Digitalization with TIA Portal: Virtual Commissioning with SIMATIC and Simulink

Use case 1: Connecting Simulink models to SIMATIC PLCSIM Advanced via API

SIMATIC S7-PLCSIM Advanced
Simulink

https://support.industry.siemens.com/cs/ww/en/view/109749187

Siemens Industry Online Support

Legal information

Use of application examples

Application examples illustrate the solution of automation tasks through an interaction of several components in the form of text, graphics and/or software modules. The application examples are a free service by Siemens AG and/or a subsidiary of Siemens AG ("Siemens"). They are non-binding and make no claim to completeness or functionality regarding configuration and equipment. The application examples merely offer help with typical tasks; they do not constitute customer-specific solutions. You yourself are responsible for the proper and safe operation of the products in accordance with applicable regulations and must also check the function of the respective application example and customize it for your system.
Siemens grants you the non-exclusive, non-sublicensable and non-transferable right to have the application examples used by technically trained personnel. Any change to the application examples is your responsibility. Sharing the application examples with third parties or copying the application examples or excerpts thereof is permitted only in combination with your own products. The application examples are not required to undergo the customary tests and quality inspections of a chargeable product; they may have functional and performance defects as well as errors. It is your responsibility to use them in such a manner that any malfunctions that may occur do not result in property damage or injury to persons.

Disclaimer of liability

Siemens shall not assume any liability, for any legal reason whatsoever, including, without limitation, liability for the usability, availability, completeness and freedom from defects of the application examples as well as for related information, configuration and performance data and any damage caused thereby. This shall not apply in cases of mandatory liability, for example under the German Product Liability Act, or in cases of intent, gross negligence, or culpable loss of life, bodily injury or damage to health, non-compliance with a guarantee, fraudulent non-disclosure of a defect, or culpable breach of material contractual obligations. Claims for damages arising from a breach of material contractual obligations shall however be limited to the foreseeable damage typical of the type of agreement, unless liability arises from intent or gross negligence or is based on loss of life, bodily injury or damage to health. The foregoing provisions do not imply any change in the burden of proof to your detriment. You shall indemnify Siemens against existing or future claims of third parties in this connection except where Siemens is mandatorily liable.
By using the application examples you acknowledge that Siemens cannot be held liable for any damage beyond the liability provisions described.

Other information

Siemens reserves the right to make changes to the application examples at any time without notice. In case of discrepancies between the suggestions in the application examples and other Siemens publications such as catalogs, the content of the other documentation shall have precedence.
The Siemens terms of use (https://support.industry.siemens.com) shall also apply.

Security information

Siemens provides products and solutions with Industrial Security functions that support the secure operation of plants, systems, machines and networks.
In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.
Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the Internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.
For additional information on industrial security measures that may be implemented, please visit https://www.siemens.com/industrialsecurity.
Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.
To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at: https://www.siemens.com/industrialsecurity.

Table of contents

1 Introduction

1.1 Overview

The Simulink software from MathWorks is frequently used in automation and controls engineering to simulate processes and create algorithms. The requirement is to simulate the model, the algorithm or the function in a few steps either in a virtual environment with PLCSIM Advanced or, using hardware, via a software controller.

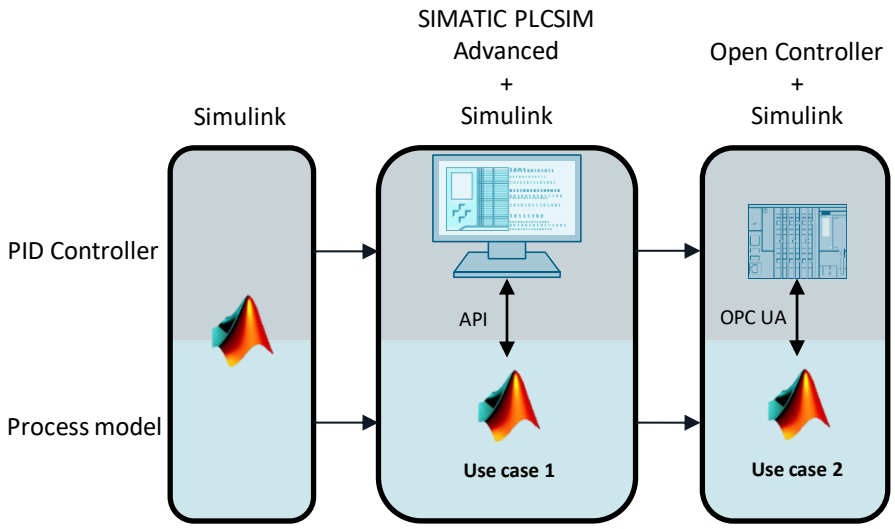
This application example provides you with the S-function "PLCSIM Advanced" for Simulink for the purpose of communication and data exchange with a virtual controller via the PLCSIM Advanced API. This makes it possible to validate and virtually commission a PID control system, running on a virtual controller, in the context of a simulated process in Simulink.

This document describes the necessary steps for configuring, commissioning and operating the application example.

The complete application example consists of the following documents:

- Main document: Overview of the two use cases and the Simulink model.
- Use case 1: Connecting Simulink models to SIMATIC PLCSIM Advanced via API (this document).
- Use case 2: Connecting Simulink models to a SIMATIC S7-1500 software controller via OPC UA.

Figure 1-1: Overview of use cases



1.2 Principle of operation

This application example provides you with a fully programmed S-function "PLCSIM Advanced". The function makes it possible to write and read tags from a PLCSIM Advanced virtual controller.

The function in Simulink is placed in a control loop rather than a controller.

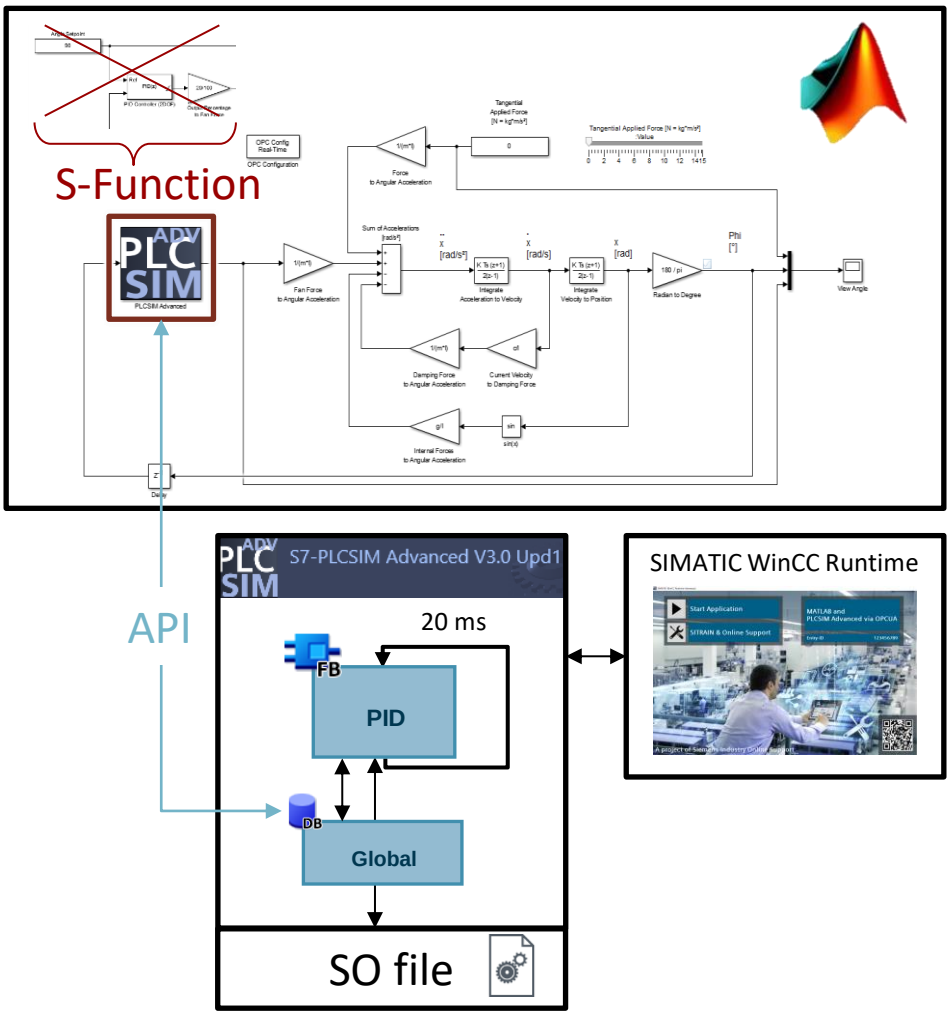
The Simulink model of a PID controller is coded with SIMATIC Target 1500S and made to run on an S7-1500 software controller. This is so that it can then be tested in the context of a simulation model.

Tags are exchanged via a global data block in the virtual controller. Here, the exchange always takes place at the controller's cycle control point.

The closed-loop controller's results are visualized, and the controller itself is controlled via a simulated HMI screen in the WinCC runtime.

Note The configuration of the HMI is not a part of this application example.

Figure 1-2



1.3 Components used

This application example was created with these hardware and software components:

Table 1-1: Software components

Components	Item number / Notes / Link
(R2019b) MATLAB V9.7 MATLAB Coder V4.3 Simulink V10.0 Simulink Coder V9.2 OPC Toolbox V4.0.8	MathWorks online documentation: http://mathworks.com/help/
STEP 7 Professional V16	6ES7822-1..06-.. Manual: https://support.industry.siemens.com/cs/ww/en/view/109773506
SIMATIC S7-1500 ODK 1500S V2.5 SP1	6ES7806- 2CD03-0YA0 Manual: https://support.industry.siemens.com/cs/ww/en/ps/13914/man
SIMATIC Target 1500S for Simulink V4.0	6ES7823-1BE03-0YA5 Manual: https://support.industry.siemens.com/cs/ww/en/ps/24443/man
S7-PLCSIM Advanced V3.0 Upd1	6ES7823-1FE02-0YA5 Manual: https://support.industry.siemens.com/cs/ww/en/view/109773484

This application example consists of the following components:

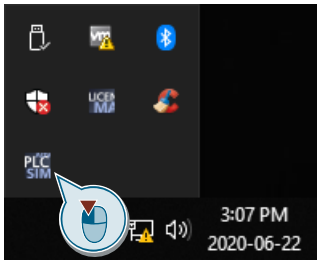
Table 1-2: Components of the application example

Components	Contents
109749187_DIGI_Usecases_MAIN_DOC_V20_en.pdf	Main document.
109749187_DIGI_Usecases_API_DOC_V20_en.pdf	This document.
109749187_DIGI_Usecases_TIAV16_PROJ_V20.zip	TIA Portal project for use cases 1 & 2.
109749187_DIGI_Usecases_Simulink_PROJ_V20.zip	Simulink models for use cases 1 & 2.

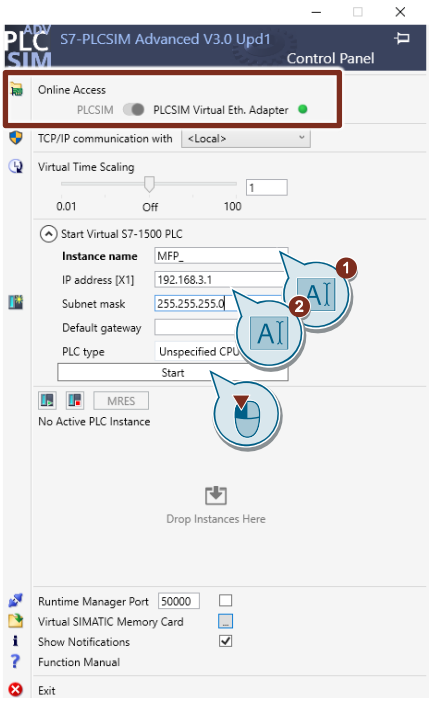
2 Engineering

2.1 Setting up and starting virtual controller

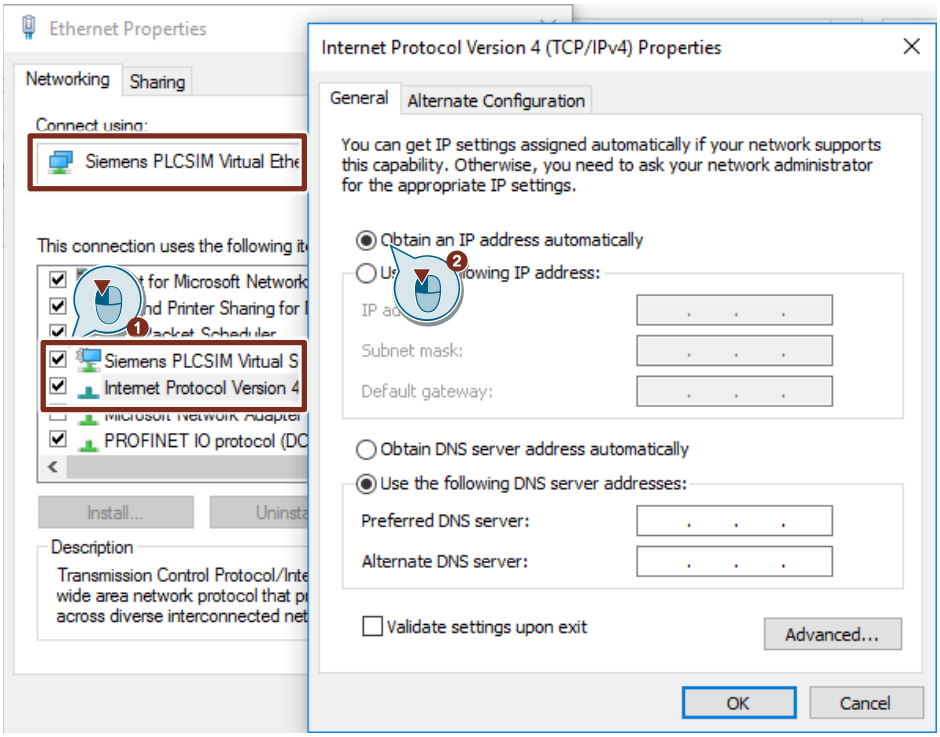
1. Start S7-PLCSIM Advanced V3.0 Upd1. The PLCSIM Advanced icon will appear in the info region of the Windows taskbar. Left-click the icon to open the graphical interface of PLCSIM Advanced, the Control Panel.



