complete hardware & software solutions.

With a myriad of standard applications, fully supported with real world drives experience and an extensive mechanical offer, HMK Automation & Drives is uniquely positioned to support and partner OEMs and System Integrators alike.

The systems offered by HMK make the specification, purchase, implementation, operation and maintenance of any drive system faster and easier than ever before. HMK provides a single point of contact for all our customers' needs. We offer true added value, greater reliability, higher efficiency and superior productivity in any automation environment and throughout the entire life cycle.

Our Key global supplier partners represent the very best products and technologies within the automation market today

Engineering Team

HMK's engineering team is experienced with a broad range of automation products, including Siemens Simotion, SINAMICS S, SINAMICS G, SINAMICS V, SIMATIC S7-1500, S7-1200, S7-400, S7-300 PLCs and HMIs.

As well as delivering training courses, HMK engineers develop drive-based solutions for customer and can assist with on-site commissioning and trouble shooting.

Further Information

HMK's website contains information on our products and services, as well as links to product documentation. The website also has enquiry forms and a live chat tool.

http://www.hmkdirect.com/

Location

HMK Automation & Drives is located in Congleton, Cheshire.

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Further Information

HMK's website has contact details for both of our sites.

http://www.hmkdirect.com/contact/

Further Information

Google Maps link for Kappa House.

https://goo.gl/maps/1Md93

Further Information

Google Maps link for Radnor Park.

https://goo.gl/maps/WH5i3

1.2 Aim Summary

The purpose of this document is to guide the user through the set-up for control of a SINAMICS V90 drive using S7-1200 PLC technology objects via pulse train output (PTO). Included is a guide to wiring, drive configuration, drive tuning and commissioning, S7-1200 configuration, and programming. This document is supported by a series of screen casts, which can be viewed by scanning the QR code at the bottom of this page.

What you will need:

See the table below for required and optional items needed to complete this application demo. You will also need a PG/PC with V-ASSISTANT and TIA Portal installed. V-ASSISTANT is a free software package from Siemens.

Note In order to commission single-phase SINAMICS V90 units, a minimum V-ASSISTANT version of 1.03.00 is required.

Item No.	Description	QTY	Application Part Number	Optional
1	SINAMICS V90 Drive Unit	1	6SL3210-5FB10-1UA0	-
2	SINAMICS V90 Control Cable (50 Core, MDR Connector)	1	6SL3260-4NA00-1VB0	-
3	USB-to-USB Micro Cable	1		-
4	SINAMICS V90 Motor Power cable	1	6FX3002-5CK01-1AD0	-
5	SINAMICS V90 Motor Feedback cable	1	6FX3002-2CT20-1AD0	-
6	Motor	1	1FL6024-2AF21-1AA1	-
7	S7-1200 PLC	1	6ES7214-1AG40-0XB0	-
8	S7-1200 Signal Board (DI 4x24VDC)	1	6ES7221-3BD30-0XB0	Yes
9	24 VDC Power Supply	1	6EP1332-1SH43	-
10	Estop Button	1		-
11	Homing Switch (Normally Open)	1		Yes
12	Clockwise Limit Switch (Normally Closed)	1		Yes
13	Counter-Clockwise Limit Switch (Normally Closed)	1		Yes

V-ASSISTANT Download

Download the free SINAMICS V90 commissioning tool from the Siemens Website.

https://support.industry.siemens.com/cs/document/109738387

Screen Casts

HMK's website contains information on our products and services, as well as links to product documentation. The website also has enquiry forms and a live chat tool.

https://www.hmkdirect.com/products/drives/discontinuous-motion/basic/sinamics-v90/

2

Application Wiring

2.1 Application Wiring Diagram

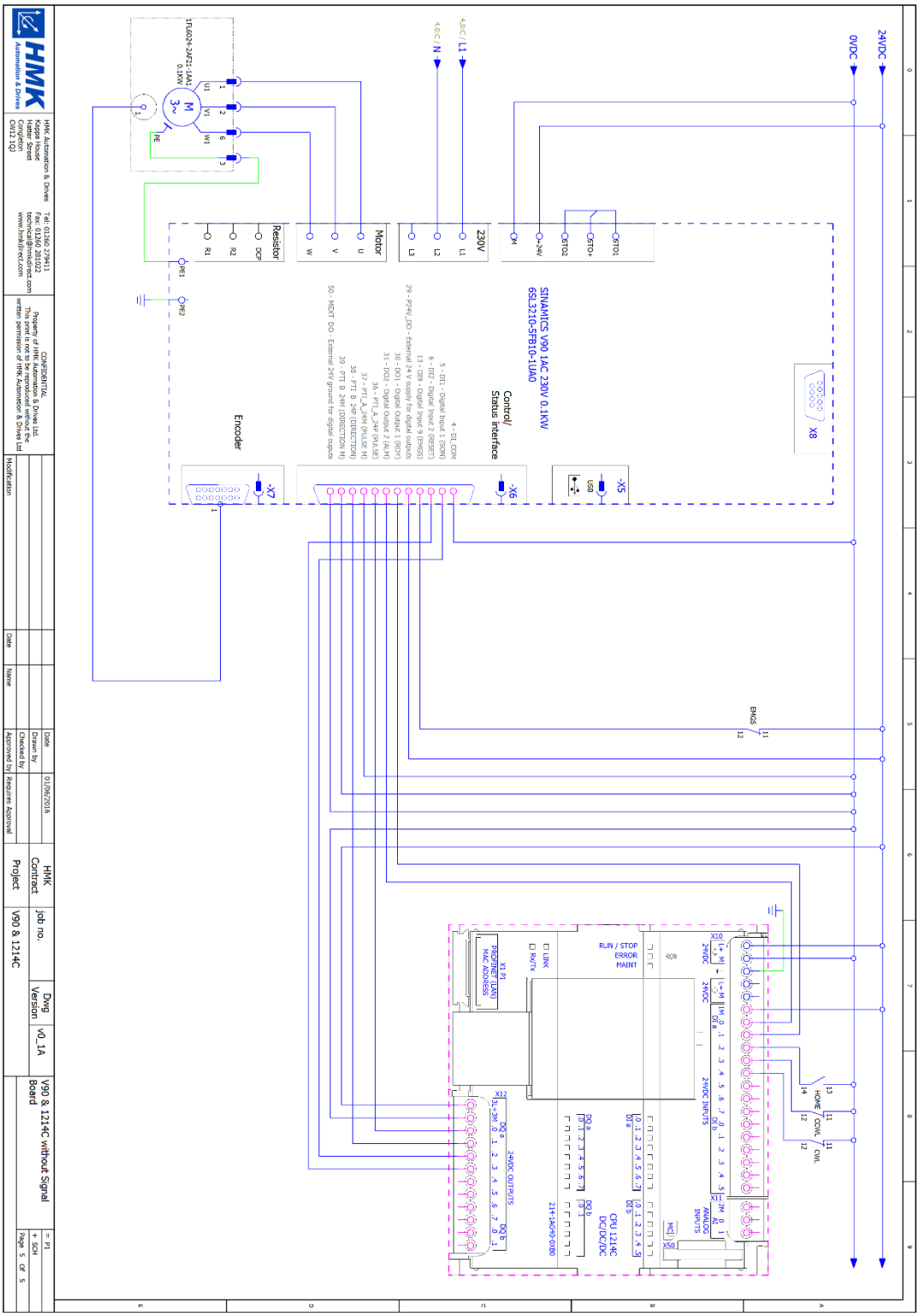
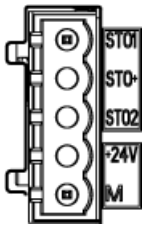


Figure 1 - Application Wiring Diagram

Note If the signal board is to be used then please refer instead to the wiring diagram in Appendix A0.

2.2 E-Stop Wiring for On-board SINAMICS V90 STO

If you wish to wire your estop to perform a safe torque off (STO), rather than an OFF3/fast-ramp stop (as per this application demo) then you will need to wire +24VDC to the EMGS input of the SINAMICS V90, and wire your estop directly to the STO interface of the SINAMICS V90, as shown below.

Interface	Signal Name	Description
	STO 1	Safe torque off channel 1
	STO +	Specific power supply for safe torque off
	STO 2	Safe torque off channel 2
	+24 V	Power supply, 24 VDC
	M	Power supply, 0 VDC
	Maximum conductor cross-section: 1.5mm^2	

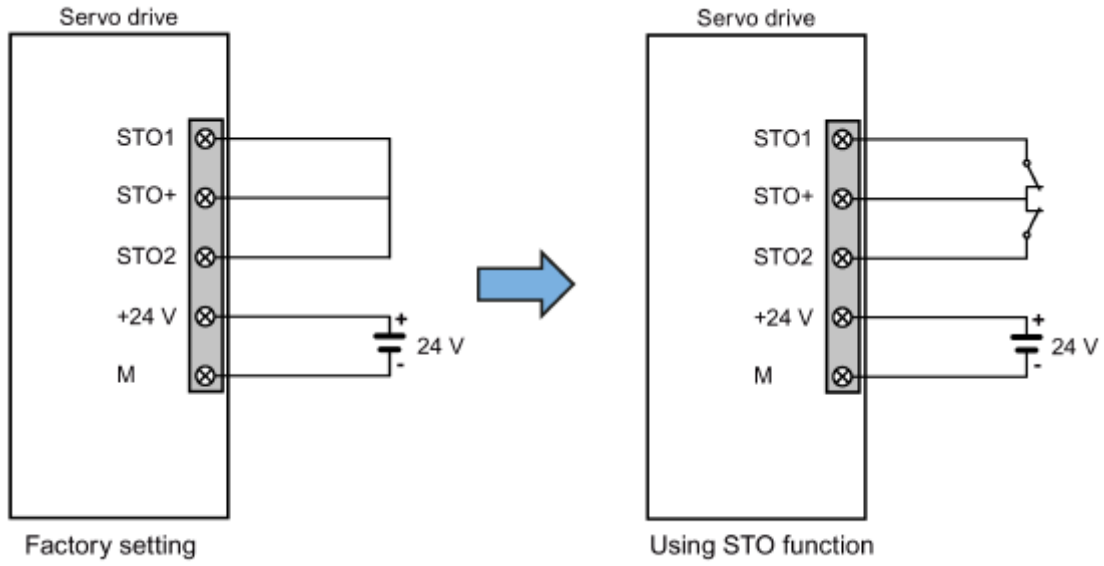


Figure 2 - SINAMICS V90 E-Stop STO Wiring

Note The safe torque off (STO) function can stop a motor using safety relays without involving any upper level control. It is disabled in the factory configuration by short-circuiting the STO
terminals. The safety function of the servo drive is SIL 2 (EN61800-5-2). Connect the STO terminals as the actual requirements.

Further Information

The V-ASSISTANT Manual contains more detailed information about the V-ASSISTANT software and the commissioning of a SINAMICS V90 drive. Download V-ASSISTANT at:

https://support.industry.siemens.com/cs/gb/en/view/109480674

3 Drive Configuration

3.1 Inserting the Drive

To start, attach the SINAMICS V90 drive to the PG/PC using a mini USB cable, and open V Assistant. The following window will appear (it may take a few seconds to recognise the drive). Select the drive form the online list, and select OK.

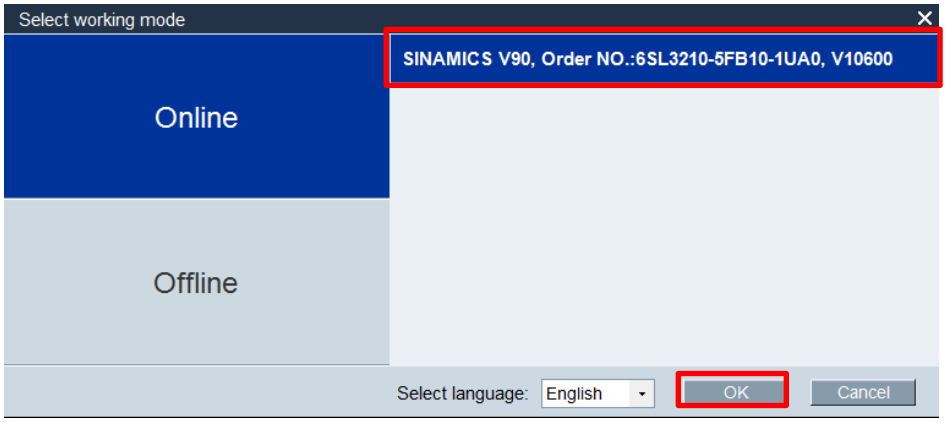


Figure 3 - Insert Drive

Use the button highlighted below to open the motor selection window. Select the motor based on the part number.

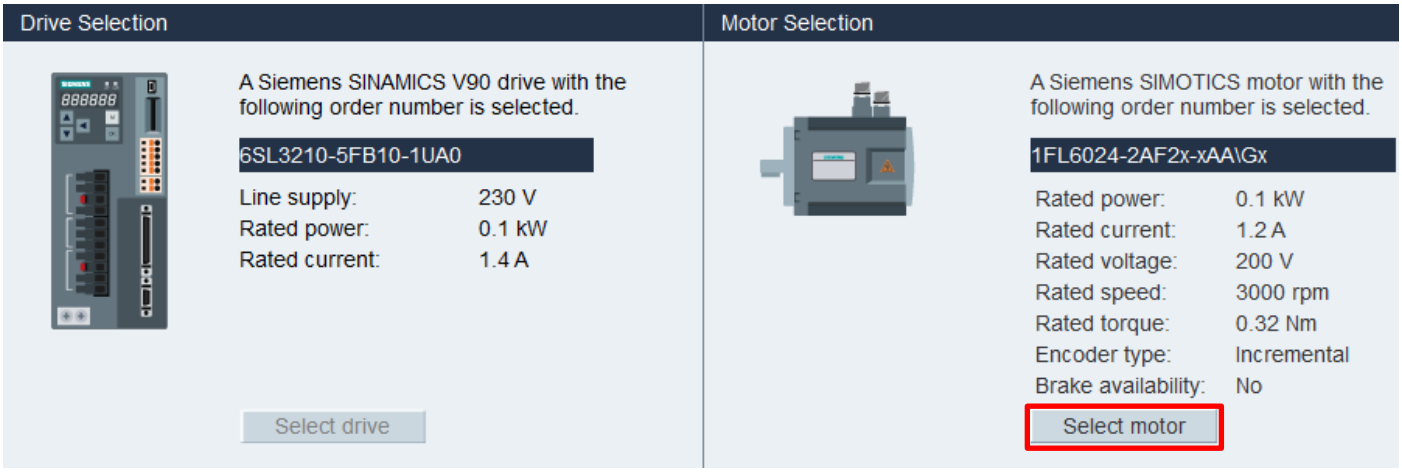


Figure 4 - Select Motor

Once, the motor has been selected, set the control mode to Pulse Train Input (PTI) from the drop down box:

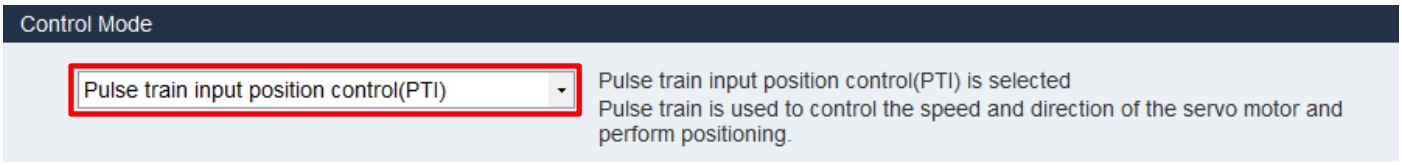


Figure 5 - Select Control Mode

3.2 Configuring the Drive

Setting the Pulses per Revolution (PPR)

The drive needs to be told how many pulses it will receive to perform one revolution of the motor shaft. This value needs to be scaled based on the maximum speed, and the maximum pulse frequency the PLC can output:

$$ppr_{max} = \frac{60 \times f_{max}}{n_{max}}$$

Where n_{max} is the maximum speed of the motor, or mechanics in rpm and f_{max} is the maximum pulse frequency available from the selected PTO output (see Appendix A1.1). E.g. for a max speed of 5000 rpm, with a maximum pulse frequency of 100KHz, the ppr = 1200.

Once calculated, this value needs to be entered into p29011, which is accessible via the 'Set electronic gear ratio' sub-tab, under the 'Parameterize' tab.

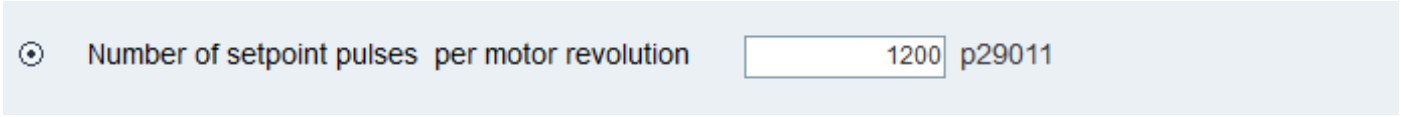


Figure 6 - Set Motor PPR

Signal Selection

Ensured that the 'Signal form selection' is set to 'Pulse + Direction Positive', and that the 'Signal level selection' is set to '24V single end'. Both can be found in sub-tab 'Set parameter setpoint', under tab 'Parameterize'.

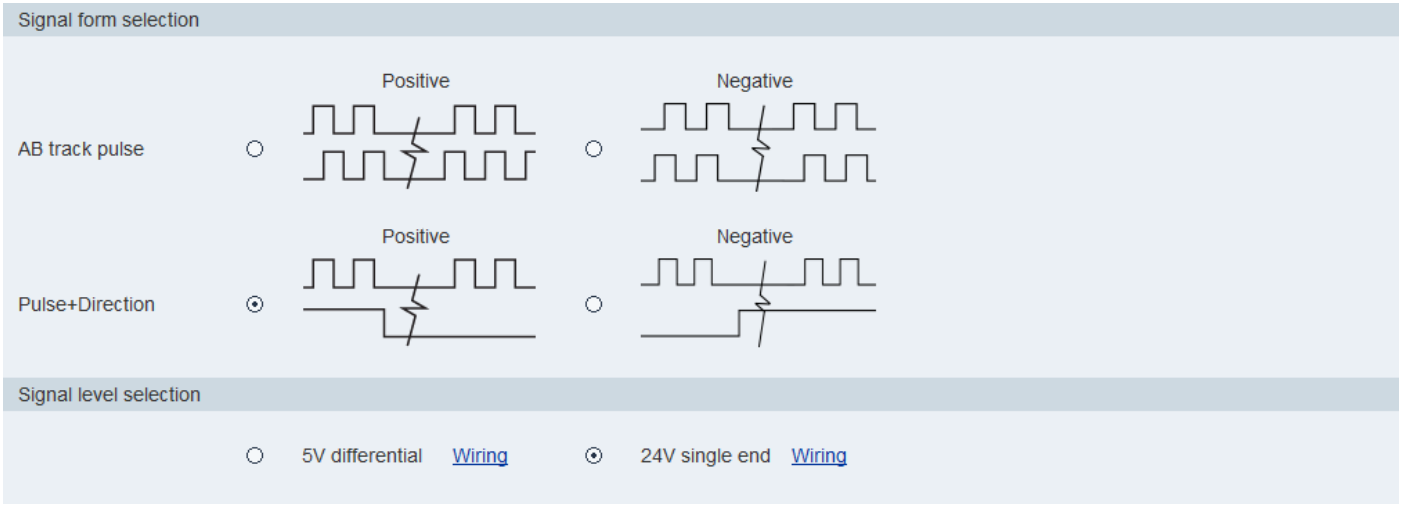


Figure 7 - SINAMICS V90 Signal Selection

Assigning the Digital Inputs

To assign DI, select the cell located in the column of the required DI and the row of the required parameter, and select 'Assign' from the drop-down list. To remove assignments, select the existing assignment and select 'Cancel' form the drop-down list.

As default, a number of DI assignments are set which are not of use in this example. Make the following assignments in the 'Configure inputs/outputs' sub-tab, under the 'parameterize' tab:

Digital input | Digital output | Analog output

Ports	DI 1	DI 2	DI 3	DI 4	DI 5	DI 6	DI 7	DI 8	DI 9	DI 10	Set to 1
SON	Assign										☐
RESET		Assign									
CWL											☑
CCWL											☑
G_CH...											
CLR											
EGEA...											
EGEA...											
TLIM1											☐
TLIM2											
SLIM1											
SLIM2											
EMGS									Assign		☐
C_MO...										Assign	

Figure 8 - Assign Digital Inputs

CWL and CCWL (clockwise and counter-clockwise limits) are the inputs for the drive hardware limits. For this example, we are going to wire the CW and CCW hardware limits to the PLC and link these to the technology object for the axis. The benefit of this method over wiring directly to the SINAMICS V90

inputs is that this will allow the PLC program to see the state of the hardware limits, and react to them accordingly.

Ensure to tick the checkboxes for CWL and CCWL in the “Set to 1” column. This tells the SINAMICS V90 that the drive hardware limits are always in the “healthy” state.

Use the table in the following section to relate DI number to the associated pin of the 50-pin MDR connector (X8 Interface).

Assigning the Digital Outputs

The DO are assigned in the same fashion as the DI. The default DO assignments are suitable for use in this example. Please ensure that the digital outputs match below:

Ports	DO 1	DO 2	DO 3	DO 4	DO 5	DO 6
RDY	Assign					
FAULT		Assign				
INP			Assign			
ZSP						
TLR					Assign	
SPLR						
MBR						Assign
OLL						
WARNING1						
WARNING2						
CM_STA						
RDY_ON						

Figure 9 - Assign Digital Outputs

Use the following table to relate DO number to the associated pin of the 50-pin MDR connector (X8 Interface).

DI	X8 Pin	Description	DO	X8 Pin	Description
DI 1	5	Digital Input 1	DO 1	30	Digital Output 1
DI 2	6	Digital Input 2	DO 2	31	Digital Output 2
DI 3	7	Digital Input 3	DO 3	32	Digital Output 3
DI 4	8	Digital Input 4	DO 4	33	Digital Output 4
DI 5	9	Digital Input 5	DO 5	34	Digital Output 5
DI 6	10	Digital Input 6	DO 6	35	Digital Output 6
DI 7	11	Digital Input 7			
DI 8	12	Digital Input 8			
DI 9	13	Digital Input 9			
DI 10	14	Digital Input 10			

Jog the Motor

Once the above steps are complete, it will be possible to jog the drive using the control panel on the 'select drive' screen. Select the 'Servo on' button to enable the drive, this will open a dialogue box which requires the user aknolwegement before the drive will become enabled. A speed can then be entered, and the motor can be run using the forward and reverse buttons.

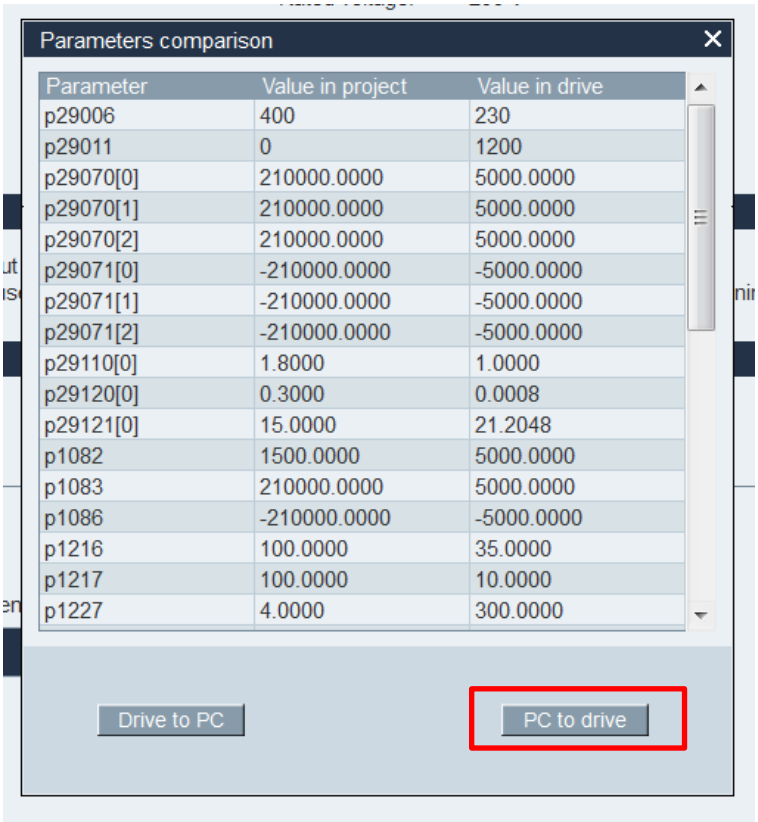
Note At this point it is assumed that the SINAMICS V90 drive has an AC supply, the safety inputs are healthy, and that it is safe to move the axis.

Figure 10 - Jog Motor

Save Parameters to ROM

All changes that are made whilst online to the drive will be saved in the drive units RAM (volatile-memory). This means that these changes will be lost if the drive loses power. In order to save the changes made to the drive, you will need to perform the 'Save Parameters to ROM' function in order to save the parameters to the non-volatile memory in the drive. Do this by selecting 'Tools' form the menu bar, and clicking on 'Save Parameters to ROM', alternatively, you can click the appropriate button from the toolbar  .

If the project was configured offline, the new parameter set will need to be downloaded to the drive. To do this, connect the drive to the PG/PC via USB, and select  from the tool bar to go online. V ASSISTANT will then scan the parameters currently in the drive and compare them to what is in the project and provide the user with a list of differences:



Select PC to drive to copy the parameter set to the drive. Once this is complete, perform a 'save parameters to ROM' as described above.

3.3 Tuning the Drive

Optimizing the Drive

The SINAMICS V90 supplies two auto-tuning modes: one-button auto tuning and real-time auto tuning. The auto tuning function can optimize control parameters with ratio of machine load moment of inertia (p29022) and set suitable current filter parameters to suppress the machine resonance automatically. You can change the dynamic performance of the system by setting different dynamic factors.

The tuning section is found in the Optimize Drive section of the Commission tab within V-ASSISTANT.

Note For more tuning methods including the one-button auto-tuning, see appendix A4.

Real-Time Auto-Tuning

Real-time auto tuning estimates the machine load moment of inertia automatically while the drive is running with the host controller command. After enabling the servo on (SON), the real-time auto tuning

function stays effective for the servo drive. If you do not need to estimate the load moment of inertia continuously, you can disable the function when the system performance is acceptable.

Note Under operating conditions that impose sudden disturbance torque during acceleration/deceleration or on a machine that its rigidity is poor, auto tuning may not function properly, either. In such cases, use one-button auto tuning or manual tuning to optimize the drive.

Pre-conditions for Real-Time Auto-Tuning

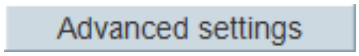
- The drive must be under the control of the host controller.
- The machine actual load moment of inertia is different when the machine moves to the different positions.
- Make sure that the motor has multiple accelerations and decelerations. Step command is recommended.
- Machine resonance frequency changes when the machine is running.

Implement Real-Time Auto-Tuning

1. Select the dynamic factor in the following area:

Figure 11 - Set Tuning Dynamic Factor

2. Click on the following button to configure the parameters for the real-time auto tuning function.



Selecting the Dynamic Factor

Refer to the 'Real-Time Auto Tuning' chapter 9.4 (p256) from 'SINAMICS V90, SIMOTICS S-1FL6 Operating Instructions' for more detailed information.

https://support.industry.siemens.com/cs/gb/en/view/109480673

3. Set the parameters in the window below:

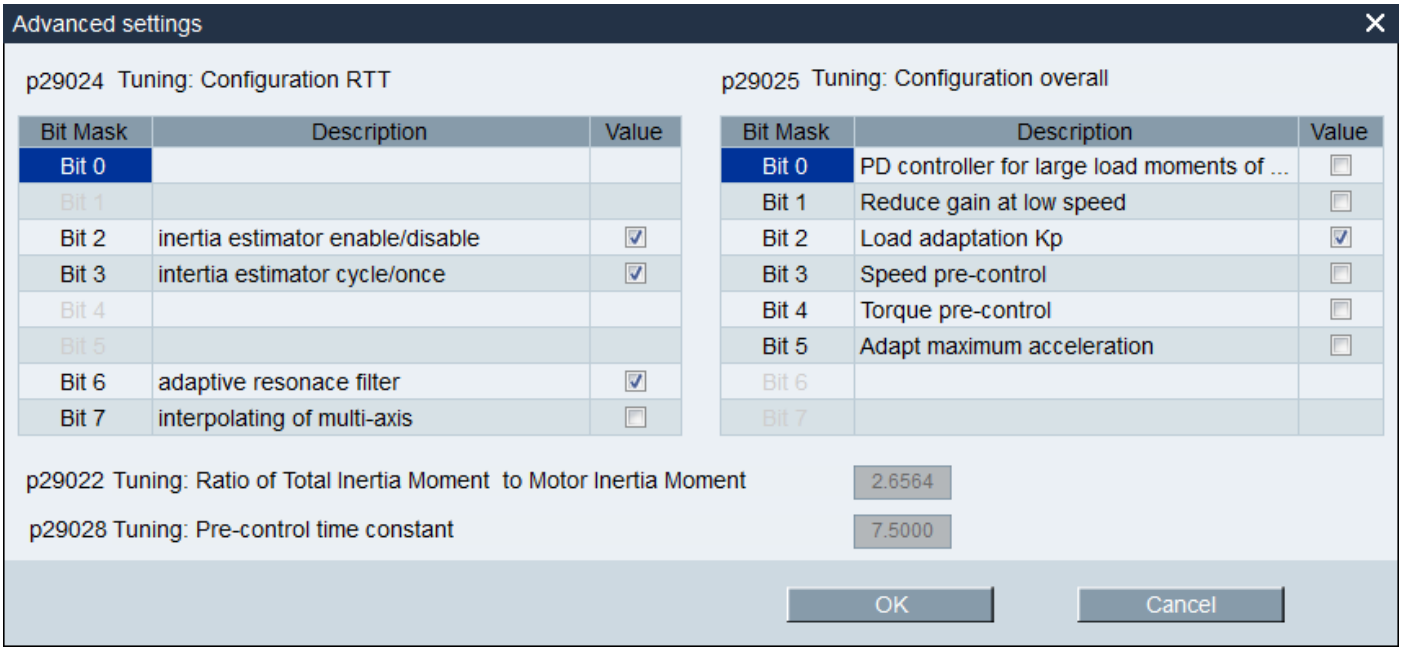
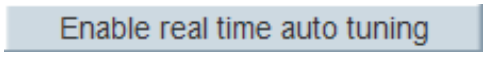


Figure 12 - Set Tuning Advanced Settings

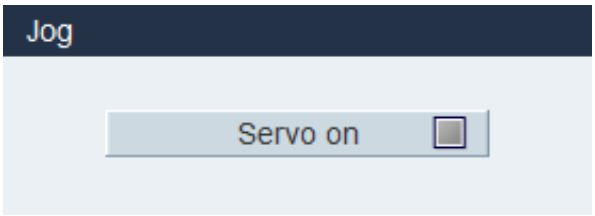
Set the ratio of machine load moment of inertia (p29022) with either of the following methods:

- Enter it manually if the ratio is known.
- Use the ratio of machine load moment of inertia estimated by the one-button auto tuning function directly.
- Estimate the ratio with the real-time auto-tuning (p29024.2 = 1). When you have executed the tuning many times and have obtained a stable value of p29022, you can stop estimating it by setting p29024.2 = 0.

4. Click the following button to enable the tuning function after the parameters have been set.



5. Perform the servo on for the drive via the host controller to start the tuning.
   For example, you can use the following method to run the motor:
   Implement servo on for the drive with the Jog function in V-ASSISTANT.



