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Use Case 3: Using SIMATIC Target 1500S for a Hardware-Based Simulation of the Simulink Model

SIMATIC S7-1500 Open Controller
SIMATIC Target 1500S
Simulink

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

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1 Introduction

1.1 Overview

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

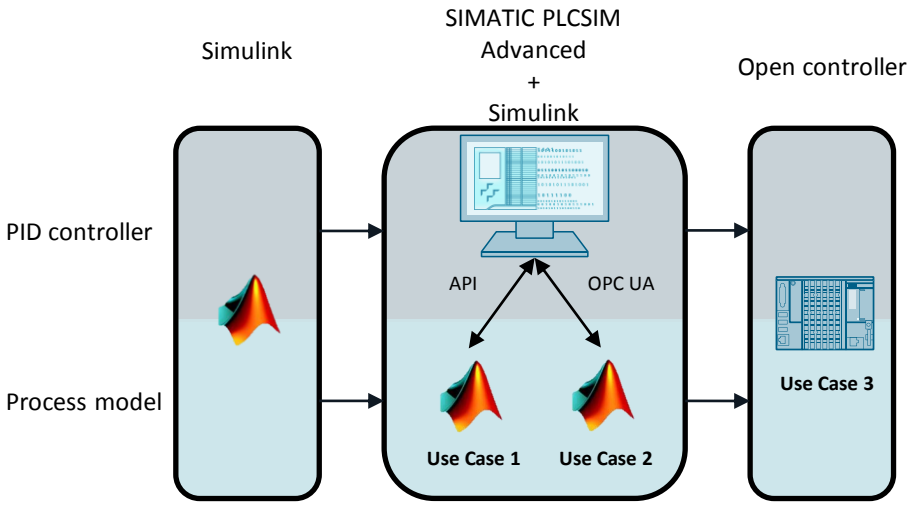
This application example shows you how to code a Simulink model with the SIMATIC Target 1500S Simulink add-on and run it on an S7-1500 Software Controller. This allows you to validate, regardless of Simulink, the function of a PID controller on the controller in conjunction with the simulated process.

This document describes the steps necessary to configure, start up and use the application example.

The following documents make up the entire application example:

- Main document: Overview of the three use cases and the Simulink model
- Use Case 1: Connecting Simulink models to SIMATIC PLCSIM Advanced via API
- Use Case 2: Connecting Simulink models to SIMATIC PLCSIM Advanced via OPC UA
- Use Case 3: Using SIMATIC Target 1500S for a Hardware-Based Simulation of the Simulink Model (this document)

Figure 1-1: Use cases overview



1.2 How the application example works

This application example codes the Simulink model (controlled system) with SIMATIC Target 1500S and runs it on an S7-1500 Software Controller.

The controlled system is controlled using the “PID_Compact” PID controller. The PID controller and the function block with the coded Simulink model are called in a cyclic interrupt OB. As a result, the model and the controller run synchronously.

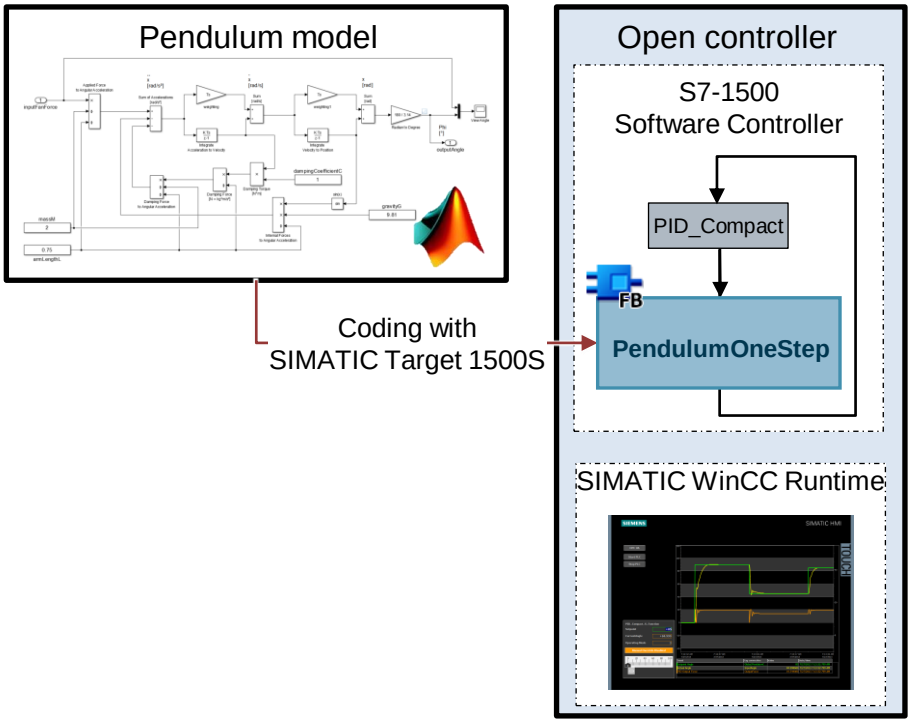
The control result and the controller’s control are visualized on an HMI screen in WinCC Runtime.

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

In addition, SIMATIC Target 1500S allows operation in External mode. This allows you to monitor the control process also in Simulink and change model parameters at runtime.

Model parameters can also be changed from the STEP 7 program at runtime.

Figure 1-2:



1.2.1 Coding with SIMATIC Target 1500S

The following figure shows the steps from creating a model in Simulink to commissioning on an S7-1500 Software Controller. Table 1-1 explains the steps in detail.

Figure 1-3:

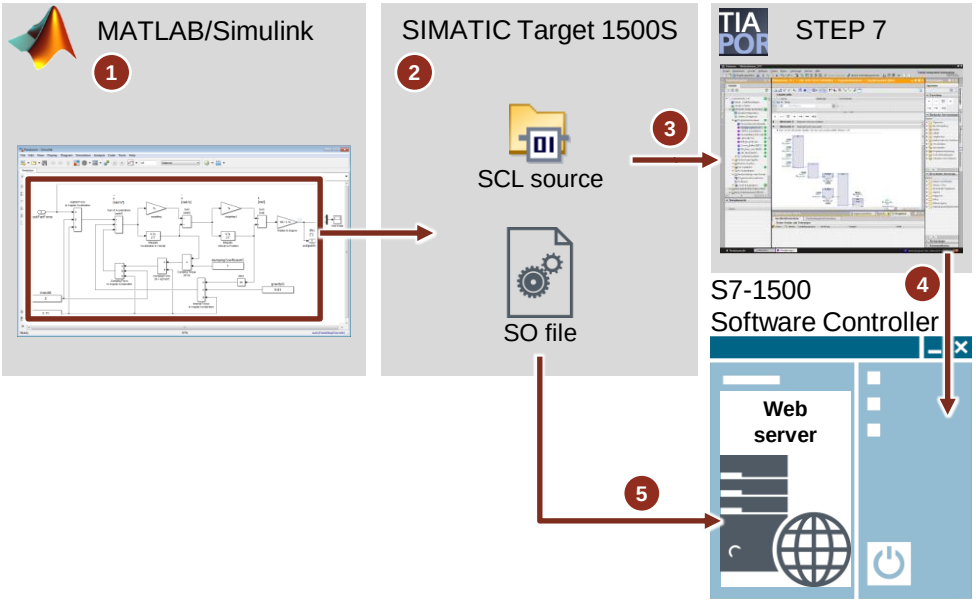


Table 1-1

Step	Action	Comment
1.	Create model in Simulink.	The pendulum controlled system is created in this example.
2.	Compile model with SIMATIC Target 1500S.	Creation of SCL blocks (sources) and SO file (shared object file / real-time function).
3.	Add SCL source in STEP 7 (TIA Portal).	Integration of the SCL blocks (sources) into the S7 program using the “External source files” function in the “Project tree”.
4.	Download S7 program to S7-1500 Software Controller.	-
5.	Load SO file to web server.	Upload of the SO file to the CPU’s web server using the “Filebrowser” function.

1.3 Components used

This application example was created with the following hardware and software components:

Table 1-2: Software components

Component	Article number / note / link
(R2016a) MATLAB V9.0 MATLAB Coder V3.1 Simulink V8.7 Simulink Coder V8.10	MathWorks Online Documentation: http://en.mathworks.com/help/
STEP 7 V14 Professional	6ES7822-1..04-.. Manual: https://support.industry.siemens.com/cs/ww/en/view/109742272
SIMATIC S7-1500 ODK 1500S V2.0	6ES7806-2CD02-0YA0 Manual: https://support.industry.siemens.com/cs/ww/en/ps/13914/man
SIMATIC Target 1500S for Simulink V1.0	6ES7823-1BE00-0YA5 Manual: https://support.industry.siemens.com/cs/ww/en/ps/24443/man Also available as a bundle with ODK 1500S: 6ES7823-1BE10-0YA0

Table 1-3: Hardware components

Component	No.	Article no.	Note
SIMATIC ET 200SP Open Controller CPU 1515SP PC 4GB (WES7-P, 64-bit)	1	6ES7677-2AA40-0AA0	-
	Manual : SIMATIC S7-1500 CPU 150xS https://support.industry.siemens.com/cs/ww/en/view/109249299		
	Manual: SIMATIC S7-1500 Software Controller Additional Information on CPU 1505S/CPU 1507S https://support.industry.siemens.com/cs/ww/en/view/104943430		
	Manual: SIMATIC ET 200SP Open Controller CPU 1515SP PC https://support.industry.siemens.com/cs/ww/en/view/109248384		

This application example consists of the following components:

Table 1-4: Components of the application example

Component	Contents
109749187_DIGI_Usecases_TARGET_DOC_V10_en.pdf	This document.
109749187_DIGI_Usecases_TIA_PROJ_V10_en.zip	TIA Portal project for Use Cases 1-3.
109749187_DIGI_Usecases_Simulink_PROJ_V10_en.zip	Simulink models for Use Cases 1-3.

2 Engineering

2.1 Simulation model in Simulink

Before you generate the code with SIMATIC Target 1500S, you have to customize the “Pendulum_Controlled.slx” Simulink model from the main document.

This chapter describes how to prepare the pendulum model to be simulated with Simulink for coding with SIMATIC Target 1500S.

Alternatively, you can open the Simulink model that has already been prepared, “Pendulum.slx”, from the sample project from the unzipped “Simulink_Usecase3” folder.