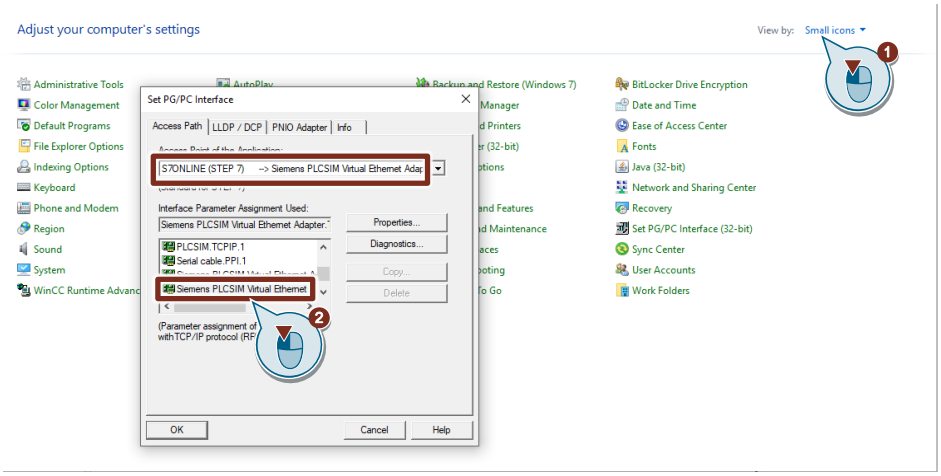
2. Start an instance of the virtual controller with the Control Panel.
   1. Select the PLCSIM Virtual Eth. adapter.
   2. Enter an instance name, for example "MFP".
   3. Enter the IP address 192.168.3.1 and subnet mask 255.255.255.0.
   4. Click on "Start".



3. Check whether the "Siemens PLCSIM Virtual Ethernet Adapter" is enabled. Also check whether "Siemens PLCSIM Virtual Switch" is enabled and "Internet Protocol Version 4 (TCP/IPv4)" is set to "Obtain an IP address automatically".



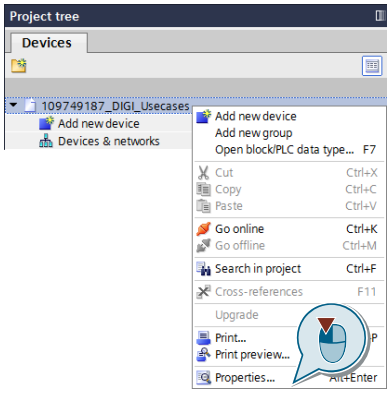
4. Set the PG/PC interface.
   1. To do this, open your Windows Control Panel.
   2. Set the appearance to "Small icons".
   3. Select "Set PG/PC Interface".
   4. For S7ONLINE (STEP 7), select the Siemens PLCSSIM Virtual Ethernet Adapter.TCPIP.1.



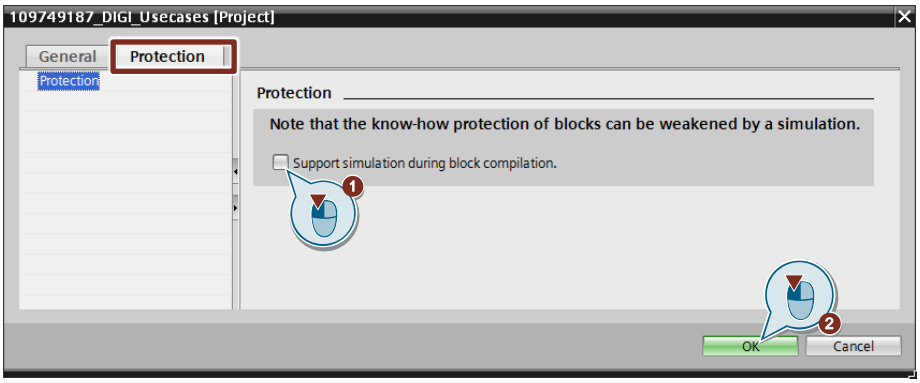
2.2 Enabling simulation support in TIA Portal

Perform the following steps to enable simulation support with PLCSIM Advanced.

1. Create a new TIA Portal project.
2. Open your project's "Properties".



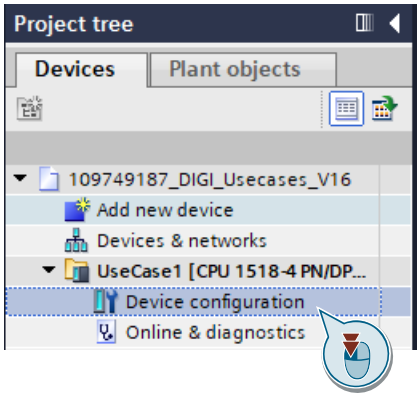
3. Enable simulation support with PLCSIM Advanced under the "Protection" tab.
   1. Enable "Support simulation during block compilation".
   2. Click "OK" to confirm the change.



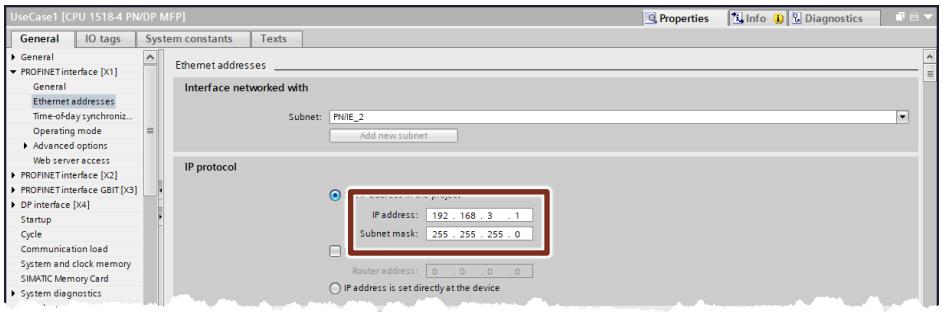
2.3 TIA Portal hardware configuration

Perform the following steps to set up the hardware configuration for your PLC.

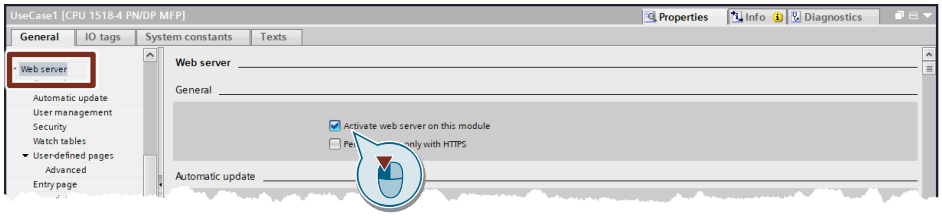
1. In the project, add a CPU 1518 MFP with V2.8. Name the PLC "UseCase1".
2. Double-click to open the CPU's "Device configuration".



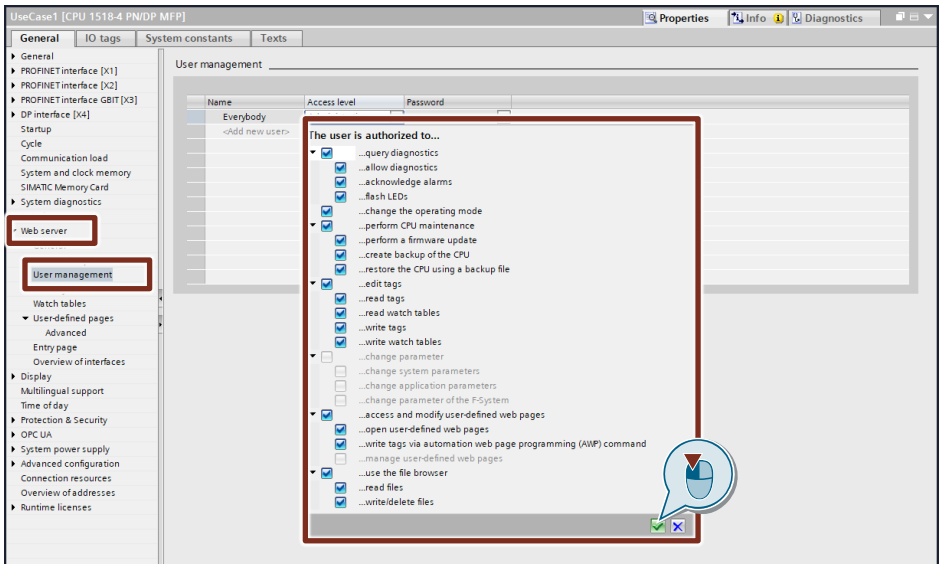
3. In the Inspector window under "Properties > General > PROFINET interface [X1] > Ethernet addresses", set the IP address (e.g. 192.168.3.1) for your CPU.



4. Enable the web server. Acknowledge the security dialog.



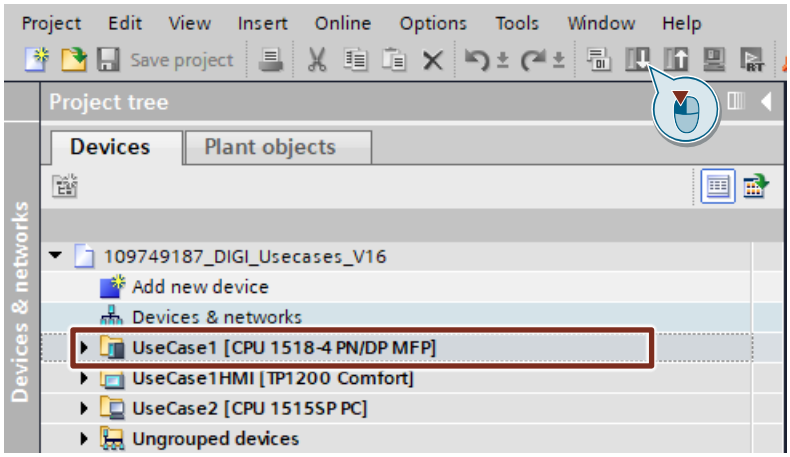
5. Navigate to "Web server > User management" and check all checkboxes under "Access level" to grant full access. Create a password if necessary.



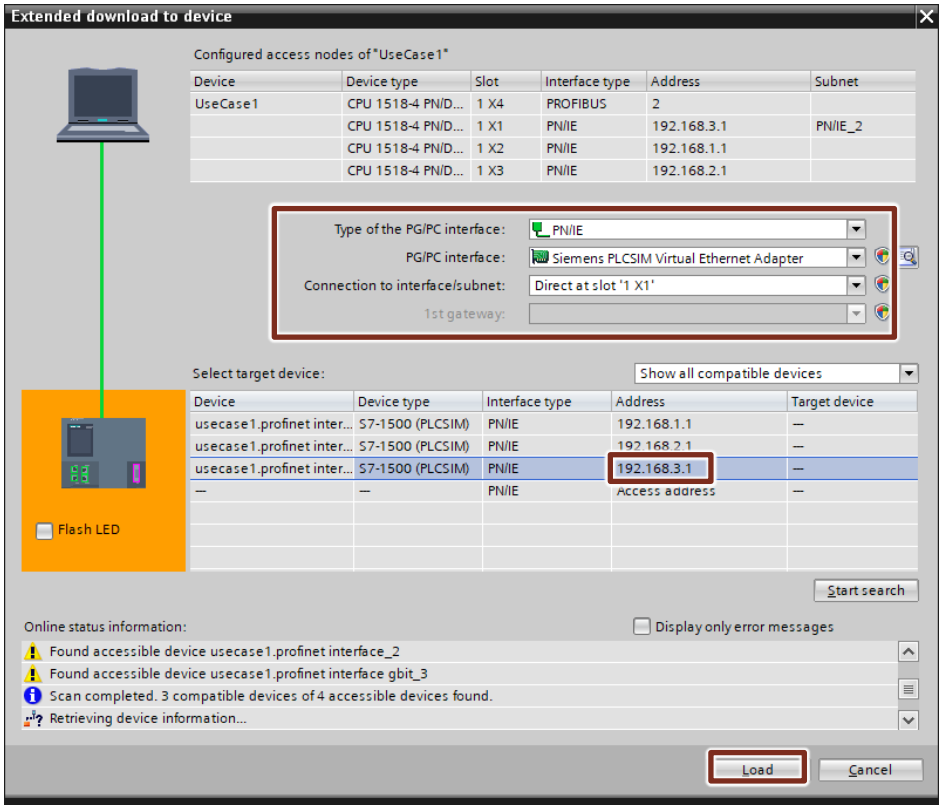
Note

In order to load the SO file to the web server or delete it, the parameters "read files" and "write/delete" files must be enabled. Any further parameters are optional.

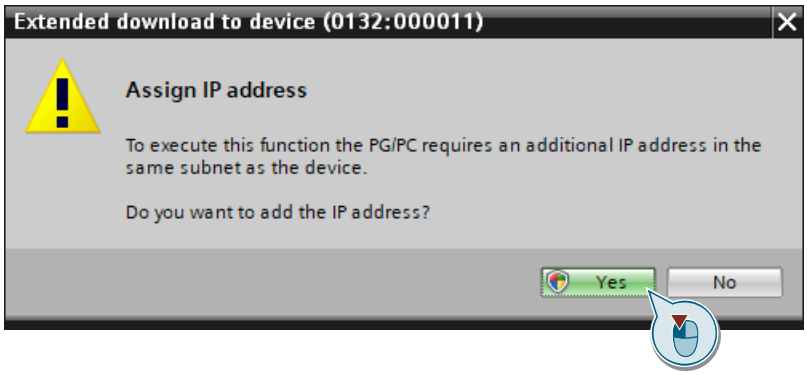
6. Download the hardware configuration to the virtual controller. Select "Usecase1" in the project tree. Click the "Download to device" button.



7. Select "PN/IE".
   - Select the Ethernet interface "Siemens PLCSIM Virtual Ethernet Adapter".
   - Select "Direct at Slot '1 X1'".
   - Click "Start search".
   - Click "Load".



8. Confirm the "Assign IP address" dialog with "Yes" and allow the Siemens PLCSIM Virtual Ethernet Adapter to assign an IP address.