Enter a speed for the motor and press and hold a direction button to run the motor.

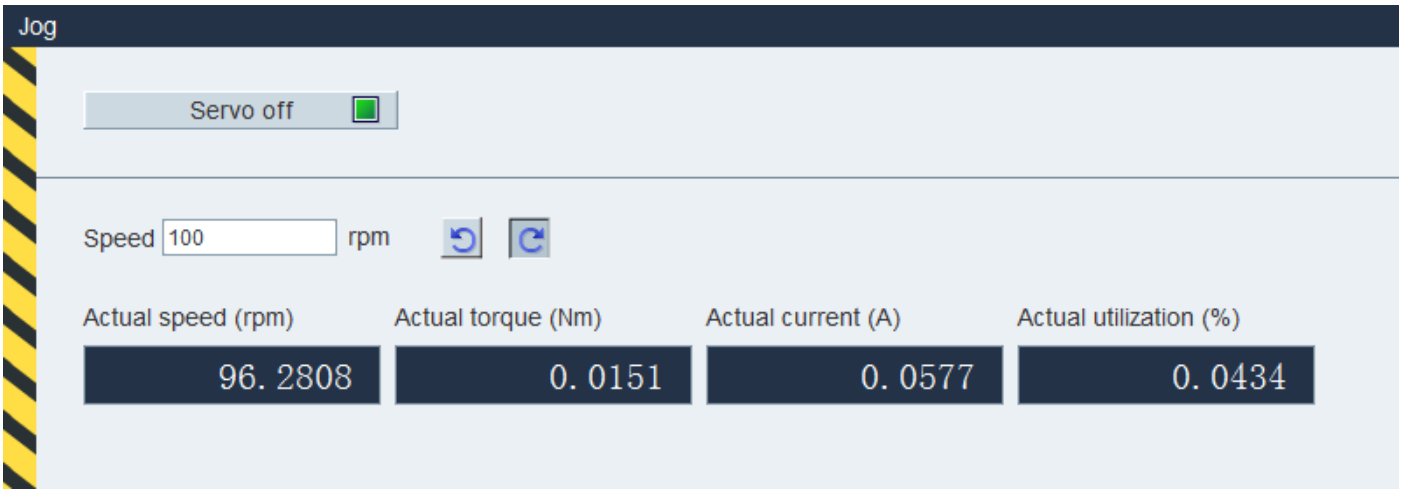


Figure 13 - Jog Motor from Control Panel

6. To achieve the desired system performance, you can change the dynamic factors or related configuration parameters during tuning.
7. If the drive performance is acceptable, disable the tuning function by servo off and set p29021 = 0.
8. Copy the tuned parameters from RAM to ROM to save them (see section 3.1, 'Save parameters to ROM').

4 Controller Configuration

4.1 S7-1200 Configuration

Adding a new device

When a new project is first created, TIA portal will change to the "Devices and networks" tab of the portal view. New devices can be added by clicking on "Add new device", selecting the type of device (Controller, HMI, PC system or Drive) and then traversing down the product tree until the exact part number of the device is found. The firmware version of the device must match that of the actual hardware.

Note New part numbers and firmware versions may require the latest version of TIA portal. If the hardware that you have is not available from the list, then TIA portal may need to be updated.

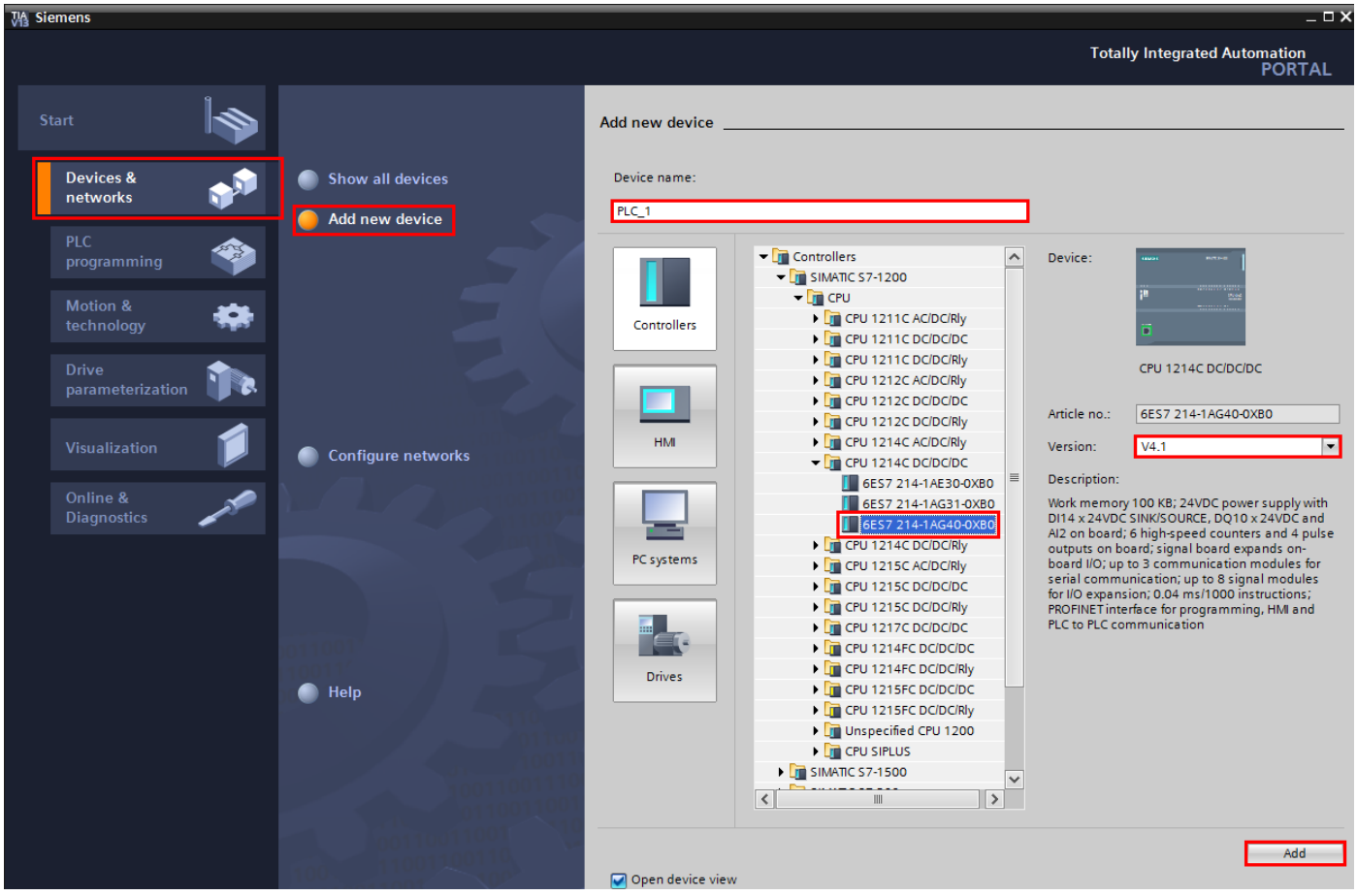


Figure 14 - Add New Device

The name of the new device can then be modified and the device added to the project with the “Add” button.

Devices can also be added in this way from the “Project View” by double clicking “Add new device” in the project tree.

Alternatively devices can be added by navigating to the “Devices & networks view” and dragging the relevant part number from the “Hardware catalogue” to empty space in the “Network view”.

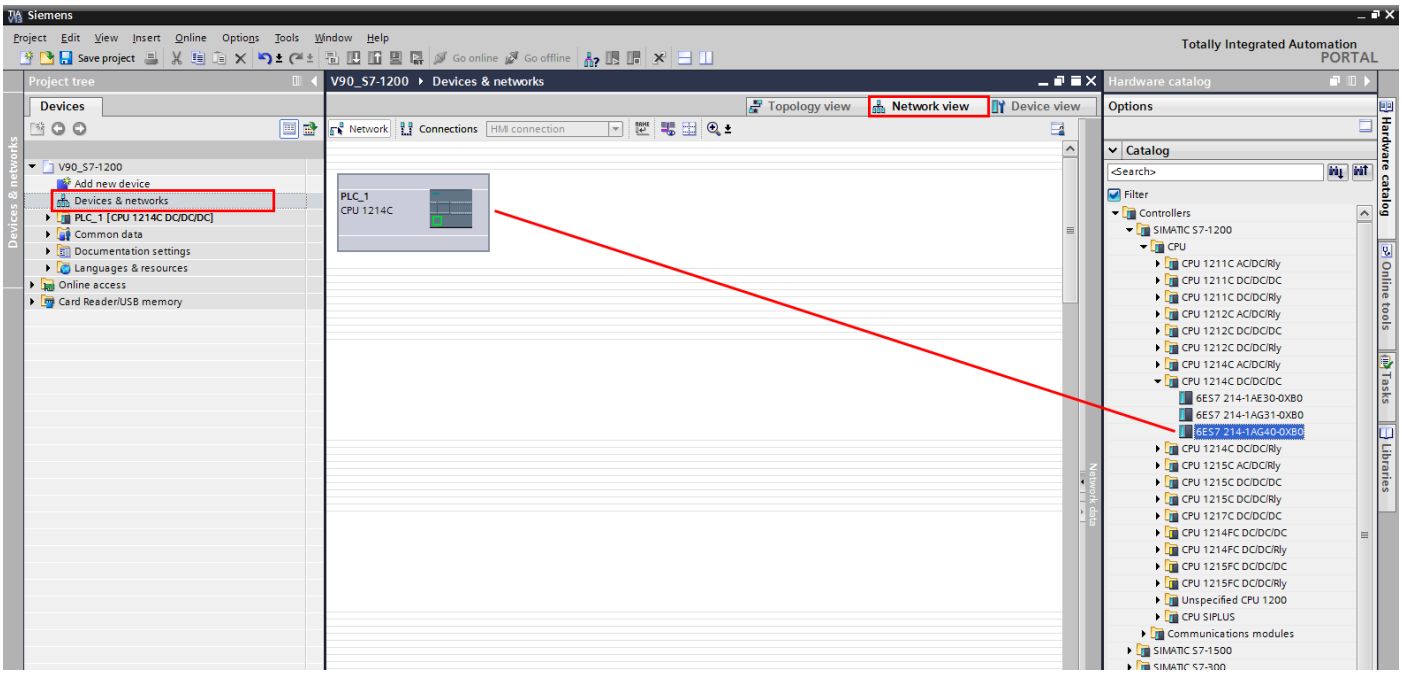


Figure 15 - Adding a Drive via Hardware Catalog

Setting the IP address of a device

Double clicking on an object in the “Devices & networks” view opens the object in the “Device view”. The IP address and subnet mask can then be set for each interface by highlighting the interface by clicking on it and editing its address in the “Properties” view, as shown below. Scroll down when in this section to set the Profinet name of the device.

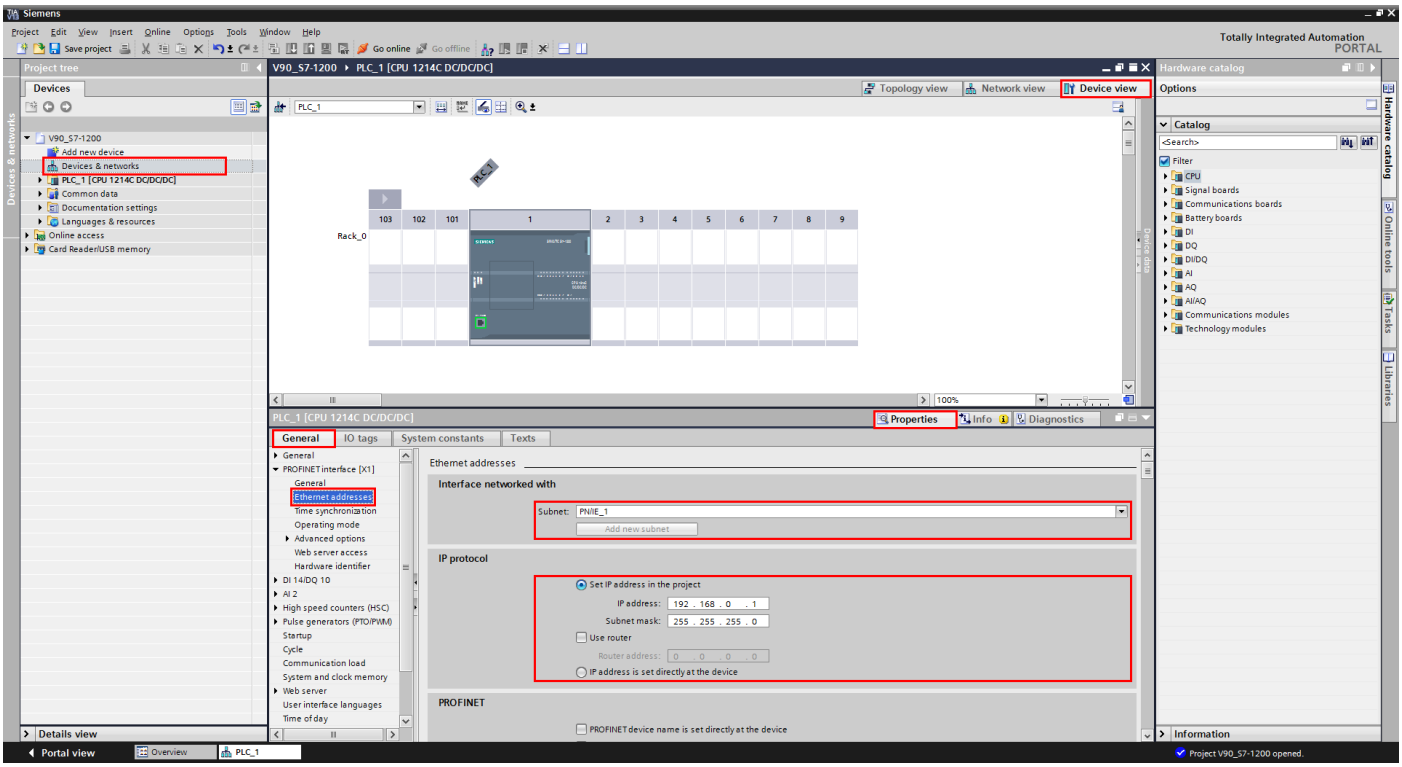


Figure 16 - Set Device IP Address

Adding Expansion Modules to a Device

To represent your PLC’s physical hardware configuration in the programming environment modules must be dragged from the “Hardware catalog” in the “Device view” and dropped in the relevant slot. Ensure that the Filter checkbox is ticked to filter the catalog by available hardware only.

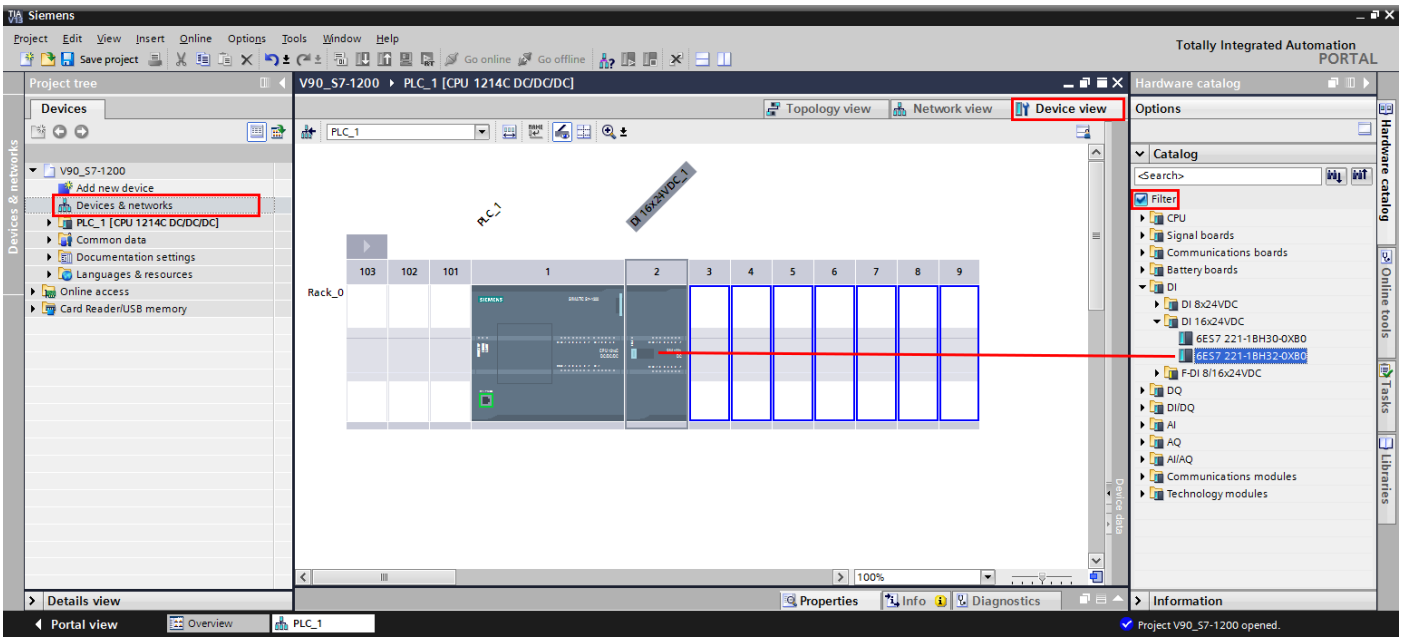


Figure 17 - Add PLC Modules

Adding a Signal Board (Optional)

The digital outputs of the SINAMICS V90 unit are sinking outputs, which means that the digital inputs of the S7-1200 PLC are required to be wired as sourcing inputs. This will then require that all digital inputs to the PLC (not just those from the SINAMICS V90) be wired as sourcing inputs. The DI 4x24VDC signal board unit for the S7-1200 PLC (6ES7 221-3BD30-0XB0) is configured, by default, to accept sourcing inputs. Adding this signal board to the PLC gives the added benefit of accepting the SINAMICS V90 sinking outputs, without any wiring changes, whilst allowing all other digital inputs to the PLC to be wired as standard (sinking) inputs.

To insert a signal board, select the correct device (based on the part number) form the "Hardware Catalog", and drag into the centre of the PLC:

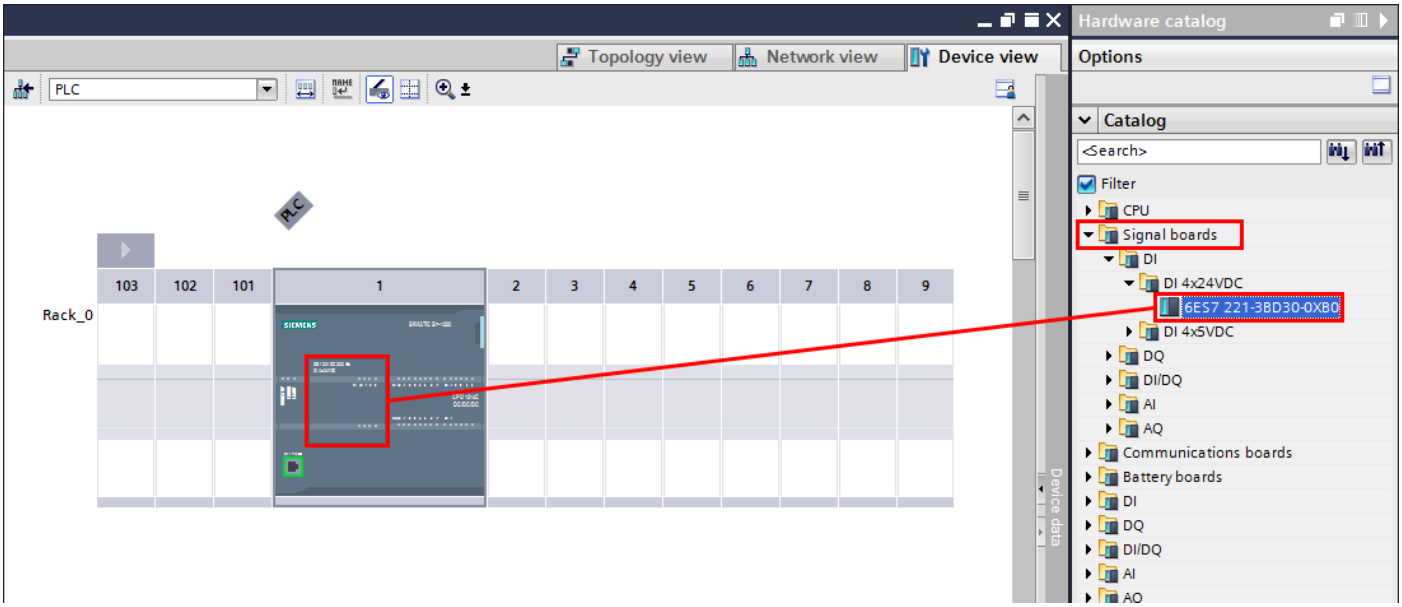


Figure 18 - Insert Signal Board

Once the signal board has been inserted into the project, the start address of the inputs needs to be found for use in the technology object set-up. This can be found by double clicking the inserted signal board in the centre of the PLC, and selecting 'IO Addresses' in the 'Properties' tab, as highlighted below. This is the start address for the inputs, so for a 4 input signal board, the input addresses will in this case be I4.0 - I4.3.

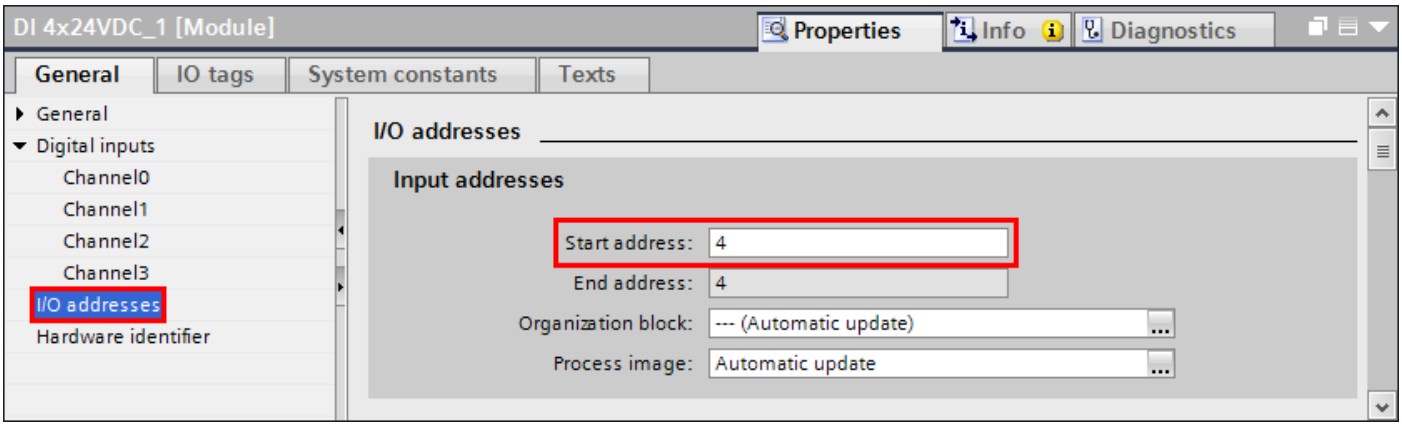


Figure 19 - Signal Board Start Address

Note If using the signal board option, please refer to the wiring diagram found in Appendix A0.

Download PLC Configuration

In order to save the PLC configuration into the device, you will need to perform a download to the PLC. To download to the PLC, ensure that the PLC is highlighted in the project tree and click the button in the toolbar. You will need to be offline to the PLC in order to perform a complete download.

The first time you download to the PLC you will need to select the device you wish to download to. Begin by clicking the 'Start Search' button in the window that opens, this will scan the configured interface for Siemens PLC devices. Ensure that your desired PLC is highlighted in the 'Compatible devices in subnet' table then click the Load button.

5 Drive Control Strategy

5.1 S7-1200 Configuration

Introduction to Technology Objects

Technology objects represent each of the real objects (e.g. a drive) in the controller. You can call the functions of the technology objects by means of Motion Control instructions in your user program. The technology objects provide open and closed-loop control of the movement of the real objects, and report status information (e.g. the current position). The configuration of the technology objects reflects the properties of the real object. The configuration data are stored in a technology data block.

Introduction to Positioning Axis Technology Objects

The positioning axis technology object calculates position setpoints, taking account of the specified dynamics, and outputs corresponding speed control setpoints to the drive. All movements of the positioning axis occur under position control. For absolute positioning, the physical position must be known to the positioning axis technology object.

Add a Positioning Axis Technology Object to the Project

Select ‘Add new object’ from under the Technology objects folder of the Project Tree.

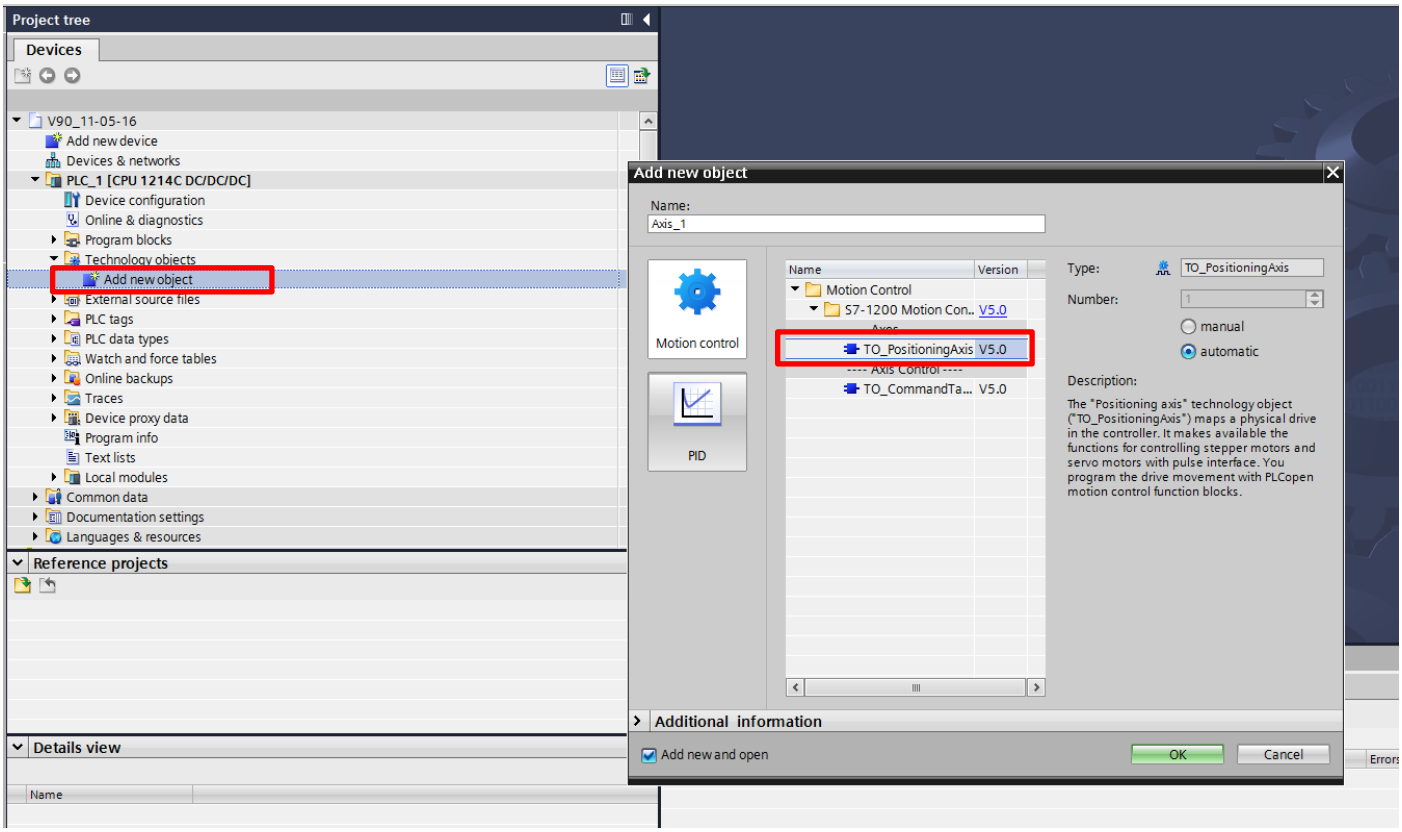


Figure 20 - Add a Technology Object

Select the Motion Control area in the window that opens, then select TO_PositioningAxis. Give the object a more meaningful name if necessary. Click OK to accept the new positioning axis object into the project.

Configure the Technology Object

To setup the positioning axis object, go to the Configuration section located under the new technology object from the Project Tree. From here you can use the graphical UI windows to set the necessary technology object settings. Ensure that you have the Function view active, and that you are not online to the PLC.

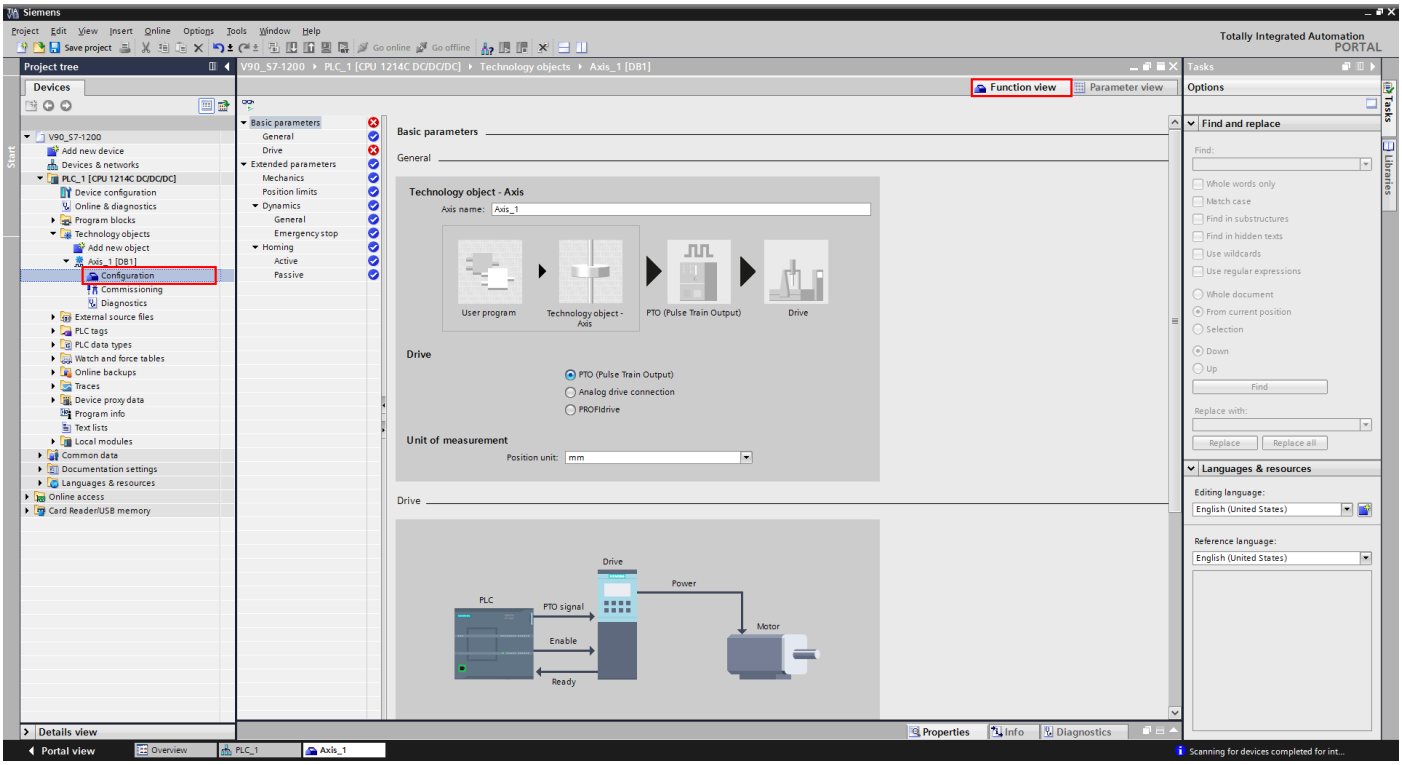


Figure 21 - Configure Technology Object

Basic Parameters - General

Axis Name

Set the name of the axis or technology object.

