Calculating OEE using PM-ANALYZE

SIMATIC WinCC Professional V15
SIMATIC STEP 7 Professional V15
PM-ANALYZE V8.6.0.33

https://support.industry.siemens.com/cs/ww/de/view/109769969

Siemens Industry Online Support

Legal information

Use of application examples

Application examples illustrate the solution of automation tasks through an interaction of several components in the form of text, graphics and/or software modules. The application examples are a free service by Siemens AG and/or a subsidiary of Siemens AG ("Siemens"). They are non-binding and make no claim to completeness or functionality regarding configuration and equipment. The application examples merely offer help with typical tasks; they do not constitute customer-specific solutions. You yourself are responsible for the proper and safe operation of the products in accordance with applicable regulations and must also check the function of the respective application example and customize it for your system.
Siemens grants you the non-exclusive, non-sublicensable and non-transferable right to have the application examples used by technically trained personnel. Any change to the application examples is your responsibility. Sharing the application examples with third parties or copying the application examples or excerpts thereof is permitted only in combination with your own products. The application examples are not required to undergo the customary tests and quality inspections of a chargeable product; they may have functional and performance defects as well as errors. It is your responsibility to use them in such a manner that any malfunctions that may occur do not result in property damage or injury to persons.

Disclaimer of liability

Siemens shall not assume any liability, for any legal reason whatsoever, including, without limitation, liability for the usability, availability, completeness and freedom from defects of the application examples as well as for related information, configuration and performance data and any damage caused thereby. This shall not apply in cases of mandatory liability, for example under the German Product Liability Act, or in cases of intent, gross negligence, or culpable loss of life, bodily injury or damage to health, non-compliance with a guarantee, fraudulent non-disclosure of a defect, or culpable breach of material contractual obligations. Claims for damages arising from a breach of material contractual obligations shall however be limited to the foreseeable damage typical of the type of agreement, unless liability arises from intent or gross negligence or is based on loss of life, bodily injury or damage to health. The foregoing provisions do not imply any change in the burden of proof to your detriment. You shall indemnify Siemens against existing or future claims of third parties in this connection except where Siemens is mandatorily liable.
By using the application examples you acknowledge that Siemens cannot be held liable for any damage beyond the liability provisions described.

Other information

Siemens reserves the right to make changes to the application examples at any time without notice. In case of discrepancies between the suggestions in the application examples and other Siemens publications such as catalogs, the content of the other documentation shall have precedence.
The Siemens terms of use (https://support.industry.siemens.com) shall also apply.

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.
In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.
Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the Internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.
For additional information on industrial security measures that may be implemented, please visit https://www.siemens.com/industrialsecurity.
Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.
To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at: https://www.siemens.com/industrialsecurity.

© Siemens AG 2019 All rights reserved

Table of contents

© Siemens AG 2019 All rights reserved

© Siemens AG 2019 All rights reserved

1 Task

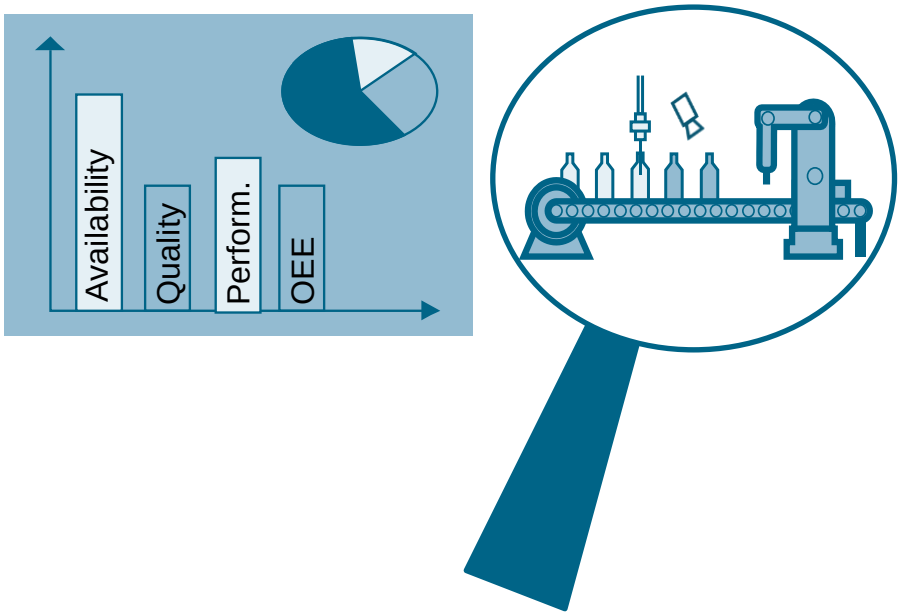
1.1 Overview

Description of the automation task

If a company is trying to decide whether to purchase equipment, restructure production lines or merely to implement optimizations, one needs reference points or indicators in order to be able to make a decision. Therefore, various machinery data such as cycle times, quality and output volume are recorded in order to evaluate the overall equipment effectiveness (OEE).

Overview of the automation task

Figure 1-1



1.2 Principle of operation

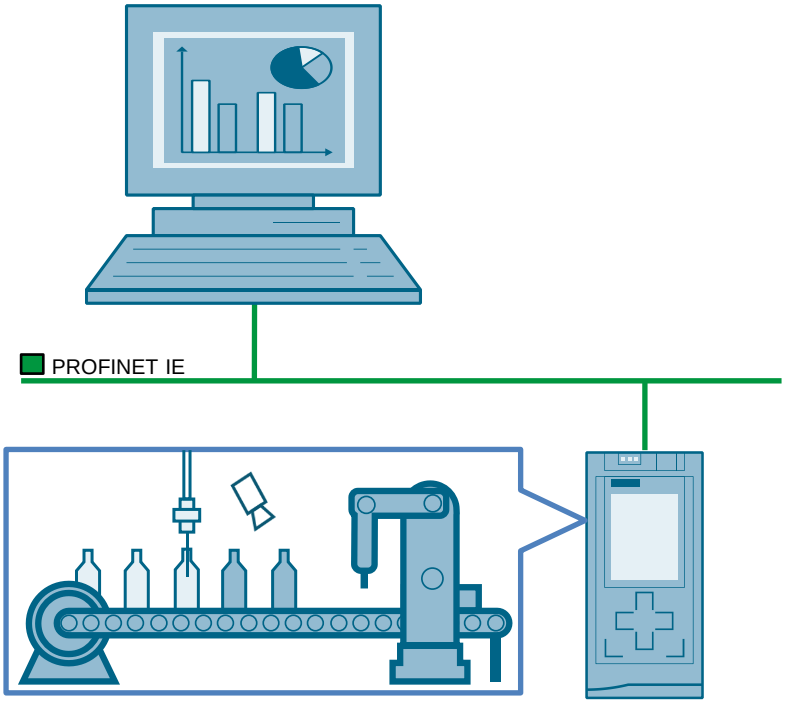
A PLC relays 4 measurement values (good parts, bad parts, machine status, and target performance) to PM-ANALYSE to calculate OEE. PM-ANALYZE then calculates the key figures Availability, Performance, Quality and OEE. These values can be visualized in the connection in the HMI. Individual figures are presented in an Excel report.

© Siemens AG 2019 All rights reserved

1.3 Solution

1.3.1 Configuration

Figure 1-2



Description

The PM-ANALYZE options package records data and calculates the overall equipment effectiveness (OEE). This value gives an exact indication of machine productivity and the overall production process in the company. Using PM-ANALYZE, you can identify weak points in production processes and derive the necessary optimization strategies, for instance "Total Productive Management", "Lean Production" or "Six Sigma".

Benefits

The solution presented here offers you the following advantages

- Identify discrepancies and potentials for optimization
- Drive down costs and reduce downtimes

Required knowledge

To implement the solution described in this document, basic knowledge of the following areas is assumed:

- Automation technology

© Siemens AG 2019 All rights reserved

1.4 Components used

The following hardware and software components were used to create this application example:

Table 1-1

Component	Quantity	Article number	Note
SIMATIC WinCC Professional V15	1	6AV2105-0BA05-0AA0	
SIMATIC STEP 7 Professional	1	6ES7822-1AA05-0YA5	
CPU 1516F-3 PN/DP	1	6ES7 516-3FN01-0AB0	
SIMATIC IPC 547G	1	6AV7241-…..-…..	
PM-ANALYZE	1	9AE7 112-1SS01-1AA0	A server with integrated client and local PM-AGENT

This Application Example consists of the following components:

Table 1-2

Component	Note
109769969_PM-ANALYZE_ Docu_v1.0_en.pdf	This document.
109769969_PM-ANALYZE_PRJ.zip	This zipped file contains WinCC, the STEP 7 Project and the PM-ANALYZE project.

Note

PM-ANALYZE Workshop

In order to familiarize yourself with all aspects of the product, we encourage you to participate in our workshop. Experienced trainers will convey all functions in detail so that you can use the product to its fullest.

You can find more information on contents, dates and bookings on our internet sites at:

www.siemens.com/process-management

Tel: (+49) 621 456 - 4186

© Siemens AG 2019 All rights reserved

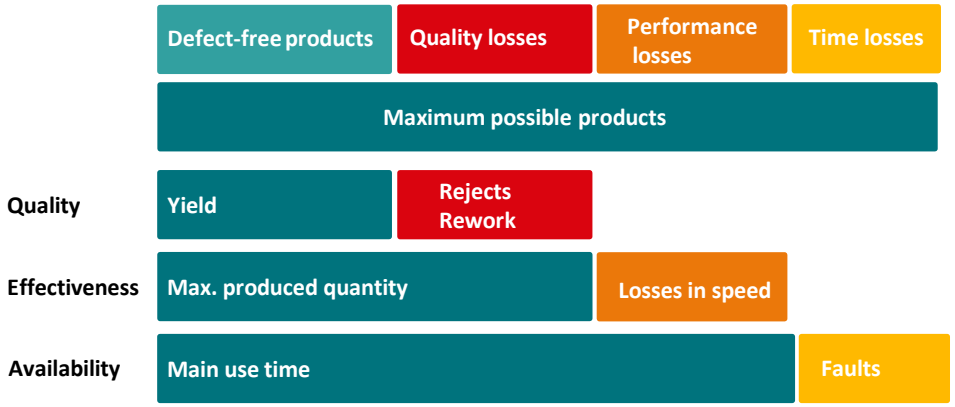
2 Basics

2.1 OEE

The overall equipment effectiveness (OEE) describes the actual effectiveness of a machine. It compares the defect-free output quantity to the theoretical maximum quantity. The ideal machine produces at maximum speed without interruption, without producing even one defective product. Because the ideal machine is never achieved in practice, a distinction is made between three essential areas where losses occur:

- Availability (loss of production time)
- Performance (loss in speed)
- Quality (loss in product quality)

Figure 2-1



© Siemens AG 2019 All rights reserved

Formula

$$OEE = Availability\ factor * Performance\ factor * Quality\ factor$$

The OEE is the product of the Availability, Performance factor and the Quality factor.

Its value is between 0% and 100%.

Evaluation

By evaluating the OEE, the plant owner can can ask the following questions:

- Why was production not happening for 100% of the operation time?
- Why was the machine not operated at 100% of its planned speed?
- Why were 100% of the products not produced in the desired quality?

2.2 Availability factor

Using the Availability factor it is possible to determine losses caused by unplanned equipment downtime. Downtime occurs due to disruptions to the machinery, which may be technical as well as organizational, or from maintenance times during which the machinery does not produce.

Formula

The Availability factor has a value between 0% and 100%.

$$Availability\ factor\ = \frac{Run\ time}{(Run\ time\ +\ downtime)} * 100$$

2.3 Performance factor

The Performance factor is a measure for the losses due to deviations from the planned target performance.

Formula

The Performance factor has a value between 0% and 100%.

$$Performance\ factor\ = \frac{Actual\ performance}{Target\ performance} * 100$$

While the actual performance (number of parts produced) is measurable, in practice it is difficult to come up with a value to represent the target performance. If the machinery manufacturer does not provide any information, the production speeds of past products are determined, and the highest production speed is defined as the target value. A loss in performance means that, although the machinery is running, it is not running at its maximum speed. Losses in performance occur through short downtimes or reduced production speed.

2.4 Quality factor

Using the Quality factor it is possible to determine the quality of the products. To do this, the defect-free parts and the defective parts (rejects) are determined.

Formula

The Quality factor has a value between 0% and 100%.

$$Quality\ factor\ = \frac{(Number\ of\ parts\ produced\ -\ number\ of\ rejects)}{Number\ of\ parts\ produced} * 100$$

© Siemens AG 2019 All rights reserved

2.5 Example

The OEE needs to be calculated for an 8-hour shift.

A filling plant runs for 7 hours during an 8-hour shift. The plant produces 5 bottles in an hour. Due to short downtimes, the plant could only product 2000 bottles during the 7 hours. Of those, 100 bottles did not have the desired fill volume (rejects).

Availability

The machinery is in operation for 420 minutes. 60 minutes are lost due to technical issues.

Run time: 7 hours (420 minutes)
Downtime: 1 Hour (60 Minutes)

$$Availability\ factor\ = \frac{Run\ time}{(Run\ time\ +\ downtime)} = \frac{420\ min}{(420\ +\ 60)\ min}\ =\ 0.875$$

The machinery has an Availability of 87.5%.
12.5% of the time available is lost due to disturbances.

Performance

The machinery is in operation for 420 minutes. The planned speed is 5 bottles per minute.

Actual performance: 2000 bottles
Target performance: 420 * 5 = 2100 bottles

$$Performance\ factor\ = \frac{Actual\ performance}{Target\ performance} = \frac{2000\ bottles}{2100\ bottles} = \ 0.952$$

The machinery has a Performance factor of 95.2%.

© Siemens AG 2019 All rights reserved

Quality

The machinery produced 2000 bottles. Of those, 100 bottles did not have the desired quality (rejects).

Number of bottles produced: 2000 bottles
Rejects: 100 bottles

$$Quality\ factor\ = \frac{((Number\ of\ parts\ produced\ -\ number\ of\ rejects)\ )}{Number\ of\ parts\ produced}$$

$$= \frac{(2000\ -\ 100) bottles}{2000\ bottles} =\ 0.95$$

The machinery has a Quality factor of 95%.

OEE

Availability factor: 0.875
Performance factor 0.952
Quality factor: 0.95

$$OEE = Availability\ factor * Performance\ factor * Quality\ factor$$

$$= 0.875 * 0.952 * 0.95\ = 0.791$$

The machinery has an equipment effectiveness of 79.1%.

© Siemens AG 2019 All rights reserved

3 PM product basics

3.1 Overview

WinCC stands out for its diversity of applications. The basic system is designed to be independent of any specific technology or industrial sector, to be modular and flexibly expandable, and to permit not only standalone applications in mechanical equipment manufacturing, but also complex multi-user solutions, or even distributed systems with several servers and clients in plant engineering.

WinCC applications that are precisely tailored to the requirements of the industrial plant have thus been created for every sector.

We distinguish between:

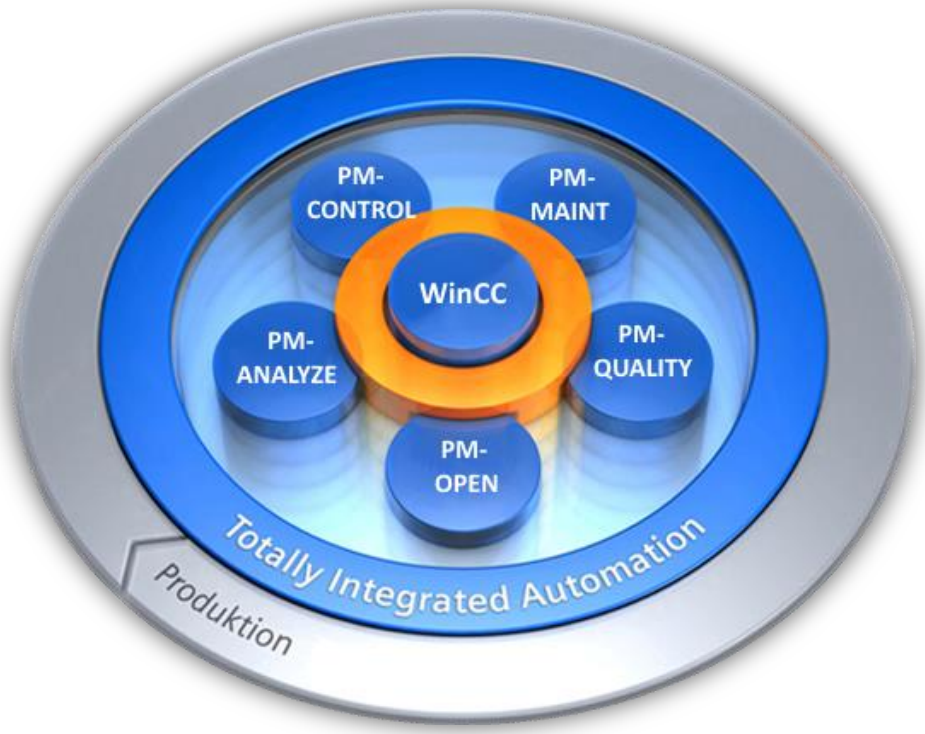
- WinCC options

WinCC options are available for a host of expansions of the WinCC basic system and they can be combined freely to meet your requirements. The options are subjected to an extensive test with the basic system. You can obtain support from our WinCC options via the central hotline and expert advisory services.

- WinCC Premium add-ons

The Premium Add-ons are checked in the Siemens Test Center for their compatibility with the basic WinCC system and supported in the first instance by the central Technical Support. Premium Add-ons are important application-specific and sector-specific add-on products that supplement WinCC.

Figure 3-1



© Siemens AG 2019 All rights reserved

3.2 PM-ANALYZE

In the Application Example, PM-ANALYZE is used to calculate complex indicators such as Availability, Quality rate, Performance and OEE. To do this, tags from a number of sources such as SCADA systems, HMI systems and controllers are read and written back. With the help of the Excel Add-In, you can access process values and compaction archives, computed values and indicators, as well as messages and operational actions, enabling you to carry out reporting.

PM-ANALYZE can also collect process alarms and reports for interruptions, operations or service from various sources, then analyze them. This enables reduced downtime and maintenance times, early detection of signs of wear and tear, and localization of error sources or weak points.

© Siemens AG 2019 All rights reserved

3.3 Database and archiving

The following table describes how the PM-SERVER exchanges data from various communication interfaces with each basic system. The PM-SERVER functions as a data delivery point for PM products and organizes all communication to and from SCADA, HMI, PLC or external systems.

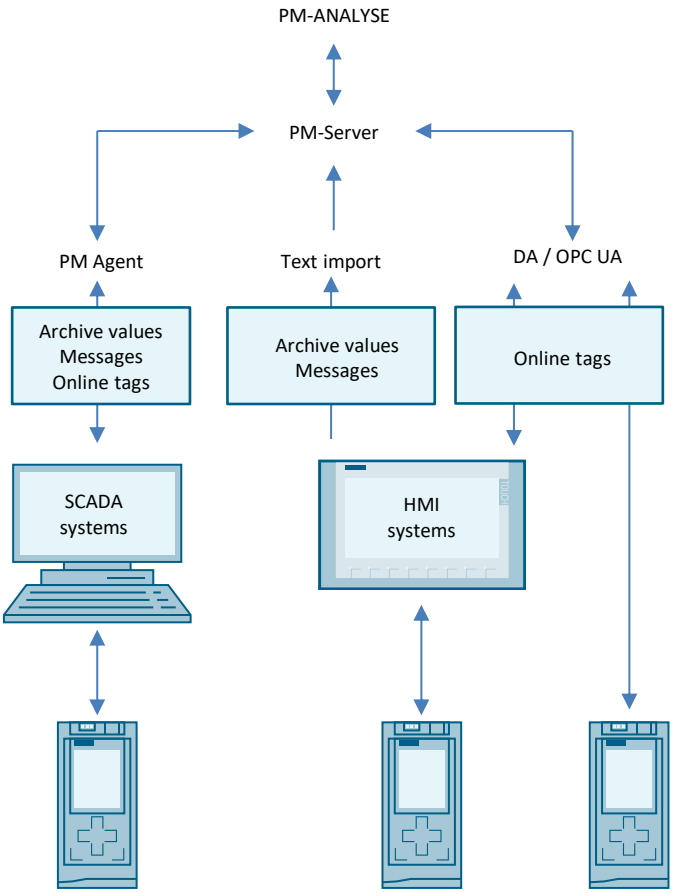
Table 3-1

Communication interface	Basic system
PM-AGENT	For data exchange to the SCADA systems SIMATIC WinCC, PCS7, and WinCC (TIA) RT Professional, the PM Server communicates with its software partner, PM-AGENT. The PM-AGENT delivers online tags, notifications und archive values from the SCADA system to the PM-SERVER. Conversely, tag contents are sent from PM products via the PM-SERVER to the PM-AGENT, which passes the values to the SCADA system.
OPC DA	HMI systems like WinCC (TIA) Comfort / RT Advanced, WinCC flexible or other OPC DA servers exchange tags via the integrated OPC DA interface.
OPC UA	PM-SERVER supports tag exchange via OPC UA for connection to HMI systems like WinCC (TIA) Comfort / RT Advanced / RT Professional, or other OPC UA servers.
Text import	Notifications and audit trails from the HMI systems WinCC (TIA) Comfort / RT Advanced or WinCC flexible are imported in CSV, TXT or rdb format.

© Siemens AG 2019 All rights reserved

The following figure describes how the PM-SERVER exchanges data from various communication interfaces with each basic system.

Figure 3-2



SCADA systems: SIMATIC WinCC (TIA) RT Professional, WinCC or PCS7

HMI systems: SIMATIC WinCC (TIA) Advanced / Comfort or WinCC flexible

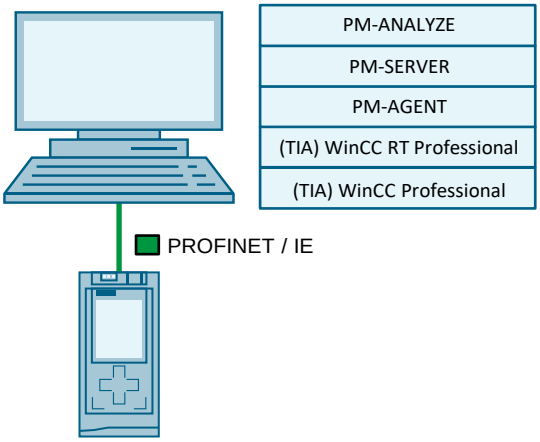
© Siemens AG 2019 All rights reserved

3.4 Configuration

3.4.1 Standalone system

In a standalone system the WinCC RT Professional software is installed parallel to the engineering system. Using the "PM-ANALYZE" installation CD, PM-AGENT, PM-SERVER and PM-ANALYZE are installed on the same system.

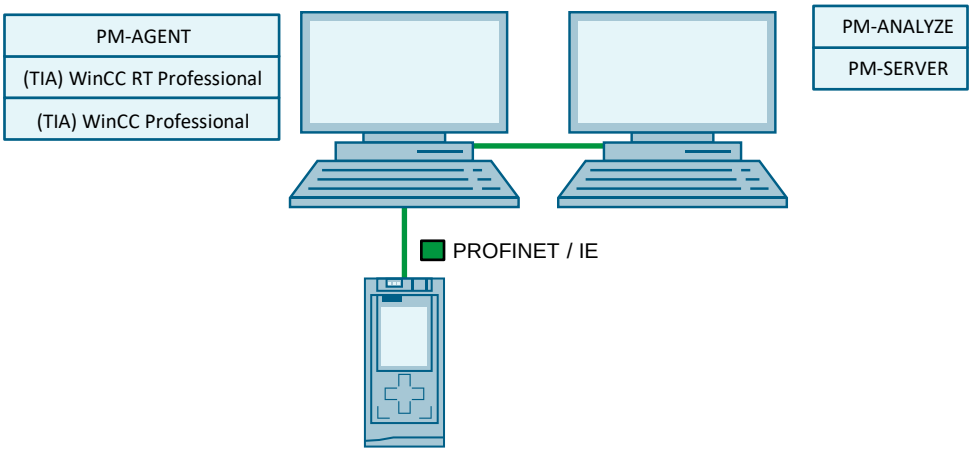
Figure 3-3



3.4.2 Multi-user system

The computers in a multi-user system are connected to each other using a TCP/IP network. PM-ANALYZE (Server) is installed on its own computer separate from WinCC Server. A separate PM-AGENT installation on the computer with WinCC Station is needed for data exchange. The PM-SERVER can establish a data connection to multiple PM-AGENT stations to collect and send data.