9. Confirm all subsequent dialogs until the download is complete.

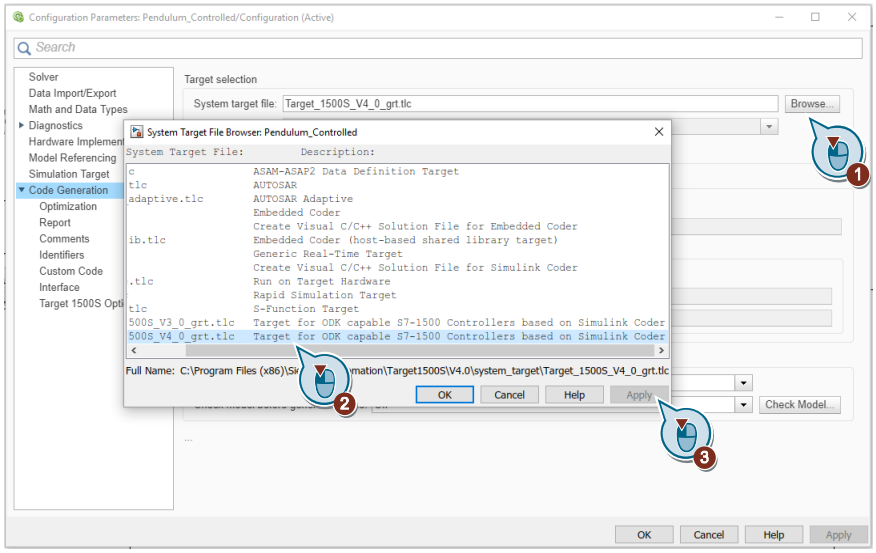
2.4 Code generation with SIMATIC Target 1500S

The following chapter describes how to prepare the simulated model of the PID controller with Simulink for coding with Target 1500S, then how to carry it out.

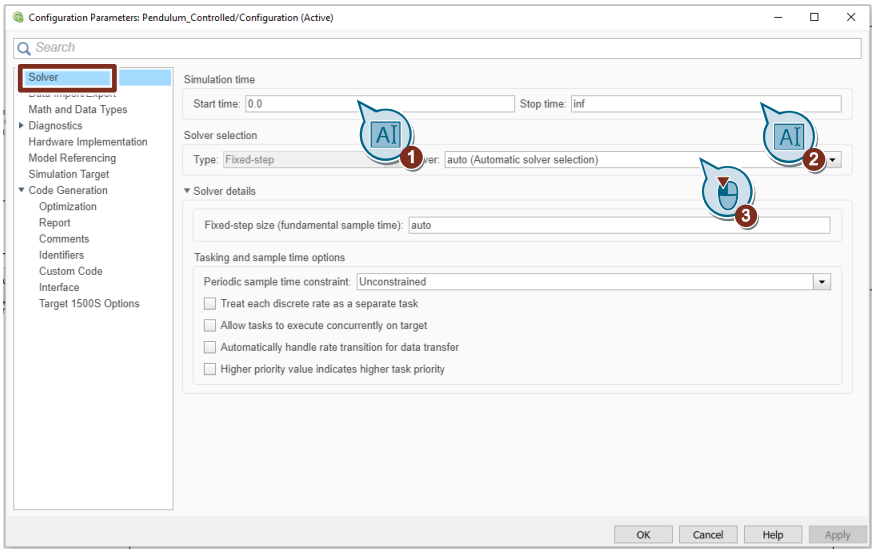
2.4.1 Settings for code generation

Make the following code generation settings for your model.

1. Open your model "Pendulum_Controlled.slx".
2. In the menu bar, click on "Code > Settings > C/C++ Code generation settings…".
3. Navigate to "Code Generation".
   1. Click the "Browse" button to open the target selection window.
   2. Select "Target_1500S_V4_0_grt.tlc".
   3. Confirm the setting with "Apply".

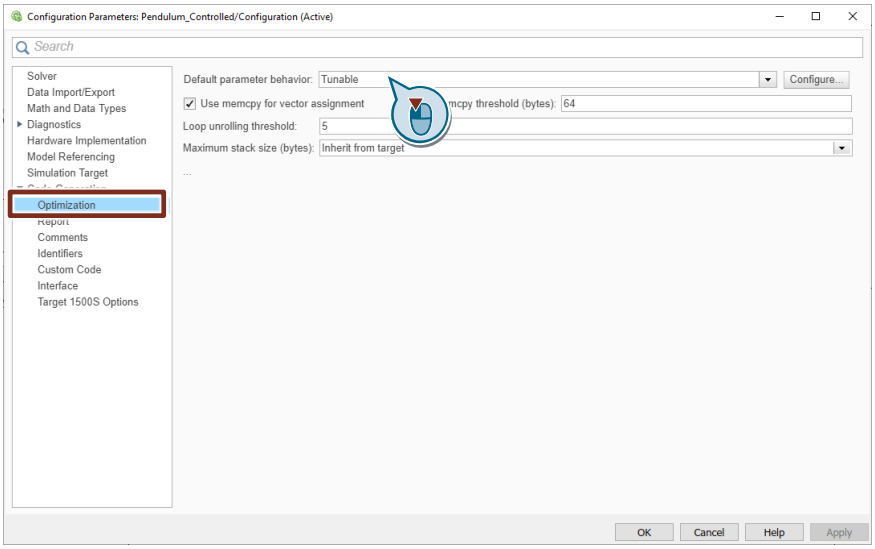


4. Navigate to "Solver".
   1. Leave "Start time" at "0".
   2. Change "Stop time" to "inf". This ensures that the External Mode will be used without a definite end.
   3. Leave "Solver" on the default "auto (Automatic solver selection)".



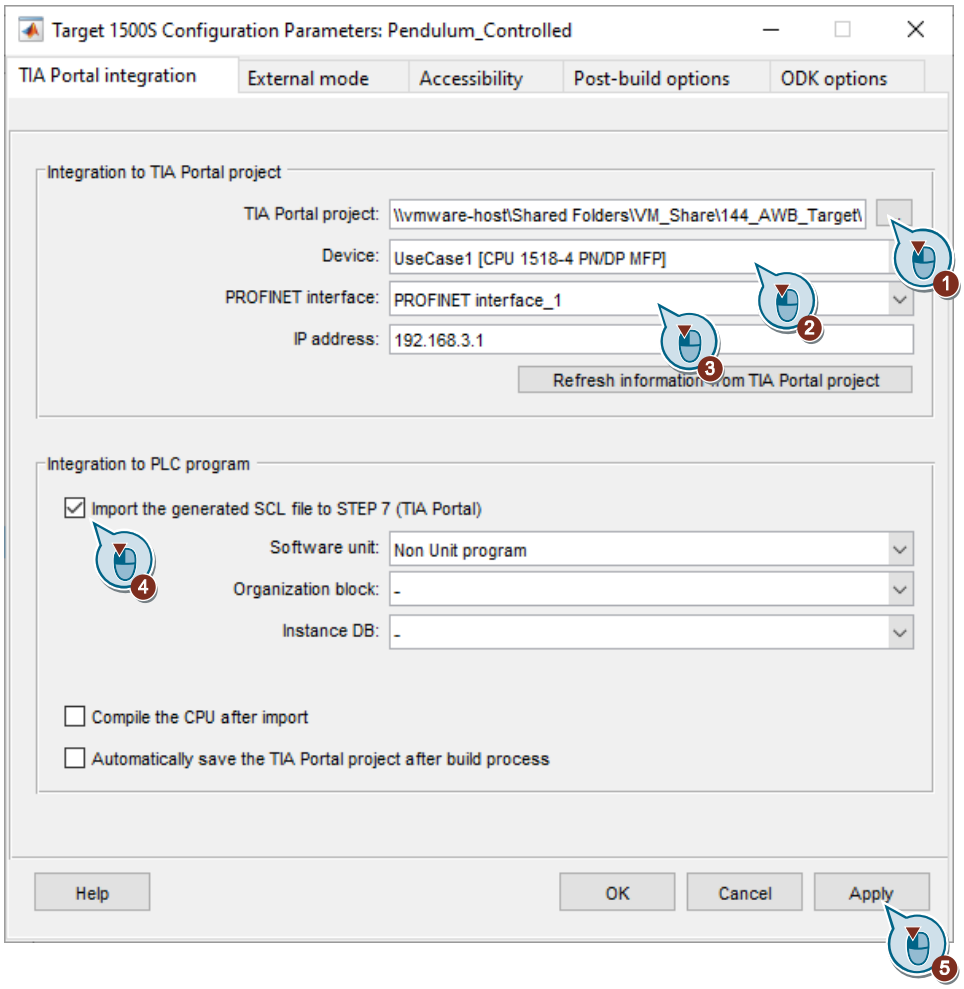
5. Navigate to "Code Generation > Optimization".
   - Set the parameter "Default parameter behavior" to "Tunable".

   After code generation, this setting gives you access with STEP 7 (TIA Portal) to all internal parameters of the model.

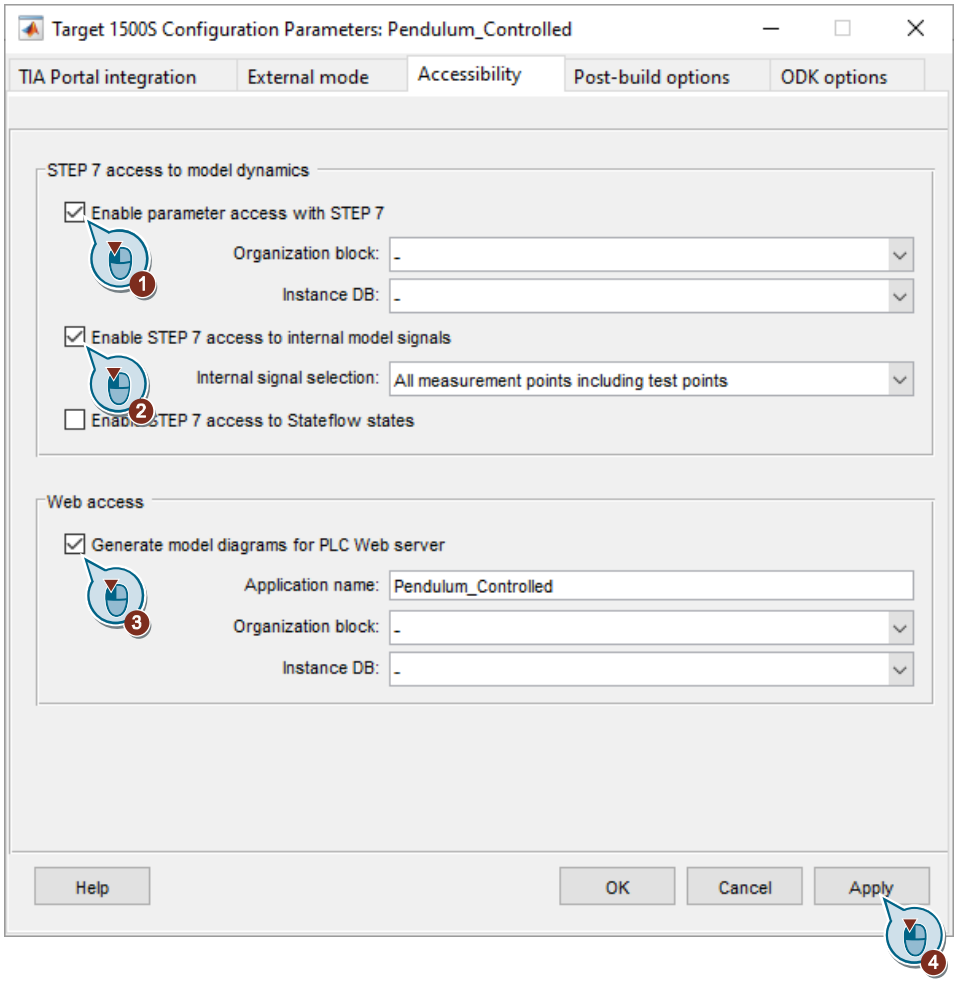


6. Click on "Target 1500S Options > Target 1500s Options".

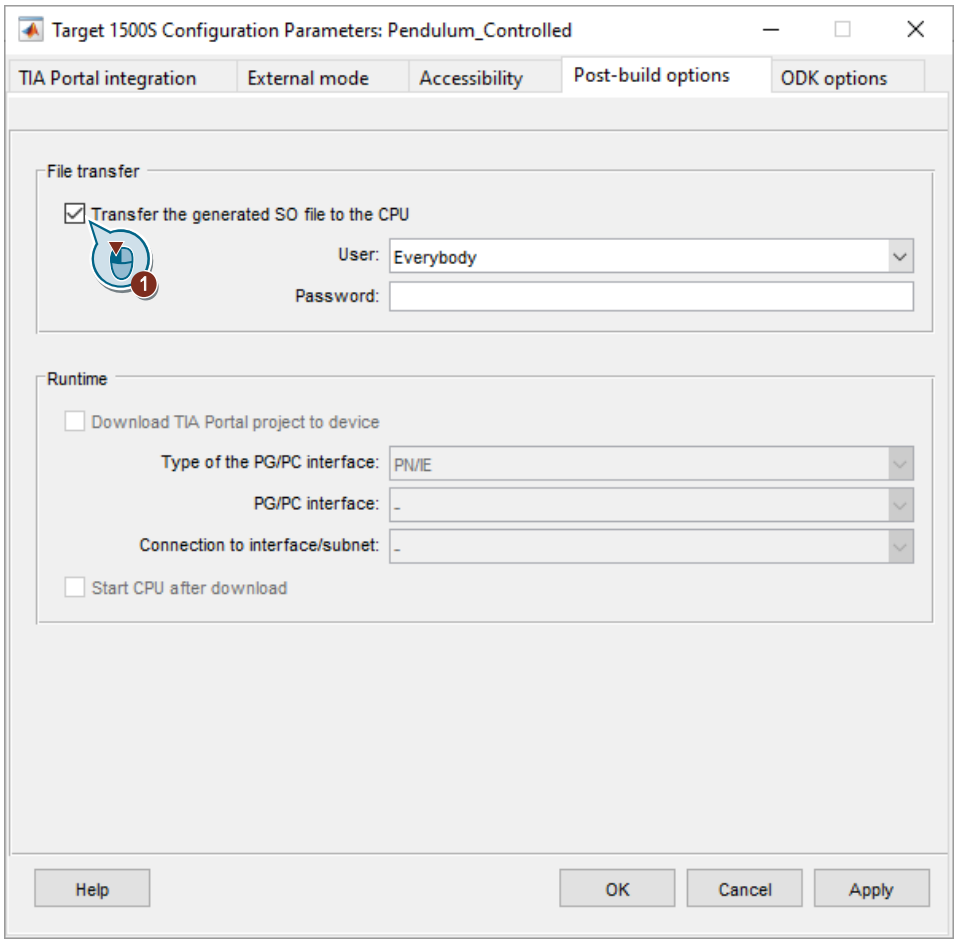
7. Navigate to "TIA Portal integration".
   1. Select your TIA project under "TIA Portal project".
   2. For "Device", set "UseCase1".
   3. For "PROFINET interface", select the [X1] interface. The IP address is modified automatically.
   4. Make sure that "Import the generated SCL file to STEP 7" is checked.
   5. Confirm with "Apply"