Drive

Switch between the 3 control methods: Pulse Train Output (PTO) Analogue drive connection, and PROFIdrive. Changing this will affect the default values and units used in some of the other settings. For the purpose of this example, set the control method to PTO.

Units of measurement

Set the default position and velocity units for the axis.

Basic Parameters - Drive

Select pulse generator

Select the pulse output to be used by the PLC to send pulses to the drive. For this application, select Pulse_1.

Signal type

Select the pulse train type. For this application, select pulse A and direction B

Pulse output

This is auto set based on the output assignment set in the device configuration, if this is not set up, select the 'device configuration' button. This will take you to the device view and display the properties of the pulse output. Ensure that enable is ticked under 'General', and then select 'Hardware outputs' under properties and assign the pulse and direction output bits to Q0.0 and Q0.1 respectively. Pulses 2, 3 and 4 need to be inactive, ensure that enable is not ticked under 'General'.

Direction output

Again, this is auto set as above. Ensure the 'Activate direction output' box is ticked.

Select enable output

This is used to select the output used to send the enable signal form the PLC to the drive. For this example, set this to Q0.2

Select ready input

This is used to set the input for the ready signal from the Drive to the PLC. For this application, set this to I0.1 for PLC only operation. For operation with a signal board, set this to I$\varkappa$.1, where $\varkappa$ = the start address of the signal board.

Extended Parameters - Mechanics

Pulses per motor revolution

This allows the user to configure the number of pulses the PLC needs to send to the SINAMICS V90 for one revolution of the motor. Set this to the same value as parameter p29011.

Load movement per revolution

This is the distance that the load will travel per revolution of the motor, e.g. for a ball screw, this will be the pitch of the screw.

Permitted direction of rotation

Allows limitation of the rotational direction if necessary.

Extended Parameters – Position limits

Hardware and Software Limit Switches

The check box activates the function of the negative and positive hardware limit switches. With enabled hardware limit switches, the drive is disabled when the hardware limit switch is approached or overshot. The drive brakes with the braking ramp configured in the PLC.

Exception: If a hardware limit switch is overshot during an active home position approach with activated direction reversal at the hardware limit switch, then the axis stops with the configured maximum deceleration, and continues the home position approach in the opposite direction.

Negative / positive HW limit switch input: In these fields, select the PLC tags of the digital input for the negative and positive HW limit switches.

Signal level selection: Select the triggering signal level ("Lower level" / "Upper level") of the hardware limit switch. At "Lower level", the input signal is FALSE after the axis has reached or passed the hardware limit switch. At "Upper level", the input signal is TRUE after the axis has reached or passed the hardware limit switch.

Note	Software position limits MUST be enabled in order to use the MC_CommandTable function block.

For this application demo, the inputs I0.3 and I0.4 were used for the negative and positive hardware limits. If you are using the signal board, then instead use inputs I0.1 and I0.2.

Extended Parameters – Dynamics

General

Configure the maximum move profile dynamics of the axis. Set the maximum velocity of the axis and also the maximum acceleration and deceleration. For acceleration/deceleration you can either enter a maximum value or you can specify the ramp time to/from maximum speed, the other value is automatically calculated. The same applies for the maximum jerk setting; you can either enter the maximum jerk value or enter the profile smoothing time. Jerk is enabled when its maximum value is set greater than zero.

Emergency Stop

You may set either the maximum emergency stop deceleration value, or you may set the emergency stop ramp-down time from the maximum velocity set in the Dynamic Limits section.

Extended Parameters – Homing

Active

In active homing mode, the Motion Control instruction "MC_Home" performs the configured home position approach. Active traversing motions are aborted. When the reference mark is detected, the position of the axis is set according to the configuration.

Digital input homing switch: select the digital input to use for the homing switch.

Homing direction: select the default homing direction of traversal.

Approach velocity: set the velocity at which the axis moves until sensing the zero mark or homing sensor.

Homing velocity: set the velocity at which the axis is homed after sensing the zero mark or homing sensor.

Home position offset: enter the distance between the homing/zero mark and the home position.

Home position: the position to which the encoder is set once homing procedure is complete.

Passive

During passive homing, the motion control instruction "MC_Home" does not carry out any homing motion. The traversing motion required for this step must be implemented by the user via other motion control instructions. Active traversing motions are not aborted upon start of passive homing. When the reference mark is detected, the axis is set according to the configuration.

Digital input homing switch: select the digital input to use for the homing switch.

Homing direction: select the default homing direction of traversal.

Home position: the position to which the encoder is set once homing procedure is complete.

Position Monitoring Tolerance Time

Positioning window: configure the size of the positioning window between setpoint and actual position. If the axis is located within this window, then the position is considered to be "reached".

Tolerance time: configure the tolerance time, in which the position value must reach the positioning window.

Commissioning a Technology Object

Navigate to the Commissioning section located under the Technology Object in the Project Tree.

Axis Control Panel

The axis control panel can be used to manually control the axis. This is useful for initially testing that the axis has been configured correctly, can be moved, and that the position scaling is correct. Activating master control on this panel removes all drive control from the PLC. The control panel allows simple speed, position or manual control and also delivers some simple axis diagnostics and actual values.

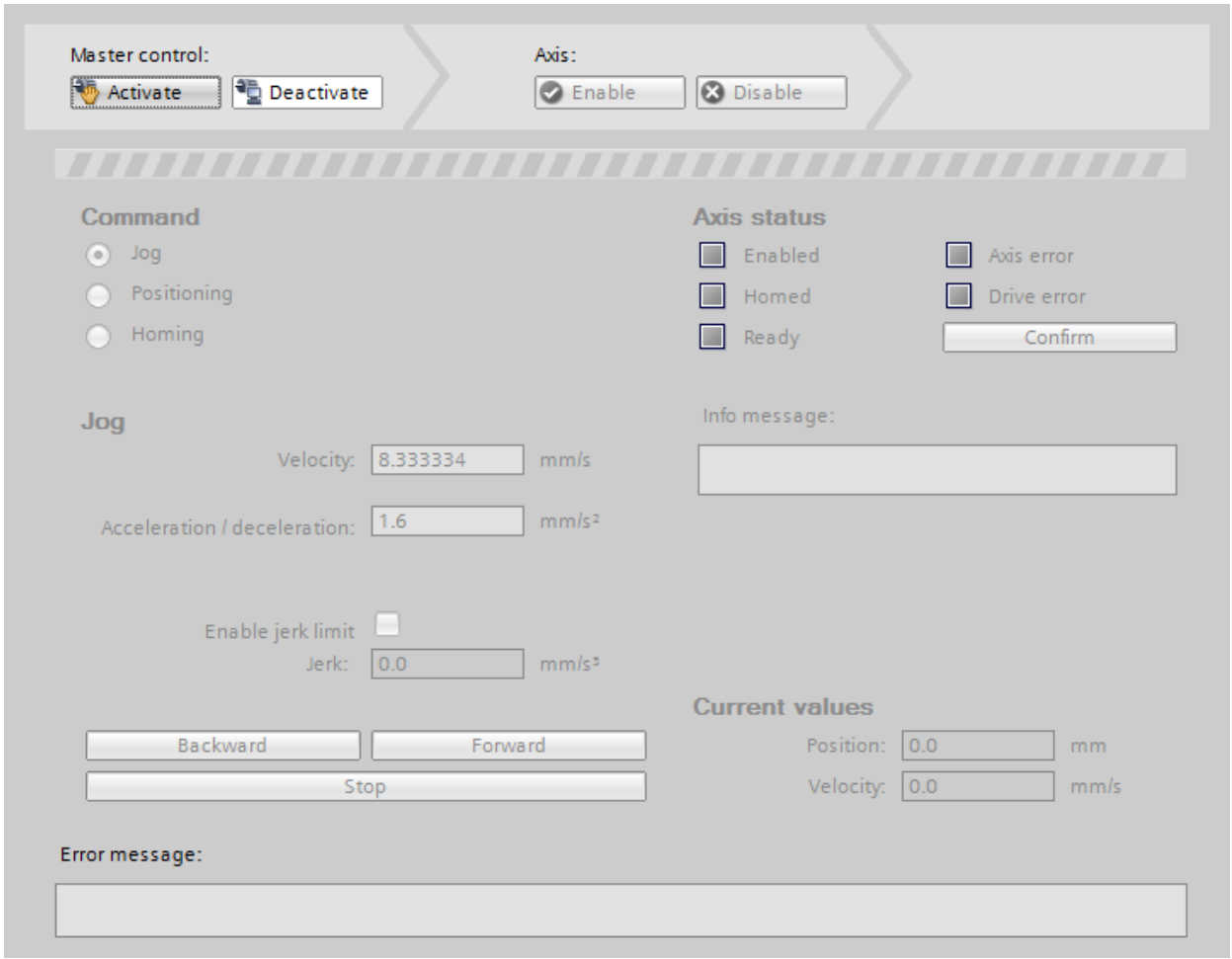


Figure 22 - Technology Object Control Panel

Diagnosing a Technology Object

Navigate to the Diagnostics section located under the Technology Object in the Project Tree.

Status and Error bits

This screen gives indicators to show common axis status, warning and faults. Clicking the green arrows next to an indicator will take you to the respective configuration parameters that affect this status.

Motion Status

Useful for easy viewing of the target and actual position, velocity and accelerations of an axis.

The S7-1200 can control up to 4 axes using this method, dependant on the CPU and number of pulse train outputs, see AX.X from the appendix for more information. To add further axes, create additional technology objects for each axis, ensuring to set unique addresses for each pulse train output and IO.

5.2 Example Program

Adding a Motion Control Function Block to the Project

Whilst in an open program block window, browse to the Technology section of the Instructions window. Open the Motion Control folder and drag and drop the appropriate block into the desired section of the program block. A window will then open asking you to specify an instance for this function block. Give the instance data block a name and click OK. The block is now added to the project.

For further information on any motion control function block, including an explanation of all input/output parameters can be found in the TIA help documentation within the TIA software, simply highlight any of the MC function blocks and press the F1 key. A detailed description of the blocks can also be found in Appendix A3.2.

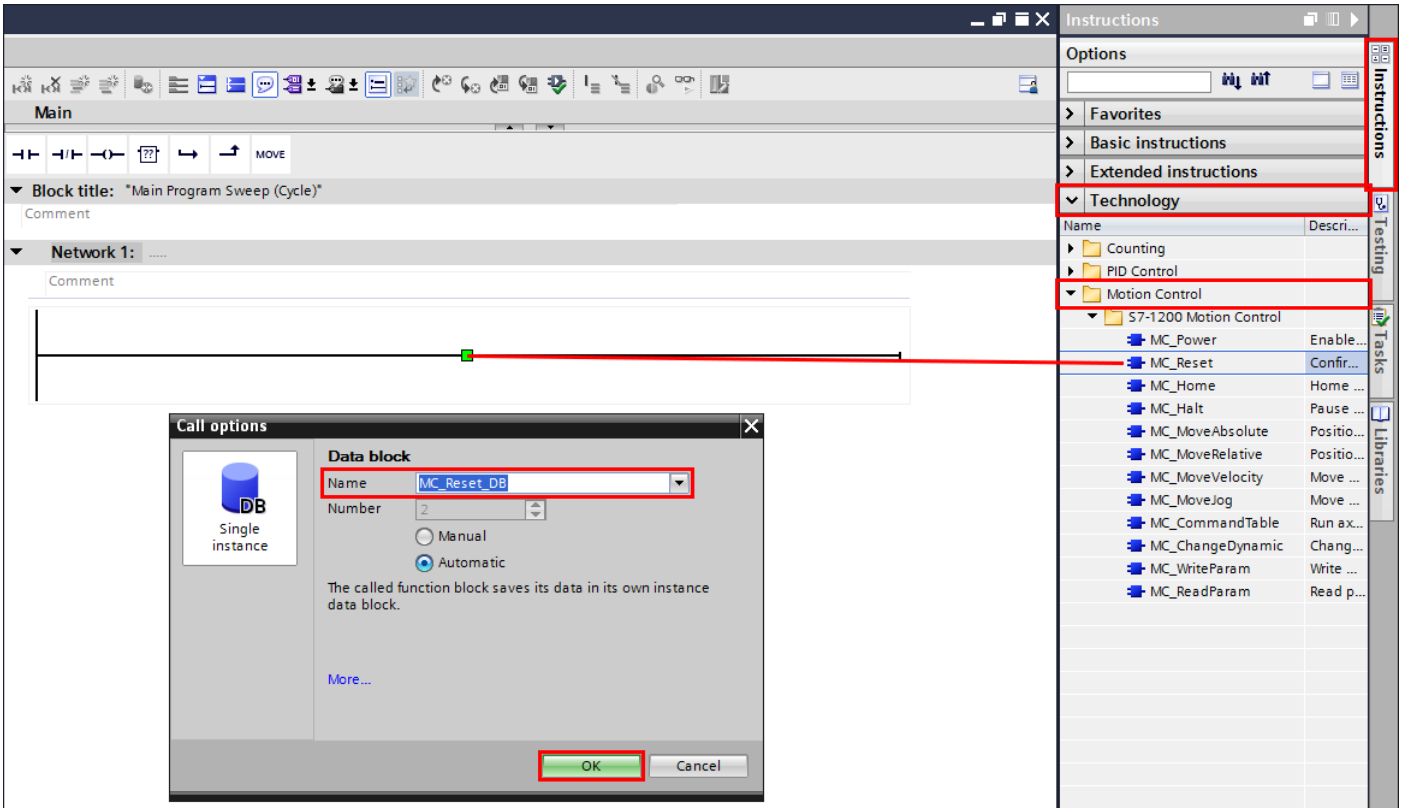


Figure 23 - Add Motion Control Function Block

Motion control function block input parameters without a default value (e.g. "Axis"), must be supplied.

After specifying the technology object in the "Axis" parameter, the following buttons are available to you:

- To open the configuration of the technology object, click on the toolbox icon.
- To open the diagnostics of the technology object, click on the stethoscope icon.

Reset and Enable the Drive

Pull in MC_Power and MC_Reset function blocks. Assign the Technology object to the Axis input. An example is given below:

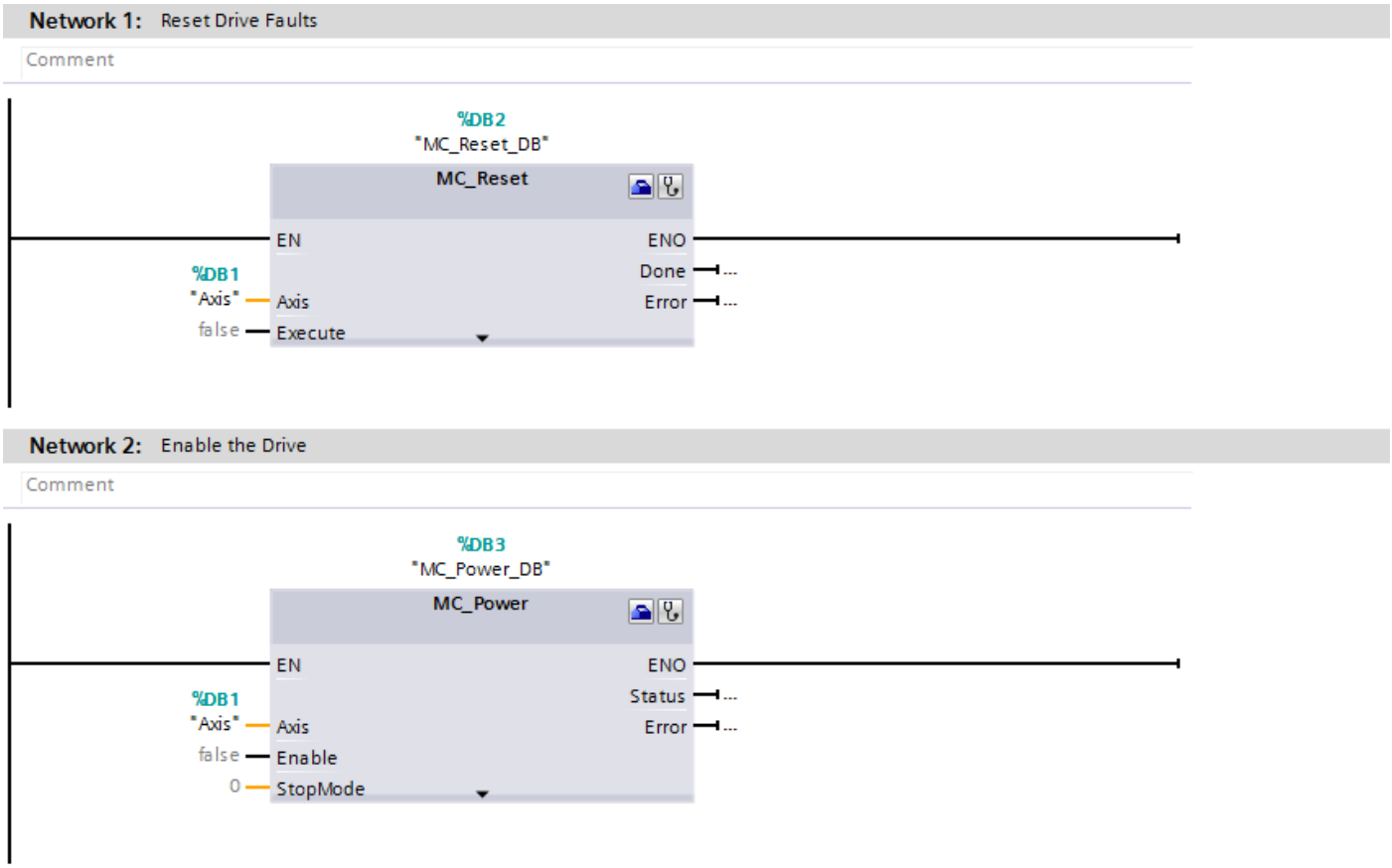


Figure 24 - Reset and Enable the Drive

You can now use MC_Reset_DB.Execute to reset any drive faults within the PLC, where "MC_Reset_DB" is the name given to your instance data block of your MC_Reset function block.

You can now use MC_Power_DB.Enable to enable and disable the drive in your control program.

Jog the Axis

To jog the axis, add a MC_MoveJog function block into the program. Again, assign the technology object to the Axis input:

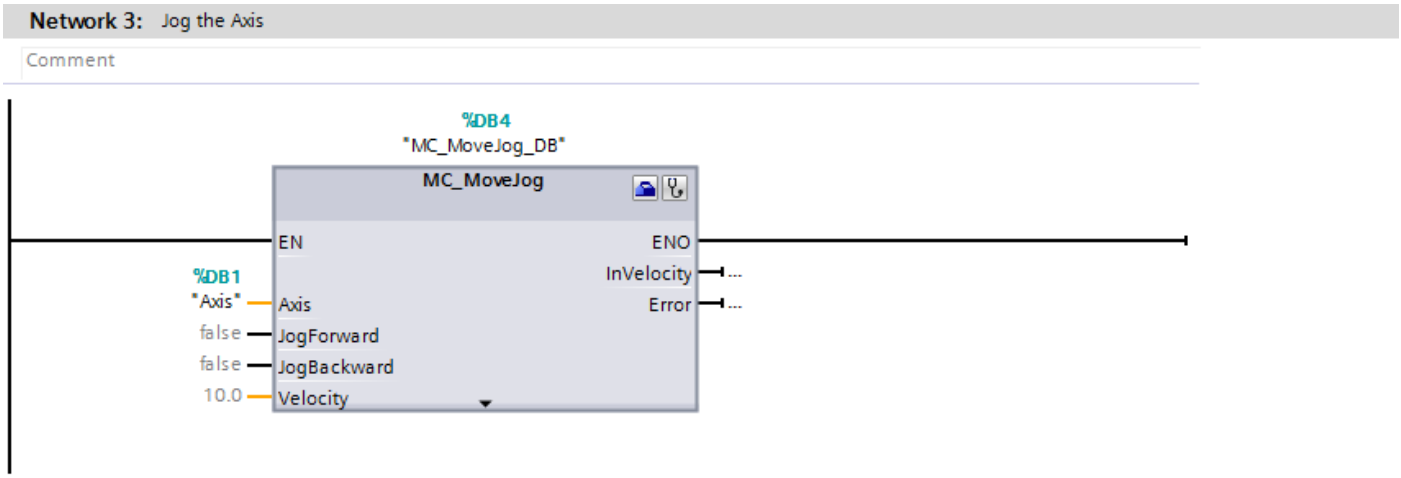


Figure 25 - Jog Axis

Provided the drive is enabled, you can now use the MC_MoveJog_DB.JogForward and MC_MoveJog_DB.JogBackward commands to jog the axis forwards and backwards respectively.

You can also use the MC_MoveJog_DB.Velocity parameter to set the jogging speed via your control program or watch table.

Move the Axis at Velocity

To run the axis at a set velocity, insert a MC_MoveVelocity function block into the ladder program. Again, assign the technology object to the Axis input:

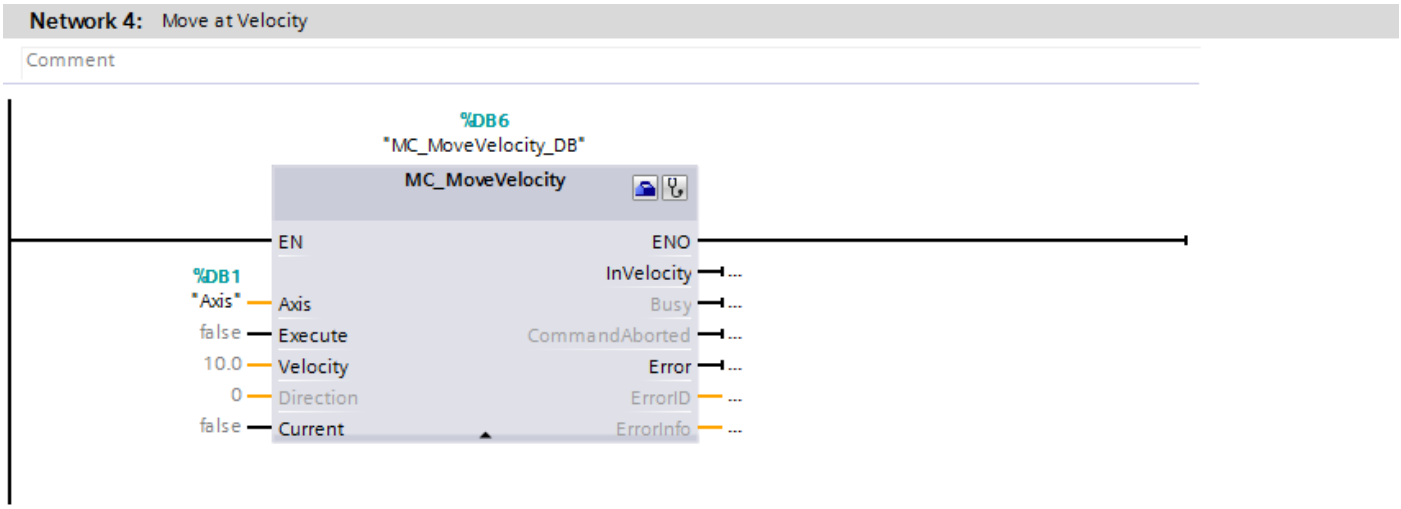


Figure 26 – Move Axis at Velocity

A rising edge on the MC_MoveVelocity_DB.Execute command can now be used to trigger the axis to run at the velocity specified by the MC_MoveVelocity_DB.Velocity parameter.

The MC_MoveVelocity_DB.Direction command can be used to set the motor rotation direction.

Note Setting the MC_MoveVelocity_DB.Execute parameter to FALSE will NOT stop the axis. The MC_Halt block or another MC function block must be used to stop the axis.

Perform Relative Position Move

To perform relative position moves, insert a MC_MoveRelative function block into the ladder program. Again, assign the technology object to the Axis input:

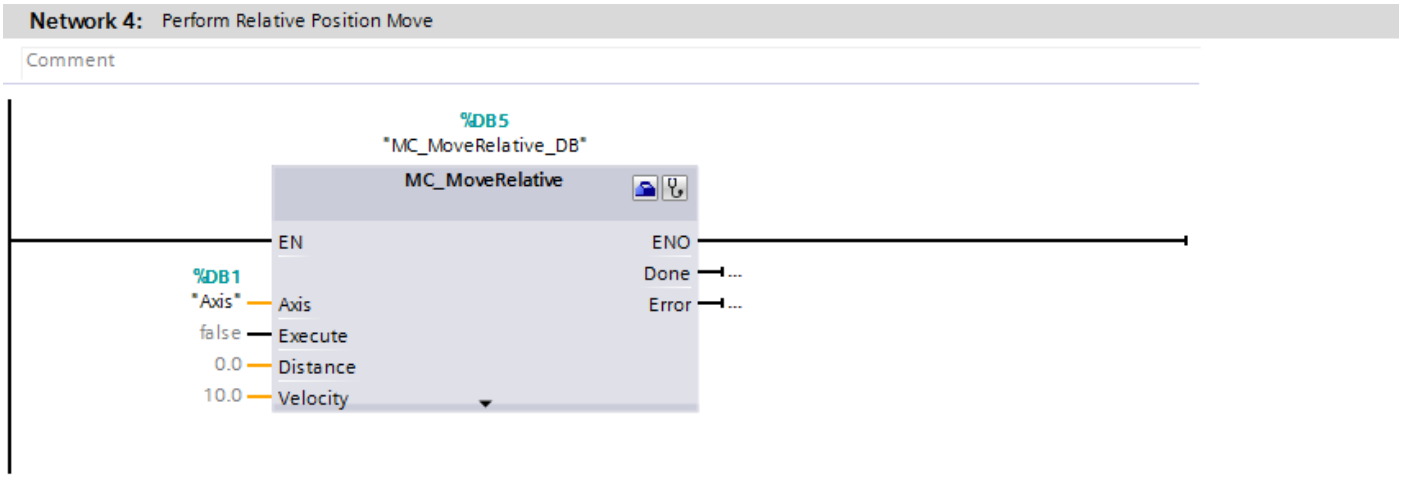


Figure 27 - Relative Position Move

A rising edge on the MC_MoveRelative_DB.Execute command can now be used to trigger a relative position move on the axis. The MC_MoveRelative_DB.Distance and MC_MoveRelative_DB.Velocity commands can be used to set the traversing distance and speed respectively.

Home Axis and Perform an Absolute Position Move

To perform an absolute position move, the axis must first be homed. Insert both a 'MC_Home' and 'MC_MoveAbsolute' block and assign the technology object to the Axis input:

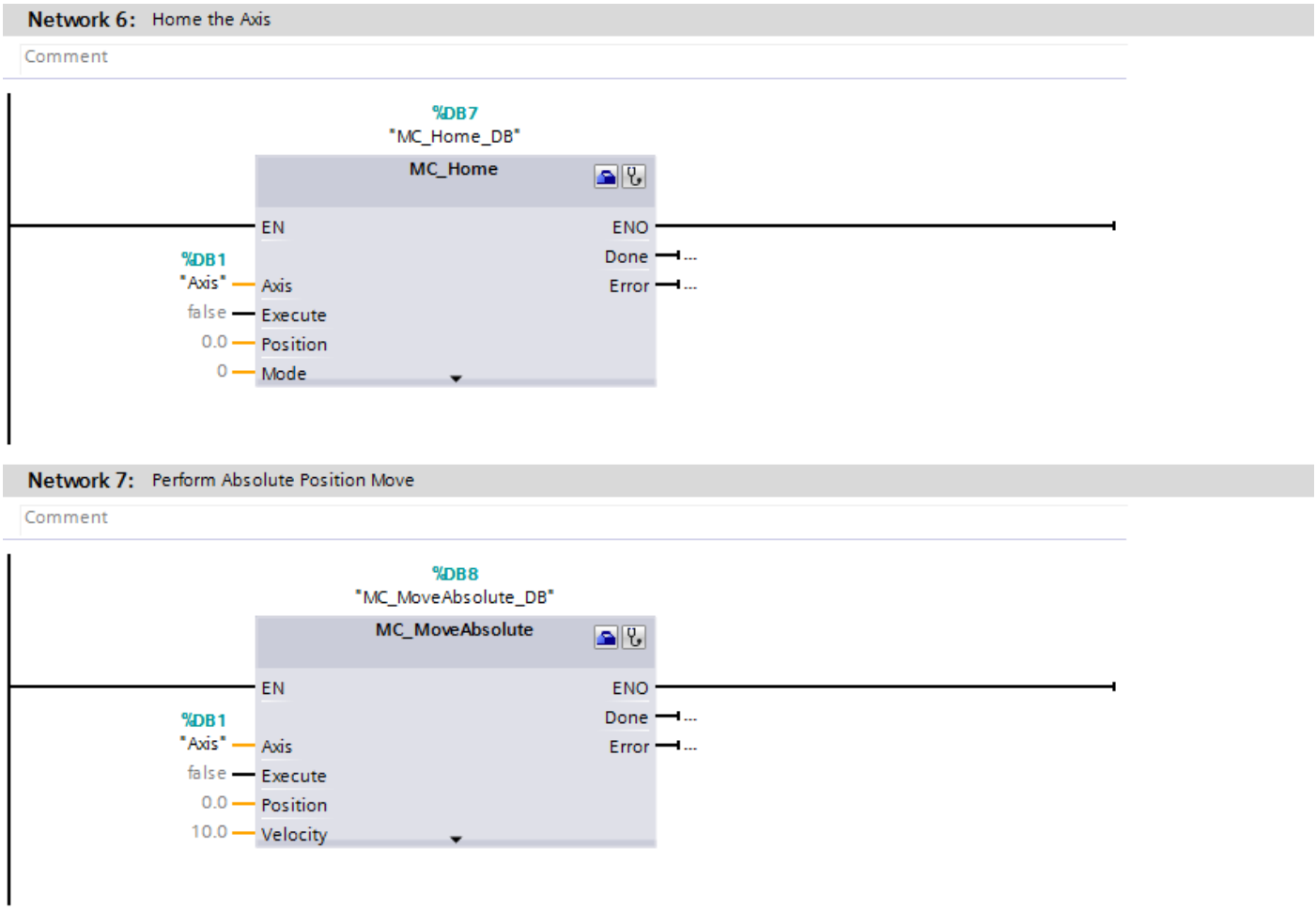


Figure 28 - Home Axis and Perform Absolute Position Move

To Home the axis, the mode of operation must first be selected. For the homing procedure with an external zero mark (such as a homing sensor) use MC_Home_DB.Mode = 3. To set the current position of the axis as zero, use MC_Home_DB.Mode = 0 (this will instantly home with axis without turning the motor shaft). You can then use the MC_Home_DB.Execute command to trigger the homing of the axis.

A rising edge on the MC_MoveAbsolute_DB.Execute command can now be used to trigger an absolute position move on the axis. The MC_MoveAbsolute_DB.Position and MC_MoveRelative_DB.Velocity commands can be used to set the traversing position and speed respectively.

Stop the Axis

In order to stop the axis whilst another motion command is executing, you will need to insert a MC_Halt function block into the ladder program.

