SIMATIC

S7-1500

SIMATIC Machine Simulator Digital Twin

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support.industry.siemens.com
# SIMATIC

## SIMATIC Machine Simulator
Virtual commissioning of machines

### Getting Started

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warranty and liability, safety information</td>
<td>1</td>
</tr>
<tr>
<td>Preface</td>
<td>2</td>
</tr>
<tr>
<td>Product overview</td>
<td>3</td>
</tr>
<tr>
<td>Commissioning the digital twin</td>
<td>4</td>
</tr>
<tr>
<td>Preparing the simulation</td>
<td>5</td>
</tr>
<tr>
<td>Creating a behavior model</td>
<td>6</td>
</tr>
<tr>
<td>Starting the simulation</td>
<td>7</td>
</tr>
<tr>
<td>List of abbreviations</td>
<td>8</td>
</tr>
</tbody>
</table>
Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

**DANGER**

indicates that death or severe personal injury will result if proper precautions are not taken.

**WARNING**

indicates that death or severe personal injury may result if proper precautions are not taken.

**CAUTION**

indicates that minor personal injury can result if proper precautions are not taken.

**NOTICE**

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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Table of contents

1 Warranty and liability, safety information ......................................................... 5
  1.1 Safety information ......................................................................................... 6
  1.2 Security information ..................................................................................... 6
2 Preface ............................................................................................................. 7
3 Product overview .............................................................................................. 9
  3.1 Scope of delivery of the SIMATIC Machine Simulator .................................... 9
  3.2 Additional programs for virtual commissioning .......................................... 9
  3.3 Mode of operation of the SIMATIC Machine Simulator ............................... 10
  3.4 Compatible versions ..................................................................................... 13
4 Commissioning the digital twin ...................................................................... 14
5 Preparing the simulation .................................................................................. 16
  5.1 Downloading the application example ......................................................... 17
  5.2 Making the MCD model kinematic ............................................................... 18
  5.3 Preparing the TIA Portal project ................................................................. 19
    5.3.1 Requirement ......................................................................................... 19
    5.3.2 Unlocking protected program blocks ...................................................... 19
    5.3.3 Setting simulation support of the project .............................................. 20
    5.3.4 Starting HMI simulation ........................................................................ 21
    5.3.5 Result .................................................................................................... 22
  5.4 Creating a SIMIT project ............................................................................. 23
    5.4.1 Overview ............................................................................................... 23
    5.4.2 Creating a new SIMIT project ............................................................... 23
    5.4.3 Coupling SIMIT with PLCSIM Advanced ........................................... 24
    5.4.4 Coupling SIMIT with MCD ................................................................. 28
    5.4.5 Setting the time slice for the MCD coupling ........................................ 31
    5.4.6 Setting the units of the signals from MCD .......................................... 32
    5.4.7 Setting the time slice of the project manager ........................................ 33
    5.4.8 Using SIMIT according to your own requirements ............................. 34
    5.4.9 Result .................................................................................................... 34
6 Creating a behavior model ................................................................. 35
   6.1 Modeling the drive behavior ....................................................... 35
   6.2 Creating chart of the axes ......................................................... 36
   6.3 Structure of the drives ............................................................... 38
   6.4 Setting properties of the PROFIdrive block ............................... 41
   6.5 Interconnecting signals ............................................................ 44
      6.5.1 Interconnecting signals ....................................................... 44
      6.5.2 Interconnection of axes 1 and 2 ......................................... 46
      6.5.3 Interconnection of axis 3 .................................................... 46
      6.5.4 Interconnection of the conveyor belt ................................... 47
   6.6 Modeling the behavior of the photoelectric barriers .................. 48
   6.7 Using the library ....................................................................... 50

7 Starting the simulation .................................................................... 51
   7.1 Requirement ............................................................................ 51
   7.2 Preparing simulation start in SIMIT ......................................... 51
   7.3 Compiling and loading to device ............................................ 53
   7.4 Calibrating the absolute value encoder of the axes ................. 56
   7.5 Controlling simulation via the operator panel ......................... 62
   7.6 Result ..................................................................................... 63

8 List of abbreviations ...................................................................... 64
Note

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1.1 Safety information

DANGER

Danger to life due to different behavior of the plant in reality

A simulation only partly represents reality. Therefore, the behavior of the plant in reality may differ from the behavior of the plant in the simulation.

- To obtain a realistic simulation, make sure that your simulation contains a sufficient level of detail.
- After importing new program codes, always start the plant using increased safety precautions.

1.2 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.