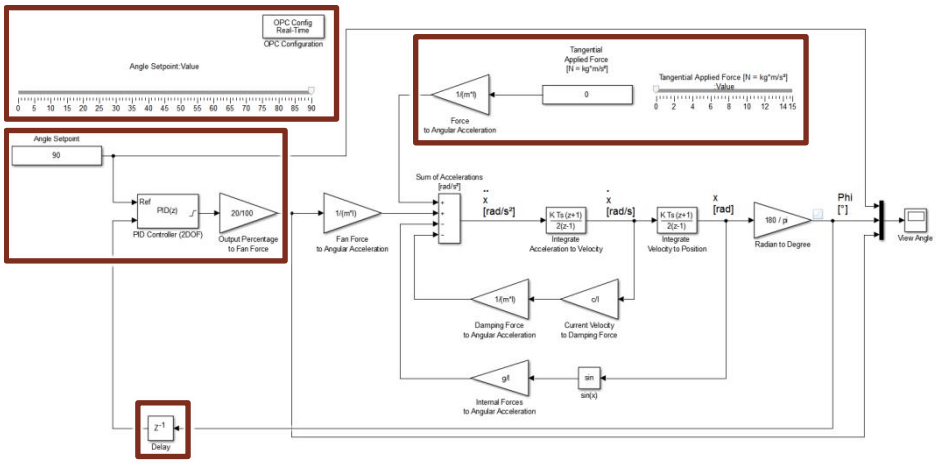
Necessary changes

The following changes must be made to the model:

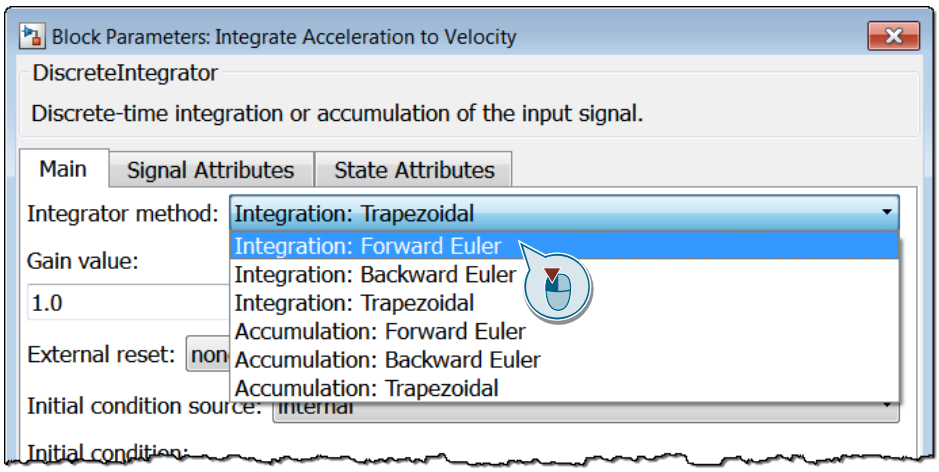
- Remove the PID controller and other blocks that are no longer required.
- Change the integration method from bilinear transformation to forward Euler and the weighting with sampling time Ts.
- Declare the simulation parameters as constants using the “Constant” Simulink block.
- Configure the model’s input and output interface.

Making the changes

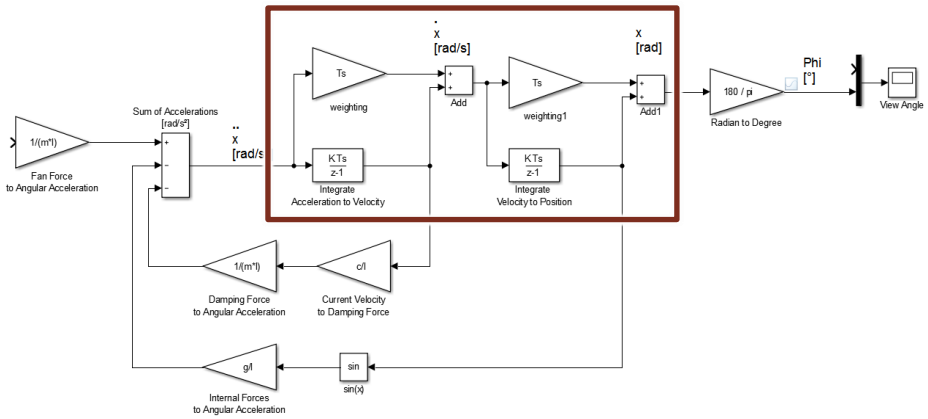
1. Open the Simulink model named “Pendulum_Controlled” from the main document. Delete the highlighted blocks and functions.



2. Double-click to open the block parameters of the “Integrate Acceleration to Velocity” integrator. In “Integrator method”, select “Integration Forward Euler”. Click “Apply” to apply the change and select “OK” to confirm.



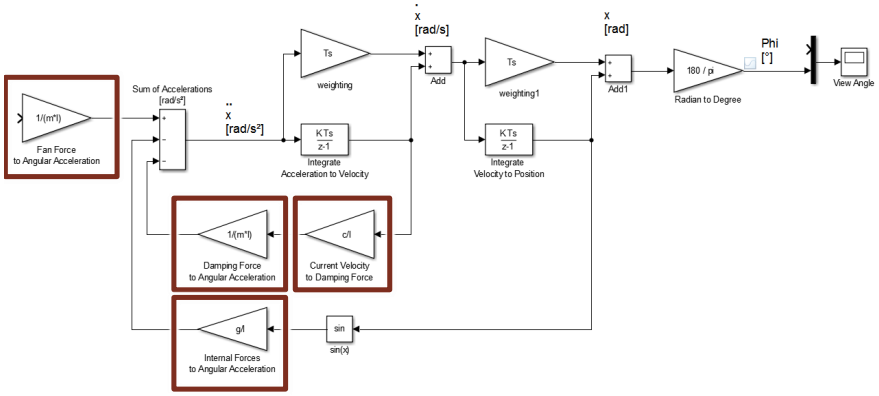
3. Repeat step 2 for the “Integrate Velocity to Position” integrator.
4. Insert two “Add” blocks and two “Gain” blocks from the “Simulink Library Browser” into the model. For the two “Gain” blocks, enter the “Ts” tag as the parameter for “Gain”.
   Connect the blocks as shown in the following figure.



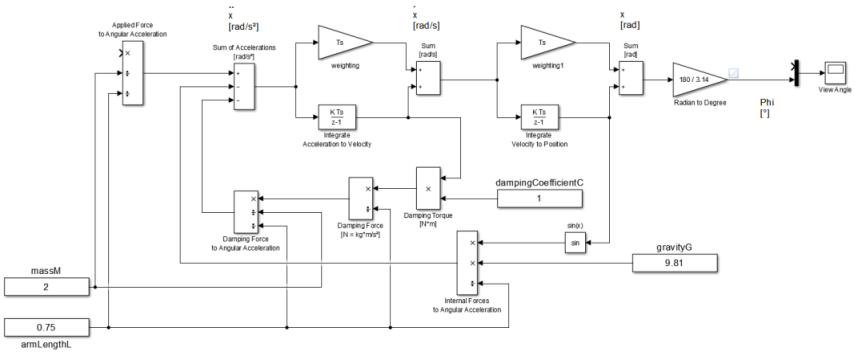
5. Insert four “Constant” blocks from the “Simulink Library Browser”. Instead of the workspace tags (l, m, c, g), these blocks are used for the model parameters. This allows you to later change the model parameters using the STEP 7 program.
   Name and configure the blocks as listed in the following table.
   Table 2-1: Name and value of the “Constant” blocks

	Name	Value	Original tag
6.	massM	2	m
7.	armLengthL	0.75	l
8.	gravityG	9.81	g
9.	dampingCoefficientC	1	c

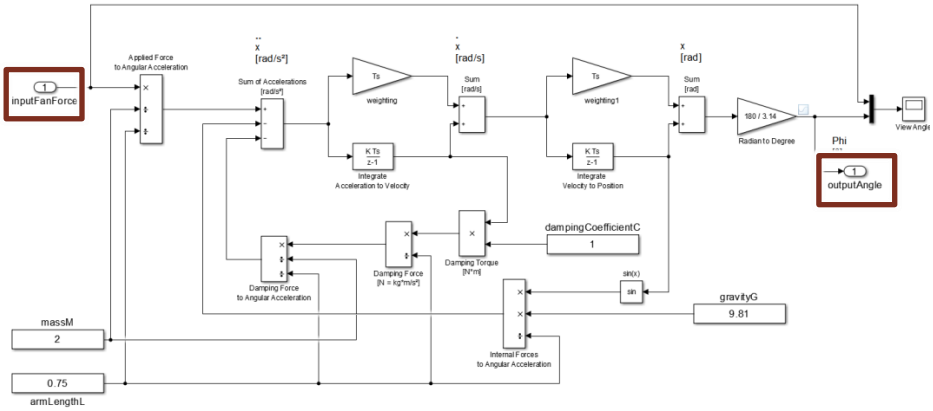
6. Delete the “Gain” blocks that contain the “c”, “l”, “m”, and “g” workspace tags. In the next step, the function of the “Gain” blocks is emulated by “Product” and “Constant” blocks.



7. Insert five “Product” blocks from the “Simulink Library Browser”. You can add more inputs to the blocks using the multiply/divide operations.
Emulate the function of the “Gain” blocks from step 6 by connecting the “Product” blocks with the appropriate “Constant” blocks.



8. Insert an “In1” input and an “Out1” output from the “Simulink Library Browser” into the model. Name the input “inputFanForce” and the output “outputAngle”. Connect the input and output to the model as shown in the following figure.



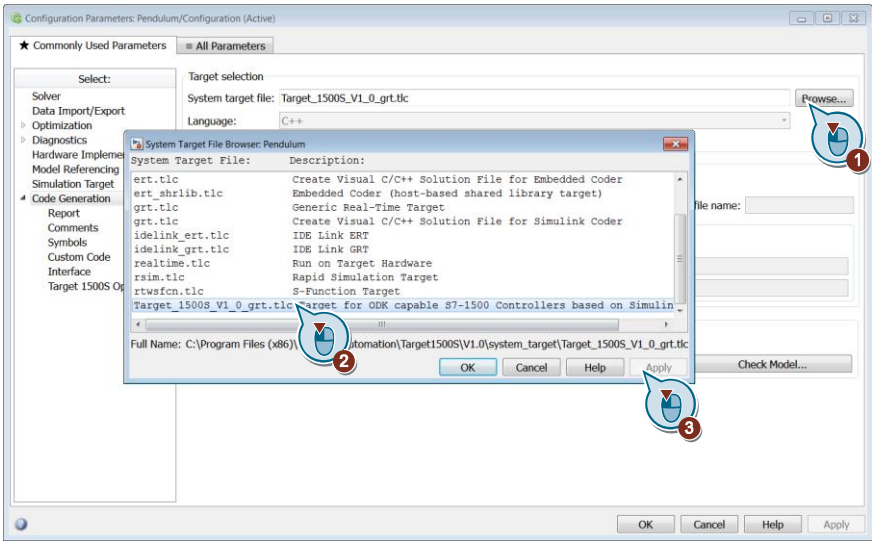
9. Save the model as “Pendulum.slx”.
You have made all the necessary changes to the model and can start generating the code with SIMATIC Target 1500S (see Chapter 2.2 Code generation with SIMATIC Target 1500S).

2.2 Code generation with SIMATIC Target 1500S

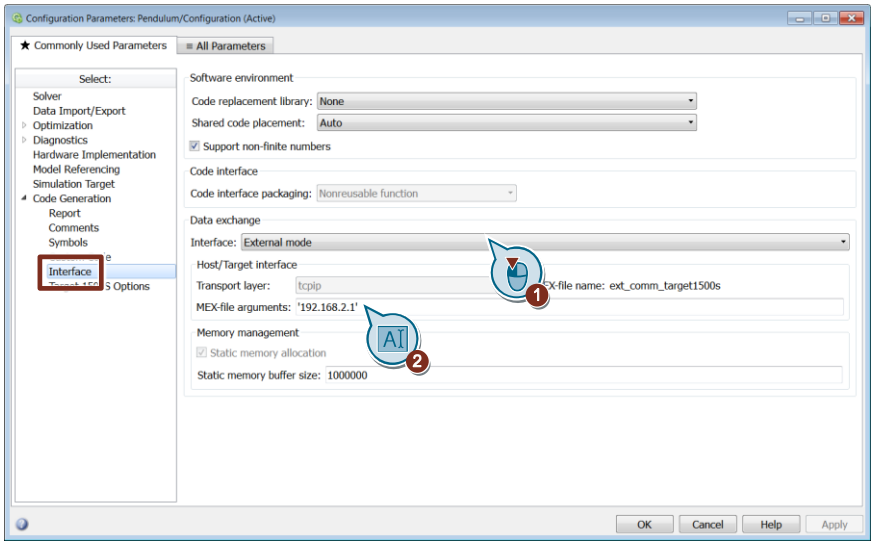
2.2.1 Settings for code generation

Make the following code generation settings for your model.
Alternatively, open the supplied sample model, “Pendulum.slx”, from the “Simulink_Usecase3” folder. For this model, all settings have already been made.