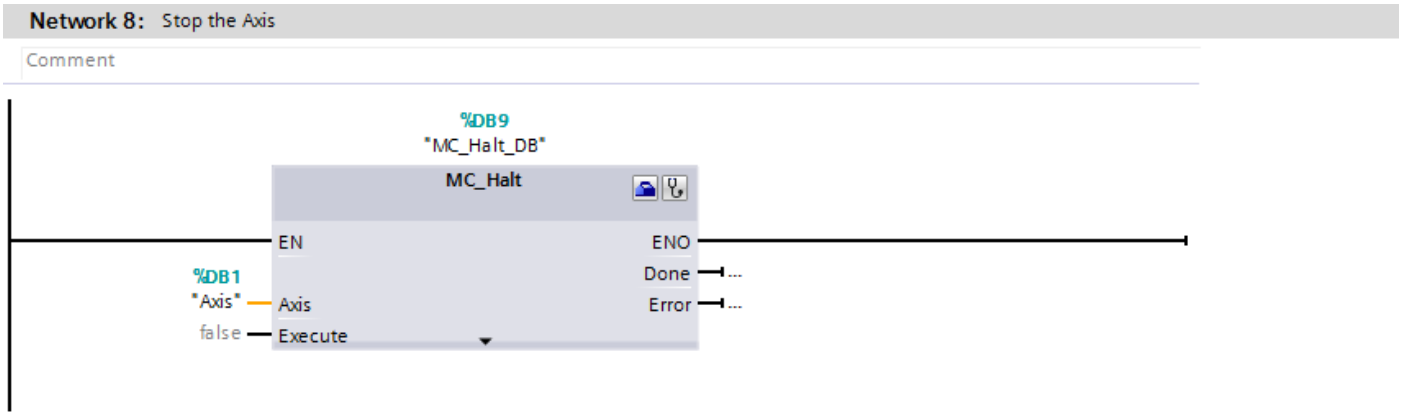


Figure 29 – Stop the Axis

You can now use the MC_Halt_DB.Execute command to stop the axis from your control program or from a watch table.

Change the Axis Dynamics

In order to alter the configured acceleration and deceleration ramps for the axis, you will need to insert an MC_ChangeDynamic function block.

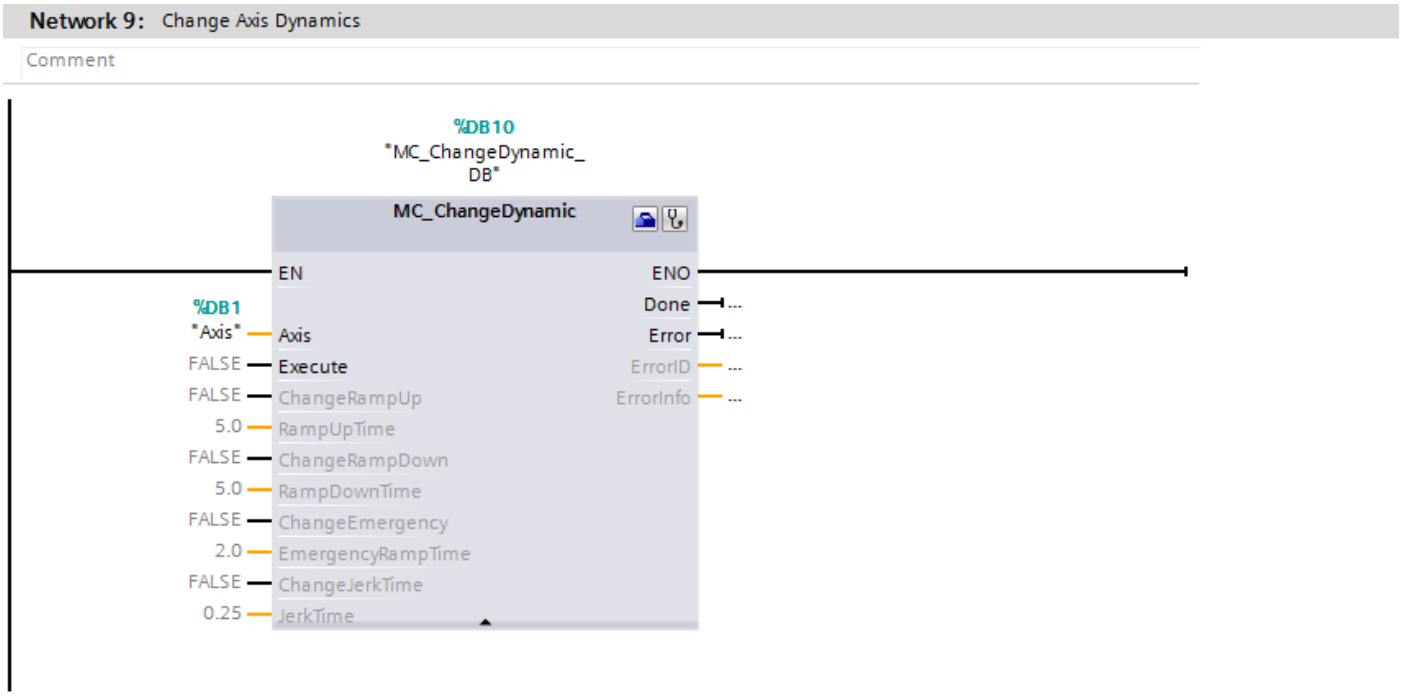


Figure 30 – Change Axis Dynamics

You can now use the inputs of this function block to configure the axis ramp up/down, jerk settings and emergency stop ramp settings. The MC_ChangeDynamic_DB.Execute command is used to transfer the new values to the drive.

Further Information

See the Siemens documentation on technology object motion control for further info:

https://support.industry.siemens.com/cs/document/108577079/simatic-step-7-s7-1200-motion-control-v13-sp1?dti=0&lc=en-GB

Control the Axis from a Watch Table

Once the ladder program is in place, a watch table can be used to actively modify variables within the PLC. To add a watch table to the project, navigate to the 'Watch and Force Tables' folder under the PLC in the project tree in TIA, then double click the 'Add new watch table'.

Now enter all the parameters that you wish to modify into the Name column of the table.

	Name	Addr...	Display format	Monitor value	Modify value		Comment
1	"MC_Reset_DB".Execute		Bool	FALSE			Reset faults
2	"MC_Power_DB".Enable		Bool	TRUE	TRUE		Enable drive
3	"MC_MoveJog_DB".Velocity		Floating-point number	10.0			Set jog velocity
4	"MC_MoveJog_DB".JogForward		Bool	FALSE			Jog forward
5	"MC_MoveJog_DB".JogBackward		Bool	FALSE			Jog backward
6	"MC_MoveVelocity_DB".Velocity		Floating-point number	10.0			Set velocity move velocity
7	"MC_MoveVelocity_DB".Execute		Bool	FALSE			Trigger velocity move
8	"MC_MoveRelative_DB".Distance		Floating-point number	0.0			Set relative position move distance
9	"MC_MoveRelative_DB".Velocity		Floating-point number	10.0			Set relative position move velocity
10	"MC_MoveRelative_DB".Execute		Bool	FALSE			Trigger relative position move
11	"MC_Home_DB".Mode		DEC+/-	3			Set homing mode
12	"MC_Home_DB".Execute		Bool	FALSE			Trigger homing procedure
13	"MC_MoveAbsolute_DB".Position		Floating-point number	0.0			Set absolute position move position
14	"MC_MoveAbsolute_DB".Velocity		Floating-point number	10.0			Set absolute position move velocity
15	"MC_MoveAbsolute_DB".Execute		Bool	FALSE			Trigger absolute position move
16	"MC_Halt_DB".Execute		Bool	FALSE			Stop axis

Figure 31 - Watch Table

In order to change the parameter values, you will need to be online to the PLC. To do this, ensure that that the PLC is highlighted in the project tree and click the Go online button.

For Boolean parameters, right-click anywhere on the row and select Modify > Modify to 0 or Modify to 1.

For non-Boolean parameters, enter the desired value into the Modify value column, then right click on the row and select Modify > Modify now.

Appendix

Application Wiring – with Signal Board

A0

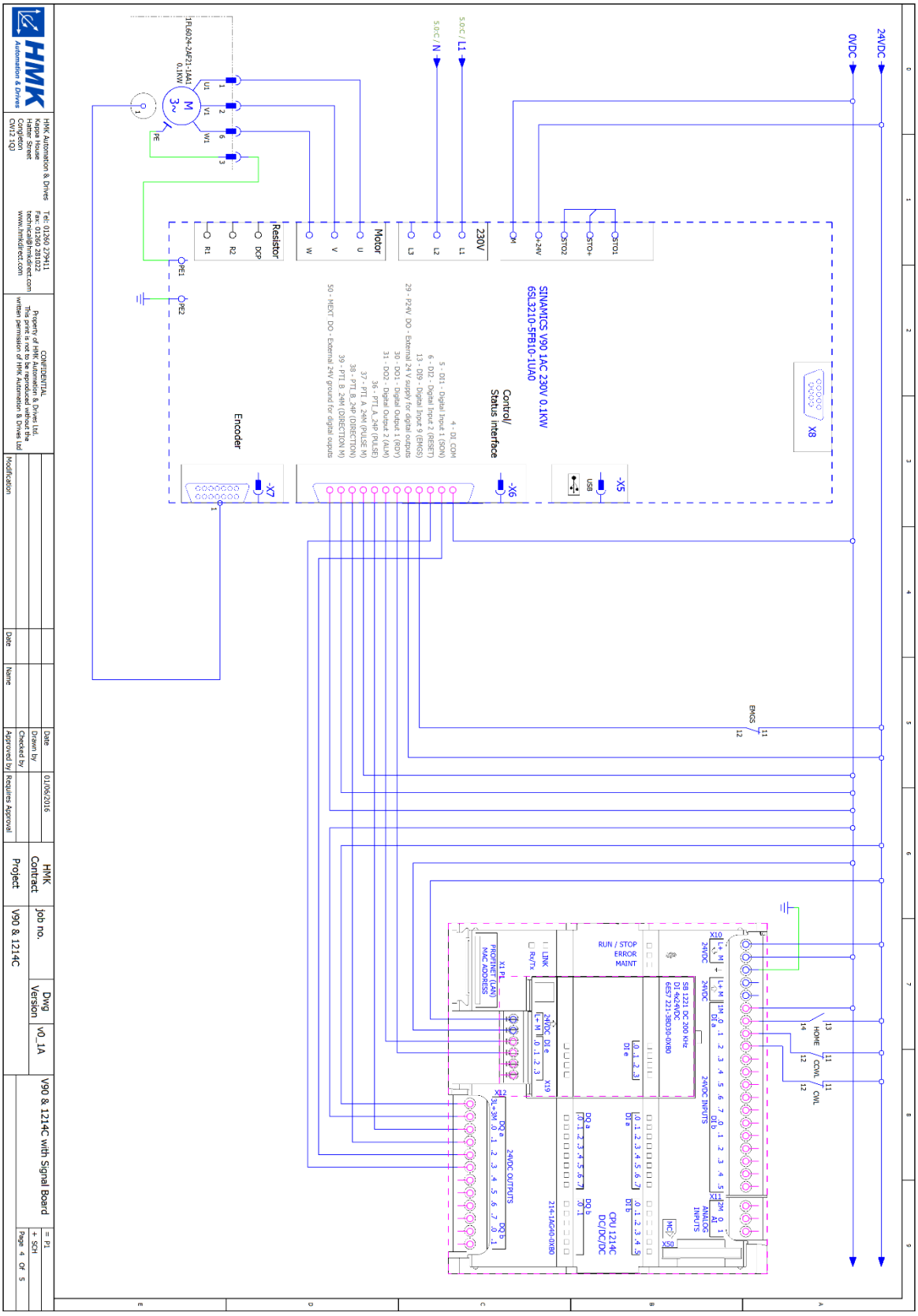


Figure 32 – Application Wiring Diagram with Signal Board

A1

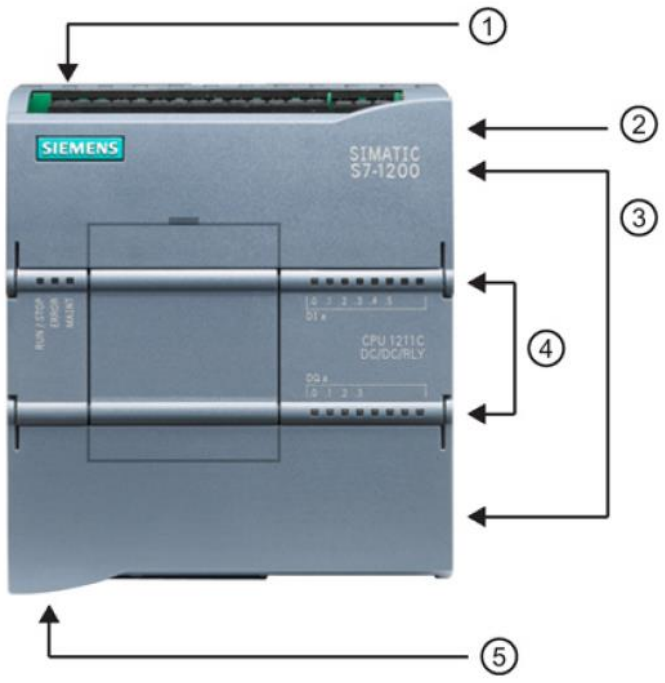
Hardware Overview

A1.1 S7-1200 PLC Hardware Overview

Introduction

The SIMATIC S7-1200 controller is designed as a "compact" controller for smaller to mid-size automation tasks. Additional signal modules and communication modules can be added depending on the size and complexity of the automation task. The S7-1200 controller provides the flexibility and power to control a wide variety of devices. The compact design, flexible configuration, and powerful instruction-set combine to make the S7-1200 a perfect solution for controlling a wide variety of applications.

The CPU combines a microprocessor, an integrated power supply, input and output circuits, built-in PROFINET, high-speed motion control I/O, and on-board analog inputs in a compact DIN rail mounted housing.



① Power connector
② Memory card slot under top door
③ Removable user wiring connectors (behind the doors)
④ Status LEDs for the on-board I/O
⑤ PROFINET connector (on the bottom of the CPU)

Figure 33 - S7-1200 CPU Overview

CPUs

The table below gives an overview of the current CPU models available along with their specifications. The CPUs are available with either AC or DC supply, and relay or digital outputs depending on the part number ordered.

Feature		CPU 1211C	CPU1212C	CPU 1214C	CPU 1215C	CPU 1217C
Physical Size (mm)		90 x 100 x 75		110 x 100 x 75	130 x 100 x 75	150 x 100 x 75
Memory	Work	50 Kb	75 Kb	100 Kb	125 Kb	150 Kb
	Load	1 Mb		4 Mb		
Local IO	Digital In	6	8	14		
	Digital Out	4	6	10		
	Analog In	2	2	2	2	2
	Analog Out	-	-	2	2	2
Signal Module Expansion		None	2	8		

Figure 34 - CPU Specification Overview

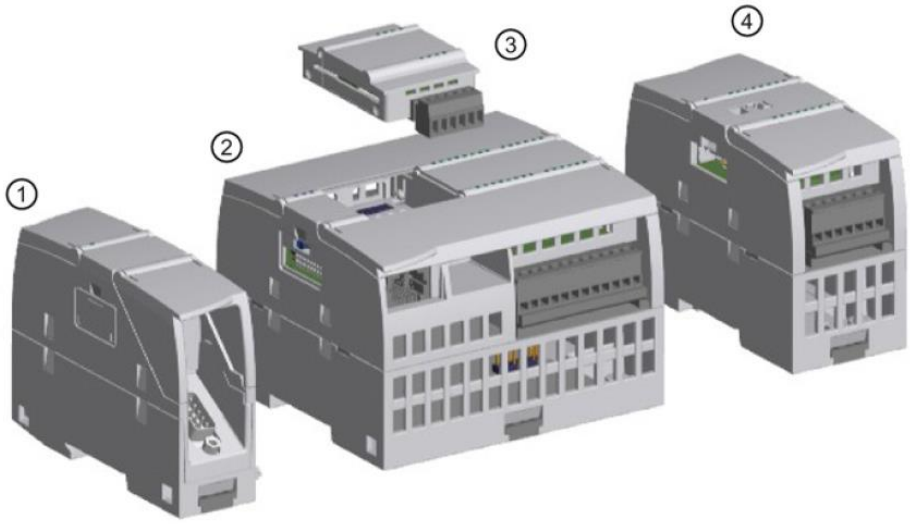
Below is a table outlining the maximum pulse frequencies for all CPU models of the SINAMICS S7-1200.

CPU	CPU output channel	Pulse and direction output	A/B, quadrature, up/down, and pulse/direction
1211C	Qa.0 to Qa.3	100 kHz	100 kHz
1212C	Qa.0 to Qa.3	100 kHz	100 kHz
	Qa.4, Qa.5	20 kHz	20 kHz
1214C and 1215C	Qa.0 to Qa.4	100kHz	100kHz
	Qa.5 to Qb.1	20 kHz	20 kHz
1217C	DQa.0 to DQa.3 (.0+, .0- to .3+, .3-)	1 MHz	1 MHz
	DQa.4 to DQb.1	100 kHz	100 kHz

Figure 35 - CPU Maximum Pulse Frequency

Expansion

The S7-1200 family provides a variety of modules and plug-in boards for expanding the capabilities of the CPU with additional I/O or other communication protocols.



① Communication module (CM) or communication processor (CP)
② CPU (CPU 1211C, CPU 1212C, CPU 1214C, CPU 1215C, CPU 1217C)
③ Signal board (SB) (digital SB, analog SB), communication board (CB), or Battery Board (BB) CPU (CPU 1211C, CPU 1212C, CPU 1214C, CPU 1215C, CPU 1217C)
④ Signal module (SM) (digital SM, analog SM, thermocouple SM, RTD SM, technology SM)

Figure 36 - CPU Expansion Overview

Installation of the boards and modules is carried out as follows;

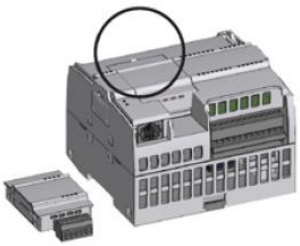
Task	Procedure
	1. Ensure that the CPU and all S7-1200 equipment are disconnected from electrical power. 2. Remove the top and bottom terminal block covers from the CPU. 3. Place a screwdriver into the slot on top of the CPU at the rear of the cover. 4. Gently pry the cover up and remove it from the CPU. 5. Place the module straight down into its mounting position in the top of the CPU. 6. Firmly press the module into position until it snaps into place. 7. Replace the terminal block covers.
 	

Figure 37 - Installing an option board

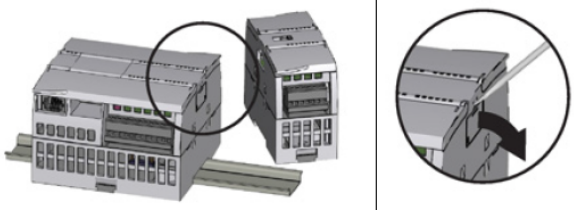
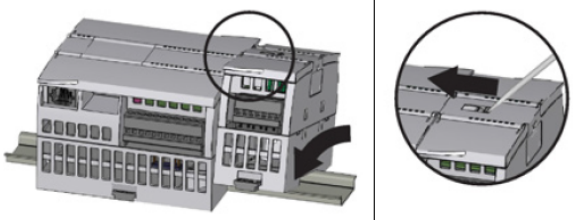
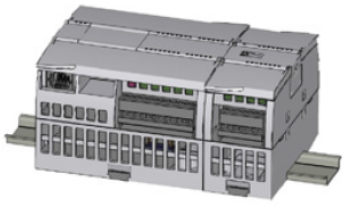
Task	Procedure
	Install your SM after installing the CPU. 1. Ensure that the CPU and all S7-1200 equipment are disconnected from electrical power. 2. Remove the cover for the connector from the right side of the CPU: – Insert a screwdriver into the slot above the cover. – Gently pry the cover out at its top and remove the cover. 3. Retain the cover for reuse.
	Connect the SM to the CPU: 1. Position the SM beside the CPU. 2. Hook the SM over the top of the DIN rail. 3. Pull out the bottom DIN rail clip to allow the SM to fit over the rail. 4. Rotate the SM down into position beside the CPU and push the bottom clip in to latch the SM onto the rail.
	Extending the bus connector makes both mechanical and electrical connections for the SM. 1. Place a screwdriver beside the tab on the top of the SM. 2. Slide the tab fully to the left to extend the bus connector into the CPU. Follow the same procedure to install a signal module to a signal module.

Figure 38 - Installing a signal module

The following types of boards and modules can be installed;

- Digital Input
- Digital Output
- Relay Output
- Combination Input/Output
- Analog Input
- Analog Output
- Combination Analog Input/Output
- Thermocouple and RTD
- GPRS (not approved for maritime applications)
- Profibus Communication (Master and Slave)
- ASi
- RS232, RS422 and RS485
- CANopen

SD Memory Card

An SD card is not necessary for the S7-1200 CPU to function, but it can be used either as a transfer card or as a program card. Any program that you copy to the memory card contains all of the code blocks and data blocks, any technology objects, and the device configuration. A copied program does not contain force values.

Note The CPU supports only the pre-formatted SIMATIC memory cards. Before you copy any program to the formatted memory card, delete any previously saved program from the memory card.

Use a transfer card to copy a program to the internal load memory of the CPU without using STEP 7

After you insert the transfer card, the CPU first erases the user program and any force values from the internal load memory, and then copies the program from the transfer card to the internal load memory. When the transfer process is complete, you must remove the transfer card.

You can use an empty transfer card to access a password-protected CPU when the password has been lost or forgotten. Inserting the empty transfer card deletes the password-protected program in the internal load memory of the CPU. You can then download a new program to the CPU.

Use a program card as external load memory for the CPU

Inserting a program card in the CPU erases all of the CPU internal load memory (the user program and any force values). The CPU then executes the program in external load memory (the program card). Downloading to a CPU that has a program card updates only the external load memory (the program card). Because the internal load memory of the CPU was erased when you inserted the program card, the program card must remain in the CPU. If you remove the program card, the CPU goes to STOP mode. (The error LED flashes to indicate that program card has been removed.)

You also use a memory card when downloading firmware updates.

Warning

Verify that the CPU is not running a process before inserting the memory card.

Do not insert V3.0 program transfer cards into S7-1200 V4.0 CPUs.

LED Display

AS well as individual LEDs to indicate the status of the local IO on the CPU, the S7-1200 controller also has three integrated LEDs to provide operational status of the module or IO.

They are **RUN/STOP**, **ERROR** and **MAINT**.

The module status can be determined from the LEDs using the table below.

Description	STOP/RUN Yellow / Green	ERROR Red	MAINT Yellow
Power is off	Off	Off	Off
Startup, self-test, or firmware update	Flashing (alternating yellow and green)	-	Off
Stop mode	On (yellow)	-	-
Run mode	On (green)	-	-
Remove the memory card	On (yellow)	-	Flashing
Error	On (either yellow or green)	Flashing	-
Description	**STOP/RUN Yellow / Green**	**ERROR Red**	**MAINT Yellow**
Maintenance requested • Forced I/O • Battery replacement required (if battery board installed)	On (either yellow or green)	-	On
Defective hardware	On (yellow)	On	Off
LED test or defective CPU firmware	Flashing (alternating yellow and green)	Flashing	Flashing
Unknown or incompatible version of CPU configuration	On (yellow)	Flashing	Flashing

Figure 39 - LED Status

Further Information

The 'S7-1200 Easy book' is an introduction to the S7-1200 PLC and can be found here:

https://support.industry.siemens.com/cs/gb/en/view/39710145/73836356363

Further Information

The S7-1200 System Manual contains detailed information and can be found here:

https://support.industry.siemens.com/cs/gb/en/view/107623221/73837491339

Further Information

See the Siemens documentation on technology object motion control for further info:

https://support.industry.siemens.com/cs/gb/en/view/108577079

A1.2 SINAMICS V90 Hardware Overview

Introduction

The SINAMICS V90 is designed to meet general purpose servo drive applications. It is easy to commission the SINAMICS V90 system - essentially just plug & play. Further, it has optimized servo performance, can be quickly integrated into SIMATIC PLC control systems and has a high degree of reliability. A seamless drive system is created by combining SINAMICS V90 servo drive with the SIMOTICS S-1FL6 servomotor.

System Connection Diagram

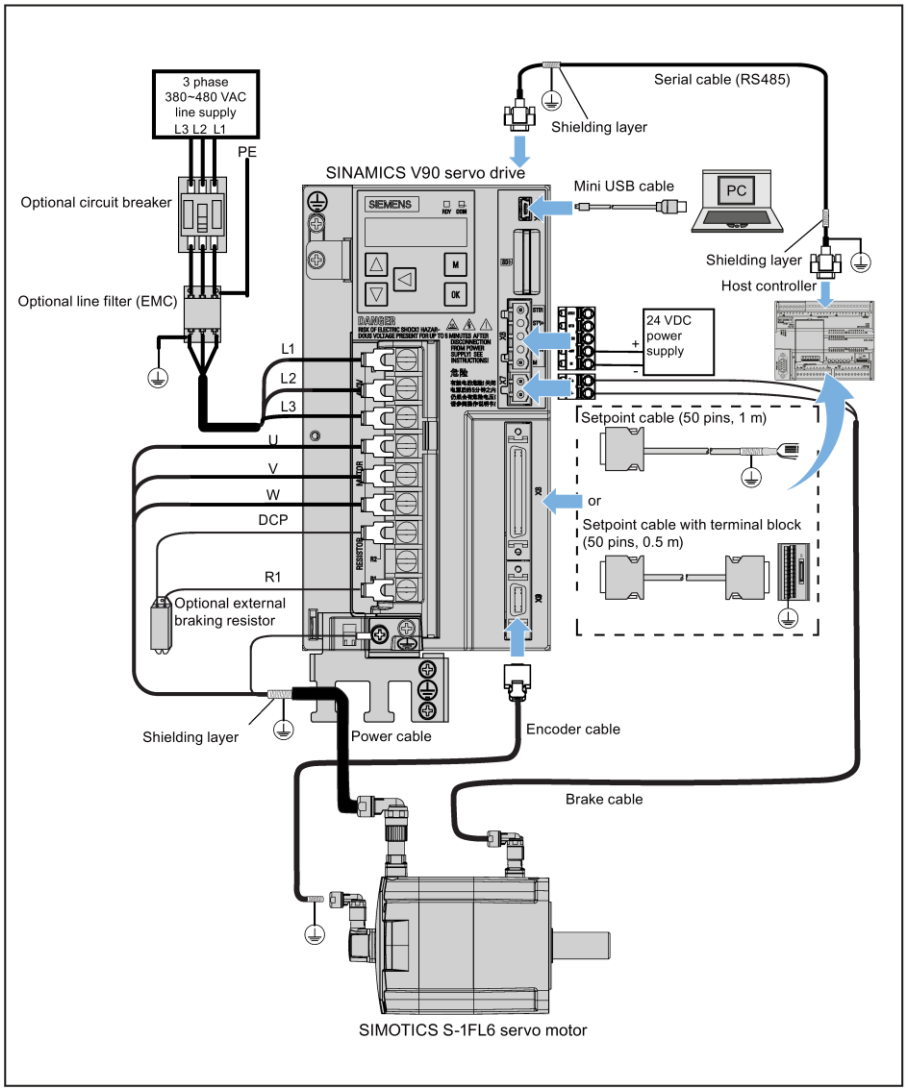


Figure 40 - System Connection Diagram

Connecting the cable shields with the shielding plate

To achieve EMC-compliant installation of the drive, use the shielding plate that is shipped with the drive to connect the cable shields. See the following example for steps to connect cable shields with the shielding plate:

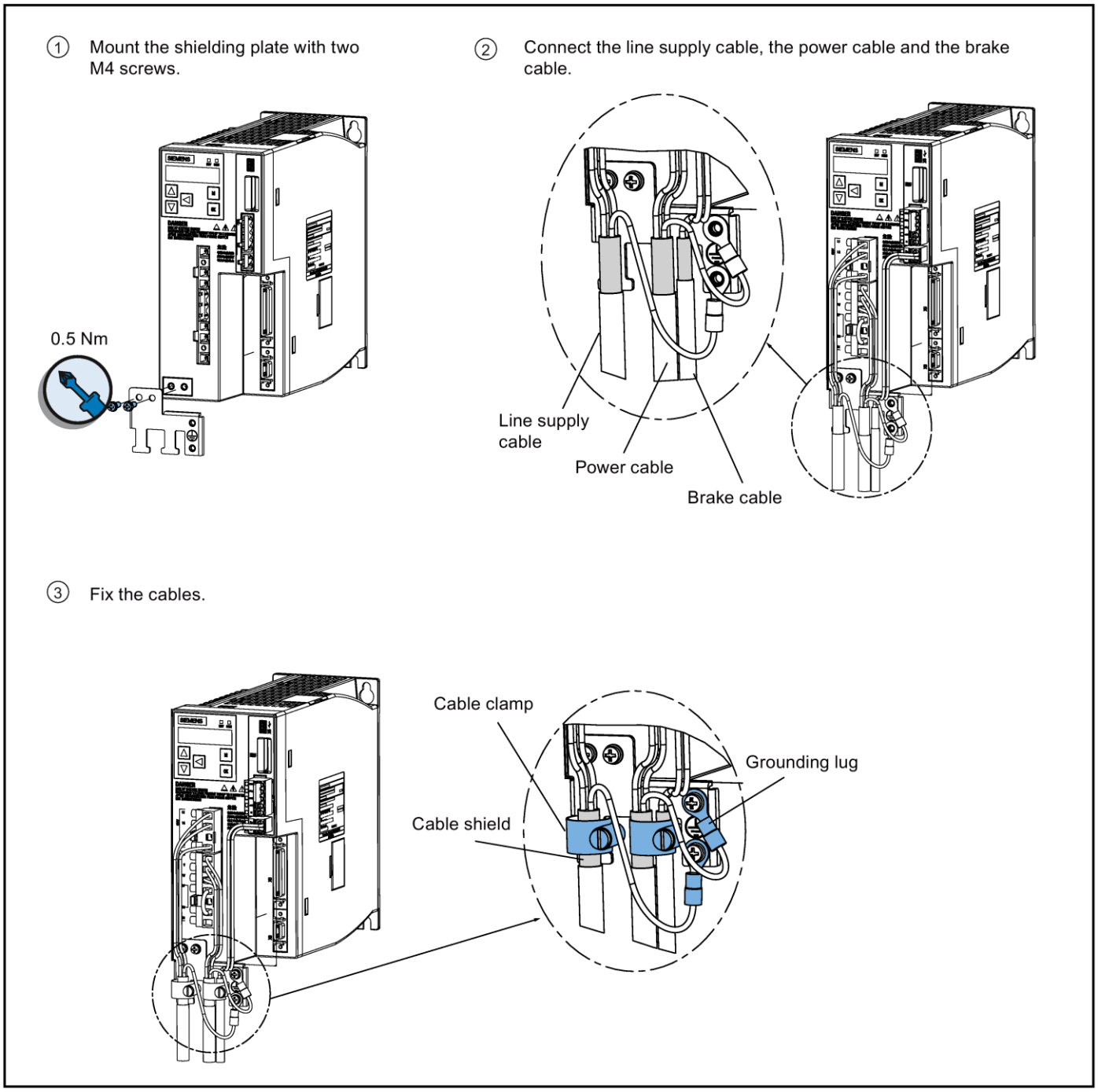


Figure 41 - SINAMICS V90 Cable Shielding

Standard Wiring for (PTI) Pulse Train Input

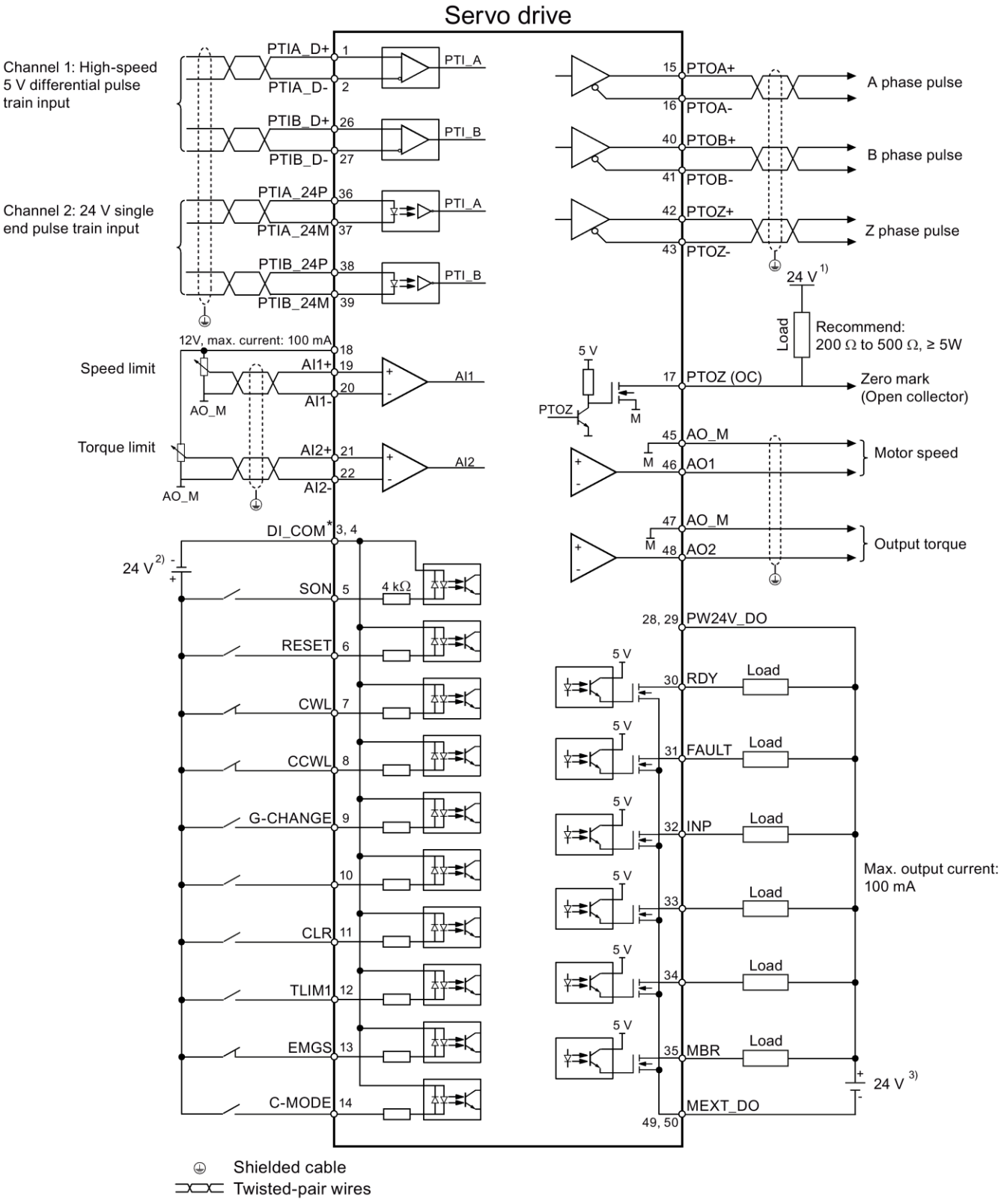


Figure 42 - SINAMICS V90 Default Wiring Schematic

Control/Status interface - X8

Pin assignment for the 50-pin MDR connector:

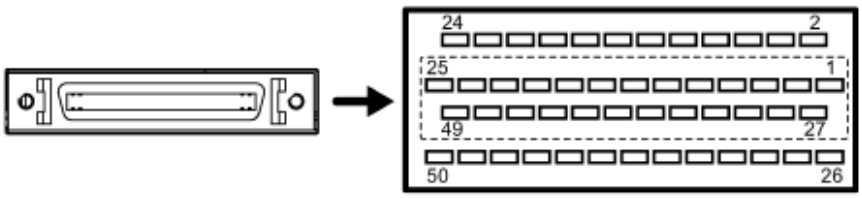
Signal type	Pin No.	Signal	Description	Pin No.	Signal	Description
 Type: 50-pin MDR socket						
Pulse train inputs (PTI)/Pulse train encoder outputs (PTO)	1, 2, 26, 27	Position setpoint with pulse train input. Exclusive for high-speed 5 V differential pulse train input (RS485) Maximum frequency: 1 MHz Signal transmission of this channel has better noise immunity.		36, 37, 38, 39	Position setpoint with pulse train input. 24 V single end pulse train input Maximum frequency: 200 kHz	
	15, 16, 40, 41	Encoder emulation pulse output with high-speed 5 V differential signals (A+/A-, B+/B-)		42, 43	Encoder Zero phase pulse output with high-speed 5 V differential signals	
	17	Encoder Zero phase pulse output with open collector				
	1	PTIA_D+	High-speed 5 V differential pulse train input A (+)	15	PTOA+	High-speed 5 V differential pulse train encoder output A (+)
	2	PTIA_D-	High-speed 5 V differential pulse train input A (-)	16	PTOA-	High-speed 5 V differential pulse train encoder output A (-)
	26	PTIB_D+	High-speed 5 V differential pulse train input B (+)	40	PTOB+	High-speed 5 V differential pulse train encoder output B (+)
	27	PTIB_D-	High-speed 5 V differential pulse train input B (-)	41	PTOB-	High-speed 5 V differential pulse train encoder output B (-)

Figure 43 - SINAMICS V90 X8 Interface

Signal type	Pin No.	Signal	Description	Pin No.	Signal	Description
	36	PTIA_24P	24 V pulse train input A, positive	42	PTOZ+	High-speed 5 V differential pulse train encoder output Z (+)
	37	PTIA_24M	24 V pulse train input A, ground	43	PTOZ-	High-speed 5 V differential pulse train encoder output Z (-)
	38	PTIB_24P	24 V pulse train input B, positive	17	PTOZ (OC)	Pulse train encoder output Z signal (open collector output)
	39	PTIB_24M	24 V pulse train input B, ground			
Digital inputs/outputs	3	DI_COM	Common terminal for digital inputs	14	DI10	Digital input 10
	4	DI_COM	Common terminal for digital inputs	28	P24V_DO	External 24 V supply for digital outputs
	5	DI1	Digital input 1	29	P24V_DO	External 24 V supply for digital outputs
	6	DI2	Digital input 2	30	DO1	Digital output 1
	7	DI3	Digital input 3	31	DO2	Digital output 2
	8	DI4	Digital input 4	32	DO3	Digital output 3
	9	DI5	Digital input 5	33	DO4	Digital output 4
	10	DI6	Digital input 6	34	DO5	Digital output 5
	11	DI7	Digital input 7	35	DO6	Digital output 6
	12	DI8	Digital input 8	49	MEXT_DO	External 24 V ground for digital outputs
	13	DI9	Digital input 9	50	MEXT_DO	External 24 V ground for digital outputs
Analog inputs/outputs	18	P12AI	12 V power output for analog input	45	AO_M	Analog output ground
	19	AI1+	Analog input channel 1, positive	46	AO1	Analog output channel 1
	20	AI1-	Analog input channel 1, negative	47	AO_M	Analog output ground
	21	AI2+	Analog input channel 2, positive	48	AO2	Analog output channel 2
	22	AI2-	Analog input channel 2, negative			
None	23	-	Reserved	25	-	Reserved
	24	-	Reserved	44	-	Reserved

Figure 44 - SINAMICS V90 X8 Interface

Overview of the Integrated BOP

The SINAMICS V90 servo drive has been designed with a Basic Operator Panel (BOP) located on the front of the servo drive:

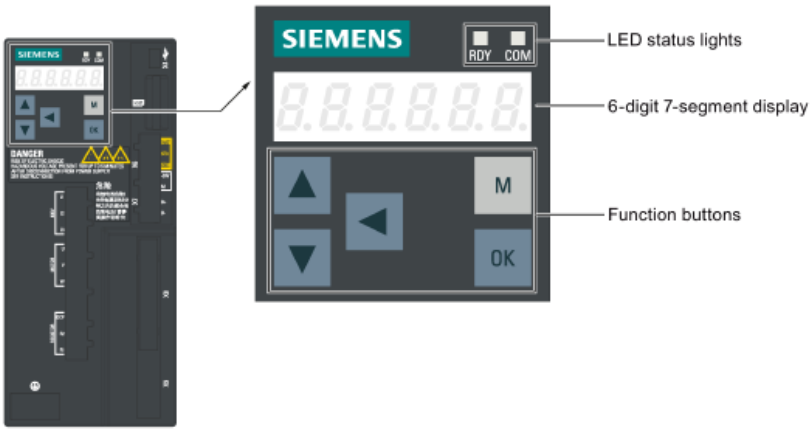


Figure 45 - SINAMICS V90 Integrated Display

Button Functions:

Button	Description	Functions
Basic buttons		
M	M button	• Exits from the current menu • Switches between operating modes in the top level menu
OK	OK button	Short-pressing: • Confirms selection or input • Enters sub menu • Acknowledges faults Long-pressing: Activates auxiliary functions • Sets Drive Bus address • Jog • Saves parameter set in drive (RAM to ROM) • Sets parameter set to default • Transfers data (drive to SD card) • Transfers data (SD card to drive) • Updates firmware
▲	UP button	• Navigates to the next item • Increases a value • JOG in CW (clockwise)
▼	DOWN button	• Navigates to the previous item • Decreases a value • JOG in CCW (counter-clockwise)
◀	SHIFT button	Moves the cursor from digit to digit for single digit editing, including the digit of positive/negative signs

Figure 46 - SINAMICS V90 Button Controls

Button	Description	Functions
Button combinations		
OK + M	Press M + OK buttons for four seconds	Restarts the drive
▲ + ◀	Press UP + SHIFT buttons	Moves current display to the left page when ⌜ is displayed at the upper right corner, for example 00.000⌜.
▼ + ◀	Press DOWN + SHIFT buttons	Moves current display to the right page when ⌟ is displayed at the lower right corner, for example 00 10⌟.

Figure 47 - SINAMICS V90 Button Controls

Operating instructions
Refer to the 'SINAMICS V90, SIMOTICS S-1FL6 Operating Instructions' for more detailed information.

https://support.industry.siemens.com/cs/gb/en/view/109480673

Further Information

The SINAMICS V90 Getting Started Manual contains detailed information and can be found here:

https://support.industry.siemens.com/cs/gb/en/view/108586654

Overview of the Programming Environment

A2

A2.1 Overview of TIA Portal

Introduction

This document provides an overview of the TIA (Totally Integrated Automation) Portal programming environment. It covers the basic user interfaces available with TIA Portal, and some of the more frequently used functions. It does not however cover all of the functions available with TIA Portal. More information can be found in the SIMATIC STEP 7 Professional System Manual, of which several pages have been taken and used this document. See link below.

Further Information

SIEMENS SIMATIC STEP 7 Professional V13.0 System Manual. This document is nearly 200MB in size.

https://support.industry.siemens.com/cs/attachments/89515142/STEP_7_Professional_V13_enUS_en-US.pdf

What is TIA Portal?

TIA Portal is an integrated software programming environment. It is used for configuring, programming and commissioning an entire automation system, including multiple related automation devices such as PLCs, HMIs and Drives in one integrated project. It is a progression from SIMATIC MANAGER or STEP 7 Classic, performing similar tasks but in a more user friendly and integrated fashion.

Opening, creating and closing projects

Open TIA Portal, the Start screen is where a project can be opened, created or closed.

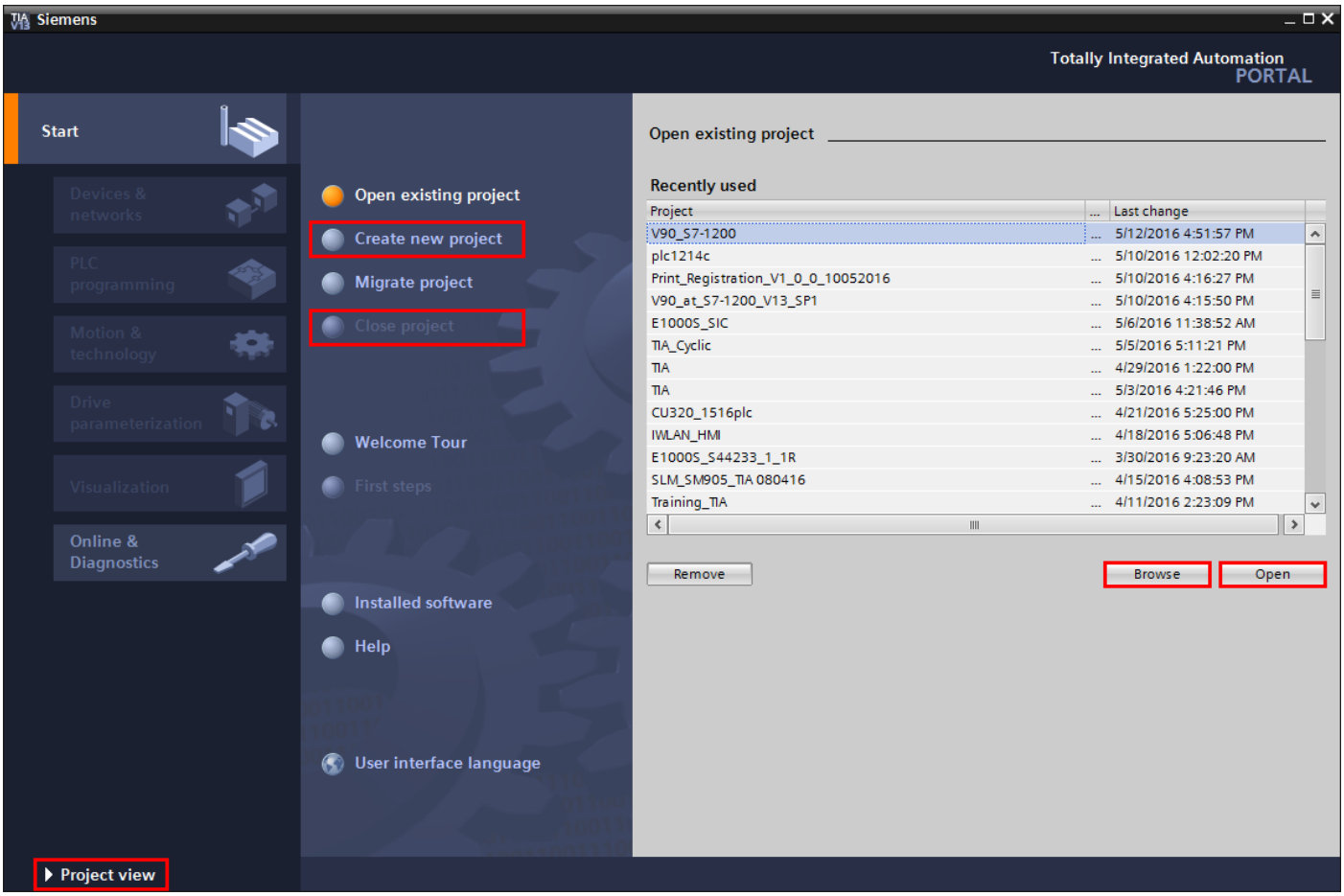


Figure 48 - TIA Start Screen

Recently used projects are automatically displayed, but the user can "Browse" to other folders to select a project stored there instead.

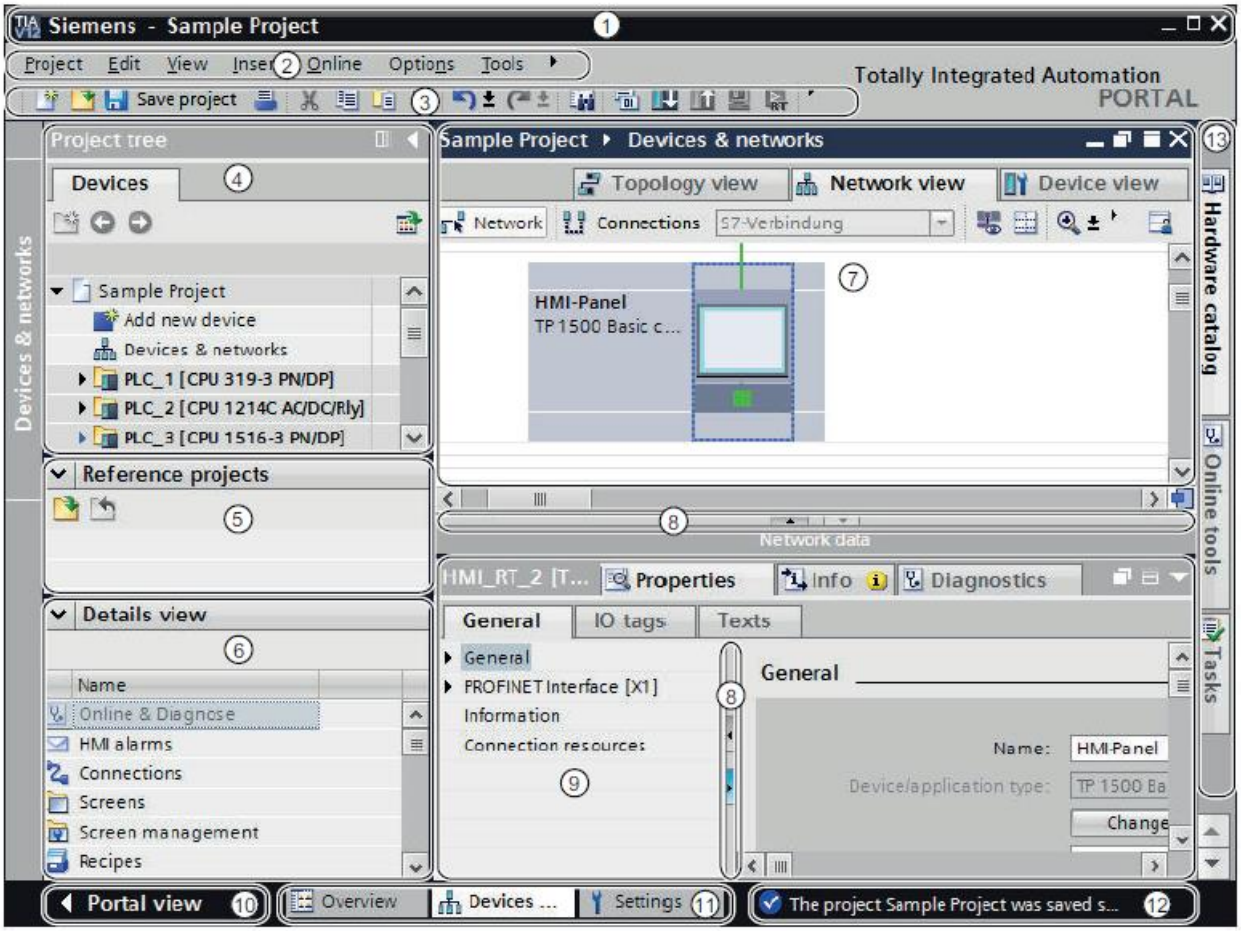
Click on "Create new project" to bring up a dialog where the project name and storage location are entered, or select a recently used project and click "Open".

"Close project" on the start screen is one option for closing projects in TIA.

"Project view" changes the look and functionality of the user interface, and it is the HMK recommended view for working on projects.

Project View

Project view gives access to much more information and functionality on all devices in the project at one time. The following picture is taken from the SIEMENS SIMATIC STEP 7 Professional V13.0 System Manual.



① Title bar
② Menu bar
③ Toolbar
④ Project tree
⑤ Reference projects
⑥ Details view
⑦ Work area
⑧ Dividers
⑨ Inspector window
⑩ Changing to the Portal view
⑪ Editor bar
⑫ Status bar with progress display
⑬ Task cards

Figure 49 - Project view

Add new device

In the Project tree area click on “Add new device”.

A dialog appears which allows a choice of Controllers, HMI, PC Systems or Drives.

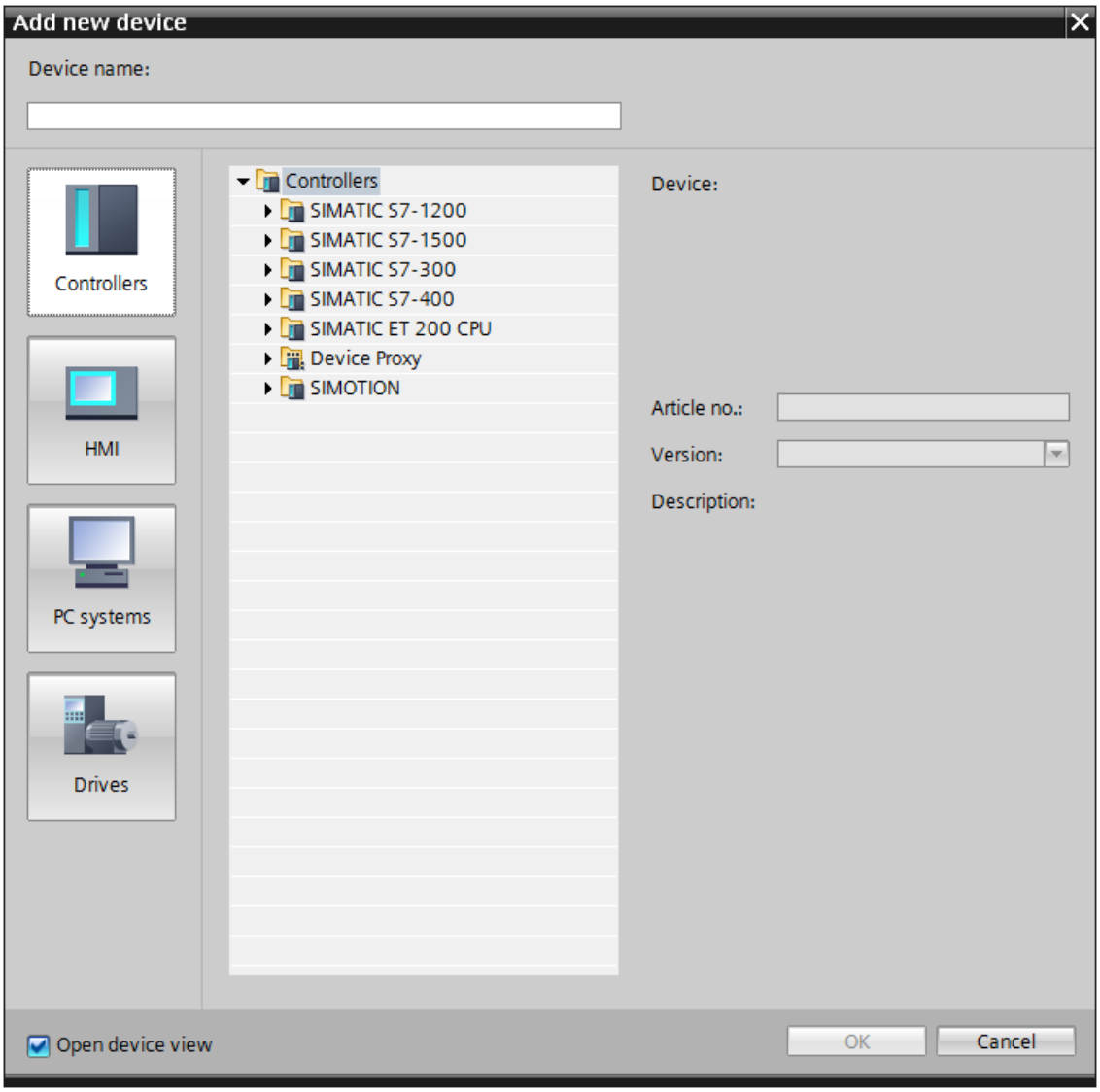


Figure 50 - Add new device

Currently the only drives which can be selected here are G110M and G120 (including C, D and P). Other drives and automation devices must be added using the Hardware catalog, detailed in the Devices & networks section.

Locate the device you wish to add, make sure the article number and version number are correct!

Add as many new devices as you need in your project.

Accessible devices

Select the highlighted icon below to open the accessible nodes dialog.

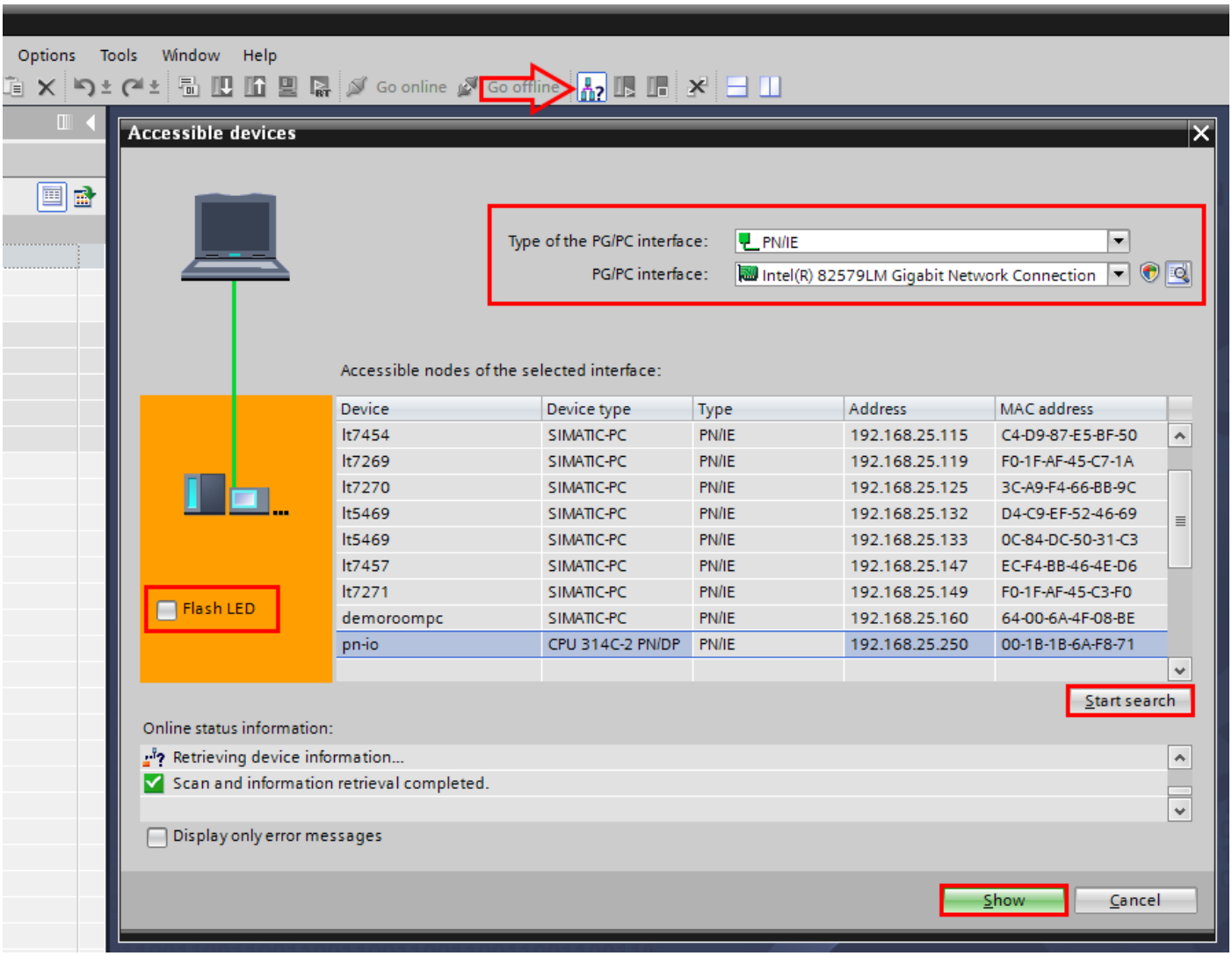


Figure 51 - Accessible devices

With this dialog it is possible to view all accessible devices that are connected to, or on the same network as the programmer. Select the PG/PC interface (the connection interface you expect to see devices connected to) and click "Start search". The list will populate with all the devices the programmer can see. It is possible to highlight a device in the list and press "Flash LED", this will flash the LED on the actual device, this can be useful if you have multiple devices of the same type connected. Clicking the "Show" button will open the selected object in the Online access folder of the Project tree. From here such functions as re-assigning the IP address, viewing diagnostics, resetting to factory defaults and firmware updates are possible. See Online & diagnostics section later in this document.

Devices & networks

Double click on “Devices & networks” in the Project tree to open the following work area.

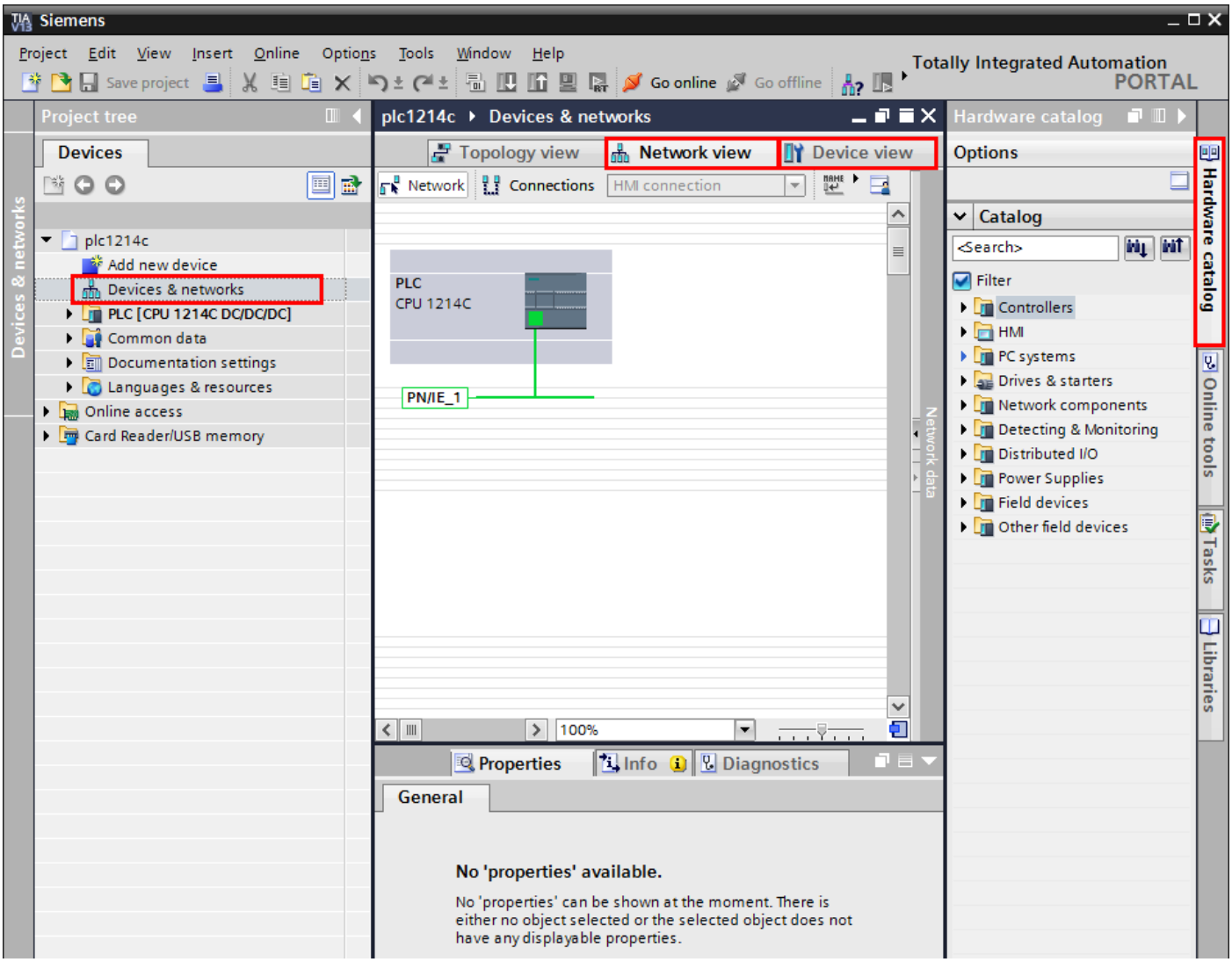


Figure 52 – Devices & Networks

This work area is used to configure properties and connections of networks and devices, as well as adding new devices. By default, the “Hardware catalog” will open in the Task cards area. The Hardware catalog is where other devices can be added into the project by dragging and dropping in to the work area. Double click on a device in the work area to open the “Device view”. The properties tab at the bottom of the screen will display and allow editing of selected object properties, and the Hardware catalog is automatically filtered to display sub-modules that can be dragged into the work area or Device overview area, depending on the device and sub module.

