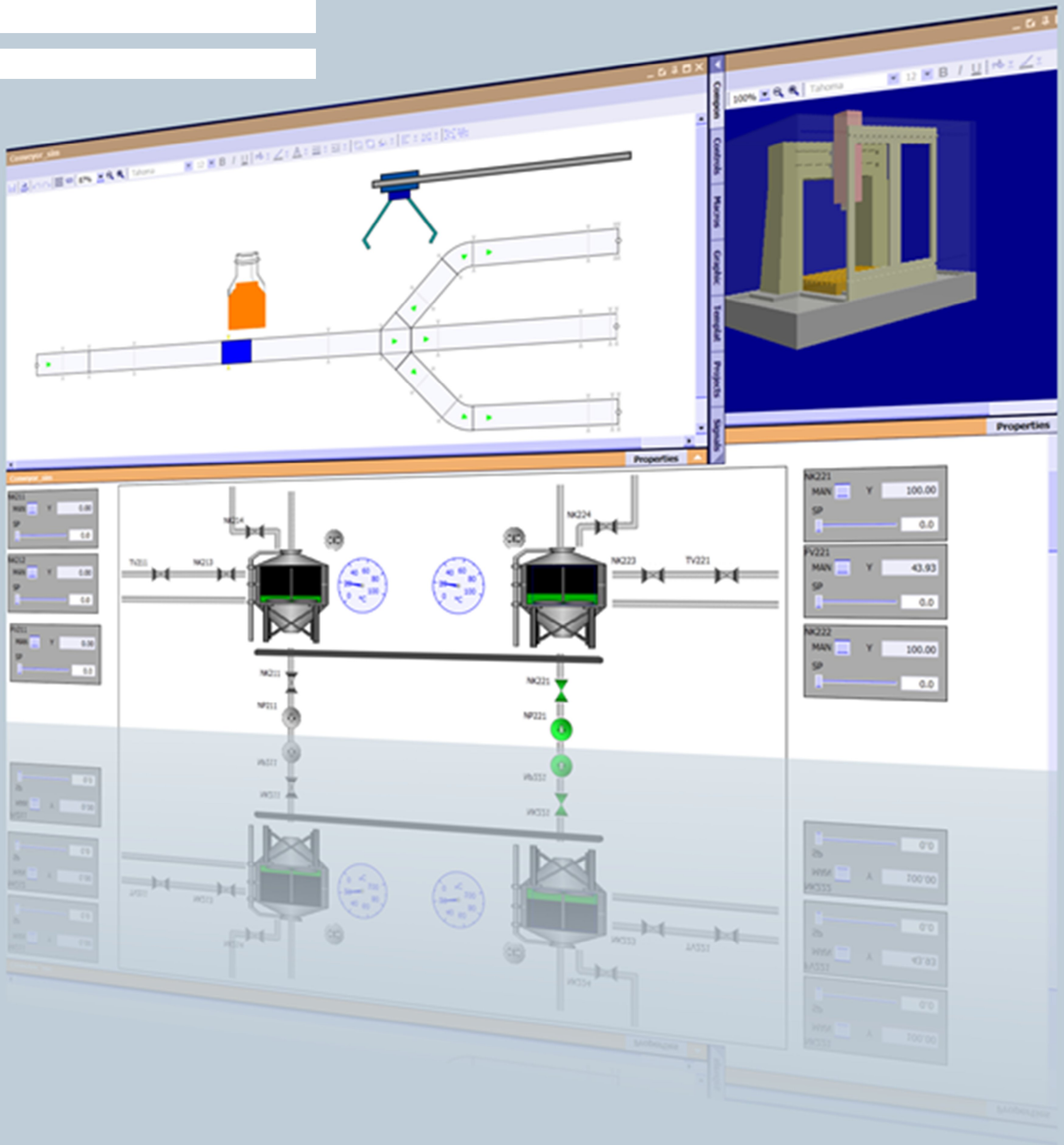

Application description• 10/2015

Simulation with SIMIT Simulation Framework and PCS 7 in a practical example

SIMIT Simulation Framework V8.1, SIMATIC PCS 7 V8.1

https://support.industry.siemens.com/cs/ww/de/view/77362399

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Preface

Aim of this Application Example

The aim of this application example is to introduce additional functions and libraries in a practical example, in addition to the SIMIT Simulation Framework Getting Started. The associated example project includes a complete simulation from the signals to the process.

Key Content

The following main topics are covered in this application example:

- The structure of a simulation project from the signal level to the process level (partly with reference to existing documentation)
- Customizing templates
- The structure of the process level with the FLOWNET library
- The simulation of a conveyor system with components of the CONTEC library
- Automatic generation of the device level using the simulated conveyor system
- Pre-prepared scripts which can be used for operator training, for example.

Validity

- SIMIT Simulation Framework V8.1
- SIMATIC PCS 7 V8.1 SP1

Table of contents

1 Task Description and Solution

1.1 Task

PCS 7 projects are becoming more and more complex due to the increasingly significant demand for availability and individuality of systems. In this regard, the automation programs must also undergo extensive testing.
To make this possible, certain system states and feedback are required from actuators and sensors to test whether the automation program is functioning correctly.
The provision of feedback or the system state is very laborious or not possible without a suitable tool. For this reason, nowadays one can find tools such as SIMIT Simulation Framework (hereafter referred to as SIMIT), which simplify the simulation of signals, devices and process states in a significant way.

1.2 Solution

This application example given here describes how to use the SIMIT simulation software to easily and quickly create the required simulation for a unit for the manufacture and packaging of soft drinks. The plant sections raw material tanks, reactors and a bottling plant are used for the simulation.

The basis for the simulation project described here is the PCS 7 project "bottling plant", which you can find on the same article page.

The application example provides a template which includes the simulation of important physical processes, devices, and signals of a raw material tank, stirred tank reactor and the filling unit. The installation is modular and is based on physical principles.

Its utilization offers the following advantages:

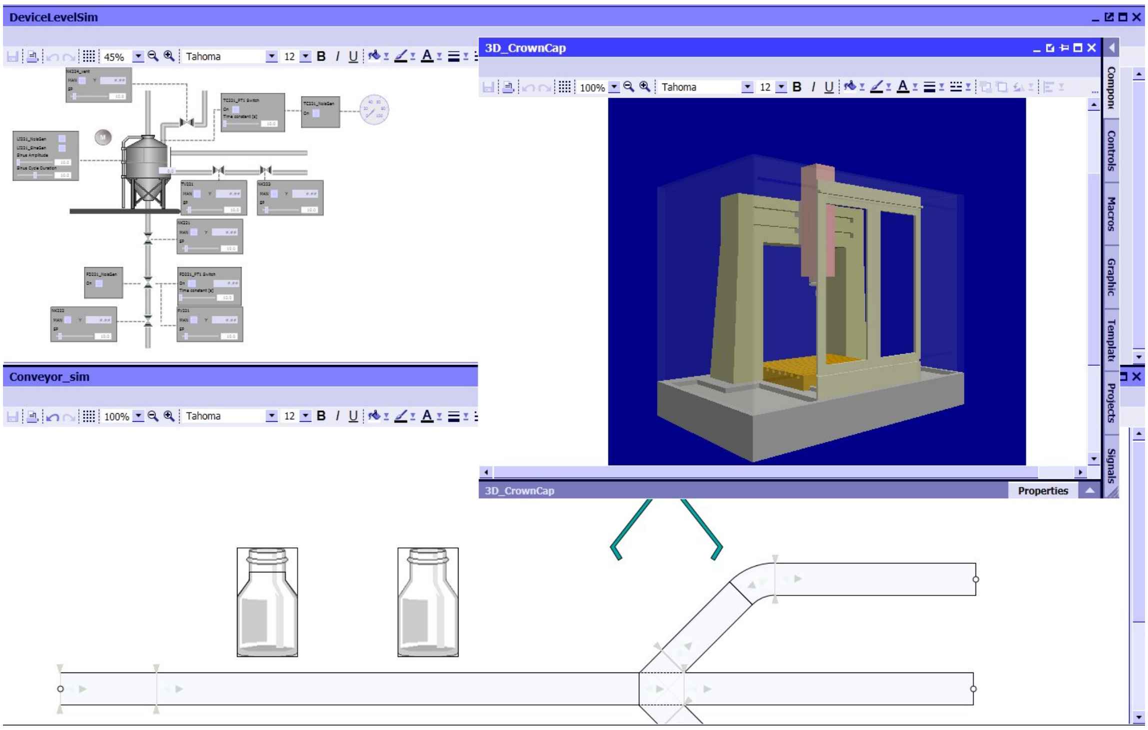
- A reduction of the knowledge necessary to develop simulations
- A decrease in the configuration effort
- Flexible installation and adjustment
- Standardized structures

1.2.1 Overview of the complete solution

Diagram

The following figure shows parts of a possible style depth of a simulation solution of a filling unit.

Figure 1–1



Description

The application example "virtual commissioning with SIMIT Simulation Framework for typical process and production automation" includes a PCS 7 project from a beverage blending and bottling plant and the associated simulation model. The PCS 7 project does not form part of the description given here and serves solely as a basis for the description of the simulation model.

The simulation model is divided into three levels:

- Signal level
- Device level
- Process level

You can find a description of the levels and of SIMIT in the application example "SIMIT Getting Started" in chapter 1 "SIMIT at a glance" (\3\).

Aim

The aim of the application example given here is to introduce functions and libraries which are not described in Getting Started. In this example, the following topics will be highlighted in particular:

- FLOWNET library
- CONTEC library
- The function "Generating the device level"
- Script function
- Creating/optimizing templates

Delimitation

Physically speaking, the technical process is illustrated in a simplified way by assuming ideal conditions.

Required Knowledge

Fundamental knowledge of the following specialist fields is a prerequisite:

- Basic knowledge of process technology
- Basic knowledge of physical modeling
- Engineering with SIMATIC PCS 7 and Advanced Process Library (APL)
- Knowledge of control technology

1.2.2 Core Functionality

The individual components of the PCS 7 project "Bottling Plant" simulation are described in the following section. The simulation consists of three main components:

- Raw material tanks
- Reactors
- Filling

The main components with the associated technical functions are derived from the technological hierarchy of the PCS 7 project.

You can find information on the generation procedure and the individual components such as signals, devices and processes in the application example "Simulation of a PCS 7 stirred tank reactor with SIMIT simulation framework" chapter 1.2. "Solution" (\4\).

1.2.3 Hardware and Software Components

The application example has been created with the following components:

Hardware Components

Table 1–1

Component	Instructions
SIMATIC PCS 7 ES/OS IPC847D W7	For the PCS 7 V8.1 example project and the SIMIT V8.1 example project

Note

In case of different hardware, please take heed of the suggested hardware configuration for installing the software components.

The suggested hardware configuration can be found in the read me file of the PCS 7 (online) \5\.

Software Components

Table 1–2

Component	Instructions
SIMATIC PCS 7 V8.1 SP1	Part of SIMATIC PCS 7 ES/OS IPC847D W7
S7-PLCSIM	The license is not a part of SIMATIC PCS 7 ES/OS IPC847D
SIMIT ULTIMATE V8.1	The software and license are not a part of SIMATIC PCS 7 IPC847D

Note

SIMIT V8.1 is offered in three versions: "STANDARD", "PROFESSIONAL" and "ULTIMATE". An overview of the contained modules is available in chapter 1.2 "product versions" of the manual "SIMIT (V8.1) Operating Manual" (\6\). In the application example, the modules "PLCSIM coupling" and "CMT import (CMT - control module type)", Component Type Editor (CTE) as well as the libraries FLOWNET and CONTEC are used. These do not form part of SIMIT V8.1 STANDARD.

Example Files and Projects

The following table contains all the files and projects used in this application example.

Table 1–3

File/project	Note
77362399_PROJECT_BottlingPlant_SIMIT_V81.zip	SIMIT V8.1 example project
77362399_PROJECT_BottlingPlant_PCS7_V81.zip	PCS 7 V8.1 example project
77362399_DOCU_Bottling_Plant_en.pdf	This document

2 Initial Work on the Project

The following will demonstrate how to create the simulation project. The functions and approaches which are already described in other application examples will simply be named. The corresponding description will be referenced.

2.1 Presentation of the Project

Description of the Plant

The basic liquid materials are dispensed from three raw material tanks into two reactors. The flow rates are regulated by valves. The liquids are then heated or cooled in the reactors. Then the liquids are bottled. After the filling process, the bottles are taken away on conveyor belts.

Task Description for the PCS 7 Project "Bottling Plant"

The bottling plant is depicted in SIMIT:

- Generating the signal level and coupling with PLCSIM
- Generating the device level and the simulation of the conveyor belt
  While doing this you will get to know the function "Generating the device level".
- Generating the physical models
  When generating the physical models you will get to know the FLOWNET libraries.
- Generating the scripts which can be used for operator training sessions, for example.

2.2 Configuring the PLCSIM Interface in the SIMATIC Manager

Before you start configuring SIMIT, you must first retrieve the "BottlingPlant_MP" project in the SIMATIC Manager, change the settings and load PLCSIM.

The approach is described in the application example SIMIT Getting Started (\3\) in chapter 2.2 "Configuring the PLCSIM interface in the SIMATIC Manager.

Note	The "BottlingPlant_MP" project includes two automation systems. For this reason, steps 4 to 9 should be executed twice (once per AS).

2.3 Configuring the PLCSIM Interface in SIMIT

The configuration approach is described in the application example SIMIT Getting Started (\3\) in chapter 2.3 "Configuring the PLCSIM interface in the SIMATIC Manager.

Note The "BottlingPlant_MP" project includes two automation systems. For this reason, steps 1 to 4 in table 2-3 and steps 1-8 in table 2-4 should be executed twice (once per AS).

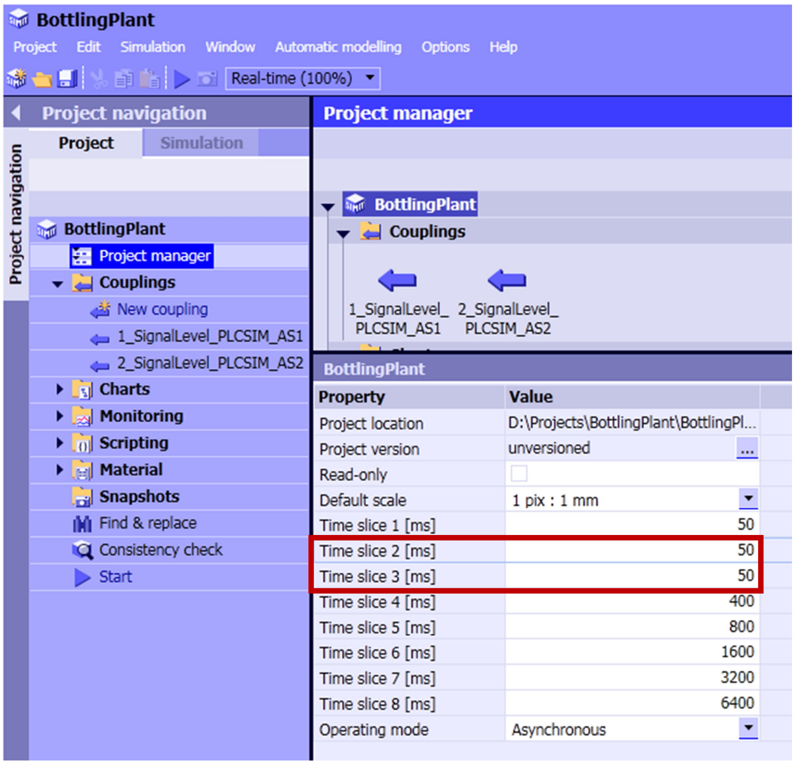
As two PLCSIM couplings are created in the application example, the couplings should be assigned unique names and one time slice each. The couplings have the following names in the application example:

- Coupling to AS1 "1_SignalLevel_PLCSIM_AS1"
- Coupling to AS1 "2_SignalLevel_PLCSIM_AS2"

Assigning the Time Slice

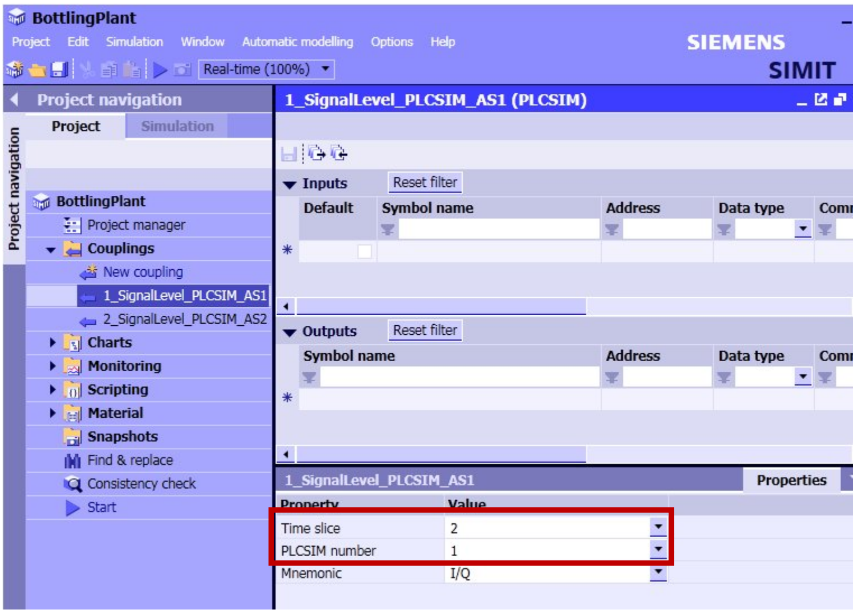
You can set the cycle times of the time slices in the properties window of the project manager. Time slices 2 and 3 are used in the application example.
A cycle time of 50 ms is set for each time slice.

