SIMATIC Machine Simulator V3.0

Getting Started

Virtual commissioning of machines

## Legal information

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<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>! DANGER</td>
<td>indicates that death or severe personal injury will result if proper precautions are not taken.</td>
</tr>
<tr>
<td>! WARNING</td>
<td>indicates that death or severe personal injury may result if proper precautions are not taken.</td>
</tr>
<tr>
<td>! CAUTION</td>
<td>indicates that minor personal injury can result if proper precautions are not taken.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>indicates that property damage can result if proper precautions are not taken.</td>
</tr>
</tbody>
</table>

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.

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Note the following:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>! CAUTION</td>
<td>Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.</td>
</tr>
</tbody>
</table>
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To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under https://www.siemens.com/industrialsecurity.
Inhaltsverzeichnis

1 Preface ................................................................................................................. 5
2 Product overview ................................................................................................. 7
   2.1 Scope of delivery of the SIMATIC Machine Simulator ..................................... 7
   2.2 Additional programs for virtual commissioning .............................................. 7
   2.3 Mode of operation of the SIMATIC Machine Simulator .................................. 8
   2.4 Compatible versions ....................................................................................... 11
3 Commissioning the digital twin ........................................................................ 12
4 Preparing the simulation ....................................................................................... 14
   4.1 Downloading the application example .......................................................... 14
   4.2 Making the MCD model kinematics ............................................................... 16
   4.3 Preparing the TIA Portal project .................................................................... 16
   4.3.1 Requirements ............................................................................................ 16
   4.3.2 Unlocking protected program blocks ......................................................... 16
   4.3.3 Setting simulation support of the project .................................................. 17
   4.3.4 Starting HMI simulation ......................................................................... 18
   4.3.5 Result ....................................................................................................... 19
   4.4 Creating a SIMIT project ............................................................................... 20
      4.4.1 Overview ................................................................................................. 20
      4.4.2 Creating a new SIMIT project ................................................................. 21
      4.4.3 Coupling SIMIT with PLCSIM Advanced ............................................. 21
      4.4.4 Coupling SIMIT with MCD ................................................................. 24
      4.4.5 Setting the time slice for the MCD coupling ......................................... 27
      4.4.6 Setting the units of the signals from MCD ............................................ 29
      4.4.7 Setting the time slice of the project manager ........................................ 30
      4.4.8 Using SIMIT according to your own requirements ................................ 31
      4.4.9 Result ................................................................................................... 31
5 Creating a behavior model .................................................................................... 32
   5.1 Modeling the drive behavior ......................................................................... 32
   5.2 Creating charts for the axes ....................................................................... 33
   5.3 Structure of the drives ............................................................................... 35
   5.4 Setting properties of the PROFldrive block ............................................. 38
   5.5 Connecting signals ....................................................................................... 40
      5.5.1 Connecting signals ............................................................................... 40
      5.5.2 Interconnection of axes 1 and 2 ............................................................ 41
      5.5.3 Interconnection of axis 3 ....................................................................... 41
      5.5.4 Interconnection of the conveyor ............................................................ 42
   5.6 Modeling the behavior of the light barriers ............................................... 43
   5.7 Using the library ......................................................................................... 44
6 Starting the simulation ......................................................................................... 45
   6.1 Requirements ............................................................................................... 45
   6.2 Preparing the simulation in SIMIT .............................................................. 45
   6.3 Preparing the simulation in MCD ............................................................... 46
   6.4 Start the simulation .................................................................................... 46
   6.5 Compiling and loading to device ............................................................... 47
   6.6 Controlling simulation via the HMI ............................................................ 50
   6.7 Result ........................................................................................................ 51
7 List of abbreviations ............................................................................................. 52
8 Appendix ............................................................................................................. 53
   8.1 Service and Support ................................................................................... 53
   8.2 Related literature ......................................................................................... 53
1  Preface

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 becomes 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 insight into the functionality 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 engineers (CAD special knowledge or machine knowledge) who test a machine using 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 V16 und SIMATIC WinCC V16 documentation (https://support.industry.siemens.com/cs/ww/en/view/109773506).
- Basics of the SIMIT coupling types
  You can find additional information on this in the SIMIT V10.2 manual (https://support.industry.siemens.com/cs/ww/en/view/109780242).
- Basics of CAD modeling
  You can find additional information on this in the NX1899 documentation (https://www.plm.automation.siemens.com/global/de/support/docs.html).