Global libraries

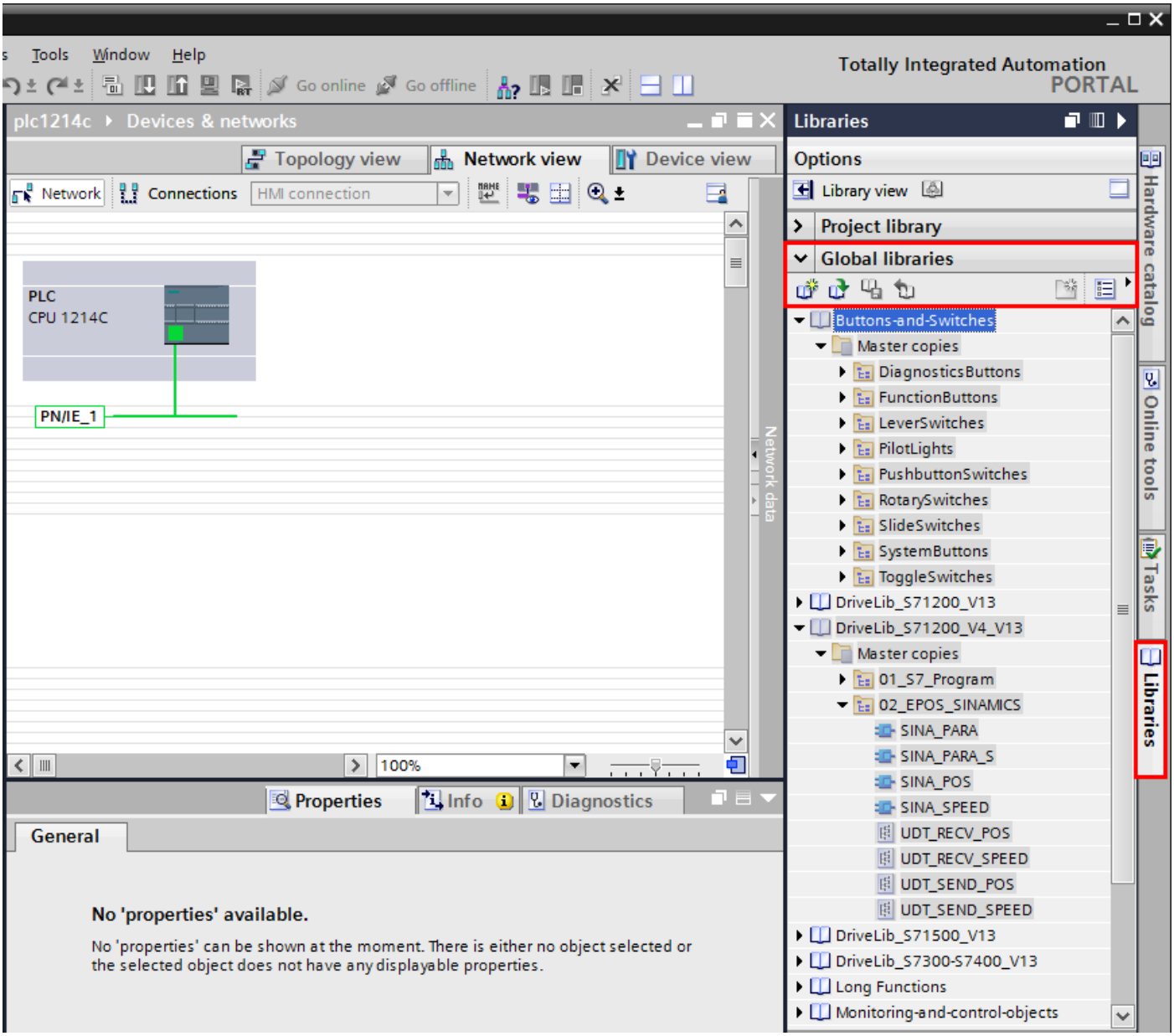


Figure 53 - Global libraries

Global libraries are available from the Libraries task card. They contain objects and functions that can be dragged and dropped into various elements of the user project. Certain libraries are installed as part of the TIA environment, but other libraries can be downloaded from the web, or even be created by the user to contain custom user-created elements that are then available to be used in later projects, or exported for other users to access.

Download and go online

Select the device in the Project tree. If you are currently offline the options to "Download" (arrow down) and "Go online" and available. If you are currently online the options to "Upload" (arrow up) or Go offline" are available.

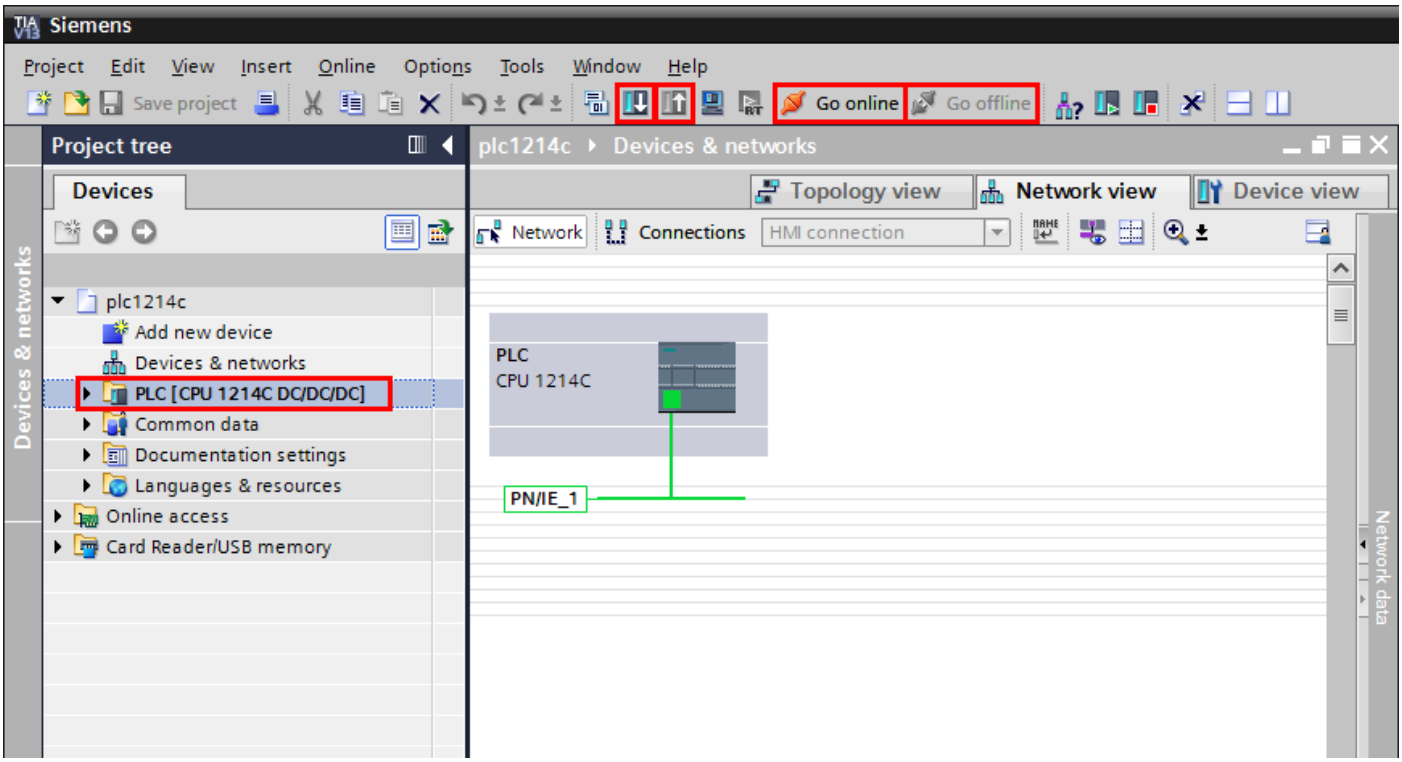


Figure 54 - Download/upload

To download a hardware configuration to a PLC, you must be offline first.

A download is defined as FROM the programmer TO the device, and an upload is FROM the device TO the programmer.

The first time you download to a device you will be presented with the dialog below. Use the drop down boxes to select your PG/PC interface (the method you expect to connect to the device with) and click " Search".

If your device appears in the list, select it and click "Load" to begin the download. If your device does not appear in the list, check your PG/PC interface settings and physical network connections.

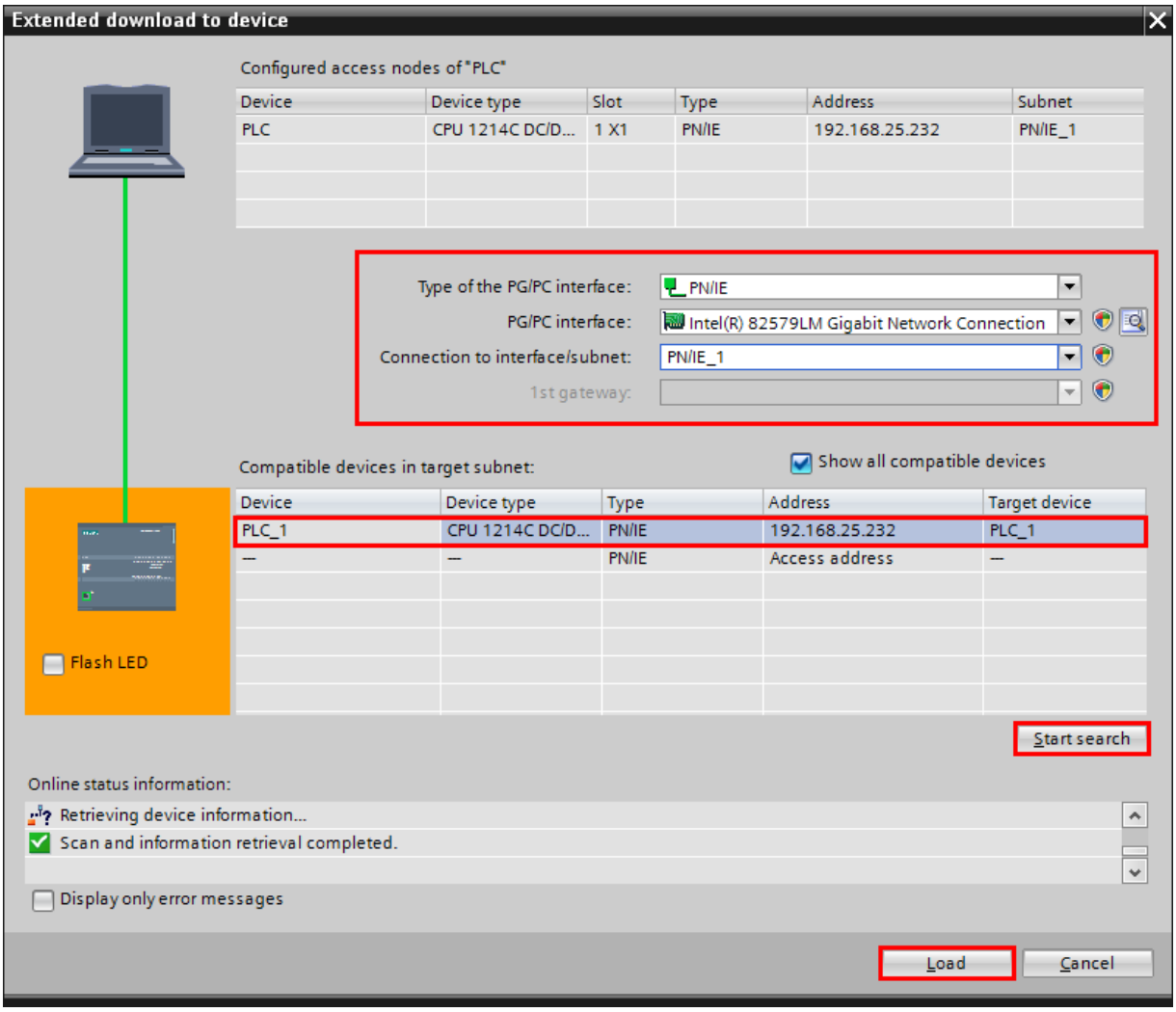


Figure 55 - First time download

Online & diagnostics

Once an online connection has been established, the bar at the top of the Work area will become orange, the bottom right of the TIA portal window will display the connection device and status and the "Online tools" card will automatically open, shown on the right of the screenshot below.

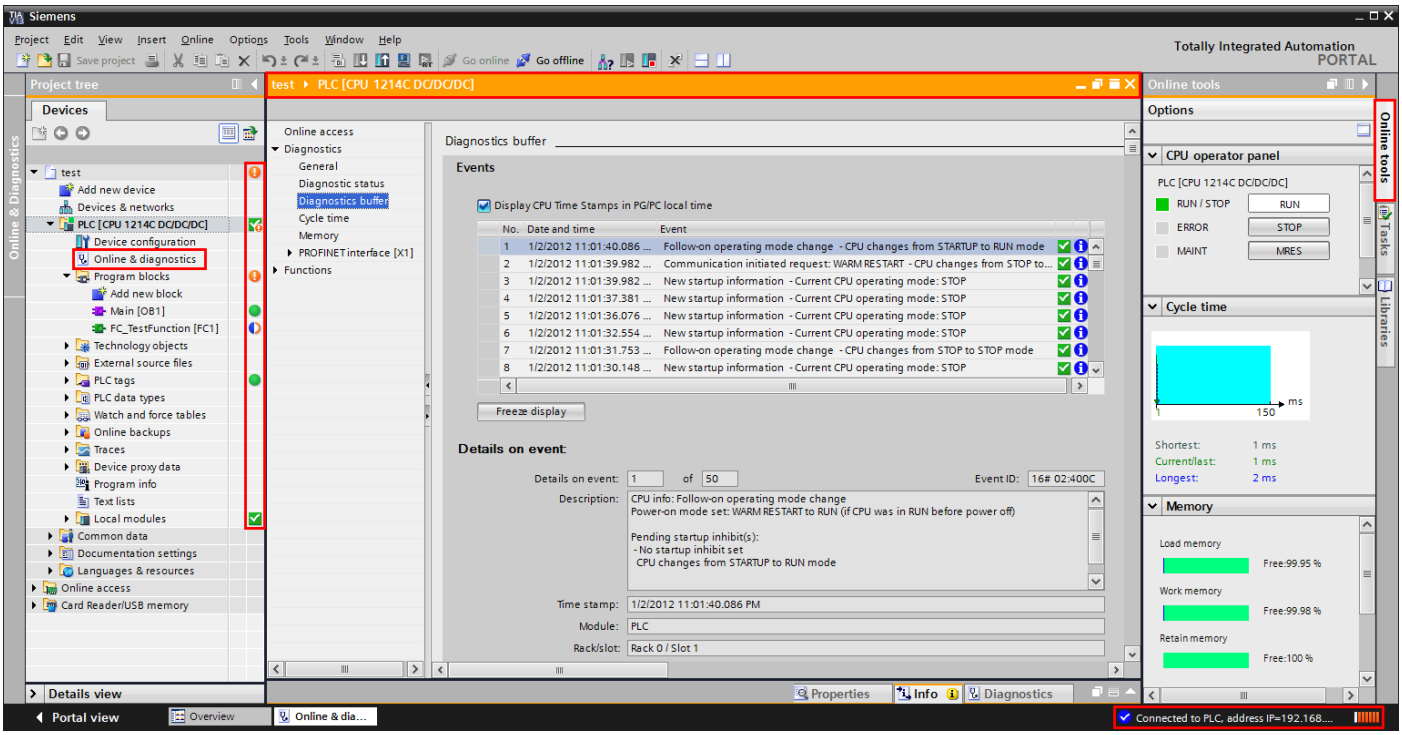


Figure 56 - Online diagnostics

Double click on the "Online & diagnostics" entry under the desired device in the Project tree to open the work area shown above. This work area gives access to various online functions such as Firmware updates, time setting etc., and also diagnostic information such as the PLC diagnostic buffer (shown).

While online an automatic online/offline comparison is done, and the results are shown as coloured icons down the right hand side of the Project tree. The meaning of the icons is shown in the table below, taken from the SIEMENS SIMATIC STEP 7 Professional V13.0 System Manual.

Symbol	Description
	Folder contains objects whose online and offline versions differ
	Comparison results are not known
	Online and offline versions of the object are identical
	Online and offline versions of the object are different
	Object only exists offline
	Object only exists online

Figure 57 - Online/offline comparison

PLC programming

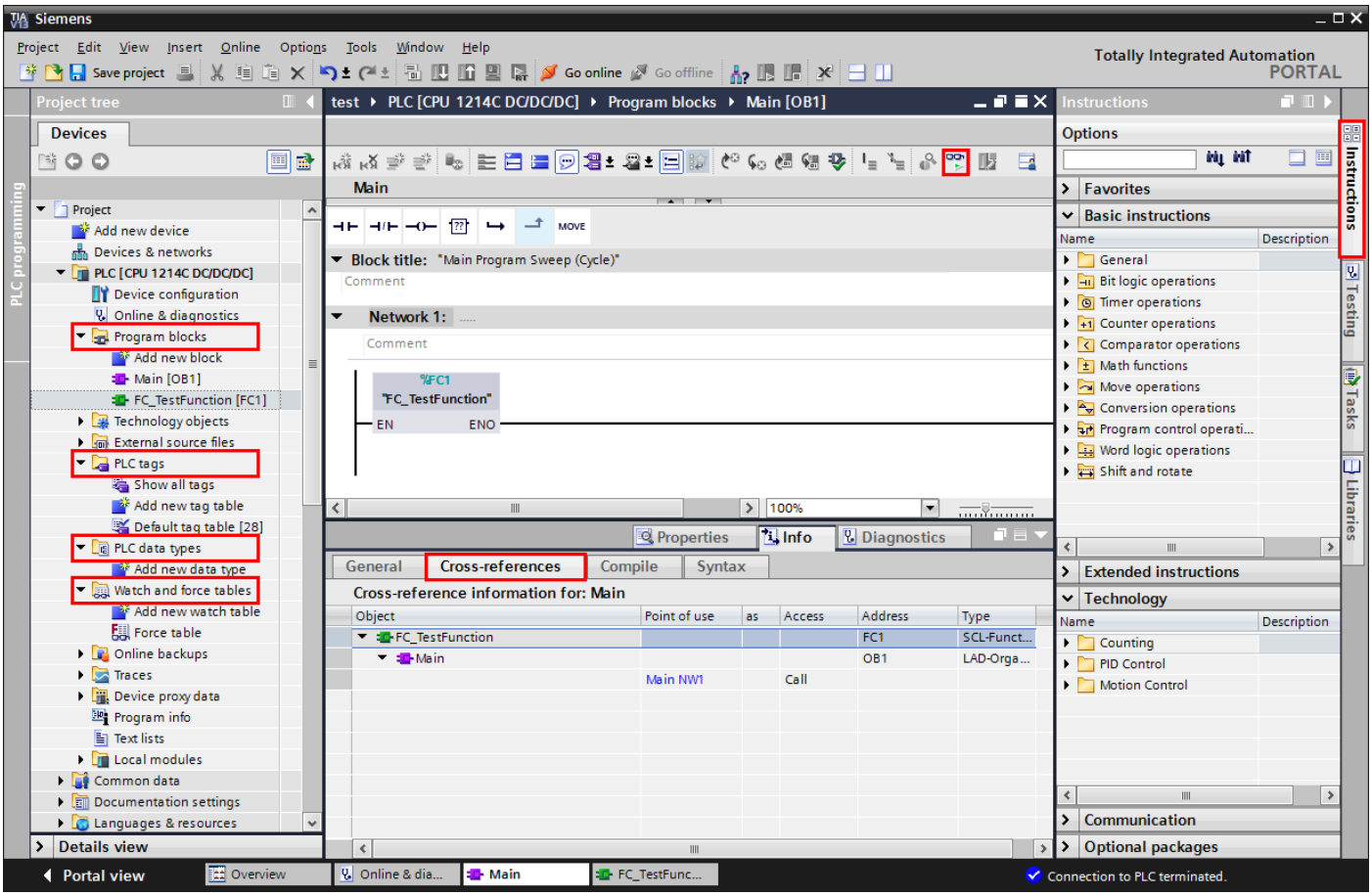


Figure 58 - PLC programming

Commonly used controls for PLC programming in the Project tree include “Program blocks” where blocks can be created or dragged in from a library. “PLC tags” where tags are created and organised, “PLC data types” which can be user created or dragged from the library and “Watch and force tables” which are useful for monitoring and setting tags in the PLC.

Cross references are available in the Inspector window, cross references are available for blocks as well as tags and can follow through to other devices in the project, i.e. a tag that is used in the PLC and HMI will show cross references to both objects.

Programming instructions that are available can be found in the "Instruction" card, above on the right. These can be dragged in to the work area.

Clicking on the "Glasses" will enable online viewing of the work area (if the programmer is connected to the device). This is very useful for fault finding in programming code.

Archiving and retrieving

Projects can be easily moved, shared, emailed etc. if they are archived. Archiving is creating a zipped file, the extension of the zipped file is .zap13 for a TIA V13 project or .zap12 for a TIA V12 project.

To open an archived project file, it first needs to be "retrieved". Once retrieved it can be opened in the normal manner as detailed earlier.

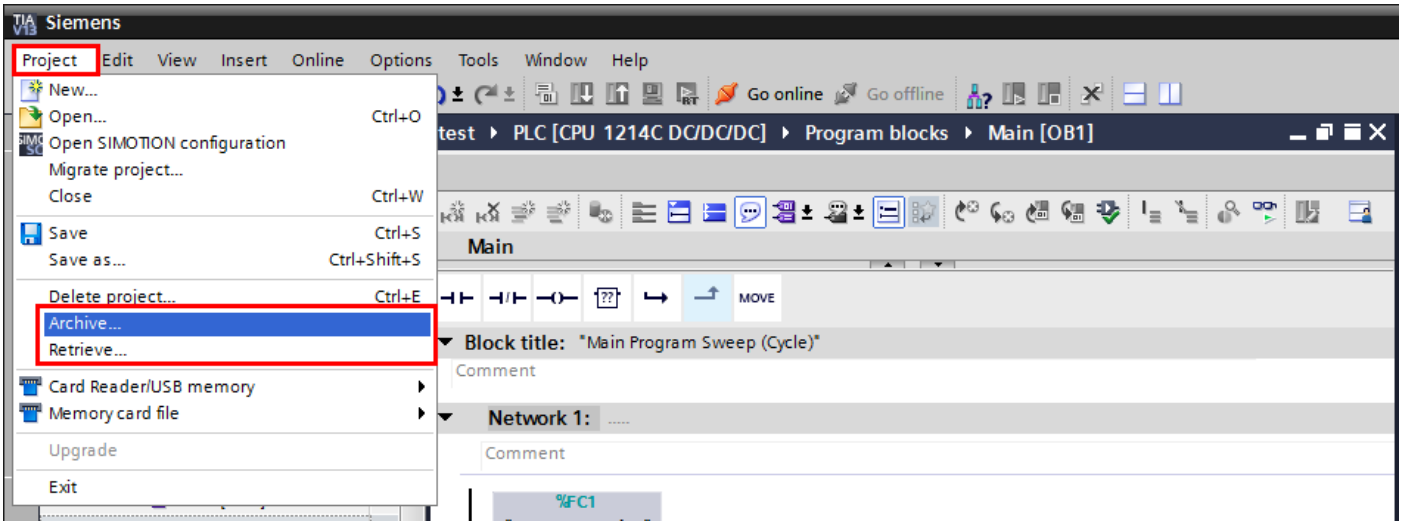


Figure 59 - Archiving and retrieving

Highlight the project in the Project tree, and click "Project" in the Menu bar. Choose from the option of Archive or Retrieve.

A2.2 Overview of V-ASSISTANT

Selecting the Working Mode

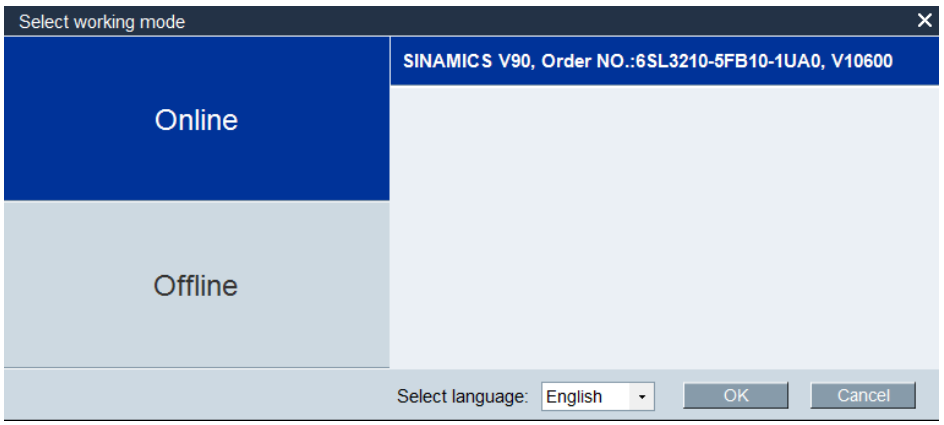


Figure 60 - Selecting Online Mode

To work in 'online' mode, connect the Drive via USB to the PG/PC. It will appear in the 'online' tab. Select the drive and select 'OK' to start working.

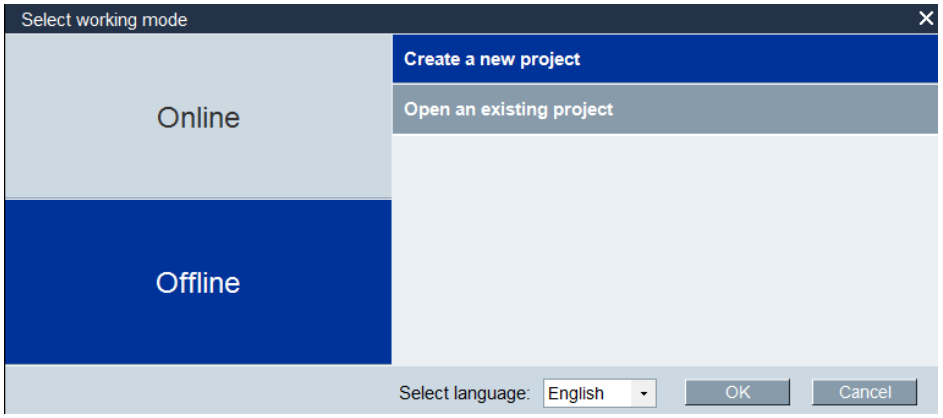
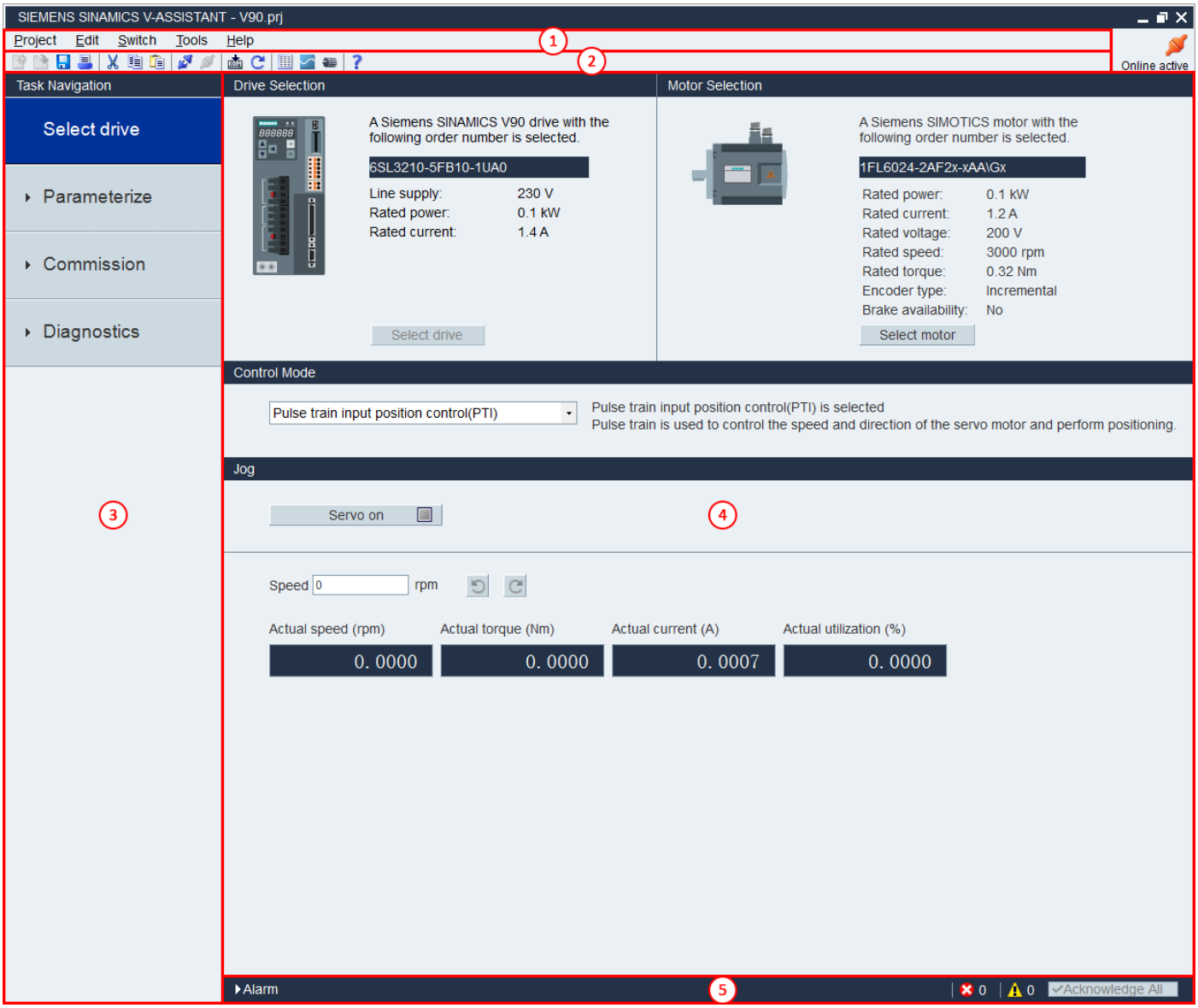


Figure 61 - Selecting offline Mode

To Work in 'Offline' mode, select one of the options: Create a new project, or open an existing project to continue previous work. Select 'OK' to start working.