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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 customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under [https://www.siemens.com/industrialsecurity].
Virtual commissioning with the digital twin

To perform virtual commissioning, an image of the real machine is required. This image is referred to as the digital twin of a machine.

By means of a digital twin, the interaction of individual components of a machine can be simulated and optimized in the virtual world – without the need for a real prototype. The virtual commissioning of a machine is therefore an efficient alternative to reduce the risk of errors and the workload required for real commissioning. This enables shorter market launch times as well as higher flexibility, efficiency and quality.

Purpose of this Getting Started

You become familiar with essential steps for performing virtual commissioning with the SIMATIC Machine Simulator based on a specific application example. You understand the principle of simulation so that you can transfer this knowledge to your individual task.

Advantages with the SIMATIC Machine Simulator

Simulation with the SIMATIC Machine Simulator offers significant advantages: You can recognize in a very early development phase whether your machine is behaving the way you want it to.

You realize virtual commissioning with the SIMATIC Machine Simulator. You can optimize the machine and its behavior in any number of simulation processes.

You can check and optimize the following at an early stage:

- Construction of your machine
  - Before building or installing a prototype
  - While the machine is still set up for a different task
- Programming of your user program
- Motion sequences of your machine
- Interaction of mechanical components, electrical components and software in the machine

Furthermore, you can simulate error scenarios and optimize the behavior in the event of component defects. Commissioning of the real machine is significantly simpler.
Optimum introduction and effective use of SIMATIC Machine Simulator

The application example in this Getting Started shows the following:

- Introduction to virtual commissioning
- Illustration of coupling and interaction of different programs
- Sample projects for each program which can serve as templates for your own applications

You gain insights into the functioning of the SIMATIC Machine Simulator and can create your own simulations according to your requirements.

Target group

The target group of the SIMATIC Machine Simulator includes:

- Programmers (special knowledge on PLCSIM Advanced, on TIA Portal or on SIMIT) who test their PLC program during development.
- Mechanical designers (CAD special knowledge or machine knowledge) who test a machine by means of virtual commissioning.
- Electricians (special knowledge of creating circuit diagrams or designing electrical components in the machine) who have written the PLC program and test the PLC program against a digital twin.

Limitation

This Getting Started does not provide information on the following topics:

- Basics of TIA Portal configuration
  
  You can find additional information on this topic in the SIMATIC STEP 7 Basic/Professional V15 and SIMATIC WinCC V15 [documentation].

- Basics of the SIMIT coupling types
  
  You can find additional information on this in the SIMIT V10.0 manual [documentation].

- Basics of CAD modeling
  
  You can find additional information on this in the NX12 [documentation].

Knowledge of these topics is required to understand the application example in this Getting Started.
3.1 Scope of delivery of the SIMATIC Machine Simulator

SIMATIC Machine Simulator is a package made up of the programs PLCSIM Advanced and SIMIT.

Note

You can use the functions of SIMATIC Machine Simulator even when you have not purchased the programs within a package but purchased and installed them individually or at different times.

PLCSIM Advanced

With PLCSIM Advanced, you simulate your user program without real hardware.

For a comprehensive function test, the STEP 7 program is loaded into a virtual S7-1500 controller via PLCSIM Advanced.

SIMIT

The SIMIT simulation software maps the behavior of active components (e.g. of drives or valves). In SIMIT, you can simulate error scenarios to analyze the behavior of the machine in a virtual space. SIMIT exchanges setpoints/actual values of the simulation via a coupling with MCD.

3.2 Additional programs for virtual commissioning

You also need the following programs for virtual commissioning of this Getting Started:

TIA Portal, STEP 7 and WinCC Engineering V15

In the TIA Portal, you create your user program with STEP 7 and your screens for operating and controlling machines with WinCC on an HMI device.

MCD

With MCD, you simulate and test the mechanical components of your machine in a virtual environment. MCD brings CAD data together with a physical engine: The CAD data is made kinematic.

The specification of the degrees of freedom of the different mechanical components defines the kinematics of the model.
3.3 Mode of operation of the SIMATIC Machine Simulator

Comparison: Reality versus simulation
How it works

Virtual commissioning

<table>
<thead>
<tr>
<th>TIA Portal</th>
<th>SIMATIC Machine Simulator</th>
<th>MCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>User program</td>
<td>Simulation Runtime Manager</td>
<td>Kinematic model</td>
</tr>
<tr>
<td>Runtime Instance</td>
<td>Runtime API</td>
<td></td>
</tr>
<tr>
<td>Virtual controller</td>
<td>coupled</td>
<td>coupled</td>
</tr>
</tbody>
</table>

How it works
Interaction of the programs

The simulation is a signaling circuit of the coupled programs of the SIMATIC Machine Simulator:

- SIMIT receives the PIP outputs (process image partition of the outputs) from the PLC.
- SIMIT sends setpoints (e.g. speed setpoints, position setpoints, binary signals) to MCD.
- MCD simulates the mechanical components based on the defined degrees of freedom and setpoints.
- MCD sends the calculated actual value (e.g. speed actual values, position actual values, binary signals) to SIMIT.
- SIMIT calculates the behavior of the machine using the drive block.
- SIMIT sends the PIP inputs (process image partition of the inputs) to the PLC.
Communication

- MCD and SIMIT exchange their data via the MCD coupling.
- PLCSIM Advanced and SIMIT exchange their data via the PLCSIM Advanced coupling.

3.4 Compatible versions

You can find the programs listed below in the Siemens Industry Mall [https://mall.industry.siemens.com](https://mall.industry.siemens.com) with specification of the article numbers.

<table>
<thead>
<tr>
<th>Program</th>
<th>Version</th>
<th>Article number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMATIC Machine Simulator</td>
<td>1.0</td>
<td>6ES7823-1HA01-0YA5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6ES7823-1HA10-0YA5</td>
</tr>
<tr>
<td>STEP 7 Professional</td>
<td>V15</td>
<td>6ES7822-1AA0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6ES7810-5CC0</td>
</tr>
<tr>
<td>S7-PLCSIM Advanced</td>
<td>V2.0</td>
<td>6ES7823-1FA0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6ES7823-1FE0</td>
</tr>
<tr>
<td>SIMIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIMIT Engineering S</td>
<td>V10.0</td>
<td>6DL8913-0AK00-0AB5</td>
</tr>
<tr>
<td>SIMIT Engineering M</td>
<td></td>
<td>6DL8913-0BK00-0AB5</td>
</tr>
<tr>
<td>SIMIT Engineering L</td>
<td></td>
<td>6DL8913-0CK00-0AB5</td>
</tr>
<tr>
<td>SIMIT Engineering XL</td>
<td></td>
<td>6DL8913-0DK00-0AB5</td>
</tr>
</tbody>
</table>

Commissioning the digital twin

Machine of the application example

Using PLCSIM Advanced as stand-alone simulation system, you can simulate and test the created user program on a virtual controller. The Runtime API makes user interfaces available for access to the simulation runtime.

In this application example, local communication via the PLCSIM-Softbus is used for data exchange with the TIA Portal. With PLCSIM Advanced, distributed communication via a virtual Ethernet adapter is also possible.

The interface to SIMIT is realized via the PLCSIM Advanced coupling, which enables simple import of the inputs and outputs of the hardware to be simulated.

Automation task

For simulation in the SIMATIC Machine Simulator, load a program into a virtual controller via PLCSIM Advanced. Through interaction with SIMIT and MCD, you validate the program in the context of the machine.

In the application example of this Getting Started, a robot takes a workpiece from the conveyor belt as soon as it has been recorded by a photoelectric barrier and places it in different positions in a box.

Components

The virtual model of the application example consists of:

- 1 SCARA with axes 1 to 3
- 1 conveyor belt
- 4 photoelectric barriers
- Workpieces (unlimited number)
- 2 boxes for storing the workpieces

Sequence

The application example runs as follows:

- The conveyor belt is activated until one of the two photoelectric barriers detects a workpiece.
- The robot takes the workpiece and places it in the box.
- A box is filled to the maximum with 9 workpieces. The robot changes to an empty box.

MCD simulates the mechanical components based on the defined degrees of freedom and setpoints and represents the simulated machine visually.
Tags, declarations, data types

The following input and output tags are defined for the communication of the controller with the transport system:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Declaration</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ConveyorBelt_Actor_Interface_AddressIn</td>
<td>Input</td>
<td>PD_TEL1_IN</td>
</tr>
<tr>
<td>Axis1_Actor_Interface_AddressIn</td>
<td>Input</td>
<td>PD_TEL105_IN</td>
</tr>
<tr>
<td>Axis2_Actor_Interface_AddressIn</td>
<td>Input</td>
<td>PD_TEL105_IN</td>
</tr>
<tr>
<td>Axis3_Actor_Interface_AddressIn</td>
<td>Input</td>
<td>PD_TEL105_IN</td>
</tr>
<tr>
<td>lightBarrierPickingPos</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>lightBarrierPlacingPos</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>boxPicked</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>lightBarrierBoxLeft</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>lightBarrierBoxRight</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>DI5-DI15</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>ConveyorBelt_Actor_Interface_AddressOut</td>
<td>Output</td>
<td>PD_TEL1_OUT</td>
</tr>
<tr>
<td>Axis1_Actor_Interface_AddressOut</td>
<td>Output</td>
<td>PD_TEL105_OUT</td>
</tr>
<tr>
<td>Axis2_Actor_Interface_AddressOut</td>
<td>Output</td>
<td>PD_TEL105_OUT</td>
</tr>
<tr>
<td>Axis3_Actor_Interface_AddressOut</td>
<td>Output</td>
<td>PD_TEL105_OUT</td>
</tr>
<tr>
<td>Axis3_ActualPosition</td>
<td>Output</td>
<td>REAL</td>
</tr>
<tr>
<td>enableVacuum</td>
<td>Output</td>
<td>BOOL</td>
</tr>
<tr>
<td>DQ0,DQ2-DQ15</td>
<td>Output</td>
<td>BOOL</td>
</tr>
</tbody>
</table>