Knowledge of these topics is required to understand the application example in this Getting Started.
2 Product overview

2.1 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 if 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.

2.2 Additional programs for virtual commissioning

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

TIA Portal, STEP 7 and WinCC Engineering
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.
2.3 Mode of operation of the SIMATIC Machine Simulator

Comparison: Reality versus simulation

Figure 2-1 Commissioning procedure (reality vs. simulation)
How it works

Figure 2-2 Principle of virtual commissioning with SIMATIC Machine Simulator

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.
2.4 Compatible versions

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

<table>
<thead>
<tr>
<th>Programm</th>
<th>Version</th>
<th>Artikelnummer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMATIC Machine Simulator</td>
<td>S V3.0</td>
<td>• 6ES7823-1HA03-0YA5</td>
</tr>
<tr>
<td></td>
<td>M V3.0</td>
<td>• 6ES7823-1HA13-0YA5</td>
</tr>
<tr>
<td>STEP 7 Professional</td>
<td>V16.0</td>
<td>• 6ES7822-1AA06</td>
</tr>
<tr>
<td>S7-PLCSIM Advanced</td>
<td>V3.0 Upd1</td>
<td>• 6ES7823-1FA02</td>
</tr>
</tbody>
</table>

**SIMIT**

<table>
<thead>
<tr>
<th>Programm</th>
<th>Version</th>
<th>Artikelnummer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMIT Engineering S</td>
<td>V10.2</td>
<td>• 6DL8913-0AK20-0AB5</td>
</tr>
<tr>
<td>SIMIT Engineering M</td>
<td></td>
<td>• 6DL8913-0BK20-0AB5</td>
</tr>
<tr>
<td>SIMIT Engineering L</td>
<td></td>
<td>• 6DL8913-0CK20-0AB5</td>
</tr>
<tr>
<td>SIMIT Engineering XL</td>
<td></td>
<td>• 6DL8913-0DK20-0AB5</td>
</tr>
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</table>

**NX MCD**

<table>
<thead>
<tr>
<th>Programm</th>
<th>Version</th>
<th>Artikelnummer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechatronics Concept Designer</td>
<td>V1907</td>
<td></td>
</tr>
</tbody>
</table>

3 Commissioning the digital twin

Machine of the application example

Using PLC SIM 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 PLC SIM-Softbus is used for data exchange with the TIA Portal. With PLC SIM Advanced, distributed communication via a virtual Ethernet adapter is also possible.

The interface to SIMIT is realized via the PLC SIM 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 PLC SIM 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 light 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 light barriers
- Workpieces (unlimited number)
- 2 boxes for storing the workpieces

Sequence

The application example proceeds as follows:

- The conveyor belt is activated until one of the two light 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>V2.6</td>
<td>6ES7 517-3UP00-0AB0</td>
</tr>
<tr>
<td>1</td>
<td>TP900 Comfort</td>
<td>V15.1.0.0</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>
4 Preparing the simulation

NOTE The higher the level of detail of the simulation, the greater the computing effort during the simulation.

4.1 Downloading the application example

1. Download the following ZIP file (contains files of the application example) to your PC:
   109758943_gettingstarted_simaticmachinesimulator_v3.0.zip
2. Unzip the ZIP file.
   The following folders will be unpacked and saved on your PC:
   - GettingStarted\MCD

Figure 4-1 Content of the MCD folder
4 Preparing the simulation

- GettingStarted\SIMIT

Figure 4-2 Content of the SIMIT folder

- GettingStarted\TIA

Figure 4-3 Content of the TIA folder

You have downloaded the files for the application example.
4 Preparing the simulation

4.2 Making the MCD model kinematics

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

You can find information on kinematizing a machine or configuring in MCD in the "Configuring in MCD" section of the following document:
SIMOTION/SIMATIC: Virtual commissioning with hardware in the loop

NOTE The application example contains a kinematized MCD model. You can find additional information on this in the section Downloading the application example (Page 14).

4.3 Preparing the TIA Portal project

4.3.1 Requirements

To use the SIMATIC Machine Simulator, a controller must be programmed in the TIA Portal.