Figure 3-4



© Siemens AG 2019 All rights reserved

4 Installation

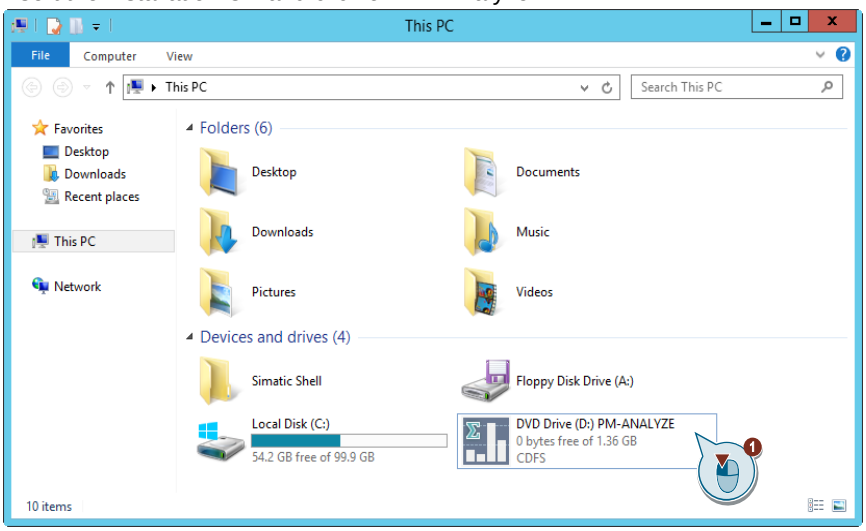
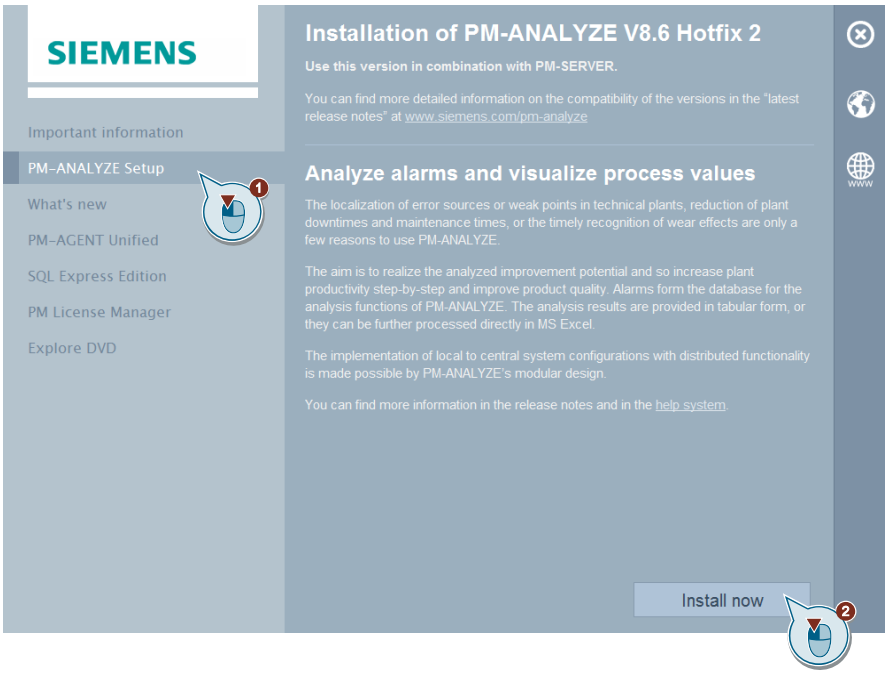
The enabled operating systems are documented in the product information on the PM product, or can be found in the "WinCC Competence Center".

You can find the TIA and WinCC V7 compatibility lists at:

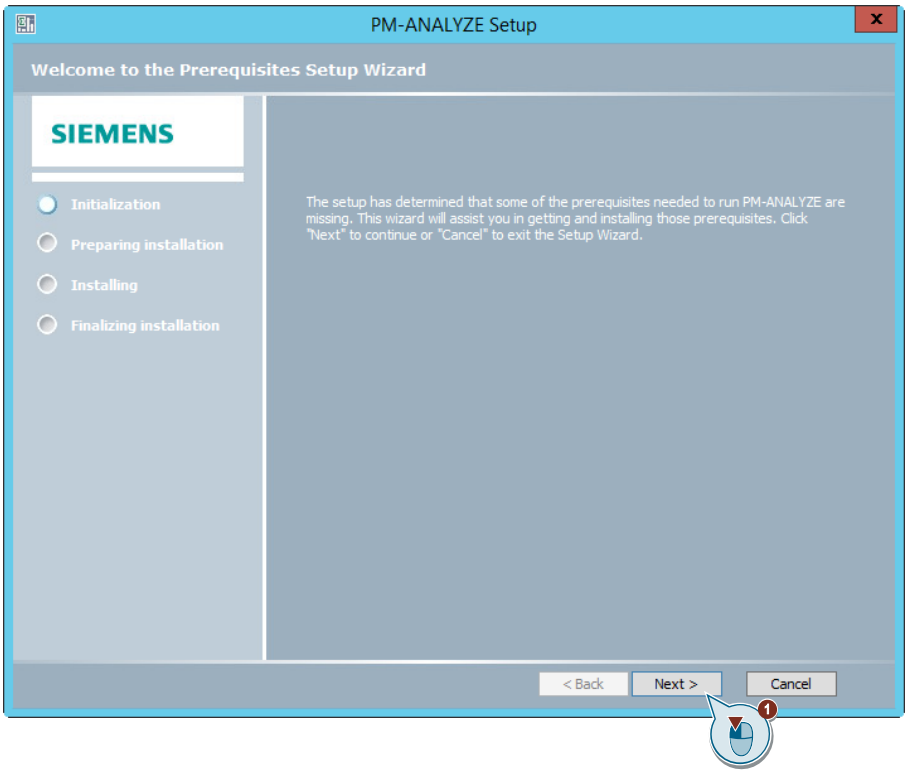
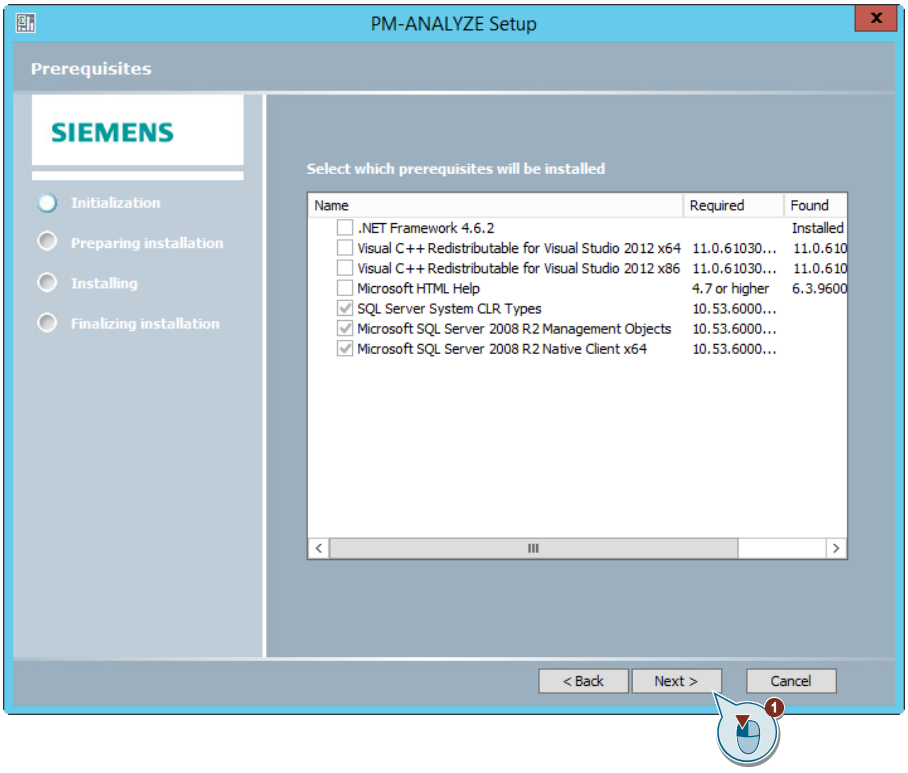
https://www.siemens.de/industrysolutions/de/de/wincc/produkte/pm-analyze/Seiten/Default.aspx

© Siemens AG 2019 All rights reserved

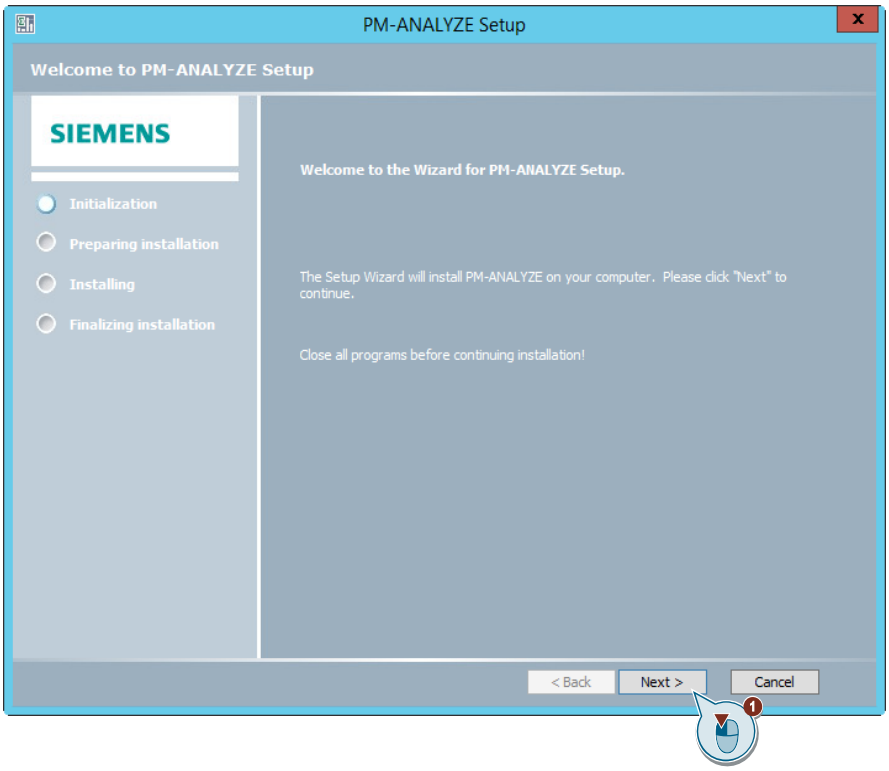
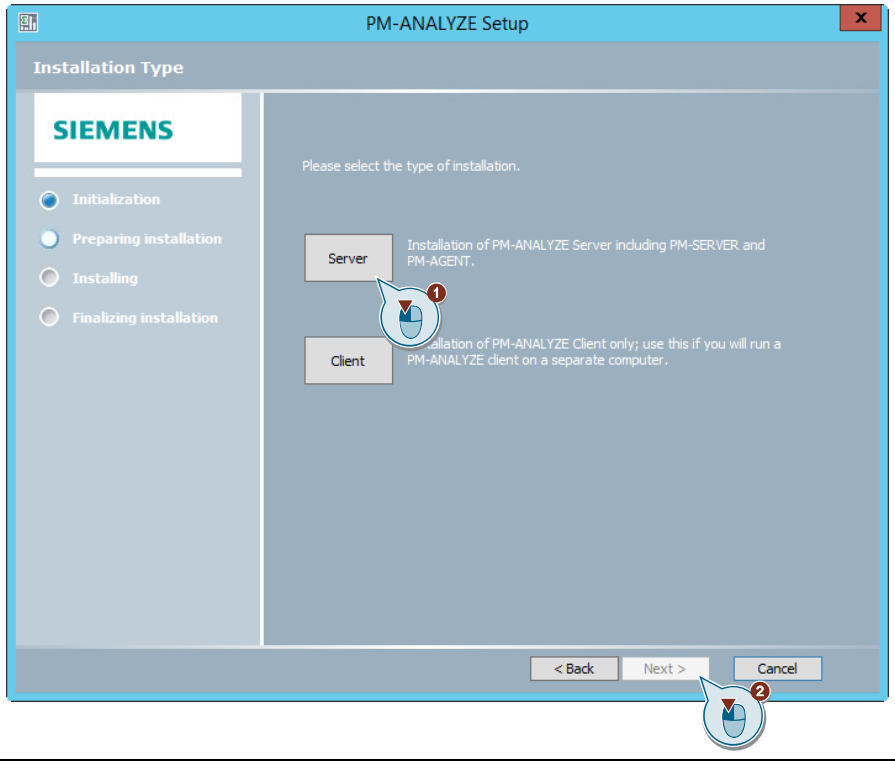
Table 4-1

No.	Action
1.	Insert the installation CD and click on PM-Analyze. 
2.	Using the left navigation menu, proceed to the PM-ANALYZE setup, which is initiated with the "Install" button. 

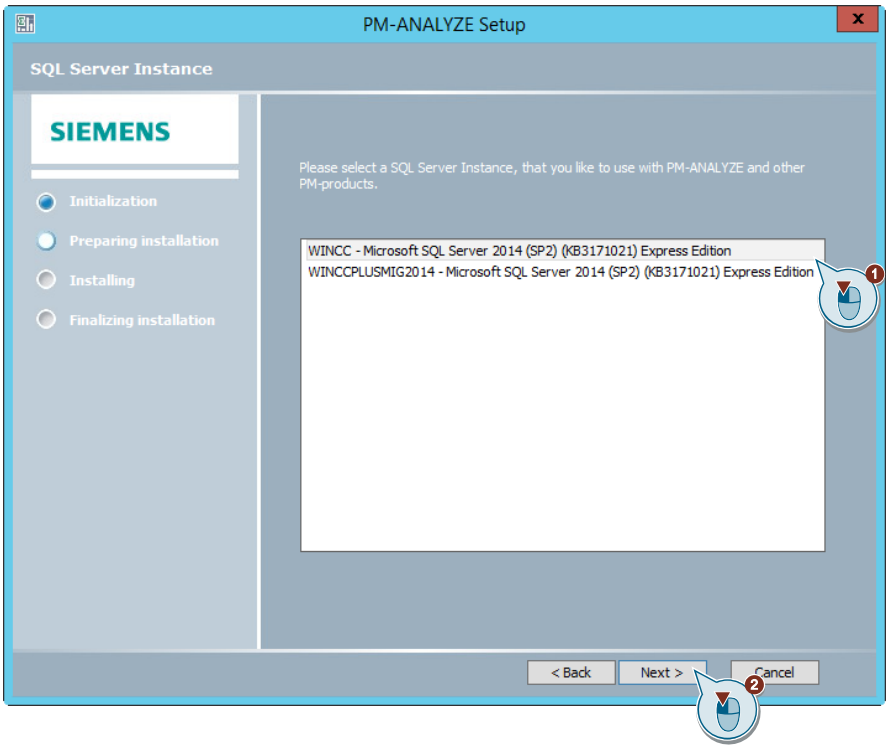
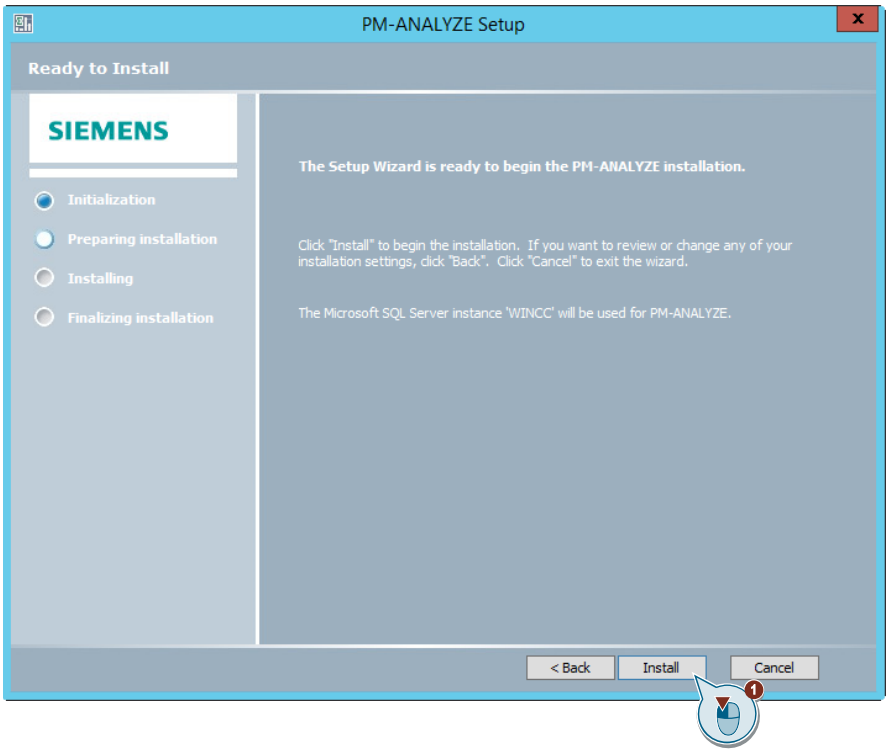
© Siemens AG 2019 All rights reserved

No.	Action
3.	The setup determines all the necessary basic components for the installation. 
4.	During installation, a dialog opens with all the necessary basic components. Before you can proceed with the PM-ANALYZE setup, the missing components must be installed. Click "Next" to install the missing components. 

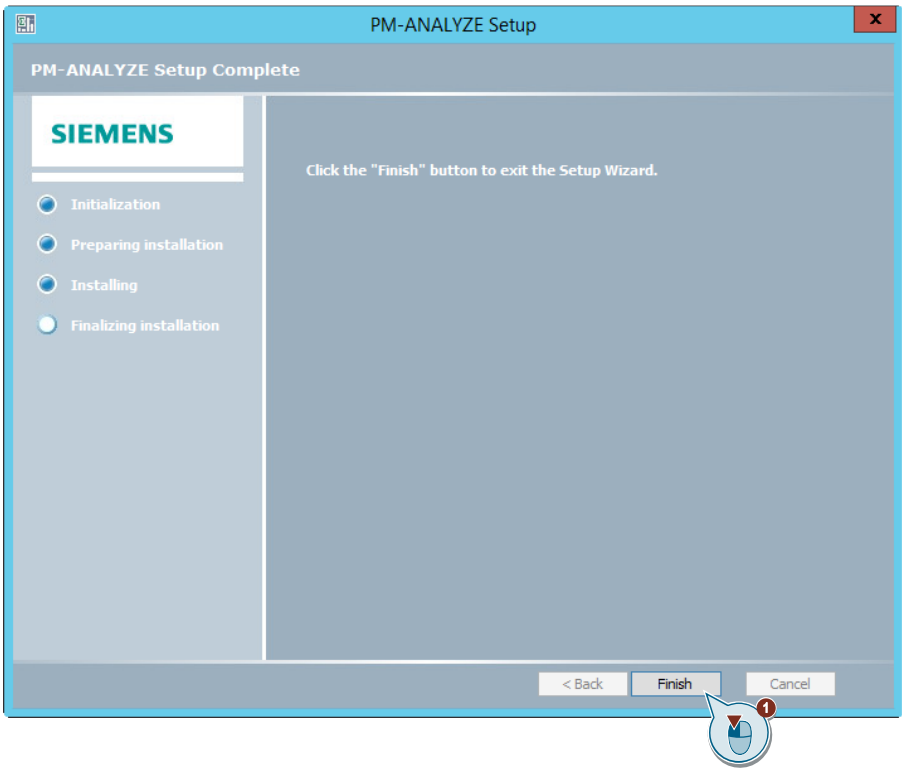
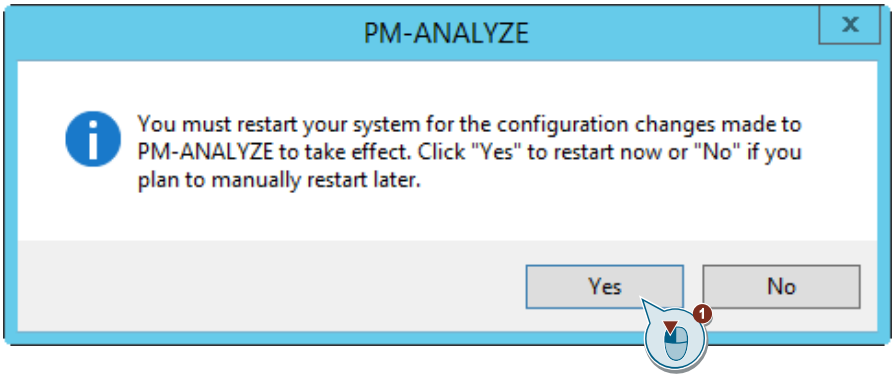
© Siemens AG 2019 All rights reserved

No.	Action
5.	Click the "Next" button to continue with the installation. 
6.	In the next dialog you can select which system package you wish to install. Because no clients can be used in the example and instead everything runs locally on one computer, select the "Server" option here and then click "Next". 

© Siemens AG 2019 All rights reserved

No.	Action
7.	Next you will be asked to select an SQL server instance for the installation. If SIMATIC WinCC is already installed on the computer, which is assumed in this example, there will be an SQL server instance named "WinCC" already selected. Do not change these settings, and click "Next". 
8.	Click the "Install" button to start the installation process. 

© Siemens AG 2019 All rights reserved

No.	Action
9.	Once the installation process is complete, click the "Finish" button. 
10.	Restart the computer. 

© Siemens AG 2019 All rights reserved

5 Licensing the software

5.1 Hardlock

The Universal PM Package is offered specially to integrators who frequently configure PM products. A USB dongle (called UPP dongle in the Help) is provided with the UPP and can be used for all PM products in different variants and versions. Licensing is processed for each PM product with the special licensing file of the file type *.upp. For this purpose, a copy of this license file is copied from the product DVD to the computer and installed via the PM License Manager. Together with the plugged-in UPP dongle, the PM product is now licensed.

Table 5-1

	Green Hardlock
Version	PM-ANALYZE >= V8.0
Image	
Information	The new (green) Hardlock is not backward-compatible. For new product versions, a new UPP Hardlock is therefore required. New orders will be delivered with the new (green) Hardlock.