User Interface Layout



1. Menu bar
2. Toolbar
3. Task navigation
4. Function Mask
5. Alarm Window

Figure 62 - V-ASSISTANT Layout

Menu bar

The menu bar is located at the top of the SINAMICS V-ASSISTANT window. You can find various commands and functions for basic operations of SINAMICS V-ASSISTANT.

Toolbar

The toolbar is located below the menu bar and provides direct access to the essential functions of SINAMICS V-ASSISTANT.

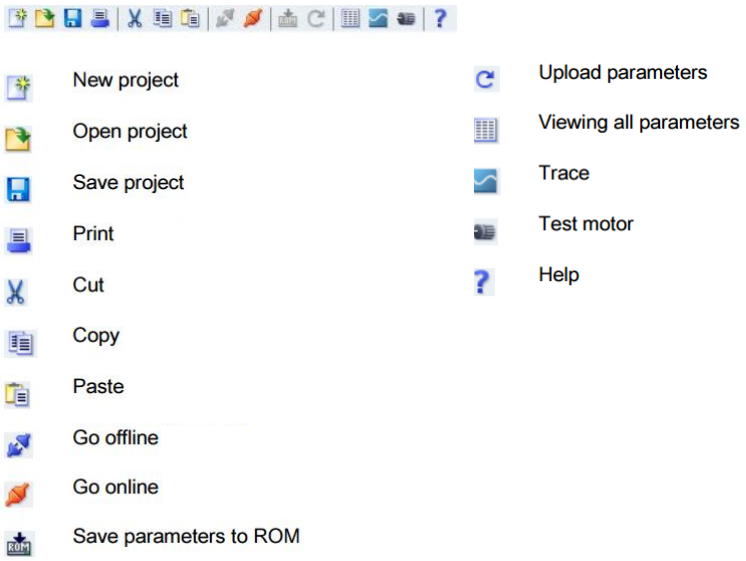


Figure 63 - V-ASSISTANT Toolbar

Task navigation

Task navigation lists the user tasks for users to fulfil. Each task contains different functions which facilitate users to parameterize all functions of SINAMICS V90 drives and monitor or diagnose the drives.

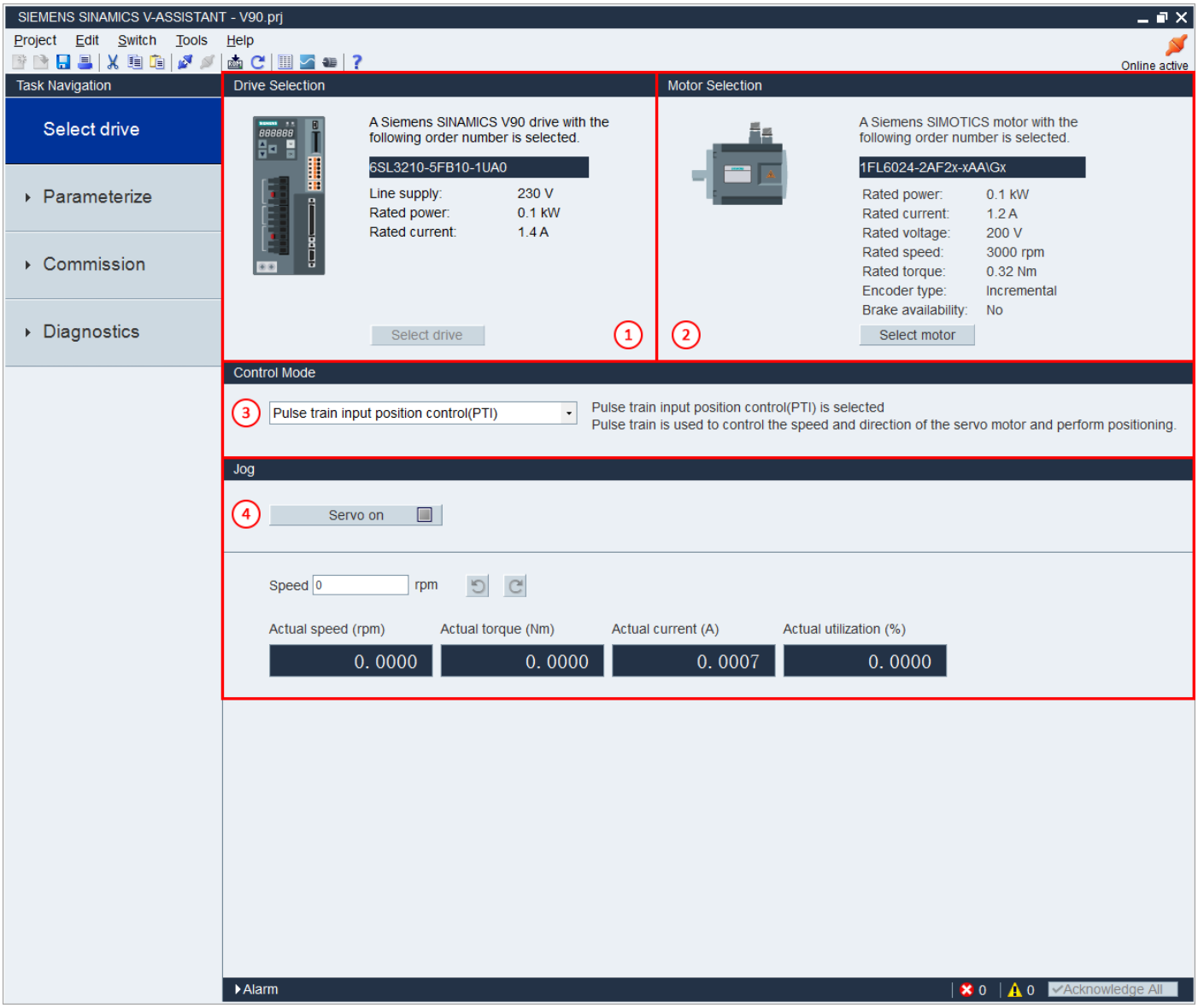
Function mask

The function mask provides the user interface of each user task for users to implement related functions.

Alarm window

In online mode, the current faults and alarms are displayed in a list with the corresponding type, number and name. In offline mode, the alarm window is disabled.

'Select Drive' Tab



1. Drive Selection
2. Motor Selection
3. Control Mode
4. Jog

Figure 64 - V-ASSISTANT layout

Note When working in online mode, the select drive button will be greyed out.

'Parameterize' Tab

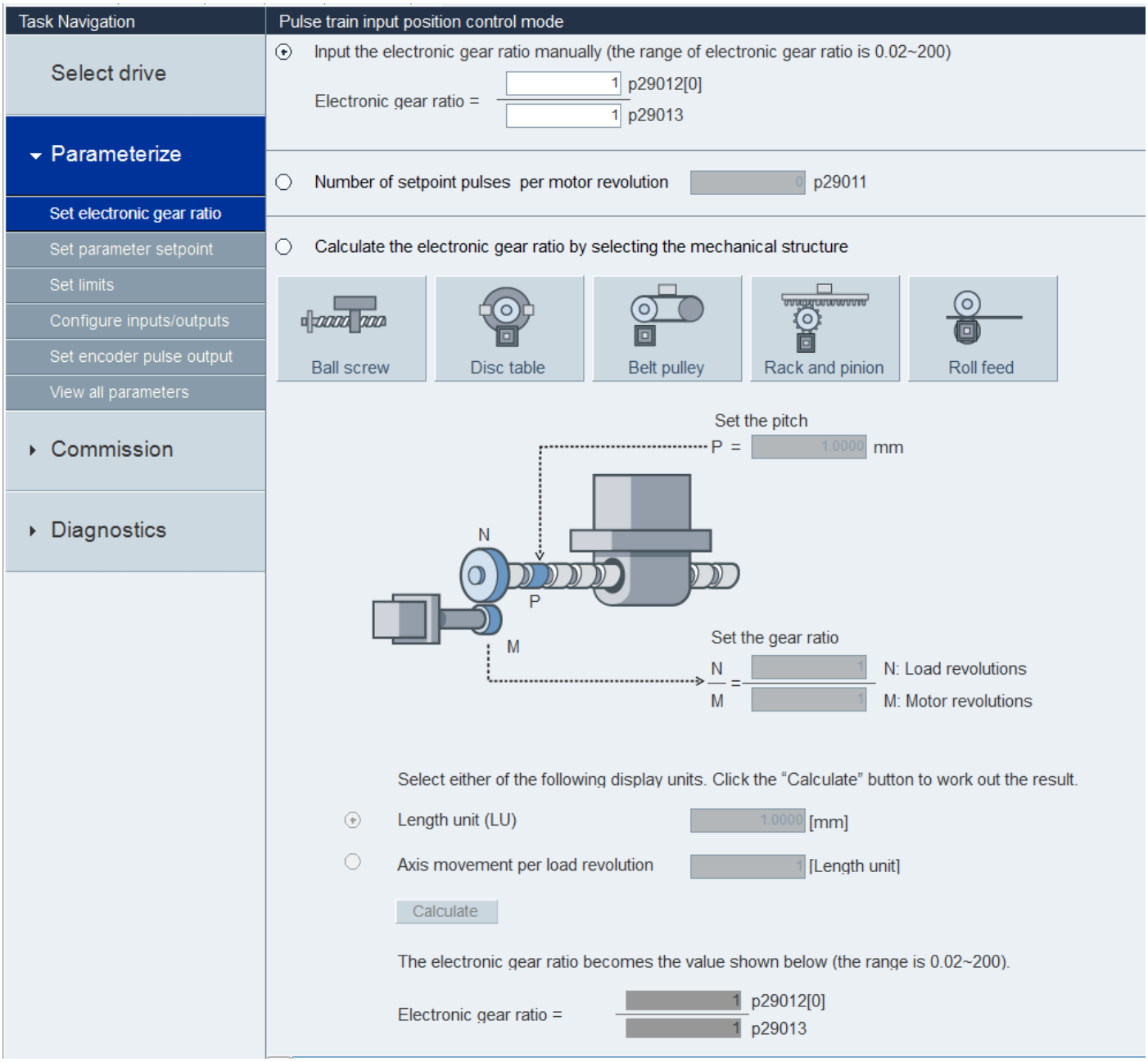
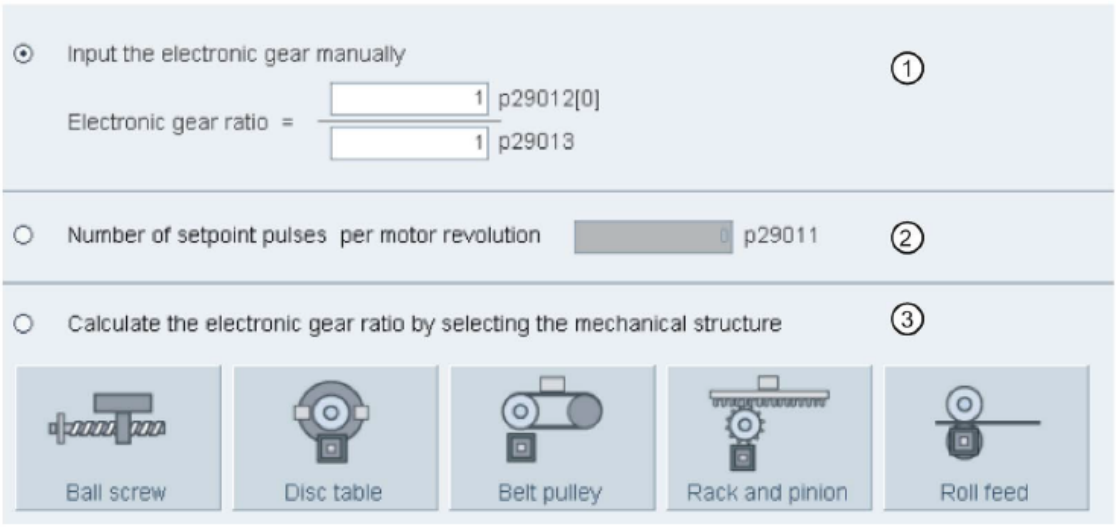


Figure 65 - V-ASSISTANT Parameterize Tab

Note Some of the displayed options are not available in all control modes.

Setting the Electronic Gear Ratio Sub-tab



Options	Description
①	When number of setpoint pulses per motor revolution (p29011) is 0, configure electronic gear ratio by setting numerator (p29012) and denominator (p29013).
②	When number of setpoint pulses per motor revolution is not 0, enter the number of setpoint pulses per motor revolution here.
③	Calculate the electronic gear ratio according to different mechanical structures. Totally, five mechanical structures are available: 1. Ball screw 2. Disc table 3. Belt pulley 4. Rack and pinion 5. Roll feed

Figure 66 - Set Electronic Gear Ratio Section

Set Parameter Setpoint Sub-tab

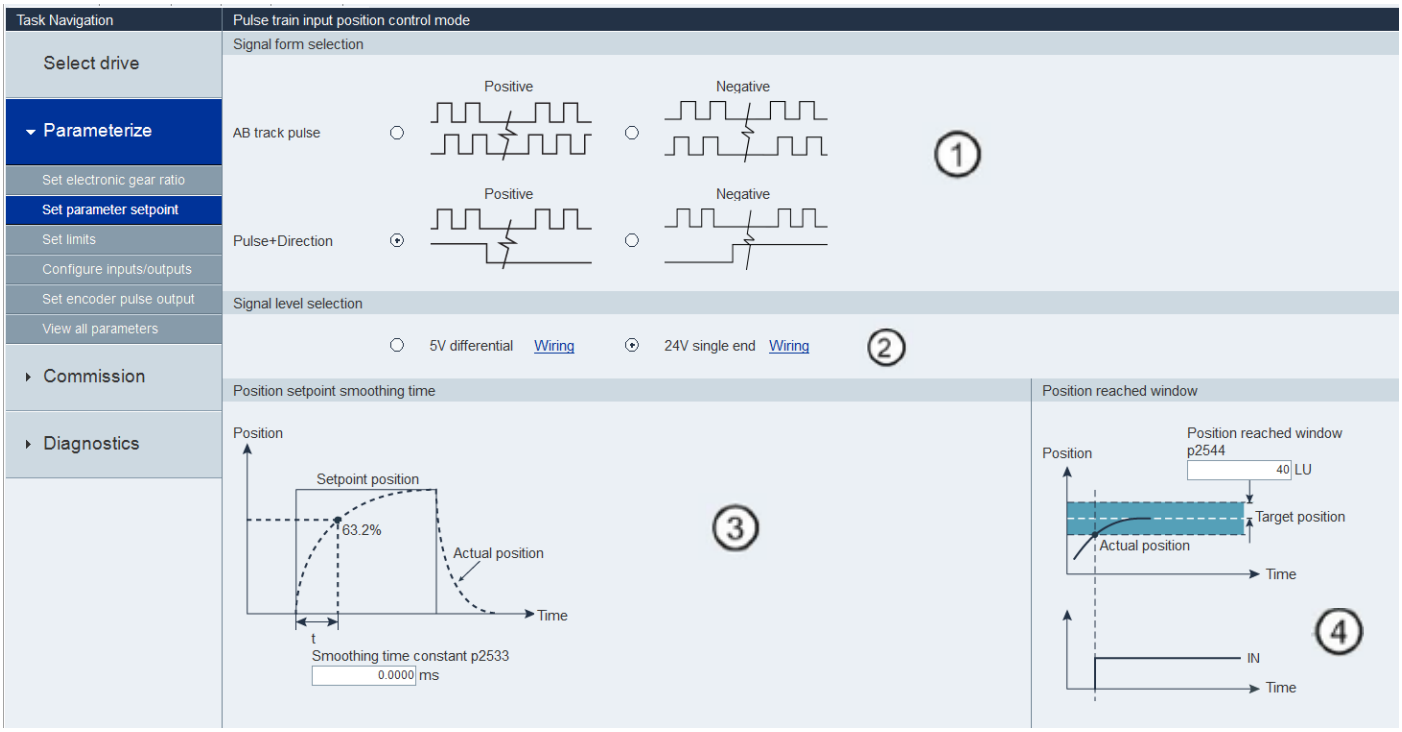


Figure 67 - Set Parameter Setpoint Section

① Signal selection: Allows the user to select the pulse method used.

② Signal level selection: Allows the user to select the type of pulse input. Hovering over 'Wiring' shows a diagram of the pulse input type.

③ Position Setpoint smoothing time: Allows the user to define the smoothing time constant.

④ Position reached window: Allows the user to define the positioning window tolerances in Load Units (LU).

Configure I/O Sub-tab

Inputs:

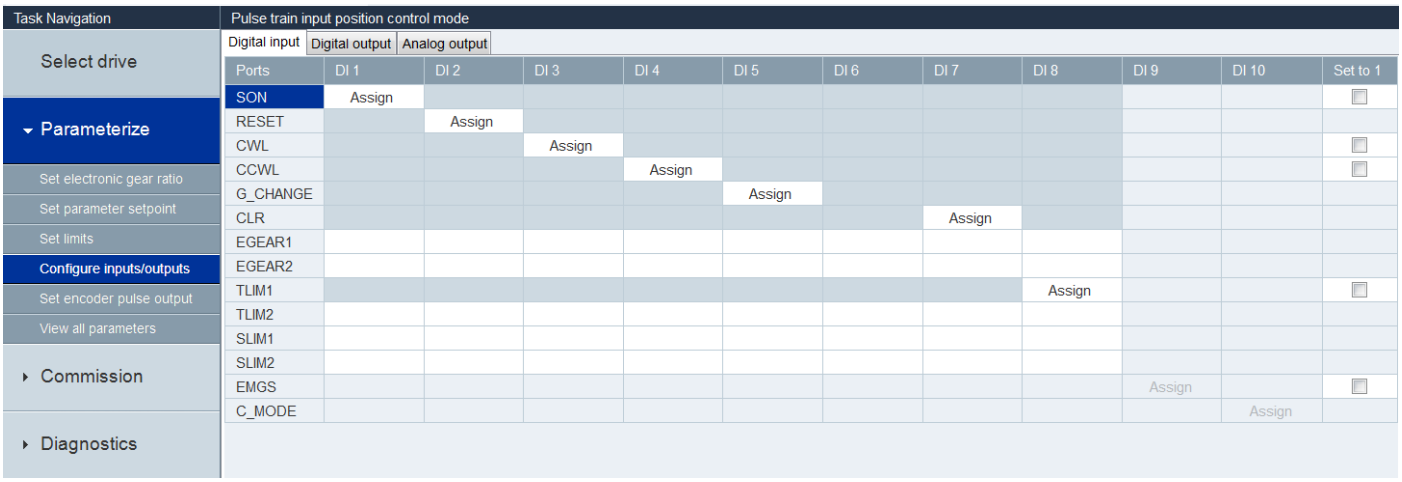


Figure 68 - Configure SINAMICS V90 Digital Inputs

Allows the user to assign Digital Inputs. The inputs can also be set permanently high using the tick boxes on the right hand side.

Outputs:

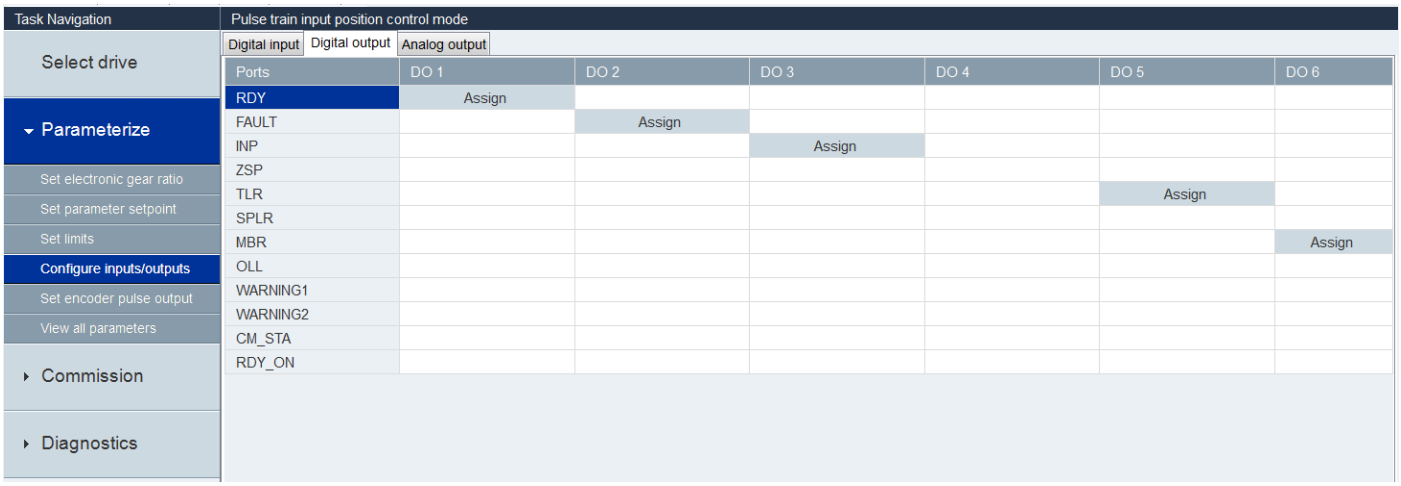


Figure 69 - Configure SINAMICS V90 Digital Outputs

Allows the user to change the assignment of the outputs, such as the ready signal.

Further Information

The V-ASSISTANT Manual contains more detailed information about the V-ASSISTANT software and the commissioning of a SINAMICS V90 drive. Download V-ASSISTANT at:

https://support.industry.siemens.com/cs/gb/en/view/109480674

Technology Objects

A3

A3.1 Technology Object Data Block

Technology Object Data Block

The technology data block represents the technology object and contains all configuration data, setpoint and actual values, and status information of the technology object. The technology data block is automatically created when the technology object is created. In your user program you can access the technology data block's data.

Evaluate Data Block StatusBits and ErrorBits Structures

Individual status and error information from the "StatusBits" and "ErrorBits" Boolean structures are available for use in the user program.

Data Block StatusBits Structure

The <TO>.StatusBits structure contains the status information of the technology object.

Tag	Description
Activated	Axis is activated
Enable	Axis is enabled
HomingDone	Axis is homed
Done	No Motion Control job is active on the axis
Error	An error has occurred on the axis
Standstill	Axis is at a standstill
PositioningCommand	Axis executes a positioning job
VelocityCommand	Axis executes a job with velocity specification
HomingCommand	Axis executes a homing job
CommandTableActive	Command table is being processed
ConstantVelocity	Axis traverses with a constant velocity
Accelerating	Axis is accelerating
Decelerating	Axis is decelerating
ControlPanelActive	Manual control mode was enabled in the axis control panel
DriveReady	Drive is ready
RestartRequired	Restart required
SWLimitMinActive	Status of lower software limit switch
SWLimitMaxActive	Status of upper software limit switch
HWLimitMinActive	Status of lower hardware limit switch
HWLimitMaxActive	Status of upper hardware limit switch

Data Block ErrorBits Structure

The <TO>.ErrorBits structure contains the error information of the technology object.

Tag	Description
SystemFault	Internal system error
ConfigFault	Faulty configuration of axis
DriveFault	Drive has displayed an error due to failure of drive-ready signal
SWLimit	Software limit switch approached or overtraveled
HWLimit	Hardware limit switch approached or overtraveled
DirectionFault	Invalid movement direction
HWUsed	Another axis is using the same PTO (Pulse Train Output) and is enabled
SensorFault	Error in encoder system
CommunicationFault	Communication with a connected device is faulty
FollowingError	The maximum permitted following error has been exceeded
PositioningFault	The positioning axis was not positioned correctly at the end of a positioning motion

Using the MC_Reset Function Block

All technology alarms that can be acknowledged in the user program are acknowledged with the Motion Control instruction "MC_Reset". Acknowledgment also resets the "Error" and "Warning" bits in the appropriate technology data block.

Technology objects are reinitialized (restarted) using the Motion Control instruction "MC_Reset" with "Restart" = TRUE. Upon restart of the technology object, the new configuration data are applied in the technology data block.

A3.2 Technology Object Function Blocks

Using the MC_Power Function Block

The Motion Control instruction "MC_Power" is used to enable and disable technology objects.

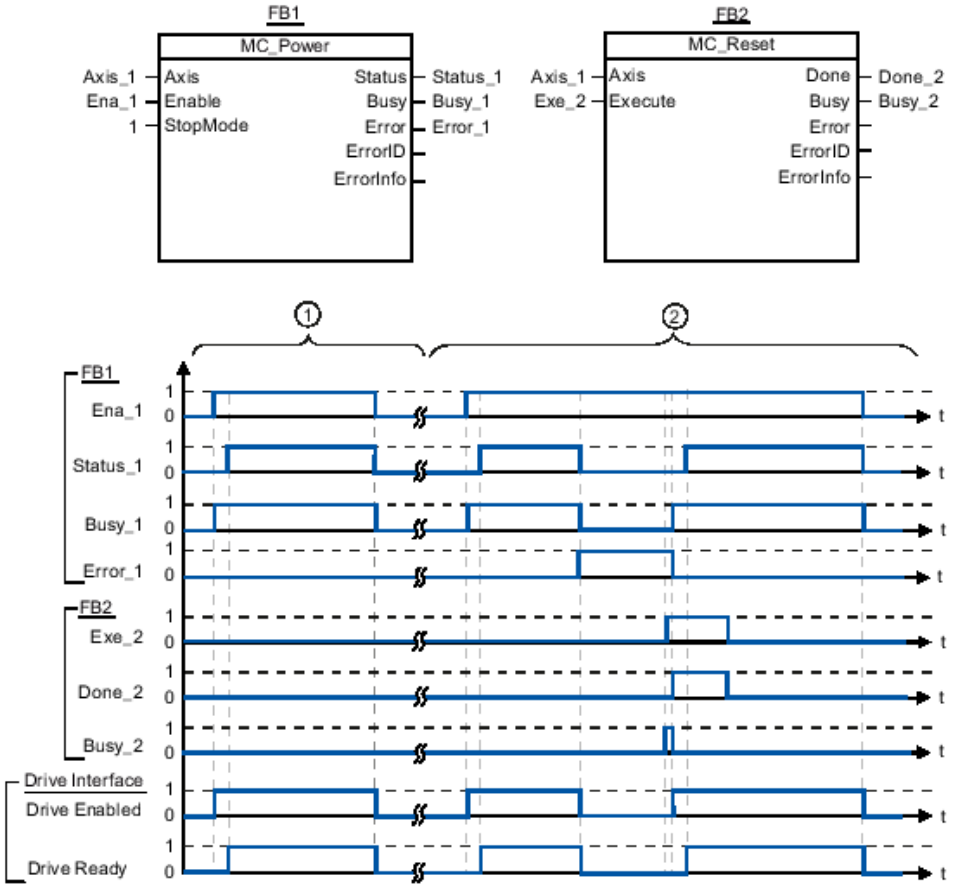


Figure 70 - MC_Power Function Block

①	An axis is enabled and then disabled again. When the drive has signaled "Drive ready" back to the CPU, the successful enable can be read out via "Status_1".
②	Following an axis enable, an error has occurred that caused the axis to be disabled. The error is eliminated and acknowledged with "MC_Reset". The axis is then enabled again.

Using the MC_Home Function Block

With the Motion Control instruction "MC_Home", you create the relationship between the position in the technology object and the mechanical position. The position value in the technology object is assigned to a homing mark at the same time. This homing mark represents a known mechanical position.

The homing process occurs according to the mode selected with the "Mode" parameter, and the configuration under "Technology object > Configuration > Extended parameters > Homing".

The homing method to be used should be selected depending on the encoder type used on the axis.

The following table describes each of the homing modes:

Mode	Direction
0	Direct homing (absolute) New axis position is the position value of parameter "Position".
1	Direct homing (relative) New axis position is the current axis position + position value of parameter "Position".
2	Passive homing Homing according to the axis configuration. Following homing, the value of parameter "Position" is set as the new axis position.
3	Active homing Homing procedure in accordance with the axis configuration. Following homing, the value of parameter "Position" is set as the new axis position.

Using the MC_MoveJog Function Block

The MC_MoveJog function is used to manually jog the axis in either direction.

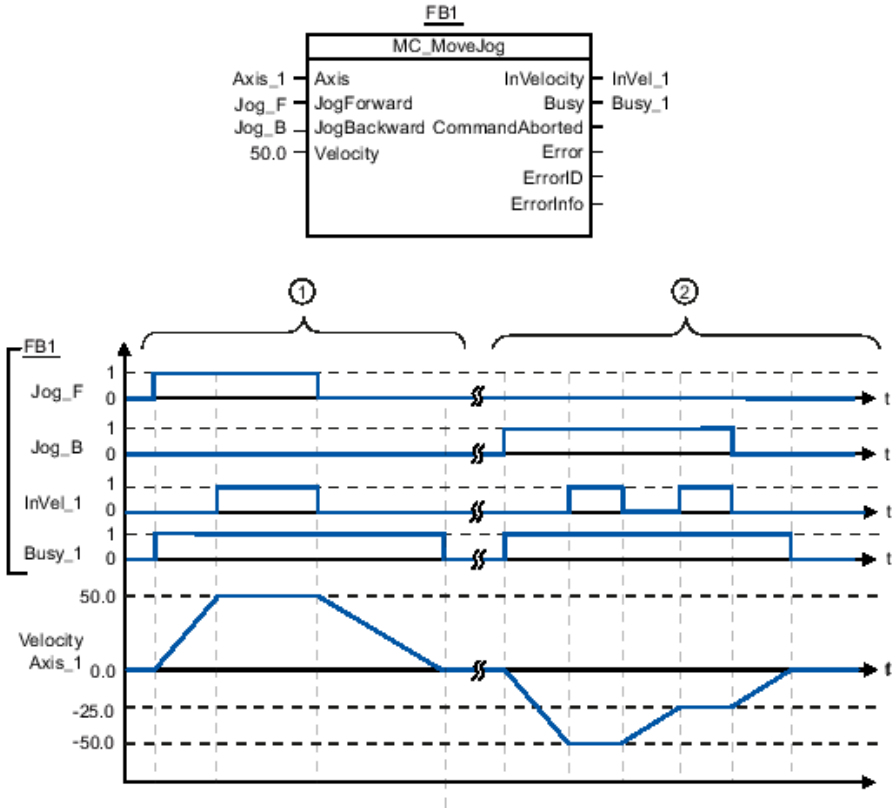


Figure 71 - MC_MoveJog Function Block

①	The axis is moved in the positive direction in jog mode via "Jog_F". When the target velocity 50.0 is reached, this is signaled via "InVel_1". After "Jog_F" is reset, the axis is braked to a standstill.
②	The axis is moved in the negative direction in jog mode via "Jog_B". When the target velocity -50.0 is reached, this is signaled via "InVel_1". When "Jog_B" is set, the value at parameter "Velocity" changes to 25.0. "InVel_1" is reset and the axis is braked. When the new target velocity -25.0 is reached, this is signaled via "InVel_1". After "Jog_B" is reset, the axis is braked to a standstill.

Using the MC_MoveVelocity Function Block

With the Motion Control instruction "MC_MoveVelocity", you can move an axis with a constant velocity.