Figure 2–1



You can assign the relevant time slice in the properties window of the coupling. You can enter the number of the PLCSIM instance in the field "PLCSIM number". You will find the number in the header of the PLCSIM window for each AS. The PLCSIM number 1 is also assigned to the coupling for AS1 in the following image.

Figure 2–2



Set the time slice 3 and the PLCSIM number 2 for AS2.

2.4 Verifying Communication between PLCSIM and SIMIT

In order to prevent communication errors between PLCSIM and SIMIT, you can test the connection in a simple way.

The precise approach is described in the application example SIMIT Getting Started (\3\) in chapter 2.4 "Verifying communication between PLCSIM and SIMIT".

2.5 The Current Status of your Project

In preparation for the actual creation of the process simulation for the "Bottling Plant" project, you have completed the following tasks:

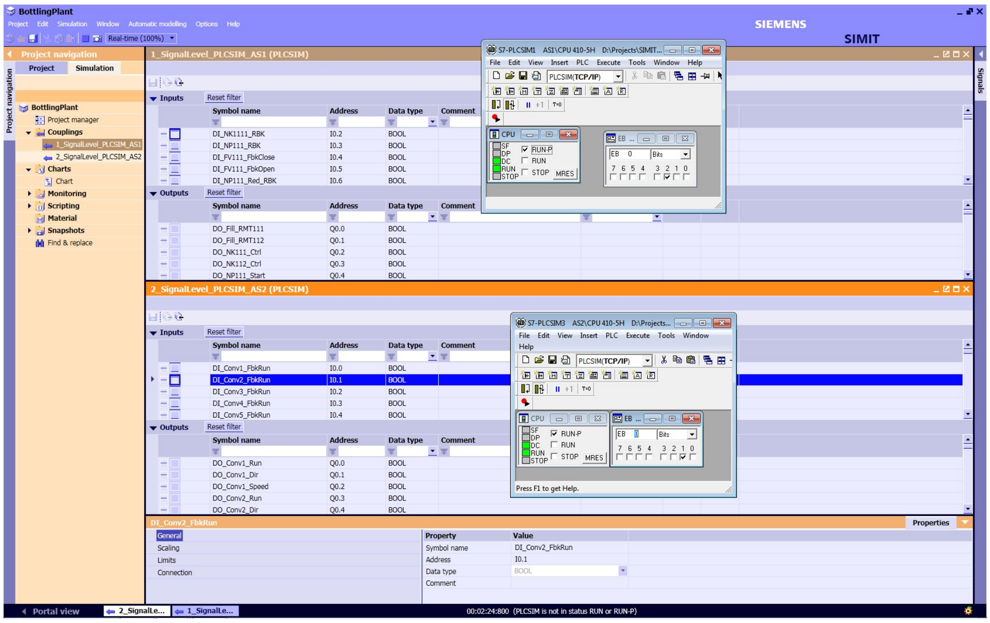
- You have retrieved the PCS 7 project "Bottling Plant" and downloaded the configured hardware in the virtual AS (PLCSIM).
- You have created two PLCSIM couplings in SIMIT and imported the symbol tables you had previously exported from PCS 7 into SIMIT.
- You have set the cycle times for the time slices and assigned a time slice to each coupling.
- You have assigned the PLCSIM number to each coupling.
- You have tested the communication between PLCSIM and SIMIT.

At the current state of your project you are now able to perform signal tests. At this stage of the simulation, you can see whether the signals are communicated from the control to the signal level (see Figure 2–3).
Tests such as the opening and closing of valves can be validated at this stage.

2.5 The Current Status of your Project

You are still unable to simulate the time response or the transient response of processes. This requires you to describe the process in detail and simulate it in SIMIT. The following chapters describe a possible process simulation for the "Bottling Plant" project.

Figure 2–3



3 Creating the Device Level

In the previous chapter, the PLCSIM couplings were configured. The PLCSIM data can be accessed for writing and reading.
If the AS sends control signals, these are sent in real application to actuators. These then perform an action that changes the process in some way. This could be, for example, a level increase or the sinking of a mass flow. This change must be detected by sensors and sent back to the AS.

In this chapter, the actuators and sensors are replicated. While doing this, you will get to know and use the functions “CMT import” and “Generation of a device level”.

3.1 Creating a Template

To be able to use the “CMT import” and “Generation of a device level” functions effectively, you must create corresponding templates for the actuators and sensors used. The templates must match the CMTs in PCS 7. That means that the template name is identical to the CMT name.

The following list comprises the required templates.

- AMON_Std
- BottlingAnalogVlv
- Bottling_2WayValve
- Bottling_Dose
- Bottling_MotorLean
- Bottling_MotorRev
- Bottling_MotorSimoCode
- Bottling_MotorSinamics
- Bottling_PID
- Bottling_ValveLean
- Conv

There are two options for creating templates. The first option is to adapt the existing templates (base templates). The second option is to create a new one.
In order to adapt the base templates, they have to be copied. For example, they could be copied into the folder project templates. After that it is possible to open and edit them.

Procedure

The following section will provide you with some examples of how to create or adapt templates.

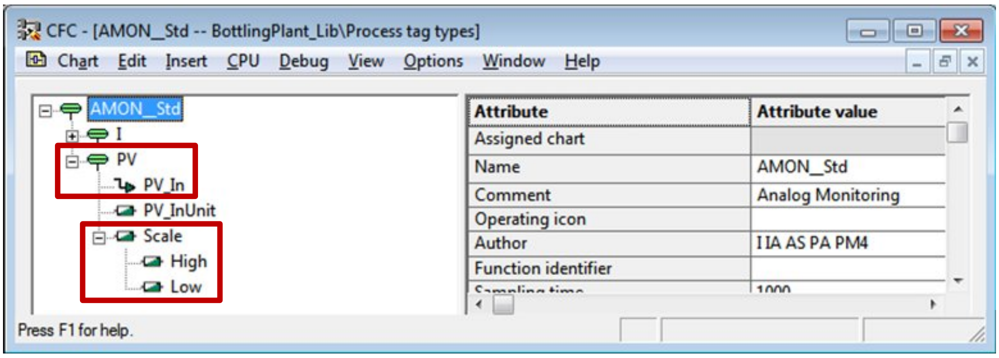
AMON_Std:

First of all, the interfaces to the CMT must be defined before creating a template. To do this, the following tasks must be performed in the SIMATIC Manager:

1. Open the CMT “AMON_Std” in the master data library of the “BottlingPlant” project.
2. Open the technical connections of the CMT “View > Technical connections”.
3. Take note of the names of the assigned blocks and the names of the associated signals and parameters which you need in the SIMIT template.

The following figure outlines these for the “AMON_Std”.

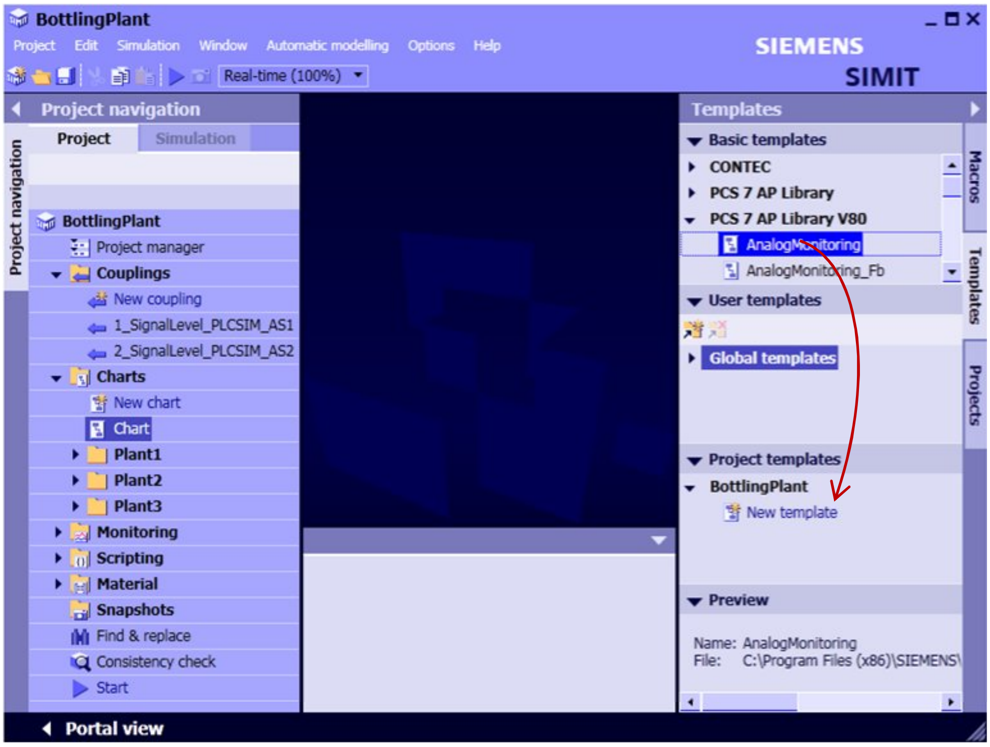
Figure 3–1



The template “AMON_Std” is created from the base template “AnalogMonitoring” from the folder “PCS 7 AP Library V80”. The following tasks need to be performed:

4. Open the base template folder “PCS 7 AP Library V80” in the Task-Card “templates” in the Tools window.
5. Select the template “AnalogMonitoring”.
6. Drag the template and drop it into the project templates.

Figure 3–2



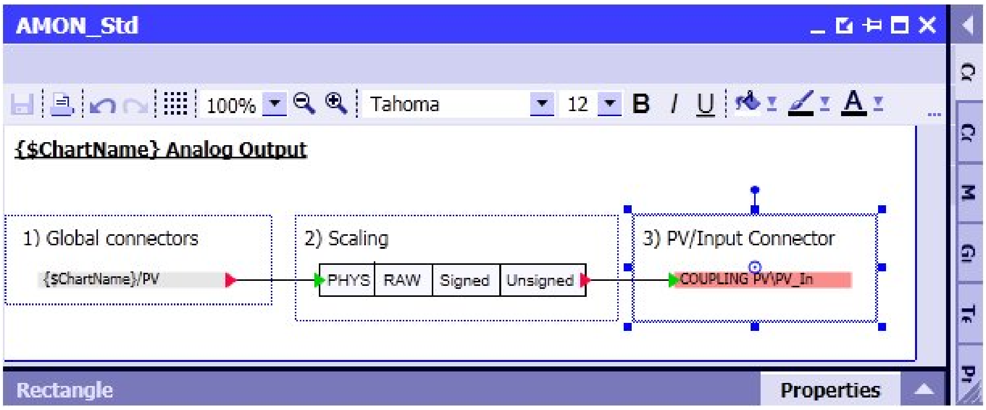
7. Change the name to “AMON_Std".
8. Double-click to open the template.
9. Make the changes according to the following table.

Table 3–1

Component	Property	Old value	New value
Connector	Name	{$ChartName}/X	{$ChartName}/PV
Phys2Raw	Name	Phys2Raw#1	{$ChartName}_Phys2Raw
	Phys_Lower_ Limit	PV_LR_Value	PV\Scale\Low
	Phys_Upper_ Limit	PV_HR_Value	PV\Scale\High
Signed2Unsigned	Name	Signed2Unsigned #1	{$ChartName}_Signed2Unsig ned
Input	Signal	COUPLING PV_SymbolName	COUPLING PV\PV_In

10. Insert text boxes to improve clarity according to the following figure.

Figure 3–3



11. Save and close the template.

Bottling_2WayValve:

Before creating the template, the names of the assigned blocks and the associated signals and parameters which you want to address in the SIMIT template need to be compiled (see steps 1 to 4 AMON_Std). The following table compiles these:

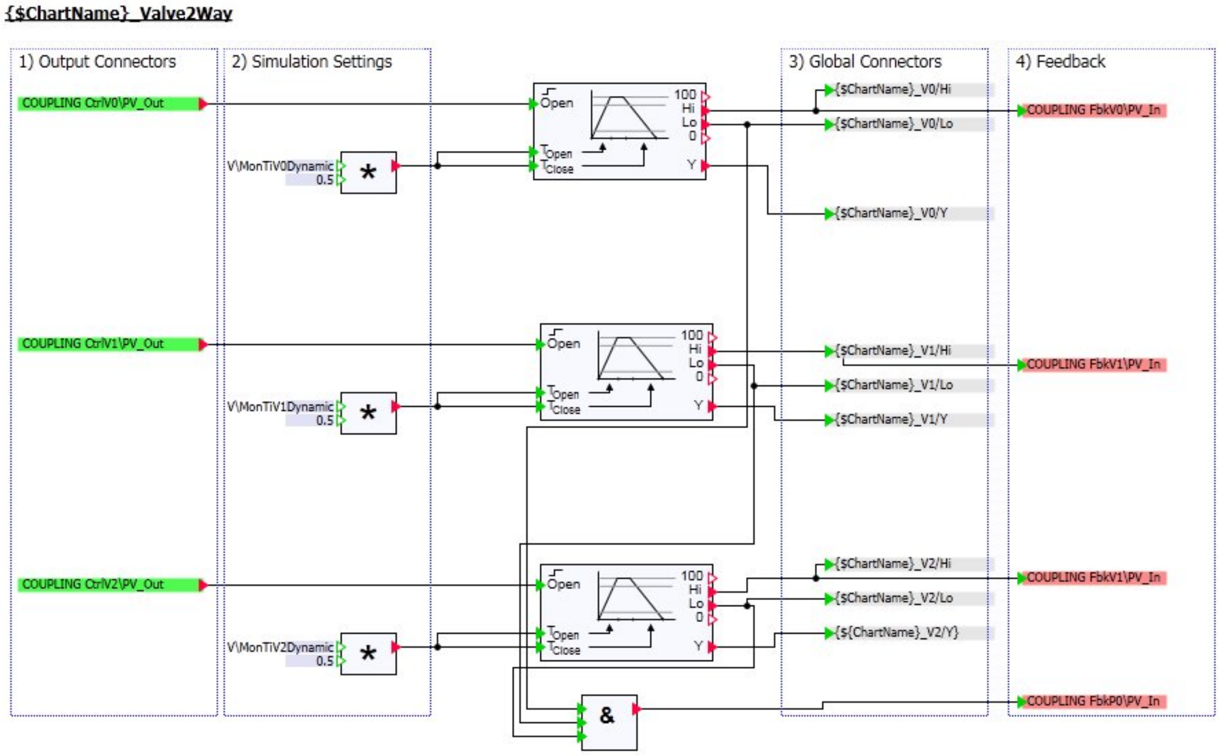
Table 3–2

Block	Signal / parameter
CtrlV0	PV_Out
CtrlV1	PV_Out
CtrlV2	PV_Out
FbkP0	PV_In
FbkV0	PV_In
FbkV1	PV_In
FbkV2	PV_In

Block	Signal / parameter
V	MonTiV0Dynamic
V	MonTiV1Dynamic
V	MonTiV2Dynamic

The template can be created with this information. The following figure shows the arrangement and the interconnection of the necessary components.