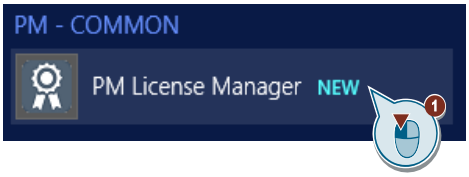
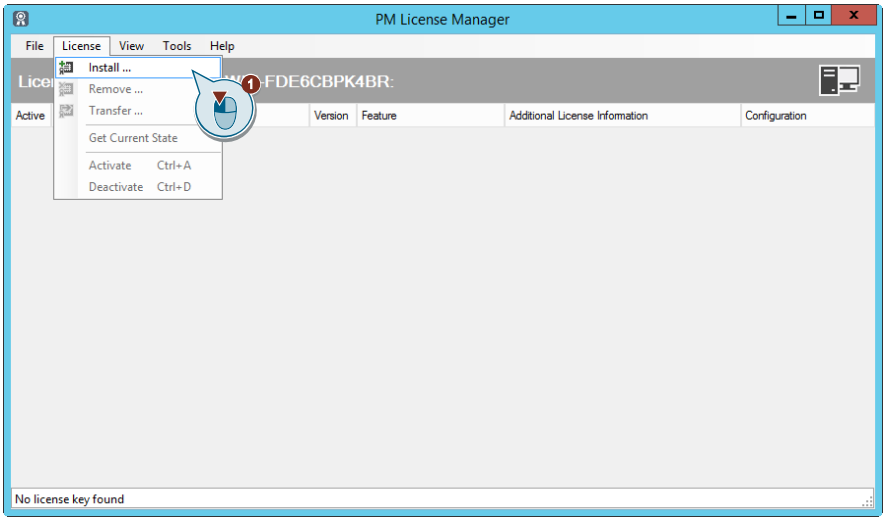
© Siemens AG 2019 All rights reserved

5.2 Transferring licenses

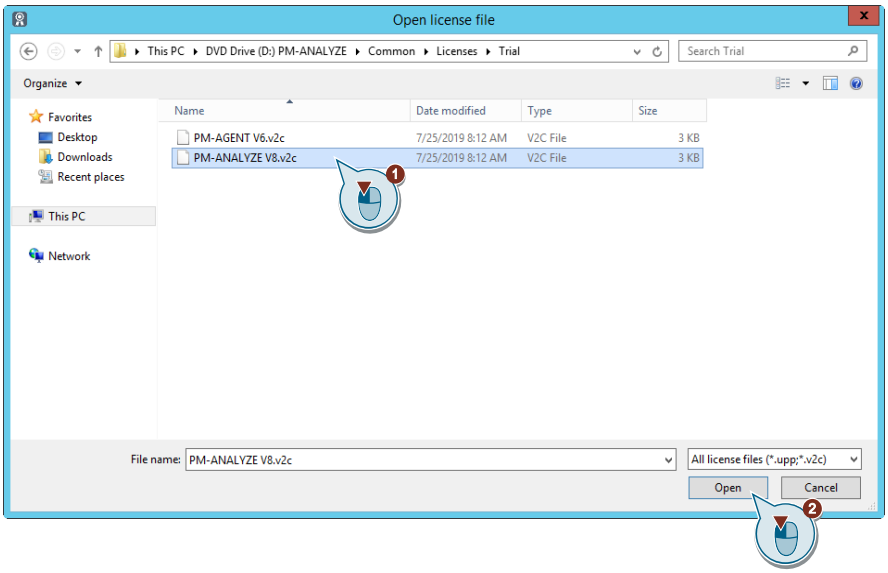
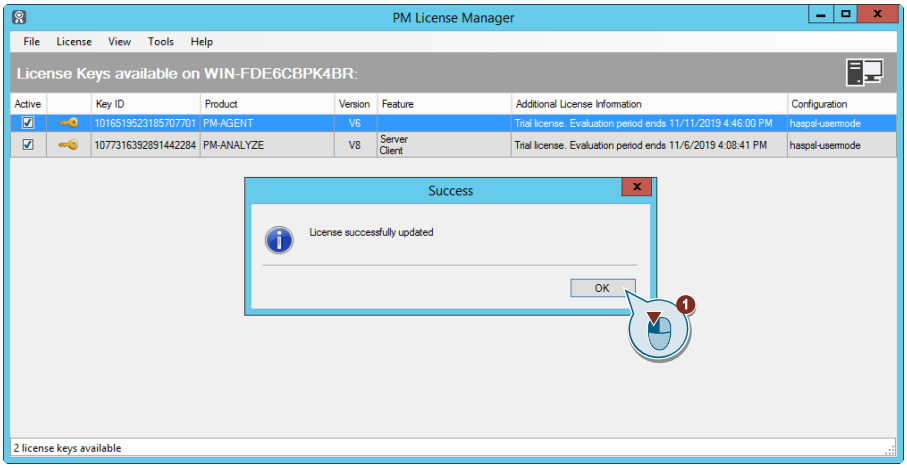
Installed hardware, software and licenses are displayed in the PM License Manager. In the following you will learn how you can activate a license.

Note A 90-day test license is available to you on the product DVD. The test license begins when the PM product is used for the first time.

Table 5-2

No.	Action
1.	Run the PM License Manager as an administrator. The PM License Manager is installed by default in C:\Program Files (x86)\Siemens\PM\PMCOMMON. 
2.	Click on the "License" button and then "Install". 

© Siemens AG 2019 All rights reserved

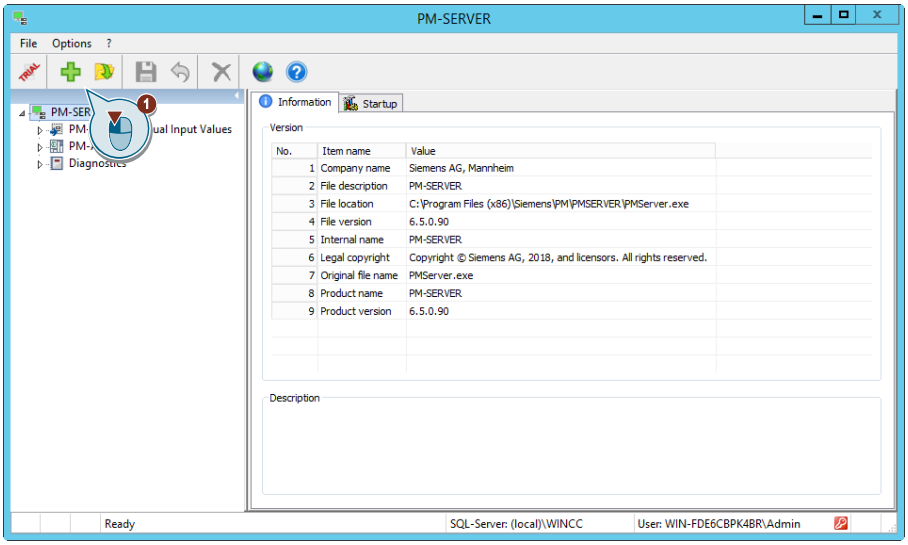
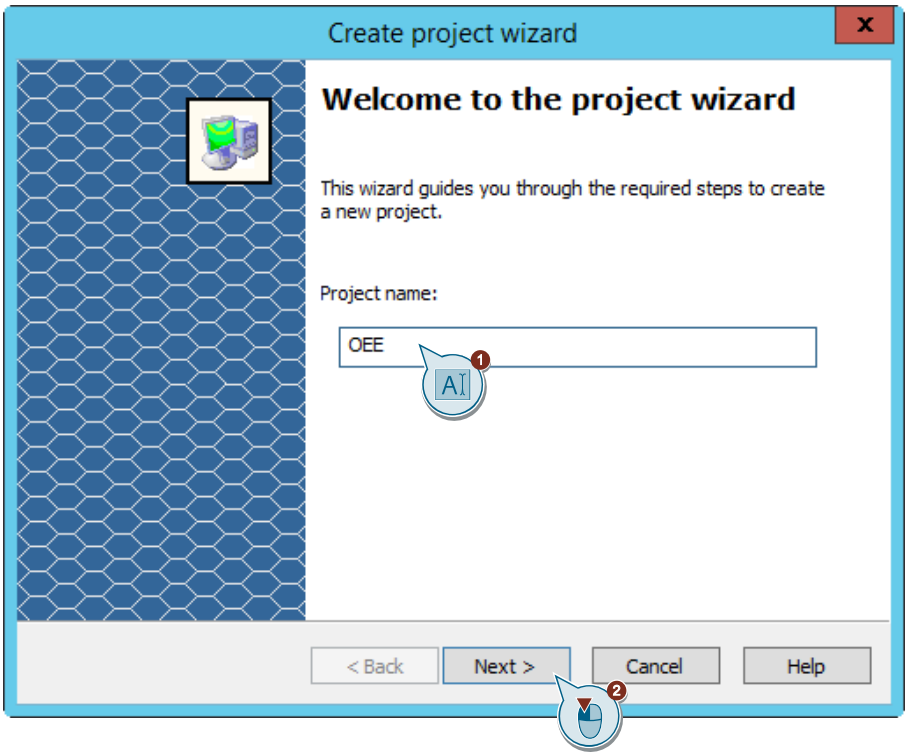
No.	Action
3.	The test license is on the product DVD under: Drive:\Common\Licenses\Trial Select the license and click "Open". For the demo project you will activate both the PM-AGENT and PM-ANALYZE licenses. 
4.	Press the "OK" button to confirm the dialog. 

© Siemens AG 2019 All rights reserved

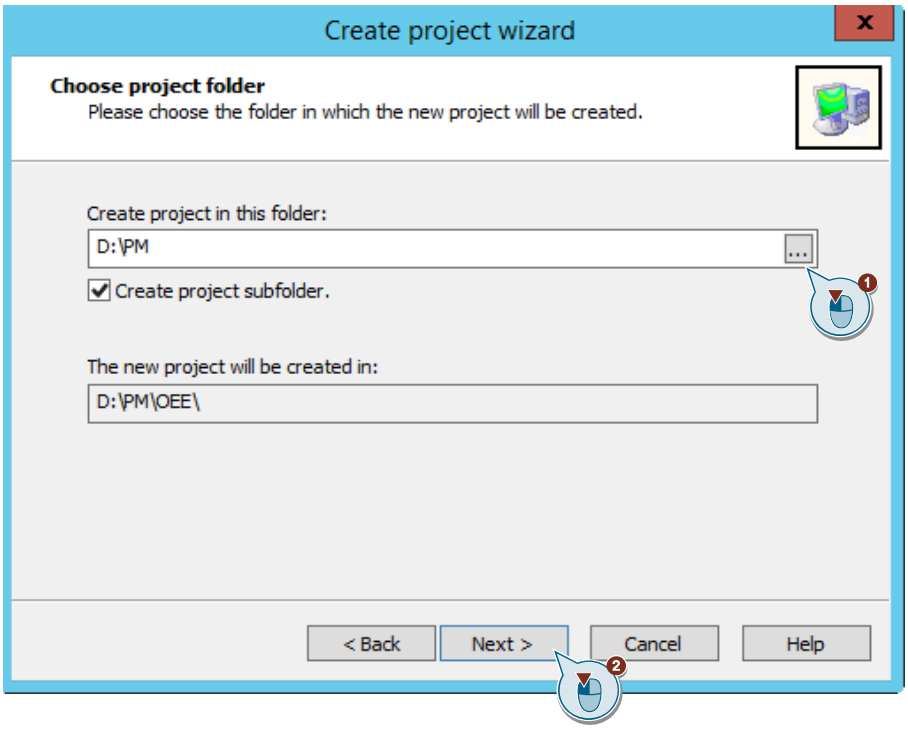
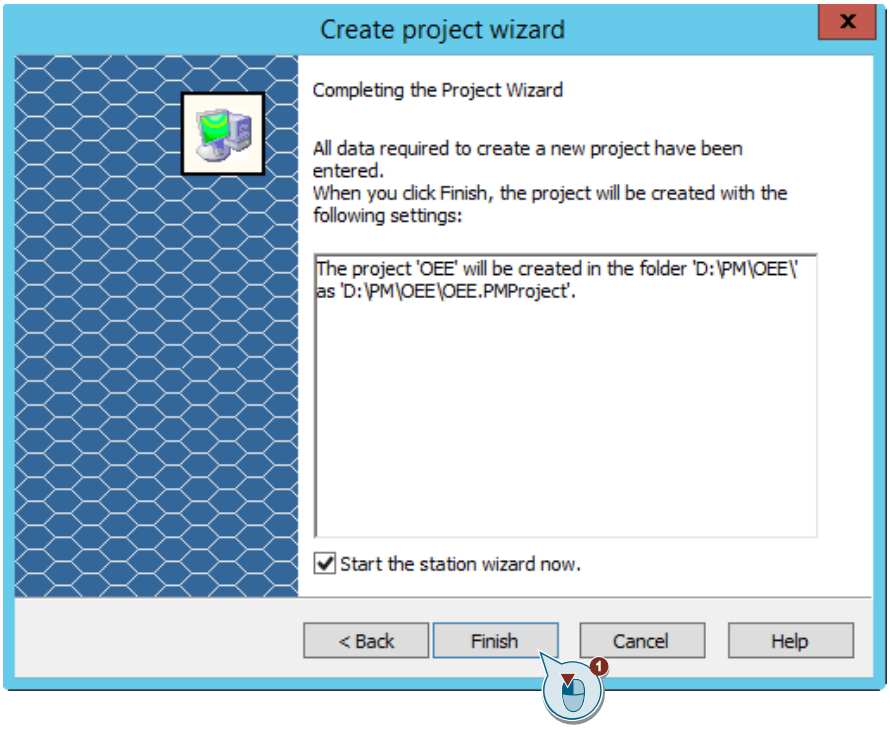
6 Create PM Server project

The PM Server project must be created independently

Table 6-1

No.	Action
1.	Once the PM Server has been opened, click on the button with the green plus in the menu bar. A new project is created in PM-SERVER. Then the project wizard opens, which will guide you through the setup. 
2.	Enter the PM Server's project name and click "Next". 

© Siemens AG 2019 All rights reserved

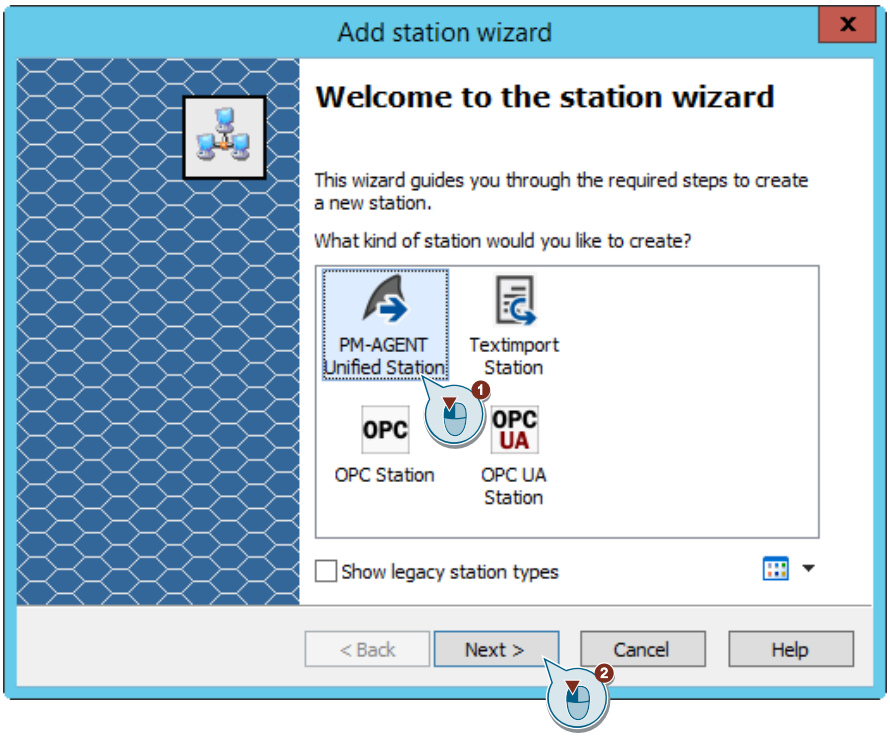
No.	Action
3.	Select the folder where the project will be saved, then click "Next". 
4.	Close the project wizard. The station wizard then opens. 

© Siemens AG 2019 All rights reserved

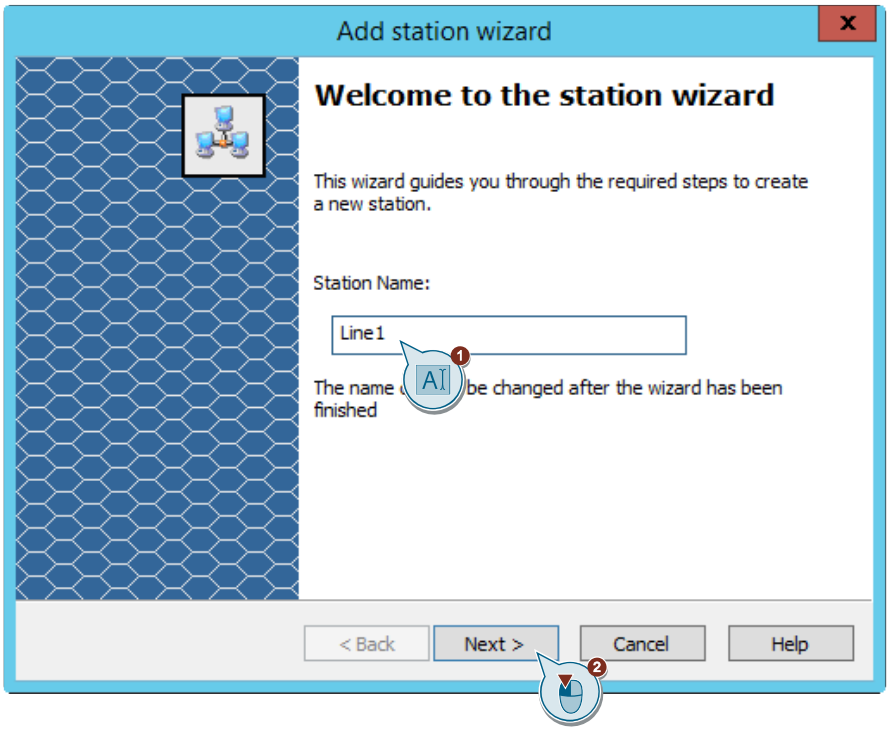
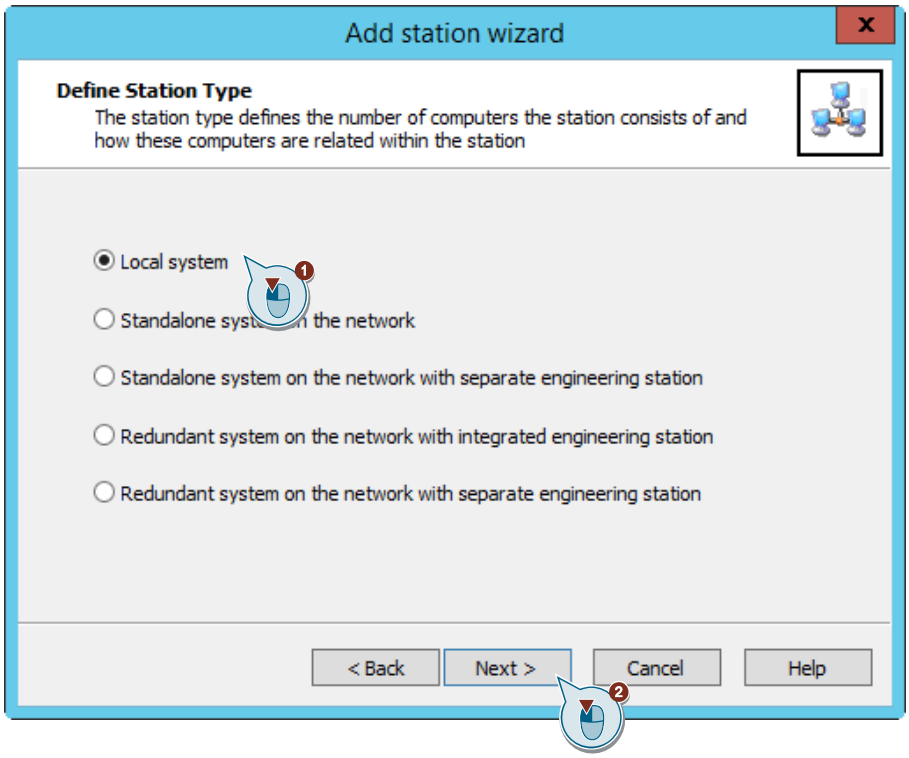
7 Creating a connection

Data exchange between PM products and WinCC RT Professional occurs via the PM Server.

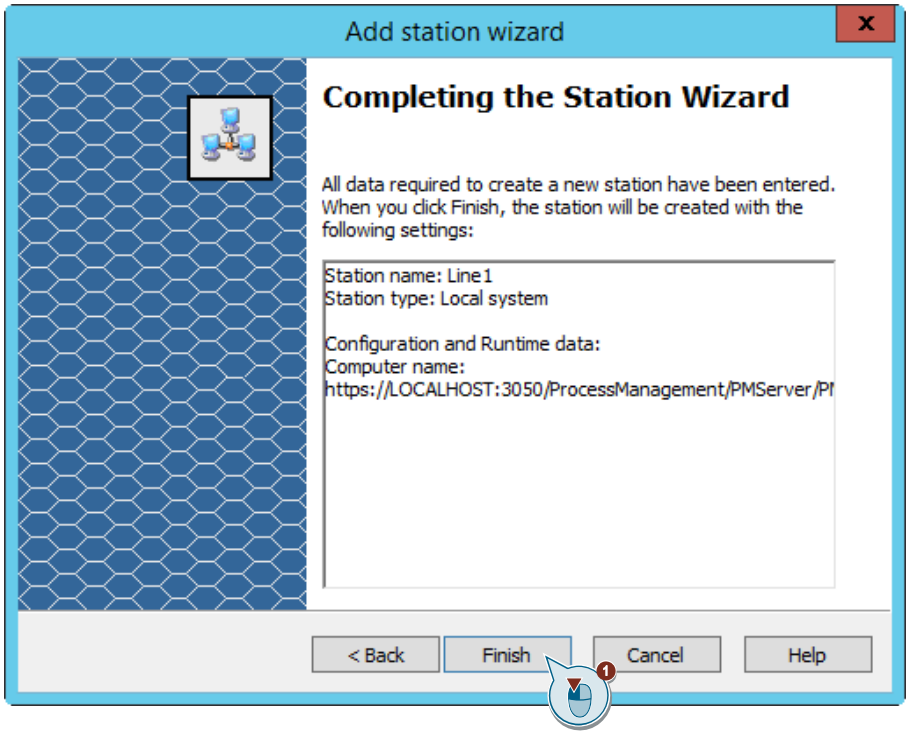
Table 7-1

No.	Action
1.	The station wizard opens. Because this will be a standalone project, the PM-AGENT Unified Station is selected here. 

© Siemens AG 2019 All rights reserved

2.	Enter the name of the Station and click "Next". 
3.	Select the station type. The example project is a standalone system on which WinCC RT Professional, WinCC RT Engineering, PM-AGENT, PM-SERVER and PM-ANALYZE are installed. 