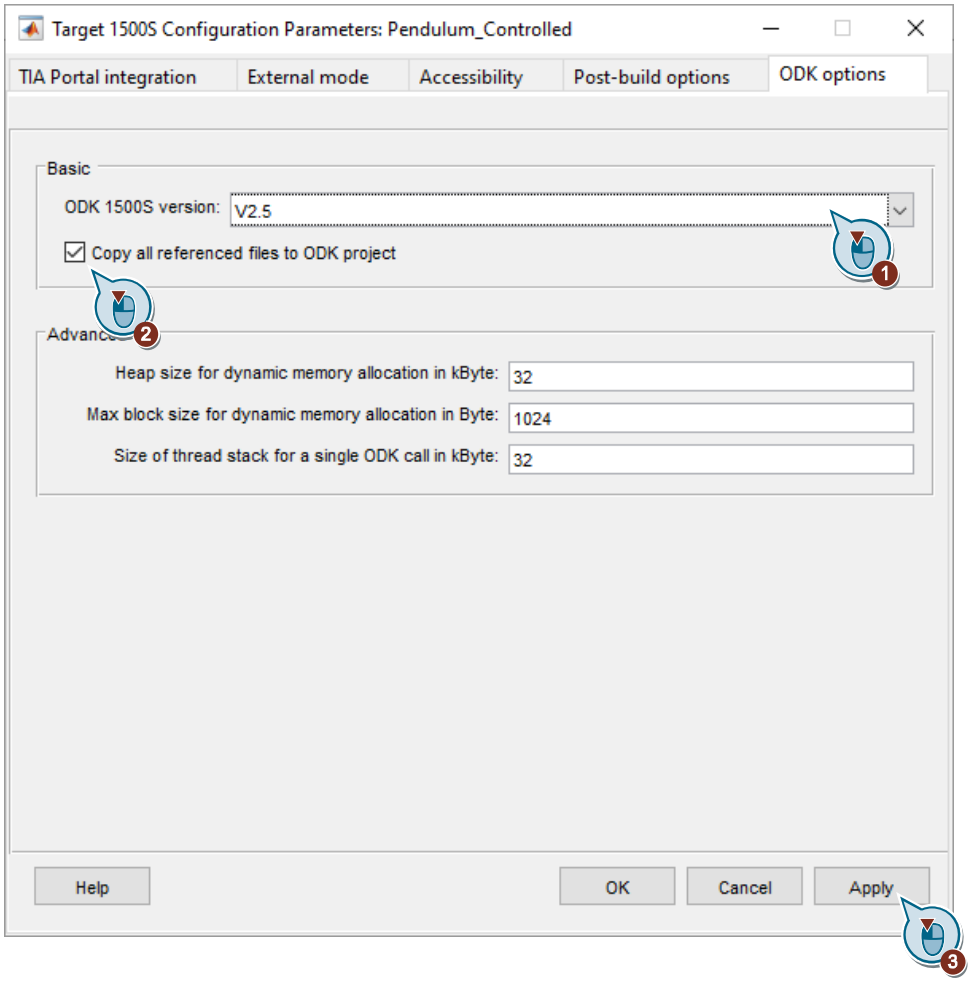
8. Navigate to "Accessibility".
   1. Check the box for "Enable parameter access with Step 7".
   2. Check the box for "Enable Step 7 access to internal model signals".
   3. Make sure that "Generate model diagrams for PLC Web server" is checked.
   4. Confirm with "Apply"



9. Navigate to "Post-build options" and make sure that the box by "Transfer the generated SO file to the CPU" is checked.



10. Navigate to "ODK options".
    1. For "ODK 1500S version", select V2.5.
    2. Check the box for "Copy all referenced files to ODK project".
    3. Confirm with "Apply"



Note

The parameters "Heap size for dynamic memory allocation in kByte" and "Max block size for dynamic memory allocation in Byte" only need to be adjusted if there are problems with the code generation.

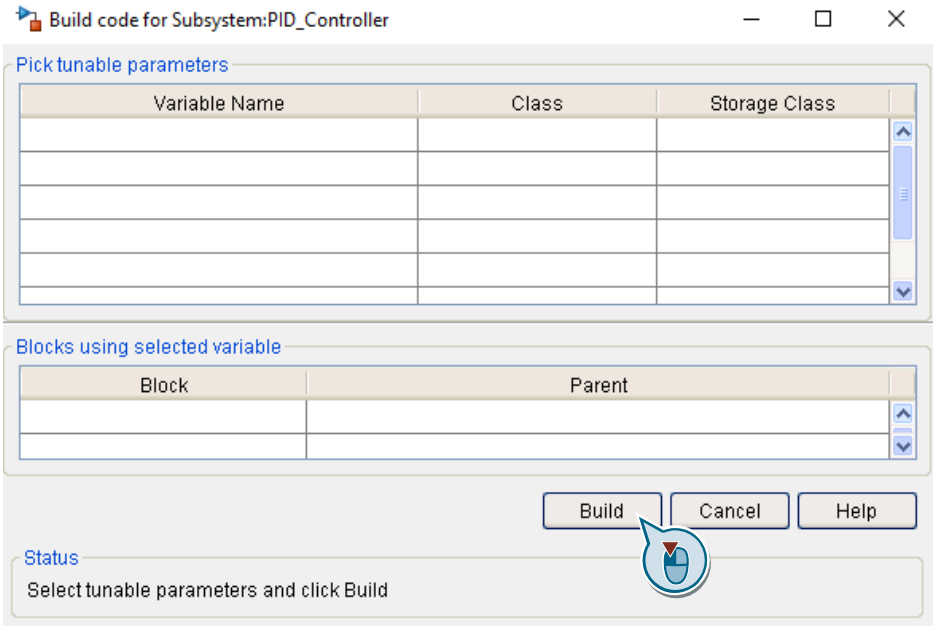
For further information on this topic, please consult the Target 1500S manual https://support.industry.siemens.com/cs/ww/en/ps/24443/man

and the SIMATIC S7-1500 ODK 1500S manual https://support.industry.siemens.com/cs/ww/en/ps/13914/man.

11. Close the dialog by clicking "OK".

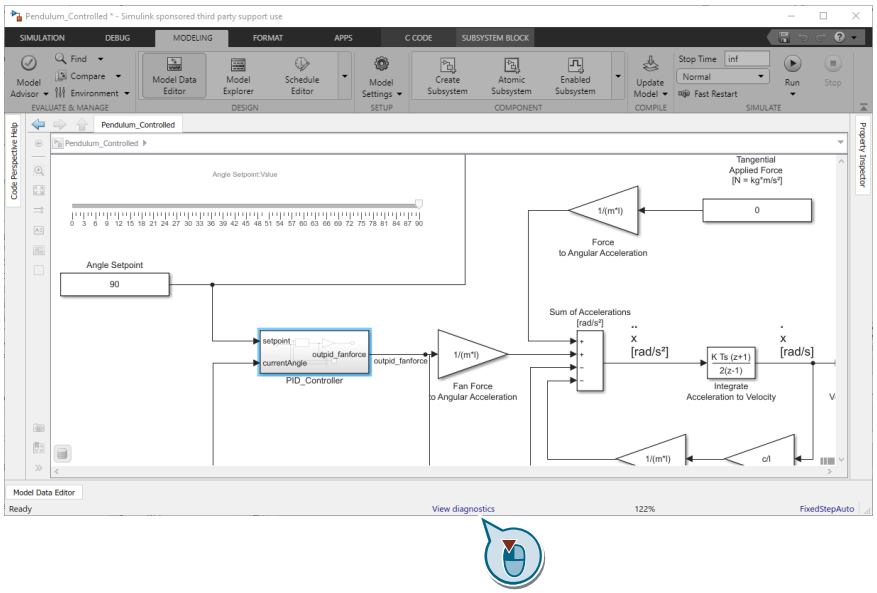
2.4.2 Coding with SIMATIC Target 1500S

1. Open your own model, or the supplied model "Pendulum_Controlled.slx".
2. Right-click to select the subsystem "PID_Controller" and click "Code > C/C++ Code > Build This Subsystem" in the selection window.
3. The "Build code for Subsystem:PID_Controller" window will open. Confirm this with "Build".



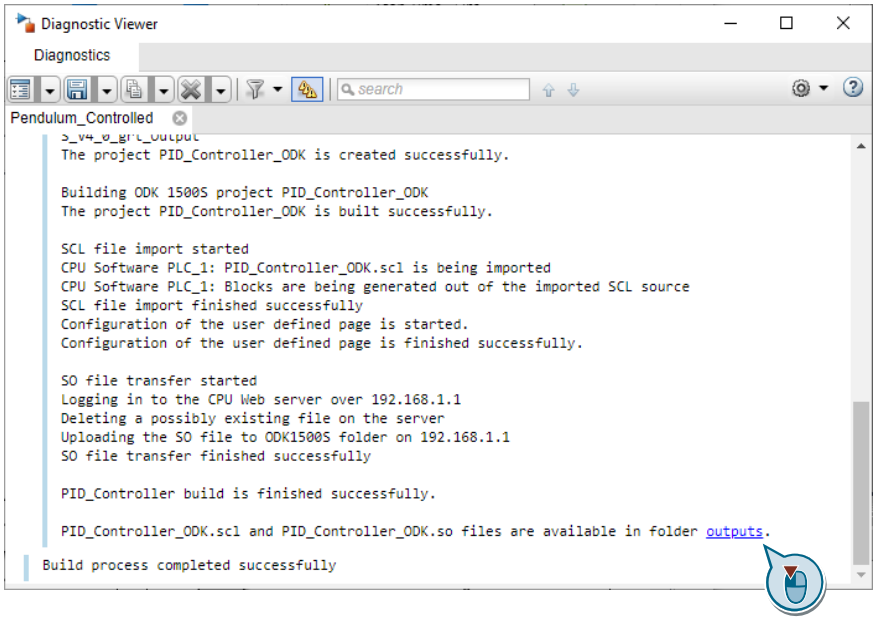
- Simulink cannot be operated while the code is generating.
- SIMATIC Target 1500S compiles the Simulink model "Pendulum_Controlled" with its input and output tags to "C/C++" code.
- This source code is then used to generate the SO file and SCL source with the ODK compiler of the SIMATIC ODK 1500S.

4. Once the code generation is done, you can click the "View..." link in the status bar of the Simulink window.

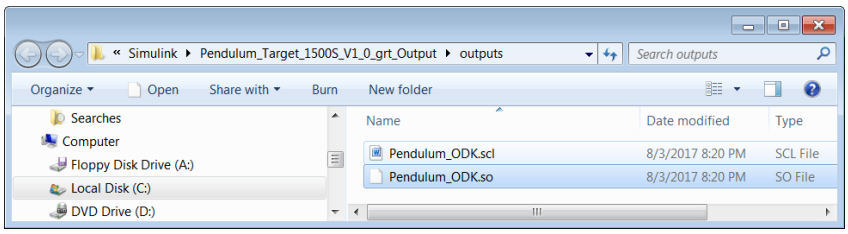


5. The "Diagnostic Viewer" opens.

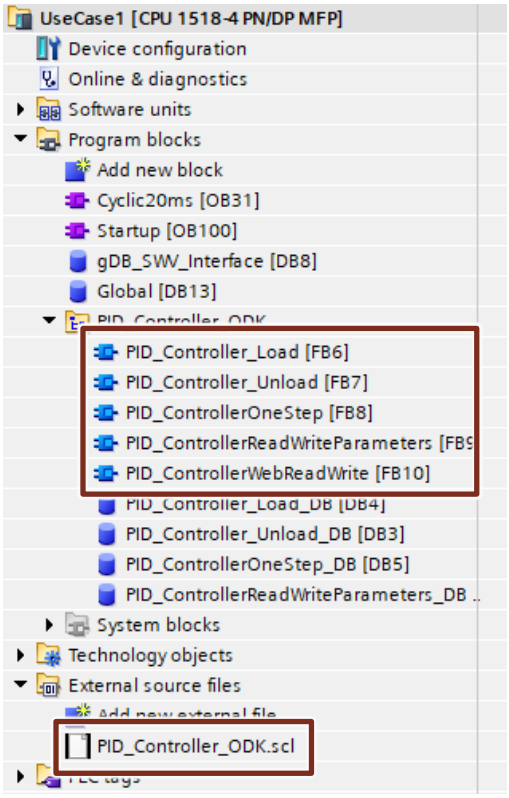
   Click the "outputs" link. You will be taken directly to the save directory of the SO file and the SCL source.



