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SIMATIC/SIMOTION virtual commissioning with "Hardware in the Loop"

TIA Portal V15 / SCOUT TIA V5.2 / SIMIT V10 / NX12 MCD

https://support.industry.siemens.com/cs/ww/en/view/109758739

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1 Introduction

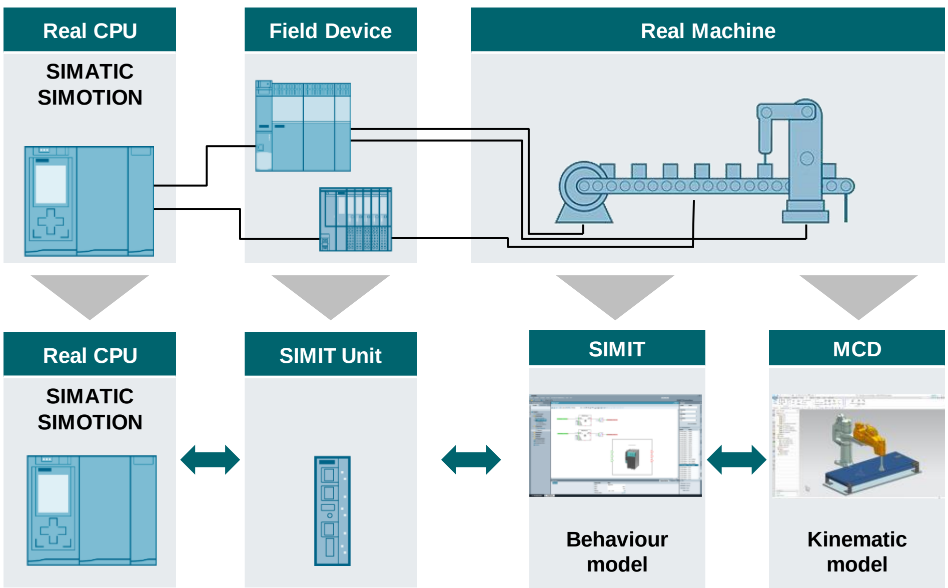
1.1 Overview

To perform a virtual commissioning, an image of the real machine is needed. This image is called the digital twin of a machine.

With the help of a digital twin the interaction of the individual components in the virtual world can be simulated and optimized - without having a real prototype. To reduce the risks and effort for the real commissioning, the virtual commissioning of a machine offers an efficient alternative. This enables shorter time-to-market and greater flexibility, efficiency and quality.

STEP 7 and the Totally Integrated Automation Portal (TIA Portal) allow you to create a "Hardware in the Loop" (HiL) scenario in order to simulate and to validate your user program. For HiL, hardware components are deployed in a simulation environment. With NX Mechatronics Concept Designer (MCD), machine builders can simulate and test the mechanical components of their machine in a virtual environment. The behavior of active components, such as drives or valves, is emulated with the SIMIT simulation software. Whereby, the field devices of the real plant are emulated in the SIMIT Unit. This combination helps with the preparation and for a problem-free commissioning. Furthermore, these tools make it possible to validate the mechanical concept of the machine, and the interaction of the mechanical system, the electrical system, the software as well as the user program, at an early development phase of a plant.

Fig. 1-1 Overview of the systems



Advantages of the application example

- Introduction to the virtual commissioning with "Hardware in the Loop".
- Illustration of the coupling and interaction of the various hardware and software components.
- Example projects for every software component that can serve as template for your own applications.

Limitations

This application example does not contain any descriptions of the following topics:

- Fundamentals of the TIA Portal configuring (for details, see SIMATIC STEP 7 Basic/Professional V15 and SIMATIC WinCC V15)
- Fundamentals of the SCOUT TIA configuring (for details, see SIMOTION SCOUT TIA Manual)
- Fundamentals of the SIMIT coupling types (for details, see SIMIT V10 Manual)
- Fundamentals of the CAD modelling (for details, see NX12 documentation)

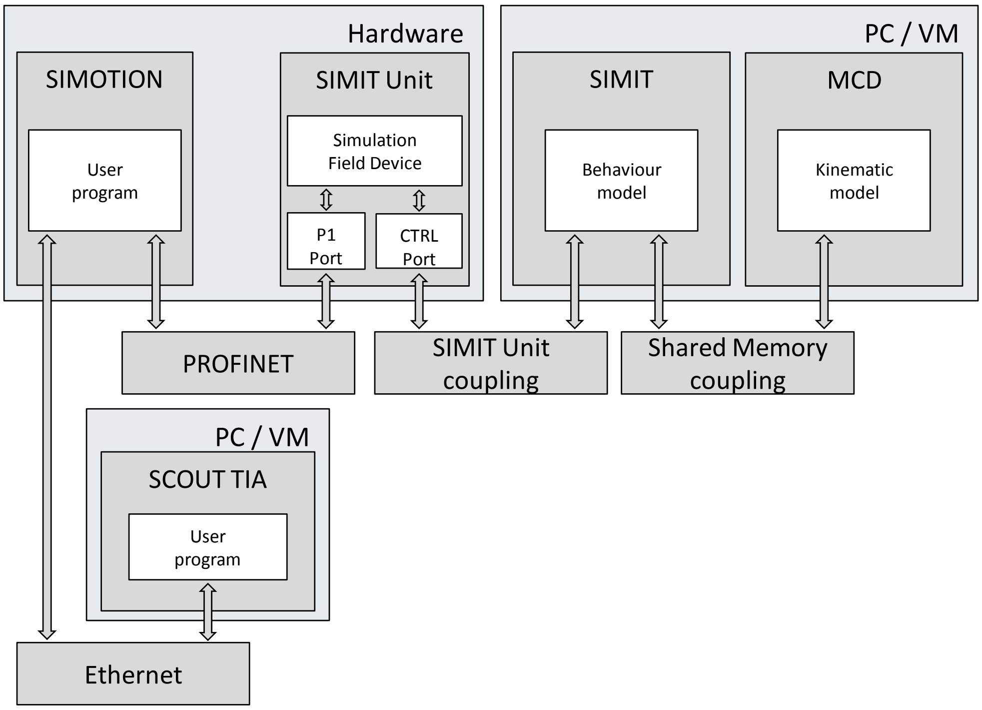
To understand this application example, it is assumed that readers have adequate knowledge of these topics.

1.2 Principle of operation

Overview

The following figure shows the operating principle of the application example.

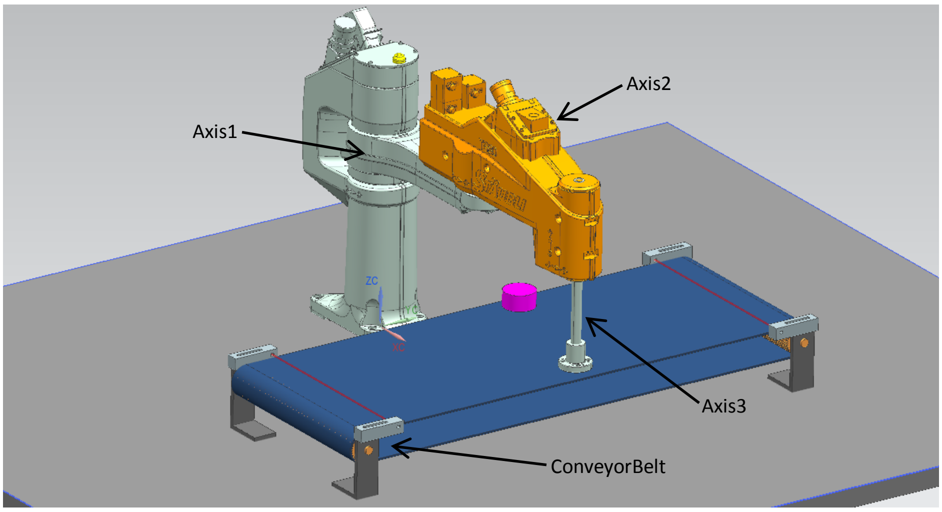
Fig. 1-2 Operating principle



SCOUT TIA

A project created in SIMOTION SCOUT TIA V5.2 controls a transport plant. For a comprehensive function test, the program is loaded into a SIMOTION. The interaction with SIMIT and MCD allows the program to be validated in the plant context. The following figure shows the transport plant with the assignments to the associated technology objects in the SCOUT project.

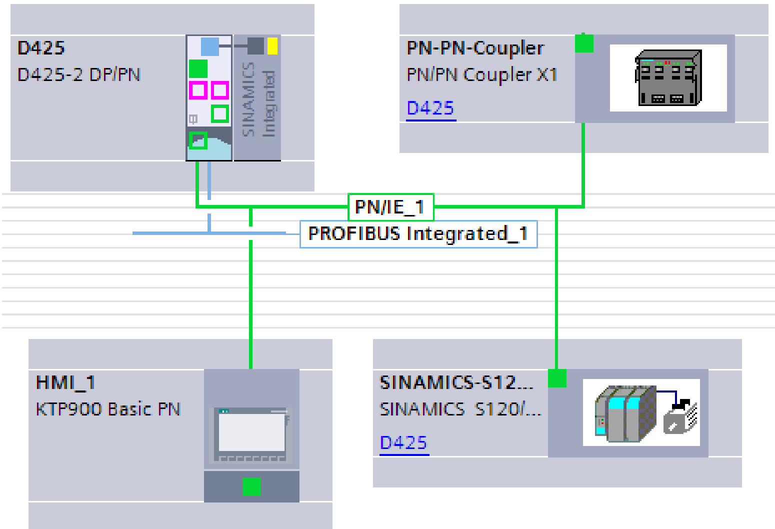
Fig. 1-3 Transport plant – Assignment of the technology objects



"Axis1", "Axis2" and "ConveyorBelt" are traversed via PROFIdrive telegrams. These axes are neither virtual nor in simulation mode. This means that these PROFIdrive telegrams are interpreted and processed during the commissioning. This requires a behavior model of the drives in SIMIT. "Axis3" shows a more simple way of the virtual commissioning. This axis in the TIA SCOUT project is switched to simulation mode (for details, see Axis simulation in SCOUT). This means no behavior model of the telegrams is required and the simulated actual position of the axis is copied in a program to an output address area and so transferred to the virtual model. For this purpose, a PN-PN coupler is created in the device view. This is used to create address areas so they can be read and written in SIMIT via the SIMIT Unit. The address area of the PN-PN coupler is also used for the required digital inputs and outputs. Alternatively, a distributed peripheral module can be configured for this purpose.

If the axes are not switched to simulation, they must be interconnected with external drives via PROFINET. In this application example, all axes are interconnected with drives in the external SINAMICS S120.

Fig. 1-4: Network view of the device configuration



The transport plant to be controlled consists of a conveyor belt and a SCARA robot. Both jogging mode and automatic mode are possible. This allows the conveyor belt, as well as axes 1-3 of the SCARA robot, to be traversed. To allow the controller to communicate with the transport plant, the following input and output variables are defined:

Table 1-1: Input and output variables

Variable	Data type	Input/output
iboLightBarrierPickingPos	BOOL	Input
iboLightBarrierPlacingPos	BOOL	Input
iboBoxPicked	BOOL	Input
qboEnableVacuum	BOOL	Output
qr32Axis3ActualPosition	DWORD	Output

Axes not switched to simulation communicate via PROFIdrive telegrams at the following address areas:

Table 1-2: PROFIdrive telegrams

Variable	Data type	I/O address area
ConveyorBelt	PD_TEL1	260 … 263
Axis1	PD_TEL105	264 … 283
Axis2	PD_TEL105	284 … 303

The visualization of the plant is simulated with WinCC Runtime. In WinCC Runtime, the plant can be controlled via an HMI screen. The following functions are possible:

- Jog the conveyor belt
- Jog SCARA axes 1 – 3
- Activate automatic mode

SIMIT Unit

In the "Hardware in the Loop" scenario, the automation program is loaded into the real automation system. Whereby, the SIMIT Unit simulates the I/O signals of the controllers and signals from field devices, e.g. actuators and sensors. The SIMIT Unit so forms the interface between the automation hardware and the behavior model in SIMIT. The connection with PROFINET allows real-time simulation.

SIMIT

In SIMIT, the behavior model of the plant and the required couplings to further software are modelled. In this application example, a drive with three axes and a simple position transfer are simulated. For the simulation of the drive, there are telegram blocks that emulate the communication as well as the state machine of a real drive. This means that the programmer does not need to make any changes in the user program. The input and output area of the telegram must be interconnected appropriately to allow this communication. If the communication must not necessarily be performed with PROFIdrive telegrams, a simple position transfer is also possible. For this purpose, the associated axis in the TIA Portal is switched to simulation.

Because the software tools calculate with different base units, the various variables are converted in SIMIT. To analyze the behavior of the plant in a safe environment, fault scenarios can be simulated in SIMIT.

MCD

Based on the existing CAD data that was either created in NX12 or made available with an import, the kinematic model of the plant is modelled in the MCD. For this purpose, rigid and collision bodies are defined, joints created and operations programmed. The parameters set in the interface to SIMIT are specified via a signal adapter. The data exchange takes place via the shared memory coupling.

1.3 Components used

Note In this application example, only the SIMOTION D and the SIMIT Unit are used as hardware components. All other configured devices are simulated by the SIMIT Unit.