1. Open your model: “Pendulum.slx”
2. In the menu bar, click “Code > C/C++ Code > Code Generation Options…”.
3. Navigate to “Code Generation”.
   1. Select the “Browse...” button to open the Target selection window.
   2. Select “Target_1500S_V1_0_grt.tlc”.
   3. Select “Apply” to confirm your setting.

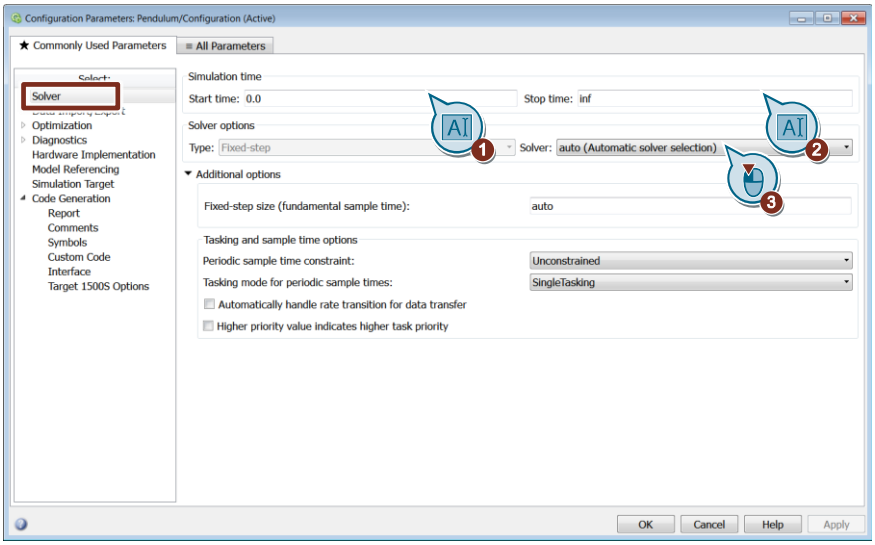


4. Navigate to “Interface”.
   1. In “Interface”, select the “External mode” setting.
   This setting enables External mode.
   2. In “MEX-file arguments”, enter the IP address of the runtime system (here: Windows interface). For the application example, enter ‘192.168.2.1’.

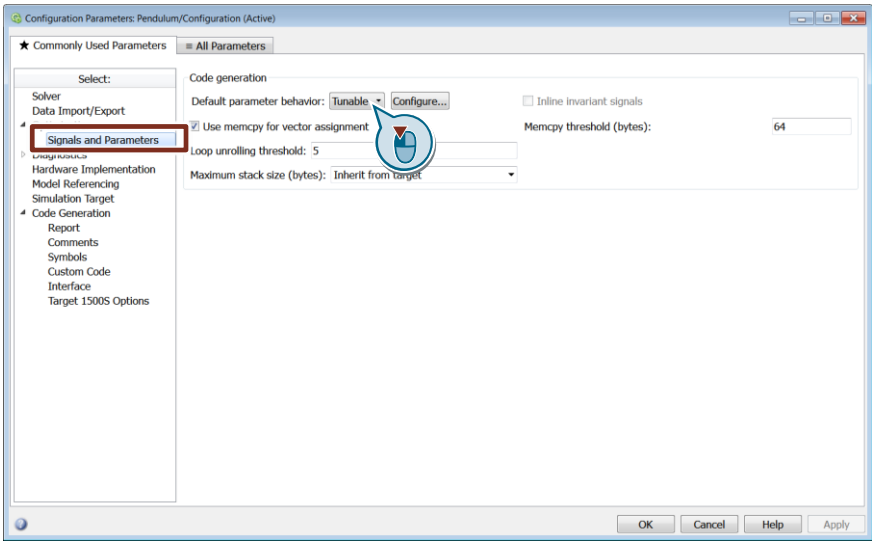


Note
The IP address must be entered with single quotation marks ‘192.168.2.1’.

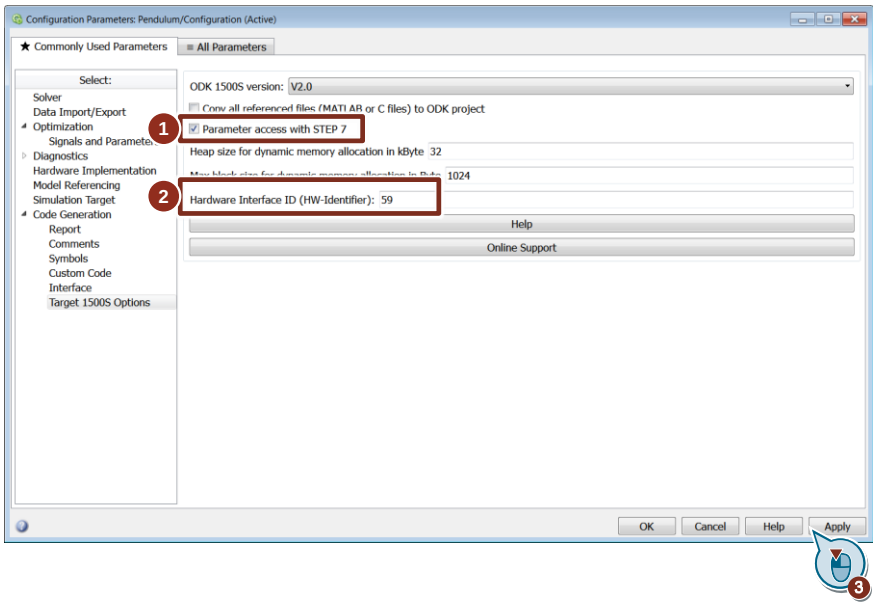
5. Navigate to “Solver”.
   1. In “Start time”, keep “0”.
   2. Change “Stop time” to “inf”. This ensures that External mode is used without a defined end.
   3. In “Solver”, leave the default setting “auto (Automatic solver selection)”.



6. Navigate to “Optimization > Signals and Parameters”.
   - Set the “Default parameter behavior:” parameter to “Tunable”.
   After code generation, this setting allows you to access all internal parameters of the model with STEP 7 (TIA Portal).



7. Navigate to “Target 1500S Options”.
   1. Check “Parameter access with STEP 7”.
   This setting enables parameter access to the model parameters via the S7 program.
   2. Make sure that the “Hardware Interface ID (HW-Identifier)” is correct.
   This value must match the HW identifier set in the STEP 7 project (here: 59, Windows interface of the open controller).
   3. Select “Apply” to confirm.

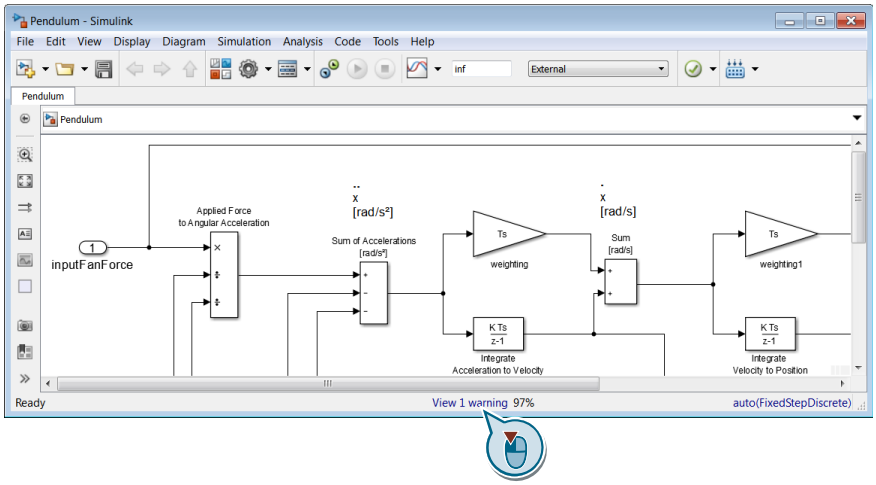


Note
The “Heap size for dynamic memory allocation in kByte” and “Max block size for dynamic memory allocation in Byte” parameters need to be changed only if there are problems with code generation.
For more information, refer to the Target 1500S manual
https://support.industry.siemens.com/cs/ww/en/ps/24443/man
and the SIMATIC S7-1500 ODK 1500S manual
https://support.industry.siemens.com/cs/ww/en/ps/13914/man.

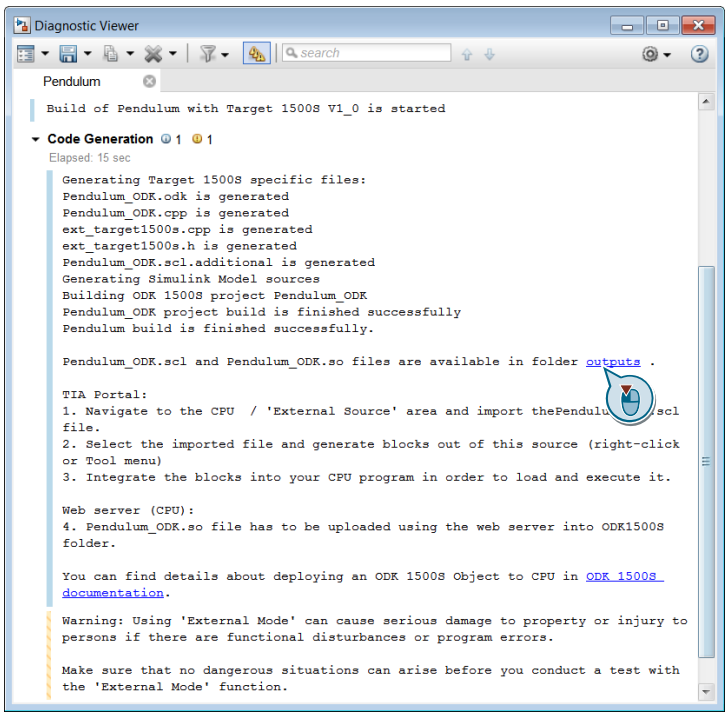
8. Select “OK” to close the dialog.

2.2.2 Coding with SIMATIC Target 1500S

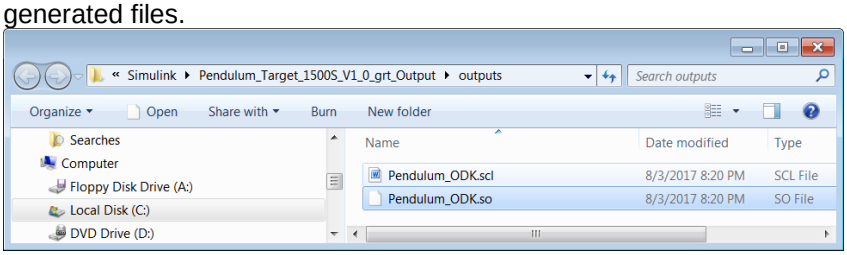
1. Open your own model or the supplied “Pendulum.slx” model.
2. In the menu bar, click “Code > C/C++ Code > Build Model”.
   Alternatively, you can also select the “Build Model” button.
3. - You cannot use Simulink during code generation.
   - SIMATIC Target 1500S compiles the “Pendulum” Simulink model, including its input and output tags, to “C/C++” code.
   - Using the ODK Compiler of SIMATIC ODK 1500S, the SO file and the SCL source are then generated from this source code.
4. As soon as code generation has started, you can click the “View...” link in the status bar of the Simulink window.



5. - The “Diagnostic Viewer” opens.
   - Click the “outputs” link. This takes you directly to the store 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.