Figure 3–4



The following list comprises the properties of the components.

Table 3–3

Component	Property	Value
Output	Signal	COUPLING Ctrl0\PV_Out
Output	Signal	COUPLING Ctrl1\PV_Out
Output	Signal	COUPLING Ctrl2\PV_Out
MUL	Name	{$ChartName}_MUL_V0
	X1	V\MonTiV0Dynamic
MUL	Name	{$ChartName}_MUL_V1
	X1	V\MonTiV1Dynamic
MUL	Name	{$ChartName}_MUL_V2
	X1	V\MonTiV2Dynamic
DriveV1	Name	{$ChartName}_V0
DriveV1	Name	{$ChartName}_V1
DriveV1	Name	{$ChartName}_V2

Component	Property	Value
AND	Name	{$ChartName}_AND
Connector	Name	{$ChartName}_V0/Hi
Connector	Name	{$ChartName}_V0/Lo
Connector	Name	{$ChartName}_V0/Y
Connector	Name	{$ChartName}_V1/Hi
Connector	Name	{$ChartName}_V1/Lo
Connector	Name	{$ChartName}_V1/Y
Connector	Name	{$ChartName}_V2/Hi
Connector	Name	{$ChartName}_V2/Lo
Connector	Name	{$ChartName}_V2/Y
Input	Signal	COUPLING FbkV0/PV_In
Input	Signal	COUPLING FbkV1/PV_In
Input	Signal	COUPLING FbkV2/PV_In
Input	Signal	COUPLING FbkP0/PV_In

Create the remaining templates according to the procedure described above.

Note

It is a huge advantage if you give every component which you place on a chart a unique name. By using {$ChartName} this can be easy and convenient when using templates. When generating charts, {$ChartName) is replaced by the plan name. If you place additional components on charts, give each of them a unique name. This makes it easier to interconnect the components beyond the limits of the chart at a later date.

3.2 CMT Import

With the aid of templates, you can create the device level with the function “CMT Import”.

Requirements

To use the function "CMT Import" for automatic model creation, a corresponding XML file is required, exported from the PCS 7 project. The PCS 7 project must also be created with the help of CMTs (control module types).

Preparation

Create the following subfolders in the folder "Chart".

- 1_SignalLevel
- 2_DeviceLevel
- 3_ProcessLevel

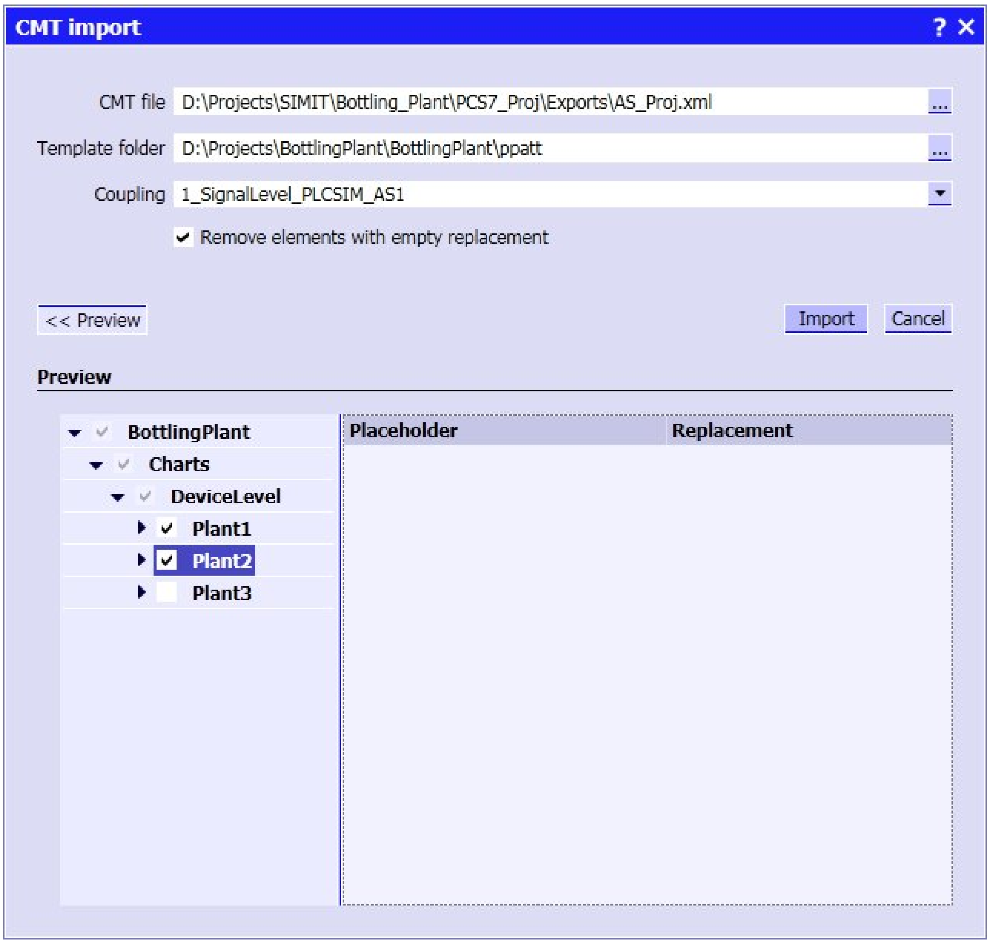
Procedure

The application example “SIMIT Getting Started” in chapters 3.3.1 “Export of XML files from PCS 7” and chapter 3.3.3 “CMT Import” describe in detail how to export the required XML files and carry out the CMT import.

The CMT import for the application example given here is described step by step in the following section.

1. Right-click the “DeviceLevel" folder.
2. Select “Automatic model generation > CMT Import” in the context menu.
3. In the “Coupling” box, select the coupling “1_SignalLevel_PLCSIM_AS1”.
4. Untick the box “Plant3” in the preview.

Figure 3–5



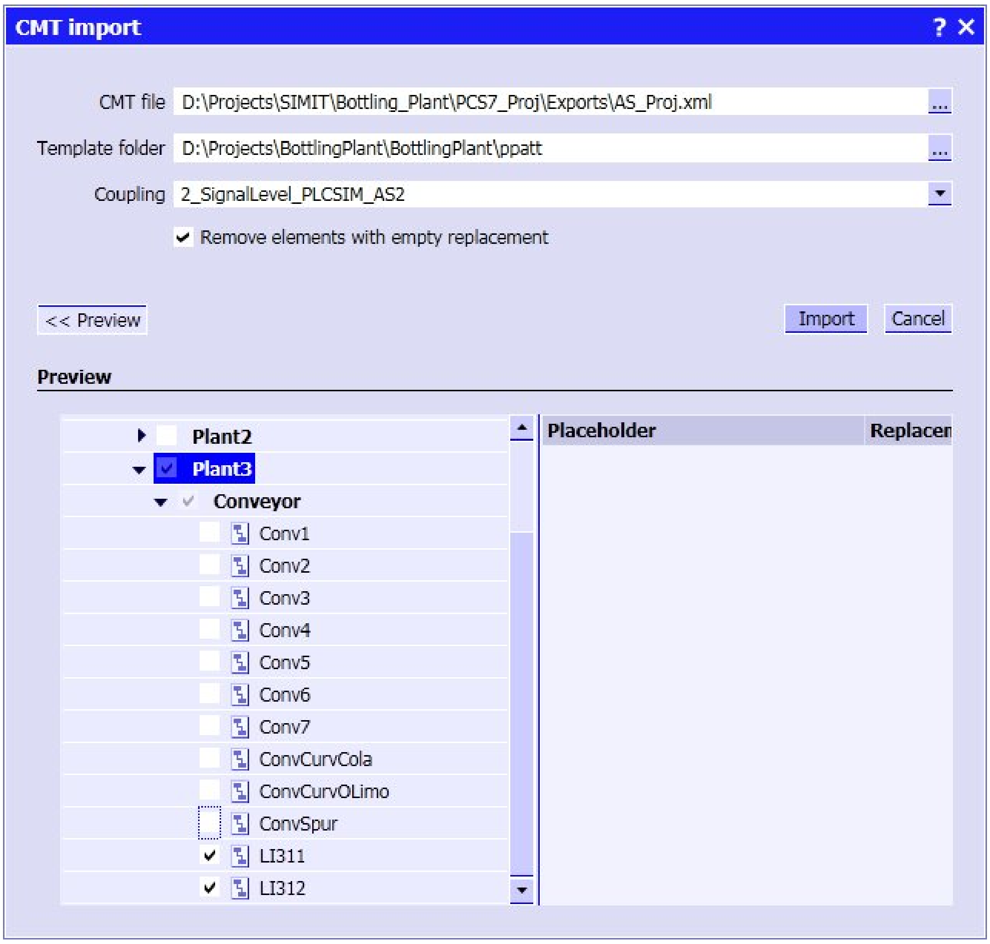
5. Click "Import" to start the import.
6. Click “OK” in the window “Import complete”.

7. Execute steps 1 to 6 for the coupling “2_SignalLevel_PLCSIM_AS2”. Apply your settings as shown in the following figure.

Note

Only the charts for the fill level measuring points are created. The charts for the conveyor line drives are created with the aid of the function “Generation of device level”.

Figure 3–6



Result

The device level is created in its entirety for the plant sections “Plant1” and “Plant2” For the plant section “Plant3”, only the fill level measuring points “LI311” and “LI312” were created.

3.3 Generating the Device Level

An additional option for creating a model automatically is the function "Generating the Device Level". When using this function, the device level is created using information from the conveyor system model which is constructed using CONTEC library components.

Templates are required for this, as with the CMT import. The templates for the "Generation of the device level" are created in the same way as the templates for the CMT import.

In the application example given here, the CMT import template "Bottling_MotorRev" is adapted and saved under the name "Conv". Then the conveyor system is replicated using the "Conveyor" components in the CONTEC library.

3.3.1 Adapting the Template

The following procedure describes how to adapt the template "Bottling_MotorRev".

8. Create a new template.
9. Name it "Conv".
10. Open the template "Bottling_MotorRev", select all the components contained in the template and copy them.
11. Close the template "Bottling_MotorRev" and switch to the template "Conv."
12. Insert the copied components into the template "Conv".
13. Adapt the available components as described in the table below:

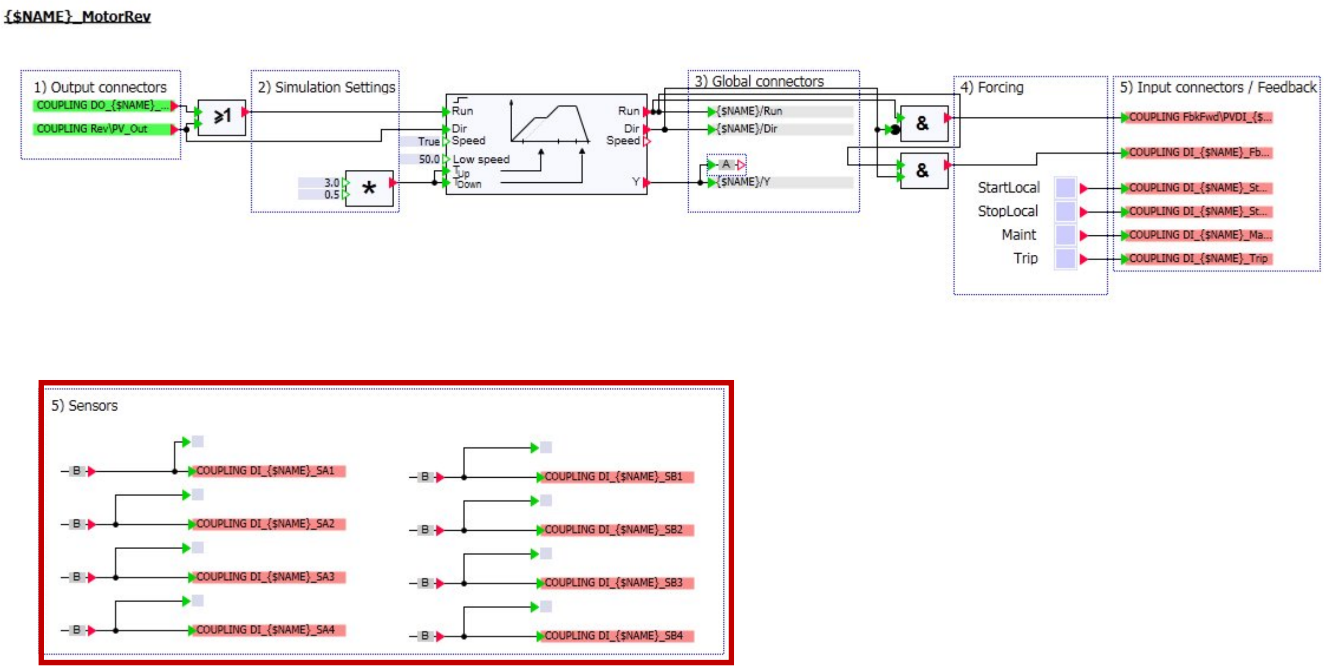
Table 3-4

Component	Property	Old value	New value
Text	Text	{$ChartName}_MotorRev	{$NAME}_MotorRev
Output	Signal	COUPLING Fwd\PV_Out	COUPLING DO_{$NAME}_Fwd
Output	Signal	COUPLING REv\PV_Out	COUPLING DO_{$NAME}_Rev
OR	Name	OR#1	OR_{$NAME}
MUL	Name	MUL#1	MUL_{$Name}
	Input X1	U\MonTiDynamic	3
	Input X2	1.0	0.5
DriveP1	Name	DriveP1#1	{$NAME}_U
Connector	Name	Connector#1	{$NAME}/Run
Connector	Name	Connector#2	{$NAME}/Dir
Connector	Name	Connector#3	{$NAME}/Y
NOTc	Name	NOTc#1	NOTc_{$NAME}
AND	Name	AND#1	AND_Fwd_{$NAME}
AND	Name	AND#2	AND_Rev_{$NAME}
Pushbutton	Name	Pushbutton#1	Pushbutton_{$NAME}_Startlocal
Pushbutton	Name	Pushbutton#2	Pushbutton_{$NAME}_Stoplocal
Switch	Name	Switch#1	Switch_{$NAME}_Maint
Switch	Name	Switch#2	Switch_{$NAME}_Trip

Component	Property	Old value	New value
Input	Signal	COUPLING FbkFwd\PV_In	COUPLING DI_{$NAME}_FbkFwd
Input	Signal	COUPLING FbkRev\PV_In	COUPLING DI_{$NAME}_FbkRev
Input	Signal	COUPLING StartLocal\PV_In	COUPLING DI_{$NAME}_StartLocal
Input	Signal	COUPLING StopLocal\PV_In	COUPLING DI_{$NAME}_StopLocal
Input	Signal	COUPLING Maint\PV_In	COUPLING DI_{$NAME}_Maint
Input	Signal	COUPLING Trip\PV_In	COUPLING DI_{$NAME}_Trip

14. Insert the components which are additionally required into the template, as shown in the following figure. These are essential for the sensors of the components in the conveyor system.