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

Table 1-3 Hardware and software components

Component	Quantity	Article number	Note
SIMATIC Field PG M5	1	6ES7717-.....-0...	Alternatively, another computer with TIA Portal V15 SP1 can also be used.
SIMOTION D425-2 DP/PN	1	6AU1 425-2AD00-0AA0	V5.2
KTP900 Basic	1	6AV2 123-2JB03-0AX0	V15.0.0.0
SINAMICS S120	1	6SL3 040-1MA01-0AA0	V4.8
PN/PN Coupler X1	1	6ES7 158-3AD00-0XA0	V01.00.00
STEP 7 Professional V15	1	6ES7822-1..05-..	-
SIMOTION SCOUT TIA V5.2 SP1	1	6AU1 810-..A52-1..0	-
SIMIT S V10	1	6DL8913-0AK00-0AB5	-
Mechatronics Concept Designer	1	NX11113, NON_PRODUCTIVE-Promotion	-

This application example comprises the following components:

Table 1-4 Components

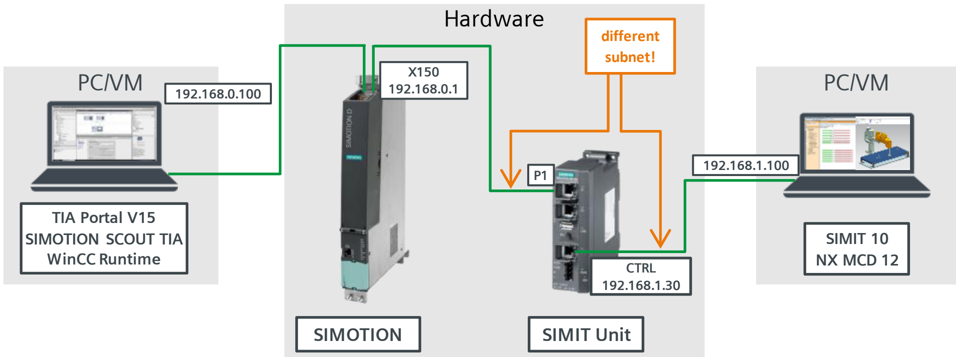
Component	File name	Note
Documentation	109758739_Documentation_HiL_en.pdf	-
STEP 7 project	109758739_HiL_STEP 7.zip	TIA Portal project (incl. SCOUT TIA)
SIMIT project	109758739_HiL_SIMIT.zip	
MCD project	109758739_HiL_MCD.zip	

2 Mounting and installation

2.1 Hardware configuration

The project example described in this application example is based on the network shown in the following figure. It is possible to execute the various programs on different computers or virtual machines (VM). The SIMIT and MCD programs, however, must be executed on the same computer or in the same VM. SIMIT Unit and SIMOTION are connected via the P1 port of the SIMIT Unit. The SIMIT computer and the SIMIT Unit are connected via the CTRL port.

Fig. 2-1 Hardware configuration



2.2 General settings

The SIMIT simulation system requires the hardware information about the devices to be emulated in order to configure the SIMIT Unit. This information is generated when compiling the hardware configuration in the TIA Portal in the form of system data blocks (SDB) or OMS files – and these are temporarily saved to the directory of the TIA Portal computer. SDB files are created for TIA Portal projects with a SIMOTION controller or an S7-300/S7-400 controller. OMS files are created for an S7-1500 controller.

In order that this data is permanently available, the Registry entries of the configuring computer must be adapted. If the TIA Portal and SIMIT are not located on the same computer, the SDB or OMS files must be transferred from the TIA Portal computer to the SIMIT computer.

The associated required work steps are explained in the following table. These steps are prerequisite for creating a new SIMIT project with a "Hardware in the Loop" solution.

Table 2-1: UnlockHWConfig

No.	Action
1.	In order that after compiling the hardware configuration, the SDB/OMS files are saved permanently in the directory of the TIA Portal computer, you must run the "UnlockHWConfig.exe" application once after installing TIA Portal. The application adapts the Registry entries appropriately. To do so, perform the following steps: 1. The application can be found in the installation directory for SIMIT at "[…]\SIMIT\SIMIT SF\data" 2. Start the "UnlockHWConfig.exe" application with administrator rights 3. Save and compile the hardware configuration in the TIA Portal 4. The SDB/OMS files are stored permanently in the following directory: a. TIA Portal (SCOUT TIA): "C:\Users\Public\Documents\TIAExport\HwConfiguration\DOWN" b. SCOUT: Temporary STEP 7 storage folder
2.	If TIA Portal and SIMIT are not installed on the same PC, you must transfer the SDB/OMS files from the PC with TIA Portal to the SIMIT PC. Also in this case, we recommend to copy the files to a local project directory.

3 Engineering

3.1 Task

In this application example, a jogging and an automatic mode should be implemented for a transport plant. To do this, a new SIMIT project should be created in which you create the required couplings and behavior model. The CAD data has already been prepared and can be found at

"[…]\109758739_HiL_MCD\HiL_Template\!MAIN_ASM_HiL_Template.prt"

In MCD, you must first kinematize the specified CAD model. The signals required for the coupling must also be created. Because this application example focuses on SIMIT and MCD, a fully programmed STEP 7 project is provided.
This project can be found at

"[…]\109758739_HiL_STEP 7\HiL_Solution\HiL_Solution.ap15"

We provide help for the configuring so you can master the required tasks. It also serves as a sample solution for each software tool for both stages. These projects are always in subfolder

"[…]\HiL_Solution"

You can also orient yourselves on these sample solutions.

3.2 Configuration in TIA Portal

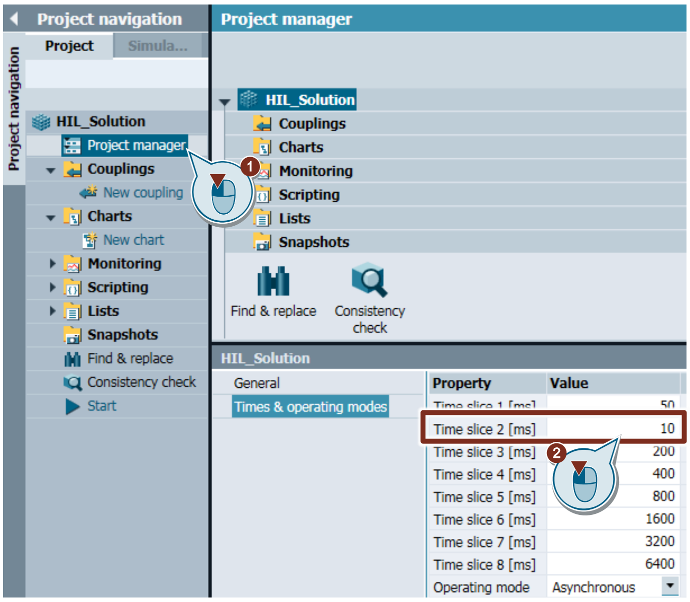
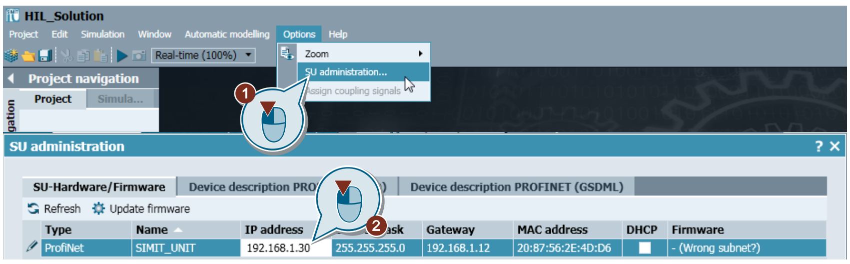
The supplied SIMOTION SCOUT TIA project does not require any further configuration. If you want to create your own project, you must observe the following points:

- For real, non-simulated axes, it can be necessary to set the gain of the axis position controller to a lower value. The reason is the asynchronous communication between MCD – SIMIT – SIMOTION. This can cause a falsified controller behavior.
- For simulated or virtual axes, the actual position calculated in the SIMOTION is copied to an output double-word. To do this, the associated parameter of the axis must be converted from LREAL to DWORD.

3.3 Configuring in SIMIT

3.3.1 General settings

Table 3-1: General SIMIT settings

No.	Action
1	1. Double-click "Project manager". 2. Enter 10 ms in time slice 2. 
2	1. Open in the "Options" menu the "SU administration" in SIMIT. 2. Assign for the SIMIT Unit the associated IP address for the CTRL port. In the application example, this is 192.168.1.30. 3. Confirm the input with the Enter key. 4. Restart the SIMIT Unit. If the SIMIT Unit is located in the same subnetwork as the PC, the current firmware is displayed. 

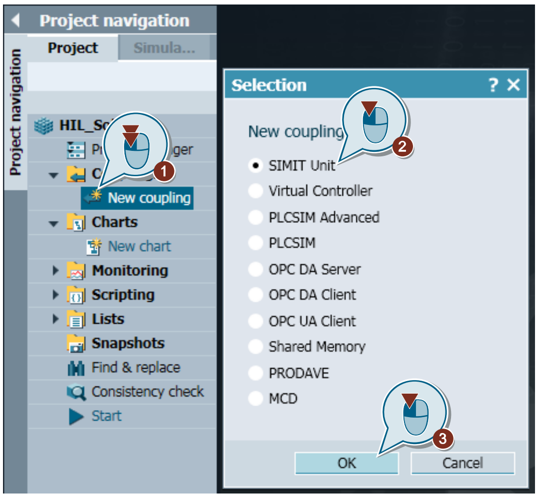
Note

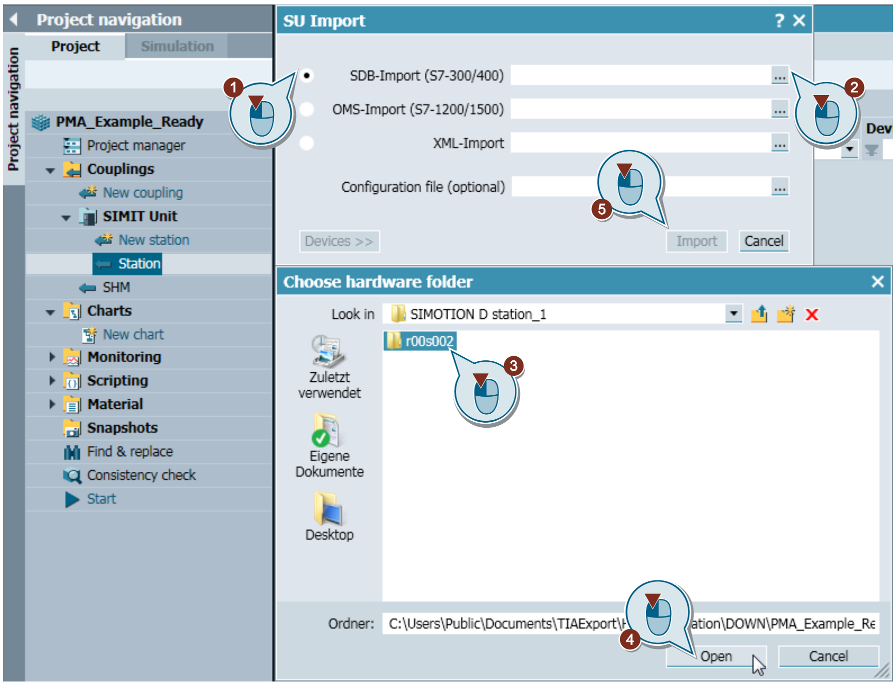
If the SIMIT Unit is not displayed in the SU management or "Incorrect subnet?" is still displayed after execution of the previous steps, the following steps can rectify this situation:

- Ensure that the SIMIT PC is connected with the CTRL port of the SIMIT Unit.
- Check the network settings of your network adapter.
- Check the firmware of the SIMIT Unit.
- If several network cards are active in Windows, deactivate all network connections in the System settings, except that with which you are connected on the CTRL port of the SIMIT Unit. Once you have successfully established the connection, the connections can be reactivated.

3.3.2 SIMIT Unit coupling

Table 3-2: SIMIT Unit coupling

No.	Action
1	1. Double-click "New coupling". 2. Select "SIMIT Unit". 3. Confirm with "OK". 4. Assign a name and confirm with Enter. 