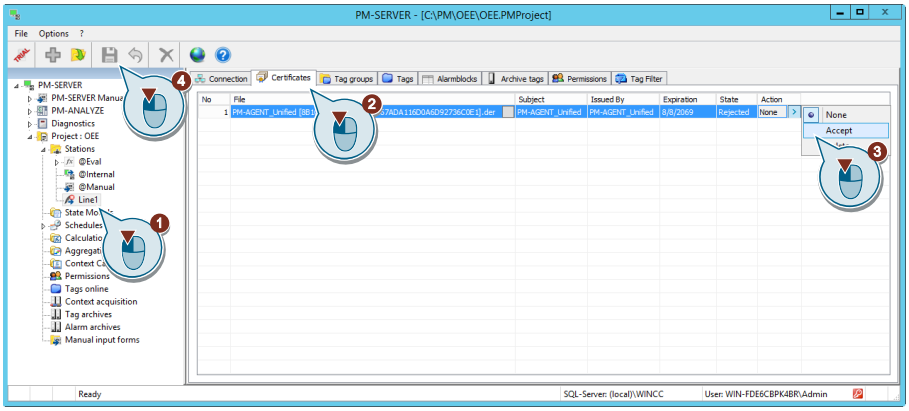
© Siemens AG 2019 All rights reserved

4.	Close the station wizard. 

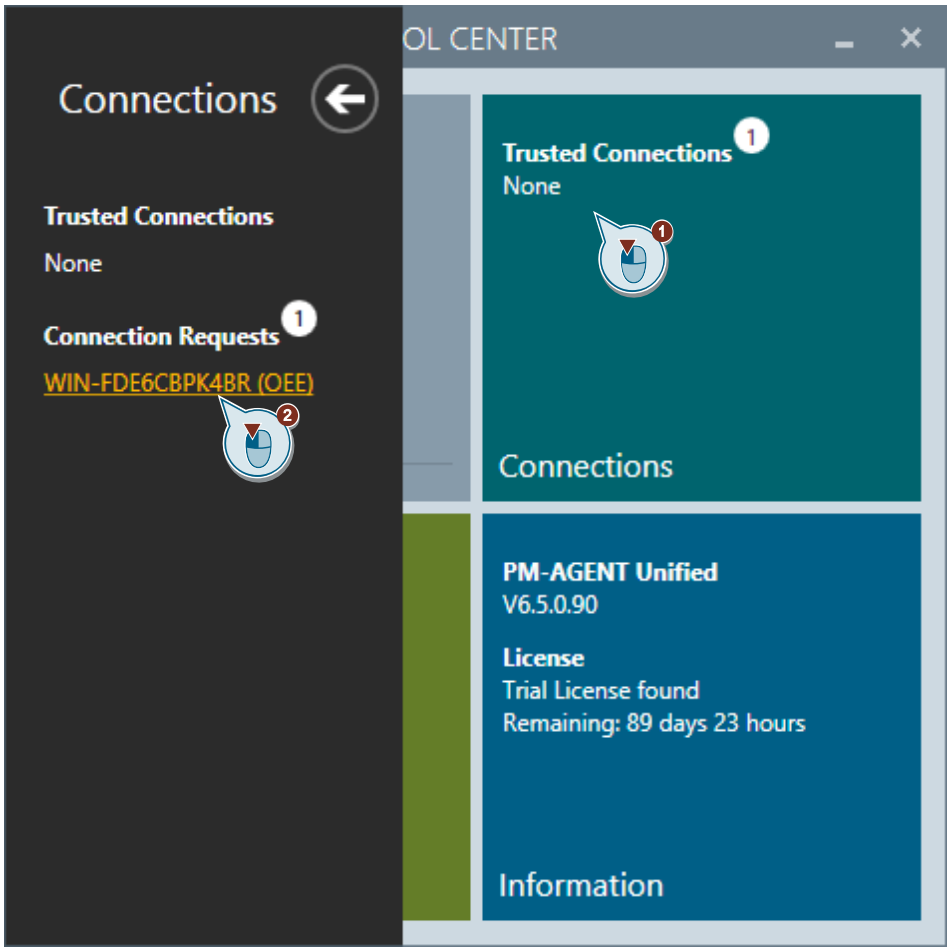
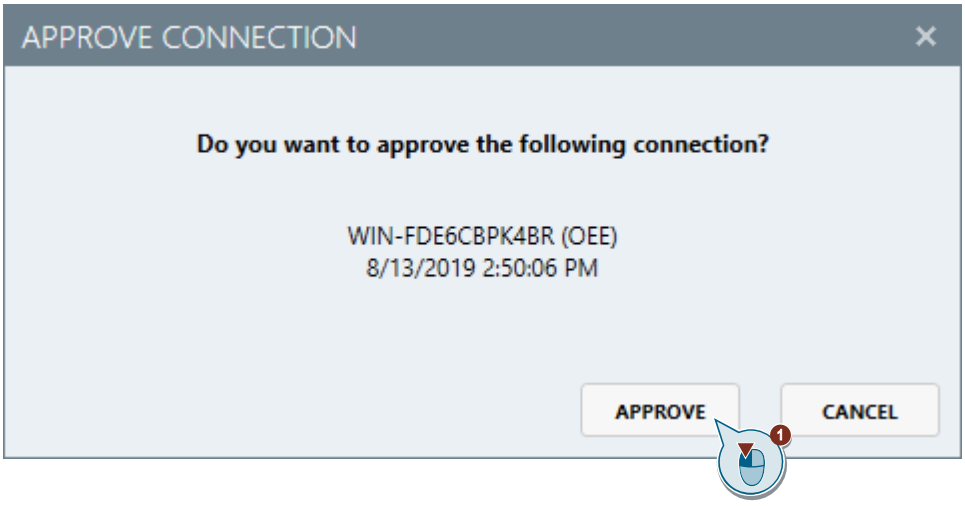
© Siemens AG 2019 All rights reserved

7.1 Accepting certificates

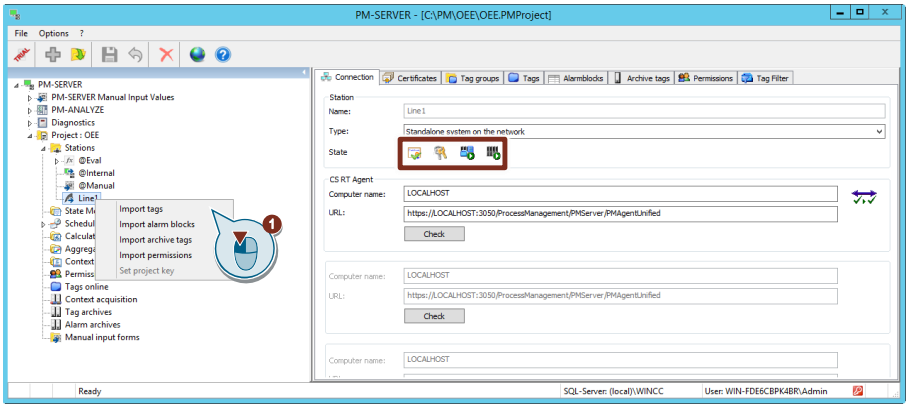
Table 7-2

No.	Action
1.	Each time a connection is established from the PM Server to a PM Agent, the respective certificate is communicated from the corresponding PM Agent Unified Service and saved in the corresponding project directory. All received certificates are listed here. Accept the project certificate in the PM Server in order to establish a connection with the PM Agent. 
2.	Start the simulation or WinCC Runtime. 
3.	Open the PM Agent Unified Control Center via the Windows Start Menu: "Start > All Programs > PM AGENT Unified > PM-AGENT Unified Control Center". 

© Siemens AG 2019 All rights reserved

No.	Action
4.	You can see in the "Connection Approvals" area if there is already a secured connection or if you still have to approve the connection. Click on Approve Connection The "Connections" window opens. In the Connection Requests area the name of the computer where PM Server is installed is displayed. Accept the connection request. 
5.	Confirm the connection request. 

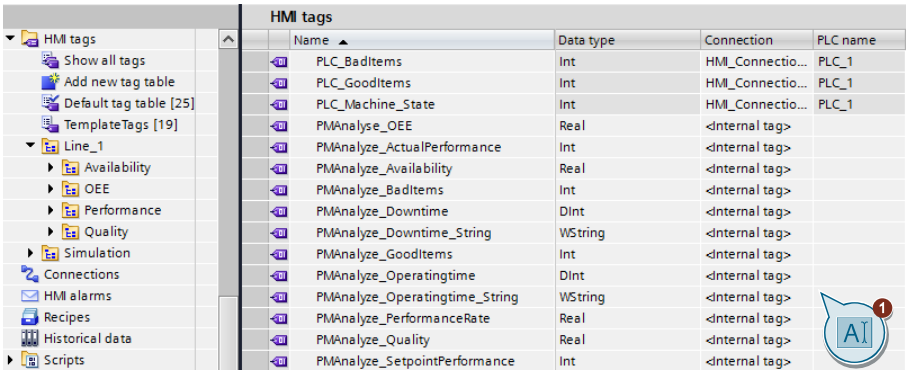
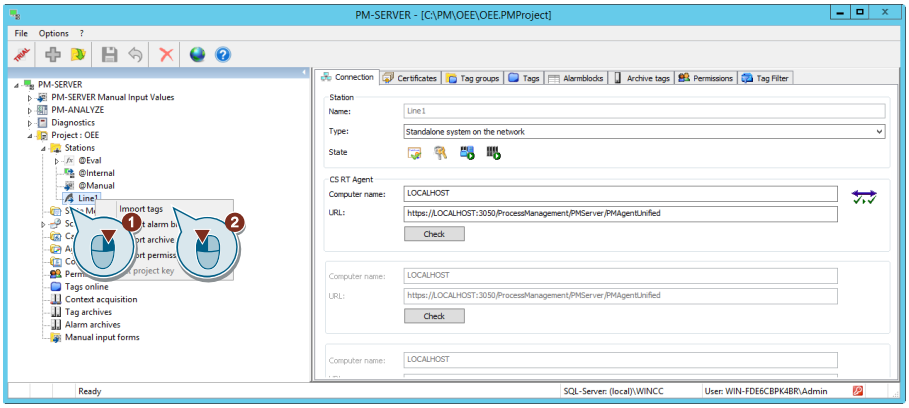
© Siemens AG 2019 All rights reserved

No.	Action
6.	From the icons marked in red, you can see that a connection is established in the PM-SERVER.  Status of the certificate: The certificates of all involved PM-AGENT Unified Services are accepted. Status of the project key: The PM Server has a connection to one or more PM Agent Unified Stations and the project key is set correctly to every PM Agent Unified Station. Status of the configuration system: The connection to the station computer with the configuration system is established. Status of the runtime system The connection to the runtime system is active.

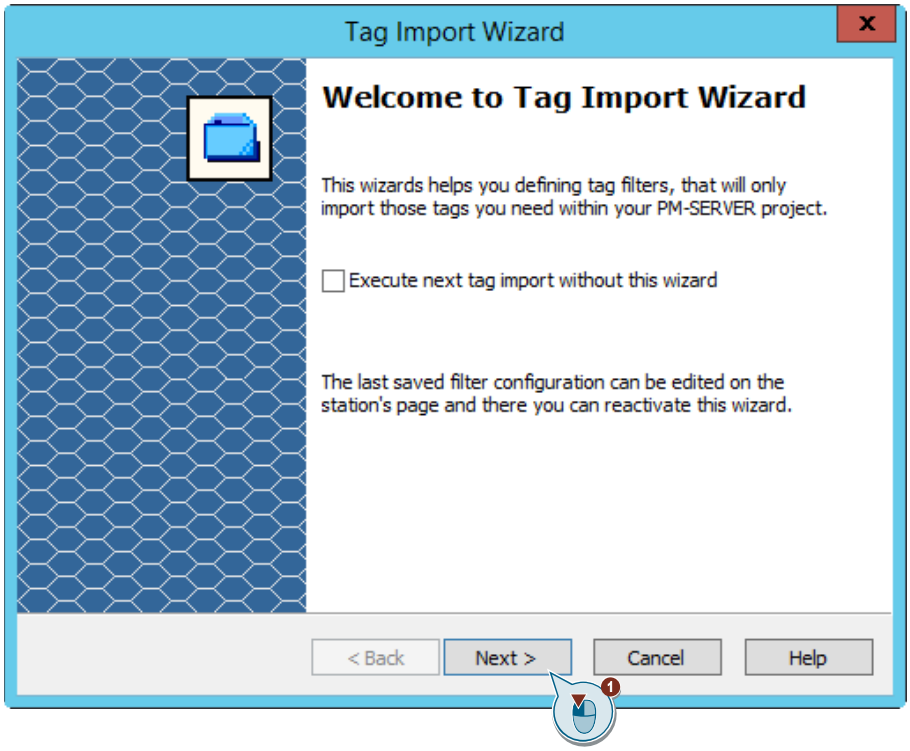
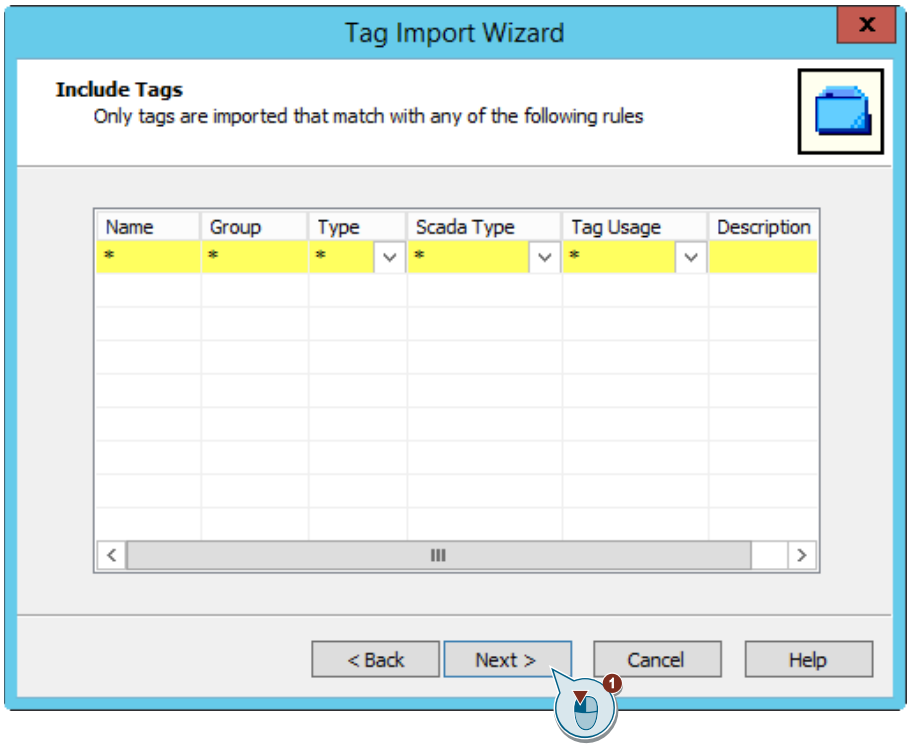
© Siemens AG 2019 All rights reserved

8 Importing tags

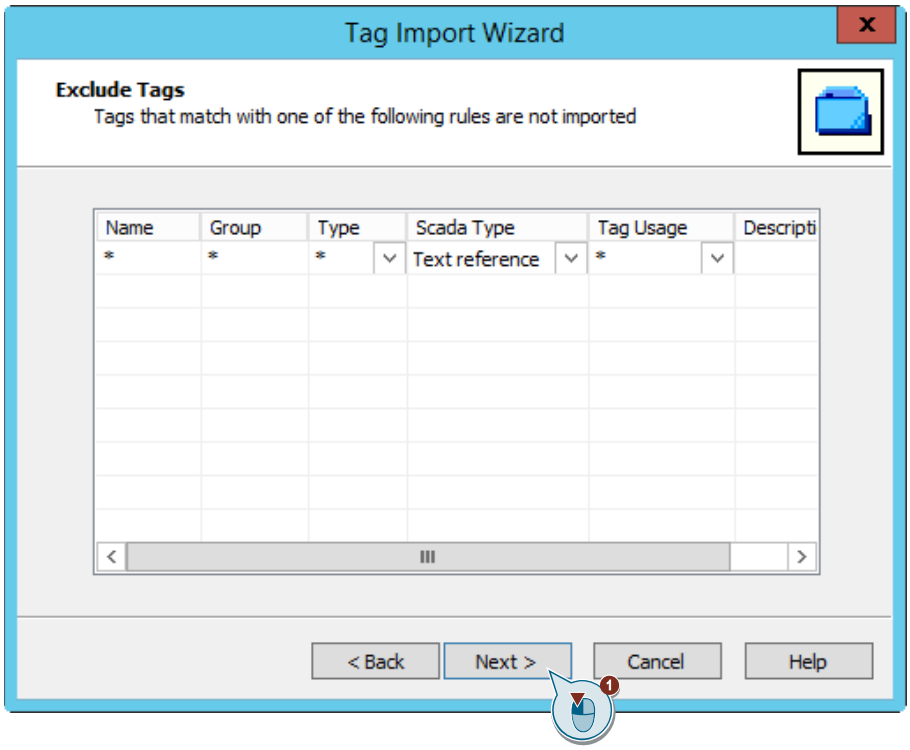
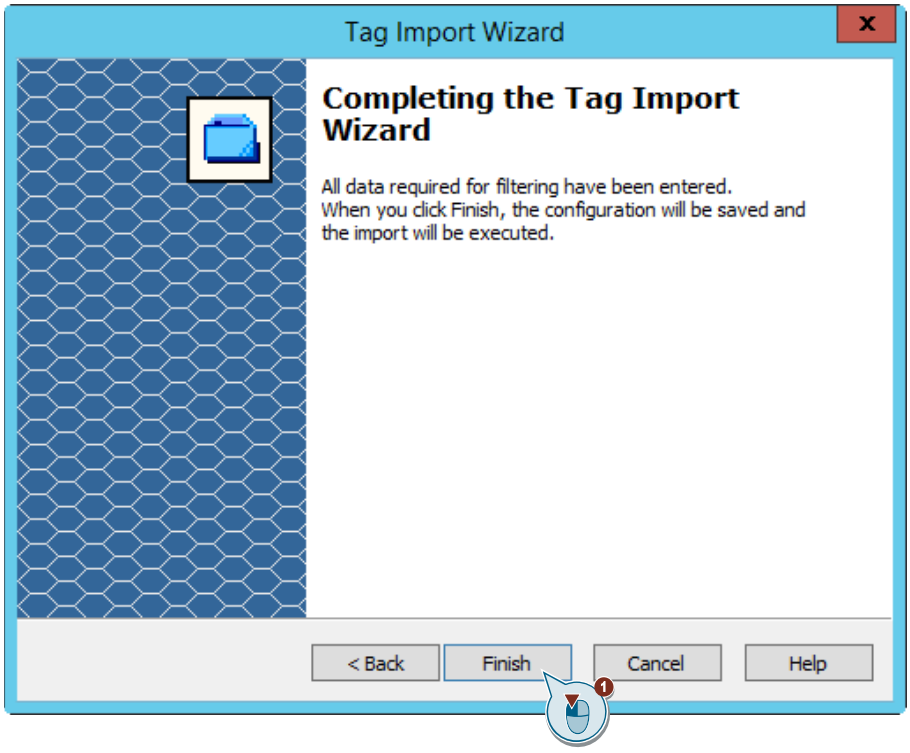
Table 8-1

No.	Action
1.	The following tag structure has been pre-configured in TIA Portal and is needed for the next KPI calculation.  In the following chapter 8.1, 8.2, 8.3 and 8.4 you will gain an overview of the functions of the tags.
2.	Click on import tags. 

© Siemens AG 2019 All rights reserved

No.	Action
3.	The import tag wizard starts. Click the "Next" button. 
4.	For importing tags, filter settings can be adjusted in the wizard so that only the necessary variables are imported from the basic system into the PM Server tag household. The filter is set up by default such that the complete tag household of the basic system is imported. Click the "Next" button. 

© Siemens AG 2019 All rights reserved

No.	Action
5.	In this dialog, filter criteria are configured which prevent the importing of certain tags. If the table has no entries/lines, no variables are excluded from the import. This is a default setting. Click the "Next" button. 
6.	Close the tag import wizard. 

© Siemens AG 2019 All rights reserved

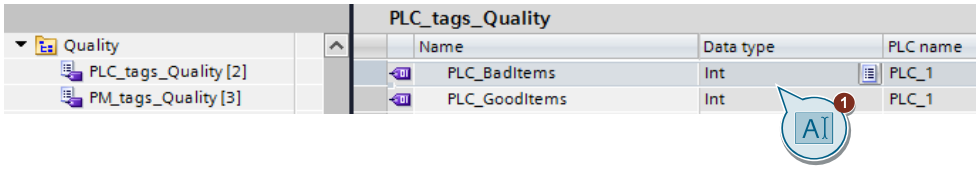
8.1 Quality

For quality, 2 tags are needed from the controller. One counter for the "good parts" and one counter for the "bad parts". These 2 tags are the input tags necessary for the calculation. As output tags you will receive the calculated values for good parts, bad parts and the Quality factor for a defined time interval.

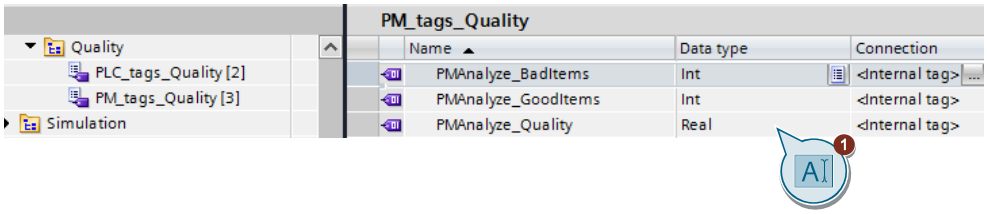
Table 8-2

Input tags	Output tags
PLC_BadItems (Int)	PMAnalyse_BadItems
PLC_GoodItems (Int)	PMAnalyse_GoodItems
	PMAnalyse_Quality

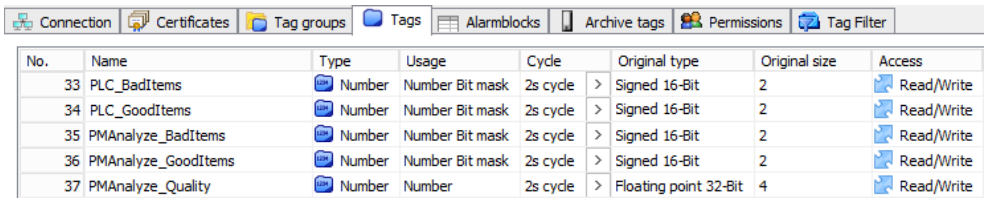
Create the following tags as input tags or find them in your control program.



Create the following tags as output tags:



In PM Analysis, the tags are available under the station's variable tags after the import:

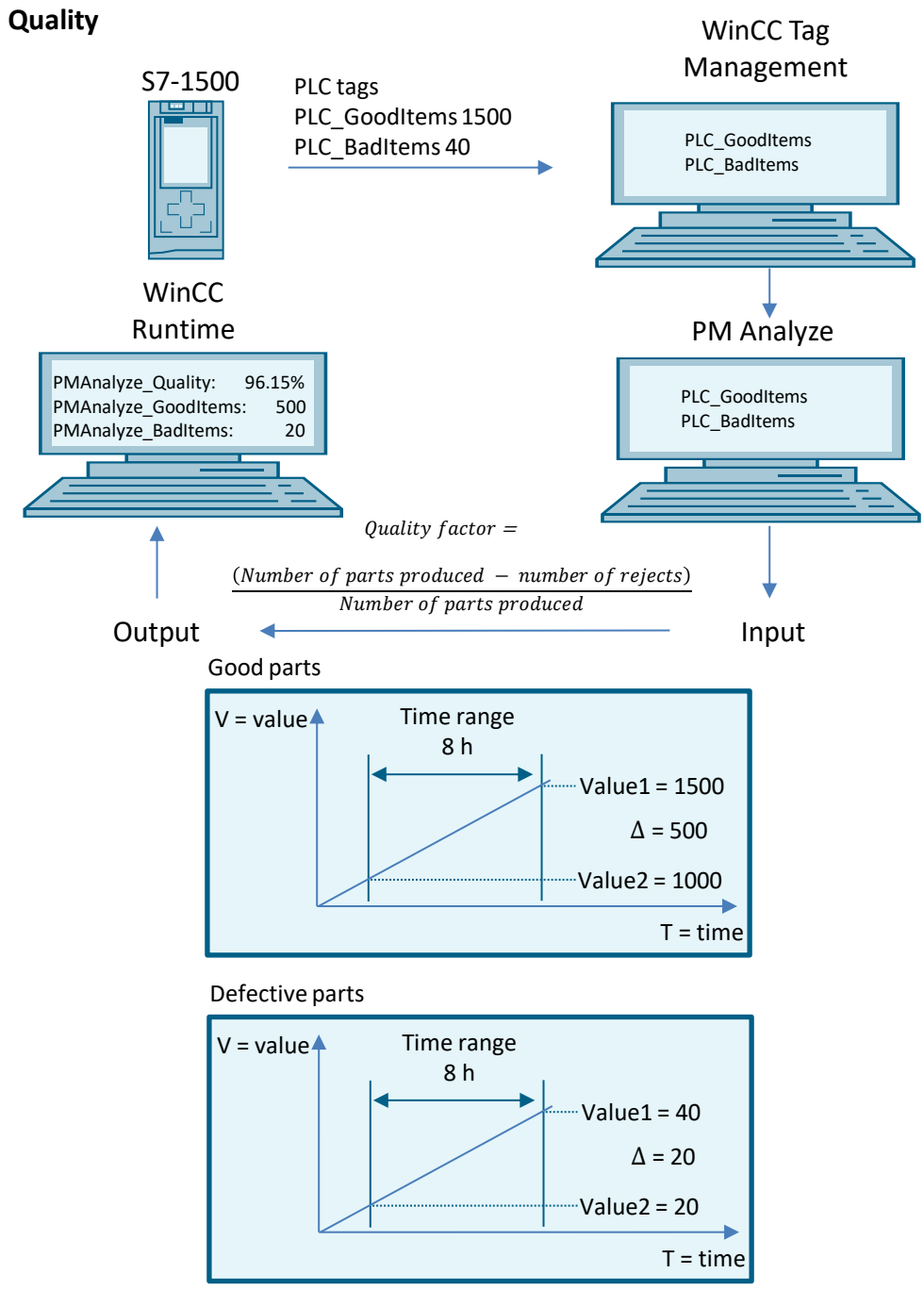


© Siemens AG 2019 All rights reserved

Example: At the start of a shift the "good parts" counter was at 1000 and the "bad parts" counter was at 20. At the end of the shift the "good parts" counter was at 1500 and the "bad parts" counter was at 40. Thus, 500 "good parts" and 20 "bad parts" were produced. The result is a Quality factor of 96.15%.