A TIA Portal V16 project "*.ap16" 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 14).

You have opened the "*.ap16" in the portal view in the TIA Portal.

4.3.2 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 17).

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.
4.3.3 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.
3. The dialog with the properties of the project opens.
4. Go to the "Protection" tab.
5. Select the check box "Support simulation during block compilation".
6. Confirm with "OK".

You have set simulation support for the TIA Portal project.
4.3.4 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".

Figure 4-5 Starting HMI simulation
4 Preparing the simulation

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

Figure 4-6 Simulation of the HMI in WinCC

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

4.3.5 Result

You have started the simulation in the TIA Portal.
4 Preparing the simulation

4.4 Creating a SIMIT project

4.4.1 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 PROFIdrive drives
    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 PROFIdrive drive
  Transfer of control and status word

- Light 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, connect the inputs and outputs of the drive blocks with the required information of the PROFIdrive telegram.

NOTE Because the programs uses different base units, SIMIT converts the tags.
4 Preparing the simulation

4.4.2 Creating a new SIMIT project

**NOTE**
You start with a new project in SIMIT for this application example. If needed, you can open 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.

4.4.3 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".

![Figure 4-7 Creating a coupling between SIMIT and PLCSIM Advanced](image)

4. In the "PLCSIM Advanced Import" window, navigate in the "TIA Portal project" line to the TIA project file.

**NOTE**
You can also import HWCN exported files in SIMIT.
4 Preparing the simulation

Figure 4-8 Import of the TIA project

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.

Figure 4-9 Coupling between SIMIT and PLCSIM Advanced

9. Assign the new name "PLC" to the "S71500-ET200MP-Station_1" by right-clicking "Rename".
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.
4.4.4 Coupling SIMIT with MCD

1. Double click "New coupling".
2. In the "Selection" window, select the "Mechatronics Concept Designer" coupling and click "OK" (Figure 4-12).
3. SIMIT adds the "Mechatronics Concept Designer" coupling to the project.
4. Rename the coupling for a shorter coupling name to "MCD".
5. Double-click the new MCD coupling so that it opens in the work area (Figure 4-13).
6. Switch to the NX MCD project and click the "Allow connection" button in the Simit Toolbar (Figure 4-14).
7. Switch to the SIMIT project and click the "Receive signals from MCD" button in the MCD link in the work area (Figure 4-15).
8. Switch to the NX MCD project and click the "Send signals to SIMIT" button in the Simit Toolbar (Figure 4-16).

Hinweis

As of SIMIT v10.2, the Mechatronics Concept Designer (MCD) project is no longer started by SIMIT. The new coupling mechanism is supported by a toolbar "Simit" implemented in the MCD toolbar.

If NX MCD is already installed, the new Simit Toolbar will be implemented in NX MCD during SIMIT v10.2 installation. The system environment variable "UGII_BASE_DIR" points to the selected NX MCD version. If different NX MCD versions are installed in parallel, pay attention to the system environment variable to implement the Simit Toolbar in the correct version.

If NX MCD is installed after SIMIT, the Simit Toolbar can be installed after the successful NX MCD installation using the SIMIT installation file. The value in the system environment variable "UGII_BASE_DIR" must also be observed here.

Figure 4-12 Creating a coupling between SIMIT and MCD
4 Preparing the simulation

Figure 4-13 SIMIT: Workspace MCD coupling

Figure 4-14 MCD: Allow Connection
4 Preparing the simulation

NOTE

The Mechatronics Concept Designer coupling in SIMIT v10.2 is able to connect and synchronize with any running NX MCD instance. In the NX MCD instance, permission to import SIMIT signals must be granted for reading the signals into SIMIT via the Simit Toolbar. After the project has been successfully read out, the coupling is created.

Figure 4-15 SIMIT: Receive signals from MCD

Figure 4-16 MCD: Send signals to Simit

The inputs and outputs of the linked MCD instance appear in the SIMIT work area. You have added the "MCD" coupling in SIMIT and linked it to the selected NX MCD instance.
NOTE

SIMIT v10.2 can also be linked to a NX MCD PLAYER instance. Please note that reading out the MCD project with a full NX MCD license is recommended.

If an MCD PLAYER instance has only been read out with an MCD PLAYER license, the physics objects are missing in the coupling. Only signals are shown in the coupling.