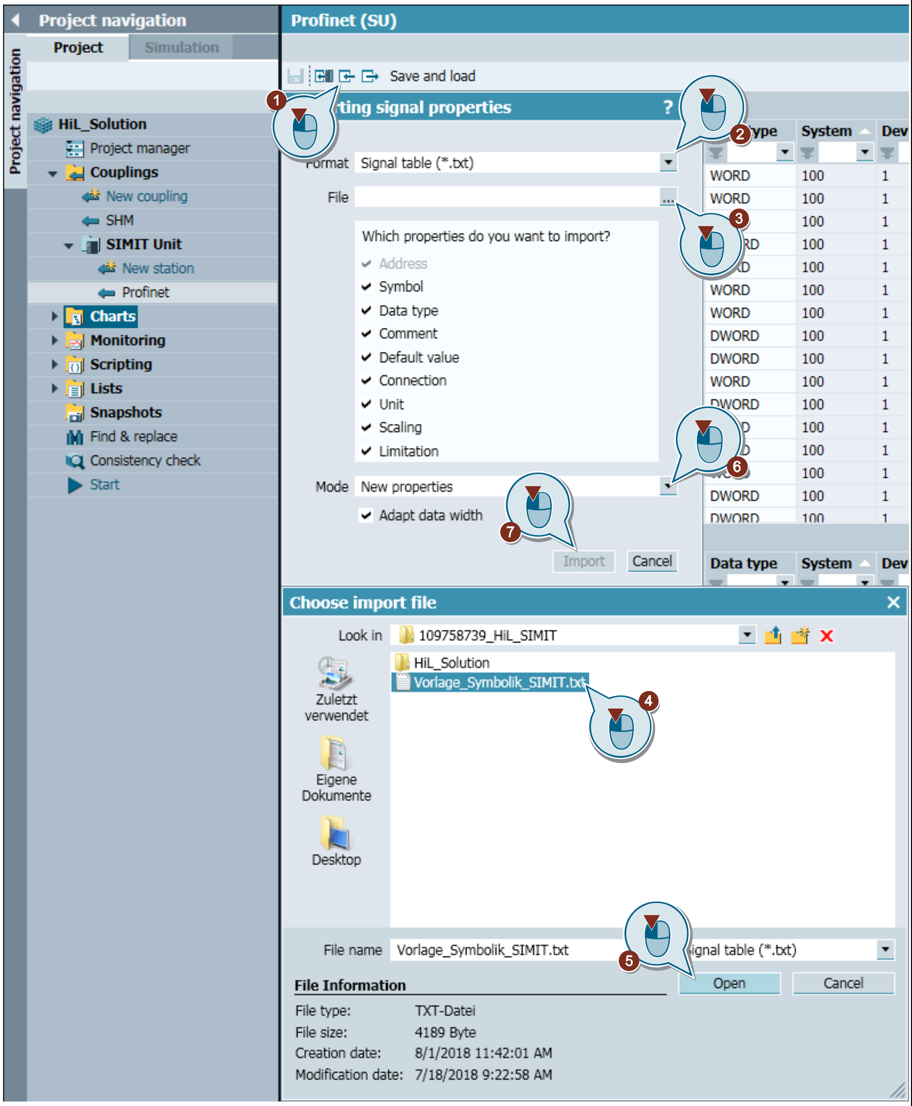
No.	Action
2	1. After confirmation with Enter, a new window opens. Click "SDB-Import" and open the file browser. 2. Open the file browser. 3. Select the last subfolder (see Table 2-1: UnlockHWConfig). 4. Open the folder by clicking "Open". 5. Start the import by clicking "Import". 

<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>3</td><td>

1. Because no symbols are created when importing the SDB/OMS files, it must be exported subsequently as text file.
To do this, click the "Import" symbol.
2. Then select "Signal Table".
3. Open the file browser.
4. Navigate to the required file.
5. Confirm with "Open".
6. If necessary, adapt the import mode.
7. Start the import by clicking "Import".

Note:

A text file located in the SIMIT sample solution folder serves as template for this import. For other projects, you need to adapt only the symbols, the data type and the address area. Alternatively, the symbols can be specified manually in SIMIT.
If necessary, adapt the address areas (see Step 5).



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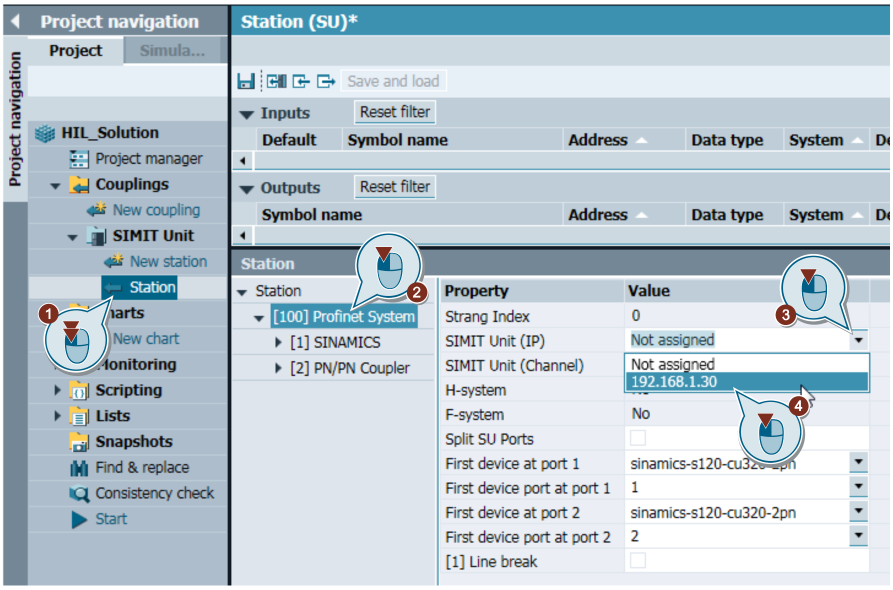
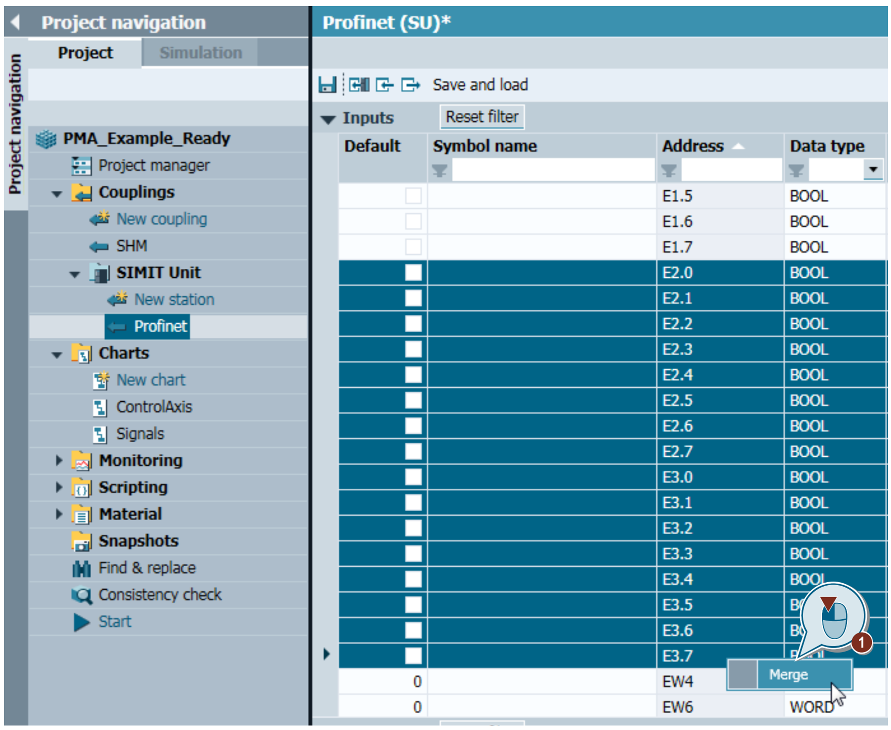
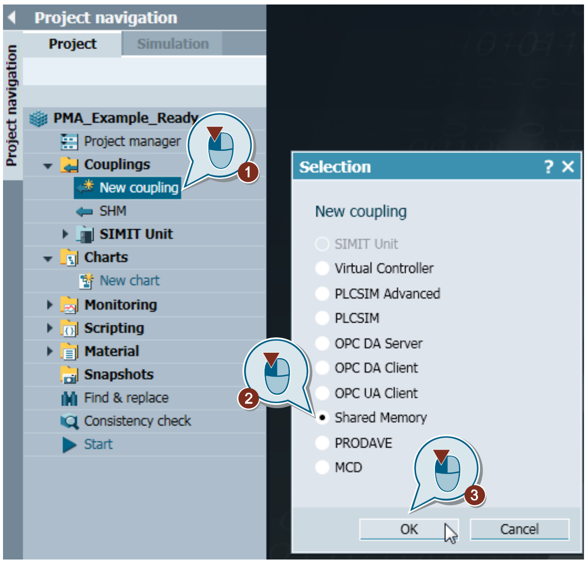
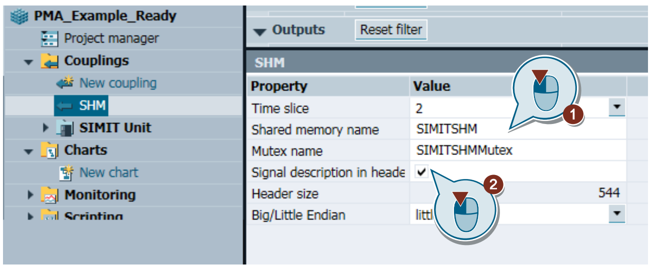
</table>

No.	Action
4	1. In the last step, you must assign the associated SIMIT Unit. To do this, double-click the imported station in the "SIMIT Unit" coupling. 2. Select the PROFINET system. 3. Open the "SIMIT Unit (IP)" tab. The system now searches automatically for available SIMIT Units. 4. Select your configured SIMIT Unit. 
5	1. To adapt the address areas, mark the required area and click "Merge". To separate address areas, proceed accordingly. 

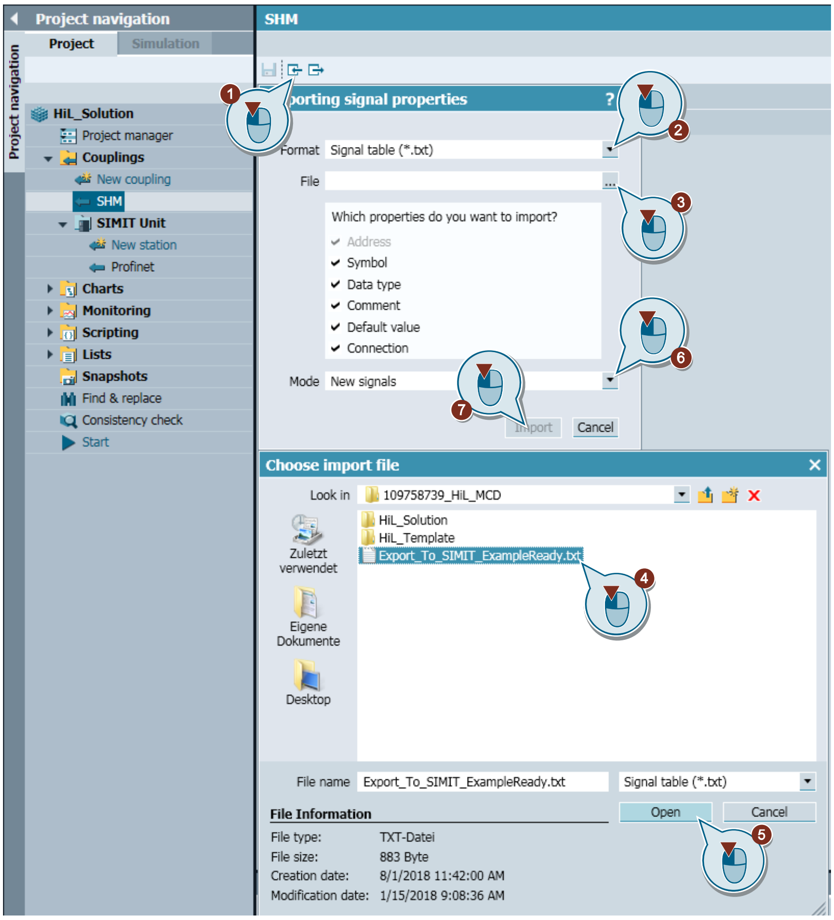
3.3.3 Shared memory coupling

Table 3-3: Shared memory coupling

No.	Action
1	1. Double-click "New coupling". 2. Select "Shared memory" in the selection window. 3. Click "OK" to confirm the selection. 
2	1. Assign a name for the shared memory coupling, e.g. "SIMITSHM". 2. Activate the "Signal description in header" checkbox. 

To import the variables that communicate with MCD via the SHM coupling, a text list is selected. This must be exported from MCD previously (see Section 3.4.9).

Table 3-4: Importing variables

No.	Action
1	1. Click the "Import" symbol. 2. Select the "Signal table" format. 3. Open the file browser. 4. Select the required text file. 5. Click the "Open" button to confirm. 6. Select the import mode. 7. Start the import by clicking the "Import" button. 

3.3.4 Creating a behavior model

In SIMIT, behavior models are programmed graphically in "Charts". A chart with predefined or self-defined components and controls is created in the chart editor.

The components for various logical and arithmetic functions, for drives, sensors, connections and communication are located on the "Components" task card at "Basic components".

“User components” contains “Global components” that were stored at „C:\ProgramData\Siemens\Automation\SIMIT\8.0\FULL\components“. Furthermore you can add any library directory.

"Project components" contains the self-defined components that were stored previously in the project folder at "[…]\pcomp".

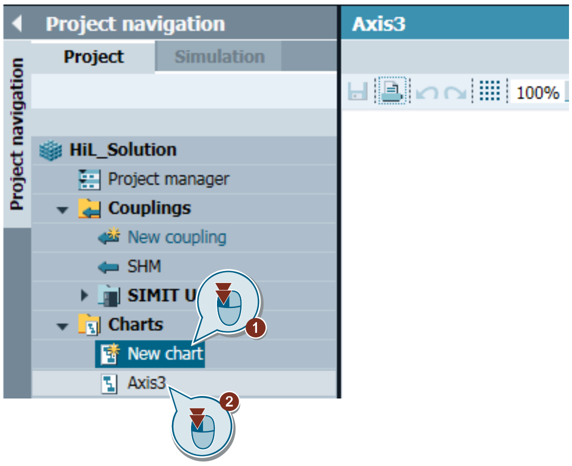
The associated objects for entering and displaying values are located on the "Controls" task card. "Display" contains objects for the dynamic display of values from a running simulation. The "Input" area contains objects for specifying values in a running simulation.