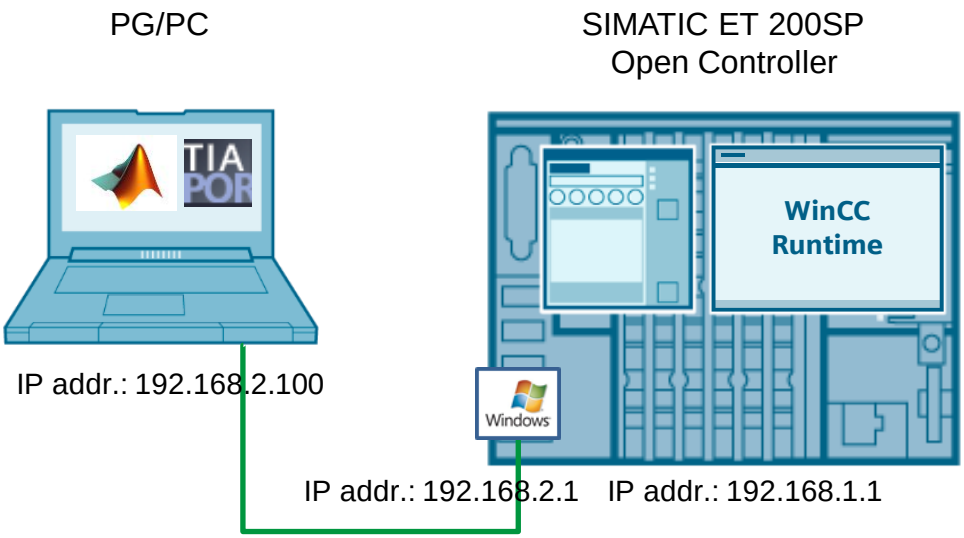


2.3 Hardware configuration

2.3.1 Overview

By default, the S7-1500 Software Controller and WinCC Runtime are preinstalled on the ET 200SP Open Controller. The following figure shows the hardware configuration of the application.

Figure 2-1: Hardware and network configuration



Use an Ethernet cable to connect the programmer (PG/PC) to the runtime system (SIMATIC ET 200SP Open Controller).

Make the following settings:

- PG/PC interface:
  - Ethernet (IP address: 192.168.2.100)
- ET 200SP Open Controller:
  - X2P1 Windows interface (IP address: 192.168.2.1)
  - X1 CPU PROFINET interface (IP address: 192.168.1.1)

The subnet mask for all interfaces is 255.255.255.0.

Note

For External mode, the correct HW identifier must be parameterized in the Target 1500S Options and in the S7 program (call of the “PendulumCallExtMode” FB). Each interface has its own HW identifier:

Interface	HW identifier
X2P1 Windows interface	59
X1 CPU PROFINET interface	64

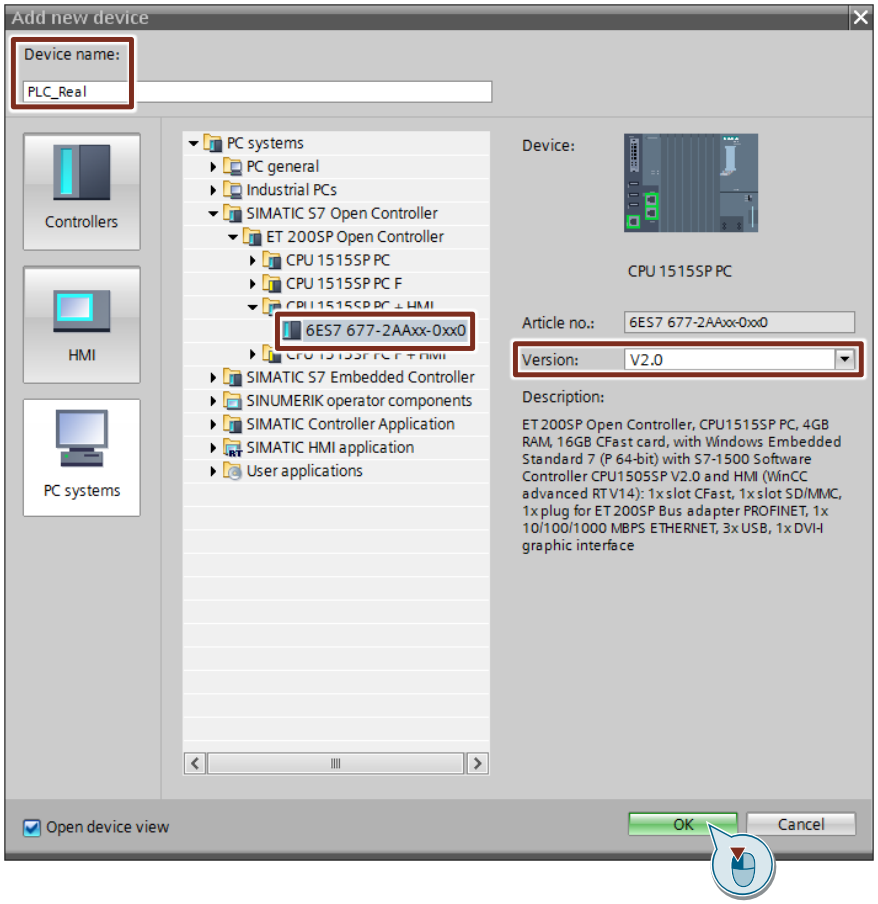
You can view the HW identifier in TIA Portal in each CPU in “PLC tags > Show all tags > System constants”.

2.3.2 Hardware configuration with STEP 7

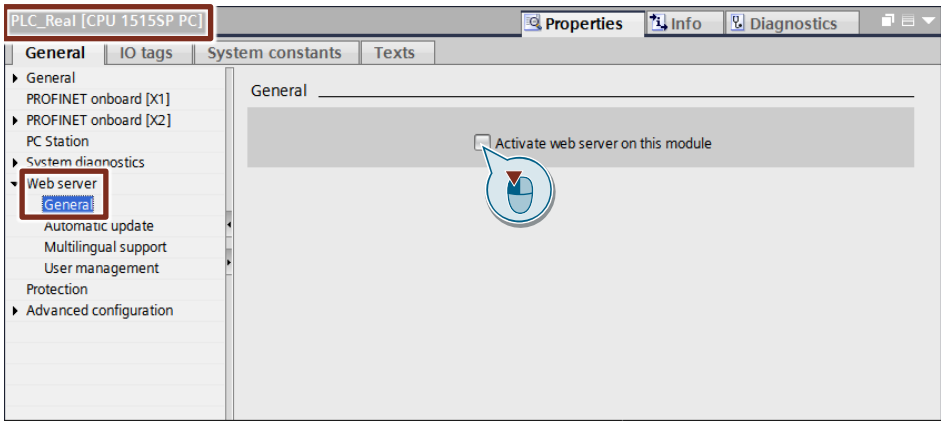
The following steps describe how to configure the hardware based on the SIMATIC ET 200SP Open Controller. Alternatively, you can also open the sample project.

1. Open TIA Portal and create a new project.

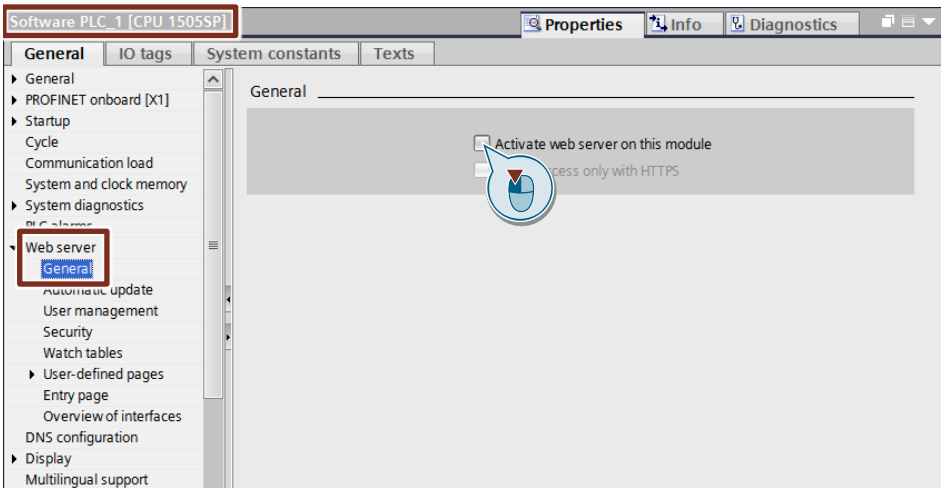
   In the project tree, click “Add new device”.
   In the dialog, select an ET 200SP Open Controller and click “OK”.



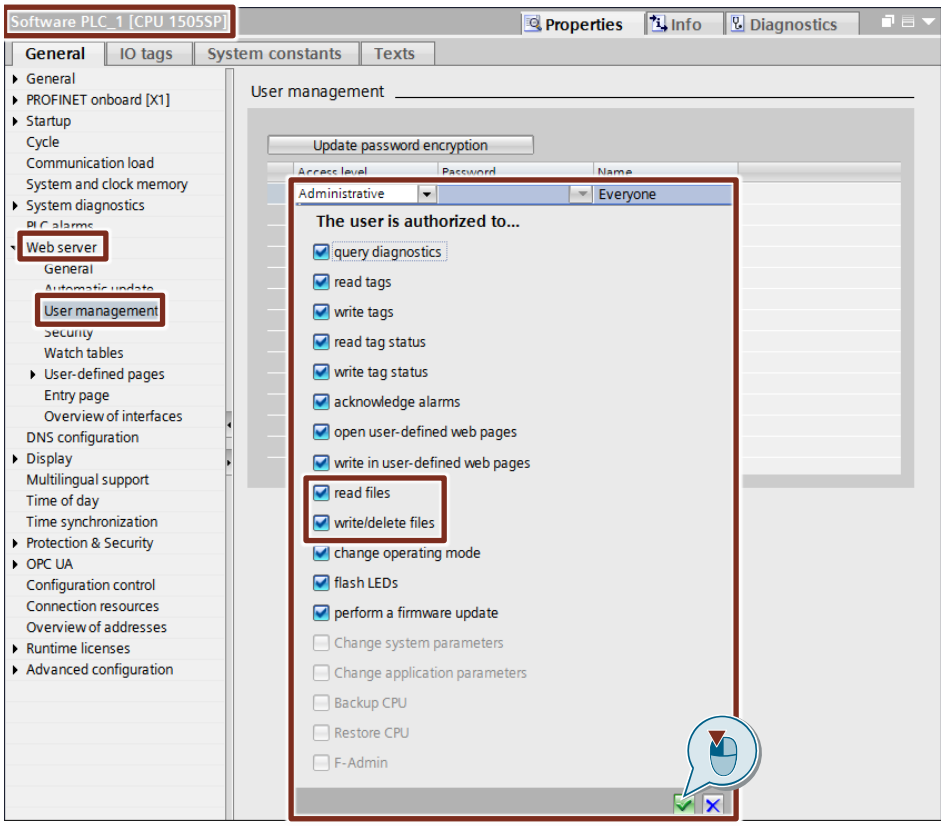
2. Activate the web server for the PC system. Acknowledge the security dialog.



3. Click the “CPU 1505SP” and check “Activate web server on this module”. Acknowledge the security dialog.

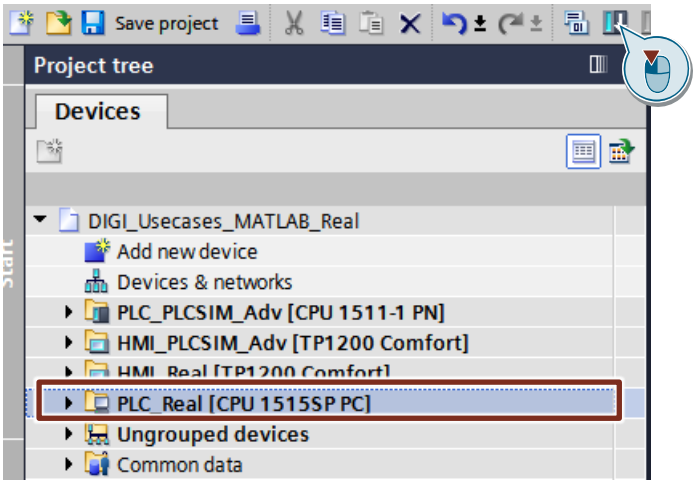


4. Navigate to “Web server > User management” and in “Access level”, check all check boxes for full access. If necessary, create a password.