An MCD coupling, which was created with a full MCD license (physics and signal objects), can easily be used with an MCD PLAYER instance.

4.4.5 Setting the time slice for the MCD coupling

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

Figure 4-17 Setting the bus synchronization of the time slice

2. Save the MCD coupling.
4 Preparing the simulation

NOTE

The MCD coupling can be adjusted via the coupling properties. All physics objects in the coupling can be hidden using the "Import physics objects" selection. Accordingly, only signals are displayed and processed in the coupling. The MCD coupling can be archived if necessary. This results in a copy of the MCD project in the SIMIT project.

The NX operating mode can be used to select whether the NX MCD model is in a "Managed" or "Unmanaged" mode. This setting is necessary for an interaction with Teamcenter.
4.4.6 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 (NInst and NSoll) at the "ProfiDrive2" block are specified in 1/min.
- "Gx_XInst" 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.

Figure 4-18 Adjusting the units of the MCD signals
4.4.7 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.

Figure 4-19 Adjusting the time slice of the project manager
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".
5. The "MC-Servo" window opens.
6. Click on the "General" tab.
7. Click on "Cycle time".
8. Make sure that "1" is selected in the "Factor" drop-down list.

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

Figure 4-20 Adjusting the cycle time in TIA portal

4.4.8 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 32).

4.4.9 Result

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

5.1 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 44).

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 14).

SIMIT chart of the axes of the application example

Under "Charts" you will find the individual components of the project. By double-clicking, the workspace shows the chart editor of the particular axis of the Getting Started application example.

Figure 5-1 SIMIT diagram of axis 1
5.2 Creating charts for 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.

Figure 5-2 Creating a new chart in SIMIT

2. Double-click the new chart "Chart".

The chart editor for "Chart" appears in the work area.
5 Creating a behavior model

Figure 5-3 Empty workspace of the new chart

3. Assemble the drive components of axis 1. You can find additional information on this in the section Structure of the drives (Page 35).

4. Adapt the properties of the components. You can find additional information on this in the section Setting properties of the PROFIdrive block (Page 38).

5. Interconnect the signals. You can find additional information on this in the section Interconnection of axes 1 and 2 (Page 40).

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 40).

See also

- Setting properties of the PROFIdrive block (Page 38)
- Interconnection of axes 1 and 2 (Page 41)
- Structure of the drives (Page 35)
- Interconnection of axis 3 (Page 41)
5 Creating a behavior model

5.3 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:

Figure 5-4 Structure of the PROFIdrive telegram 105

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.
5 Creating a behavior model

SCARA axis 3
Axis 3 represents the stroke axis of the SCARA robot and is switched to simulation in the TIA Portal. With this, PLC SIM 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.

Drive of the conveyor belt
The simulated drive of the conveyor belt consists of a PROFIdrive1 block and has the following structure:

Figure 5-5 Structure of a PROFIdrive1 block
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.

Figure 5-6 Components of the SIMIT library
5.4 Setting properties of the PROFIdrive block

Consistency of parameters

NOTE

In order for the simulation to work smoothly with the PROFIdrive block, the parameters in SIMIT must match the TO-parameters in the TIA Portal.

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

To open the parameters in TIA Portal, proceed as follows:
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. Go to charts and click on the PROFIdrive block of the respective axis.
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"

Figure 5-7 Setting the properties of the PROFIdrive block
4. In the TIA portal, disable the automatic transfer of encoder parameters for all four TOs.

Figure 5-8 Deactivate automatic application of encoder parameters
5 Creating a behavior model

5.5 Connecting signals

5.5.1 Connecting signals

Connection 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-hand side, 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 40), Interconnection of axis 3 (Page 41) and Interconnection of the conveyor (Page 42).

NOTE
Keep the <Shift> key pressed while dragging the signal.

Figure 5-9 Inserting and connecting signals in diagrams

4. Connect the signal to the component.

<table>
<thead>
<tr>
<th>Signal not connected to component</th>
<th>PLCAxis1_Actor_INTERFACE_AddressOut.STW1</th>
<th>0</th>
<th>STW1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drag connection from signal to component with the mouse</td>
<td>PLCAxis1_Actor_INTERFACE_AddressOut.STW1</td>
<td>0</td>
<td>STW1</td>
</tr>
<tr>
<td>Signal connected to component</td>
<td>PLCAxis1_Actor_INTERFACE_AddressOut.STW1</td>
<td>0</td>
<td>STW1</td>
</tr>
</tbody>
</table>

NOTE
- Input connectors have a red background.
- Output connectors have a green background.
5.5.2 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 better overview.