Simulated hardware components

<table>
<thead>
<tr>
<th>Number</th>
<th>Component</th>
<th>Version</th>
<th>Article number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CPU 1517TF-3 PN/DP</td>
<td>V2.5</td>
<td>6ES7 517-3UP00-0AB0</td>
</tr>
<tr>
<td>1</td>
<td>TP900 Comfort</td>
<td>V15.0.0.0</td>
<td>6AV2 124-0JC01-0AX0</td>
</tr>
<tr>
<td>3</td>
<td>SINAMICS S120</td>
<td>V5.1</td>
<td>6SL3 040-1MA01-0AA0</td>
</tr>
</tbody>
</table>
Preparing the simulation

Note

The higher the level of detail of the simulation, the greater the computing effort during the simulation.
5.1 Downloading the application example

1. Download the following ZIP file (contains files of the application example) to your PC:
   SIMATIC_Machine_Simulator_getting_started.zip
   [https://support.industry.siemens.com/cs/ww/en/view/109758943]

2. Unzip the ZIP file.
   The following folders will be unpacked and saved on your PC:
   - GettingStarted\MCD
Preparing the simulation

5.2 Making the MCD model kinematic

You have downloaded the files for the application example.

5.2 Making the MCD model kinematic

The machine needs to have physical properties in order to be simulated. To equip the machine with physical properties, you need to make it kinematic.

You can find information on making a machine kinematic or configuring in MCD in the "Configuring in MCD" section of the following document:

SIMOTION/SIMATIC: Virtual commissioning with hardware in the loop
[https://support.industry.siemens.com/cs/ww/en/view/109758739]

Note

The application example contains a kinematic MCD model.

You can find additional information on this in the section Downloading the application example (Page 17).
5.3 Preparing the TIA Portal project

5.3.1 Requirement

To use the SIMATIC Machine Simulator, a controller must be programmed in the TIA Portal. A TIA Portal V15 project "*.ap15" is included in the download for the application example in this Getting Started. You can find additional information on this in the section Downloading the application example (Page 17). You have opened the "*.ap15" in the portal view in the TIA Portal.

5.3.2 Unlocking protected program blocks

Make sure that you unlock protected blocks before setting the simulation support in your project. You can find additional information on this in the section Setting simulation support of the project (Page 20). You can recognize a protected program block by the padlock symbol. The TIA Portal project of this Getting Started does not contain any blocks with know-how protection. After you have set simulation ability of the blocks, you can protect the block again. You can find more information on disabling know-how protection in the TIA Portal information system.
5.3 Preparing the TIA Portal project

### 5.3.3 Setting simulation support of the project

Set the TIA Portal project in such a way that it supports simulation.

1. Select the open project in the project navigation.
2. Select "Properties" in the shortcut menu of the project.
   The dialog with the properties of the project opens.
3. Go to the "Protection" tab.
4. Select the check box "Support simulation during block compilation".
5. Confirm with "OK".

You have set simulation support for the TIA Portal project.
5.3.4 Starting HMI simulation

An operator panel (HMI) is simulated in this application example.

1. Call the shortcut menu in the TIA Portal by right-clicking on "HMI_1".
2. Click "Start simulation".
Preparing the simulation

5.3 Preparing the TIA Portal project

The "SIMATIC WinCC Runtime Advanced" window with the "SIMATIC HMI" operator panel appears.

You have started the simulation of the operator panel. Save and close the project.

5.3.5 Result

You have started the simulation in the TIA Portal.
5.4 Creating a SIMIT project

5.4.1 Overview
SIMIT contains the required couplings to the MCD and PLCSIM Advanced programs and simulates the behavior of the machine.