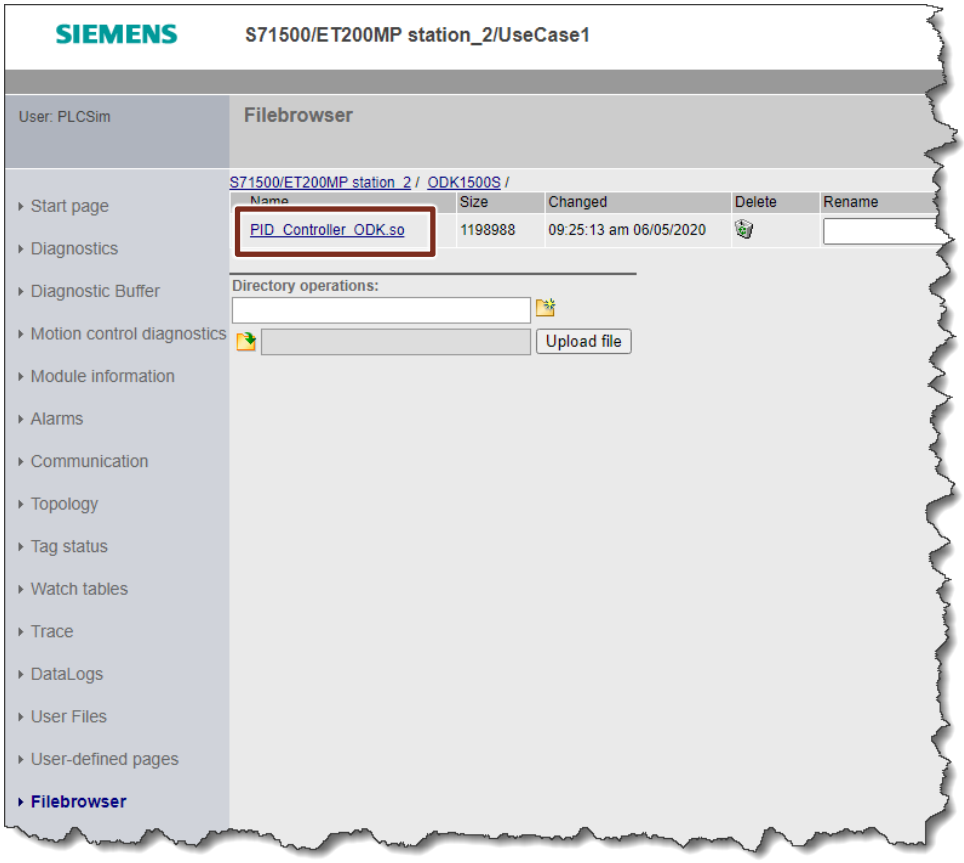
6. The directory of the Simulink model, "…\Pendulum_Target_1500S_V1_0_grt_Output\outputs", contains the generated files.



7. In the TIA Portal project, check whether the SCL files have been automatically imported. Otherwise, manually add the SCL file that was generated from Matlab. Here, follow the steps for "Importing SCL source" in Creating Step 7 program.



8. Check whether the SO file was automatically saved in the web server under "Filebrowser > ODK1500S". Otherwise, perform this upload manually ("Load SO file to web server" in "Creating Step 7 program").



2.4.3 Description of the generated function blocks

The following table describes all blocks that have been generated from the SCL source.

Table 2-1: Block explanation

Generated block	Functional description
FB PID_Controller_Unload	Block clears the SO file from the CPU's memory.
FB PID_Controller_Load	Block loads the SO file from the web server into the CPU's memory
FB PID_ControllerOneStep	Block calls up the SO file. The interfaces correspond to the original Simulink model.
FB PID_ControllerWebReadWrite (optional)	Block is called for reading or writing via the user-defined website.
FB PID_ControllerReadWriteParameters (optional)	Block is called to read or write manipulated model parameters.

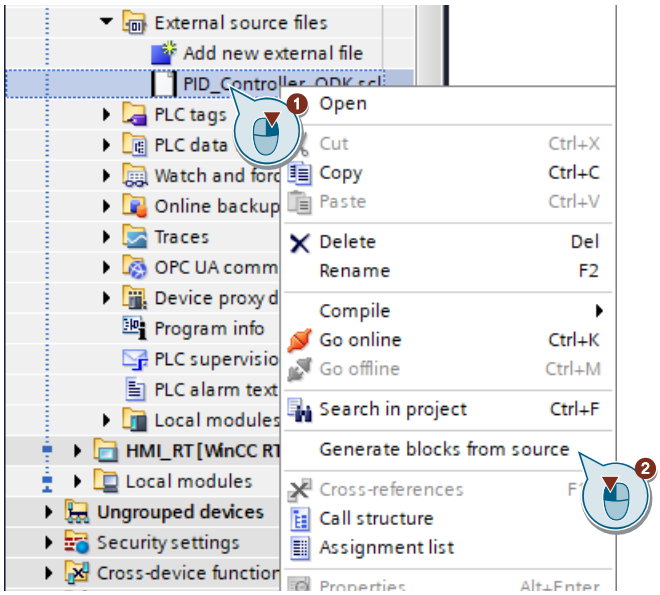
2.5 Create Step 7 program

Importing SCL source

In case the automatic import of the SCL source did not work, perform the following steps to import the SCL source, which was generated by the Target 1500S.

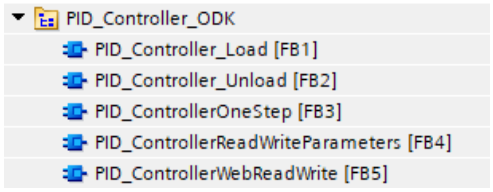
1. In the "Project tree", navigate to "External source files".
2. Click "Add new external file".
3. Select the generated SCL source "PID_Controller_ODK.scl" and import the file in to the S7 program.

4. Generate:
   1. Right-click the file "PID_Controller_ODK.scl".
   2. Click "Generate blocks from source" and confirm the dialog.

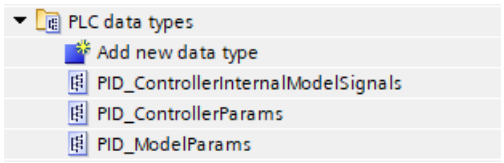


TIA Portal will use the SCL source to generate the blocks created by Target 1500S.

5. You will find the generated blocks under "Program blocks".



6. You will find the generated PLC data types under "PLC data types".



OBs and global DBs

Follow the steps outlined below to create the global project tags and tags for communicating with the Simulink model.

1. Add the following blocks to your S7 program:
   - Cyclic Interrupt OB: "Cyclic20ms" (with an interrupt time of 20 ms)
   - Startup OB: "Startup"
   - Global DB: "Global"

   Note

   The cycle of the OB "Cyclic20ms" must match the cycle Ts of the Simulink model (here, Ts=0.02, or 20 ms).
2. Open the DB "Global" and add the following tags. The tags are bundled in a structure.
   - pendulumController [Struct]
     - angleSetpoint [Int]
     - currentAngle [LReal]
     - fanforce [LReal]
     - operatingMode [Int] (starting value = 3)
   - internalsignals [PID_ControllerInternalModelSignals]
   - modelParams [PID_ControllerParams]

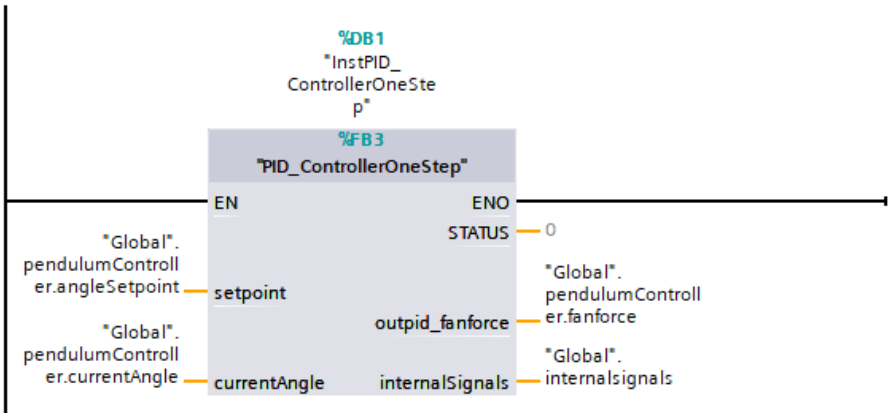
Global

	Name	Data type	Start value
1	Static		
2	pendulumController	Struct	
3	angleSetpoint	LReal	0.0
4	currentAngle	LReal	0.0
5	fanforce	LReal	0.0
6	operatingMode	Int	3
7	internalsignals	"PID_ControllerInternalModelSignals"	
8	modelParams	"PID_ControllerParams"	

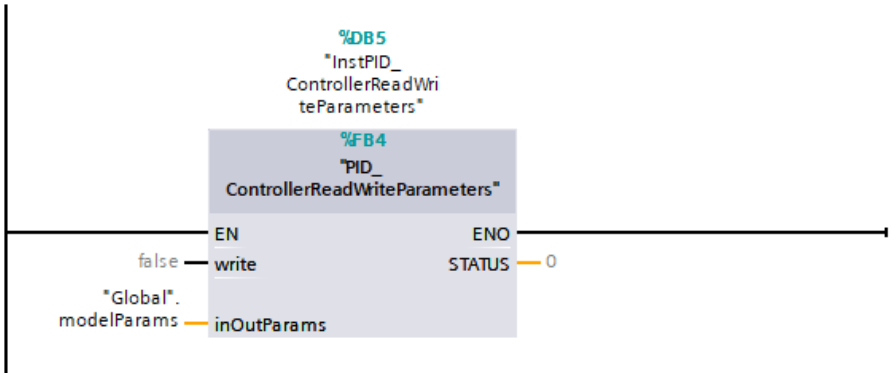
OB "Cyclic20ms"

Carry out the following steps to program the "Cyclic20ms" OB.

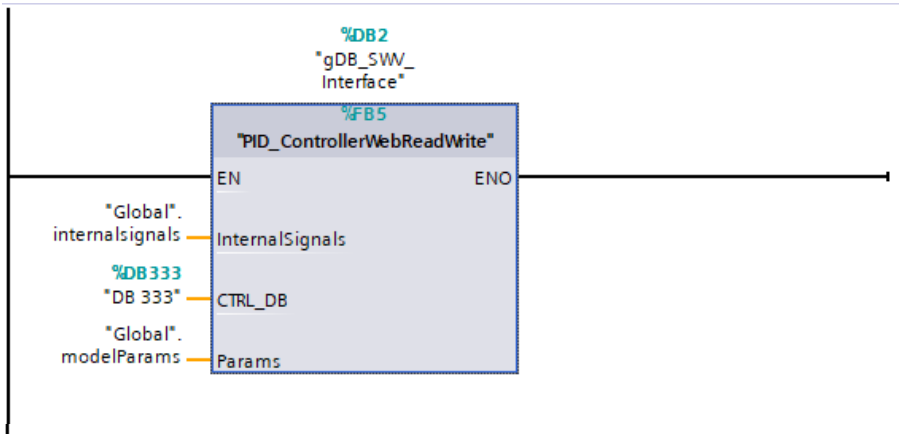
1. Open the cyclic interrupt OB "Cyclic20ms".
2. Call the block "PID_ControllerOneStep" and interconnect as shown in the figure below.



3. Call the block "PID_ControllerReadWriteParameters" and interconnect it as shown in the figure below.



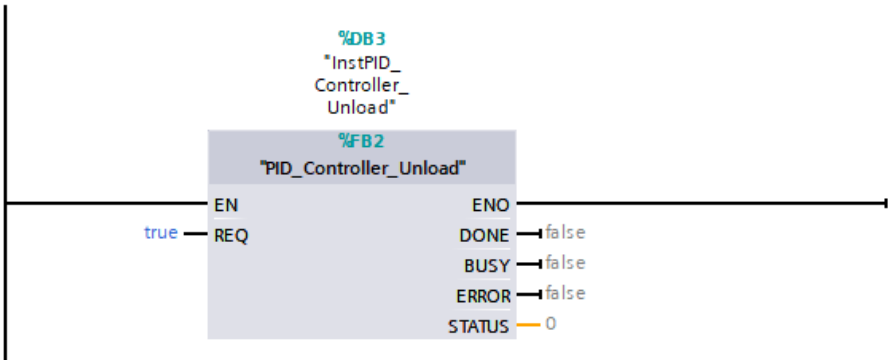
4. Call the block "PID_ControllerWebReadWrite" and interconnect it as shown in the figure below. Here, the instance name must be "gDB_SWV_Interface".



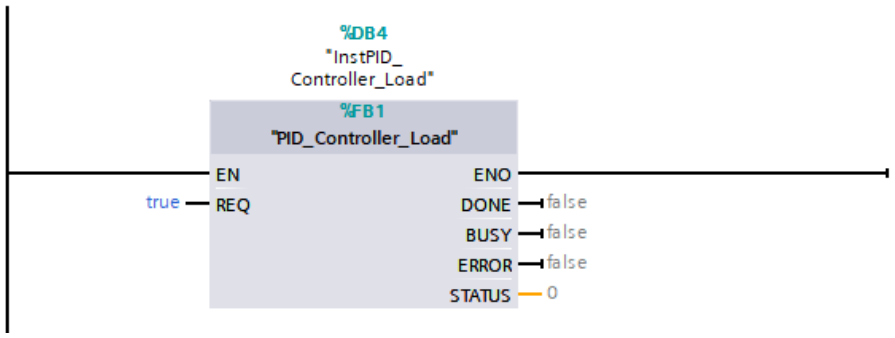
OB "Startup"

Perform the following steps to program the "Startup" OB.

1. Call the block "PID_Controller_Unload" and interconnect it as shown in the figure below.



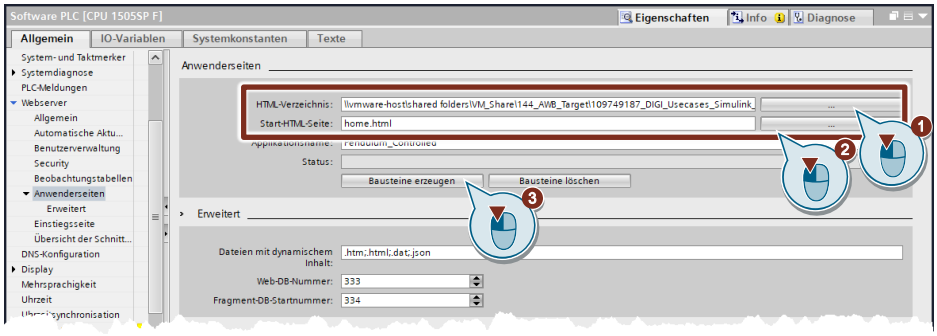
2. Call the block "PID_Controller_Load" and interconnect it as shown in the figure below.