Figure 3–7



15. Adjust the properties of the components as summarized in the table below.

Table 3–5

Component	Property	Value
BConnector	Name	BConnector_{$NAME}-SensorA1
	Input	{$NAME} SensorA1
BConnector	Name	BConnector_{$NAME}-SensorA2
	Input	{$NAME} SensorA2

Component	Property	Value
BConnector	Name	BConnector_{$NAME}-SensorA3
	Input	{$NAME} SensorA3
BConnector	Name	BConnector_{$NAME}-SensorA4
	Input	{$NAME} SensorA4
Binary Display	Name	Binary display_{$NAME}_SensorA1
Binary Display	Name	Binary display_{$NAME}_SensorA2
Binary Display	Name	Binary display_{$NAME}_SensorA3
Binary Display	Name	Binary display_{$NAME}_SensorA4
Input	Signal	COUPLING DI_{$NAME}_SA1
Input	Signal	COUPLING DI_{$NAME}_SA2
Input	Signal	COUPLING DI_{$NAME}_SA3
Input	Signal	COUPLING DI_{$NAME}_SA4
BConnector	Name	BConnector_{$NAME}-SensorB1
	Input	{$NAME} SensorB1
BConnector	Name	BConnector_{$NAME}-SensorB2
	Input	{$NAME} SensorB2
BConnector	Name	BConnector_{$NAME}-SensorB3
	Input	{$NAME} SensorB3
BConnector	Name	BConnector_{$NAME}-SensorB4
	Input	{$NAME} SensorB4
Binary Display	Name	Binary display_{$NAME}_SensorB1
Binary Display	Name	Binary display_{$NAME}_SensorB2
Binary Display	Name	Binary display_{$NAME}_SensorB3
Binary Display	Name	Binary display_{$NAME}_SensorB4
Input	Signal	COUPLING DI_{$NAME}_SB1
Input	Signal	COUPLING DI_{$NAME}_SB2

Component	Property	Value
Input	Signal	COUPLING DI_{$NAME}_SB3
Input	Signal	COUPLING DI_{$NAME}_SB4
AConnector	Name	{$NAME}-Speed

16. Save and close the template “Conv”.

Conveyor System Simulation Chart

In the application example given here, there is a separate chart for the simulation of the conveyor system. The following will describe how to create this chart.

Chart Properties

1. Create the folder “Conveyor” in the folder “3_ProcessLevel”.
2. Create a new chart “Conveyor_sim” in this folder.
3. Adapt the size and scale in line with the following figure.

Note The dimensions of the components from the CONTEC library play a decisive role in the simulation as the lengths of the conveyor lines and the sensor positions are derived from these. You can find more information in chapter 7.3.2.5 “Scale” in the manual “SIMIT (V8.1)” (\6\).

Figure 3–8

Conveyor System

The conveyor system is created using components from the CONTEC library. The following section will describe how to create the simulation of the conveyor system.

1. Place the components “Conveyor-S4”, “ConveyorCurve45-R60” and “SpurConveyor-2” on the chart “Conveyor_sim”, as shown in the following figure.

2. Adjust the properties of the components using the table below.

Figure 3–9

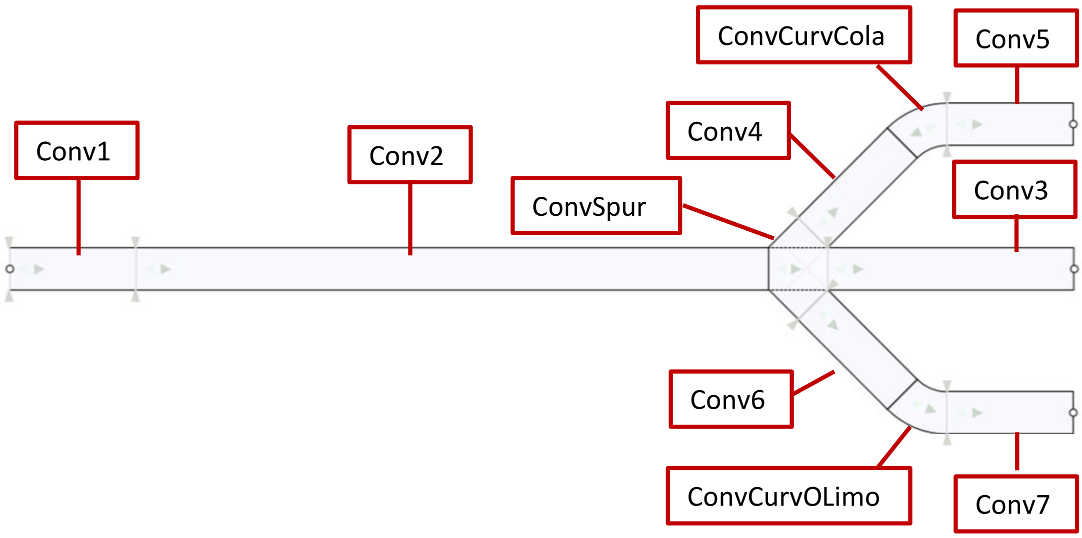


Table 3–6

Component	Property	Value
Conv1	Name	Conv1
	SensorPositionA1	1200
	MatarialType	CBoxDS256
	TEMPLATE	Conv
	HIERARCHY	Conveyor
Conv2	Name	Conv2
	Width	12000
	NominalSpeed	0.5
	NbrOfSensorsA	3
	SensorPositionA1	2000
	SensorPositionA2	6000
	SensorPositionA3	10000
ConvSpur	TEMPLATE	Conv
	HIERARCHY	Conveyor
Conv3	Name	Conv3
	Width	7200
	RemoveA3	Conv3-SensorA3 OUT
	NbrOfSensorsA	3
	SensorPositionA1	1000
	SensorPositionA2	6000
	SensorPositionA3	7000
	TEMPLATE	Conv
	HIERARCHY	Conveyor

Component	Property	Value
Conv4	Name	Conv4
	SensorPositionA1	1000
	TEMPLATE	Conv
	HIERARCHY	Conveyor
Conv6	Name	Conv6
	SensorPositionA1	1000
	TEMPLATE	Conv
	HIERARCHY	Conveyor
ConvCurvCola	Name	ConvCurvCola
	TEMPLATE	Conv
	HIERARCHY	Conveyor
ConvCurvOLimo	Name	ConvCurvOLimo
	TEMPLATE	Conv
	HIERARCHY	Conveyor
Conv5	Name	Conv5
	Width	5000
	RemoveA2	Conv5-SensorA2 OUT
	NbrOfSensorsA	3
	SensorPositionA1	4000
	SensorPositionA2	4900
	SensorPositionA3	10
	TEMPLATE	Conv
	HIERARCHY	Conveyor
Conv7	Name	Conv7
	Width	5000
	RemoveA2	Conv7-SensorA2 OUT
	NbrOfSensorsA	2
	SensorPositionA1	4000
	SensorPositionA2	4800
	TEMPLATE	Conv
	HIERARCHY	Conveyor

3.3.2 Procedure for “Generating the Device Level”

The following section will describe the procedure for the function “Generating the Device Level”.

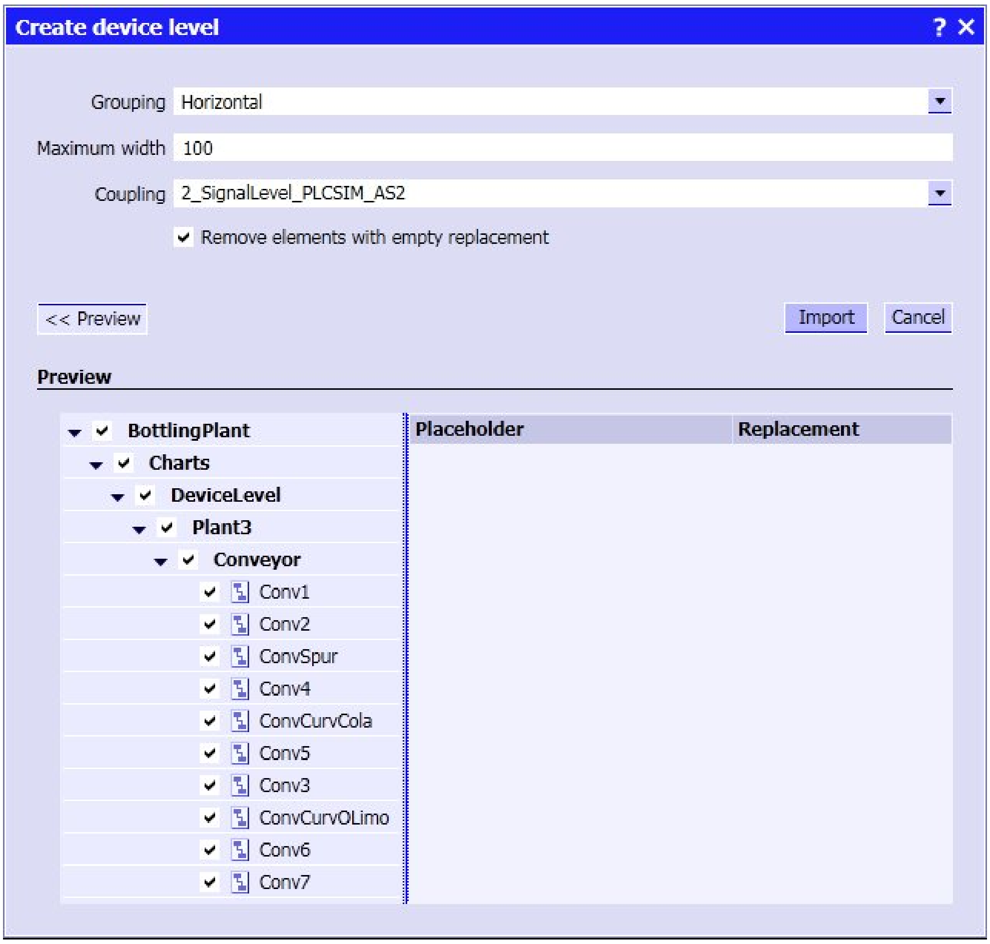
Requirement

The requirement for using the function “Generating the Device Level” is that you have created the relevant template (if you are not using the base templates) and you have created the model of the conveyor system with the components from the CONTEC library.

Procedure

1. Right-click “Plant3” in the “DeviceLevel" folder.
2. Select “Automatic model generation > Device Level Generation” in the context menu.
3. Set the coupling “2_SignalLevel_PLCSIM_AS2” in the “Coupling” box.

Figure 3–10



4. Click "Import".
5. Click “OK” in the window “Import complete”.

3.3.3 Final Adjustments/Additions

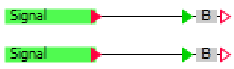
Adjustments and/or additions have to be made to the charts “ConvSpur” and “ConvCurvCola” because the template used does not meet all requirements.

Note If you have several charts of the same type which need to be adapted after generating the device level, it is sensible to have a separate template for these charts.

ConvSpur

1. Open the chart ConvSpur.
2. Insert two components from each of the types “Output” and “BConnector”.
3. Interconnect these as shown in the following figure.

Figure 3–11



Adjust the properties of the components as summarized in the table below.

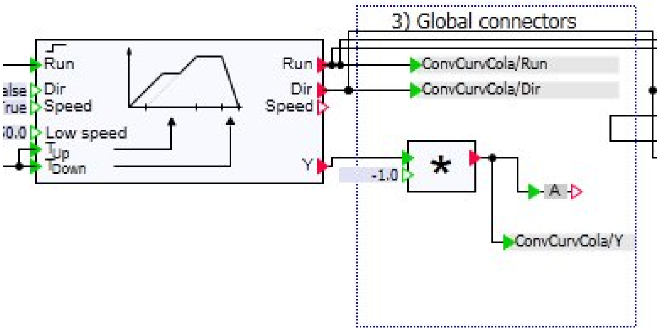
Table 3–7

Component	Property	Value
Output	Signal	2_SignalLevel_PLCSIM_AS2 DO_ConvSpure_S_AB
Output	Signal	2_SignalLevel_PLCSIM_AS2 DO_ConvSpure_S_AD
BConnector	Name	ConvSpur-Switch1
BConnector	Name	ConvSpur-Switch2

ConvCurvCola

1. Open the chart “ConvCurvCola”.
2. Insert the component “MUL”.
3. Interconnect these as shown in the following figure.

Figure 3–12



4. Adjust the properties of the components as summarized in the table below.

Table 3–8

Component	Property	Value
MUL	Name	MUL_Speed_ConvCurvCola
	X2	-1.0

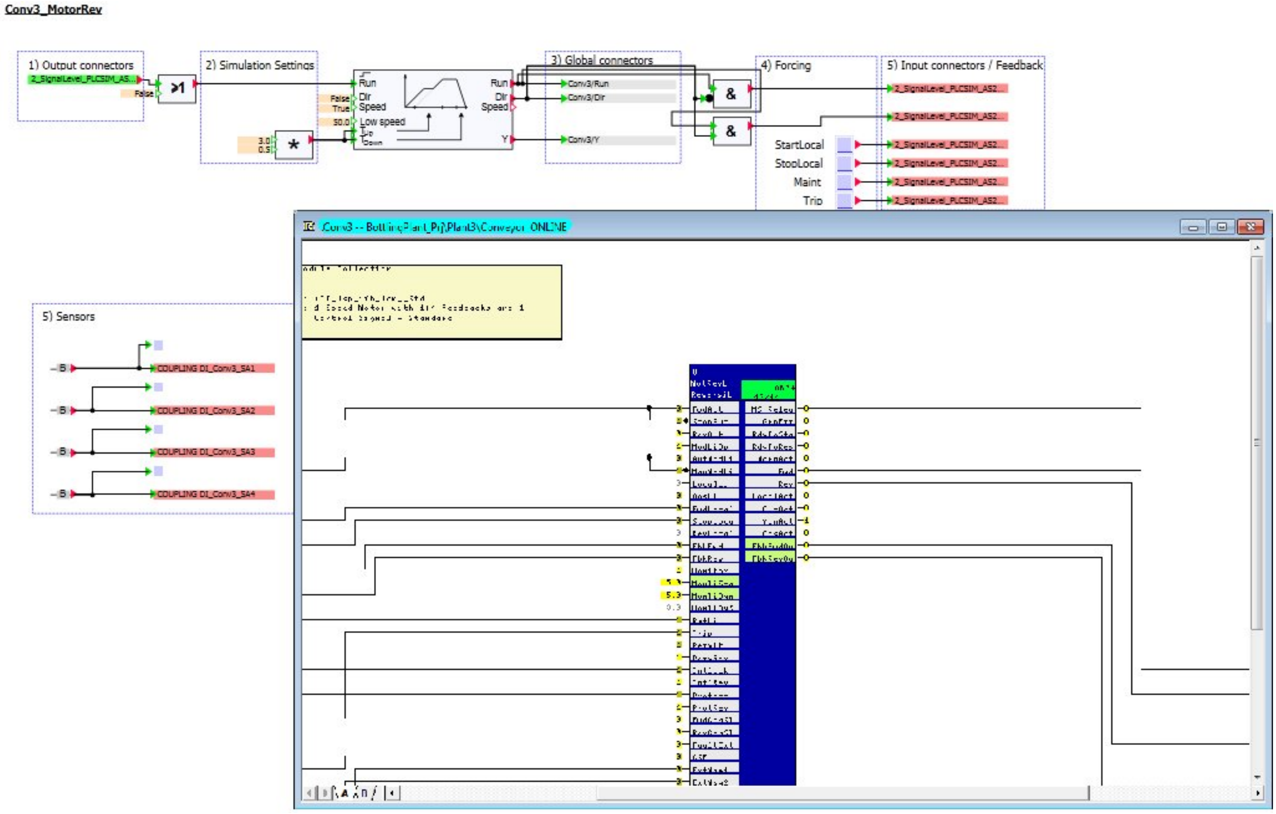
Result

The device level is created in its entirety for the plant section “Plant3”.

3.4 The Current Status of your Project

You have reproduced the device level of the PCS 7 project in SIMIT in full and can now execute the measuring point test.

Figure 3–13



4 Modeling Physical Correlations

The following section will describe how to reproduce the models of physical correlations in the PCS 7 project “Bottling Plant” in SIMIT, using components from the standard library, the FLOWNET library and a component created with the CTE tool.