The following is simulated in this application example:

- SCARA robot with 3 positioning axes
  - 2 axes with simulation of PROFlode drive
    Transfer of control and status word
  - 1 axis with active simulation in the PLC
    Transfer of the actual position
- Conveyor belt with 1 speed axis
  Simulation of the PROFlode drive
  Transfer of control and status word
- Photoelectric barriers

SIMIT simulates the drives with separate drive blocks which adjust the communication and the state machine of a real drive. The state machine defines the transitions from one state to another. A state transition is triggered by a defined bit in the control word. The current status can be recognized by the status word.

You do not need to change the user program as compared to the real machine.

To enable SIMIT to communicate with the drive blocks, interconnect the inputs and outputs of the drive blocks with the required information of the PROFlode telegram.

Note
Because the programs compute with different base units, SIMIT converts the tags.

5.4.2 Creating a new SIMIT project

Note
You start with a new project in SIMIT for this application example.

If needed, you can download a finished SIMIT project from the download folder.

1. Open SIMIT.
2. Click "Create new project".
3. Enter the name and click "Create".
4. Click "Project view".

SIMIT has created a new project. The file has the extension *.simit.
5.4.3 Coupling SIMIT with PLCSIM Advanced

1. Make sure that the project is closed in the TIA Portal.
2. Double-click "New coupling".
3. Select "PLCSIM Advanced" and click "OK".
4. In the "PLCSIM Advanced import" window, navigate in the "TIA project" line to the TIA project file.

**Note**

You can also import HWCN export files with SIMIT.

SIMIT calculates the station preview.

5. Select the "Bus synchronous" check box.

6. Select "Create new" from the "Symbols" drop-down list.

7. Select the "Adapt data width" check box.

8. Confirm the entries by clicking on "Import".
SIMIT has added the "PLCSIM Advanced" coupling in the project navigation.
Inputs/outputs as tags

When you double-click on "PLC", a window with the inputs/outputs of the controller as tags appears in the work area.
5.4.4 Coupling SIMIT with MCD

1. Double-click "New coupling".
2. Select "MCD" in the "Selection" window and click "OK".

SIMIT adds the "MCD" coupling to the project.

3. Double click on "MCD".
   
   The "MCD" window appears in the SIMIT work area.
4. Click on "Link with external file".

**Note**
"Link with external file" establishes a connection to the MCD file. The MCD files remain at their original storage location. If the MCD project is changed, the coupling can be updated via this button.

"Import" copies the MCD files once into the SIMIT project directory. The MCD project can no longer be changed.

5. In the "Select MCD parts file" window, navigate to the main parts file in the "MCD parts file (*.prt)" line.

**Note**
**Same file extension**
All MCD files have the same extension *.prt and can be distinguished only by their file name.

Place a special character (e.g. "!") and the term "MAIN" in front of the file name of the main parts file. With alphabetical sorting, the main parts file is at the start of the list and is also identified by the word "MAIN".
6. Open the main parts file.

The "Select MCD parts file" window appears.

7. Confirm the selection of the main parts file by clicking "Link".

The inputs and outputs of the linked MCD main parts file appear in the SIMIT work area.

You have added the "MCD" coupling in SIMIT and linked it with the main parts file.
5.4.5 Setting the time slice for the MCD coupling

1. Select the "Bus synchronous" check box for time slice 2.

2. Save the input.
5.4.6 Setting the units of the signals from MCD

The units for the signals from the MCD must be set as they are used in the charts. Conversions are thus avoided. The units used are defined by the blocks which are called in the charts.

- Actual and setpoint speed (Nlist and NSoll) at the "ProfiDrive2" block are specified in 1/min.
- "Gx_Xlist" at the "SensorProcessRotatory" block is specified in degrees.
- Position values of "Axis 3" are defined as mm in the TIA Portal and are converted to m in the "ControlAxisV10" chart.
- The speeds of "Axis 3" and "ConvoyerBelt" are transferred to MCD in m/sec.

In the "Project navigation", double-click on "Couplings > MCD" and set the correct units for all signals.

The following screenshot shows the correct units for all signals of this application example.

![Screenshot of MCD units configuration](image-url)
5.4.7 Setting the time slice of the project manager

Make sure that the following values are identical:

- Time slice cycle of the project manager in SIMIT
- Application cycle of the controller in the TIA Portal

If necessary, correct the value for the time slice cycle of the project manager in SIMIT.