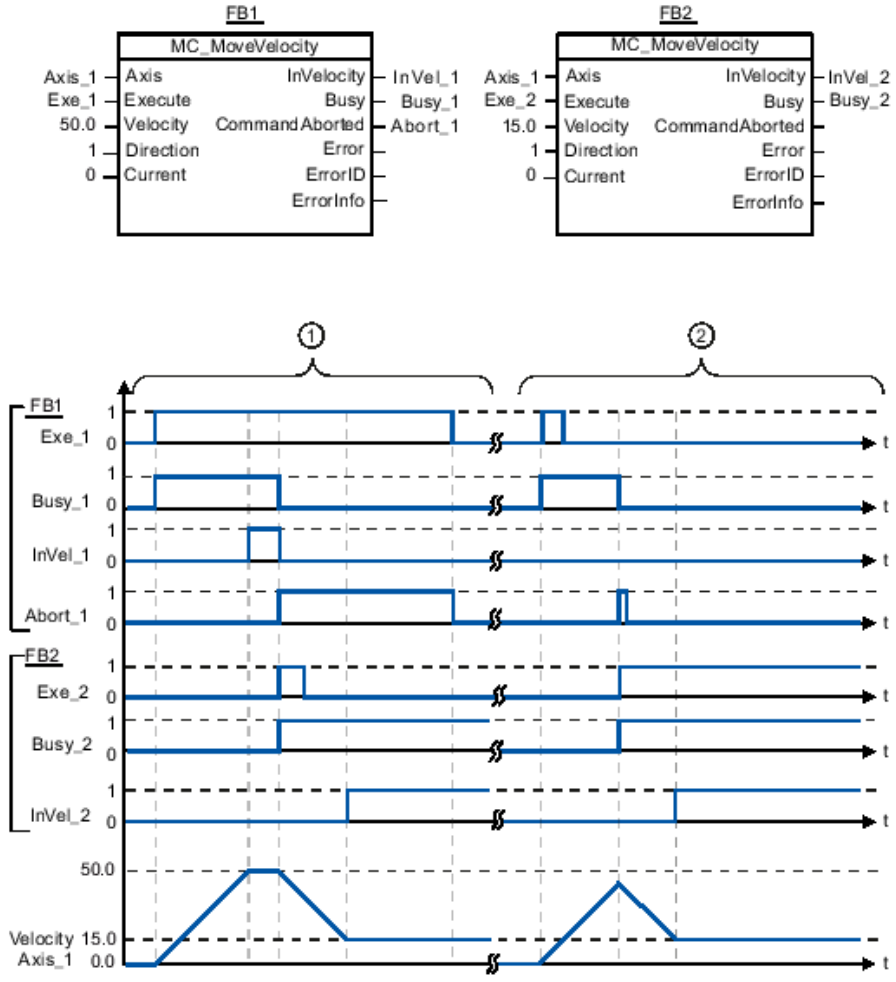


Figure 72 - MC_MoveVelocity Function Block

①	An active MC_MoveVelocity command signals via "InVel_1" that its target velocity has been reached. It is then aborted by another MC_MoveVelocity command. The abort is signaled via "Abort_1". When the new target velocity 15.0 is reached, this is signaled via "InVel_2". The axis then continues moving at the new constant velocity.
②	An active MC_MoveVelocity command is aborted by another MC_MoveVelocity command prior to reaching its target velocity. The abort is signaled via "Abort_1". When the new target velocity 15.0 is reached, this is signaled via "InVel_2". The axis then continues moving at the new constant velocity.

Using the MC_MoveRelative Function Block

This function block is used to move an axis relative to the position that exists at the beginning of job processing. Dynamic behaviour during movement is defined with the parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

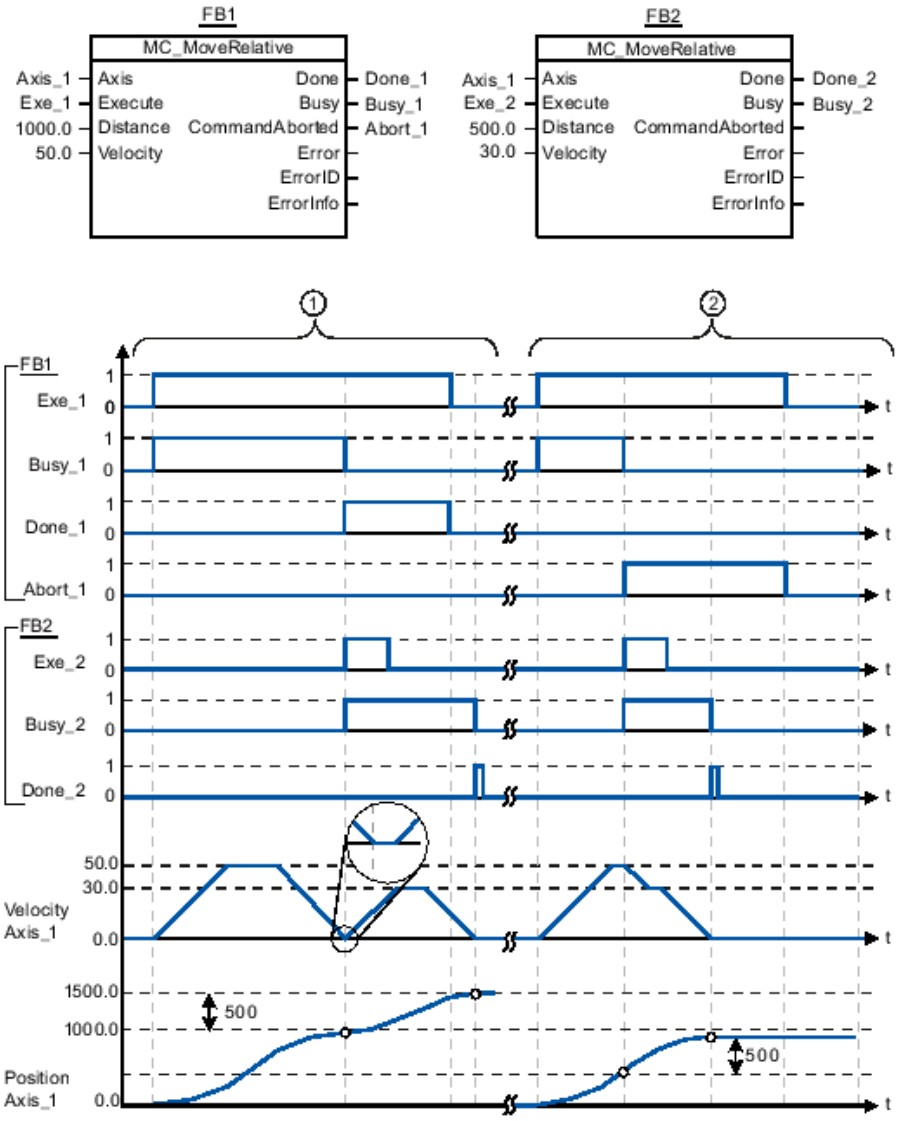


Figure 73 - MC_MoveRelative Function Block

①	The axis is moved by an MC_MoveRelative command by the distance ("Distance") 1000.0. When the axis reaches the target position, this is signaled via "Done_1". When "Done_1" = TRUE, another MC_MoveRelative command, with travel distance 500.0, is started. Because of the response times (e.g., cycle time of user program, etc.), the axis comes to a standstill briefly (see zoomed-in detail). When the axis reaches the new target position, this is signaled via "Done_2".
②	An active MC_MoveRelative command is aborted by another MC_MoveRelative command. The abort is signaled via "Abort_1". The axis is then moved at the new velocity by the new distance ("Distance") 500.0. When the new target position is reached, this is signaled via "Done_2".

Using the MC_MoveAbsolute Function Block

Use this function block to move the axis to an absolute position. Dynamic behaviour during movement is defined with the parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

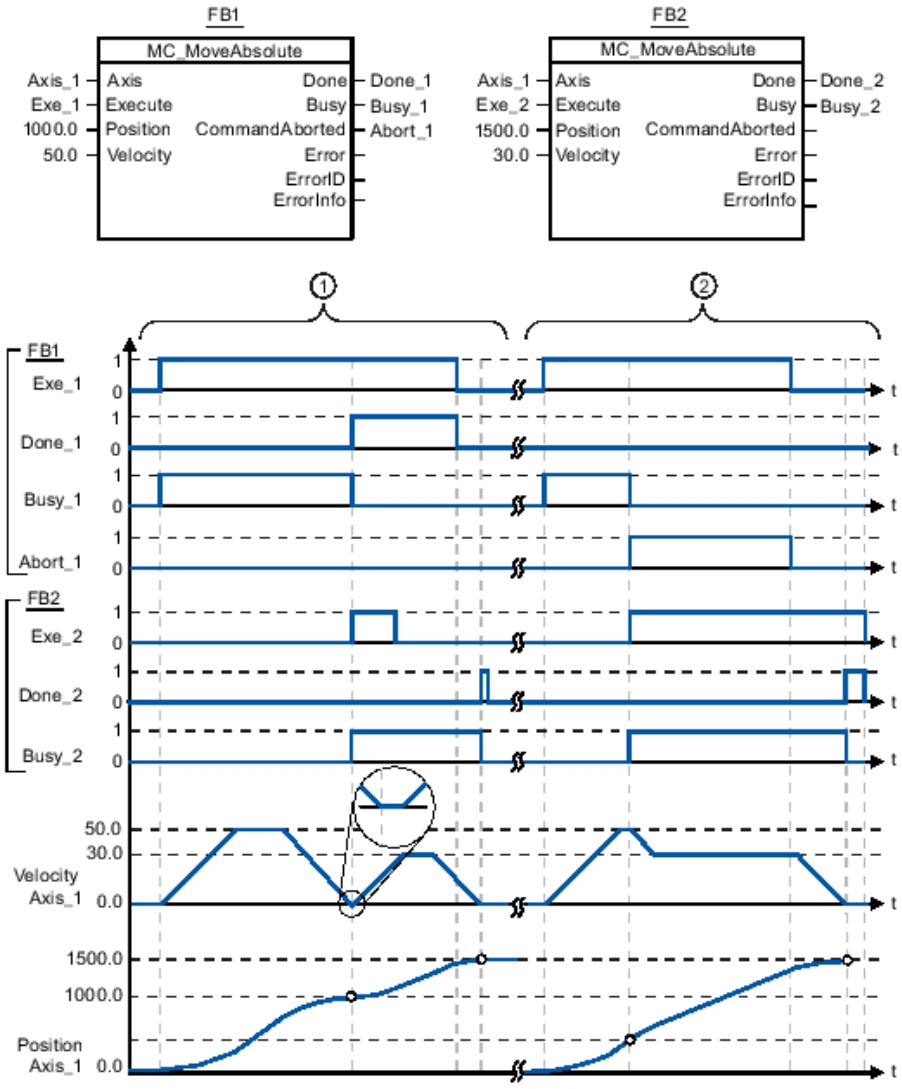


Figure 74 - MC_MoveAbsolute Function Block

①	An axis is moved to absolute position 1000.0 with an MC_MoveAbsolute command. When the axis reaches the target position, this is signaled via "Done_1". When "Done_1" = TRUE, another MC_MoveAbsolute command, with target position 1500.0, is started. Because of the response times (e.g., cycle time of user program, etc.), the axis comes to a standstill briefly (see zoomed-in detail). When the axis reaches the new target position, this is signaled via "Done_2".
②	An active MC_MoveAbsolute command is aborted by another MC_MoveAbsolute command. The abort is signaled via "Abort_1". The axis is then moved at the new velocity to the new target position 1500.0. When the new target position is reached, this is signaled via "Done_2".

Using the MC_Halt Function Block

The MC_Halt function block is used to brake an axis to a standstill. The block is also used to abort any currently active job on the axis.

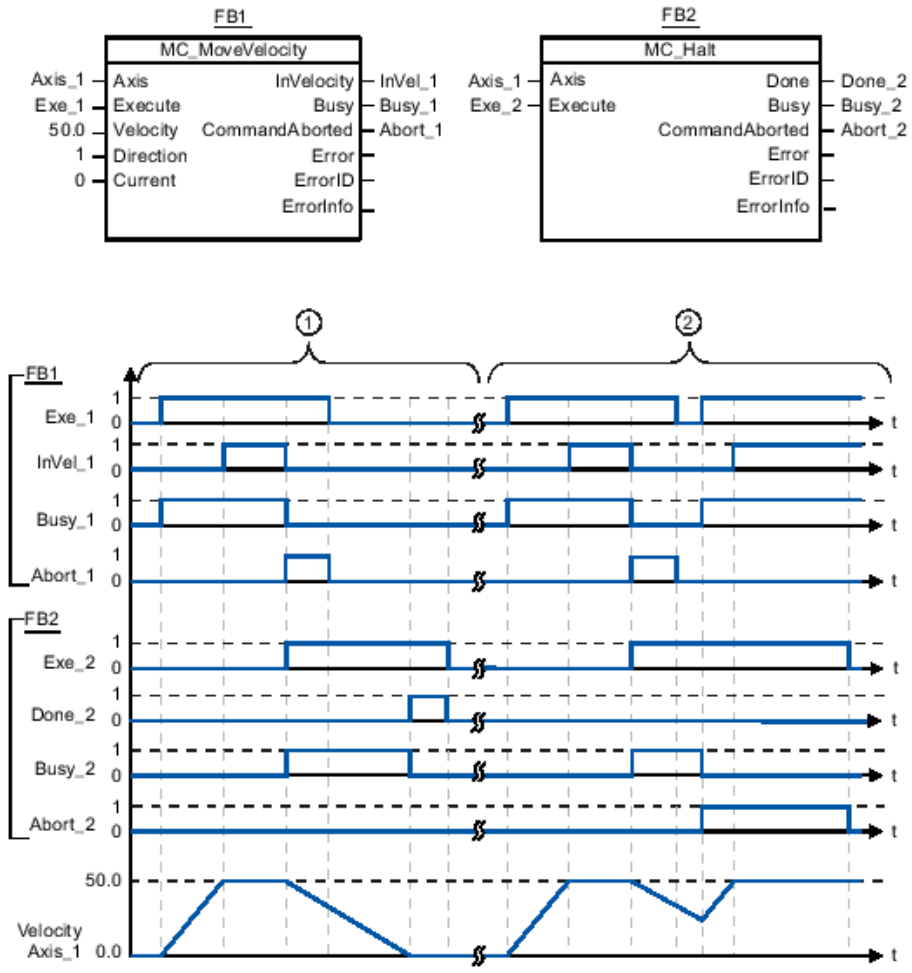


Figure 75 - MC_Halt Function Block

①	The axis is braked by an MC_Halt command until it comes to a standstill. The axis standstill is signaled via "Done_2".
②	While an MC_Halt command is braking the axis, this command is aborted by another motion command. The abort is signaled via "Abort_2".

Using the MC_CommandTable Function Block

This function block is used to perform a sequence of motion commands.

Parameter	Declaration	Data type	Default Value	Description
Axis	INPUT	TO_SpeedAxis	-	Axis technology object
CommandTable	INPUT	TO_CommandTable	-	Command table technology object
Execute	INPUT	BOOL	FALSE	Command table start with positive edge
StartStep	INPUT	INT	1	Defines the step at which the execution of the command table should begin Limit values: 1 ≤ StartStep ≤ EndStep
EndStep	INPUT	INT	32	Defines the step up to which the execution of command table should take place Limit values: StartStep ≤ EndStep ≤ 32
Done	OUTPUT	BOOL	FALSE	Command table has been successfully executed
Busy	OUTPU	BOOL	FALSE	The command table is being executed
CommandAborted	OUTPUT	BOOL	FALSE	The command table was cancelled by another command.
Error	OUTPUT	BOOL	FALSE	An error occurred during execution of the command table. The cause of the error can be found in parameters "ErrorID" and "ErrorInfo".
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "Error"
ErrorInfo	OUTPUT	WORD	16#0000	Error info ID for parameter "ErrorID"
CurrentStep	OUTPUT	INT	0	Step in command table currently being executed
StepCode	OUTPUT	WORD	16#0000	User-defined numerical value / bit pattern of the step currently being executed

Using the MC_ChangeDynamic Function Block

This function block must be used in order to change any of the technology object axis dynamics.

Parameter	Declaration	Data type	Default Value	Description
Axis	INPUT	TO_SpeedAxis	-	Axis technology object
Execute	INPUT	BOOL	FALSE	Start of the command with a positive edge
ChangeRampUp	INPUT	BOOL	FALSE	Change ramp-up time in line with input parameter "RampUpTime"
RampUpTime	INPUT	REAL	5	Time (in seconds) to accelerate axis from standstill to configured maximum velocity without jerk limit. The change will influence the tag <Axis name>. Config.DynamicDefaults.Acceleration. For the effectiveness of the change, refer to the description of this tag.
ChangeRampDown	INPUT	BOOL	FALSE	Change ramp-down time to correspond to input parameter "RampDownTime"
RampDownTime	INPUT	REAL	5	Time (in seconds) to decelerate axis from the configured maximum velocity to standstill without jerk limiter. The change will influence the tag <Axis name>. Config.DynamicDefaults.Deceleration . For the effectiveness of the change, refer to the description of this tag.
ChangeEmergency	INPUT	BOOL	FALSE	Change emergency stop ramp-down time in line with input parameter "EmergencyRampTime"
EmergencyRampTime	INPUT	REAL	2	Time (in seconds) to decelerate the axis from configured maximum velocity to standstill without jerk limiter in emergency stop mode. The change will influence the tag <Axis name>. Config.DynamicDefaults.EmergencyDeceleration . For the effectiveness of the change, refer to the description of this tag.
ChangeJerkTime	INPUT	BOOL	FALSE	Change smoothing time according to the input parameter "JerkTime"
JerkTime	INPUT	REAL	0.25	Smoothing time (in seconds) used for the axis acceleration and deceleration ramps The change will influence the tag <Axis name>. Config.DynamicDefaults.Jerk . For the effectiveness of the change, refer to the description of this tag.
Done	OUTPUT	BOOL	FALSE	The changed values have been written to the technology data block. The description of the tags will show when the change becomes effective.

Error	OUTPUT	BOOL	FALSE	An error occurred during execution of the command. The cause of the error can be found in parameters "ErrorID" and "ErrorInfo".
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "Error"
ErrorInfo	OUTPUT	WORD	16#0000	Error info ID for parameter "ErrorID"

Using the MC_WriteParam Function Block

This function block allows you to write to tags of the axis technology object. In contrast to the value assignment of tags within the user program, with this function block you can also change the values of read-only tags.

Parameter	Declaration	Data type	Default Value	Description
Parameter	INPUT	VARIANT (BOOL, INT, DINT, REAL)	-	VARIANT pointer to the technology object tag positioning axis (destination address) to be written
Value	INPUT	VARIANT (BOOL, INT, DINT, REAL)	-	VARIANT pointer to the value to be written (source address)
Execute	INPUT	BOOL	FALSE	Start of the command with a positive edge
Done	OUTPUT	BOOL	FALSE	Value was written
Busy	OUTPUT	BOOL	FALSE	The command is being executed
Error	OUTPUT	BOOL	FALSE	An error occurred during execution of the command. The cause of the error can be found in parameters "ErrorID" and "ErrorInfo".
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "Error"
ErrorInfo	OUTPUT	WORD	16#0000	Error info ID for parameter "ErrorID"

Using the MC_ReadParam Function Block

This function block allows for continuous reading of motion and status data from a technology object axis.

Parameter	Declaration	Data type	Default Value	Description
Enable	INPUT	BOOL	FALSE	Read the tag specified with the "Parameter" and store the value in the destination address specified with "Value".
Parameter	INPUT	VARIANT (REAL)	-	VARIANT pointer to the value to be read. The following tags are permitted: <Axis name>.Position <Axis name>.Velocity <Axis name>.ActualPosition <Axis name>.ActualVelocity <Axis name>.StatusPositioning.<Tag name> <Axis name>.StatusDrive.<Tag name> <Axis name>.StatusSensor.<Tag name> <Axis name>.StatusBits.<Tag name> <Axis name>.ErrorBits.<Tag name> The description of the tags named and the tag structures can be found in the Appendix Tags of the positioning axis technology object as of V4.
Value	INOUT	VARIANT (REAL)	-	VARIANT pointer to the target tag or destination address to which the read value is to be written.
Valid	OUTPUT	BOOL	FALSE	The read value is valid.
Busy	OUTPUT	BOOL	FALSE	The command is being executed
Error	OUTPUT	BOOL	FALSE	An error occurred during execution of the command. The cause of the error can be found in parameters "ErrorID" and "ErrorInfo".
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "Error"
ErrorInfo	OUTPUT	WORD	16#0000	Error info ID for parameter "ErrorID"

A4 Tuning the SINAMICS V90 Drive

A4.1 One Button Auto-Tuning

One-button auto tuning estimates the machine load moment of inertia and mechanical characteristics with internal motion commands. To achieve the desired performance, you can execute the process many times before you control the drive with the host controller. The maximum speed is limited by the rated speed.

Note The one-button auto tuning function is valid for V-ASSISTANT firmware version V1.04.00 and higher.

Note Before using the one-button auto tuning, move the servo motor to the middle of mechanical position to avoid approaching the actual machine position limit.

Pre-conditions for One Button Auto-Tuning

- The ratio of machine load moment of inertia is unknown and needs to be estimated.
- The motor is allowed to rotate both clockwise and anti-clockwise.
- The motor rotation position (p29027 defines that one revolution equals to 360 degree) is allowed by the machine.
    - For a motor with an absolute encoder: position limitation is defined by p29027.
    - For a motor with an incremental encoder: the motor must be allowed to rotate freely by two turns when tuning starts.

Implement One Button Auto-Tuning

1. Select the dynamic factor in the following area:

Figure 76 - Set Tuning Dynamic Factor

Selecting the Dynamic Factor

Refer to the 'One-Button Auto Tuning' chapter 9.3 (p252) from 'SINAMICS V90, SIMOTICS S-1FL6 Operating Instructions' for more detailed information.

https://support.industry.siemens.com/cs/gb/en/view/109480673

2. Configure the test signal in the section below:

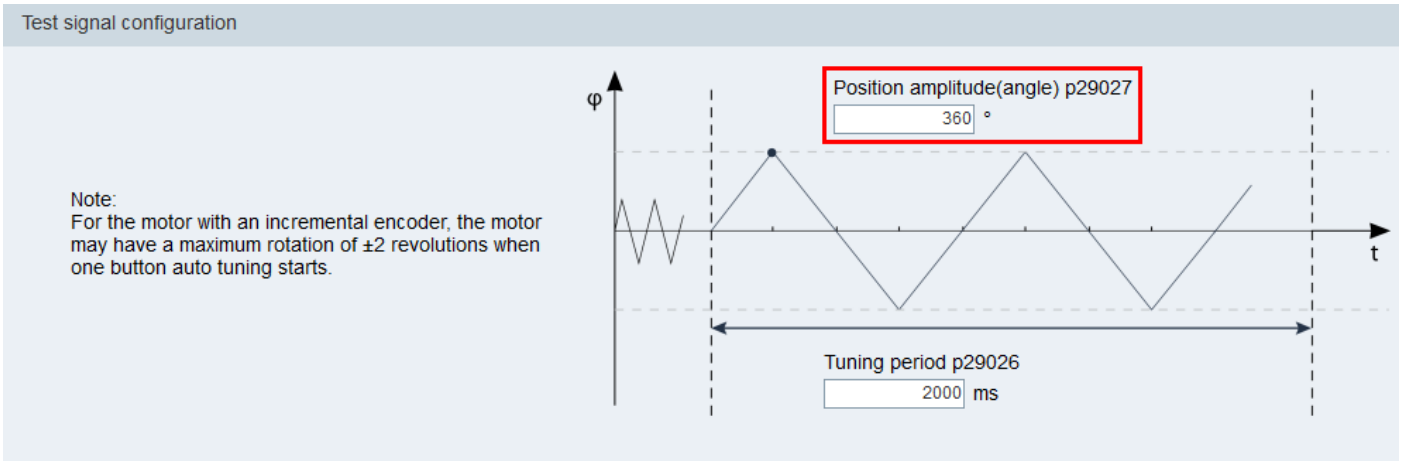
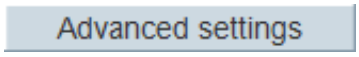


Figure 77 - Configure Tuning Test Signal

Note The recommended position amplitude (p29027) is 360 degrees.

3. Click on the following button to configure the parameters for the one-button auto tuning function.



4. Set the parameters in the window below:

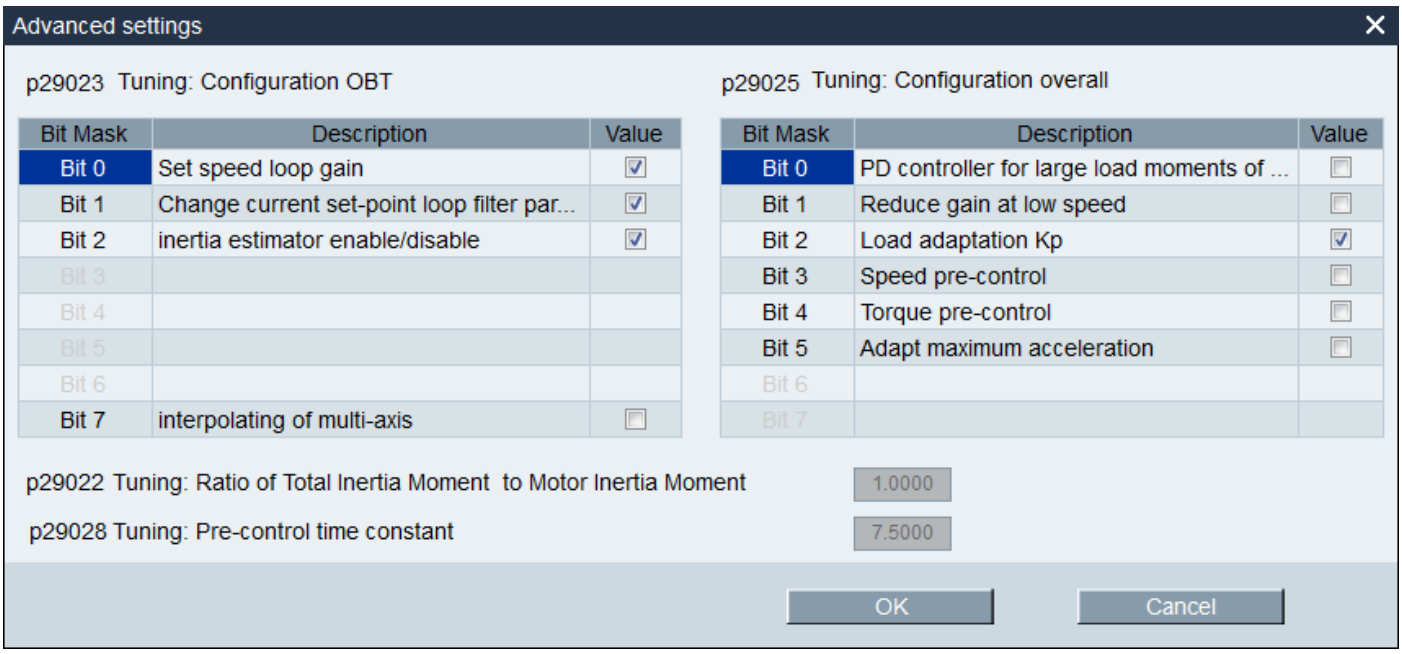


Figure 78 - Set Tuning Advanced Settings

Set the ratio of machine load moment of inertia (p29022) with either of the following methods:

- Enter it manually if the ratio is known.

- Estimate the ratio with the one-button auto-tuning (p29023.2 = 1). When you have executed the tuning many times and have obtained a stable value of p29022, you can stop estimating it by setting p29023.2 = 0.

5. Click the following button to enable the tuning function after the parameters have been set.

   Enable one button auto tuning

6. Click the following button the start the tuning function.

   Servo on

7. After the tuning is complete, the tuning results window appears:

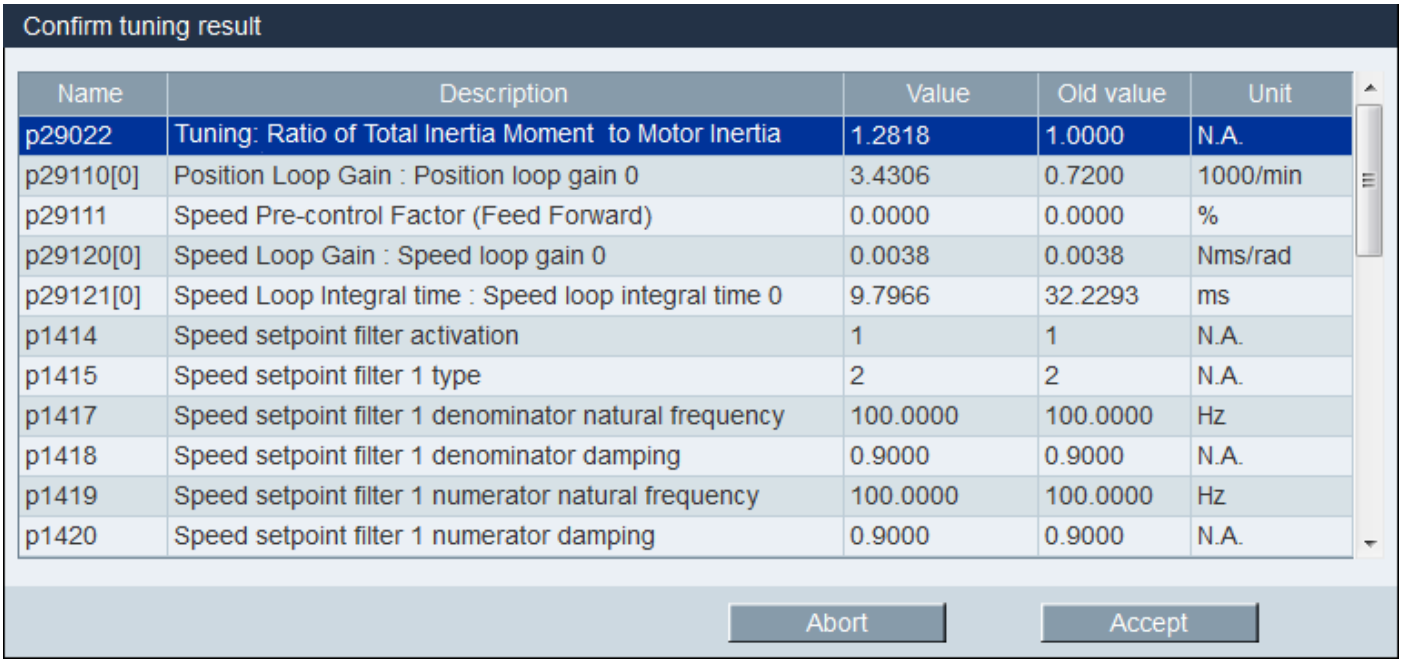


Figure 79 - Confirm Tuning Results Window

Press the 'Accept' button to apply the values obtained through the tuning function, or press the 'Abort' button to revert back to the old values.

8. Once the tuning is complete and the drive performance is acceptable, perform a 'Save Parameters to ROM' function to save the tuning values in the drive.

Note After servo on, the motor will run with the test signal.
When the one-button auto tuning process completes successfully, the parameter p29021 will be set to 0 automatically. You can also set the parameter p29021 to 0 before servo on to interrupt the one-button auto tuning. Before you save the parameters on the drive, make sure that p29021 has changed to 0.

Note Do not use the JOG function when you use the one-button tuning function.

Note After the one-button tuning function is activated, no operation will be allowed except the

servo off and emergency stop.

Note After one-button auto tuning is activated, do not change other auto tuning related control/filter parameters since these parameters can be set automatically and your changes will not be accepted.

Note One-button auto tuning can cause some changes of the control parameters. When the system rigidity is low, this may lead to a situation that when you set EMGS = 0, the motor
needs take long time to emergency stop.

Revision History

A5

Version	Date	Change
V0_0A	06/2016	Initial Version
V0_0B	03/2021	V-ASSISTANT version and links updated