The following graphic illustrates the data flow.

Figure 8-1



© Siemens AG 2019 All rights reserved

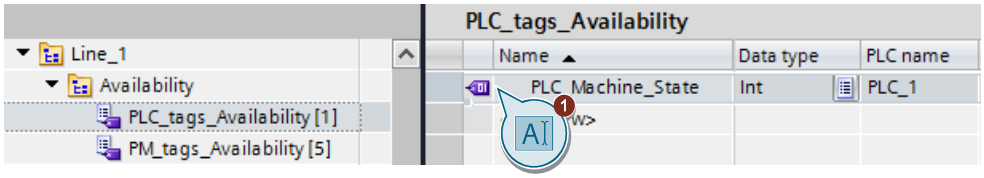
8.2 Availability

For Availability, one tag from the controller is needed. The machine status indicates through a numerical value whether the machinery is in operation or is currently inactive. This tag is the input tag necessary for the calculation. As output tags you will receive the calculated values for good parts, bad parts and the Quality factor for a defined time interval.

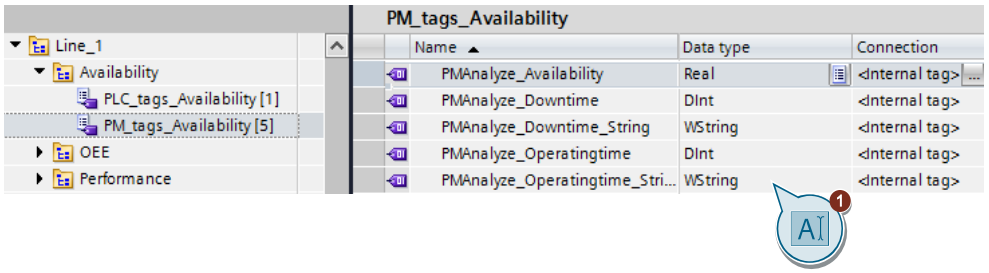
Table 8-3

Input tags	Output tags
PLC_Machine_State	PMAnalyse_Availability
	PMAnalyse_Downtime
	PMAnalyse:OperatingTime

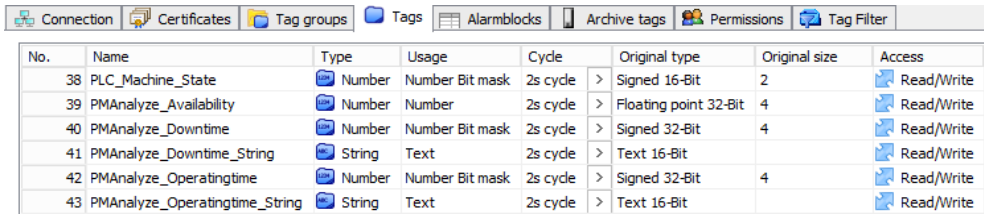
Create the following tags as input tags or find them in your control program.



Create the following tags as output tags:



In PM Analysis, the tags are available under the station's variable tags after the import:

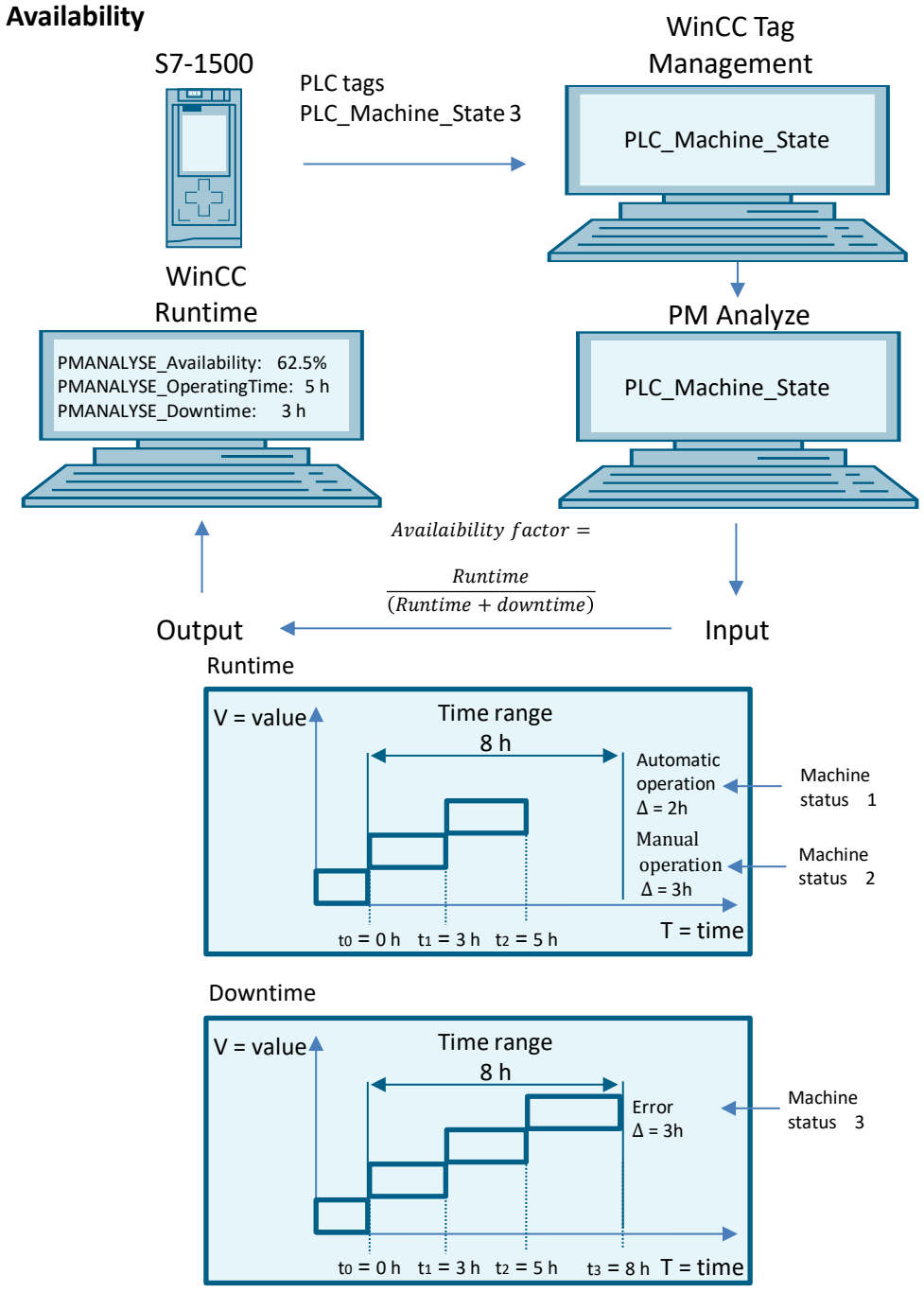


© Siemens AG 2019 All rights reserved

Example: At the start of a shift, the machinery was in manual operation for 3 hours, automatic operation for 2 hours, for 3 hours an error was pending. Therefore the run time was 5 hours and the downtime 3 hours. This results in an Availability factor of 62.5%.

The following graphic illustrates the data flow.

Figure 8-2



© Siemens AG 2019 All rights reserved

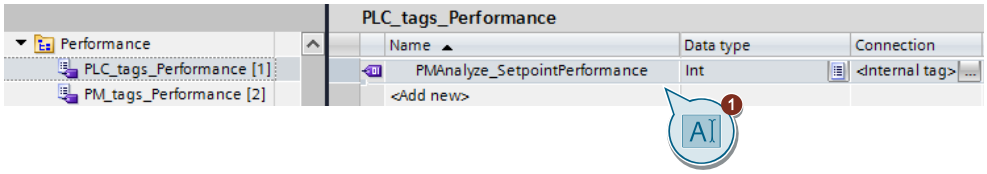
8.3 Performance factor

For Availability, one tag from the controller is needed, which specifies the target performance of a machine. This tag is the input tag necessary for the calculation. As output tags you will receive the calculated values for the actual performance and the Performance factor for a defined time interval.

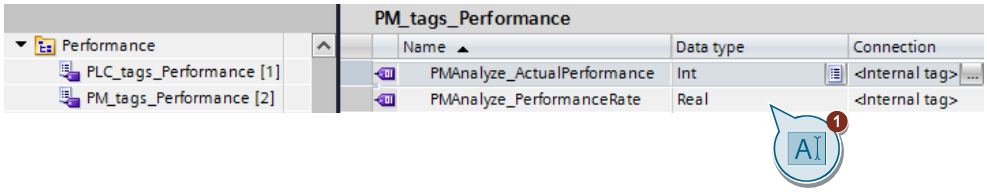
Table 8-4

Input tags	Output tags
PLC_SetpointPerformance	PMAnalyse_PerformanceRate
	PMAnalyse_ActualPerformance

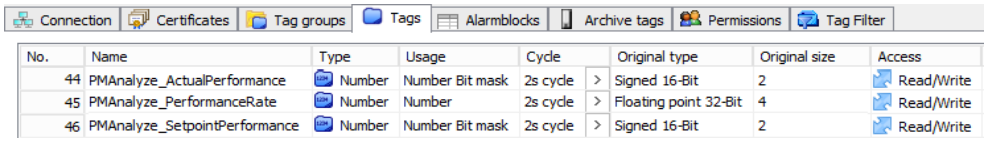
Create the following tags as input tags or find them in your control program.



Create the following tags as output tags:



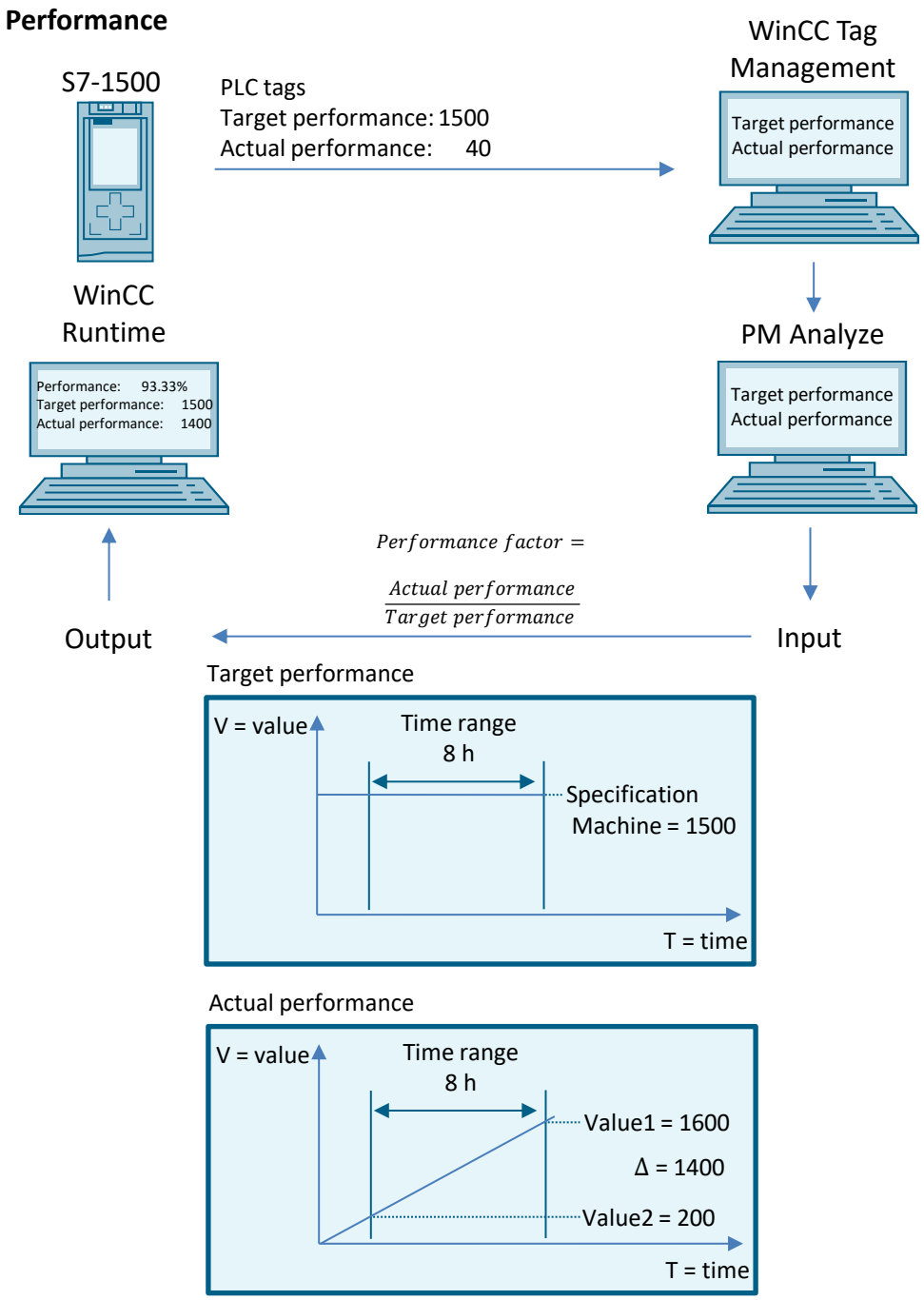
In PM Analysis, the tags are available under the station's variable tags after the import:



© Siemens AG 2019 All rights reserved

Example: At the start of a shift a target performance of 1500 units has been specified. The actual performance at the beginning of the shift was 200 parts and at the end of the shift was 1600 parts. The result is an actual performance of 1400 parts and a Performance factor of 93.33%.

The following graphic illustrates the data flow.



© Siemens AG 2019 All rights reserved

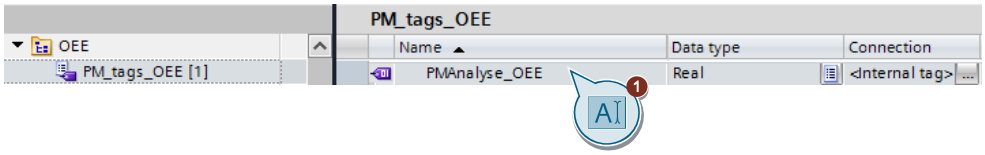
8.4 OEE

For the OEE, one tag is needed to be written to. This tag is the output tag of a calculation for a defined time interval.

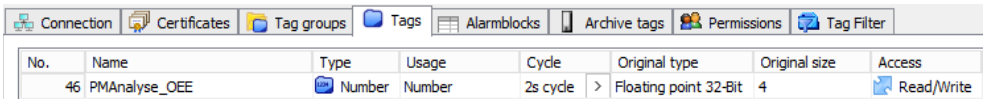
Table 8-5

Input tags	Output tags
	PMAnalyse_OEE

Create the following tags as output tags or find them in your control program.



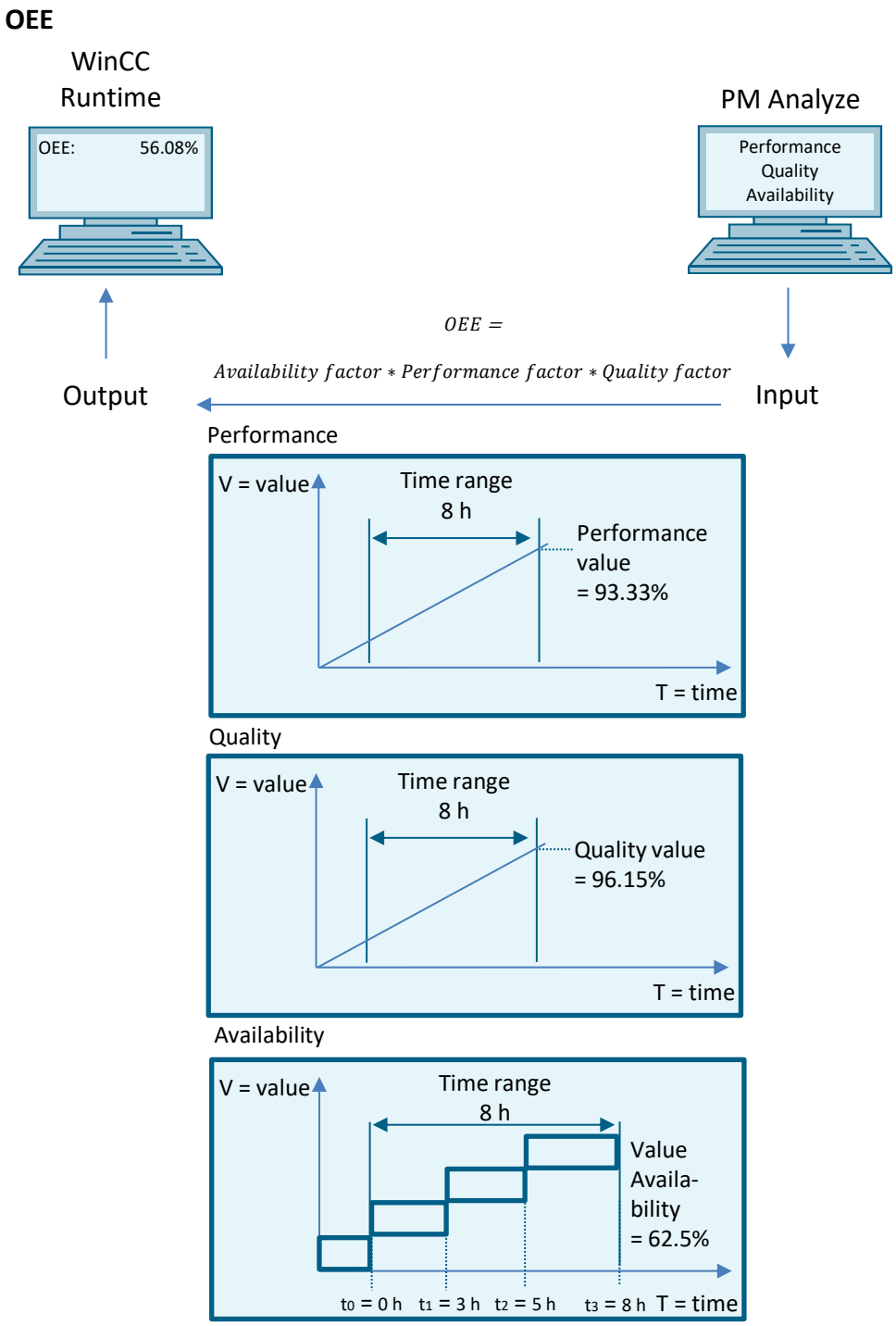
In PM Analysis, the tags are available under the station's variable tags after the import:



© Siemens AG 2019 All rights reserved

Example: At the end of a shift a Performance factor of 93.33%, a Quality factor of 96.15% and an Availability factor of 62.5% were determined. This gives an OEE of 56.08%.

The following graphic illustrates the data flow.



© Siemens AG 2019 All rights reserved

9 Schedules

In the PM Server, schedules are needed in order to set the time point of a calculation. This makes it possible to implement cyclical calculations, for example. In addition to the time point, a schedule contains the time interval which the calculation will reference.

You can select the following schedules for calculating KPIs:

- Static schedules: For fixed reporting intervals (e.g. daily report)
- Shift schedules: Freely configurable shift definitions
- Dynamic schedules: Event-based

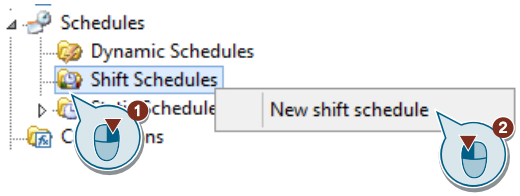
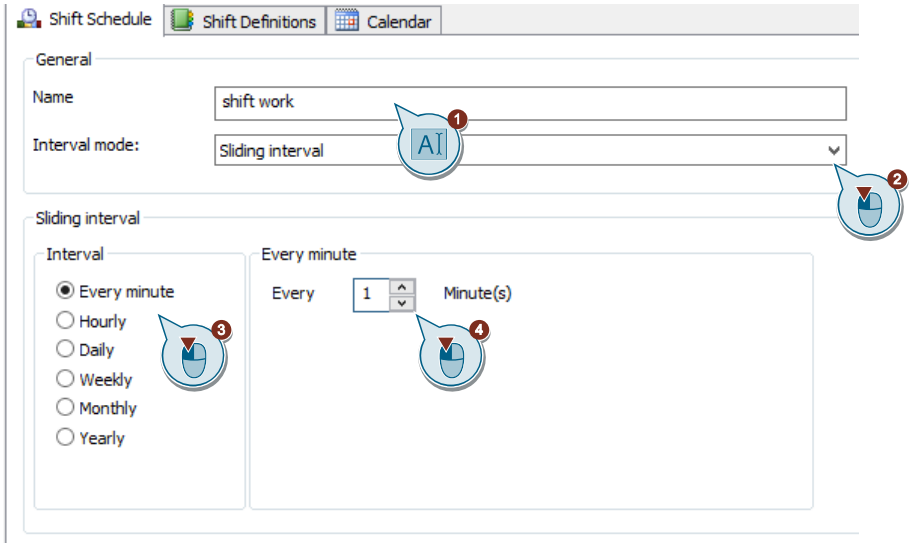
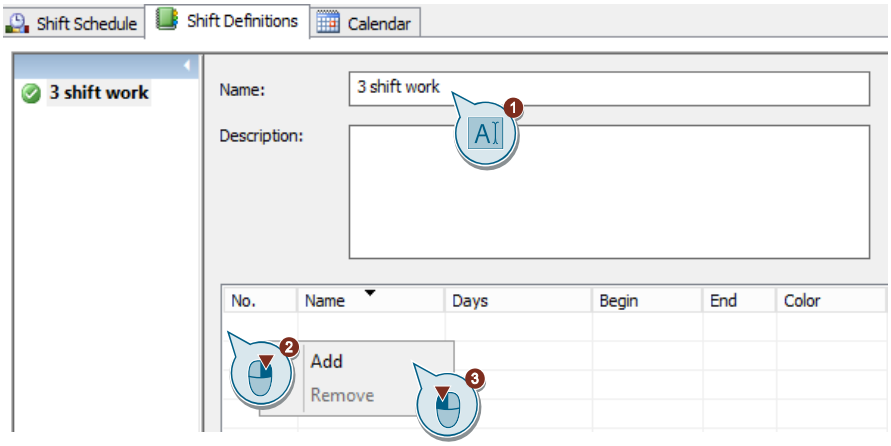
The following chapter will show the configuration of the shift schedule and static schedule.