Note Self-defined components are developed with the SIMIT component type editor (CTE) and included via the project library or via user components.

Behavior model for axis 3

The technology object for axis 3 is operated with active simulation and the simulated actual position is copied to a double-word in the output address area of the controller. This double-word must now be converted in SIMIT to a REAL value and sent to MCD via the SHM coupling. To do this, proceed as follows:

Table 3-5 Axis 3 behavior model

1.	1. To add a new chart, double-click "New chart". 2. Assign an appropriate name, confirm with Enter and open the chart. 

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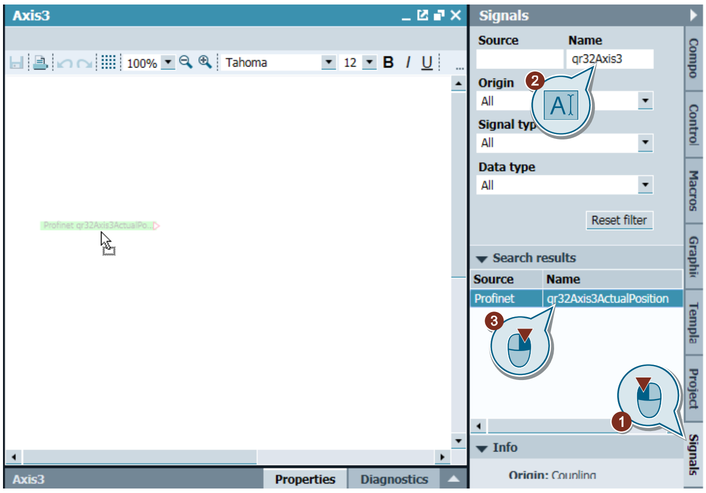
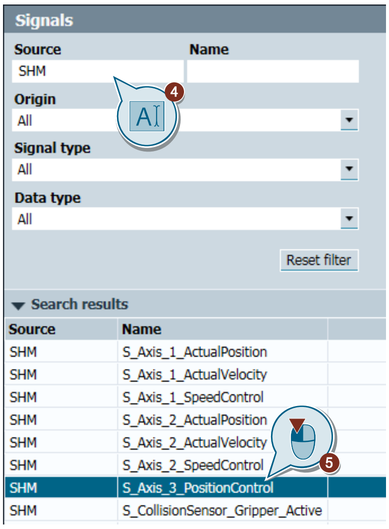
<tr><td>2.</td><td>

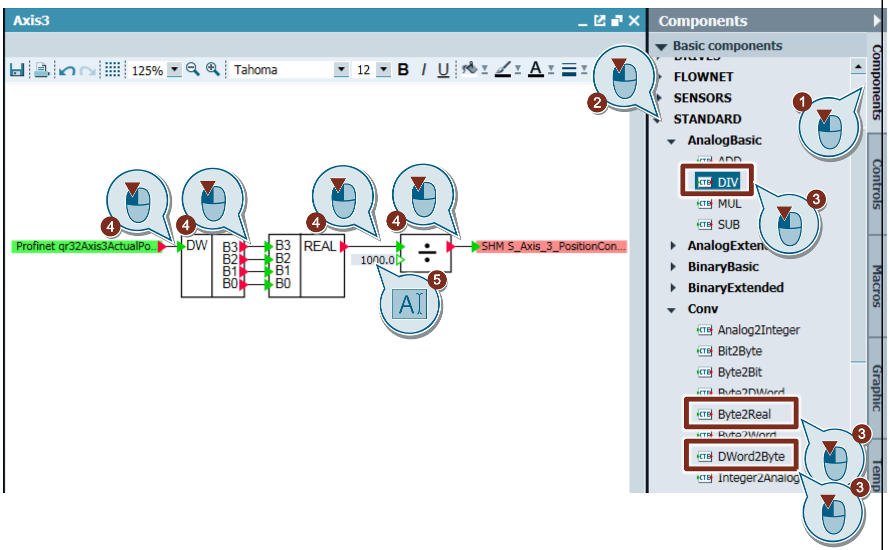
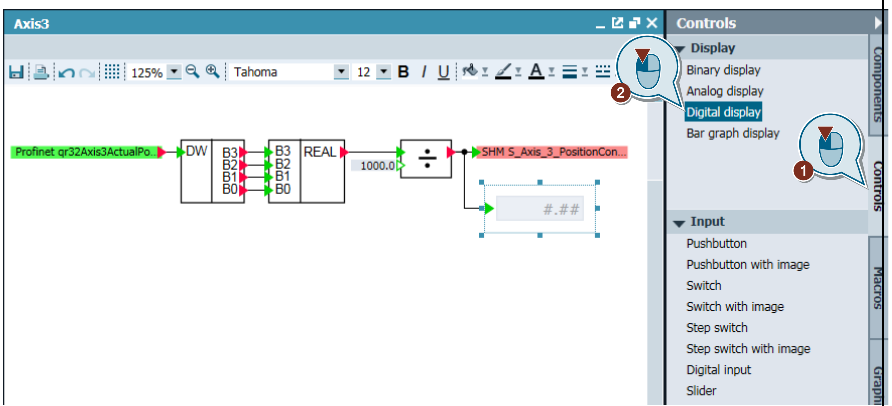
1. All signals of the project can be found in the "Signals" task card.
2. Filter according to the "qr32Axis3ActualPosition" variable.
3. Mark the required signal. Keep the Shift key pressed and drag-and-drop the signal to the chart.



4. You can also search according to the source.
5. The signal for the position of axis 3 in the shared memory coupling is called "S_Axis_3_PositionControl". Drag the signal to the chart.



</td></tr>
</table>

3.	The position of axis 3 is converted in SIMOTION to a DWORD so it can be written to the output address. MCD expects the position for the position controller, but as REAL. SIMOTION also sends the position in millimeters. MCD, however, expects the position in meters. Consequently, the value must be converted in SIMIT: 1. The "Components" task card contains comprehensive libraries for behavior modelling. 2. The STANDARD library contains the components required for the conversion. 3. Drag the components to the chart. 4. Interconnect the components with the mouse. 5. Enter 1000.0 in the second input of the DIV component. 
4.	1. The "Controls" task card contains the blocks for displaying and entering signals at the simulation runtime. 2. Add a digital display that shows the position of axis 3 at runtime. 

Behavior model for axes 1 and 2

The technology objects for axes 1 and 2 are not operated in simulation. The technology objects so communicate with the associated PROFIdrive telegrams via PROFINET addresses. This requires that a behavior model of the PROFIdrive drives is created in SIMIT. You can build the behavior model of various PROFIdrive drives from the components of the DRIVES/PROFIdrive library. In this example, PROFIdrive telegram 105 is used for axes 1 and 2. An overview of the telegrams that can be simulated is contained in the SIMIT V10 manual.

Table 3-6 Axis 1 behavior model

<table>
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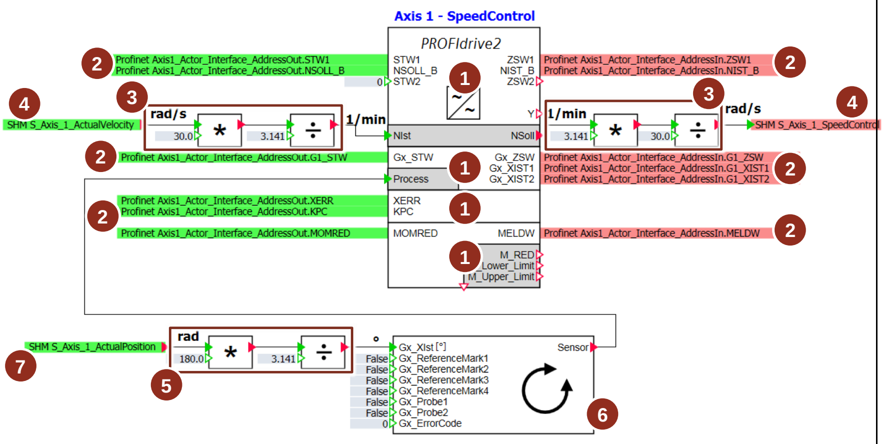
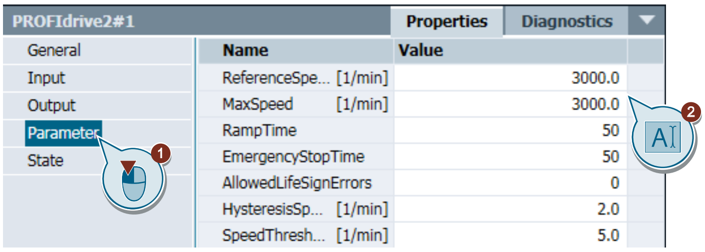
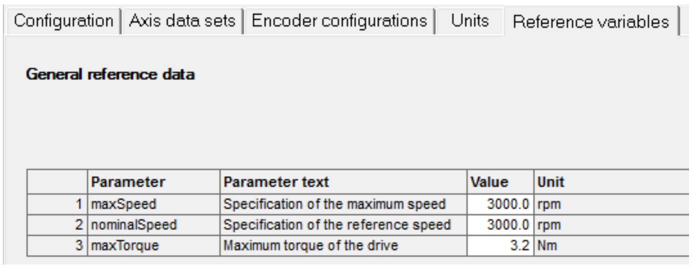
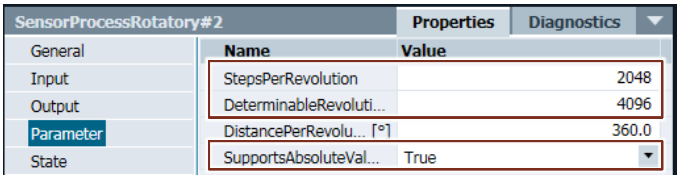
<tr><td>1.</td><td>

Drag the "PROFIdrive2", "Sensor", "DynamicServoControl" and "MomentumReduction" project components to your chart, and interconnect them as shown here.
Interconnect all telegram signals of axis 1 to the associated inputs and outputs of the telegram component. In STW2 and ZSW2, the sign-of-life is exchanged between the drive and the controller. The asynchronous simulation, however, allows the sign-of-life to be transferred non-deterministically in each bus cycle. The monitoring of the sign-of-life in the telegram block is most easily suppressed by not interconnecting the STW2 and ZSW2 signals.
The setpoint speed and the actual speed at the telegram block are specified in rpm. MCD, however, expects the rad/s unit here. Consequently, add the required conversions.
Interconnect the signals of the SpeedController from MCD for axis 1 from the SHM coupling with the setpoint speed or actual speed.
The actual position comes from MCD in the rad unit and should be interconnected at the telegram block in the degree unit. Add the required conversions.
A rotary encoder is implemented at axis 1. Consequently, add the "SensorProcessRotatory" component to your chart and interconnect its "Sensor" output with the "Process" input of the "Sensor" component.
Interconnect the actual position from the SHM coupling with the "SensorProcessRotatory" component.



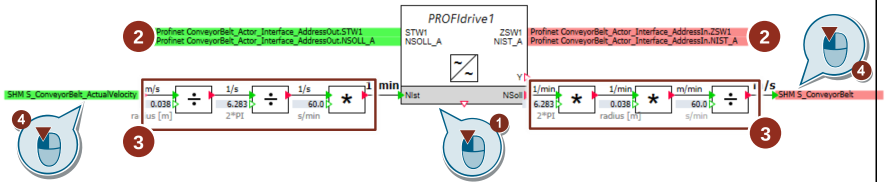
</td></tr>
</table>

2.	In addition to the inputs and outputs, the individual telegram components also have parameters. They must be set correctly in the block properties and match the parameters of the axis in TIA SCOUT. To adapt the parameters, proceed as follows: **PROFIdrive2 component:** 1. Open the properties of the PROFIdrive2 block in your chart whose values you want to change by marking the block. Select the "Parameter" folder. 2. Adapt the "ReferenceSpeed" and "MaxSpeed" to the reference data from their technology object.   **SensorProcessRotatory component:** 1. Adapt the parameters marked red of the encoder configuration.  

Behavior model for the conveyor belt

The technology object for the conveyor belt is operated as speed axis with PROFIdrive telegram 1 in the TIA SCOUT. Use the "PROFIdrive1" component from the DRIVES/PROFIdrive library for the behavior model of this drive in SIMIT:

Table 3-7 Behavior model for the conveyor belt

1.	1. Drag the "PROFIdrive1" component to your chart. 2. Interconnect all telegram signals of the conveyor belt to the associated inputs and outputs of the telegram component. 3. The setpoint speed and the actual speed at the telegram block are specified in rpm. This rotary movement must be converted to the linear movement of the conveyor belt in the m/s unit. Consequently, add the required conversions. 4. Interconnect the signals of the conveyor belt from MCD from the SHM coupling with the setpoint speed or actual speed. 