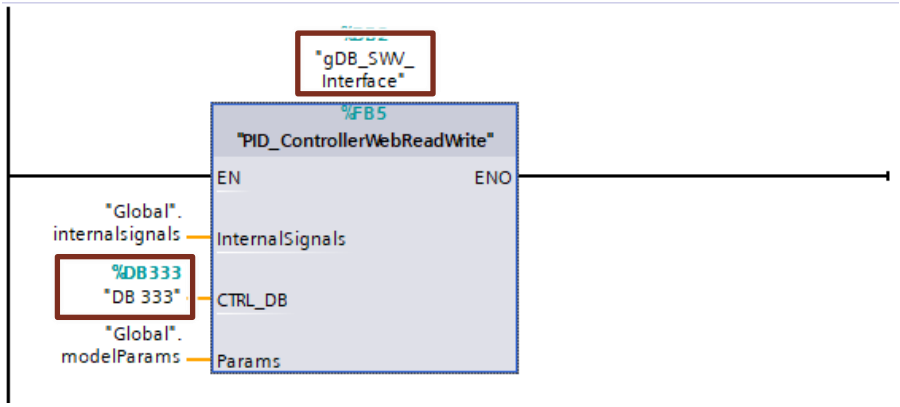
Web server user pages

Perform the steps below in order to add the user page to the web server.

1. Select the directory of the website generated from the Matlab model: "…\Pendulum_Target_1500S_V1_0_grt_Output\website".
2. Make "home.html" the start HTML page.
3. Generate the blocks.

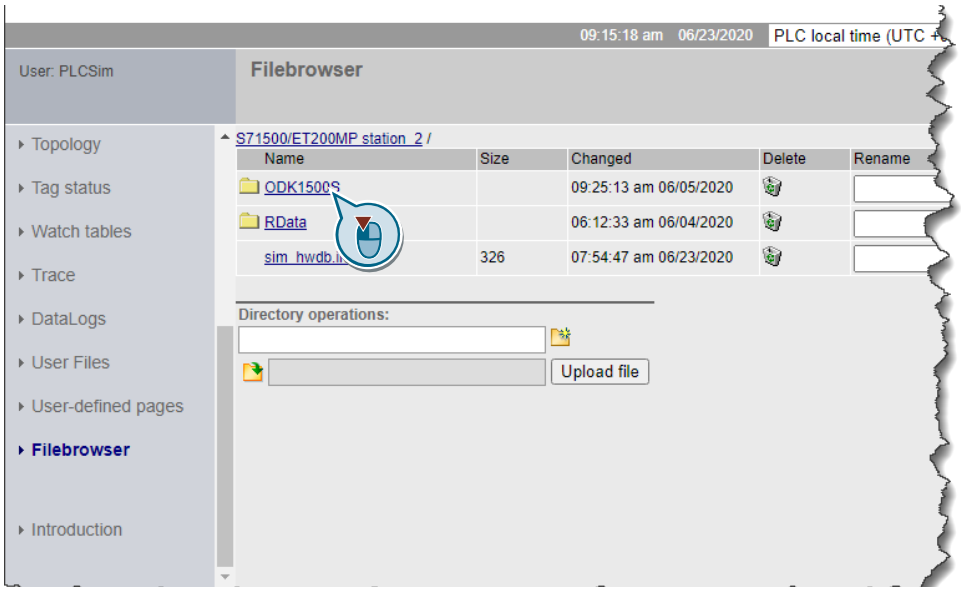


4. Check in the OB "Cyclic20ms" whether the selected web DB number (here 333) is populated when the FB "PID_ControllerWebReadWrite" is called, and that the instance is named "gDB_SWV_Interface".

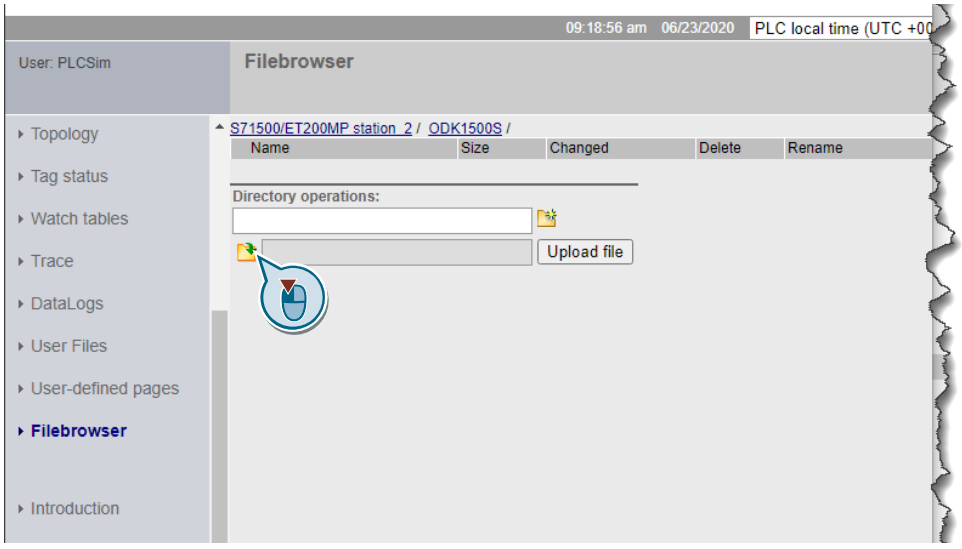


Upload SO file to web server

1. Open a browser of your choice (Internet Explorer, Firefox, etc.).
2. Open the website http://192.168.3.1. The homepage of the CPU web server will open.
3. Click "Enter".
4. Navigate to "Filebrowser".
5. Click the folder "ODK1500S".



6. Click the "Browse" button.



7. Navigate to the "PID_Controller_ODK.so" file, which was created by Target 1500S. The file is located in the "outputs" folder of the generated Target 1500S code.
8. Select the file and click "Open".
9. Click the "Upload file" button.
10. Close the browser.

Note Once you have uploaded the SO file to the web server, you must restart the CPU.

The SO file will only be loaded to the CPU's memory once the block "PID_Controller_Load" is called in the OB "Startup".

2.6 Insert S-function in Simulink model

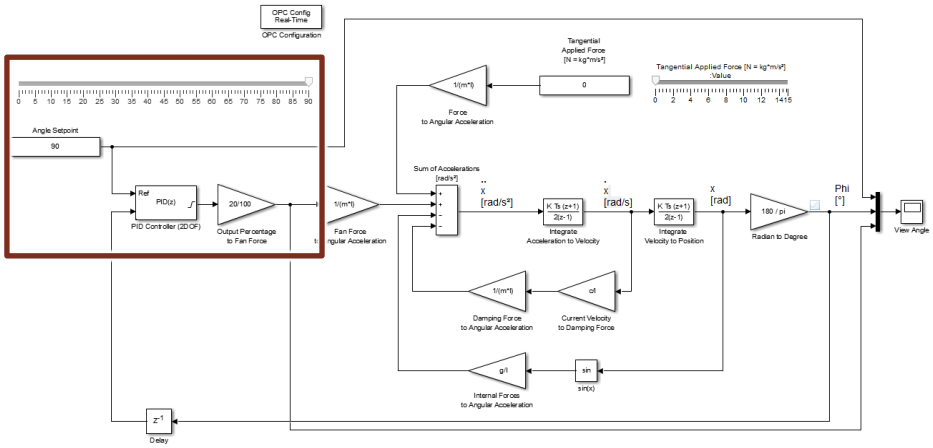
Requirement

- You have started an instance of the virtual controller with PLCSIM Advanced.
- You have fully programmed the S7 program and loaded it to the virtual controller.
- You have stored the included folder "S-Function" from the compressed folder "Simulink_Usecase1" in a known directory on your computer, and added the file with all child filed to the search path in MATLAB.

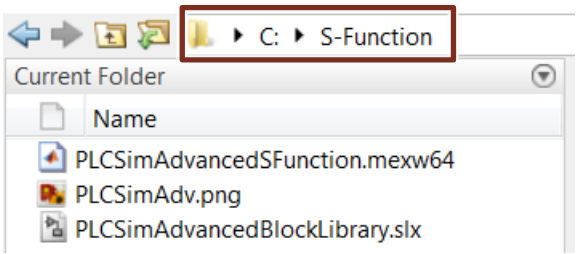
Perform the following steps to use the S-function in the Simulink model.

1. Open the Simulink model "Pendulum_Controlled" from the compressed folder "Simulink_Main".

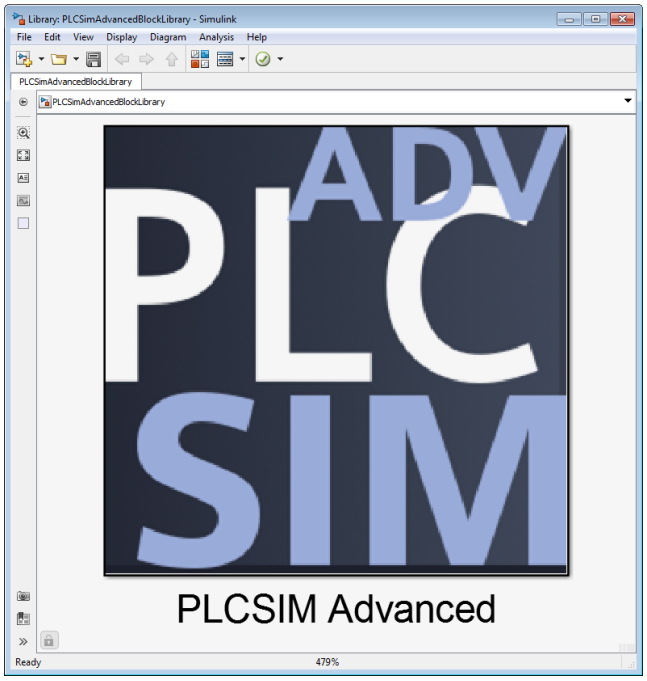
   Remove the PID controller and the function that are executed by the S7 program.



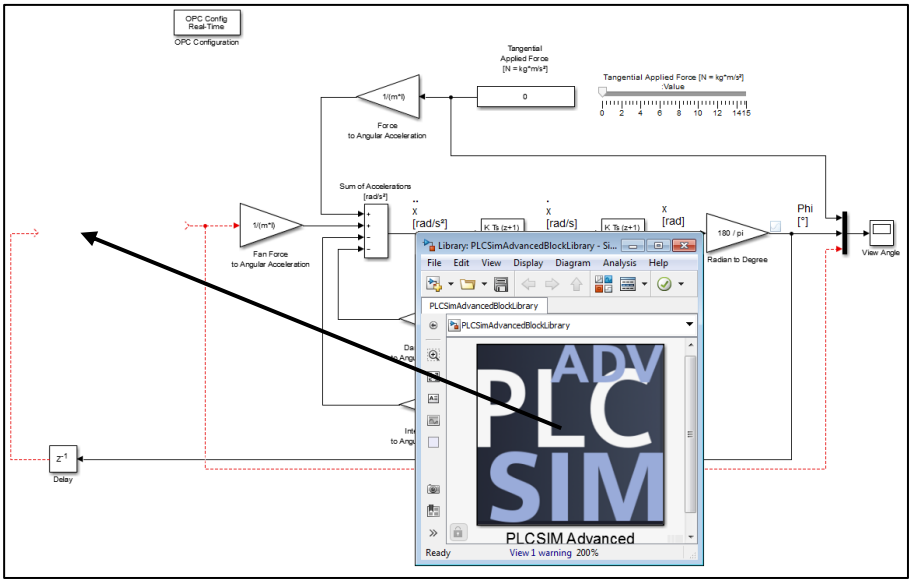
2. Switch to the MATLAB interface and navigate in the directory to where you stored the extracted "S-function" folder.



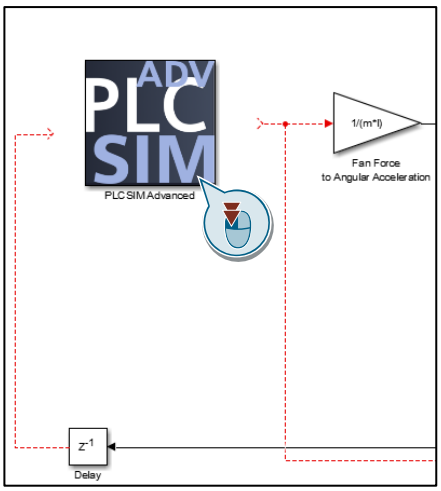
3. Double-click to open the library object "PLCSimAdvancedBlockLibrary.slx". A new window will open.



4. Drag and drop the S-function block "PLCSIM Advanced" into the Simulink model with the control path.

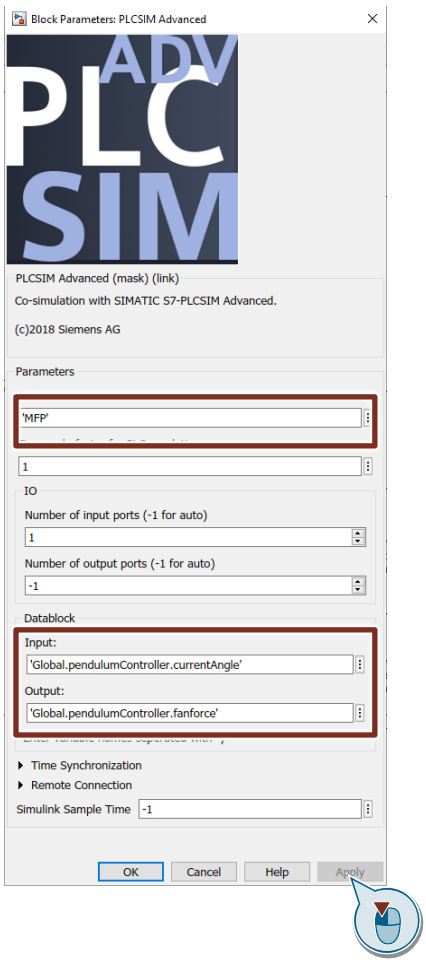


5. Double-click to open the block parameters of the S-function "PLCSIM Advanced".

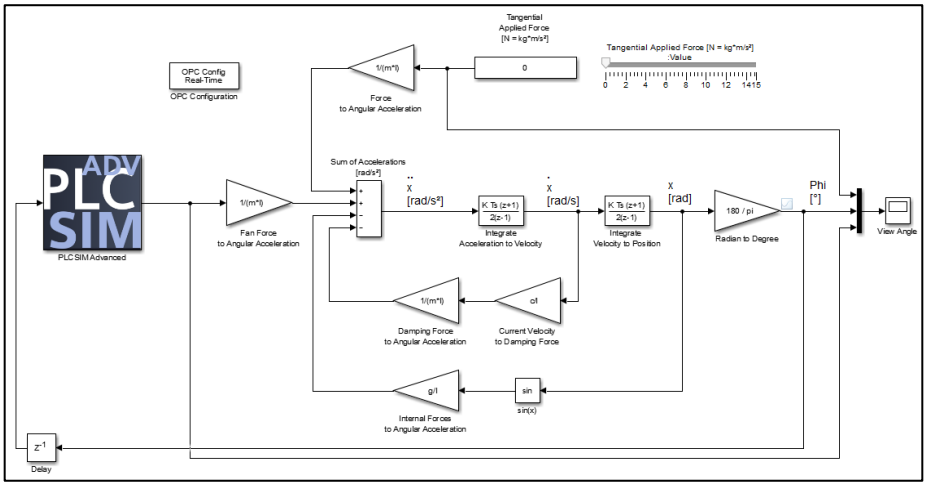


6. Enter the instance name of the started virtual controller of PLCSIM Advanced in apostrophes ('MFP'). Also specify the input ('Global.pendulumController.currentAngle') and the output ('Global.pendulumController.fanforce).