9.1 Shift schedules

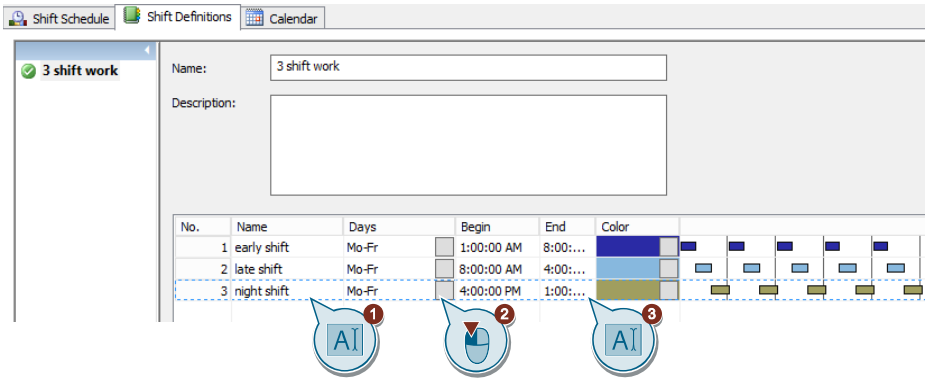
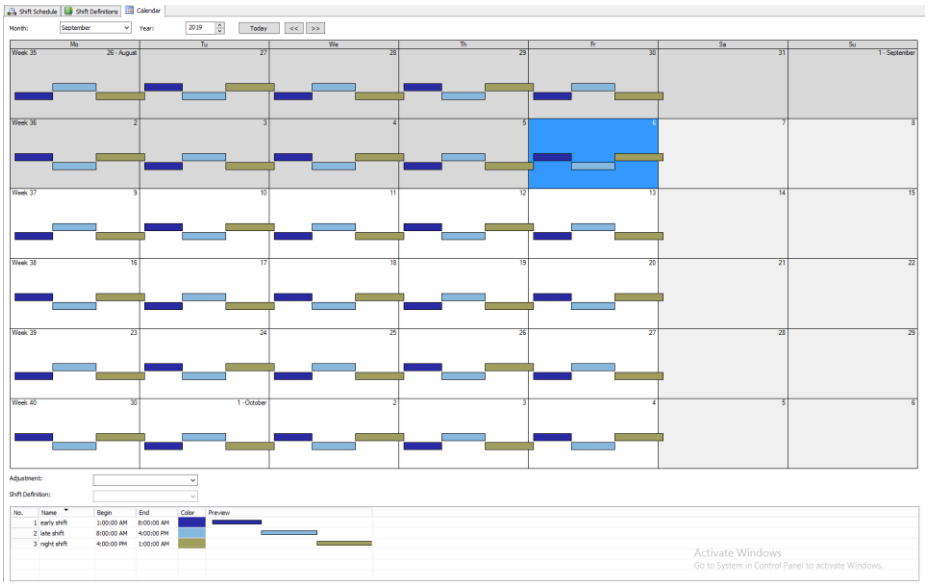
Shift schedules trigger calculations. However, no time points are defined, but rather shifts. A shift consists of a beginning time point and an end time point, as well as a name. In this manner, for example, you can define a morning shift, an evening shift and a night shift.

© Siemens AG 2019 All rights reserved

Table 9-1

No.	Action
1.	Click on the "New shift schedule" button. 
2.	Assign a name to the shift schedule. For interval mode, select Sliding Interval. This will initiate calculation in set cycles. Using this mode, a calculation does not result only with the completion of the total interval, but intermediate results can instead be calculated before the end is reached. For an interval, select a time unit (by minute, hourly, daily, weekly, monthly, and yearly) within which the calculation will be activated. 
3.	Click on Shift Definitions. Assign a name to the shift. Add 3 shifts for morning shift, evening shift and night shift to the table using the "Add" button. 

© Siemens AG 2019 All rights reserved

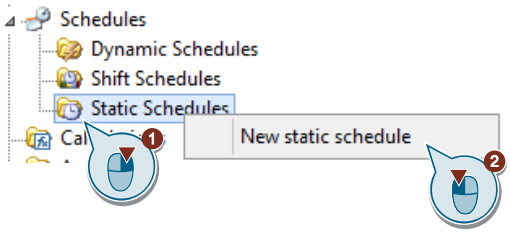
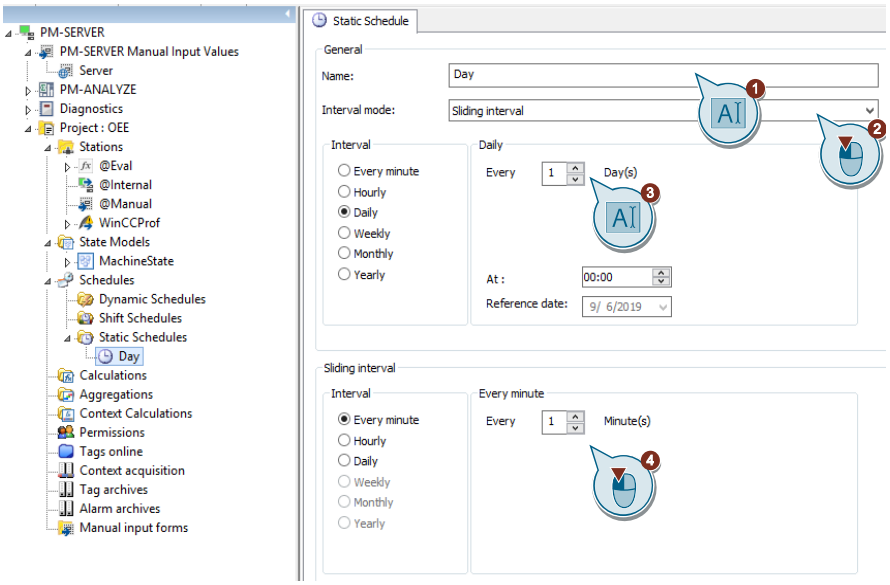
No.	Action
4.	Define a time interval for the shifts. 
5.	In the calendar you can see a visual representation of the shift for a calendar month. If there are any overlaps with other shifts, these are highlighted in the visualization and can be easily identified. 

© Siemens AG 2019 All rights reserved

9.2 Static schedules

With static schedules, cyclical time points can be defined at which a calculation will be triggered.

Table 9-2

No.	Action
1.	Click on the "New static schedule" button. 
2.	Assign a name to the static schedule. For interval mode, select "Fliding Interval". This will initiate calculation in set cycles. Using this mode, a calculation does not result only with the completion of the total interval, but intermediate results can instead be calculated before the end is reached. For a total interval, select a time unit (by minute, hourly, daily, weekly, monthly, and yearly) within which the calculation will be activated. For the intermediate results of the sliding interval, select a time unit (by minute, hourly, daily, weekly, monthly, and yearly) within which the calculation will be activated. 

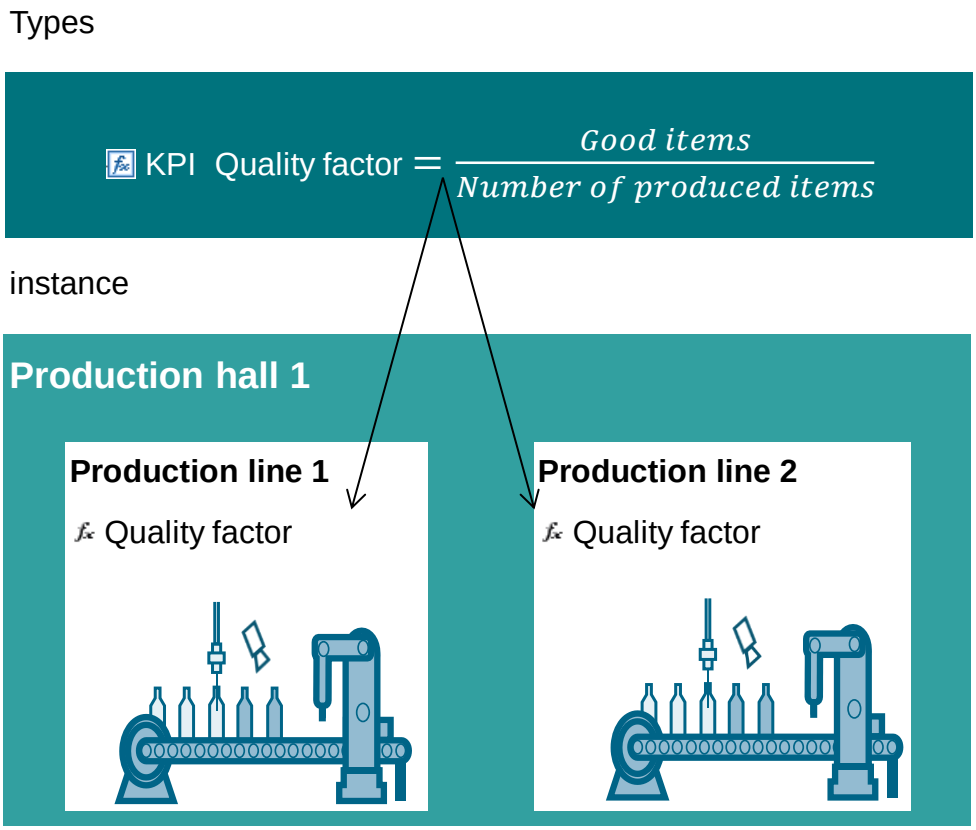
© Siemens AG 2019 All rights reserved

10 Configuring formulas

10.1 Basics

PM-ANALYZE uses the "type and instance" concept. In that sense, you will create a formula once and use it multiple times (instances) for different production lines.

Figure 10-1



Types

For KPIs, set the calculation formula (e.g. Availability factor, Performance factor, Quality factor or OEE). The indicator is calculated for a defined time interval.

Instances

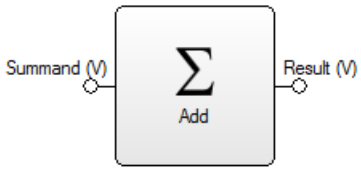
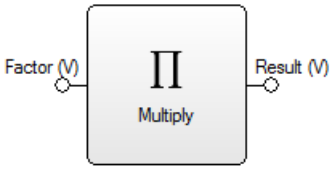
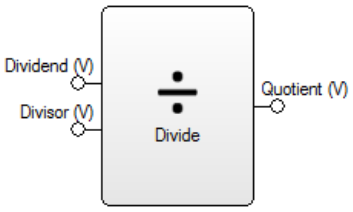
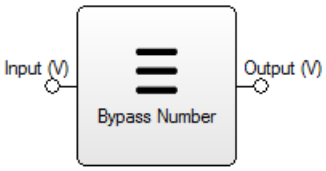
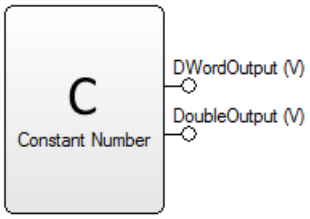
Once you have defined the formula, assign the necessary input and output values for your production line to the instance.

© Siemens AG 2019 All rights reserved

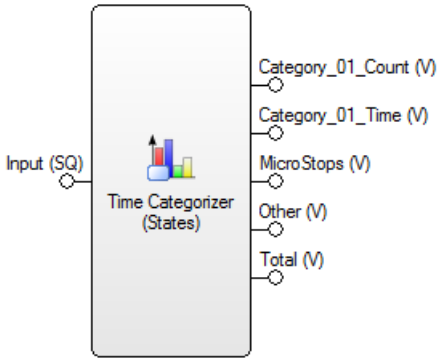
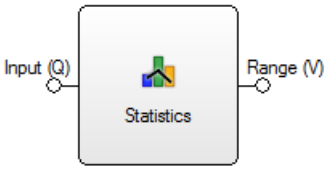
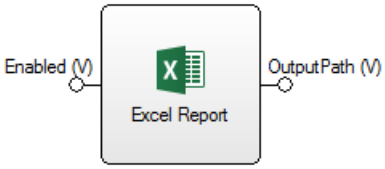
10.1.1 Blocks

The following blocks are used for calculating the OEE.

Table 10-1

Function block	Description
Add (Arithmetical) 	The function block "Add" forms the sum from the inputs.
Multiply (Arithmetical) 	The function block "Multiply" yields the product from the inputs.
Divide (Arithmetical) 	The function block "Divide" yields the result of a division.
Bypass Number (Bypass) 	The function block "Bypass Number" enables multiple output connections.
Constant Number (Constant) 	The function block "Constant Number" supplies a configurable constant single value.

© Siemens AG 2019 All rights reserved

Function block	Description
Time Categorizer (Queue) 	"Time Categorizer" expects a sequence of values with states of a state model and gives the time in seconds at which a state was queued. A maximum of five value ranges are configurable.
Statistics (Queue) 	The range is calculated in the "Statistics" function block. The range is the end value minus the starting value in a certain time interval.
Excel Report (Reporting) 	The "Excel Report" creates a report for the current time window based on an Excel template.

© Siemens AG 2019 All rights reserved

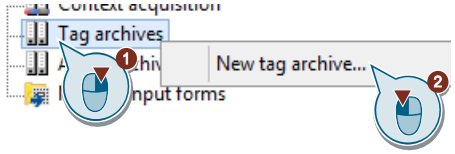
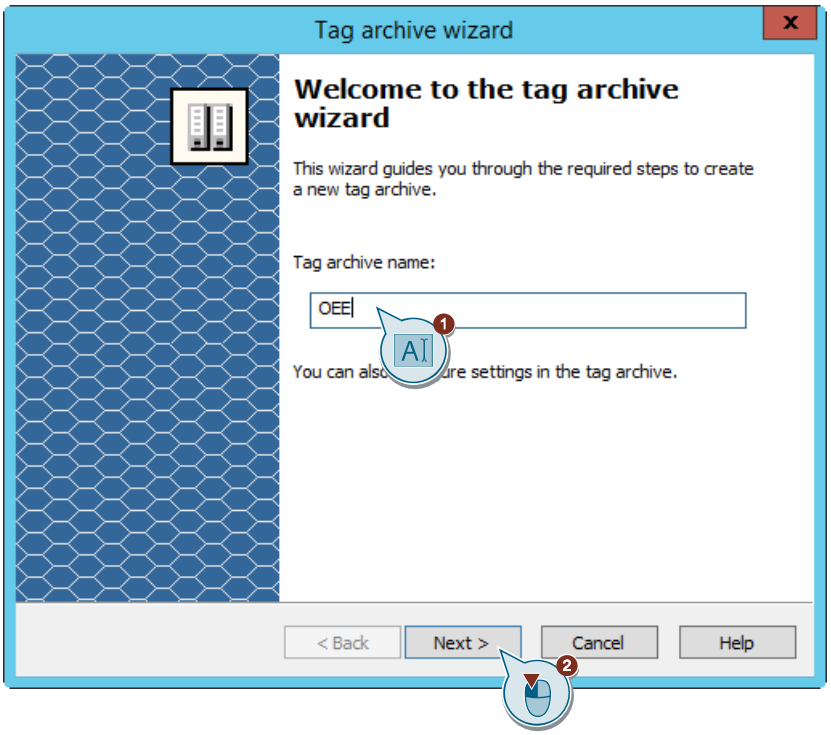
10.1.2 Input pin meanings

Table 10-2

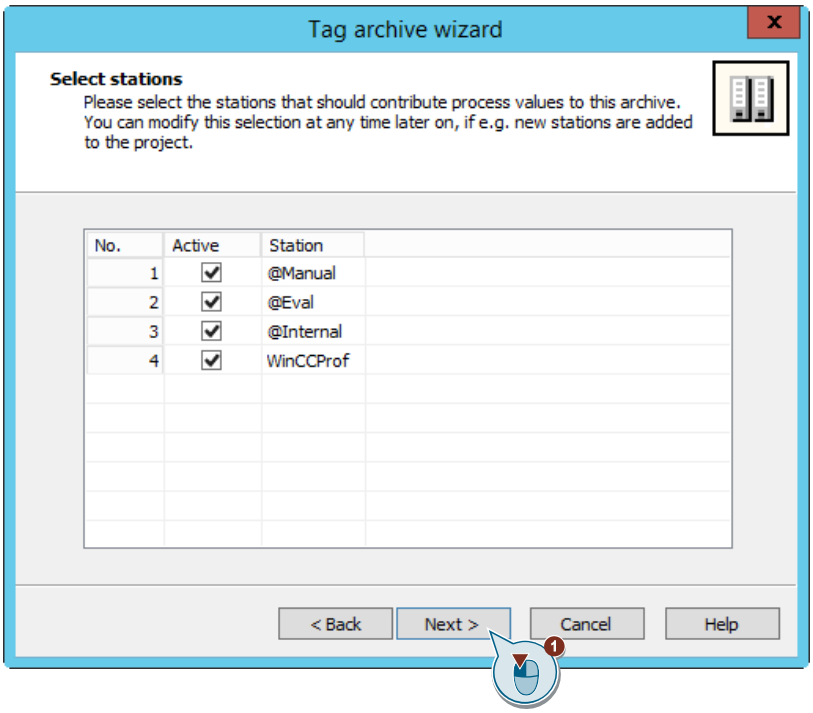
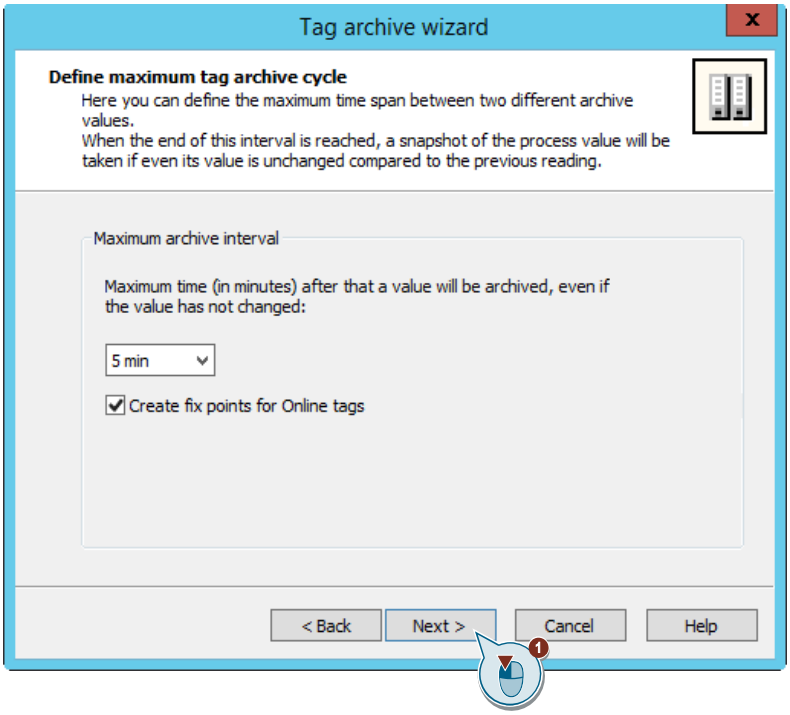
Pin	Meaning
States (SQ)	Expects a state model as a connection.
Values (Q)	As a connection, expects a value sequence, e.g. from an archive tag.
Value (V)	Expects a value (numeric or alphanumeric)

10.2 Configuring a process value archive

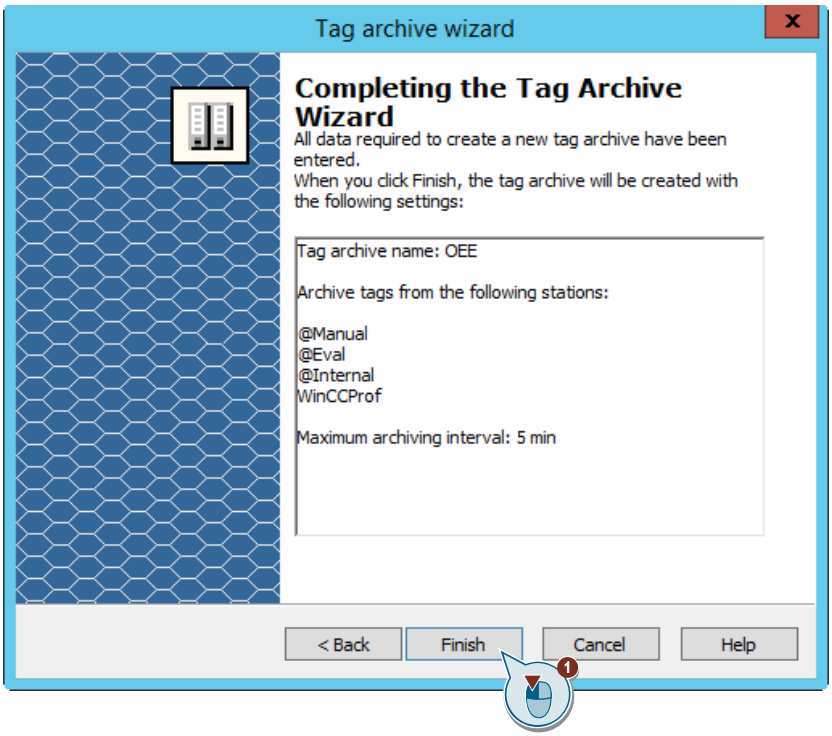
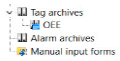
Table 10-3

No.	Action
1.	To create a process value archive, open the menu item "Process value archive" and select "New process value archive". 
2.	A wizard will open to guide you through configuring the process value archive. Give the newly-created process value archive a name and confirm your choice by pressing "Next". 

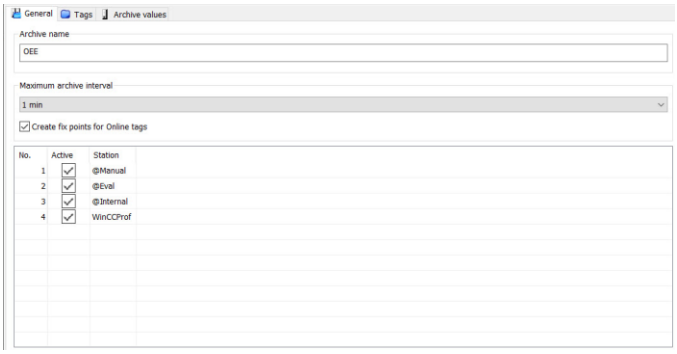
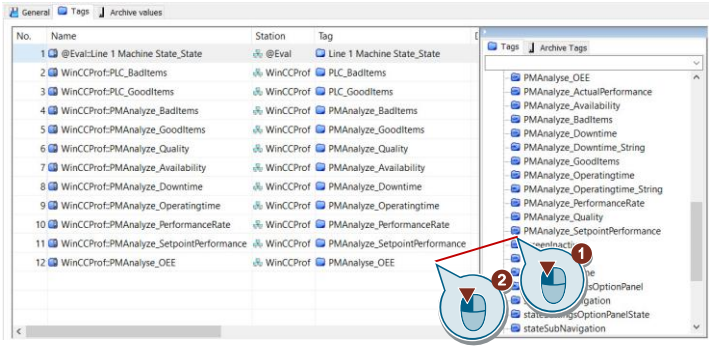
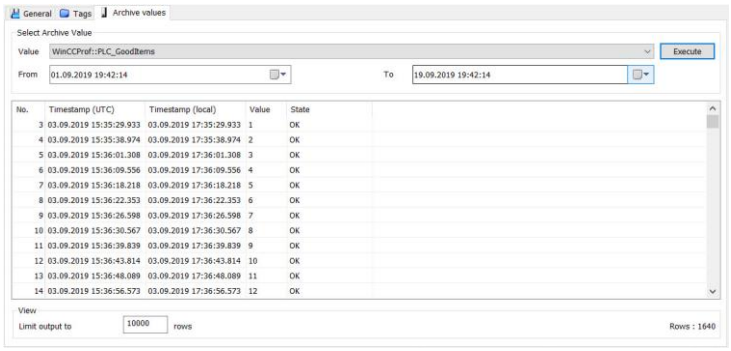
© Siemens AG 2019 All rights reserved

No.	Action
3-	The dialog lists the stations which have already been configured. Using the control box it is possible to select the stations from which values will be archived in the process value archive. This selection can be later modified in the "General" tab. Click "Next" to confirm the configuration. 
4.	The maximum archiving interval is set in the dialog. This is the span of time in which, at the latest, an unmodified value of the tags will be written to the process value archive, if the tag contents have not previously changed. Click "Next" to confirm the configuration. 

© Siemens AG 2019 All rights reserved

No.	Action
5.	The final dialog lists for inspection the names assigned for the process value archive, the names of the stations from which tag and archive values will be input to the process value archive, and the maximum set archiving interval. The process value archive is created by clicking the "Finish" button. 
6.	Once the wizard has been successfully completed, the newly-created process value archive appears as a sub-entry under "Process value archives" in the PM Server. 

© Siemens AG 2019 All rights reserved

No.	Action
7.	If the archive is selected, its settings are shown in the PM Server. There are three tabs for this: "General", "Tags" and "Archive values". The "General" tab has already been configured through the process value archive wizard and can be retroactively modified here.  In the "Tags" tab, all necessary tags can be inserted by drag & drop into the table window for the process value archive. Drag and drop the tags that you imported from the WinCC station in chapter 8 , into the process value archive.  In the final "Archive values" tab, the values of the tags present in PM-SERVER can be displayed. In addition, the tags are selected via a drop-down menu and you can set a time range for which the data should be displayed. After clicking the "Apply" button the values are finalized. 