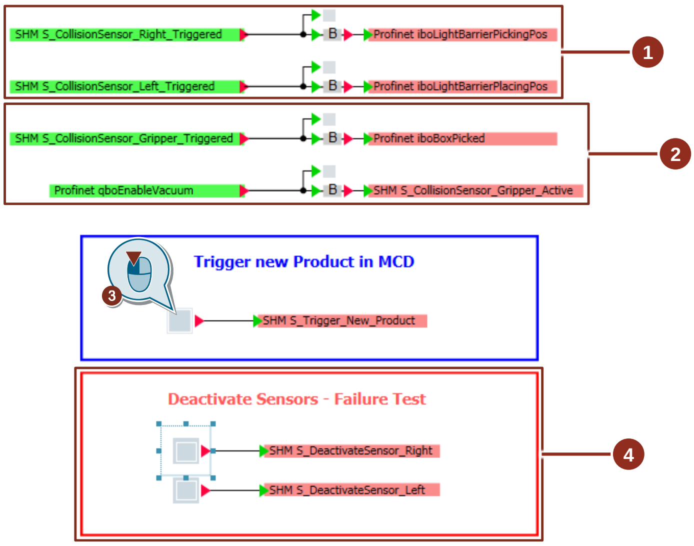
Other signals for the simulation

In addition to the behavior models for the drives, the signals of the sensors from MCD must also be connected with the associated input variables of the PLC in SIMIT. The vacuum of the gripper should also be controlled via an output variable of the PLC. To do this, the output variable must be connected with the correct signal from the SHM coupling. The correct interconnection of the signals is shown below:

Table 3-8 Other signals in SIMIT

<table>
<tr><th></th><th></th></tr>
<tr><td>1.</td><td>

1. Connect the light barriers on the conveyor belt with the associated controller inputs. The "BConnector" component for connecting two binary signals can be found in the component library at STANDARD/Misc.
2. Connect the gripper signals with the appropriate input/output of the PLC.
3. Add a pushbutton from the "Controls" task card to control the creation of new products in the MCD.
4. Implement fault scenarios. For example, cause the light barriers in the MCD project to fail. To do this, use a "Switch".



</td></tr>
</table>

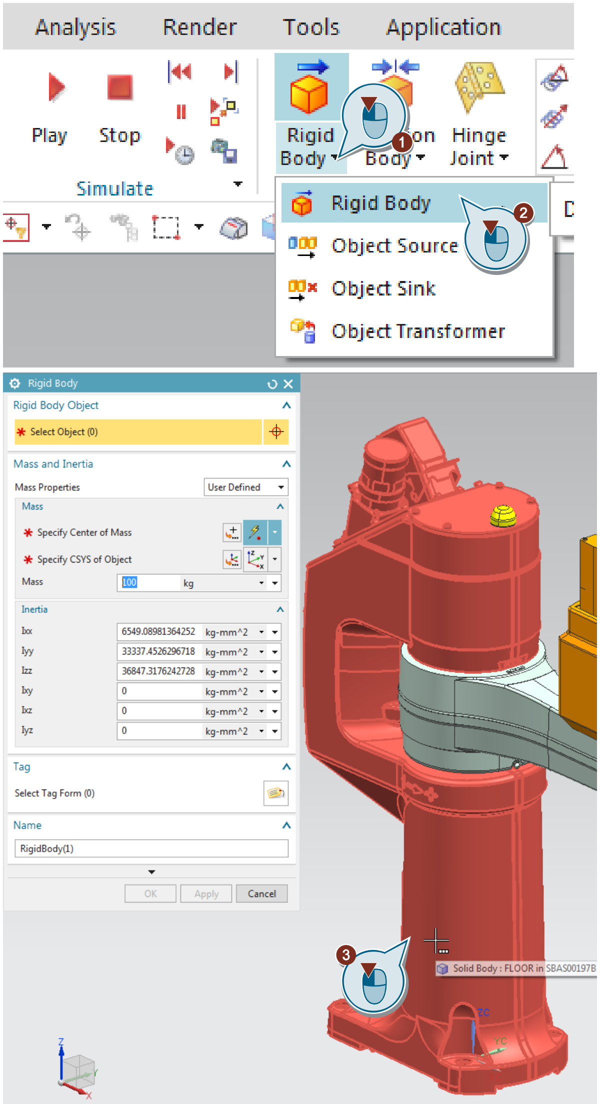
3.4 Configuration in MCD

To kinematize your CAD model in the MCD, among other things, rigid bodies, collision bodies, joint connections and operations must be configured. The following sections provide general descriptions how the elements are configured. To make movements possible in the MCD, the moving parts must first be defined as rigid body. The rigid bodies can then be connected with joint connections to form a kinematic chain. To affect the movements of the joint, speed and position controllers are implemented. They are linked in a signal adapter with signals from the SHM coupling so that the movement can be controlled from SIMIT. For example, collision sensors can be simulated with light barriers.

3.4.1 Creating a rigid body

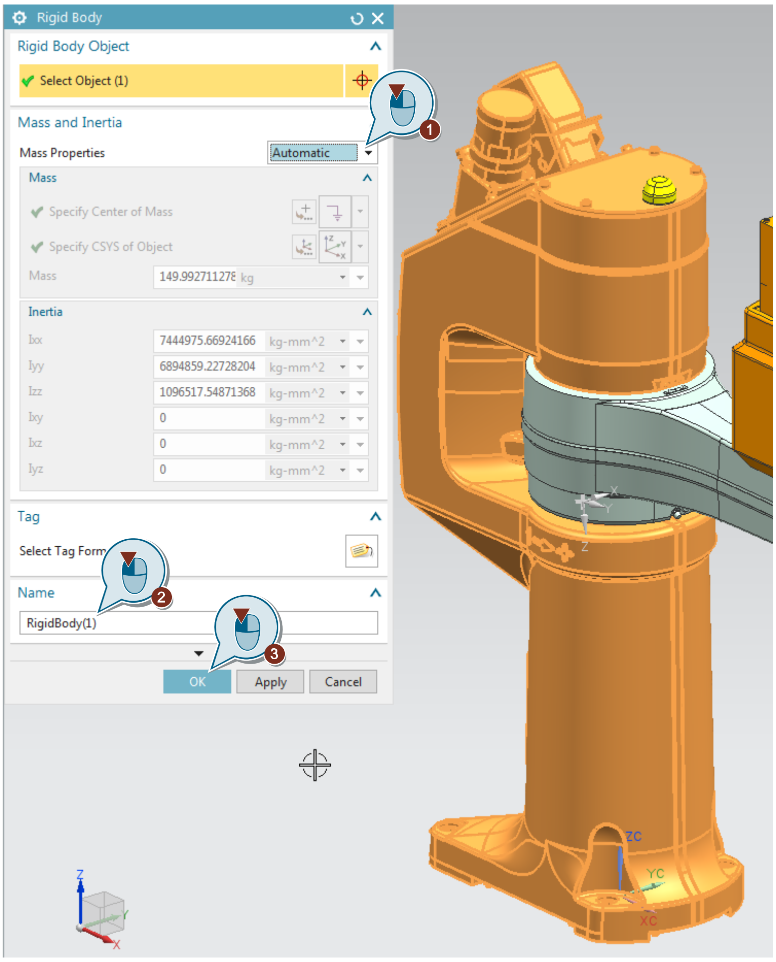
Use the "Rigid Body" command to define a component as movable component. A rigid body is an element that acts as mass and responds to forces such as gravitational force in your simulation.

Table 3-9: Creating a rigid body

No.	Action
1	1. Open the "Rigid Body" drop-down list 2. Select "Rigid Body". 3. First, select the required object. If you move the cursor over an object, the object is marked red. Clicking the object accepts the object as rigid body. 

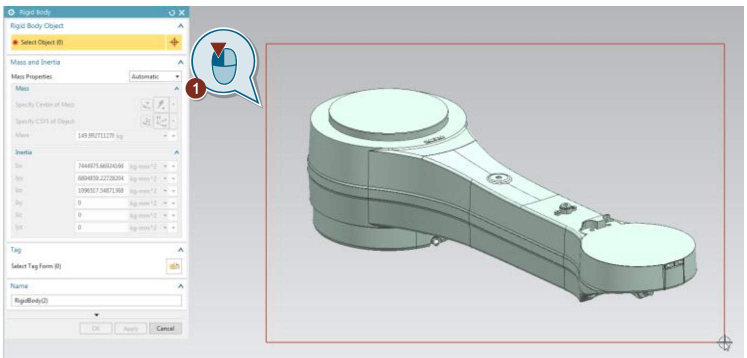
<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>2</td><td>

1. Select "Automatic" at "Mass Properties". The mass and the moment of inertia are so calculated automatically.
2. Assign a name for the rigid body.
3. Confirm the inputs with "OK".



</td></tr>
<tr><td>3</td><td>

1. In some cases, it is possible that the rigid body cannot be selected automatically. Objects can also be selected by selecting multiple "Faces". To do this, keep the left button pressed and stretch a rectangle over the required elements.

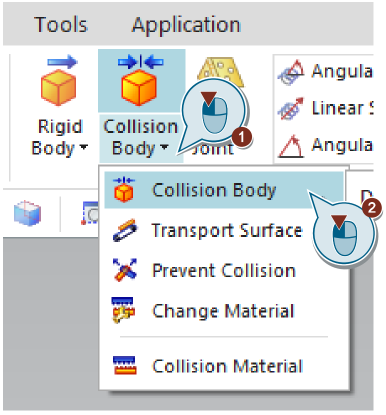
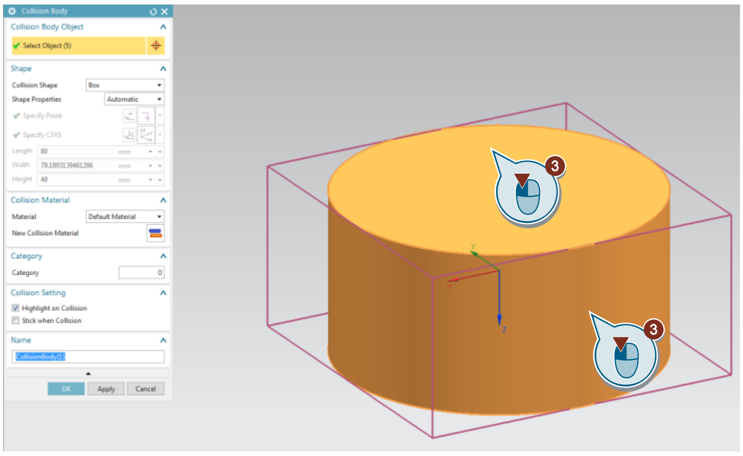


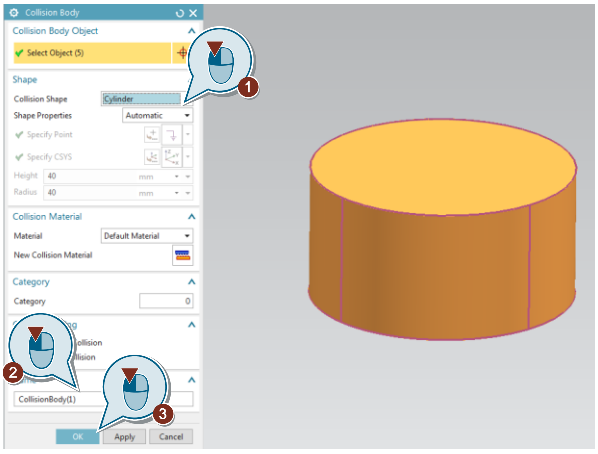
</td></tr>
</table>

3.4.2 Creating a collision body

Use the "Collision Body" command to specify how elements collide with other elements that also have a collision body. Objects without collision body penetrate other objects.

Table 3-10: Creating a collision body

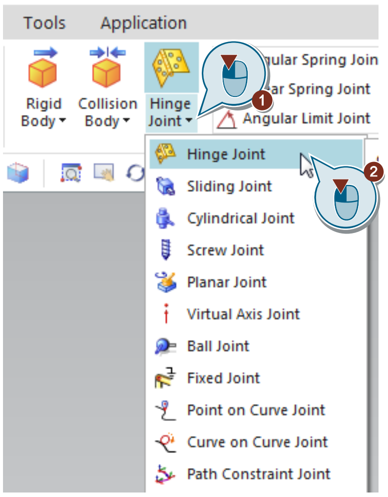
No.	Action
1	1. Open the "Collision Body" drop-down list. 2. Select the "Collision Body". 3. Select the required faces that should be combined to form a collision body.  

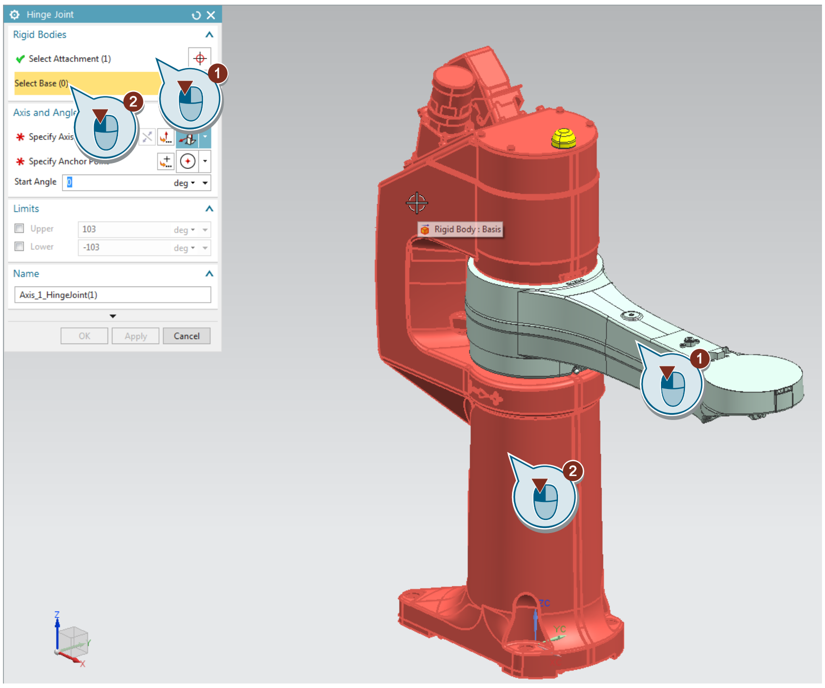
No.	Action
2	1. Select at "Collision Shape" the degree of detail of the collision body. The higher the degree of detail, the greater the computing time during the simulation. 2. Assign a name. 3. Confirm the inputs with "OK". 