Time slice cycle of the project manager in SIMIT

The following figure shows the time slice cycle of the project manager in SIMIT.
5.4 Creating a SIMIT project

Application cycle in the TIA Portal

You call the application cycle of the controller in the TIA Portal as follows:

1. Double click on the "PLC_1" device in the TIA Portal project navigation.
2. Double-click on "Program blocks".
3. Right-click on the "MC-Servo" organization block.
4. Click "Properties".
   The "MC-Servo" window opens.
5. Click on the "General" tab.
6. Click on "Cycle time".
7. Make sure that "1" is selected in the "Factor" drop-down list.

The value for the controller is displayed in the "Application cycle" line.

5.4.8 Using SIMIT according to your own requirements

You will find an overview of the possibilities for using SIMIT according to your own requirements in the section Creating a behavior model (Page 35).

5.4.9 Result

You have created a *.simit file.
Creating a behavior model

6.1 Modeling the drive behavior

In the following sections, you will learn how to model the drive behavior in SIMIT according to your requirements.

You can find additional information on the library in the section Using the library (Page 50).

**Note**

You do not need to program any charts for the application example in this Getting Started. All interconnections are made available for download.

You can find additional information on this in the section **Downloading the application example** (Page 17).

**SIMIT chart of the axes of the application example**

When you double-click on the "ControlAxisV10" chart, the work area shows the chart editor of the axes for the Getting Started application example.
6.2 Creating chart of the axes

1. Double-click "New chart".

SIMIT adds a new chart called "Chart" to the list of charts.

**Note**

You can change the name of the chart.
2. Double-click the new chart "Chart".
   The chart editor for "Chart" appears in the work area.

3. Assemble the drive components of axis 1. You can find additional information on this in the section Structure of the drives (Page 38).

4. Adapt the properties of the components. You can find additional information on this in the section Setting properties of the PROFIdrive block (Page 41).

5. Interconnect the signals. You can find additional information on this in the section Interconnection of axes 1 and 2 (Page 46).

6. Repeat the axis 1 procedure for axis 2.

7. Interconnect axis 3. You can find additional information on this in the section Interconnection of axis 3 (Page 46).

See also

- Setting properties of the PROFIdrive block (Page 41)
- Interconnection of axes 1 and 2 (Page 46)
- Structure of the drives (Page 38)
- Interconnection of axis 3 (Page 46)
6.3 Structure of the drives

Drives of SCARA axes 1 and 2

The simulated drives of axes 1 and 2 of the application example are assembled in a modular fashion of the following components:

1. "PROFIdrive2" component: Control/status word and speed setpoint/actual speed
2. "Sensor" component: Encoder connection
3. "DynamicServoControl" component: Drive-internal position controller
4. "SiemensMomentumReduction" component: Torque reduction

The group of blocks as shown above represents the behavior of a PROFIdrive drive as an example for PROFIdrive telegram 105.
SCARA axis 3

Axis 3 represents the stroke axis of the SCARA robot and is switched to simulation in the TIA Portal. With this, PLCSim Advanced calculates the position of the axis.

The drive must not be simulated with a PROFIdrive block.
- The PLC simulates the axis.
- SIMIT transfers the result of this simulation (actual position) to MCD.
- MCD transfers the actual position to a PositionController.
- The PositionController represents the position.

SCARA axis 4

The SCARA axis 4 (rotation of gripper) is not used in this application example. It is therefore not included in this chart.

Conveyor belt drive

The simulated drive of the conveyor belt consists of a PROFIdrive1 block and has the following structure:
Components of SCARA axes 1, 2 and of the conveyor belt

You can find the components used in the SIMIT library, on the right-hand side in the "Components" task card with open "Basic components" pane.
6.4 Setting properties of the PROFIdrive block

Consistency of parameters

<table>
<thead>
<tr>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the simulation with the PROFIdrive block to work smoothly, the parameters in SIMIT need to correspond to the TO parameters in the TIA Portal.</td>
</tr>
</tbody>
</table>

You can find the parameters in the TIA Portal project navigation under [Device] > Technology objects > [TO name] > Configuration > Basic parameters.

To call the parameters in the TIA Portal, follow these steps:
1. In the TIA Portal project navigation, open the drop-down list of "PLC_1".
2. Click on the relevant TO under "Technology objects".
3. You can see the parameters in the detail view.
Setting properties of the PROFIdrive block

1. In the "ControlAxisV10" chart in SIMIT, click on a PROFIdrive block.
2. Click on the line "Parameters" in the property window.
3. Check the preset parameters of the following blocks and change them if necessary so that the properties in SIMIT correspond to the TO parameters in the TIA Portal:
   - “PROFIdrive2”
   - “SensorProcessRotary”
   - “Sensor”
4. In the TIA Portal, disable the automatic transfer of encoder parameters for all four TOs.
6.5 Interconnecting signals

6.5.1 Interconnecting signals

Interconnection of the signals is shown based on the example of the PROFIdrive2 block of axis 1.