© Siemens AG 2019 All rights reserved

10.3 Configuring availability

State model

A state model first needs to be created for the system. The machine state contains a list with states to which values or value ranges can be assigned.

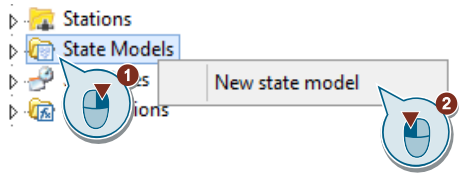
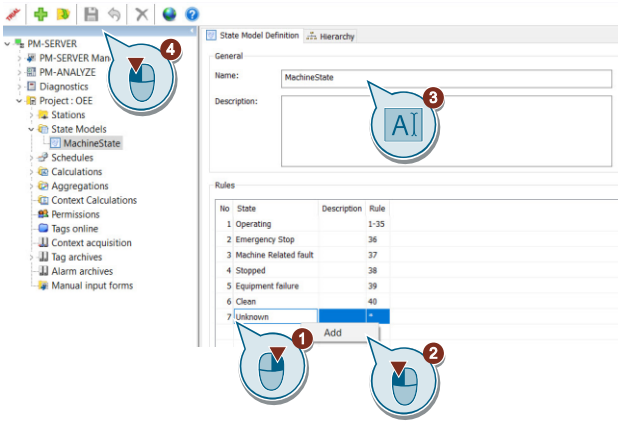
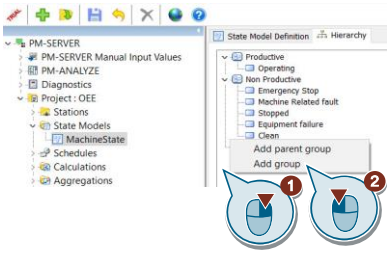
Table 10-4

Status	Value	Availability
Operation	1-35	Run time
Emergency stop	36	Downtime
Machine-related error	37	Downtime
System paused	38	Downtime
Device failure	39	Downtime
System cleaning	40	Downtime

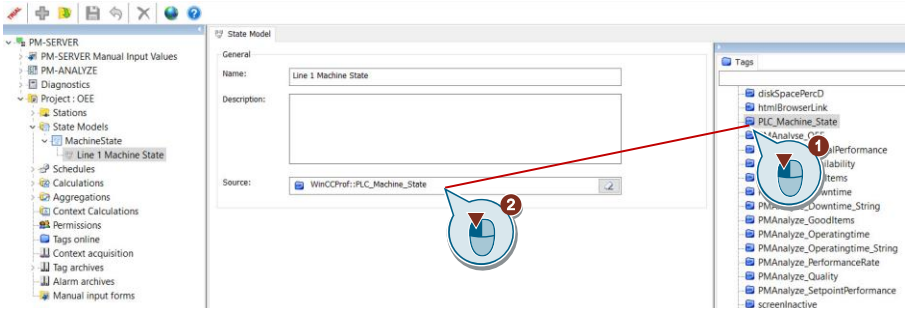
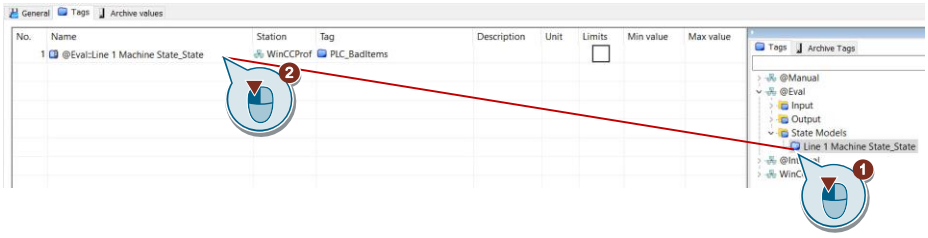
© Siemens AG 2019 All rights reserved

Creating a state model

Table 10-5

No.	Action
1.	A state model first needs to be created for a machine. To do this, open under project: PM Server the context menu for Object state model by right clicking and select "New state model". 
2.	In the State model definition tab, set the name and the states of the state model. The machine is intended to be able to accept 6 states: Operation (run time) 1. Operation (run time) 2. Emergency stop (downtime) 3. Machine-related error (downtime) 4. System paused (downtime) 5. Device failure (downtime) 6. System cleaning (downtime) Click Save. 
3.	In the "Hierarchy" tab, insert super-ordinate groups named "run time" and "downtime" for the run time and downtime states. 

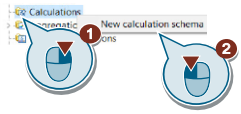
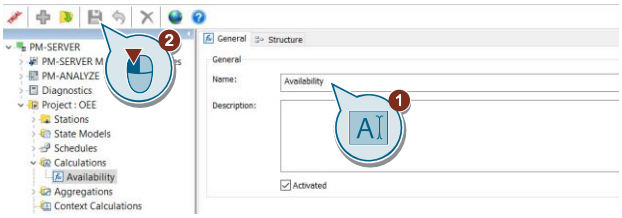
© Siemens AG 2019 All rights reserved

No.	Action
4.	Then create a new instance using the context menu.  The state model, and connect a numeric tag to each using drag & drop. 
5.	The name of the newly-created tag consists of the instance name, appended with "_State". This tag contains the result of the evaluation of the state model for this instance. So that an evaluation of the states over the time range can be carried out, this tag must be cyclically archived in PM Server in a process value archive. Open your newly-created process value archive "OEE" and add the tag "Line1 Machine State_State" to your process value archive. 

© Siemens AG 2019 All rights reserved

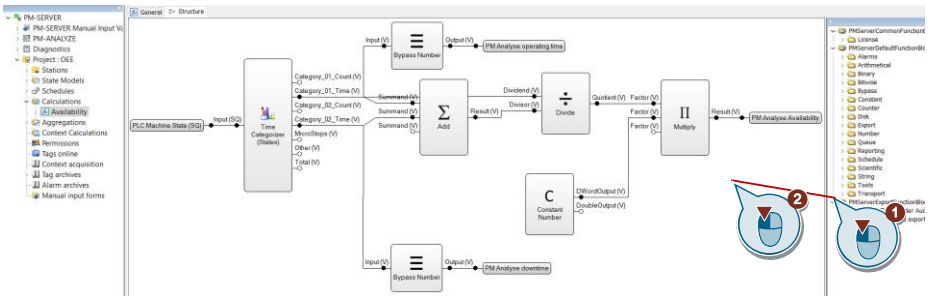
Formula

Table 10-6

No.	Action
1.	Click on "Add new calculation scheme". 
2.	Name the calculation scheme "Availability". Click "Save". 

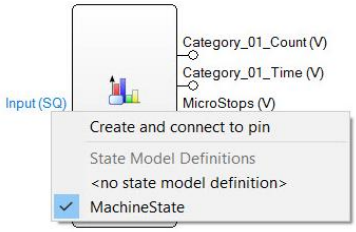
No.	Action
3.	Insert the following function blocks in order to represent the formula for Availability.

$$Availability\ factor\ = \frac{Run\ time}{(Run\ time\ +\ downtime)} * 100$$

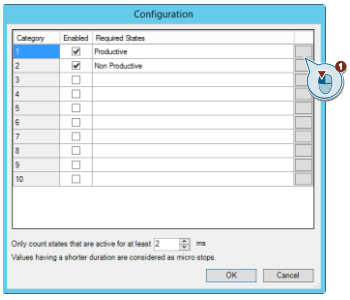


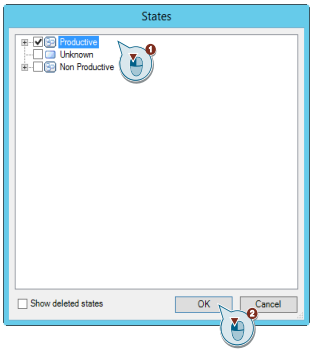
1x Time Categorizer (Queue): The Time Categorizer expects a sequence of values with states of a state model (machine states) and gives the time in seconds at which a state was queued. Using "TimeCategorizer" the run time and the downtime are recorded.

Select the newly-created state model MachineState.

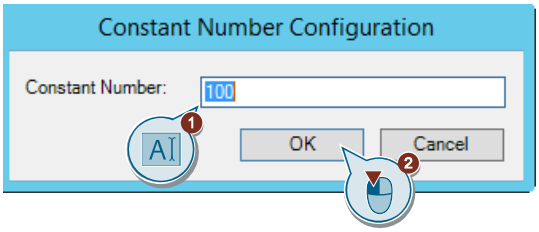
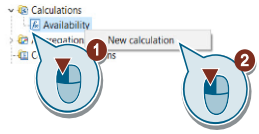
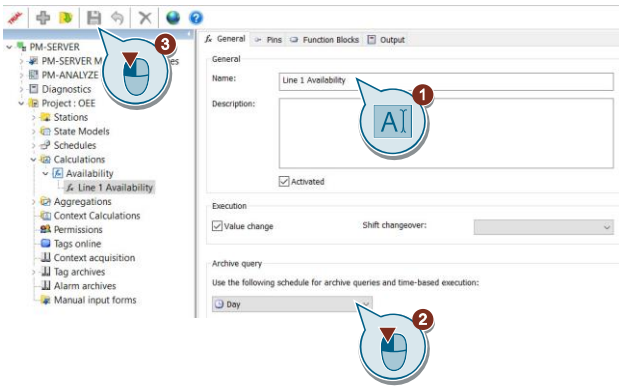
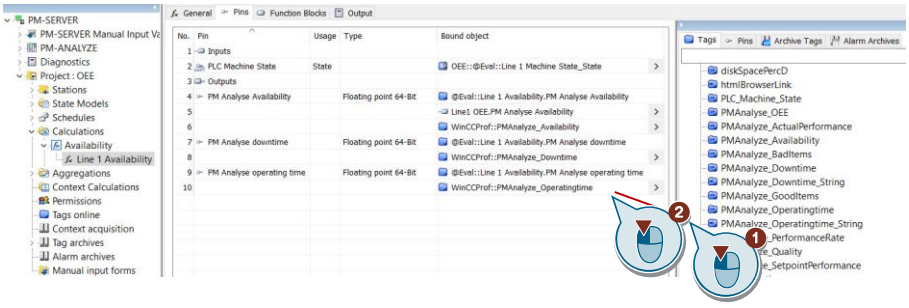


Click the button to select the run time or downtime states.

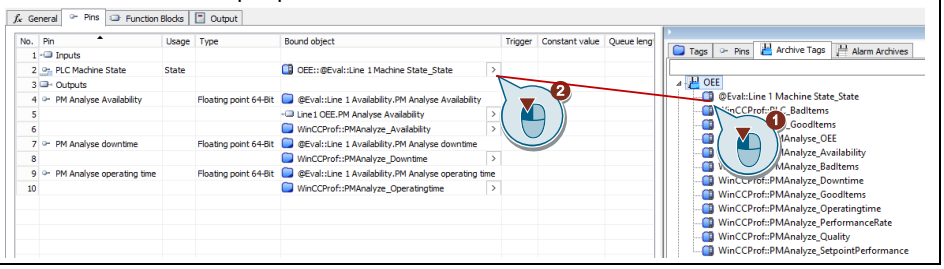




© Siemens AG 2019 All rights reserved

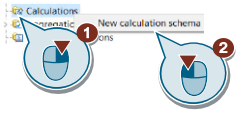
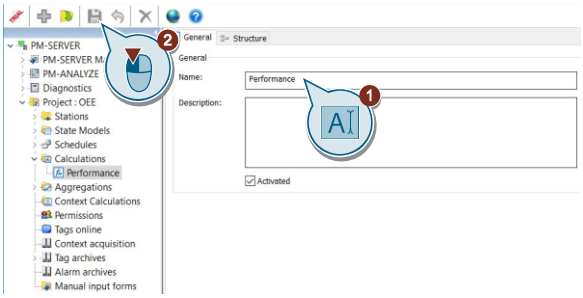
No.	Action
3.	1x Add (Arithmetical): The function block Add forms the sum from the inputs run time plus downtime. 1x Divide (Arithmetical): The function block Divide yields the result of a division of run time / (run time + downtime). 1x Multiply (Arithmetical): The function block Multiply yields the product of the constant 100 and the formula run time / (run time + downtime). 1x Constant Number (Constant): The function block "Constant Number" supplies a constant single value of 100.  2x Bypass Number (Bypass): This function block enables multiple output connections. In our case, the outputs for run time and downtime are written to external tags.
4.	Click on "New calculation". 
5.	Name the instance "Line 1 Availability". Assign the created "Day" schedule. 
6.	Drag and drop the imported tags "PMAnalyze_Availability", "PMAnalyze_Downtime" and "PMAnalyze_Operatingtime" to the corresponding output pins. 

© Siemens AG 2019 All rights reserved

No.	Action
7.	Drag the process archive tag @Eval::Line 1 Machine State_State from the process value archive to the input pin "PLC Machine State". 

10.4 Configuring Performance factor

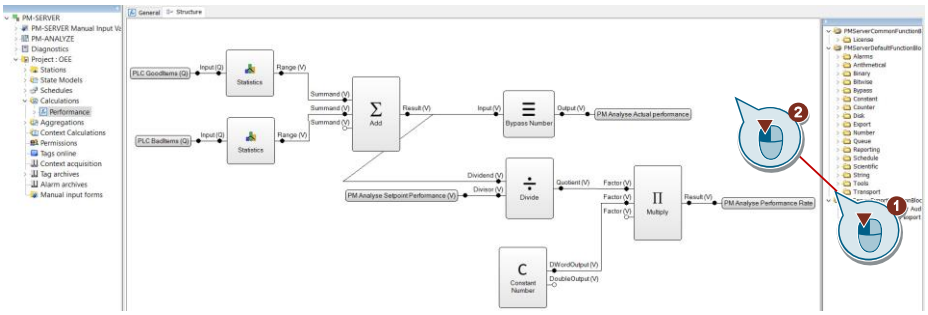
Table 10-7

No.	Action
1.	Click on "Add new calculation scheme". 
2.	Name the calculation scheme "Performance". Click "Save". 

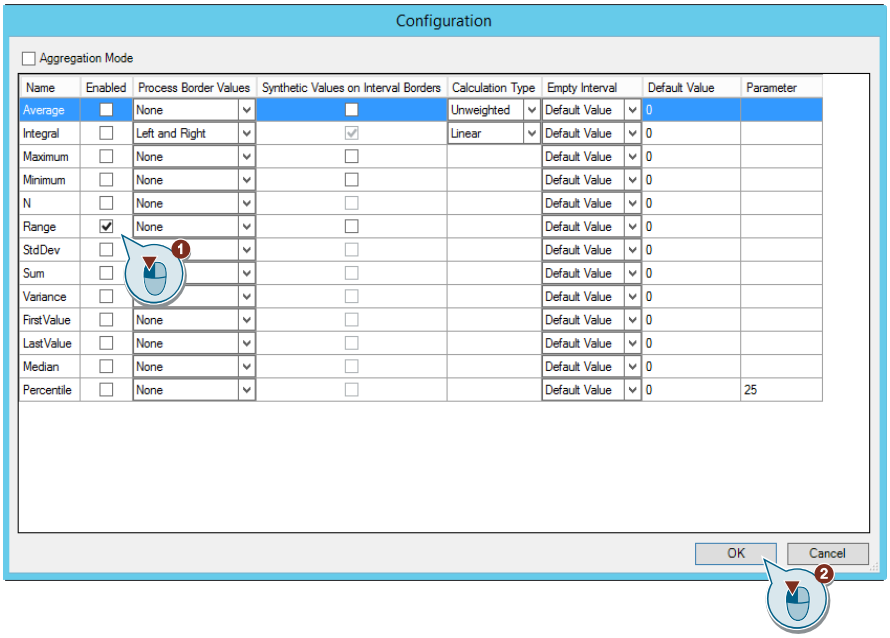
© Siemens AG 2019 All rights reserved

No.	Action
3.	Insert the following function blocks in order to represent the formula for Performance.

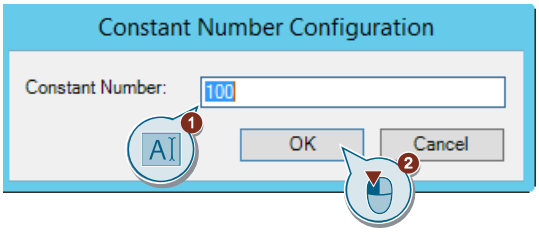
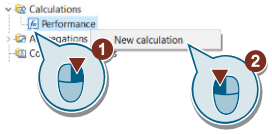
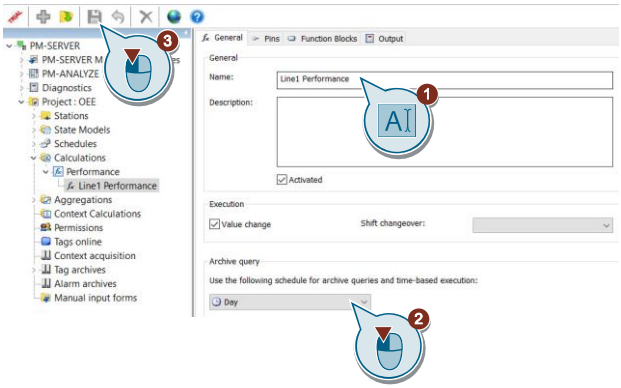
$$Performance\ factor\ = \frac{Actual\ performance}{Target\ performance} * 100$$



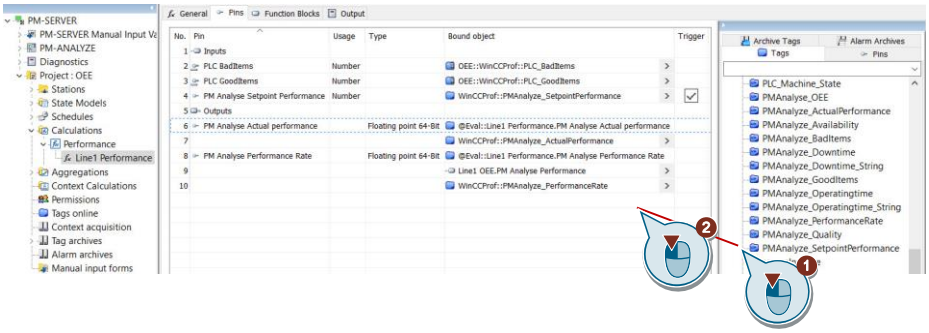
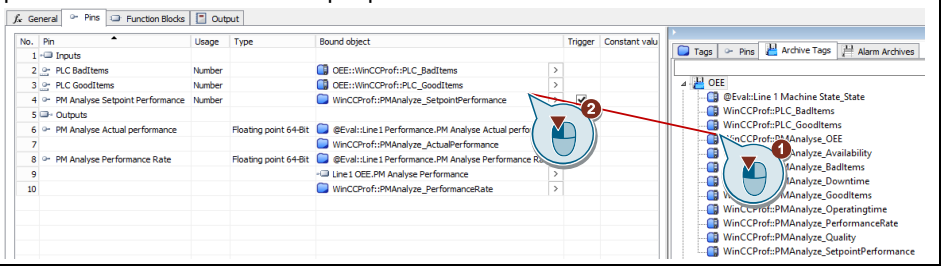
The range for the good parts and bad parts is calculated 2x in the "Statistics" function block. The range is the end value minus the starting value in a certain time interval. The block expects a process value archive tag at the input.



© Siemens AG 2019 All rights reserved

No.	Action
3.	1x Add (Arithmetical): The function block "Add" forms the sum from the inputs for good parts and bad parts. 1x Divide (Arithmetical): The function block Divide yields the result of a division of actual performance / target performance. 1x Multiply (Arithmetical): The function block Multiply yields the product of the constant 100 and the formula for actual performance / target performance. 1x Constant Number (Constant): The function block "Constant Number" supplies a constant single value of 100.  1x Bypass Number (Bypass): This function block enables multiple output connections. In our case, the output for actual performance is written to an external tag.
4.	Click on "New calculation". 
5.	Name the instance "Line 1 Performance". Assign the created "Day" schedule. 

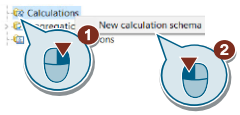
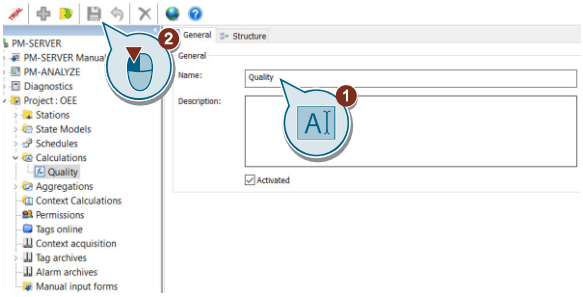
© Siemens AG 2019 All rights reserved

No.	Action
6.	Drag and drop the imported tags "PMAnalyze_SetpointPerformance", "PMAnalyze_ActualPerformance" und "PMAnalyze_PerformanceRate" to the corresponding output pins. 
7.	Drag the process archive tag "PLC_BadItems" and "PLC_GoodItems" from the process value archive to the input pins 

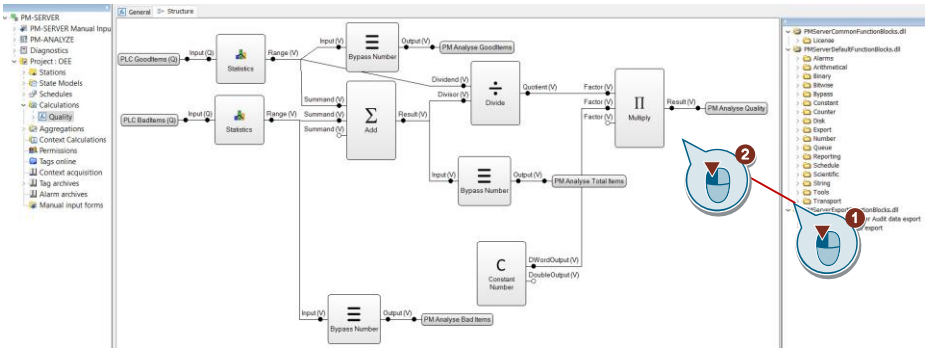
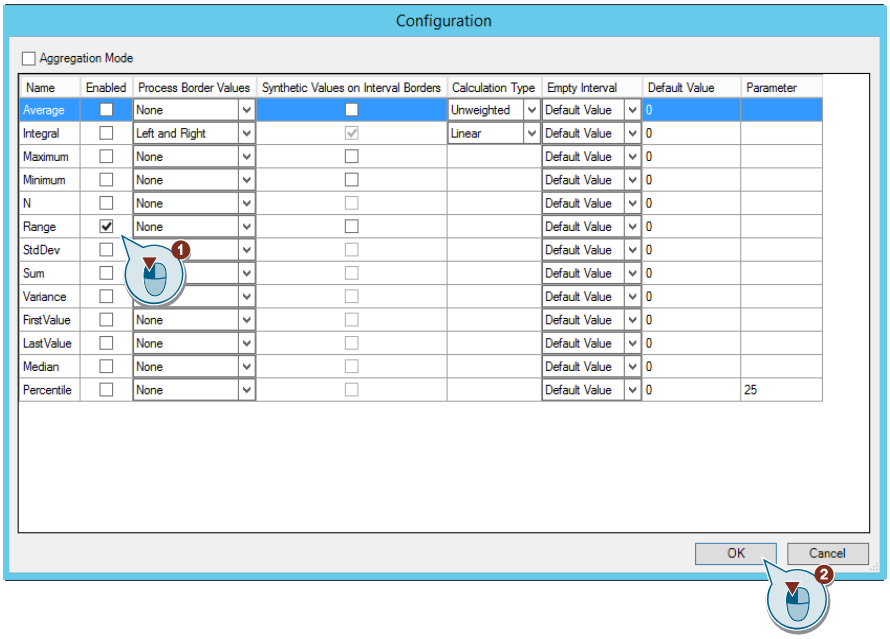
© Siemens AG 2019 All rights reserved

10.5 Configuring Quality factor

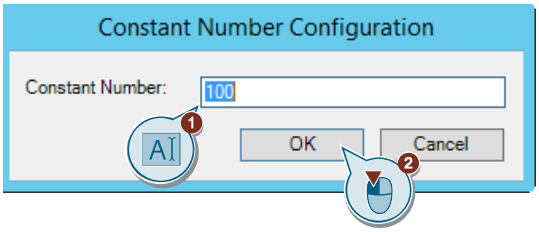
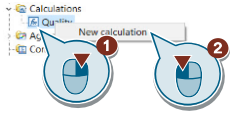
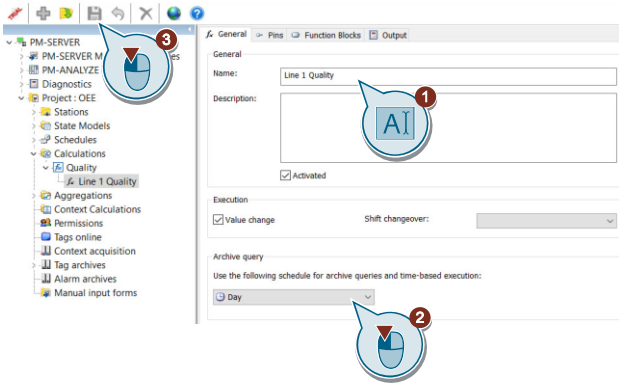
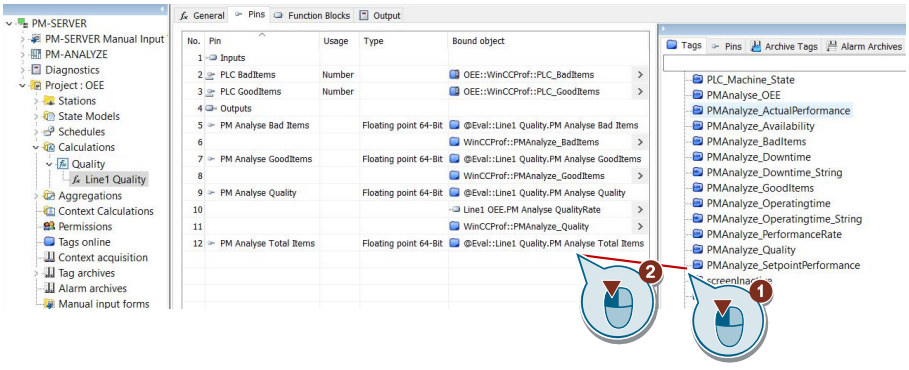
Table 10-8

No.	Action
1.	Click on "Add new calculation scheme". 
2.	Name the calculation scheme "Quality". Click Save. 