   Apply the change with "Apply".



7. The inputs and outputs of the S-function are derived from the PLC tags and generated automatically. Connected the "PLCSIM Advanced" block with the control path.

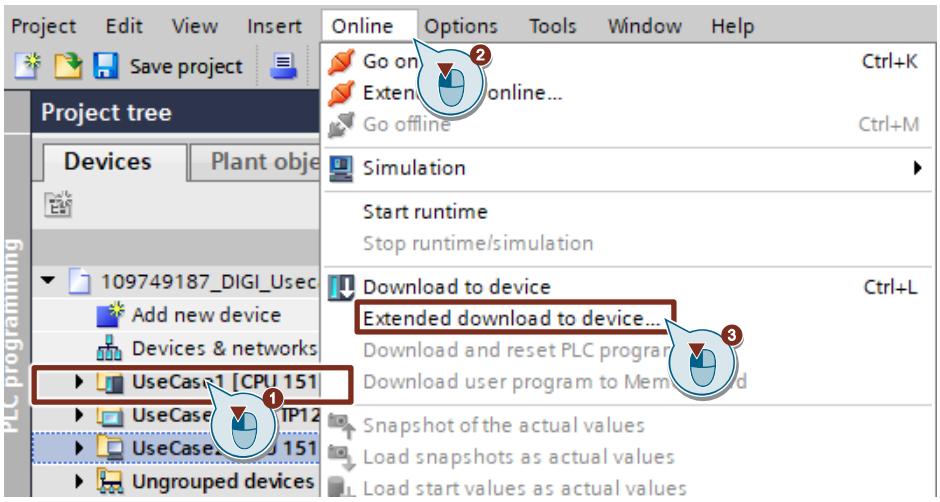


2.7 Commissioning the example application

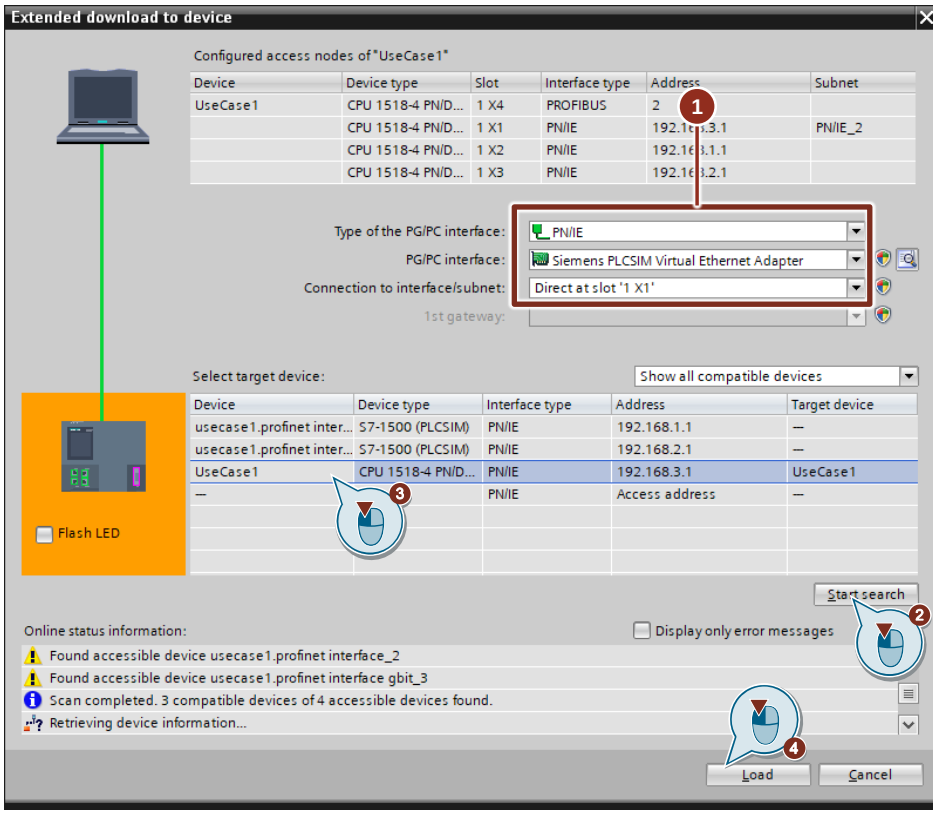
Perform the steps below to commission the simulation with the supplied TIA Portal project and the supplied Simulink model. The S-function with the parameterized instance name "MFP" has already been added to the Simulink model.

2.7.1 Download project

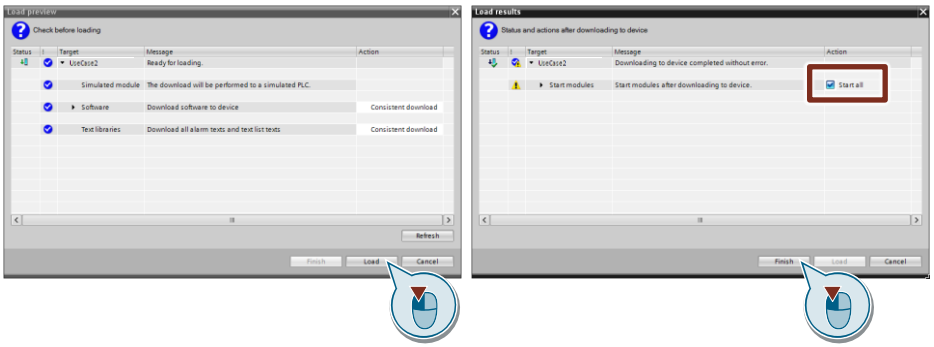
1. Open the example project or your TIA Portal project.
2. In the project tree, select the controller "UseCase1" and select "Online > Extended download to device" in the TIA Portal menu bar.



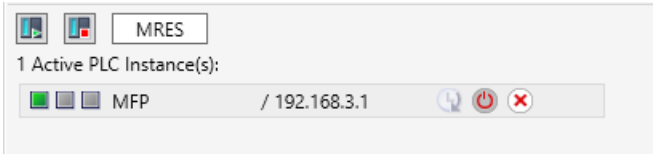
3. Download:
   1. Set the interface to the controller.
   2. Start the search.
   3. Select the found virtual controller from the list.
   4. Download the project.



4. Follow subsequent TIA Portal messages and start the controller.

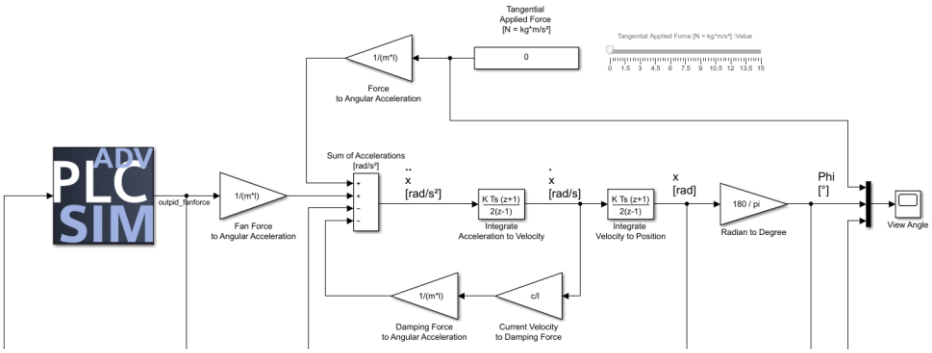


The virtual controller is put in "RUN" mode.



2.7.2 Start Simulink simulation

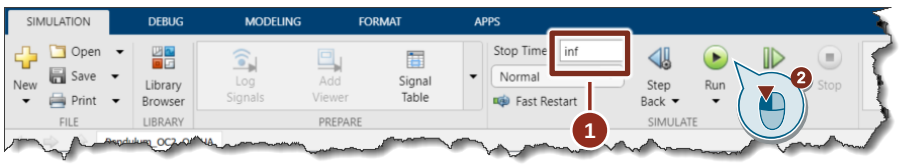
1. Open the supplied Simulink model "Pendulum_PLCSIMAdv_API.slx".



Note

The "S-function" folder must be added to the MATLAB search path. "startup1.m" can be run to do this.

2. Start the simulation of the Simulink model.
   1. Set the simulation duration to "inf" (unlimited).
   2. Click the "Run" icon.

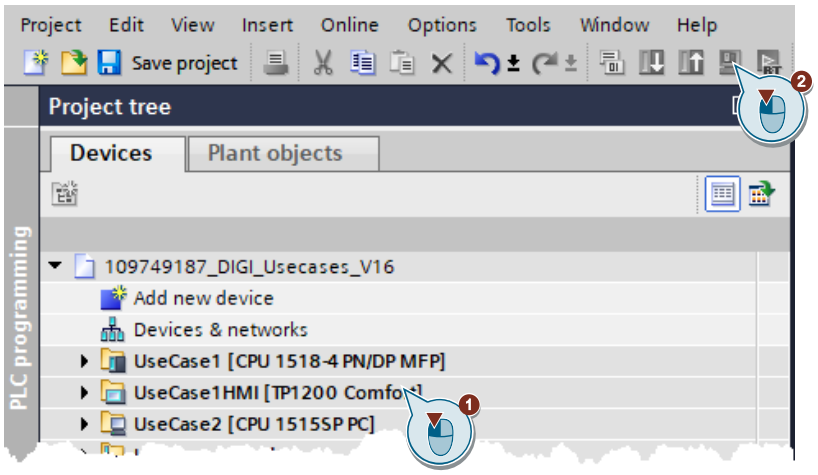


3 Operation

3.1 Operating the PID controller

Start HMI

1. In the project tree, select the HMI "HMI_PLCSIM_Adv".
2. Click "Start simulation".



3. Select "Start Application".

Specify setpoint

Click in the input box "Setpoint" and enter a setpoint value for the pendulum's deflection angle. Confirm your entry with Enter.

Figure 3-1: Specify setpoint

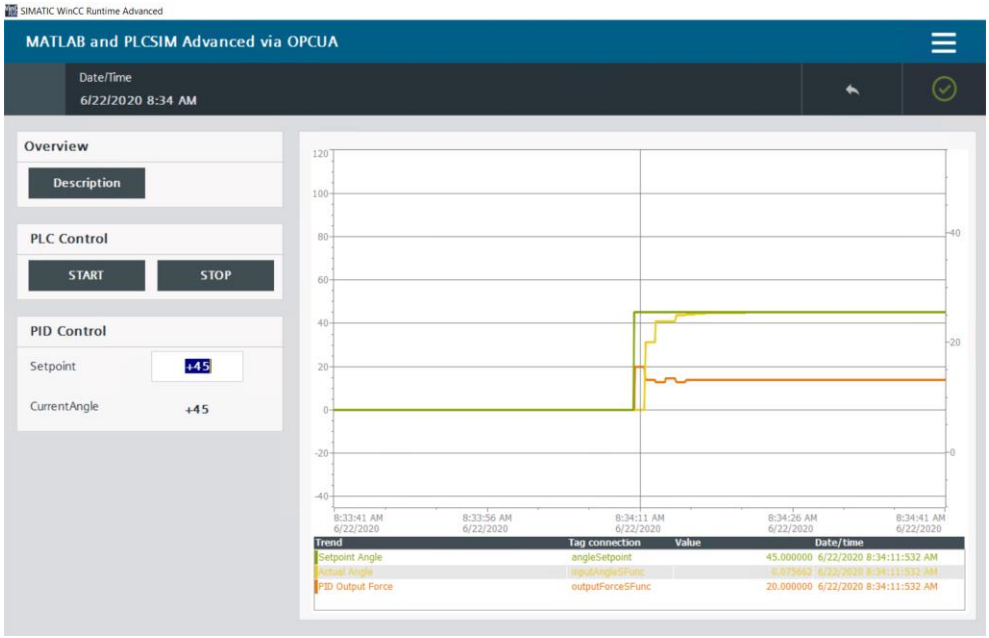
3.2 Monitor control result

You have two ways of monitoring the control result.

First, the trace in the simulation of the HMI represents the history of the setpoint, the actual value (deflection angle) and the manipulated variable (force) of the PID controller.

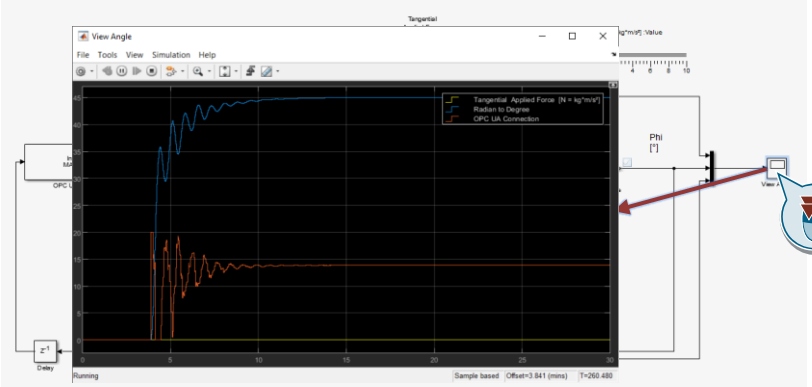
The figure shows curves for a setpoint angle of 45 °.

Figure 3-2: HMI simulation



Second, you can also monitor the control result via a display window in Simulink. Open the display window by double-clicking the "Scope" function in the Simulink model.