1. Open the "Signals" task card on the right next to the SIMIT work area.
2. Filter the signals, if necessary.

**Note**

Filtering distinguishes between upper and lower case (case sensitivity).

3. Insert the desired signal into the chart editor using drag-and-drop. You can find additional information on this in the sections Interconnection of axes 1 and 2 (Page 46), Interconnection of axis 3 (Page 46) and Interconnection of the conveyor belt (Page 47).

**Note**

Keep the <Shift> key pressed while dragging the signal.
4. Connect the signal to the component.

<table>
<thead>
<tr>
<th>Signal not connected to component.</th>
<th>PLC_Axis1_Actor_Interface_AddressOut-STW1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drag connection from signal to component with the mouse.</td>
<td>PLC_Axis1_Actor_Interface_AddressOut-STW1</td>
</tr>
<tr>
<td>Signal connected to component.</td>
<td>PLC_Axis1_Actor_Interface_AddressOut-STW1</td>
</tr>
</tbody>
</table>

**Note**
- Input connectors have a red background.
- Output connectors have a green background.
6.5 Interconnecting signals

6.5.2 Interconnection of axes 1 and 2

Note
The display of the drive components, signals and connections is adapted to the page format of this Getting Started for a clearer overview.

6.5.3 Interconnection of axis 3
6.5.4 Interconnection of the conveyor belt

Note
The display of the drive components, signals and connections is adapted to the page format of this Getting Started for a clearer overview.
6.6 Modeling the behavior of the photoelectric barriers

Interconnecting the "Bitlogik" chart

MCD photoelectric barriers are simulated in the application example. The following figure shows the signal interconnection in the SIMIT chart editor "Bitlogik".

![Diagram showing signal interconnection in SIMIT chart editor "Bitlogik" for MCD collision sensors and PLC interactions]
Error test

Test the behavior of the machine in the event of a failure/defect of the right-hand photoelectric barrier

1. Start the simulation. You can find additional information on this in the section Starting the simulation (Page 51).
2. Switch a photoelectric barrier off or on.

Note

In the SIMIT chart editor "Bitlogik", the two gray squares in "Deactive Sensors - Failure Test" function as buttons. The photoelectric barriers can be turned off and on with a click during the simulation.

In the simulation, you will see the behavior of the machine in the event of failure of a photoelectric barrier.
6.7 Using the library

You can find the library in the right-hand pane in SIMIT. You can choose between components and controls, for example.

- You can find a large number of elements in the standard library that you can use for your behavior model.
- In the project library, you will find blocks that you stored in the project folder under "...\pcomp".

**Procedure**

1. Open the task card of the library and a substructure if necessary.
2. Use a drag-and-drop operation to move the desired block into the chart.
Starting the simulation

7.1 Requirement

You have prepared the simulation. You can find additional information on this in the section [Preparing the simulation](Page 16).

7.2 Preparing simulation start in SIMIT

1. Open the *.simit file for the application example in the project view.
2. Start the simulation by clicking “Start”.

![Simulation Start in SIMIT](image)
MCD starts and shows the machine.

SIMIT changes from the blue color scheme to the orange color scheme.

A simulation of the controller is created in PLCSIM Advanced and set to the "Run" operating state.

You have connected SIMIT to the simulated PLC online.
7.3 Compiling and loading to device

1. Compile the hardware and software of the PLC_1 device in the TIA Portal.
2. Start "Download to device" for the PLC_1 device.
3. Set the following parameters in the "Extended download" window.
   - Type of the PG/PC interface: PN/IE
   - PG/PC interface: PLCSIM
   - Connection with interface/subnet: Try all interfaces
4. Click "Start search".
5. In the list under "Select target device" select the "PLC_1" device with the address 192.168.0.1.
6. Click “Load”.

Note

TIA Portal saves the connection settings.

You only need to enter the settings in the “Extended download” window once. The TIA Portal establishes the connection automatically during the next “Download to device”.

The “Load preview” window appears.

7. Click “Load”.
8. Select "Start module" in the "Action" column in the "Load results" window.

9. Click "Finish".

   The window closes.
   The TIA Portal project is loaded into the instance of PLCSIM Advanced. With this, the TIA Portal concludes the loading process.
   You have compiled PLC_1 and downloaded it to the device; in this case, the virtual controller in PLCSIM Advanced.

**Checking the download of the user program into the PLCSIM Advanced instance (optional)**

By finishing the action in section Compiling and loading to device (Page 53), you downloaded the PLC program for PLC_1 into a virtual S7-1500 controller.