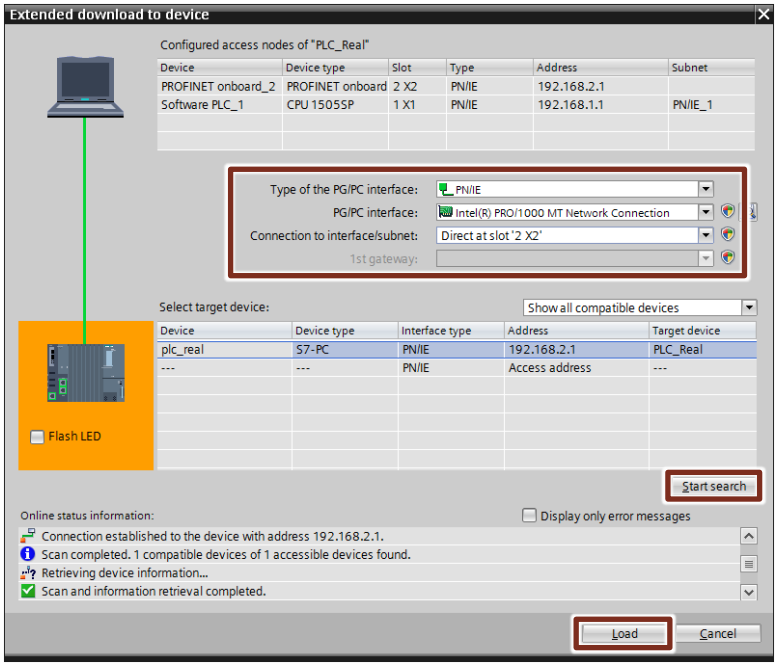


Note
To load the SO file to the web server or delete it, the “read files” and “write/delete files” parameters must be checked. All other parameters are optional.

5. Download the hardware configuration to the ET 200SP Open Controller.
   - In the project tree, select “PLC_Real”.
   - Click the “Download to device” button.



6. Select “PN/IE”.
   - Select the Ethernet interface of your PG/PC.
   - Select “Direct at Slot ‘2 X2’”.
   - Click the “Start search” button.
   - Click “Load”.



7. Confirm all the dialogs that follow until the download is complete.

Note

When downloading the hardware configuration of the SIMATIC ET 200SP Open Controller for the first time, you must use the Windows interface (here: IP address 192.168.2.1).

Make sure that the IP address of the Windows interface matches the parameter assignment in TIA Portal.

2.4 Creating the program and downloading it to the CPU

2.4.1 Overview

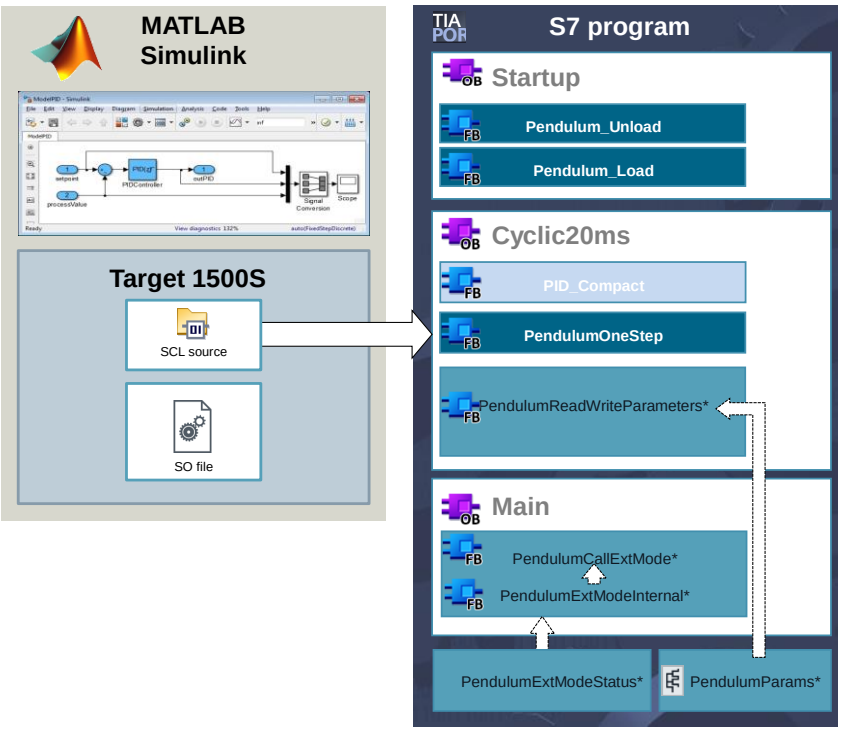
The following figure shows the PID controller (PID_Compact) and all function blocks/PLC data types generated from the SCL source created by Target 1500S. Depending on the code generation settings, some blocks are optional:

- External mode
- Parameter access with STEP 7

The OBs (Startup and Cyclic20ms) are created manually. As shown in the below figure, calling the FBs is recommended.

“PID_Compact” from the technology instructions of TIA Portal is used as a PID controller.

Figure 2-2: Simulink model in the S7 program



* Optional blocks (depending on parameters in Target 1500S)

2.4.2 Description of the generated function blocks

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

Table 2-2: Explanation of the blocks

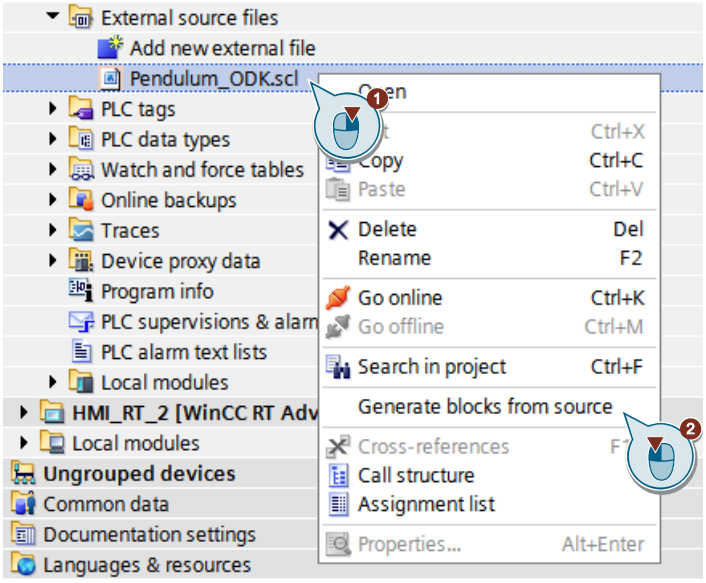
Generated block / PLC data type	Functional description
FB Pendulum_Unload	The block deletes the SO file from the CPU's work memory.
FB Pendulum_Load	The block loads the SO file from the web server to the CPU's work memory.
FB PendulumOneStep	The block calls the SO file. The interfaces correspond to the original Simulink model.
FB PendulumCallExtMode (optional)	The block is called for using Simulink External mode.
PLC data type Pendulum xtModeStatus (optional)	PLC data type of the "STATUS" output of the PendulumCallExtMode FB.
FB PendulumExtModeInternal (optional)	The block includes internal functions for using External mode. This block is called in the PendulumCallExtMode FB and must not be called elsewhere in the S7 program.
FB PendulumReadWriteParameters (optional)	The block is called for read/write of the model parameters to be manipulated.
PLC data type PendulumParams (optional)	PLC data type of the "inOutParams" in/out parameter of the "PendulumReadWriteParameters" FB.

2.4.3 Integrating the Simulink model into the S7 program

Importing the SCL source

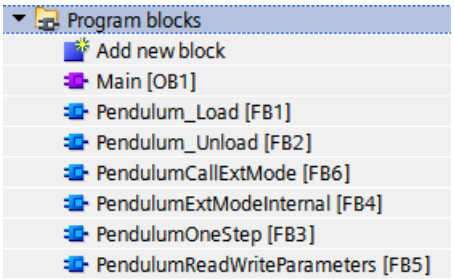
Perform the following steps to import the SCL source generated by Target 1500S.

1. Use TIA Portal to open the S7 program with the hardware configuration you have already created.
2. In the “Project tree”, navigate to “External source files”.
3. Click “Add new external file”.
4. Select the generated SCL source, “Pendulum_ODK.scl”, and import the file into the S7 program.
5. 1. Right-click the “Pendulum_ODK.scl” file.
   2. Click “Generate blocks from source” and confirm the dialog.

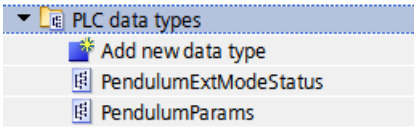


From the SCL source, TIA Portal generates the blocks created by Target 1500S.

6. In “Program blocks”, you will find the generated blocks.



7. In “PLC data types”, you will find the generated PLC data types.



Creating OBs and global DBs

Perform the following steps to create the OBs and global DBs.

1. Add the following organization blocks and data blocks to your S7 program:
   - Startup OB: “Startup” (language: SCL)
   - Cyclic interrupt OB: “Cyclic20ms” (cyclic interrupt time: 20 ms; language: SCL)
   - Global DB: “Global”
   - Global DB: “LocalInterface”

   Note
   The cycle of the “Cyclic20ms” OB must match the cycle Ts of the “Pendulum” in the Simulink model (here: 0.02 or 20 ms).

2. Open the “Global” DB and add the following tags and structures to control the PID controller:
   - pendulumControllerLocal [Struct]
     - angelSetpoint [Int]
     - manualOutputPercentage [Int]
     - manualOutputEnable [Bool]
     - operatingMode [Int]

Global

	Name	Data type	Start value
1	Static		
2	pendulumControllerLocal	Struct	
3	angleSetpoint	Int	0
4	manualOutputPercentage	Int	0
5	manualOutputEnable	Bool	false
6	operatingMode	Int	3

3. Open the “LocalInterface” DB and add the following tags:
   - fanForce [Real]
   - currentAngle [LReal]
   - writeParameters [Bool]
   - getParameters [Bool]
   - parameters [PendulumParams]

LocalInterface

	Name	Data type	Start value
1	Static		
2	fanForce	Real	0.0
3	currentAngle	LReal	0.0
4	writeParameters	Bool	false
5	getParameters	Bool	false
6	parameters	"PendulumParams"	
7	massM_Value	LReal	0.0
8	armLengthL_Value	LReal	0.0
9	IntegrateVelocityt...	LReal	0.0
10	IntegrateVelocityt...	LReal	0.0
11	gravityG_Value	LReal	0.0
12	IntegrateAccelerati..	LReal	0.0
13	IntegrateAccelerati..	LReal	0.0
14	dampingCoefficie...	LReal	0.0
15	weighting_Gain	LReal	0.0
16	weighting1_Gain	LReal	0.0
17	RadiantoDegree_G.	LReal	0.0

“Startup” OB

Perform the following steps to program the “Startup” OB.