4.1 Establishing the Physical Process Model

The basic procedure for establishing a physical process model is described in the application example “Simulation of a PCS 7 stirred tank reactor with SIMIT simulation framework” (\4\) chapter 2 “Basics of Process Engineering”.

4.2 Model Plant Section “Plant1”

The following section will describe the development of the process model for the plant section “Plant1”. The plant section “Plant1” describes raw material tanks and injection into the reactors of plant section “Plant2”. The plant section consists of three raw material tanks. The modeling is carried out for raw material tanks 1 and 3 with components from the standard library. Raw material tank 2 is created using components from the FLOWNET library. Macros are created for calculations which occur repeatedly.

4.2.1 Creating Macros

The following section will describe the procedure for creating the required macros.

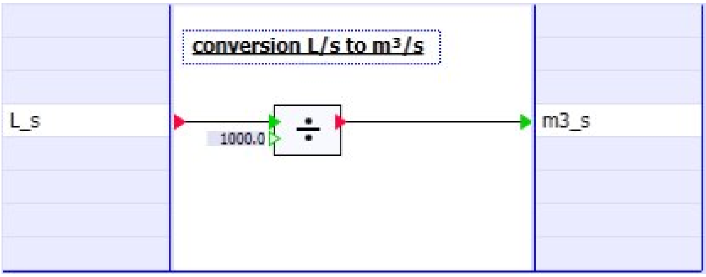
Macro “LiterSTom3s”

The macro “LiterSTom3s” converts the volume flow from liters per second to m³ per second. The procedure for creating this is described below step-by-step.

1. Switch to the Task-Card “Macros” in the Tools window.
2. Create a new macro.
3. Rename this macro “LiterSTom3s".
4. Open the macro.
5. Open the properties of the macro.
6. Assign the property “Code” the value “LiterSTom3s”.
7. Insert the component “DIV” from the standard library into the macro.
8. Assign it a suitable name (e.g. DIV_convert_Liter_s_to_m3_s).
9. Assign the input X2 the value 1000,0.
10. Connect the input “X1” of the “DIV” component to the sidebar for inputs.
11. Rename the input “L_s”.
12. Connect the input “Y” of the “DIV” component to the sidebar for outputs.

13. Rename the output “m3_s”.

Figure 4–1

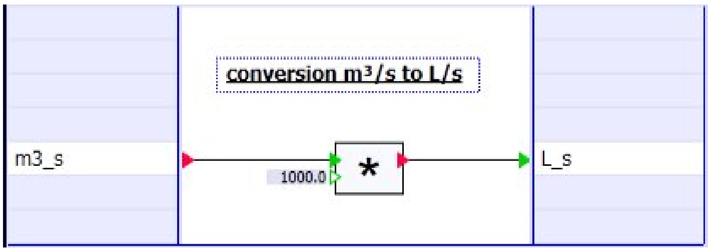


Macro “m3sToLiterS”

The macro “m3sToLiterS” converts the volume flow from m³ per second to liters per second. The procedure for creating the macro is the same as the procedure for creating the macro “LiterSTom3s”.

The following figure shows the components and their connection to the macro.

Figure 4–2



Adjust the properties of the macro and components as summarized in the table below.

Table 4–1

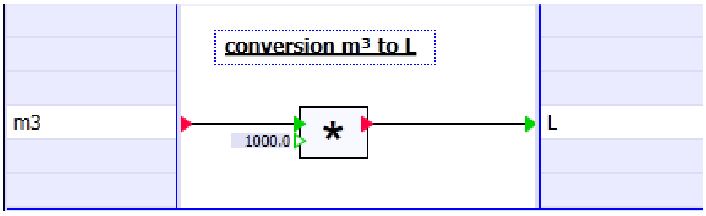
Component	Property	Value
Macro	Code	m3sToLiterS
MUL	Name	MUL_convert_m3_s_to_Liter_s
	X1	Connection to m3_s
	X2	1000
	Y	Connection to L_s

Macro “m3ToLiter”

The macro “m3ToLiter” converts the volume from m³ to liters. The procedure for creating the macro is the same as the procedure for creating the macro “LiterSTom3s”.

The following figure shows the components and their connection to the macro.

Figure 4–3



Adjust the properties of the macro and components as summarized in the table below.

Table 4–2

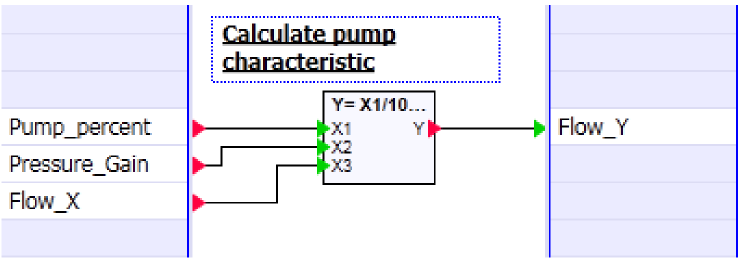
Component	Property	Value
Macro	Code	m3ToLiter
MUL	Name	MUL_convert_m3_to_Liter
	X1	Connection to m3
	X2	1000
	Y	Connection to L

Macro “PumpPress”

The macro “PumpPress” simulates the characteristic of a pump. The procedure for creating the macro is the same as the procedure for creating the macro “LiterSTom3s”.

The following figure shows the components and their connection to the macro.

Figure 4–4



Adjust the properties of the macro and components as summarized in the table below.

Table 4–3

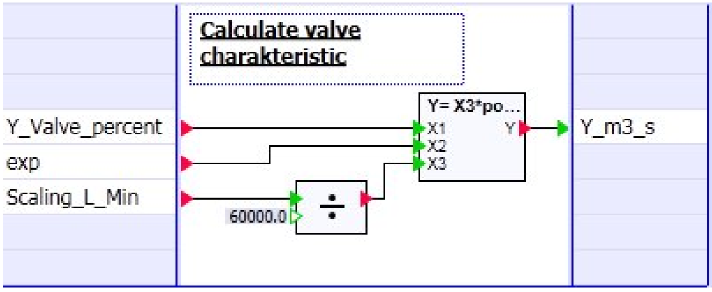
Component	Property	Value
Macro	Code	PumpPress
AFormula	Name	AFormula_PumpPress
	X1	Connection to Pump_percent
	X2	Connection to Pressure_Gain
	X3	Connection to Flow_X
	Y	Connection to Flow_X
	Formula	X1/100*X2*X3

Macro “ValveCurve”

The macro “ValveCurve“ simulates the equal percentage characteristic of a valve. The procedure for creating the macro is the same as the procedure for creating the macro “LiterSTom3s”.

The following figure shows the components and their connection to the macro.

Figure 4–5



Adjust the properties of the macro and components as summarized in the table below.

Table 4–4

Component	Property	Value
Macro	Code	ValveCurve
AFormula	Name	AFormula_ ValveCurve
	X1	Connection to Y_Valve_percent
	X2	Connection to exp
	Y	Connection to Y_m3_s
	Formula	X3*pow(X1/100,X2)
DIV	DIV_ValveCurve	Connection to Scaling_L_Min
	X2	60000,0

4.2.2 Additional Preparations

Besides the actual models, components are also essential for the simulation of the physical correlations as they can be used to set specific states. Separate charts are created for these.

1. Create the folder “Misc” (from “miscellaneous”) in the folder “Charts”.
2. Create the chart “Connections” in the folder “Misc”.

Components and their connections which are used in this chart are described in the following section.

4.2.3 Creating the Chart “RMT1”

The purpose of the chart is to simulate the physical model of the raw material tank “RMT1”.

In the application example given here, the capacity of the raw material tank is simulated according to the following formula:

$$V = \int \dot{V}_{in} + \dot{V}_{out}\, dt$$

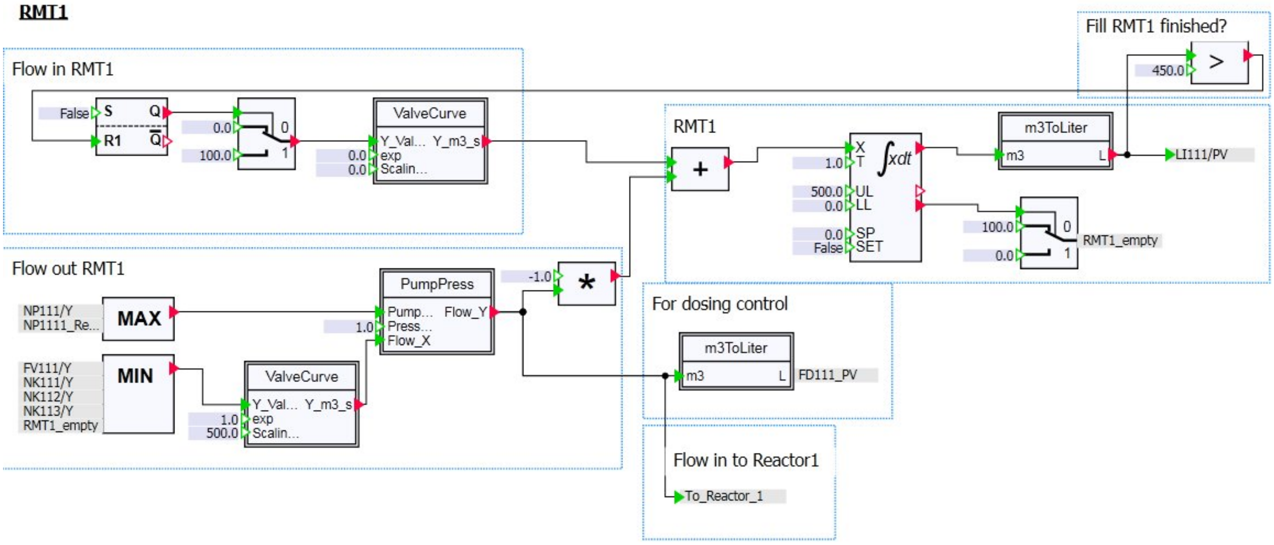
Procedure

The following section will describe the creation procedure.

1. Create a new folder in the folder “3_ProcessLevel”.
2. Rename it “Plant1”.
3. Create a new chart in the folder “Plant1”.
4. Rename it “RMT1”.
5. Insert the relevant components into the chart (see the figure below).

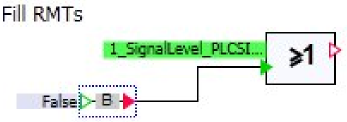
6. Interconnect the components as shown in the following figure.

Figure 4–6



7. Open the chart “Connections”.
8. Insert the components shown in the following figure into the chart.
9. Interconnect the components as shown in the following figure.

Figure 4–7



10. Adjust the properties of the components as summarized in the table below.

Table 4–5

Component	Property	Value
BConnector	Name	BConnector_Fill_RMTs
Output	Signal	1_SignalLevel_PLCSIM_AS1 DO_RMT1_Filling
OR	Name	OR_Fill_RMT1

11. Save and close the chart “Connections”.
12. Open the chart “RMT1”.
13. Adjust the properties of the components as summarized in the table below.

Table 4–6 Flow in RMT1

Component	Property	Value
RS_FF	Name	RS_FF_Fill_RMT1
	S	OR_Fill_RMT1 OUT

Component	Property	Value
Selection	Name	Selection_Fill_RMT1
	X1	100
ValveCurve	Name	ValveCurve_Fill_RMT1
	exp	1
	Scaling_L_Min	900

Table 4–7 Flow out RMT1

Component	Property	Value
Connector	Name	NP111/Y
Connector	Name	NP1111_Red/Y
Connector	Name	FV111/Y
Connector	Name	NK111/Y
Connector	Name	NK112/Y
Connector	Name	NK113/Y
Connector	Name	RMT1_empty
MinMax	Name	MinMax_Pumps_RMT1
	MinMax	MAX
MinMax	Name	MinMax_Valves_RMT1
	MinMax	MIN
ValveCurve	Name	ValveCurve_RMT1
	exp	1.0
	Scaling_L_Min	500
PumpPress	Name	PumpPress_RTM1
	Press_Gain	1.0
MUL	Name	MUL_RMT1_Out
	X1	-1.0

Table 4–8 RMT1

Component	Property	Value
ADD	Name	ADD_sum_flow_RMT1
INT	Name	INT_RMT1
	UL	500.0
m3ToLiter	Name	m3ToLiter_RMT1
Selection	Name	Selection_RMT1_empty
	X1	100
Connector	Name	LI111/PV
Connector	Name	RMT1_empty

Table 4–9 Fill RMT1 finished?, For Dosing Control, Flow into Reactor1

Component	Property	Value
m3ToLiter	Name	m3ToLiter_FD111/PV
Connector	Name	FD111_PV
Connector	Name	RMT1_to_Reactor_1
Compare	Name	Compare_Fill_RMT1_finished
	X2	450.0
	Comparison	>

14. Save and close the chart “RMT1”.

4.2.4 Creating the Chart “RMT2”

The purpose of the chart is to simulate the physical model of the raw material tank “RMT2”.

In the application example given here, the capacity of the raw material tank is simulated according to the following formula:

$$V = \int \dot{V}_{in} + \dot{V}_{out}\, dt$$

The chart “RMT2” is created using components from the FLOWNET library.
The FLOWNET library contains components for creating the simulation of piping networks. You can find a detailed description of piping networks and components in the FLOWNET library in chapter 7 “The FLOWNET Library” in the manual “SIMIT V8.1” (\6\).

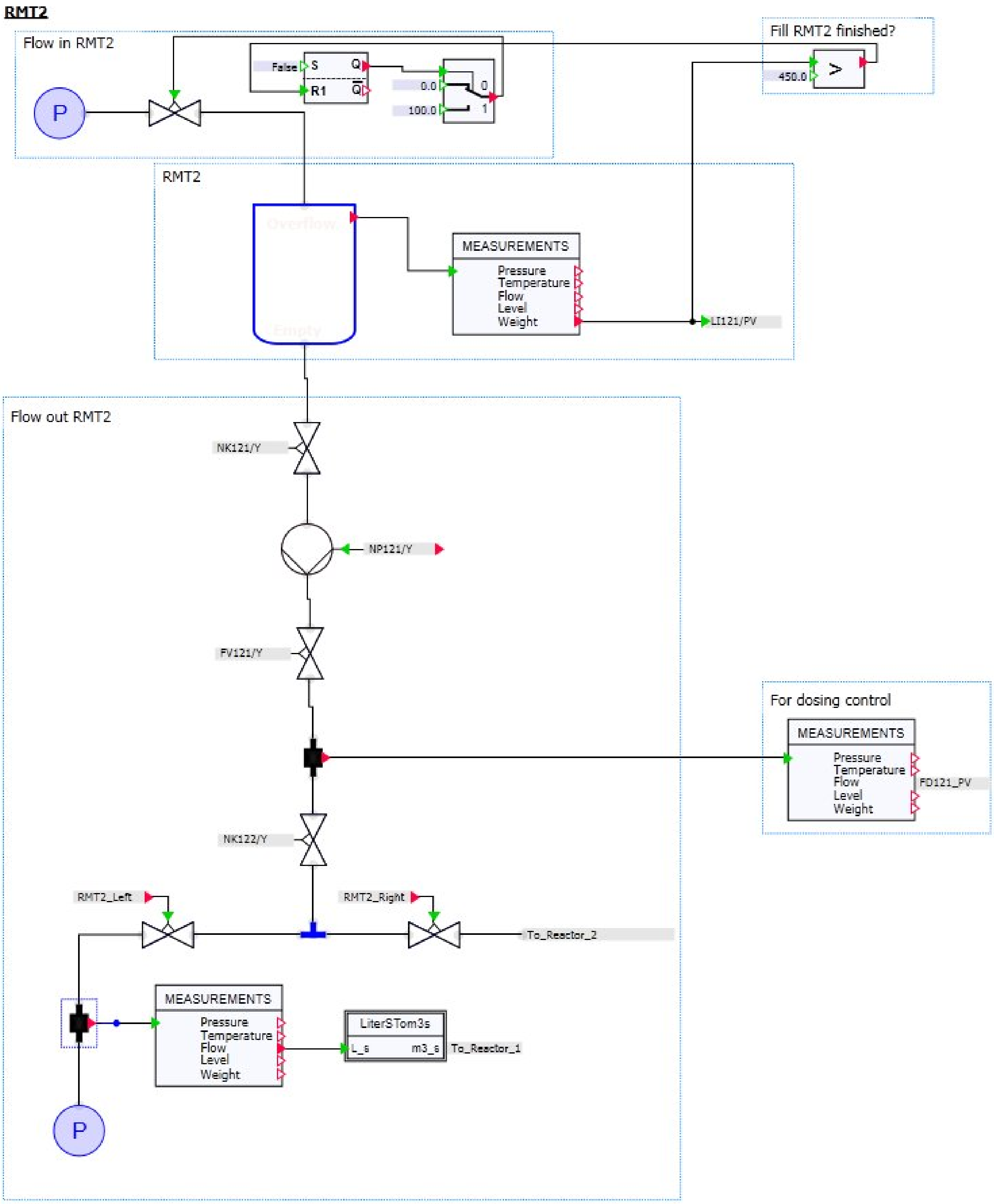
Procedure

The following section will describe the creation procedure.