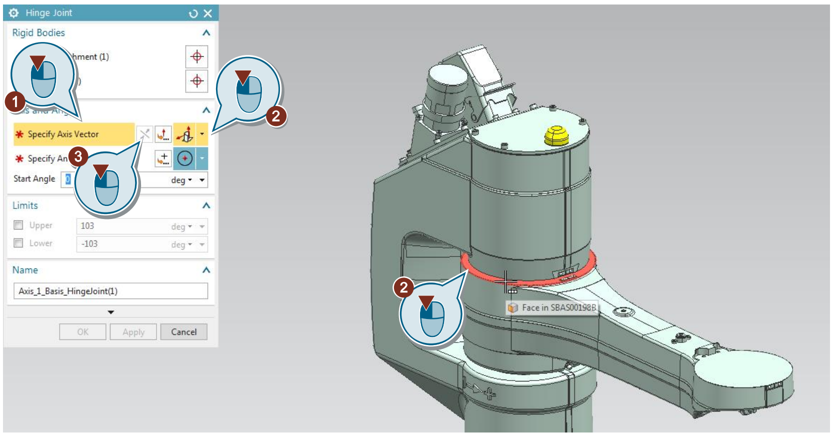
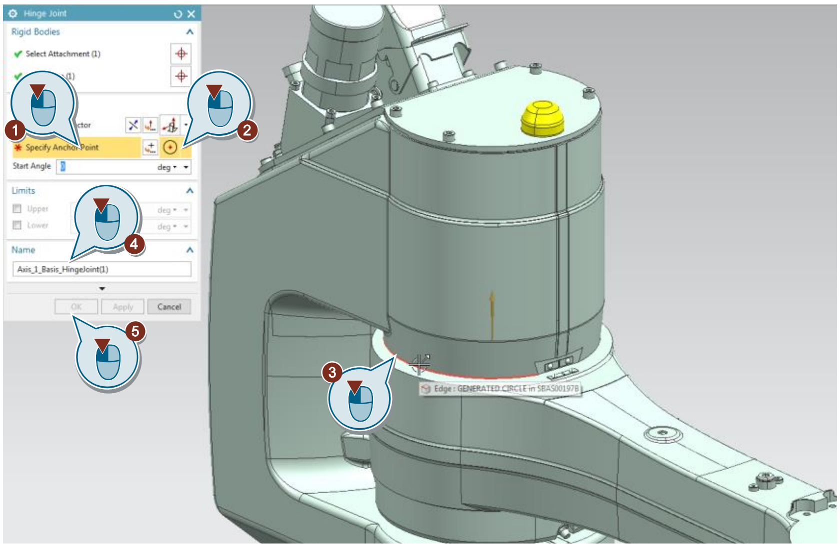
3.4.3 Creating a hinge joint

Use the "Joint Connection" command to create a connection between two bodies that permits a rotation degree of freedom along an axis. A hinge joint does not permit any translation movement in any direction between the two bodies.

Table 3-11: Creating a hinge joint

No.	Action
1	1. Open the "Hinge Joint" drop-down list. 2. Select the "Hinge Joint". 

No.	Action
2	1. Select the "Attachment" of the joint connection. 2. Select the "Base" of the joint connection. You can select both objects either via the "Physics Navigator" or directly in the 3D view. 

No.	Action
3	1. For a hinge joint, you require a vector for the direction of rotation and a defined point for this vector. In this scenario, select a face normal and the center point of a circle. 2. Select via the "Face/Plane Normal" drop-down menu and then the required face. 3. You can change the direction of rotation by clicking the "Reverse Direction" button. 
4	1. Mark "Specify Anchor Point". 2. For the circle center point, select "Arc/Ellipse/Sphere Center" via the the drop-down menu. 3. Then select the appropriate partial circle. 4. Assign a name. 5. Confirm the inputs with "OK". 

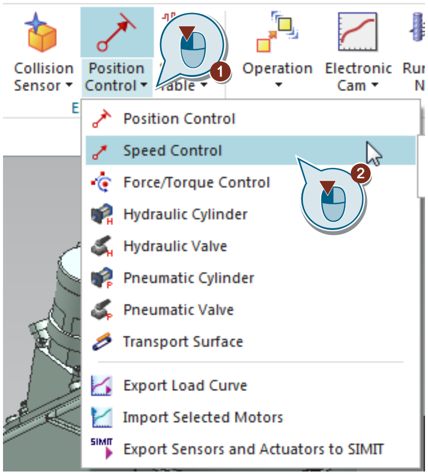
3.4.4 Creating a speed controller

Use the "Speed Control" command to create an actuator that specifies the movement of an axis defined by the joint at a predefined constant speed. Use the "Speed Control" command with a transport user interface to create conveyor systems.

Table 3-12: Creating a speed controller

<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>1</td><td>

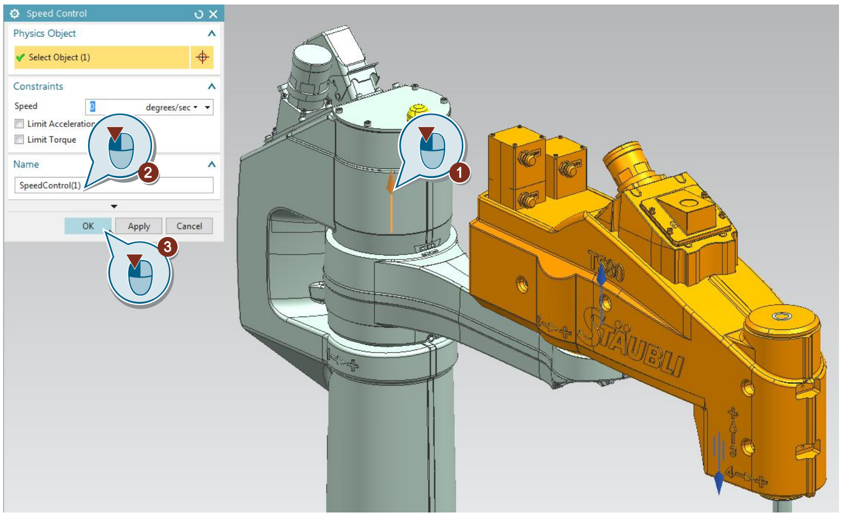
1. Open the "Position Control" drop-down list.
2. Select "Speed Control".



</td></tr>
<tr><td>2</td><td>

1. Select the required axis (that you kinematized with a joint connection previously).
2. Assign a name.
3. Confirm your inputs with "OK".

Note: Proceed accordingly for configuring a "Position Control".

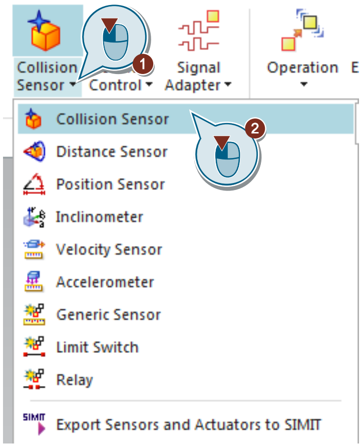
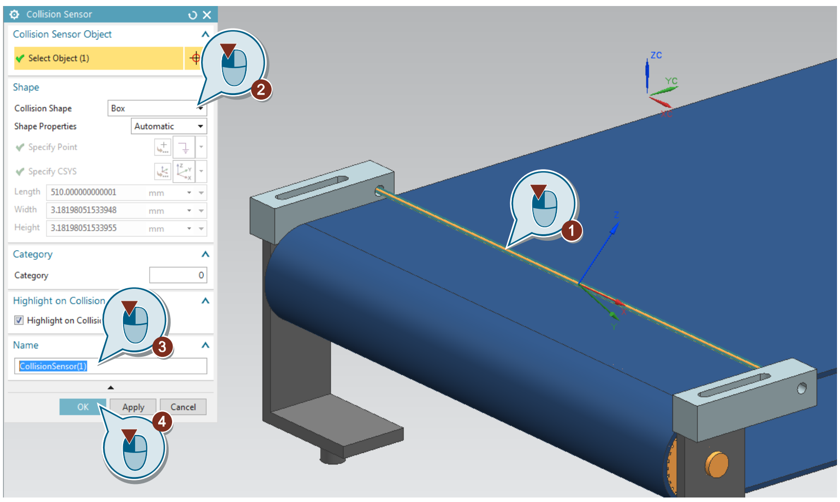


</td></tr>
</table>

3.4.5 Creating a collision sensor

Add a collision sensor to the geometry to receive a feedback about the interaction of bodies during a simulation.

Table 3-13: Creating a collision sensor

No.	Action
1	1. Open the "Collision Sensor" drop-down list. 2. Select "Collision Sensor". 
2	1. Select the required face. 2. Select 3. Assign a name. 4. Confirm the inputs with "OK". 

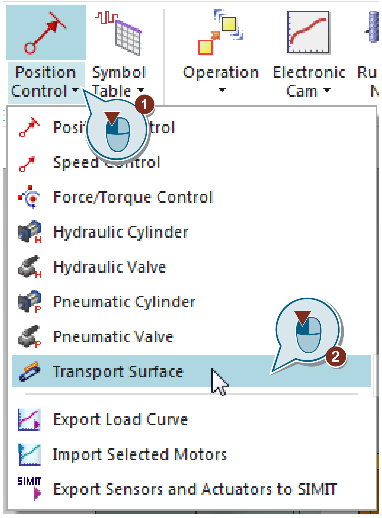
3.4.6 Creating a transport surface

The "Transport Surface" command adds a physical property that converts each selected flat surface on a conveyor belt. You can use the transport surface to move geometries along a straight path or a curved path on a flat surface.

Table 3-14: Creating a transport surface

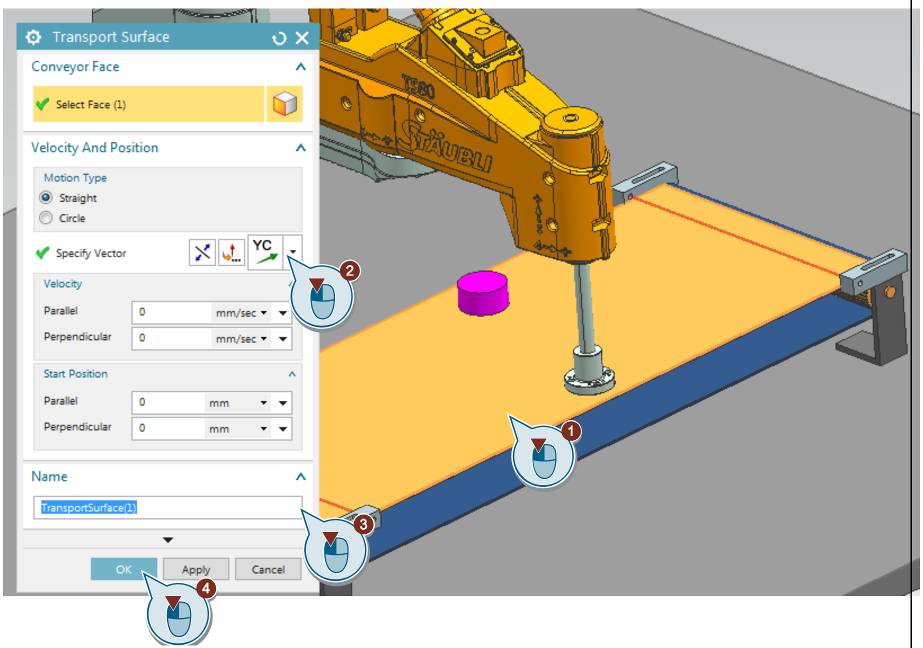
<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>1</td><td>

1. Open the "Position Control" drop-down list.
2. Select "Transport Surface".



</td></tr>
<tr><td>2</td><td>

1. Select the required object.
2. Specify the vector for the movement on the transport surface.
3. Assign a name.
4. Confirm the inputs with "OK".