1. Open the “Startup” OB.
2. Call the “Pendulum_Unload” FB and interconnect the “REQ” input with “TRUE”.

```
1  "InstPendulum_Unload"(REQ := TRUE);
```

3. Call the “Pendulum_Load” FB and interconnect the “REQ” input with “TRUE”.

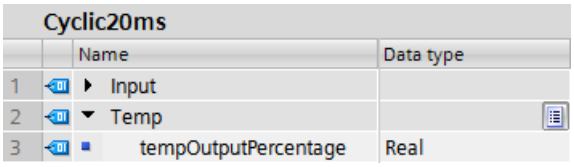
```
2  "InstPendulum_Load"(REQ:=TRUE);
```

4. Close the OB.

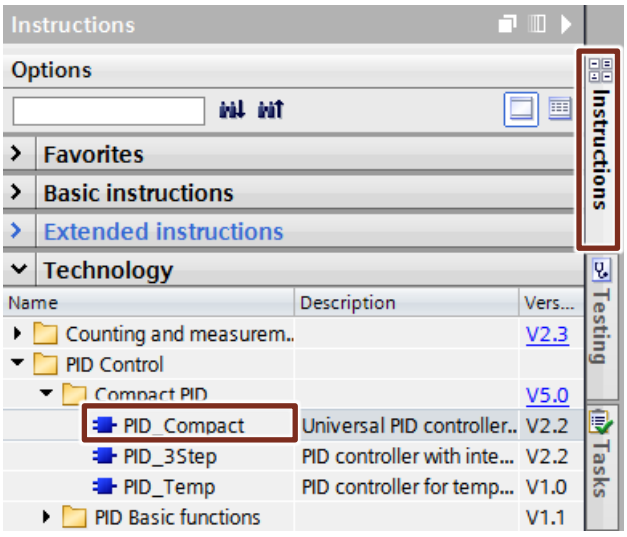
“Cyclic20ms” OB

Perform the following steps to program the “Cyclic20ms” OB.

1. Open the “Cyclic20ms” cyclic interrupt OB.
2. Add a temporary tag called “tempOutputPercentage”.



3. In “Technology > PID Control > Compact PID”, drag the “PID_Compact” controller from “Instructions” to your project.



4. Name the instance DB “InstPIDCompactLocal” and interconnect the instruction as shown in the following figure.

```
3   "InstPIDCompactLocal"(Setpoint := "Global".pendulumControllerLocal.angleSetpoint,
4                         Input := LREAL_TO_REAL("LocalInterface".currentAngle),
5                         ManualEnable := "Global".pendulumControllerLocal.manualOutputEnable,
6                         ManualValue := "Global".pendulumControllerLocal.manualOutputPercentage,
7                         ModeActivate := TRUE,
8                         Output => #tempOutputPercentage,
9                         Mode := "Global".pendulumControllerLocal.operatingMode);
```

5. Scale the PID controller's output percentage to the maximum force of 20 Newton.

```
11      "LocalInterface".fanForce := #tempOutputPercentage * 20 / 100;
```

6. Call the "PendulumOneStep" FB. Name the instance DB "InstPendulumOneStep" and interconnect the FB as shown in the following figure.

```
13      "InstPendulumOneStep"(inputFanForce:="LocalInterface".fanForce,
14                            outputAngle=>"LocalInterface".currentAngle);
```

7. Insert a condition (IF…) and call the "PendulumReadWriteParameters" FB in this condition. Name the instance DB "InstPendulumReadWriteParameters". Interconnect the condition and the FB as shown in the following figure.

```
16      IF "LocalInterface".getParameters OR "LocalInterface".writeParameters THEN
17
18          "InstPendulumReadWriteParameters"(write:="LocalInterface".writeParameters,
19                                            inOutParams:="LocalInterface".parameters);
20
21          "LocalInterface".getParameters := false;
22          "LocalInterface".writeParameters := false;
23      END_IF;
```

8. Close the OB.

"Main" OB

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

1. Open the "Main" cycle OB.
2. - Call the "PendulumCallExtMode" FB.
   - Name the instance DB "InstPendulumCallExtMode".
   - Interconnect the "EnableExtMode" input with "TRUE".
   - Interconnect the "HW-Identifier" input with 59.

```
1 "InstPendulumCallExtMode"(EnableExtMode:=TRUE,
2                           "HW-Identifier":=59);
```

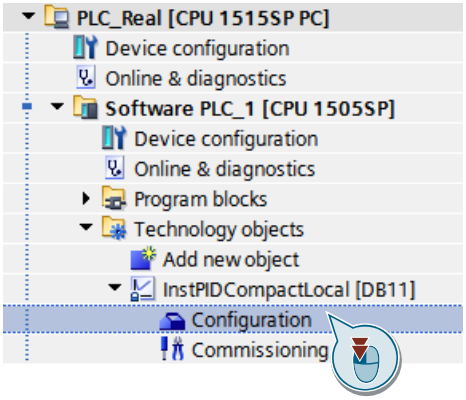
3. Close the OB.

Configuring the PID controller

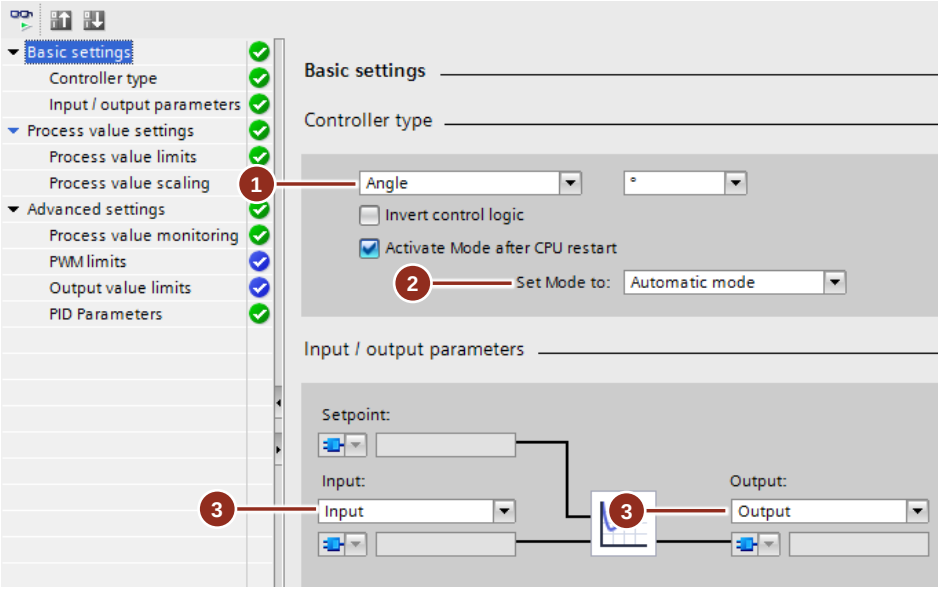
Note For the calculation of the PID parameters from step 5, refer to the main document: "109749187_DIGI_Usecases_MAIN_DOC_V10_en.pdf"

Perform the following steps to configure the PID controller.

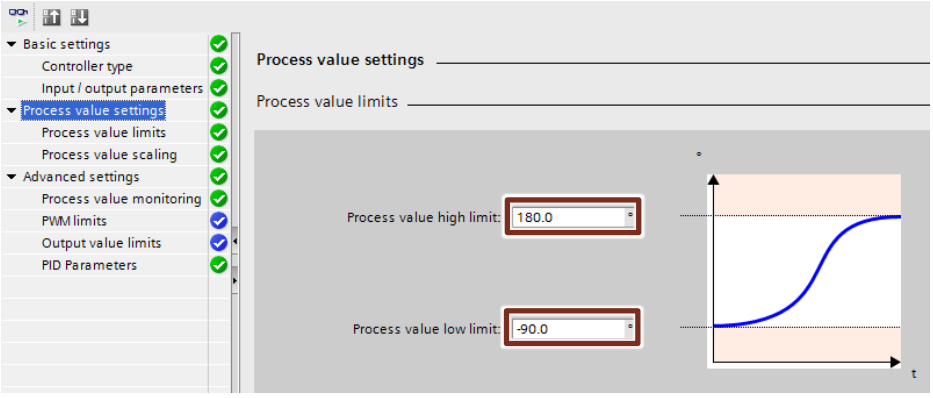
1. In the project tree, double-click to open the “Configuration” of the “InstPIDCompactLocal” instance of the PID controller.



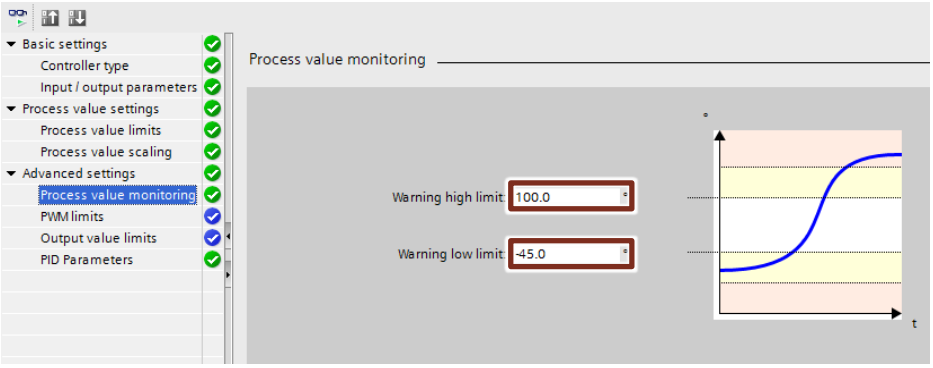
2. Make the basic settings.
   1. In “Controller type”, select “Angle” as the physical quantity.
   2. Set the mode to “Automatic mode”.
   3. Select “Input” for the input parameter and “Output” for the output parameter.



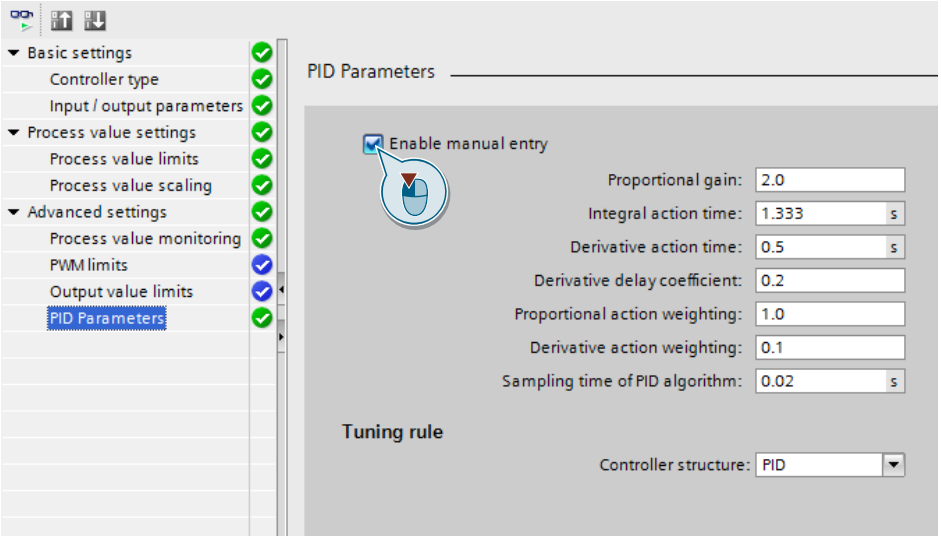
3. Make the process value settings.
   For the process value high limit, set 180.0. For the process value low limit, select -90.0.



4. In the advanced settings for process value monitoring, set 100.0 as the warning high limit and -45.0 as the warning low limit.



5. In the “Advanced settings”, set the PID parameters.
   To do this, check “Enable manual entry” and set the following PID parameters:
   - Proportional gain = 2
   - Integral action time = 1.333
   - Derivative action time = 0.5
   - Derivative delay coefficient = 0.2
   - Proportional action weighting = 1.0
   - Derivative action weighting = 0.1
   - Sampling time of PID algorithm = 0.02



2.5 Loading the SO file to the web server

Requirement

- You have downloaded the hardware configuration with the activated web server to the SIMATIC S7-1500 Software Controller (see Chapter 2.3 Hardware configuration).
- In the “Windows firewall” setting of the open controller, “Inbound Rules”, you have allowed access via port 81.