1. Create a new chart in the folder “Plant1”.
2. Rename it “RMT2”.
3. Insert the relevant components into the chart (see the figure below).

4. Interconnect the components as shown in the following figure.

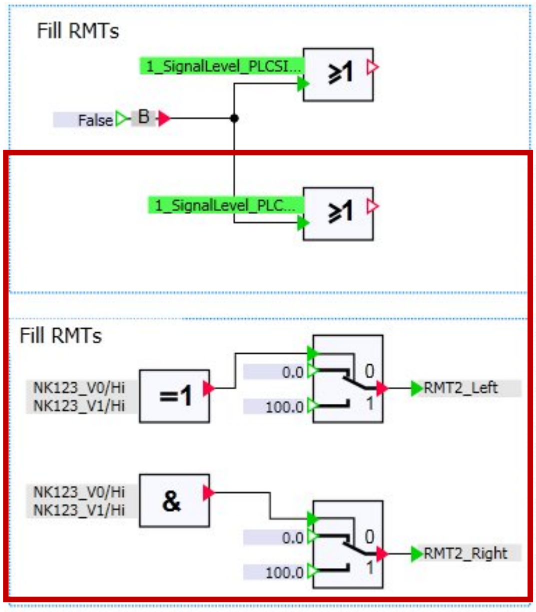
Figure 4–8



5. Open the chart “Connections”.
6. Insert the components with a red frame in the figure into the chart.

7. Interconnect the components as shown in the following figure.

Figure 4–9



8. Adjust the properties of the components as summarized in the table below.

Table 4–10

Component	Property	Value
Output	Signal	1_SignalLevel_PLCSIM_AS1 DO_RMT2_Filling
2x Connector	Name	NK123_V0/Hi
2x Connector	Name	NK123_V1/Hi
XOR	Name	XOR_RMT2_Left
AND	Name	AND_RMT2_Right
Selection	Name	Selection_RMT2_Left
	X1	100.0
Selection	Name	Selection_RMT2_Right
	X1	100.0
Connector	Name	RMT2_Left
Connector	Name	RMT2_Right

9. Save and close the chart “Connections”.
10. Open the chart “RMT2”.
11. Adjust the properties of the components as summarized in the table below.

Table 4–11 Flow in RMT2

Component	Property	Value
PnodeLiquid	Name	PnodeLiquid_In_RMT2
	Pressure	4.0
Valve	Name	Valve_Fill_RMT2
	Cvs	55.0
	ShowFlow	True
	ShowFlowDirection	True
RS_FF	Name	RS_FF_Fill_RMT2
	S	OR_Fill_RMT2 OUT
Selection	Name	Selection_Fill_RMT2
	X1	100.0

Table 4–12 RMT2

Component	Property	Value
StorageTankLiquid	Name	StorageTankLiquid_RMT2
	Volume	0.5
	Height	5.0
	LevelInit	0.0
Measurements	Name	Measurements_LI121
Connector	Name	LI121/PV

Table 4–13 Flow out RMT2

Component	Property	Value
Valve	Name	Valve_NK121
	ShowFlow	True
	ShowFlowDirection	True
Pump	Name	Pump_NP121
	NominalPressure	4.5
	NominalMassflow	3
	ShowFlow	True
Connector	Name	NP121/Y
Valve	Name	Valve_FV121
	Cvs	30.0
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	FV121/Y
PipeMeasure	Name	PipeMeasure_Dosing_control_FD121
Valve	Name	Valve_NK122
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	NK122/Y
JointLiquid	Name	JointLiquid_RMT2_Flow_out

Component	Property	Value
Valve	Name	Valve_RMT2_Right
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	RMT2_Right
Topology	Name	To_Reactor_2
Valve	Name	Valve_RMT2_Left
	ShowFlow	True
	ShowFlowDirection	True
PipeMeasure	Name	PipeMeasure_Flow_into_Reacor1
Measurements	Name	Measurements_Flow_into_Reactor
LiterSTom3s	Name	LiterSTom3s_Flow_into_Reactor1
Connector	Name	RMT2_to_Reactor_1
PnodeLiquid	Name	PnodeLiquid_Flow_out_RMT2

Table 4–14 Fill RMT2 finished?, for dosing control

Component	Property	Value
Compare	Name	Compare_Fill_RMT2_finished
	X2	450.0
	Comparison	>
Measurements	Name	Measurements_FD121
Connector	Name	FD121_PV

12. Save and close the chart “RMT2”.

4.2.5 Creating the Chart “RMT3”

The purpose of the chart is to simulate the physical model of the raw material tank “RMT3”.

In the application example given here, the capacity of the raw material tank is simulated according to the following formula:

$$V = \int \dot{V}_{in} + \dot{V}_{out} \, dt$$

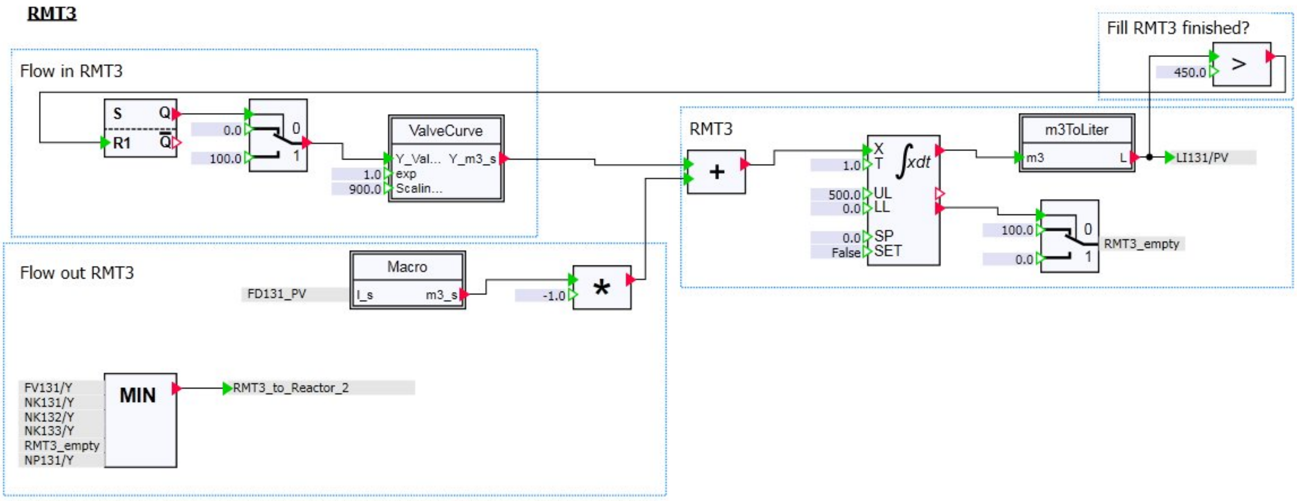
Procedure

The following section will describe the creation procedure.

1. Create a new chart in the folder “Plant1”.
2. Rename it “RMT3”.
3. Open the chart “RMT1”.
4. Select all of the components and copy them.
5. Close the chart “RMT1”
6. Insert the copied components into the chart “RMT3”.

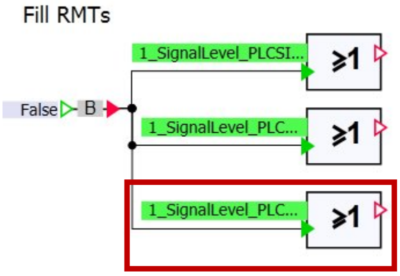
7. Remove the following components:
   - Connector “NP1111_Red/Y“
   - MinMax “MinMax_Pumps_RMT1”
   - PumpPress “PumpPress_RTM1”
   - ValveCurve “ValveCurve_RMT1”
   - m3ToLiter “m3ToLiter_FD111/PV”
8. Connect the connector “NP111/Y” to the component “MinMax_Valves_RMT3”, as shown in the following figure.
9. Insert the macro “LiterSTom3s” and connect it as shown in the following figure.

Figure 4–10



10. Open the chart “Connections”.
11. Insert the components with a red frame in the figure into the chart.
12. Interconnect the components as shown in the following figure.

Figure 4–11



13. Adjust the properties of the components as summarized in the table below.

Table 4–15

Component	Property	Value
Output	Signal	1_SignalLevel_PLCSIM_AS1 DO_RMT3_Filling
OR	Name	OR_Fill_RMT3

14. Save and close the chart “Connections”.
15. Open the chart “RMT3”.
16. Adjust the properties of the components as summarized in the table below.

Table 4–16 Flow in RMT3

Component	Property	Old value	New value
RS_FF	Name	RS_FF_Fill_RMT1	RS_FF_Fill_RMT3
	S	OR_Fill_RMT1	OR_Fill_RMT3
Selection	Name	Selection_Fill_RMT1	Selection_Fill_RMT3
ValveCurve	Name	ValveCurve_Fill_RMT1	ValveCurve_Fill_RMT3

Table 4–17 Flow out RMT3

Component	Property	Old value	New value
Connector	Name	FV111/Y	FV131/
Connector	Name	NK111/Y	NK131/
Connector	Name	NK111/Y	NK132/
Connector	Name	NK111/Y	NK133/
Connector	Name	RMT1_empty	RMT3_empty
MinMax	Name	MinMax_Valves_RMT1	MinMax_Valves_RMT3
Connector	Name	NP111/Y	NP131/Y
MUL	Name	MUL_RMT1_Out	MUL_RMT3_Out
Connector	Name	FD111_PV	FD131_PV
LiterSTom3s	Name	LiterSTom3#1	LiterSTom3s_RTM3
Connector	Name	RMT1_to_Reactor_1	RMT3_to_Reactor_2

Table 4–18 RMT3

Component	Property	Old value	New value
ADD	Name	ADD_sum_flow_RMT1	ADD_sum_flow_RMT3
INT	Name	INT_RMT1	INT_RMT3
m3ToLiter	Name	m3ToLiter_RMT1	m3ToLiter_RMT3
Selection	Name	Selection_RMT1_empty	Selection_RMT3_empty
Connector	Name	LI111/PV	LI131/PV
Compare	Name	Compare_Fill_RMT1_finished	Compare_Fill_RMT3_finished

4.3 Model Plant Section “Plant2”

The following section will describe the development of the process model for the plant section “Plant2”. The plant section “Plant2” describes the reactors and dosage into the reactors of plant section “Plant3”. The plant section consists of two reactors. Modeling for “Reactor1” takes place with a reactor component created with the CTE tool and with components from the standard library. “Reactor2” is created with components of the FLOWNET library. Macros created previously are used for calculations which occur repeatedly.

4.3.1 Preparation

The reactor component “StirredTankReactor” must be created with the CTE tool first of all, to be able create the chart for the “Reactor1” process model in SIMIT.

You can find the model equations for the component “StirredTankReactor” in the application example “Simulation of a PCS 7 stirred tank reactor with SIMIT simulation framework” chapter 2.4 “Simulation of a process”. In the application example given here, these have been adapted and simplified.
You can find information regarding the creation of your own components and the syntax in the CTE tool in the "SIMIT - Component Type Editor" manual.

You can open the component “StirredTankReactor” with the CTE tool, look at the source code and, if required, adapt it.

4.3.2 Creating the Chart “Reactor1”

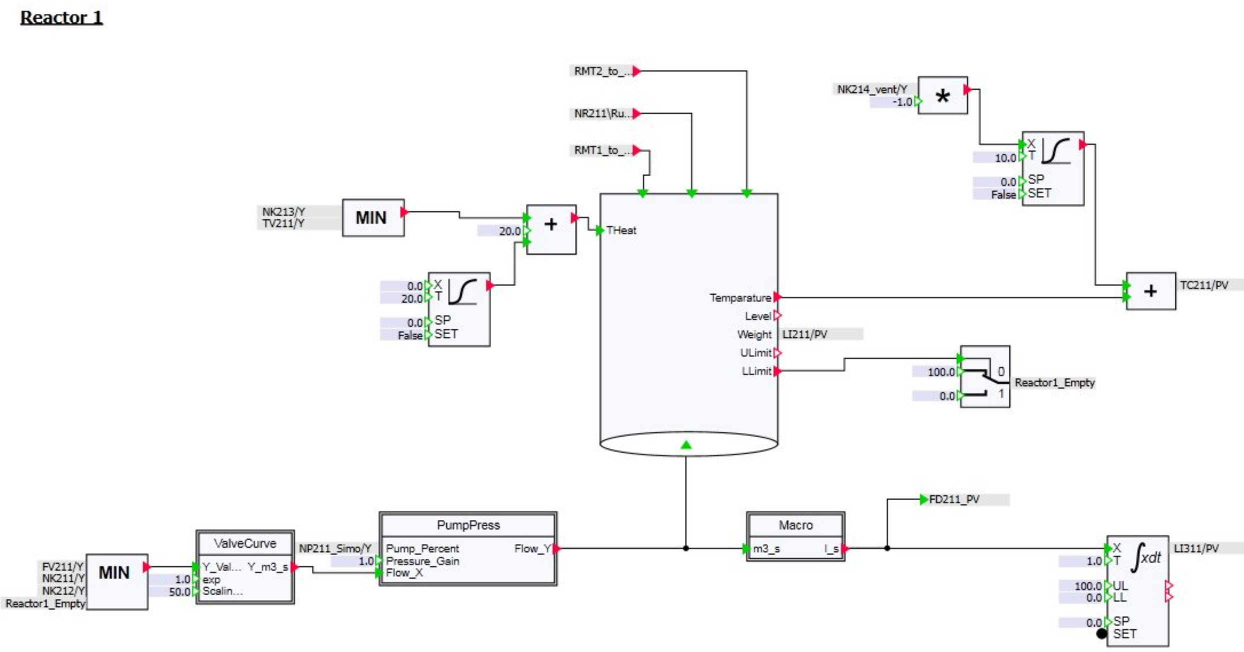
The purpose of the chart is to simulate the physical model of the reactor “Reactor1”.

Procedure

1. Create the folder “Plant2” in the folder “3_ProcessLevel”.
2. Create a new chart in the folder “Plant2”.
3. Rename it “Reactor1”.
4. Insert the relevant components into the chart (see the figure below).

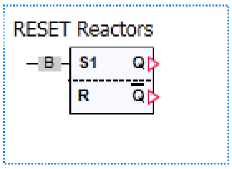
5. Interconnect the components as shown in the following figure.

Figure 4–12



6. Open the chart “Connections”.
7. Insert the components shown in the following figure into the chart.
8. Interconnect the components as shown in the following figure.

Figure 4–13



9. Adjust the properties of the components as summarized in the table below.

Table 4–19

Component	Property	Value
BConnector	Name	Bconnector_RESET_Reactors
SR_FF	Name	SR_FF_RESET_Reactors

1. Close the chart “Connections”.
2. Open the chart “Reactor1”.
3. Adjust the properties of the components as summarized in the table below.