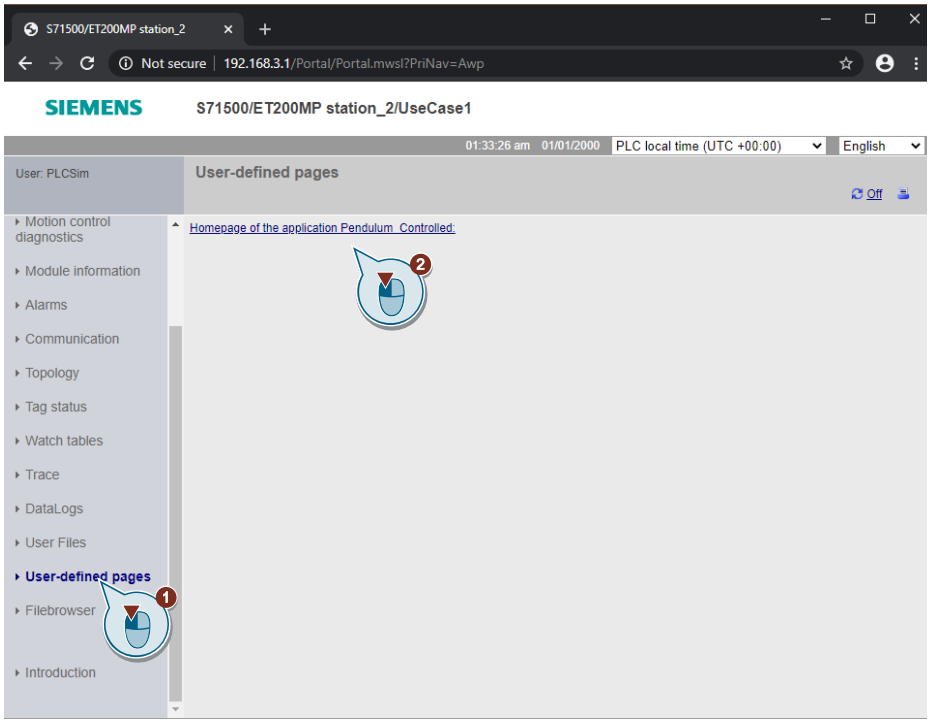
Figure 3-3: "Scope" function



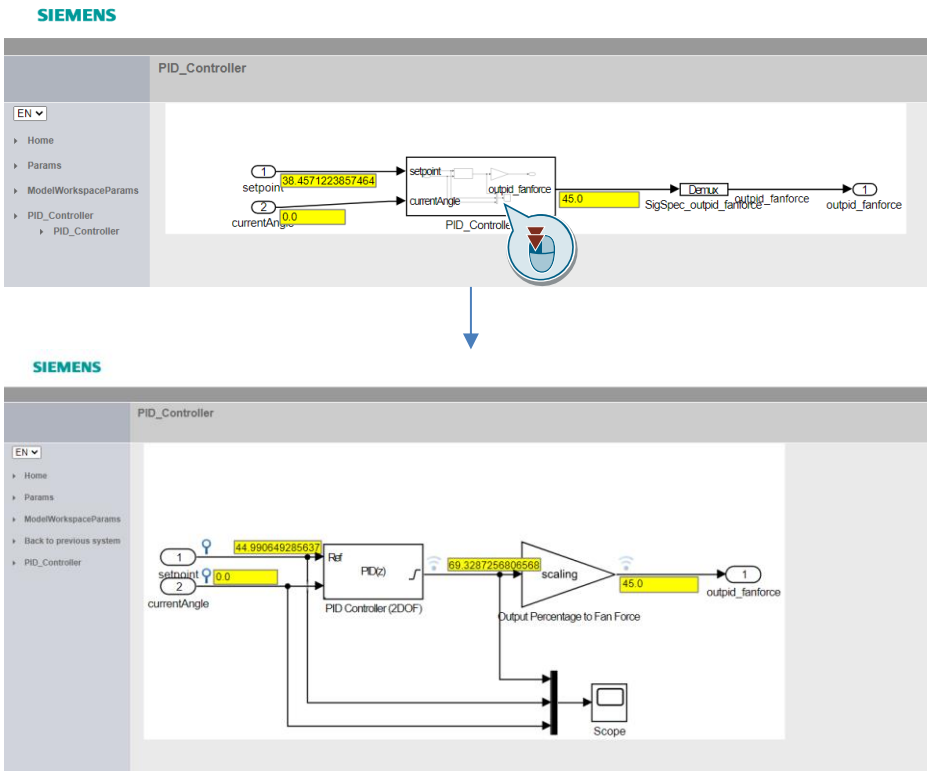
3.3 Using the user website

The browser-based user site is another option for monitoring and controlling the PID controller.

1. Open the user site in the web server.



2. The values at the input and output, as well as inside the PID_Controller, can be viewed in the user site. For the values inside, click on the subsystem.



3. The parameters of the PID_Controller can be adjusted under ModelWorkspaceParams.

3.4 Speeding up/slowing down the controller's virtual time

For test purposes, you can speed up or slow down the virtual time of the controller by using a scaling factor.

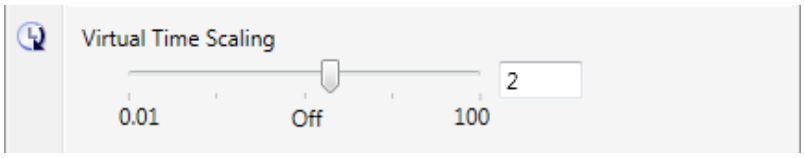
- **Fast mode:** A scaling factor of greater than 1 speeds up the virtual clock. Example: Scaling factor 2.0 → The virtual time runs twice as fast.
- **Slow motion:** A scaling factor of less than 1 slows down the virtual clock. Example: Scaling factor 0.5 → The progression of virtual time slows to 50%.

Note Fast mode and slow motion do not change the execution speed of the CPU machine code. For example, the speed at which all operations of an OB1 cycle are performed does not change. The execution speed depends on the processor of the PC that the virtual controller is running on. If you modify the scaling factor, more or fewer cycle control points are reached in a fixed amount of virtual time.

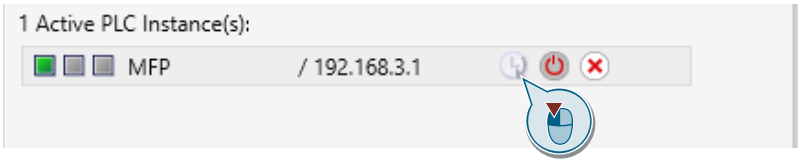
Make sure to enable the option "Enable time synchronization" in the block parameters of the S-function "PLCSIM Advanced" so that the Simulink model synchronizes with the modified simulation speed.

Perform the following steps to speed up or slow down the virtual time of the controller.

1. Open the PLCSIM Advanced graphical interface.
2. Use the slider to set the scaling factor.



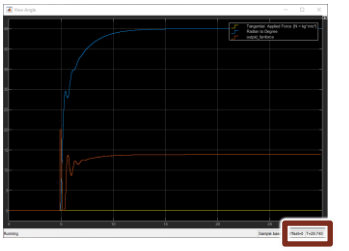
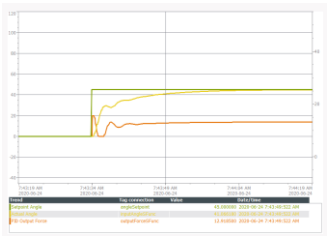
3. Enable the scaling factor for the instance of the virtual controller.



4. Specify a setpoint value for the PID controller and monitor the effect of the change in virtual time.

The following figure shows possible effects of the accelerated or slowed virtual time.

Figure 3-4

Scaling factor	WinCC Runtime	Simulink
1.0	 Virtual time is almost identical to real time.	 The PseudoRealtime is almost identical to the real time.
0.5	 Virtual time runs 50% slower. The control is slower on the real time base.	 The PseudoRealtime runs 50% slower, synchronized to the virtual time of the controller.
2.0	 Virtual time runs twice as fast. The regulation is faster on the real time basis.	 The PseudoRealtime runs twice as fast, synchronized to the virtual time of the controller.

4 Useful information

4.1 Block parameters of the S-function "PLCSIM Advanced"

Figure 4-1: Block parameters, S-function, "PLCSIM-Advanced"

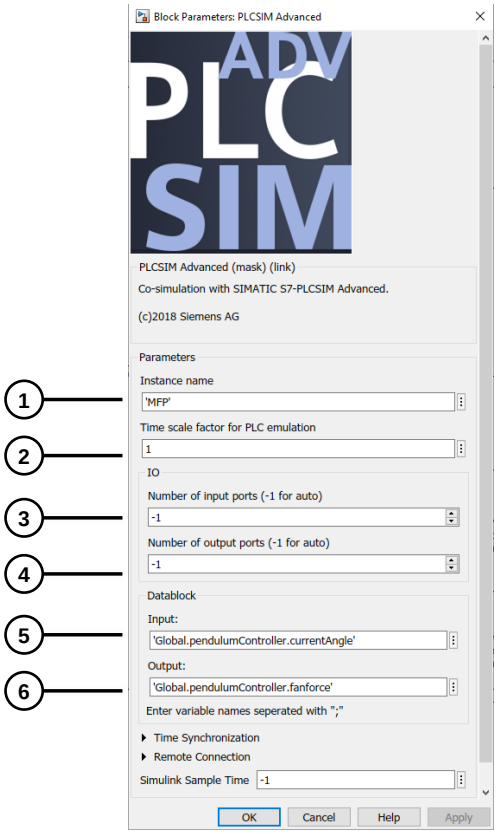


Table 4-1: Description of block parameters

Item	Description	Note
1.	Instance name of the virtual controller	The instance name must be written between two apostrophes.
2.	Scaling factor for the virtual time of the virtual controller	Scale factor preset. Relevant for creating the instance of a virtual controller from Simulink.
3.	Number of inputs	If "-1" is entered, the number of inputs is derived automatically from the number of PLC input tags.
4.	Number of outputs	If "-1" is entered, the number of outputs is derived automatically from the number of PLC input tags.
5.	Tags of the inputs	The tag must be written between two apostrophes.
6.	Tags of the outputs	The tag must be written between two apostrophes.

4.2 S-function "PLCSIM Advanced"

The source code for the S-function "PLCSIM Advanced" is programmed in the high-level programming language C++ and contains instructions for data exchange with an instance of the virtual controller via the PLCSIM Advanced API. An MEX file is generated from it so that the code can be run in MATLAB. The MEX file can be integrated into Simulink with an S-function.

Automatic generation of an instance of the virtual controller

Mechanisms for generating a new instance of the virtual controller are programmed in the code of the S-function "PLCSIM Advanced", in case they do not yet exist.

When applying the modified block parameters of the S-function, a new instance of the virtual controller is automatically generated if the name entered for the instance does not yet exist in the directory of the Virtual SIMATIC Memory Card[1] of PLCSIM Advanced.

In this case the instance is started immediately if PLCSIM Advanced is already started. Otherwise, only the SIMATIC Memory Card with the instance name will be created in the directory of the Virtual SIMATIC Memory Card, and the instance must be manually started via the Control Panel of PLCSIM Advanced.

Note

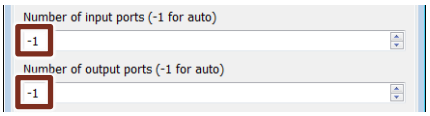
The S-function "PLCSIM Advanced" automatically derives the number of inputs and outputs for the block from the PLC tags of the virtual controller.

For this reason it is recommended to first start the virtual controller and load it with a project, and only then to insert the S-function in Simulink.

Inputs/outputs

The S-function "PLCSIM Advanced" automatically derives the number of contacts for the inputs and outputs of the blocks from the PLC tags of the virtual controller if "-1" is set for the number of inputs and outputs in the block parameters of the S-function.

Figure 4-2



There are the following two cases of when the contacts can be generated.

- The S-function is inserted into the Simulink model before a virtual controller has been started and loaded with TIA Portal project. After the instance name of the virtual controller is entered in the block parameters of the S-function and the changes are applied, an instance of the virtual controller will be automatically generated when PLCSIM Advanced is started. The contacts are only generated when the TIA Portal project is loaded to the virtual controller and the Simulink simulation has been started. After the simulation is stopped, the S-function ca be connected with the Simulink model.
- The instance of the virtual controller has been manually generated and already loaded with the TIA Portal project. The S-function is then inserted into the Simulink model. After the instance name of the virtual controller is entered in the block parameters of the S-function and the changes are applied, the contacts are automatically generated and the block can be connected.

[1]The Virtual SIMATIC Memory Card saves the user program, the hardware configuration and the retentive data for the virtual controller.

Tag exchange

Tags are exchanged at the cycle control point of the virtual controller. If the cycle control point has not yet been reached, the S-function waits for the cycle end of the virtual controller. The S-function reads the output tags and writes the input tags from the list of PLC tags.

4.3 Synchronization

The S-function facilitates a synchronization of the Simulink model with the virtual time of the virtual controller. To do this, the option "Enable time synchronization" must be enabled in the block parameters of the S-function.

In such case, tag exchange occurs not only at the cycle control point, but also when the pseudo-real-time of the Simulink model and the virtual time of the virtual controller are nearly the same. In order to follow the modified virtual time of the virtual controller, Simulink will slow down or speed up the pseudo-real-time.

5 Appendix

5.1 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:

support.industry.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts.

Please send queries to Technical Support via Web form:

support.industry.siemens.com/cs/my/src

SITRAIN – Training for Industry

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:

siemens.com/sitrain

Service offer

Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog web page:

support.industry.siemens.com/cs/sc

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for iOS and Android:

support.industry.siemens.com/cs/ww/en/sc/2067

5.2 Industry Mall

The Siemens Industry Mall is the platform on which the entire siemens Industry product portfolio is accessible. From the selection of products to the order and the delivery tracking, the Industry Mall enables the complete purchasing processing – directly and independently of time and location:
mall.industry.siemens.com

5.3 Links and literature

Table 5-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/109749187
\3\	Manual: SIMATIC S7-PLCSIM Advanced https://support.industry.siemens.com/cs/ww/en/view/109773484
\4\	MathWorks online documentation: http://mathworks.com/help/
\5\	Manual: STEP 7 Professional V16 https://support.industry.siemens.com/cs/ww/en/view/109773506

5.4 Change documentation

Table 5-2

Version	Date	Modifications
V1.0	12/2017	First edition
V2.0	09/2020	Revised use cases 1 & 2