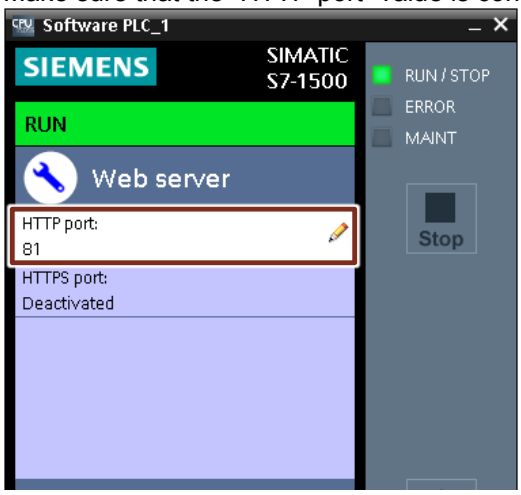
Web server port

This example uses the Windows interface of the open controller for loading. To open the CPU's web server via the Windows interface, you need the correct port (default: 81).

1. Establish a remote connection to the open controller (IP address of the Windows interface in this application example: 192.168.2.1).
2. Open the CPU display of the CPU 1500S (icon on the desktop).

3. Double-click the "Settings" button.

4. Double-click the "Web server" subitem.
5. Make sure that the "HTTP port" value is correct (default: 81).



6. Close the remote connection.

Note

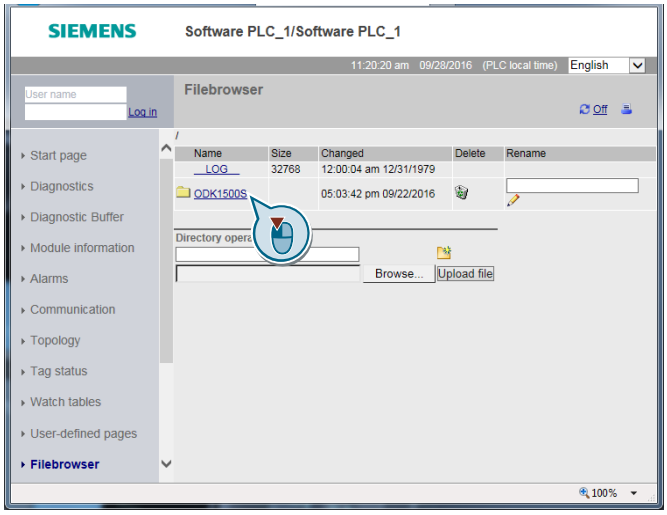
For more information, refer to the "SIMATIC S7-1500 CPU 150xS" manual, "Configuring the web server" and "Virus scanners and firewall".

https://support.industry.siemens.com/cs/ww/en/view/109249299

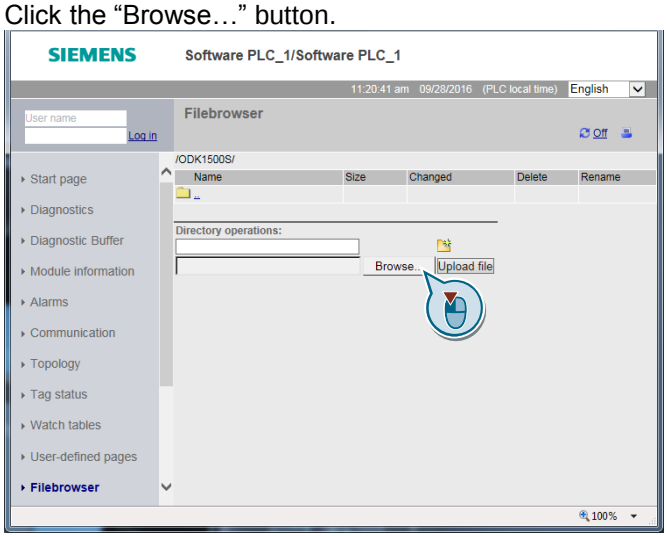
Loading the SO file to the web server

1. Open any browser (Internet Explorer, Firefox, etc.).
2. Open the web page: http://192.168.2.1:81. The CPU web server home page opens.
3. Click "Enter".
4. Navigate to "Filebrowser".

5. Click the “ODK1500S” folder.



6. Click the “Browse…” button.



7. Navigate to the “Pendulum_ODK.so” file 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

When you have loaded the SO file to the web server, restart the CPU.

The SO file is not loaded to the CPU’s work memory until the “PendulumLoad” block is called in the “Startup” OB.

2.6 Commissioning with STEP 7

Aside from downloading the S7 program, commissioning also includes downloading the ready-to-use HMI screens to WinCC Runtime. The configuration of WinCC Runtime and the HMI screens is not part of this documentation.

The HMI screens are used to monitor and control the simulation.

Note

If you are using your own project, refer to the supplied sample project for the WinCC configuration.

Instead of monitoring and controlling the model using an HMI screen, you can also use a watch table in TIA Portal and visualize the simulation process using External mode in Simulink via the “Scope” block. For more information, refer to the “SIMATIC Target 1500S: Calling Simulink® Models” application example at the following link:
https://support.industry.siemens.com/cs/ww/en/view/109482830

Requirement

- You have downloaded the hardware configuration with the activated web server to the SIMATIC S7-1500 Software Controller (see Chapter 2.3 Hardware configuration).
- You have completed programming the S7 program (see Chapter 2.4 Creating the program and downloading it to the CPU).
- You have loaded the SO file to the CPU’s web server (see Chapter 2.5 Loading the SO file to the web server).

Downloading the S7 program

1. Open TIA Portal.
2. Open your project or the sample project.
3. Select “Software PLC_1” and click the “Download to Device” button.
4. Select “Load” to confirm the dialog.
5. Select “Finish” to confirm the dialog.
6. Check “Start all”.
7. Select “Finish” to confirm the dialog.

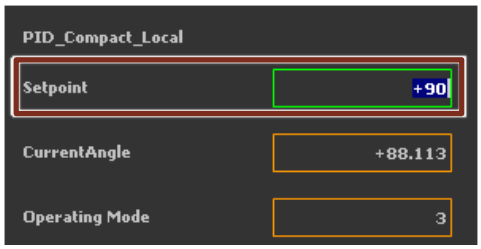
Downloading WinCC Runtime

When you have opened the supplied sample project or configured HMI screens for operator control and monitoring in your project, perform the following steps.

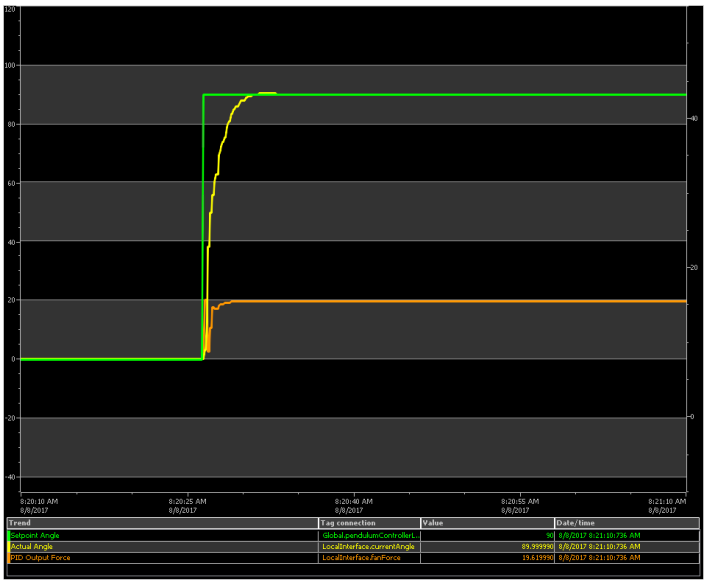
1. Select “HMI_RT_1” and click the “Download to device” button.
2. Select “Load” to confirm the dialog.
3. Select “Finish” to confirm the dialog.
4. Check “Start all”.
5. Select “Finish” to confirm the dialog.

Commissioning using the HMI screen

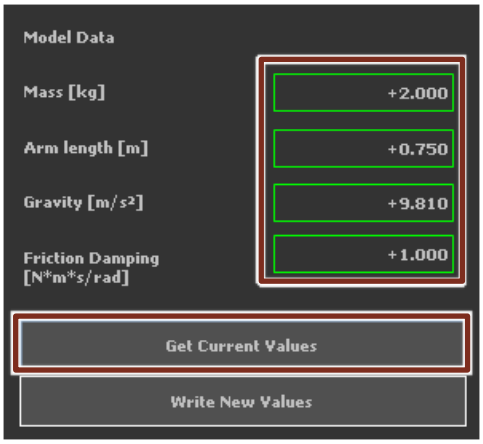
1. Establish a remote connection to the open controller (IP address in this application example: 192.168.2.1).
2. If not yet running, start WinCC Runtime on the open controller.
3. In the “Setpoint” field, enter an angle of deflection for the model. Enter, for example, 90 for a 90-degree deflection and press Enter to confirm.



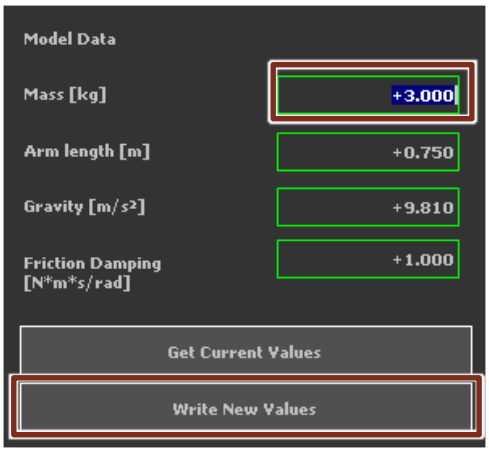
4. In the trend display, monitor and verify the control result trend.



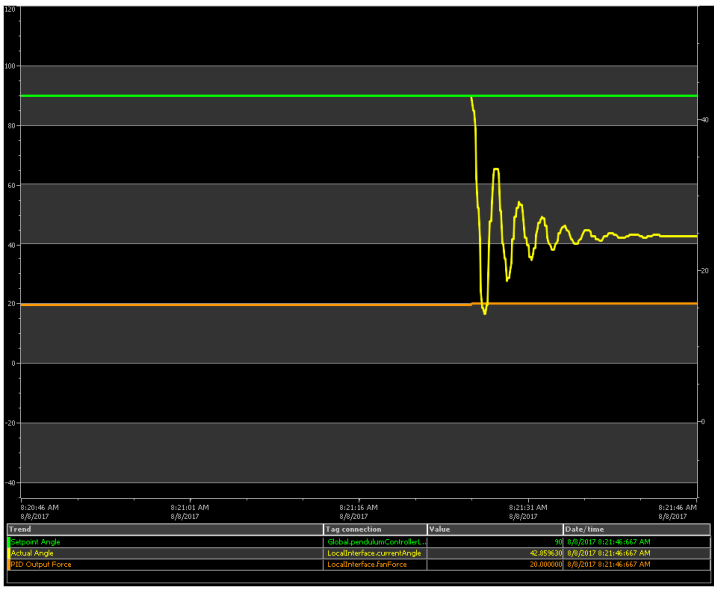
5. Click “Get Current Values” to view the current model parameters.



6. You can also define new model parameters.
   For example, enter the value 3 in the “Mass” field and press Enter to confirm.
   Click “Write New Values” to transfer the changed parameter to the model.



7. Monitor the changed model behavior.



Note

When you change values of parameters using the HMI screen, these changes are only valid until a restart of the CPU. After a restart, the original values are valid again.