Figure 5-10 Interconnection of signals / SIMIT components of axes 1 and 2

5.5.3 Interconnection of axis 3

Figure 5-11 Interconnection of signals / SIMIT components of axis 3
5 Creating a behavior model

5.5.4 Interconnection of the conveyor

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

Figure 5-12 Interconnection of signals / SIMIT components of the conveyor
5.6 Modeling the behavior of the light barriers

Interconnecting the "Bitlogik" chart

MCD light barriers are simulated in the application example. The following figure shows the signal connection in the SIMIT chart "Bitlogik".

Figure 5-13 Bitlogik (Signal connections / Create product / Deactivate light barriers)

Error test

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

1. Start the simulation. You can find additional information on this in the section Starting the simulation (Page 44).
2. Switch a light barrier off or on.

NOTE

In the SIMIT chart "Bitlogik", the two gray squares in "Deactive Sensors - Failure Test" function as buttons. The light 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 a failure of a light barrier.
5.7 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 drag-and-drop to move the desired block into the chart.
6 Starting the simulation

6.1 Requirements

You have prepared the simulation. You can find additional information on this in the section Preparing the simulation (Page 46).

6.2 Preparing the simulation in SIMIT

1. Open the *.simit file for the application example in the project view.

Figure 6-1 Loaded SIMIT project
6 Starting the simulation

6.3 Preparing the simulation in MCD

1. Start NX MCD and open the „GettingStarted_Solution“ project with the .prt file „MAIN_ASM_GettingStarted_Solution.prt“.
2. Click „Allow Connection“ in the Toolbar “simit”.

Figure 6-2 NX MCD: Allow Connection to SIMIT

6.4 Start the simulation

Click „Start“ to start the simulation.

Figure 6-3 Start SIMIT simulation

SIMIT changes from the blue color scheme to the orange color scheme.
MCD switches to simulation mode.
A PLCSIM Advanced instance is created and set to the “Run” operating state.
You have connected SIMIT online to the simulated PLC.
6.5 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".

Figure 6-4 Setting the interface between PG and controller

5. Select the "PLC_1" in the list "Select target device" with the address 192.168.0.1.
6 Starting the simulation

Figure 6-5 Compiling the hardware / software and downloading to the controller

NOTE
TIA Portal saves the connection.
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.

6. Click "Load".
7. Select "Start module" in the "Action" column in the "Load results" window.
8. Click "Finish".

The window closes.
The TIA Portal project is loaded into the instance of PLCSIM Advanced. This completes the loading process in the TIA Portal. 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 steps in section Compiling and loading to device (Page 47), 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").
6.6  Controlling simulation via the HMI

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

   Figure 6-7 Starting the user program via the HMI

   The operator panel switches to the "Automatic" view.

2. Click "ON/OFF".

   The color of the button changes from gray (OFF) to green (ON).
   The user program starts.
The movement simulation of the machine starts in the MCD program window.

Figure 6-8 The simulation is started

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.

6.7 Result

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

<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>SIMATIC Component Type Editor, see SP, with which you can design blocks and integrate them into the SIMATIC 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>PLCSIM</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>SIMATIC</td>
<td>&quot;Siemens&quot; and &quot;Automatic&quot;: 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>TO</td>
<td>Technologieobjekt</td>
</tr>
<tr>
<td>ZSW</td>
<td>Zustandswort, siehe STW</td>
</tr>
</tbody>
</table>

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

8.1 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.
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Service offer

Our range of services includes, inter alia, the following:

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

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https://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 Apple iOS, Android and Windows Phone:
https://support.industry.siemens.com/cs/ww/en/sc/2067

8.2 Related literature

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<td>Link auf die Beitragsseite des Anwendungsbeispiels <a href="https://support.industry.siemens.com/cs/ww/de/view/109758943">https://support.industry.siemens.com/cs/ww/de/view/109758943</a></td>
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