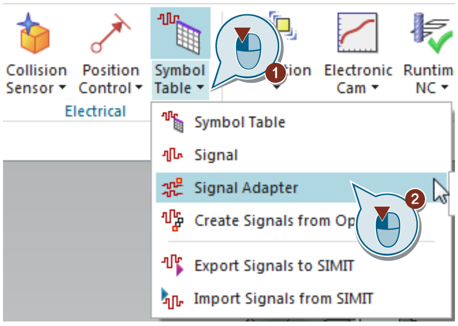


</td></tr>
</table>

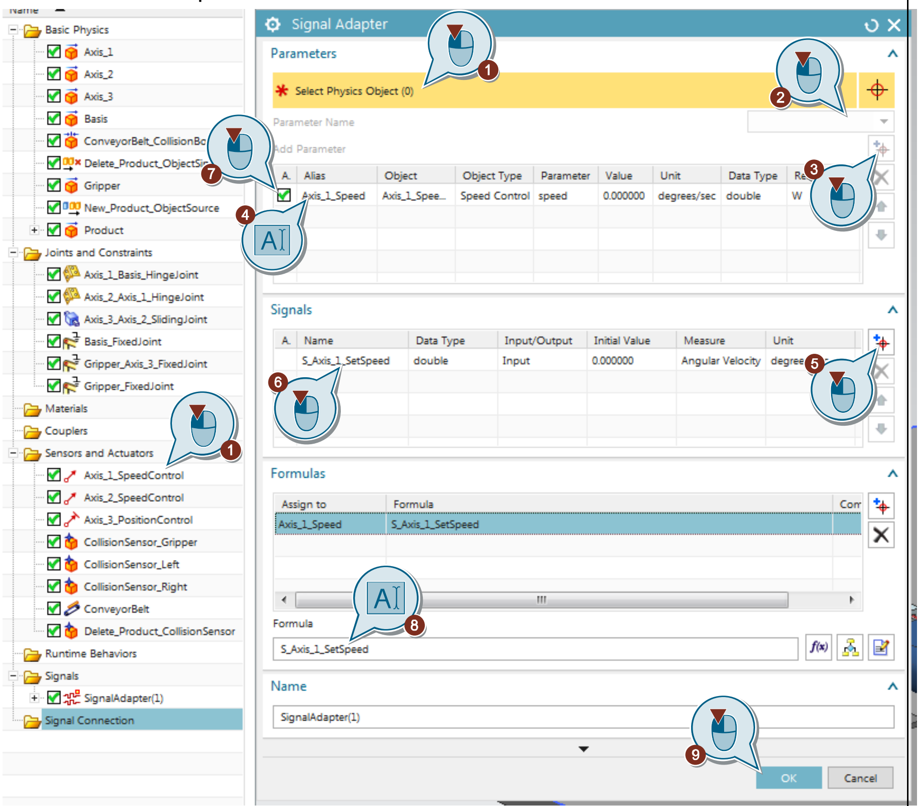
3.4.7 Creating a signal adapter

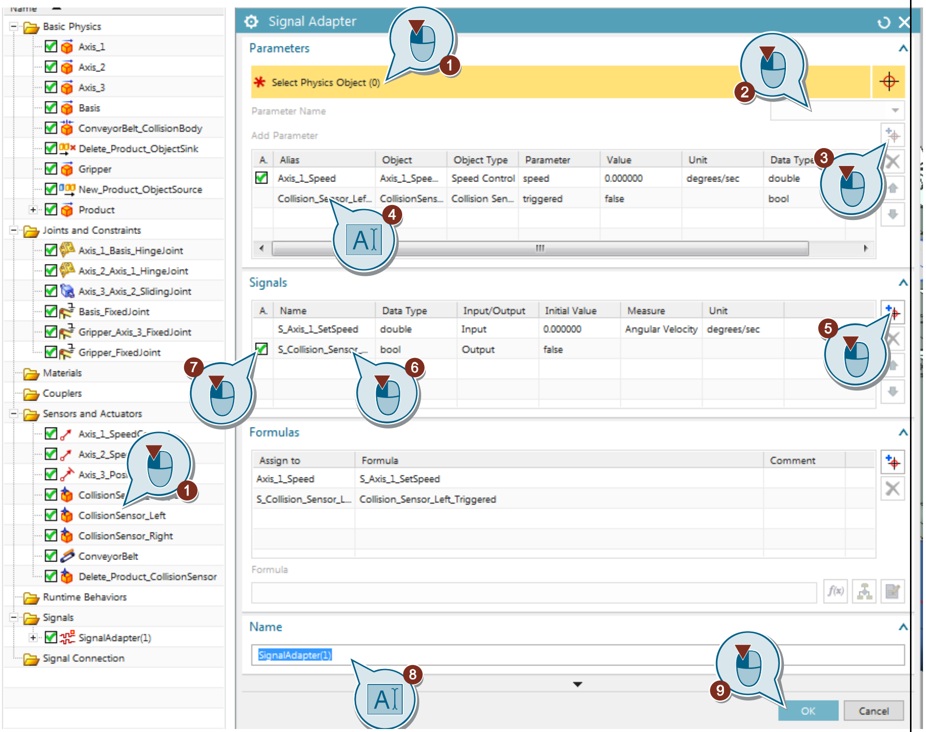
Use the signal adapter to connect runtime parameters and signals. A signal adapter can have multiple signals and parameters. Signals can be used to connect with external signals, e.g. via an SHM coupling. Add a signal adapter for all parameters that you write to SIMIT or control from SIMIT.

Table 3-15: Creating a signal adapter

No.	Action
1	1. Open the "Symbol Table" drop-down list. 2. Select "Signal Adapter". 

No.	Action
2	**Procedure for an input signal** 1. First select the sensor or actuator. 2. Select the parameter, e.g. "speed". 3. Add the parameter. 4. Assign a name. 5. Add a new signal. 6. Assign a name and select the signal properties, e.g. "Data Type": "double", "Input/ Output"): "Input". 7. To interconnect parameters and signals, first select the parameter. 8. Then enter the appropriate signal in the "Formula" line and press Enter to accept the formula. 9. Confirm the inputs with "OK".

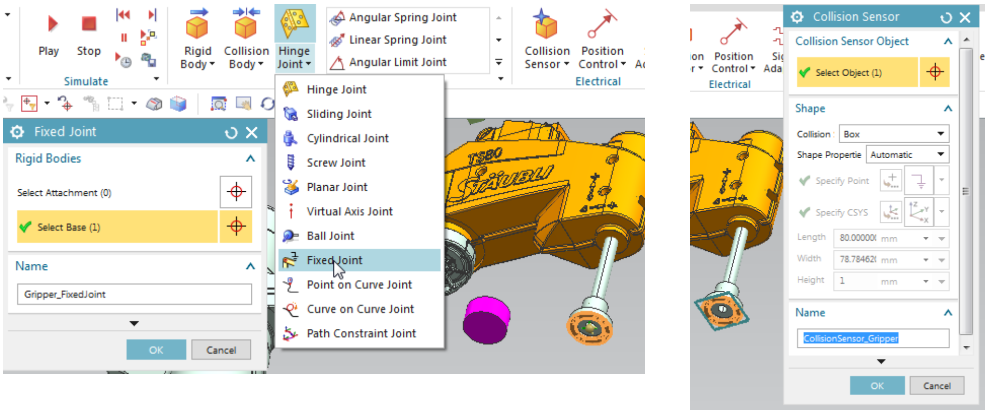


No.	Action
3	**Procedure for an output signal** 1. First select the sensor or actuator. 2. Select the parameter, e.g. "triggered". 3. Add the parameter. 4. Assign a name. 5. Add a new signal. 6. Assign a name and select the signal properties, e.g. "Data Type": "bool", "Input/Output": "Output". 7. To interconnect parameters and signals, first select the signal. 8. Then enter the appropriate parameter in the "Formula" line. 9. Confirm the inputs with "OK". 

3.4.8 Creating an operation

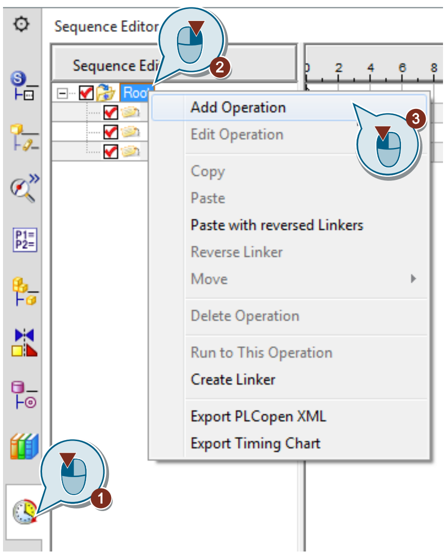
Conditional "Operations" can be defined in MCD. Such operations are executed during the simulation and can so emulate a required behavior. In this application example, the workpiece must be lifted and placed on the opposite side of the conveyor belt. This requires that a "Fixed Joint" is created for the receiving module whose attachment is initially unoccupied:

Fig. 3-1 Fixed joint and collision sensor for Pick&Place operation

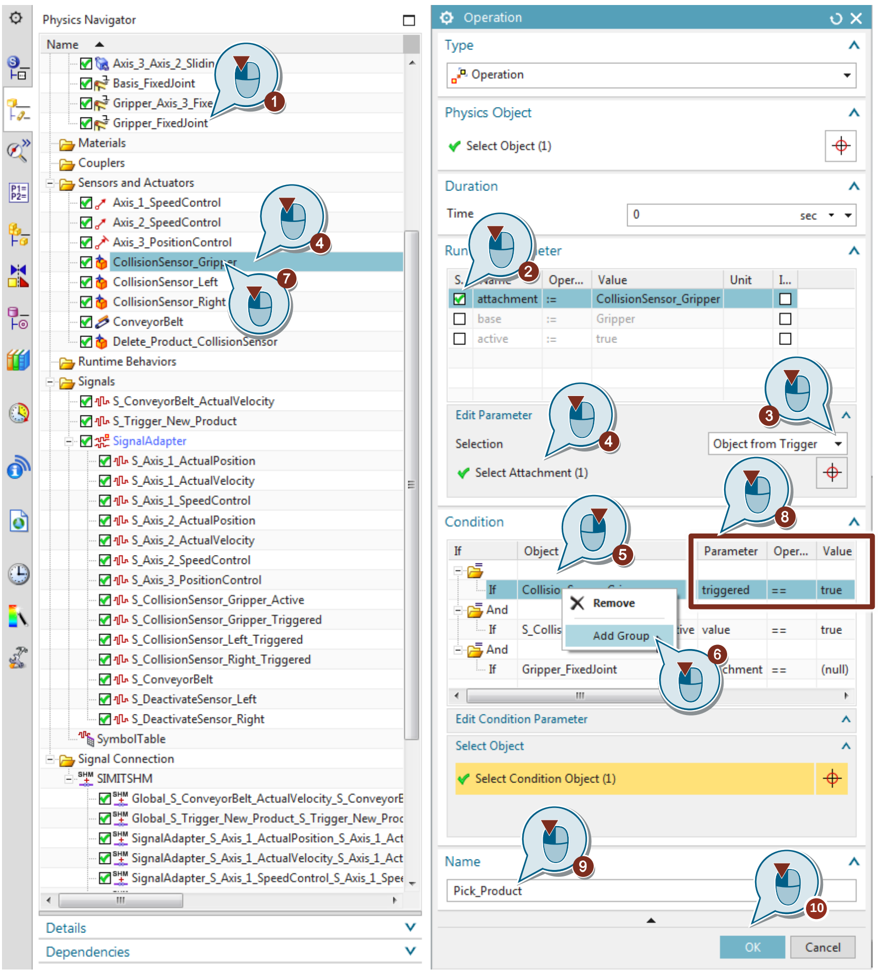


During the simulation, an attachment is now added when specific conditions are satisfied. For the Pick&Place process, an associated collision sensor is also placed on the receiving module. To create an operation, proceed as follows:

Table 3-16: Creating an operation

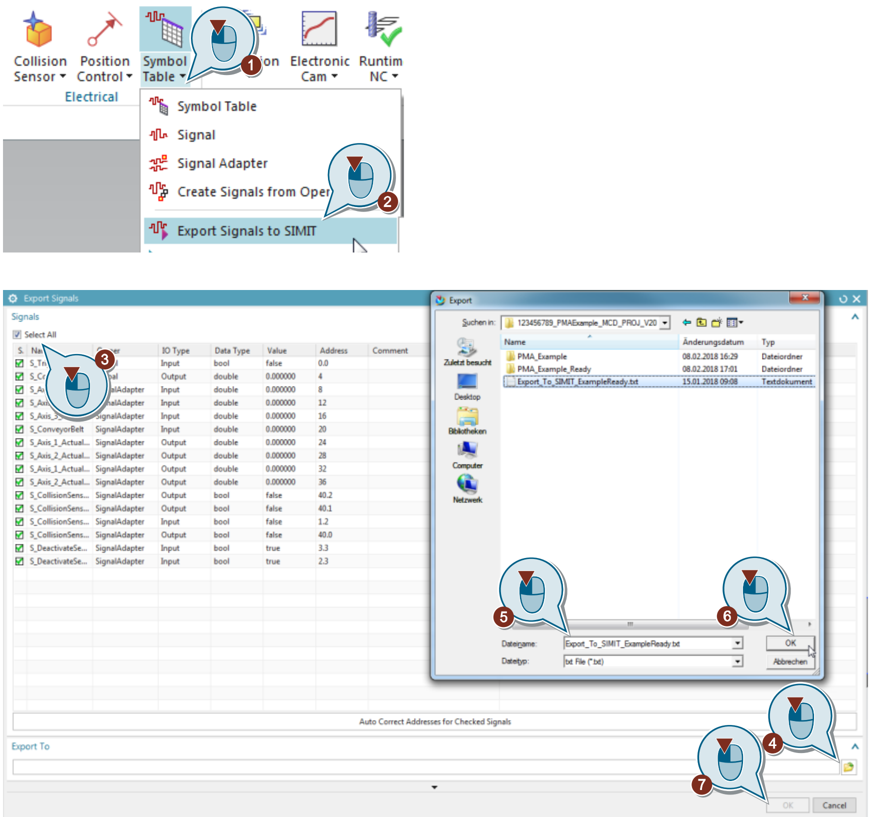
<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>1</td><td>1. Click "Sequence Editor" in the toolbar.
2. Right-click "Root".
3. Add an operation with "Add Operation".