After a successful download, the PLCSIM Advanced Control Panel shows an active instance with green LED ("RUN").
7.4 **Calibrating the absolute value encoder of the axes**

With every commissioning, you need to calibrate the zero positions of the axes once.

---

**Note**

The absolute value encoders retain their zero positions.

After commissioning, you do not need to calibrate the zero positions again on restart of the machine.

---

**Requirement**

End the movement of the machine, if applicable, by clicking "ON/OFF" on the simulated SIMATIC HMI operator panel. You can find additional information on this in the section [Controlling simulation via the operator panel](Page 62).

**Procedure**

Calibrate the axes 1 to 4 as follows:

1. Open the TIA Portal project in the project view.
2. Select "Start simulation" in the shortcut menu of the "HMI_1" device.

   The "SIMATIC WinCC Runtime Advanced" window with the simulated SIMATIC HMI operator panel appears.
3. On the operator panel, click on the "Staeubli" tab on the right.
4. Click "Manual control" in the top left.

"Manual control" switches from "inactive" to "active".

5. Click on the “Axis control” tab at the bottom.

6. Click on the "Enable" tab on the left.
Starting the simulation

7.4 Calibrating the absolute value encoder of the axes

7. Click "Enable all axes".

8. Click on the "Home" tab on the left.
9. Click "Axis_1" at the top.
10. Click "Absolute encoder adjustment".
11. Enter 0 for "Homing position".
12. Confirm the entries with <Enter>.
13. Click the "Set" button.

14. Proceed in the same way for "Axis_2" and "Axis_4".

15. Click "Axis_3".

16. Enter 0 mm for "Homing position".

17. Confirm the entries with <Enter>.
18. Click the “Set” button.

19. Click “Manual control” in the top left.
   
   "Manual control" switches from "active" to "inactive".

   You have calibrated the 4 axes of the SCARA.
7.5 Controlling simulation via the operator panel

1. On the simulated SIMATIC HMI operator panel, click on "Automatic".

2. Click "ON/OFF".

   The color of the button changes from gray (OFF) to green (ON).

   The user program starts.
Starting the simulation

7.6 Result

The movement simulation of the machine starts in the MCD program window.

Stopping the simulation

Click on the "ON/OFF" button on the operator panel to stop the simulation.

The color of the button changes from green (ON) to gray (OFF).

The movement simulation of the machine stops in the MCD program window.

7.6 Result

You have started the simulation of the application example and set the machine in motion.
### List of abbreviations

**Note**

Entries in **bold** are (partial) trade names of Siemens AG.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
</tr>
<tr>
<td>CAE</td>
<td>Computer Aided Engineering</td>
</tr>
<tr>
<td>CAM</td>
<td>Computer Aided Manufacturing</td>
</tr>
<tr>
<td>CTE</td>
<td>SIMIT Component Type Editor, see SP, with which you can design blocks and integrate them into the SIMIT project library</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>MCD</td>
<td>Mechatronics Concept Designer, part of the Siemens program NX</td>
</tr>
<tr>
<td>NX</td>
<td>Trade name of the Siemens CAD program</td>
</tr>
<tr>
<td>PID</td>
<td>Proportional Integral Derivative</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
</tr>
<tr>
<td><strong>PLCSIM Advanced</strong></td>
<td>Trade name of the Siemens program with which you can create virtual controllers for simulation of S7-1500 and ET 200SP controllers and use them for comprehensive function simulation</td>
</tr>
<tr>
<td>PLM</td>
<td>Product Lifecycle Management</td>
</tr>
<tr>
<td>SCARA</td>
<td>Selective Compliance Assembly Robot Arm</td>
</tr>
<tr>
<td>SHM</td>
<td>Shared Memory</td>
</tr>
<tr>
<td><strong>SIMATIC</strong></td>
<td>“Siemens” and “Automatic”: Trade name for Siemens products in automation technology, control technology and the manufacturing execution level</td>
</tr>
<tr>
<td>SIMIT</td>
<td>See CTE and SP</td>
</tr>
<tr>
<td>SP</td>
<td>SIMIT Simulation Platform, see CTE</td>
</tr>
<tr>
<td>STW</td>
<td>Control word, see ZSW</td>
</tr>
<tr>
<td><strong>TIA Portal</strong></td>
<td>“Totally Integrated Automation” Portal. Siemens organization concept which combines the interaction of different individual automation technology components, software tools and services into a consistent automation solution</td>
</tr>
<tr>
<td>TO</td>
<td>Technology object</td>
</tr>
<tr>
<td>ZSW</td>
<td>Status word, see STW</td>
</tr>
</tbody>
</table>