If you want to permanently change the values from the S7 program, change the parameter values directly in the data block. For more information, refer to the “SIMATIC Target 1500S: Calling Simulink® Models” application example, Chapter “2.8.3 Permanently changing model parameters with the data block” at the following link:
https://support.industry.siemens.com/cs/ww/en/view/109482830

2.7 External mode

Simulink External mode provides you with the option to monitor the model while the CPU is running and change model parameters online.

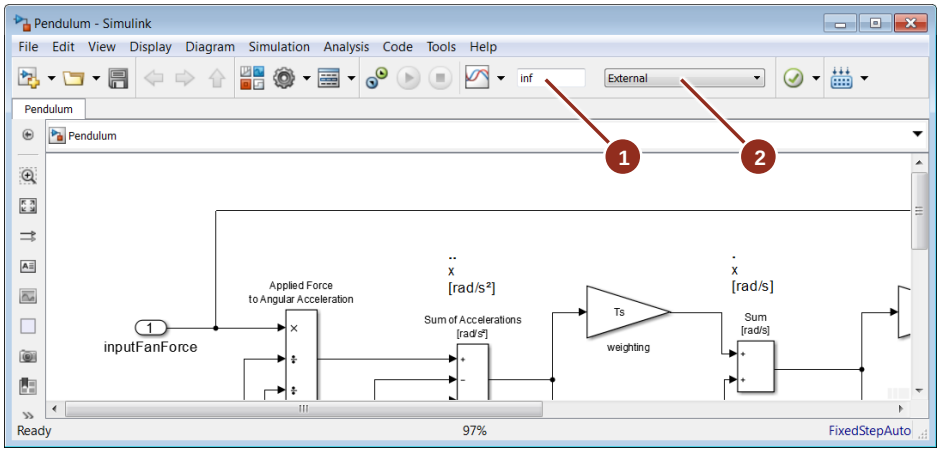
Note When using External mode, follow the information provided in the Target 1500S manual.
https://support.industry.siemens.com/cs/ww/en/ps/24443/man

Requirement

- Before generation, you have configured External mode (see Chapter 2.2.1 Settings for code generation).
- When calling the “PendulumCallExtMode” FB, you have interconnected the “EnableExtMode” input with “TRUE”.
- You have loaded the SO file to the CPU’s web server (see Chapter 2.5 Loading the SO file to the web server).
- You have downloaded the S7 program to the CPU (see Chapter 2.6 Commissioning with STEP 7).
- You have set the CPU to “RUN”.
- You have connected your PG/PC (MATLAB/Simulink) to the CPU via Ethernet (in this application example: OpenController – Windows interface).
- In the “Windows firewall” setting of the open controller, “Inbound Rules”, you have allowed access via port 17725.

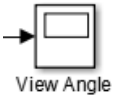
2.7.1 Monitoring

1. Open MATLAB.
2. Set the following values:
   1. “Simulation stop time”: “inf”
   2. “Simulation Mode”: “External”

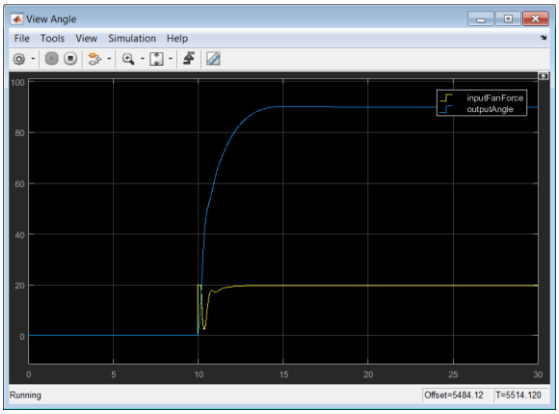


3. Click “Connect to target”.

4. To open the “Scope” window, double-click the “Scope” icon in the Simulink model.



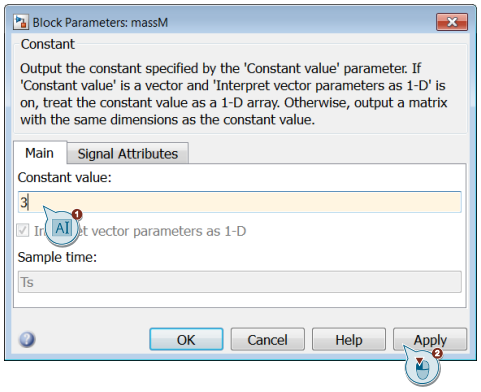
If you change the setpoint from 0.0 to 90 (HMI screen), you get the following signal chart.



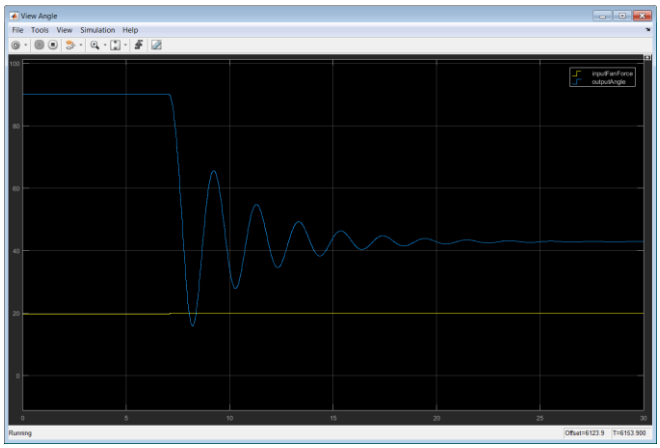
5. Click “Disconnect from target” to disconnect the connection.

2.7.2 Changing model parameters

1. Open MATLAB.
2. Open the “Pendulum.slx” model.
3. Use External mode to connect to the CPU.
4. Double-click a “Constant” block, for example “massM”, to open the parameters.
5. 1. Specify a new value for the constant.
   2. Click “Apply”.



6. The scope exhibits a changed model behavior.



7. This procedure allows you to change any value in the model.

Note

When you change parameter values using External mode, these changes are only valid until a restart of the CPU. After a restart, the original values are valid again.

If you want to permanently change the values, regenerate the blocks using Target 1500S. Reload the SO file to the web server. Restart the CPU.

If you change not only parameters but also the model, you have to reintegrate the SCL source into the S7 program.

3 Alternative Solutions

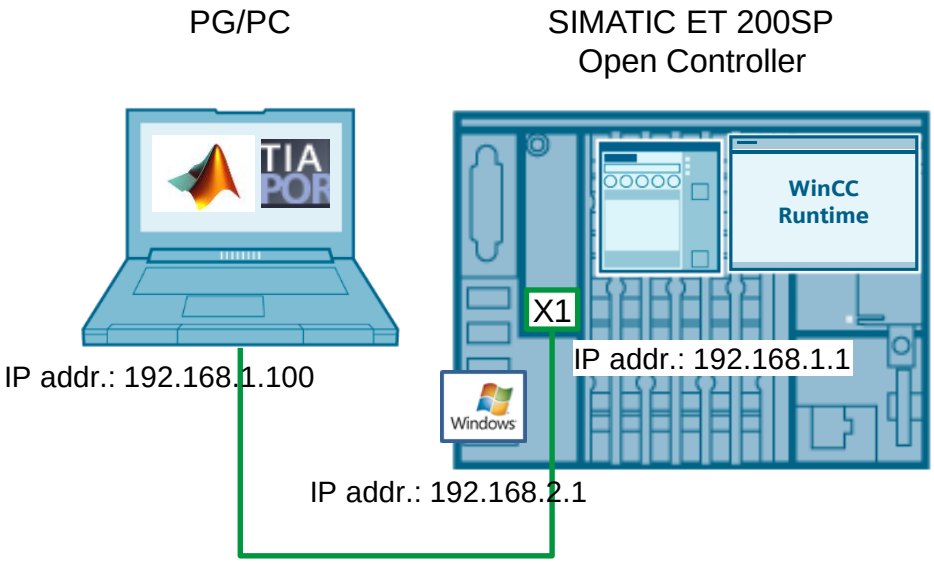
Alternatively, as described in Use Case 2, you can exchange data with the Simulink model via the OPC UA interface. This enables you to test the PID controller on the real CPU in the context of the simulation model. To do this, you additionally need a Runtime license for the OPC UA server.

In the sample project, the following has already been set up and configured:

- Enabled OPC UA server in the hardware configuration of the S7-1500 Software Controller.
- PID controller for controlling the Simulink model via OPC UA.
- “OPC_Interface” HMI screen for controlling the controller and monitoring the control process in WinCC Runtime on the open controller.

Connect the PG/PC where the Simulink model with the integrated “Read_OPC_Func” MATLAB function is running to the X1 PROFINET interface of the CPU and start the simulation of the Simulink model. For more information about connecting the Simulink model via OPC UA, refer to the document for Use Case 2.

Figure 3-1:



4 Appendix

4.1 Service and Support

Industry Online Support

Do you have any questions or do you need support?

With Industry Online Support, our complete service and support know-how and services are available to you 24/7.

Industry Online Support is the place to go to for information about our products, solutions and services.

Product Information, Manuals, Downloads, FAQs and Application Examples – all the information can be accessed with just a few clicks:
https://support.industry.siemens.com

SITRAIN – Training for Industry

Well-trained employees are a crucial factor in any company's success. Skills development and expert knowledge make companies competitive and innovative. With our globally available training courses for industry, we help you achieve these goals – with practical experience, innovative learning methods, and a concept that's tailored to the customer's specific needs.

www.siemens.com/sitrain

Technical Support

Siemens Industry's Technical Support offers you fast and competent support for any technical queries you may have, including numerous tailor-made offerings ranging from basic support to custom support contracts.

You can use the web form below to send queries to Technical Support:
www.siemens.com/industry/supportrequest.

Service offer

Our service offer includes the following services:

- Product Training
- Plant Data Services
- Spare Part Services
- Repair Services
- Field & Maintenance Services
- Retrofit & Modernization Services
- Service Programs & Agreements

For detailed information about our service offer, please refer to the Service Catalog:
https://support.industry.siemens.com/cs/sc

Industry Online Support app

The "Siemens Industry Online Support" app provides you with optimum support while on the go. The app is available for Apple iOS, Android and Windows Phone:
https://support.industry.siemens.com/cs/ww/en/sc/2067

4.2 Links and literature

Table 4-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the entry page of the application example https://support.industry.siemens.com/cs/ww/en/view/109749187
\3\	Manual: STEP 7 V14 Professional https://support.industry.siemens.com/cs/ww/en/view/109742272
\4\	Manual: SIMATIC S7-1500 ODK 1500S https://support.industry.siemens.com/cs/ww/en/ps/13914/man
\5\	Target 1500S manual https://support.industry.siemens.com/cs/ww/en/ps/24443/man
\6\	SIMATIC S7-1500 CPU 150xS manual https://support.industry.siemens.com/cs/ww/en/view/109249299
\7\	Manual: SIMATIC S7-1500 Software Controller Additional Information on CPU 1505S/CPU 1507S https://support.industry.siemens.com/cs/ww/en/view/104943430
\8\	Manual: SIMATIC ET 200SP Open Controller CPU 1515SP PC https://support.industry.siemens.com/cs/ww/en/view/109248384
\9\	MathWorks Online Documentation: http://en.mathworks.com/help/
\10\	Application Example: SIMATIC Target 1500S: Calling Simulink® Models https://support.industry.siemens.com/cs/ww/en/view/109482830
\11\	Target 1500S for Simulink, product page http://www.siemens.com/simulink
\12\	Target 1500S for Simulink, Industry Online Support page https://support.industry.siemens.com/cs/ww/en/ps/6ES7823-1BE00-0YA5

4.3 Change documentation

Table 4-2

Version	Date	Modifications
V1.0	12/2017	First version