</td></tr>
</table>

No.	Action
2	1. Select the object for which you want to create an operation. To do this, switch again to the Physics Navigator via the toolbar. 2. Select the parameter you want to change. 3. Select the object at "Edit Parameter" via the drop-down menu. "Object from Trigger" defines the object as "attachment" that the operation has triggered. 4. To add the workpiece as "attachment" to the "Fixed Joint" of the gripper, select the collision sensor on the gripper at "Select Attachment". 5. Right-click in the "Condition" window. 6. Add conditions with "Add Group" so that the operation is executed only for specific states. 7. Select the appropriate object in the Physics Navigator. 8. Define the conditions. 9. Assign a name. 10. Confirm the inputs with "OK".



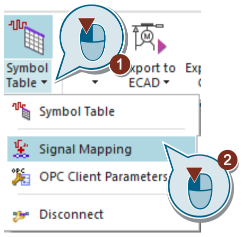
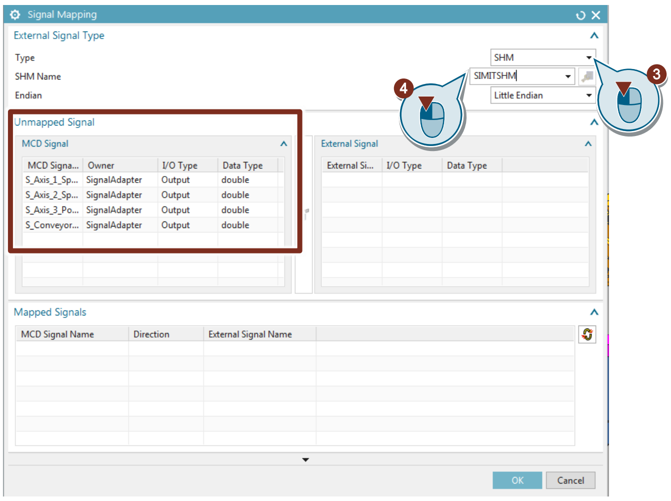
3.4.9 Exporting SHM signals

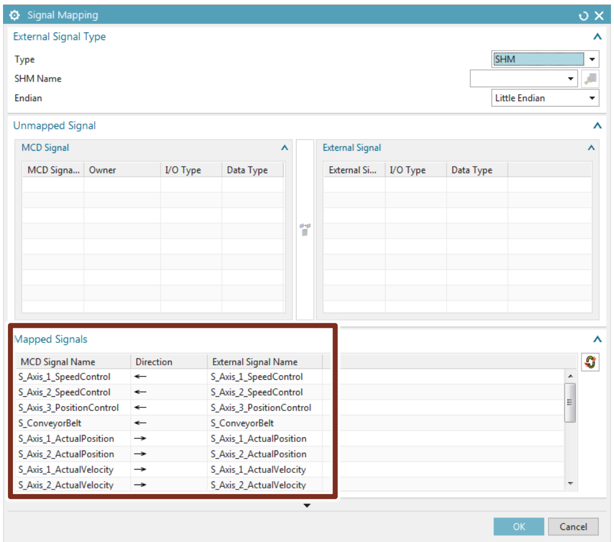
Table 3-17: Exporting SHM signals

No.	Action
1	1. Open the "Symbol Table" drop-down list. 2. Click "Export Signals to SIMIT". 3. Select either all signals or the required signals. 4. Open the file browser. 5. Assign a file name. 6. Confirm the file browser with "OK". 7. Start the export with "OK" . 

3.4.10 Coupling the SHM signals

Table 3-18: Coupling the SHM signals

No.	Action
1	1. Open the "Symbol Table" drop-down list. 2. Click "Signal Mapping". 3. Select the "SHM" coupling type. 4. Enter the name of your SHM connection that you defined in SIMIT. 5. Confirm the input with the Enter key. **Note:** The simulation in SIMIT must have already been started in order that the SHM connection is active (see 3.5.1).  

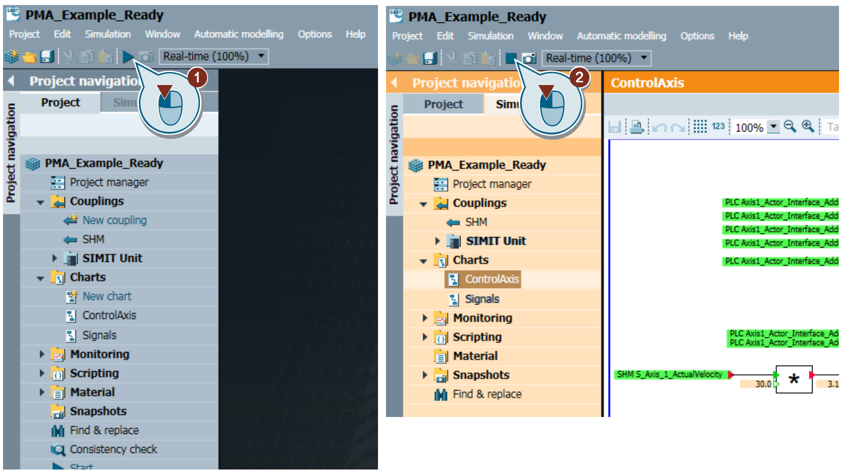
No.	Action
2	1. The signals are now displayed at "Mapped Signals". 

3.5 Operation

3.5.1 Starting the simulation in SIMIT

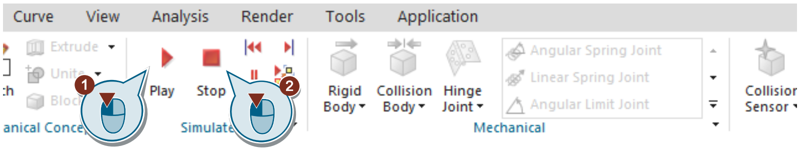
Once you have programmed all couplings and charts in SIMIT, you can start the simulation in SIMIT. An orange background indicates that the simulation is active. Starting the simulation loads the hardware configuration into the SIMIT Unit.

Table 3-19: Starting the simulation in SIMIT

No.	Action
1	1. Click the "Start" symbol to start the simulation. 2. Click the "Stop" symbol to stop the simulation. 

3.5.2 Starting the simulation in MCD

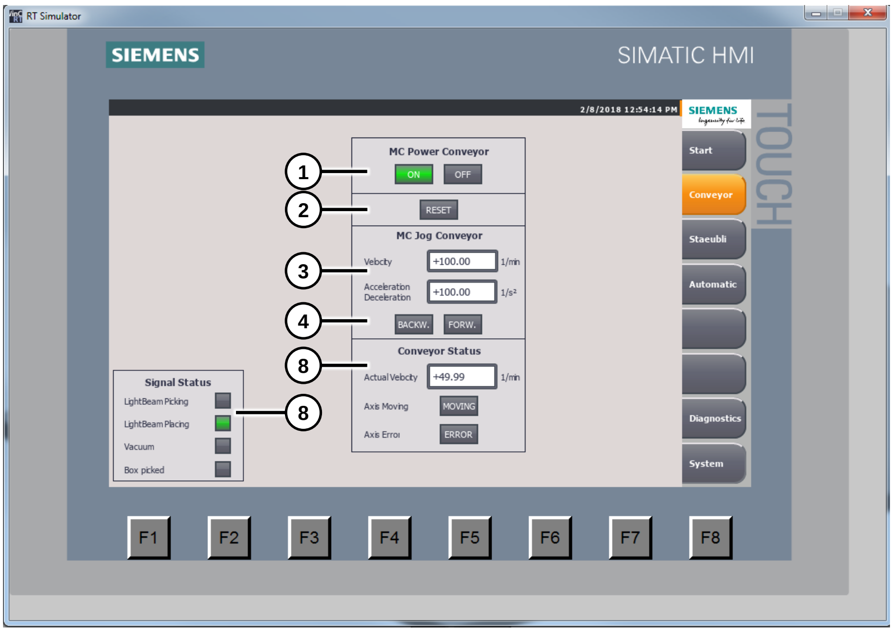
Table 3-20: Starting simulation in MCD

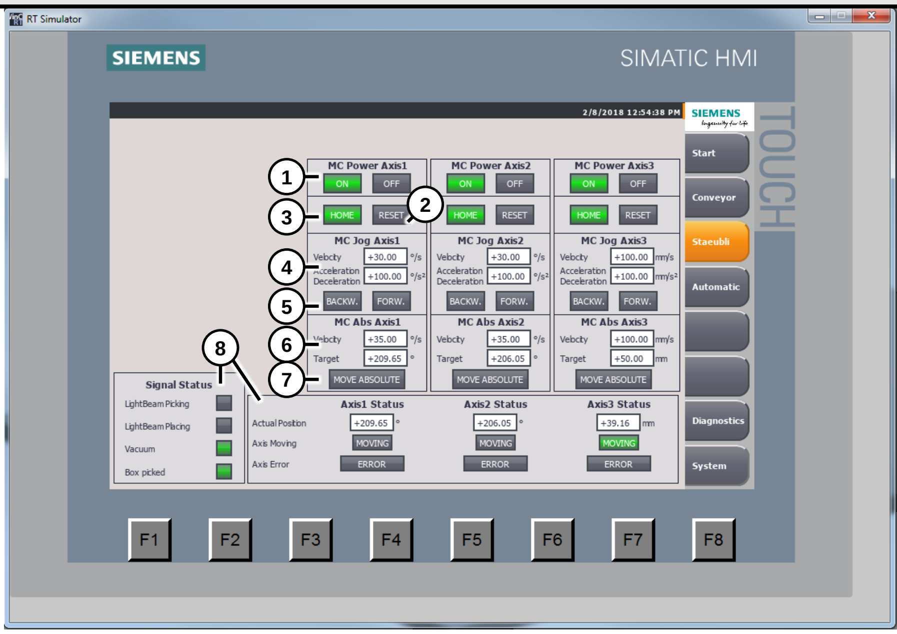
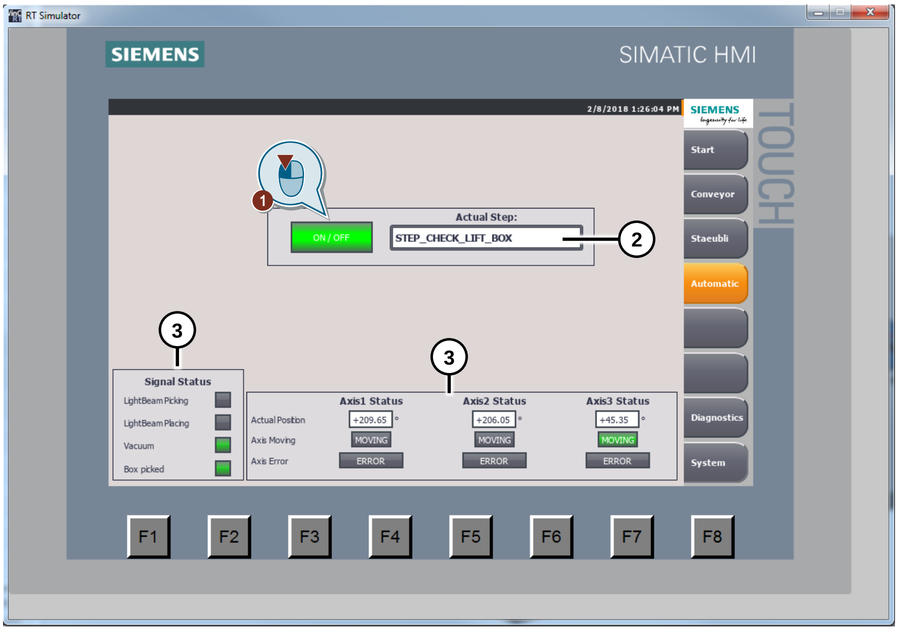
No.	Action
1	1. Click the "Play" symbol to start the simulation in MCD. The grayed-out symbols indicate that the simulation is active. 2. Click the "Stop" symbol to stop the simulation. 

3.5.3 Operating the panel

To operate the application example, a Basic Panel was configured with which you can control the transport plant. The following tables show how you can operate the simulation.

Table 3-21: Operating the simulation

No.	Action
1	1. Switch on/off the conveyor belt / SCARA axis 2. Fault acknowledgment 3. Set the actual position to 180° (axes 1 and 2) / 0 mm (axis 3) 4. Specification of speed and acceleration (jogging operation) 5. Jog forwards/backwards 6. Specification of speed and target position (absolute positioning) 7. Start absolute positioning 8. Display the current status 

No.	Action
	
2	1. Start the automatic mode by clicking the "ON/OFF" button. (Axes 1-3 must have been homed and be in the starting position) 2. Display the current step. 3. Display the current status 

4 Appendix

4.1 Service and support

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- Repair services
- On-site and maintenance services
- Retrofit and modernization services
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https://support.industry.siemens.com/cs/ww/en/sc/2067

4.2 Application support

Siemens AG
Digital Factory Division
Factory Automation
Production Machines
DF FA PMA APC
Frauenauracher Str. 80
91056 Erlangen, Germany

mailto: tech.team.motioncontrol@siemens.com

4.3 Links and references

Table 4-1: Links and references

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the article page of the application example https://support.industry.siemens.com/cs/ww/en/view/109758739
\3\	SIMATIC STEP 7 Basic/Professional V15 and SIMATIC WinCC V15 Manual https://support.industry.siemens.com/cs/ww/en/view/109755202
\5\	SIMIT V10 Manual https://support.industry.siemens.com/cs/ww/en/view/109759317
\6\	NX12 documentation https://docs.plm.automation.siemens.com/tdoc/nx/12.0.2/nx_help/

4.4 Change documentation

Table 4-2: Change documentation

Version	Date	Change
V1.0	08/2018	First edition – DF FA PMA