Table 4–20

Component	Property	Value
Connector	Name	FV211/Y
Connector	Name	NK211/Y
Connector	Name	NK212/Y
Connector	Name	Reactor1_Empty
MinMax	Name	MinMax_FlowOut_Reactor1
	Parameter	MIN
ValveCurve	Name	ValveCurve_Reactor1
	Exp	1.0
	Scaling_L_Min	50
PumpPress	Name	PumpPress_Reactor1
Connector	Name	TV211/Y
Connector	Name	NK213/Y
MinMax	Name	MinMax_Temperature_Reactor1
	Parameter	MIN
PTn	Name	PTn_Disturb_Temp_Reactor1
	T	20.0
ADD	Name	ADD_Heating_Reactor1
	X2	20.0
StirredTankReactor	Name	StirredTankReactor_Reactor1
	SET	Connection to Bconnector_RESET_Reactors OUT
	Volume	1.2
	Height	5.0
	ULimit	Connection to SR_FF_RESET_Reactors R
Connector	Name	LI211/Y
Connector	Name	NK214_vent/Y
MUL	Name	MUL_Temp_Reactor1
	X2	-1.0
PTn	Name	PTn_Vent_Reactor1
	T	10.0
Selection	Name	Selection_Reactor1_Empty
	X0	100

Component	Property	Value
Connector	Name	Reactor1_Empty
m3sToLiters	Name	m3sToLiters_Reactor1
Connector	Name	FD211_PV
ADD	Name	ADD_Temp_Reactor1
NOTc	Name	NOTc_INT_Reactor_LI311
	IN	Connection to Conv2 SensorA2
INT	Name	INT_LI311
Connector	Name	TC221/PV
Connector	Name	LI311/PV

4. Close the chart “Reactor1”.

4.3.3 Creating the Chart “Reactor2”

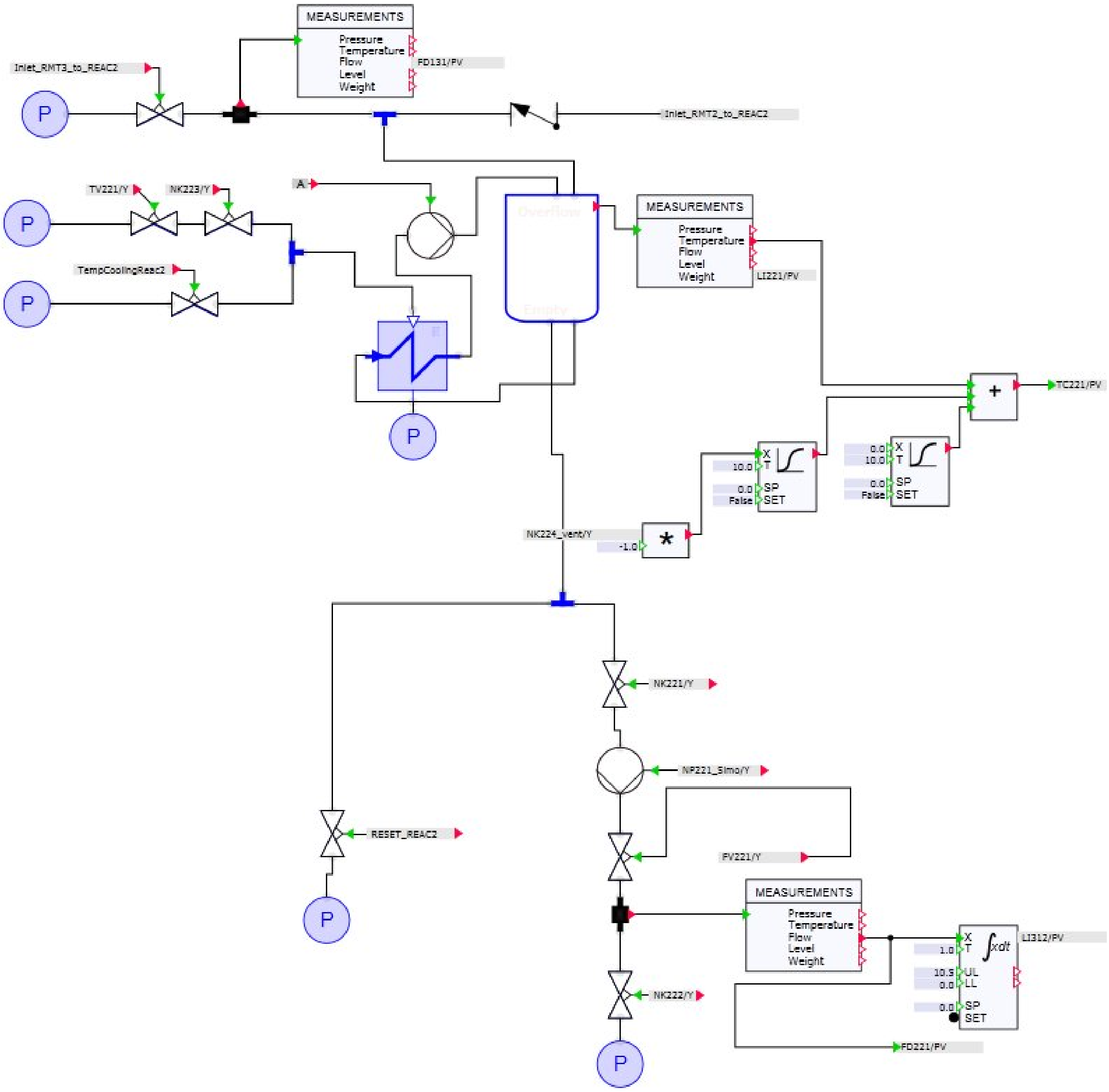
The purpose of the chart is to simulate the physical model of the reactor “Reactor2”.

Procedure

1. Create a new chart in the folder “Plant2”.
2. Rename it “Reactor2”.
3. Insert the relevant components into the chart (see the figure below).

4. Interconnect the components as shown in the following figure.

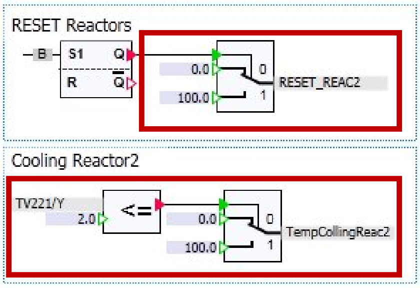
Figure 4–14



5. Open the chart “Connections”.
6. Insert the components shown in the following figure into the chart (in a red frame).

7. Interconnect the components as shown in the following figure.

Figure 4–15



8. Adjust the properties of the components as summarized in the table below.

Table 4–

Component	Property	Value
Selection	Name	Selection_RESET_Reactor2
	X1	100
Connector	Name	RESET_REAC2
Connector	Name	TV221/Y
Compare	Name	Compare_TV221
	X2	2.0
	Comparison	<=
Selection	Name	Selection_Cooling_Reac2
	X1	100
Connector	Name	TempCoolingReac2

9. Close the chart “Connections”.
10. Open the chart “Reactor2”.
11. Adjust the properties of the components as summarized in the table below.

Table 4–21

Component	Property	Value
PnodeLiquid	Name	PnodeLiquid_Inlet_RMT3_to_Reac2
	Pressure	40.0
PnodeLiquid	Name	PnodeLiquid_for_Heating_Liquid
	Pressure	50.0
	Temperature	200.0
PnodeLiquid	Name	PnodeLiquid_for_Heating_Liquid
	Pressure	50
Valve	Name	Valve_RMT3_to_Reactor_2
	CVs	30.0
	ShowFlow	True
	ShowFlowDirection	True

Component	Property	Value
Connector	Name	RMT3_to_Reactor_2
Valve	Name	Valve_TV221/Y
	CVs	360.0
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	TV221/Y
Valve	Name	Valve_NK223/Y
	CVs	360.0
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	NK223/Y
Valve	Name	Valve_TempCoolingReac2
	CVs	360.0
	ShowFlow	True
	ShowFlowDirection	True
PipeMeasure	Name	PipeMeasure_RMT3_to_Reactor_2
Measurement	Name	Measurement_FD131
Connector	Name	FD131_PV
JointLiquid	Name	JointLiquid_Temp_Reac2
AConst	Name	AConst_Pump_Heating
	Constant	100.0
JointLiquid	Name	JointLiquid_SUM_Inlet_to_Reac2
Pump	Name	Pump_Heating
	ShowFlow	True
HeatExchangerLiquid	Name	HeatExchangerLiquid_Reac2
	VolumeTS	1.2
PnodeLiquid	Name	PnodeLiquid_HeatExange_Out
	Pressure	0.1
StopValve	Name	StopValve_RMT2_to_Reactor_2
	CVs	30.0
Topology	Name	To_Reactor_2
StorageTankLiquid	Name	Reactor2
	Volume	1.2
	Height	5.0
	NbrOfStubs	4
Measurements	Name	Measurements_Reactor2
JointLiquid	Name	LI221/PV
MUL	Name	MUL_Reactor2
	X2	-1.0
Connector	Name	NK224_vent
PTn	Name	PT1_Reac2_NK224_vent
	T	10.0

Component	Property	Value
PTn	Name	PT1_Disturb_Reac2
	T	10.0
ADD	Name	ADD_Temp_Reactor2
JointLiquid	Name	JointLiquid_Outlet_Reac2
Valve	Name	ResetValve_Reac2
	CVs	360.0
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	RESET_REAC2
PnodeLiquid	Name	PnodeLiquid_Reset_Reac2
Valve	Name	Valve_NK221
	CVs	3.0
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	NK221/Y
Pump	Name	Pump_NP221
	NominalPressure	4.5
	NominalMassflow	1.0
	ShuwFlow	True
Connector	Name	NP221_Simo/Y
Valve	Name	Valve_FV221
	CVs	0.5
	ShowFlow	True
	ShowFlowDirection	True
Connector	Name	FV221/Y
PipeMeasure	Name	PipeMeasure_FD221
Valve	Name	Valve_NK222
	CVs	3.0
	ShowFlow	True
	ShowFlowDirection	True
PnodeLiquid	Name	PnodeLiquid_to_Plant3
Measurements	Name	Measurements_FD221
Connector	Name	FD221_PV
NOTc	Name	NOTc_LI312
	IN	Connection to Conv2-SensorA2 OUT
INT	Name	LI132
	UL	10.5
Connector	Name	LI312/PV

12. Close the chart “Reactor2”.

4.4 The Current Status of your Project

At the current state of your project you can already test the program of the AS. So far you have created all actuators and sensors in the folder “2_DeviceLevel", and associated their inputs and outputs with the symbolic addresses. Besides this, there are replicas of your plant's physical processes in the “3_ProcessLevel" folder.

5 Simulation of the Conveyor System

In chapter 3 you created the conveyor system with the components from the CONTEC library and derived the simulation of the drives with the function “Generating the Device Level”. The following procedure describes how to interconnect the sensors and model the goods conveyed.

5.1 Modeling the Goods Conveyed

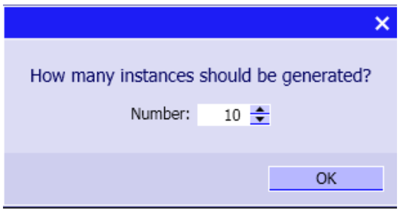
The CONTEC library makes the relevant components available for the simulation of the goods conveyed. These can be used to model the goods conveyed.

5.1.1 Creating the List of Goods Conveyed

An inventory of goods to be conveyed is compiled into a materials list for the simulation. Proceed as follows to create this:

1. In the Project window, open the “Material" folder.
2. Double-click “New list”. A new list is created and opened in the workplace.
3. Open the “MATERIAL" folder in the CONTEC library.
4. Drag and drop the component “CBoxDS256” onto the workplace by holding down the “Alt” key.
5. In the window “How many instances should be created?”, set the number to 10 and click “OK”.

Figure 5–1



6. Set the “SizeOfStorage" parameter for the goods conveyed to 8.
7. Save and close the list.

5.1.2 Calculating the Color of the Goods Conveyed

In the application example given here, the goods conveyed constitute beverage crates. Depending on the color of the beverage crate, the relevant drink is filled into bottles. The component “BoxProperty” assists in assigning or reading the color of the beverage crate. The component is not part of the CONTEC library and was created using the CTE tool. The application example given here does not describe the creation process.

Besides the component “BoxProperty”, the application example given here contains two other components which are not part of a SIMIT library.

- “CompareBox”
- “CompareMix”

Component “BoxProperty”

The component “BoxProperty” invokes system functions which enable access to the simulation of the goods conveyed. When the conveyed goods are created by the “Conveyor” component in the CONTEC library, the conveyed goods are assigned a unique ID. This can be read, for example, using the output “SensorIdA1”. The component “BoxProperty” has read or write access to the conveyed goods.

Note You can find information regarding the system functions of the CONTEC library in chapter “7.3.4.3 System functions” in the manual “SIMIT (V8.1)”.

The “BoxProperty” component has the input “Id” which enables the sensor of the “conveyor” component to read the Id. Furthermore, the component has the inputs “READ” and “WRITE”. If the input “WRITE” is active, then the information present at the other inputs of “BoxProperty” is written to the memory and the properties of the conveyed goods. This includes the values for the inputs “R”, “G”, and “B”. With these values, the color of the conveyed goods in the simulation is defined.

Note You can find information regarding the properties of the conveyed goods (e.g. color of conveyed goods) in chapter 7.3.3.4 “Component types for the simulation of conveyed goods” in the handbook “SIMIT (V8.1)”.

In the application example given here, an additional Id is written to memory which represents the color of the goods conveyed.

- Id “10” red
- Id “20” green
- Id “30” blue

If the input “READ” is active, then the memory of the item conveyed is read. Which item conveyed is read, depends on the Id of the item conveyed. This is transferred to the “BoxProperty” component with the aid of the “Conveyor” component sensors.

The information from the memory is written to the outputs of the “BoxProperty” component and can be used there for further processing. The Color-Id is read in the application example given here.

“CompareBox” Component

The component “CompareBox” imports a number at input X. The outputs are then written using the number. The outputs relate to the color inputs of the item conveyed. Furthermore, the Id of each color is written to the output “Id”.

“CompareMix” Component

The “CompareMix” component imports the color-Id and reveals at the output whether it is cola, orange-lemonade or a mix of both.

5.1.3 “Calc” Chart

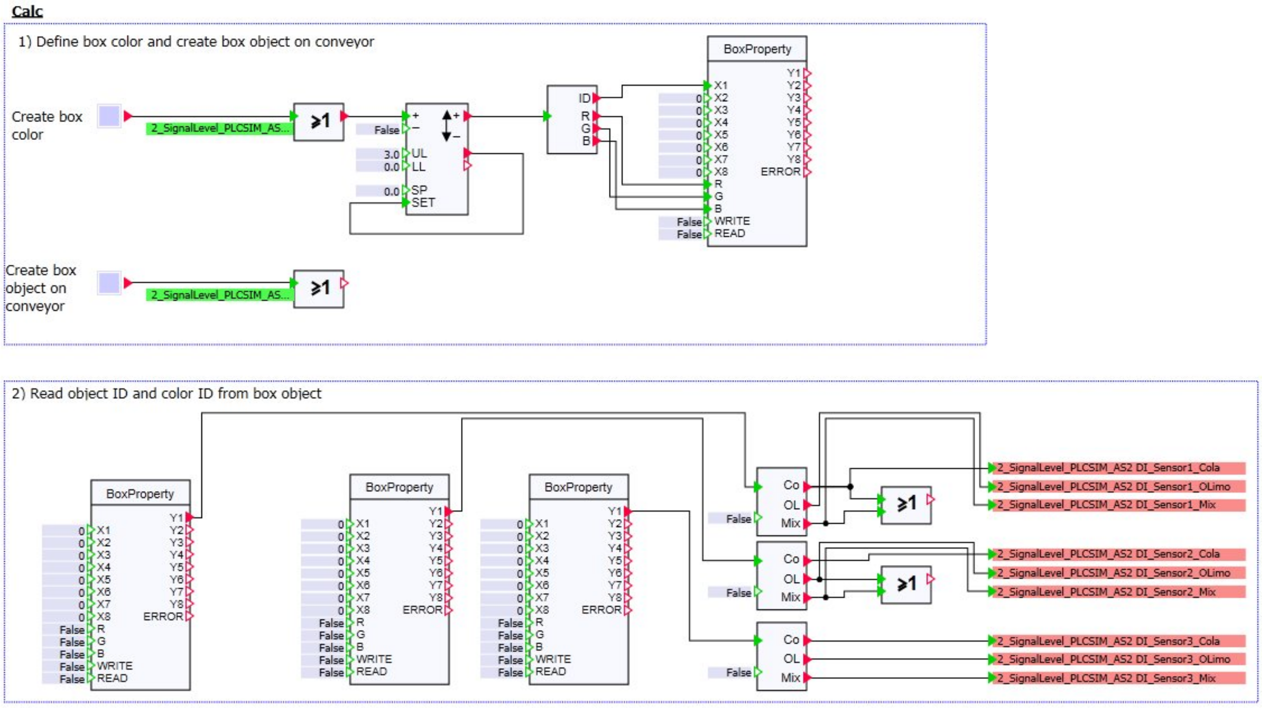
The purpose of the “Calc” chart is to model the color of the item conveyed.
It contains the components described in chapter 5.1.2. Besides modeling the color of the item conveyed, the conveyor system’s sensors also analyze the Ids entered. The following section will describe the procedure for creating the chart.

Procedure

1. Create a new folder in the folder “ProcessLevel”.
2. Rename it “Conveyor”.
3. Move the chart “Conveyor_sim”, which you have already created (see chapter 3.2.2.) into the folder “Conveyor”.
4. Create another folder in the folder “Conveyor”.
5. Rename it “Misc”.
6. Create a new chart in the folder “Misc”.
7. Rename it “Calc”.
8. Open the chart.
9. Insert the relevant components into the chart (see the figure below).

10. Interconnect the components as shown in the following figure.

Figure 5–2



11. Adjust the properties of the components as summarized in the table below.

Table 5–1 Define box color and create box object on conveyor

Component	Property	Value
Pushbutton	Name	Pushbutton_CreateBoxColor
Output	Signal	2_SignalLevel_PLCSIM_AS2 DO_ConvSpure_S_AD
OR	Name	OR_CreateBoxColor
Counter	Name	Counter_CreateBoxColor
	UL	3.0
CompareBox	Name	CompareBox_CreateBoxColor
BoxProperty	Name	BoxProperty
	Id	Connection to Conv1 SensorIdA1
	WRITE	Connection to Conv1 SensorA1
Pushbutton	Name	Pushbutton_CreateBoxColor
Output	Signal	2_SignalLevel_PLCSIM_AS2 DO_PickUp
OR	Name	OR_CreateBoxObject
	OUT	Connection to Conv1 CreateObject

Table 5–2 Read object ID and color ID from box object

Component	Property	Value
BoxProperty	Name	BoxProperty_ReadIDs_Conv2_A1
	Id	Connection to Conv2 SensorIdA1
	READ	Connection to Conv2 SensorA1
BoxProperty	Name	BoxProperty_ReadIDs_Conv2_A2
	Id	Connection to Conv2 SensorIdA2
	READ	Connection to Conv2 SensorA2
BoxProperty	Name	BoxProperty_ReadIDs_Conv2_A3
	Id	Connection to Conv2 SensorIdA3
	READ	Connection to Conv2 SensorA3
CompareMix	Name	CompareMIX_Conv2_A1
	Sin	Connection to Conv2 SensorA1
CompareMix	Name	CompareMIX_Conv2_A2
	Sin	Connection to Conv2 SensorA2
CompareMix	Name	CompareMIX_Conv2_A3
	Sin	Connection to Conv2 SensorA3
OR	Name	OR_Cola_or_Mix
OR	Name	OR_OLimo_or_Mix
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor1_Cola
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor1_OLimo
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor1_Mix
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor2_Cola
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor2_OLimo
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor2_Mix
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor3_Cola
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor3_OLimo
Input	Signal	2_SignalLevel_PLCSIM_AS2 DI_Sensor3_Mix

12. Save and close the chart “Calc”.

5.2 The Current Status of your Project

At the current state of your project you can test the automation of the conveyor system.

6 Animation of the Crown Cap Machine

Besides the simple two-dimensional animation of graphic elements, SIMIT gives you the option to create three-dimensional animations. The three-dimensional animation of the crown cap machine is created below.

6.1 Creating the 3D Viewer Control

The 3D viewer control (Taskcard Control) is contained in the basic library of SIMIT. 3D animations can be created quickly and easily with this control, as it gives you the option to import the geometry model of machines from a CAD system. The import requirement is that the model has been exported in the format VRLM V2.0.

Note

The description given here does not cover the generation of the geometry model.

You can find further information regarding the 3D viewer control and the data format requirement in chapter 7.1.7.4 “The 3D Viewer Control” in the SIMIT manual (V8.1) (/6/).

Procedure

1. Create a new chart in the folder “Conveyor”.
2. Rename it “3D_CrownCap”.
3. Open the chart.
4. Insert the component “3D viewer” from the task card “Controls”.
5. Adjust the properties of the components as summarized in the table below.

Table 6-1

Component	Property	Value
3D-Viewer	Name	CrownCapMaschine
	X	160
	Y	15
	Width	520
	Height	695
	3D model	MASCHINE.wrl

Note

The file “MASCHINE.wrl” belongs to the ZIP files “77362399_PROJ_SIMIT_V81_Bottling.zip” which is available for download from the article page.

6. Save and close the chart.

6.2 Creating the Animation

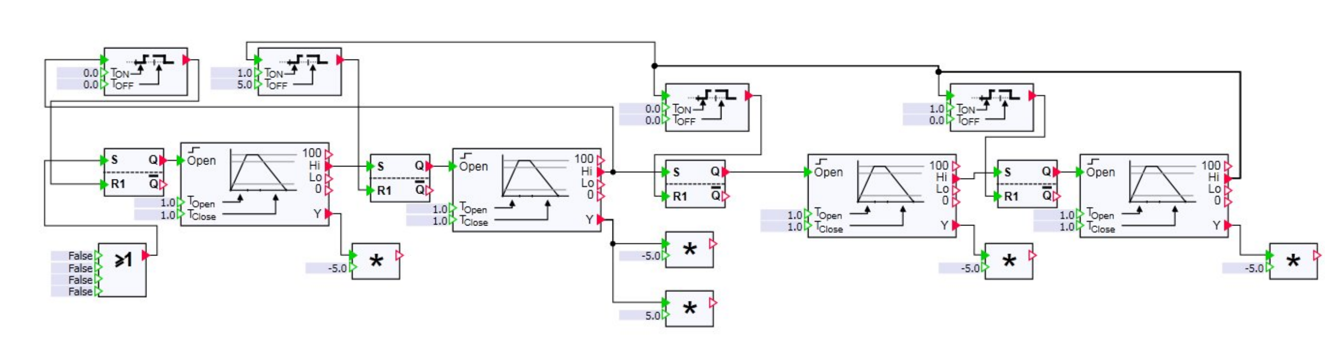
After you have integrated the geometry model of the machine into the 3D viewer control, it will have various connectors (see properties of the 3D viewer control “CrownCapMachine”). These can be used to address and animate the model. For the animation, the movements of the individual machine parts are modeled using standard library components. The animation begins as soon as a item has left the conveyor line.

The following section will describe the procedure for creating the animation.

Procedure

1. Create a new chart in the “Misc” folder of the “Conveyor” folder.
2. Rename it “AnimationControl”.
3. Open the chart.
4. Insert the relevant components into the chart (see the figure below).
5. Interconnect the components as shown in the following figure.

Figure 6–1



6. Adjust the properties of the components as summarized in the table below.

Table 6–2

Component	Property	Value
Delay	Name	Delay_sonsor_z_axis_TY_move_back
RS_FF	Name	RS_FF_sonsor_z_axis_TY
OR	Name	OR_start_animation
	IN1	Connection to Conv5 SensorA2
	IN2	Connection to Conv3 SensorA3
	IN3	Connection to Conv7 SensorA2
DriveV1	Name	DriveV1_sonsor_z_axis_TY
MUL	Name	MUL_sonsor_z_axis_TY
	X2	-5.0

Component	Property	Value
Delay	Name	Delay_doors_close
	T_ON	1.0
	T_OFF	5.0
RS_FF	Name	RS_FF_door_sensors
DriveV1	Name	DriveV1_door_sensors
MUL	Name	MUL_door_sensor_left_TX
	X2	-5.0
MUL	Name	MUL_door_sensor_right_TX
	X2	5.0
Delay	Name	Delay_sensor_y_axis_TX_move_back
RS_FF	Name	RS_FF_sonsor_y_axis_TX
DriveV1	Name	DriveV1_sonsor_y_axis_TX
MUL	Name	MUL_sonsor_y_axis_TX
	X2	-5.0
Delay	Name	Delay_sonsor_x_axis_TX_move_back
	T_ON	1.0
RS_FF	Name	RS_FF_sonsor_x_axis_TX
DriveV1	Name	DriveV1_sonsor_x_axis_TX
MUL	Name	MUL_sonsor_x_axis_TX
	X2	-5.0

7. Save and close the chart “AnimationControl”.
8. Open the chart “3D_CrownCap”.
9. Select the 3D viewer control components and adjust the properties according to the table below.

Table 6–3

Component	Property	Value
CrownCapMaschine	Sensor_X-axis#TX	Connection to MUL_sonsor_x_axis_TX Y
	Sensor_Y-axis#TX	Connection to MUL_sonsor_y_axis_TX Y
	Sensor_Z-axis#TX	Connection to MUL_sonsor_z_axis_TY Y
	Door_sensor_left#TX	Connection to MUL_door_sensor_left_TX Y
	Door_sensor_right#TX	Connection to MUL_door_sensor_right_TX Y

10. Save and close the chart.

6.3 The Current Status of your Project

At the current state of your project you have created a 3D viewer control and integrated a corresponding geometry model. In addition, you have created animation for the 3D viewer control.

Configuration is complete at this point. The following section will introduce you to the scripts and snapshots contained in the project.

In the example project given here, there are charts which contain other animations with graphic elements and controls which are not described in the application example given here. For this, some charts which were created throughout the application example, were adjusted. These adjustments are optional and not part of the description given here.

Note You can find information regarding graphic elements and controls in the SIMIT manual (V8.1) (/6/) and in the application example “SIMIT Getting Started” (/3/), in chapter 5 “Creating the graphical interface”.

7 Scripts and Snapshots

The example project given here contains three scripts and a snapshot.
The following section describes the functions of the scripts and snapshots. Both of these functions offer great advantages when developing an Operator Training System.

7.1 Scripts

SIMIT gives you the opportunity to influence the simulation by using the Automatic Control Interface with automated scripts. This allows you to create situations such as the overheating of a reactor. Furthermore, scripts can be used to create snapshots. This allows you to create a plant status with a script and then save it as a snapshot. Furthermore, you can create log files with measurement values for the period of time that a script is running. This allows you to determine, for example, the operator reaction time required to prevent, for example, the overheating of a reactor.

Creating Scripts

Scripts are created in the folder “Scripting” in the project window. These can be created before the simulation starts or during the simulation. Changes can be made to the scripts throughout the simulation. To create a script, open the folder “Scripting” and execute the function “New script”. You can enter the commands in the editor window and if the simulation is running, you can start the script using the “Start script” button.

Note For detailed information about creating and starting scripts and commands, please refer to chapter 6 "the Automatic Control Interface (ACI)" of the "SIMIT (V8.1)” operating manual.

“LeanPIDTest” Script

A simple control test for temperature regulation of “Reactor1” can be carried out using the “LeanPIDTest” script. After the script has started, a log file is created. The start date and start time are recorded in the log file. A query appears to check whether the target value of 10°C is set on the regulator. If the response is “yes”, a plot of the actuating value is created for the valve TV211. After a period of 20,000 cycles, a disturbance of 10°C is added to the temperature value TC211 for another 20,000 cycles. At the end, the disturbance is removed and a snapshot “Lean-OTS” is created.

Note The paths specified in the script can be adjusted, if required.

Script "Reactor1OverHeating"

The overheating of "Reactor1" is simulated using "Reactor1OverHeating". After the script has started, a log file is created. The start date and start time are recorded in the log file. Then a disturbance variable is added to the reactor temperature. The disturbance variable is only removed when the operator opens the valve "NK214_vent" (in the WinCC Runtime). At the end of the script, the operator's reaction time is recorded in the protocol file.

Note The paths specified in the script can be adjusted, if required.

Script "Reactor2OverHeating"

The script "Reactor2OverHeating" corresponds to the script "Reactor1OverHeating". Only "Reactor2" is heated and reacts to valve "NK224_vent" being opened.

7.2 Snapshots

The snapshot "Lean-OTS" is included in the application example given here. This was created automatically by the script "LeanPIDTest". It can be created manually using the function "Snapshots". You can select this in the menu "Simulation > Snapshots" by clicking the button "Snapshots" in the toolbar or in the folder "Snapshots" in the project window.

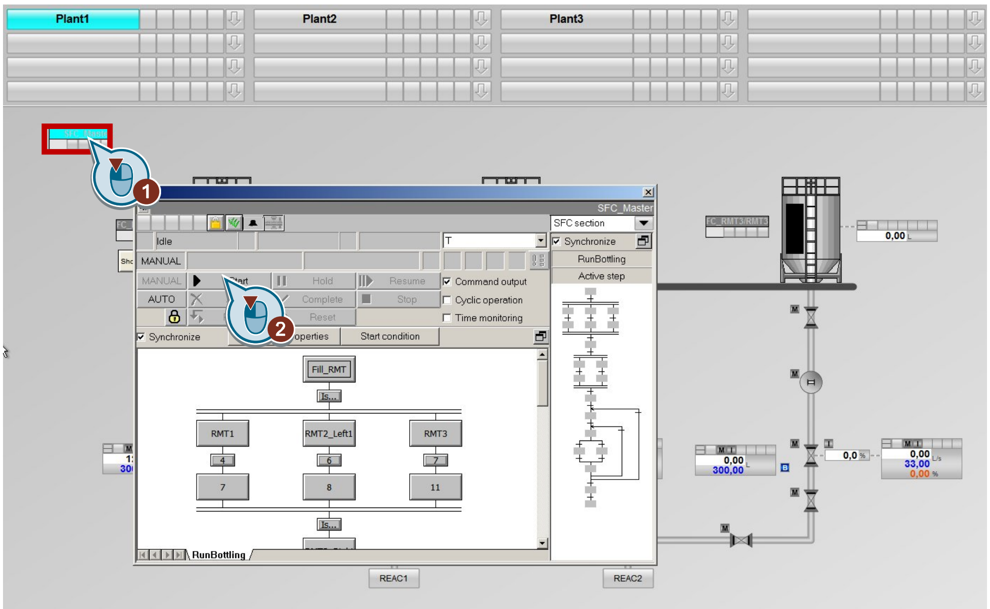
You can retain the plant status in a snapshot and reload it as often as you like.

8 Commissioning

The commissioning procedure for the SIMIT and PCS 7 project is described in detail in the application example “Simulation of a PCS 7 stirred tank reactor with SIMIT simulation framework” (\4\).

Start the SFC “SFC_Master” in the WinCC figure “Plant1” after you have started the simulation and the WinCC Runtime (see the following figure).

Figure 8–1



9 Related literature

Table 9–1

	Topic	Title
\1\	Siemens Industry Online Support	http://support.industry.siemens.com
\2\	Download page of this entry	https://support.industry.siemens.com/cs/ww/de/view/77362399
\3\	SIMIT Getting Started	https://support.industry.siemens.com/cs/ww/en/view/77362399
\4\	Simulation of a PCS 7 stirred tank reactor with SIMIT simulation framework	https://support.industry.siemens.com/cs/en/en/view/93148023
\5\	Process control system SIMATIC PCS 7 PCS 7 read-me V8.1 incl. SP1 (online)	https://support.industry.siemens.com/cs/ww/en/view/109474
\6\	Operating Manual “SIMIT (V8.1)”	https://support.industry.siemens.com/cs/de/en/view/93842565

10 History

Table 10–1

Version	Date	Modification
V1.0	10/2015	First edition