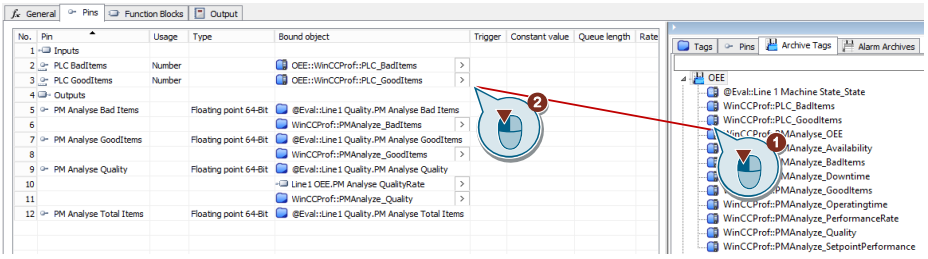
© Siemens AG 2019 All rights reserved

No.	Action
3.	Insert the following function blocks in order to represent the formula for the Quality factor. $$Quality\ factor\ =$$ $$\frac{(Number\ of\ parts\ produced\ -\ number\ of\ rejects)}{Number\ of\ parts\ produced} * 100$$  The range for the good parts and bad parts is calculated 2x in the "Statistics" function block. The range is the end value minus the starting value in a certain time interval. The block expects a process value archive tag at the input. 

© Siemens AG 2019 All rights reserved

No.	Action
3.	1x Add (Arithmetical): The function block "Add" forms the sum from the inputs for good parts and bad parts. 1x Divide (Arithmetical): The function block Divide yields the result of a division of good parts / number of parts produced. 1x Multiply (Arithmetical): The function block Multiply yields the product of the constant 100 and the formula for actual performance / target performance. 1x Constant Number (Constant): The function block "Constant Number" supplies a constant single value of 100.  2x Bypass Number (Bypass): This function block enables multiple output connections. In our case, the outputs for good parts and bad parts are written to an external tag.
4.	Click on "New calculation". 
5.	Name the instance "Line 1 Quality". Assign the created Day schedule. 
6.	Drag and drop the imported tags "PMAnalyze_BadItems", "PMAnalyze_GoodItems" and "PMAnalyze_QualityRate" to the corresponding output pins. 

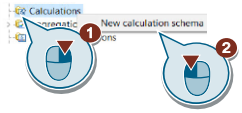
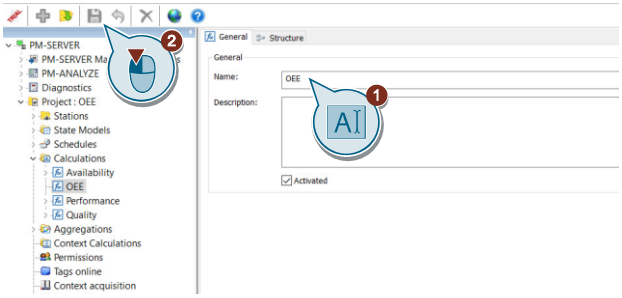
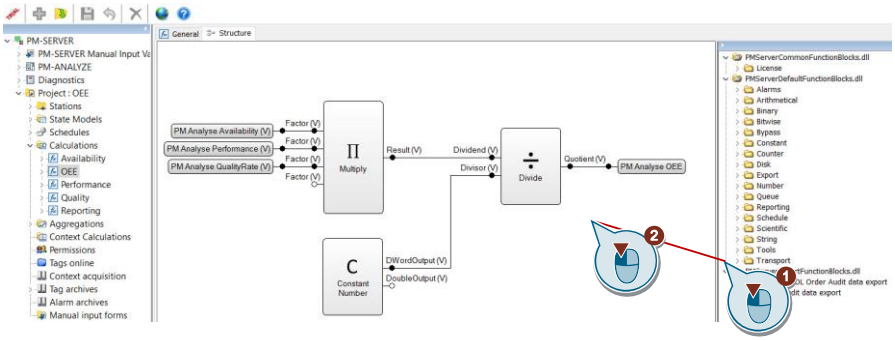
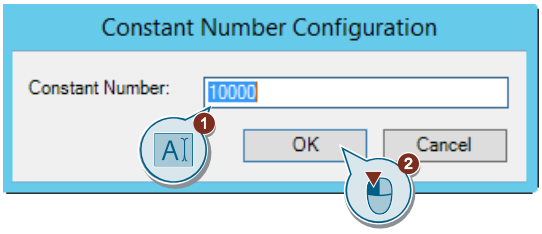
© Siemens AG 2019 All rights reserved

No.	Action
7.	Drag the process archive tag "PLC_BadItems" and "PLC_GoodItems" from the process value archive to the input pins 

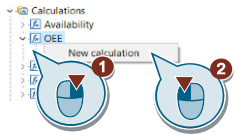
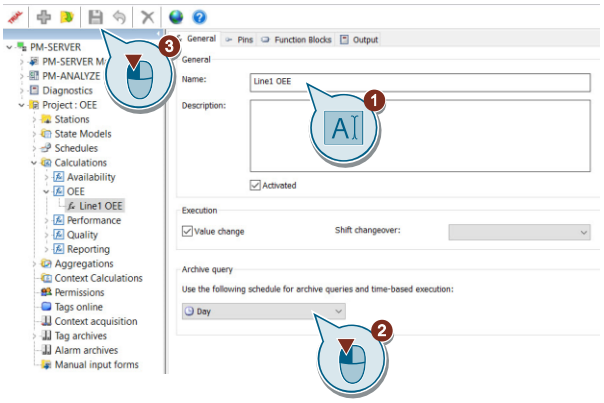
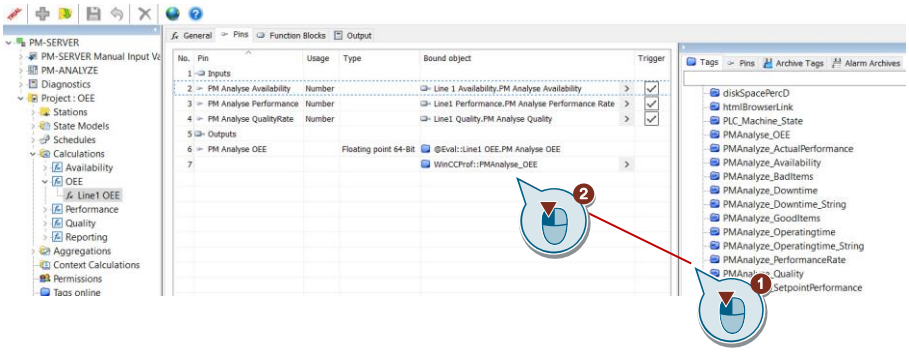
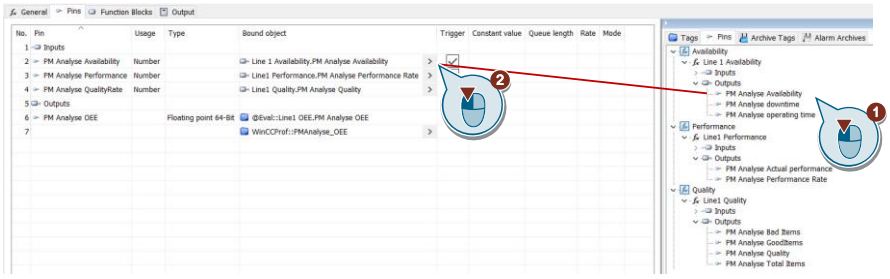
© Siemens AG 2019 All rights reserved

10.6 Configuring OEE

Table 10-9

No.	Action
1.	Click on "Add new calculation scheme". 
2.	Name the calculation scheme "OEE". Click Save. 
3.	Insert the following function blocks in order to represent the formula for OEE. $$OEE = Availability\ factor * Performance\ factor * Quality\ factor$$  1x Multiply (Arithmetical): The function block Multiply yields the product from the inputs for Availability factor, Performance factor and Quality factor. 1x Constant Number (Constant): The function block Constant Number supplies a constant single value of 10000.  1x Divide (Arithmetical): The function block Divide yields the result of a division of OEE / constant. This normalizes the OEE to a value between 0 and 100.

© Siemens AG 2019 All rights reserved

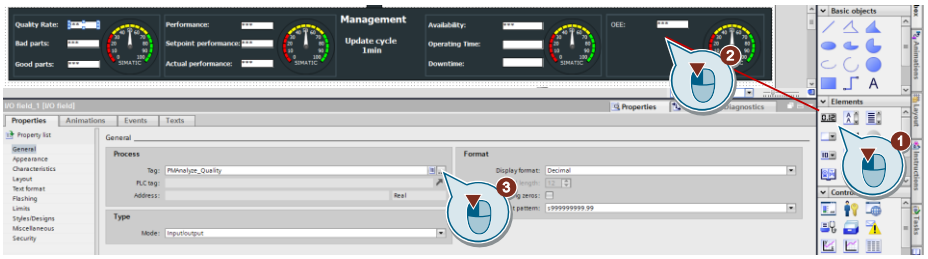
No.	Action
4.	Click on "New calculation". 
5.	Name the instance "Line 1 OEE". Assign the created "Day" schedule. 
6.	Drag and drop the imported tag "PMAnalyze_OEE" to the corresponding output pins. 
7.	Connect the input pins for OEE calculation with the output pins of the preceding calculations for Availability, Performance and Quality. 

© Siemens AG 2019 All rights reserved

10.7 Visualization

Configure 10 I/O fields for visualization in WinCC Professional.

Table 10-10

No.	Action
1.	Connect the tags "PMAnalyze_Quality" "PMAnalyze_BadItems" "PMAnalyze_GoodItems" "PMAnalyze_PerformanceRate" "PMAnalyze_SetpointPerformance" PMAnalyse_ActualPerformance "PMAnalyze_Availability" "PMAnalyze_Operatingtime" "PMAnalyze_Downtime" "PMAnalyze_OEE" with the I/O fields. 

© Siemens AG 2019 All rights reserved

11 Excel reporting

With the help of the Excel Add-In, you can access process values and compaction archives, computed values and indicators, as well as messages and operational actions. Here you can access statistics functions such as average, integral, min/max, sum, standard deviation, median or percentile. You can perform additional operations on the generated reports using further function blocks (e.g. print or forward via email).

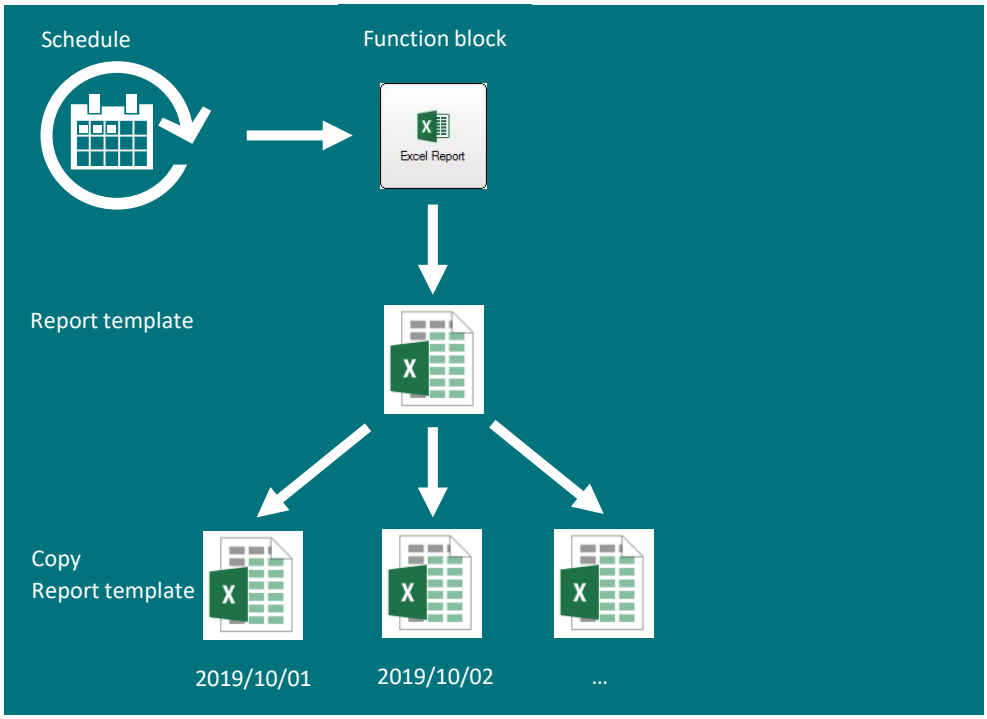
Possible output formats may be:

- Excel
- PDF

Principle of operation

You will create a report template with Excel. In this template, you will select tags from the process value archive with the help of the Add-In. The report template is populated with data by a function block. A schedule controls the calling of the block. A copy of the report template is then populated with data for the time interval in question.

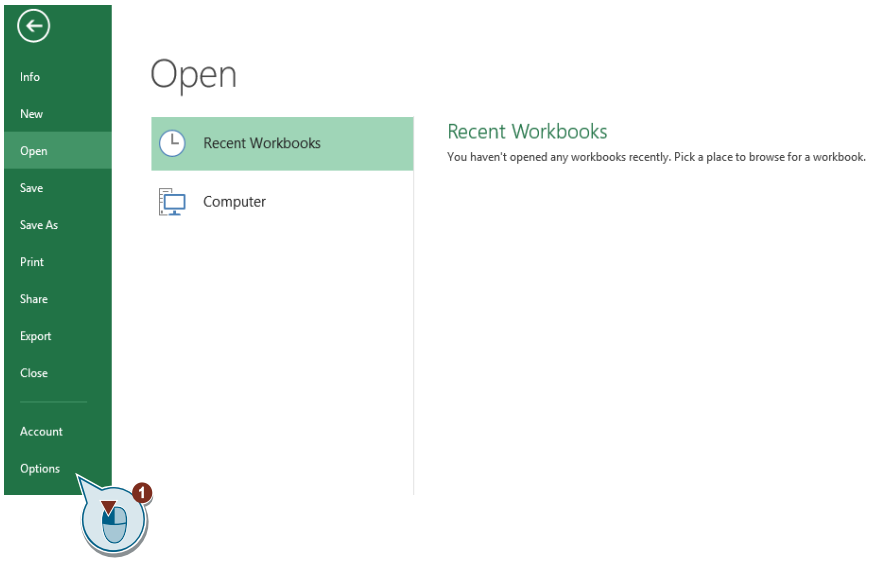
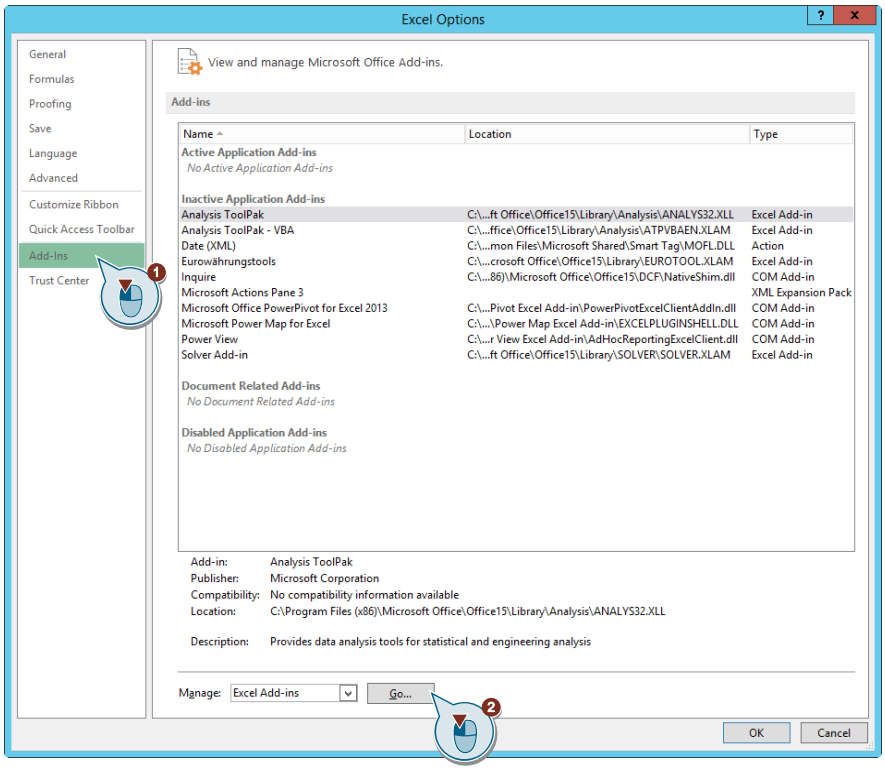
Figure 11-1



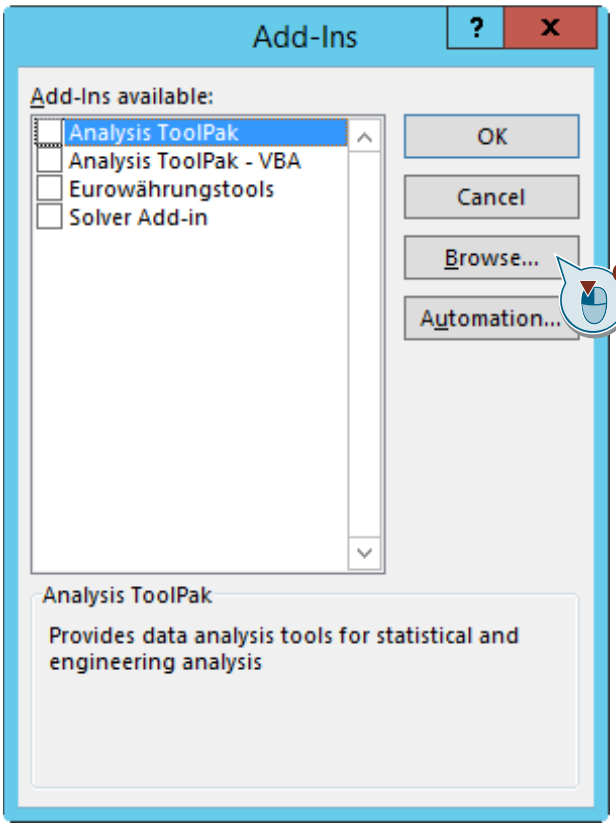
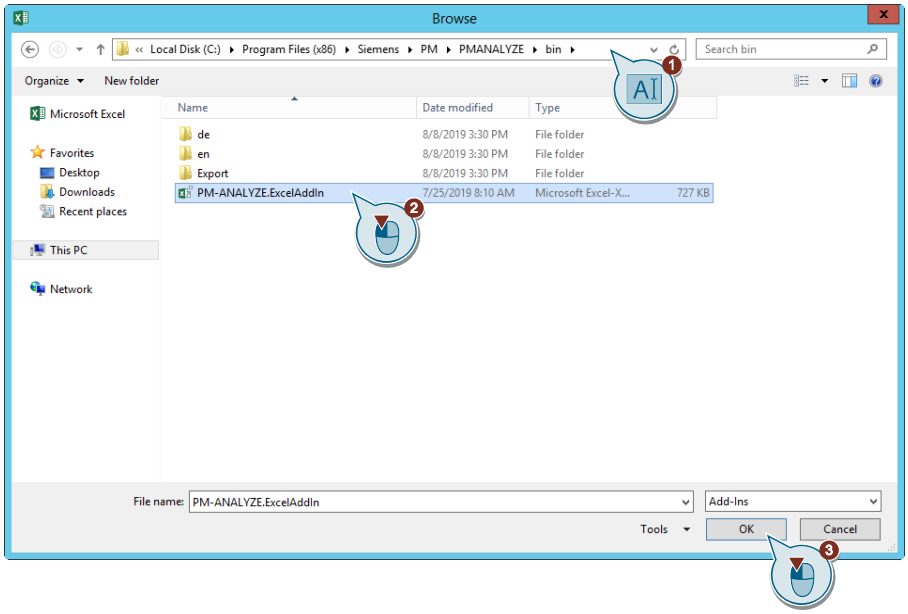
© Siemens AG 2019 All rights reserved

11.1 Installing the Excel Add-In

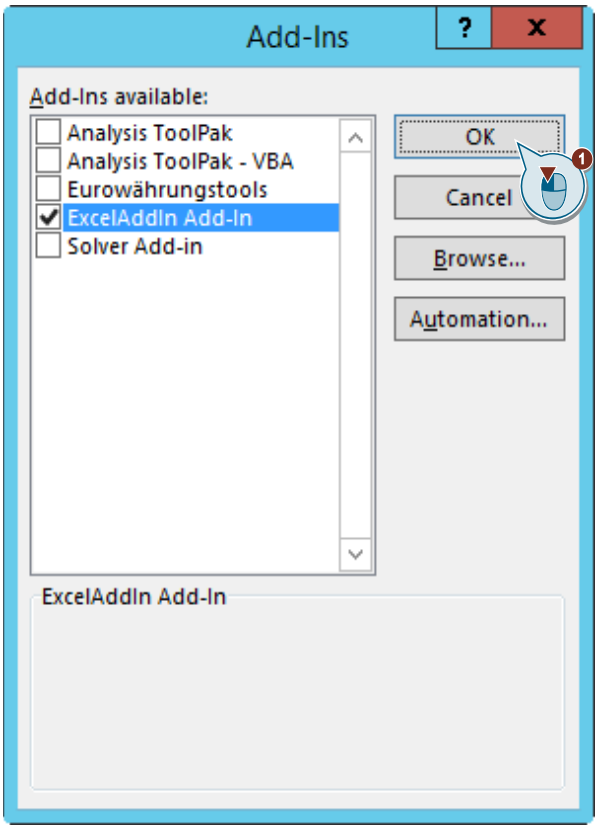
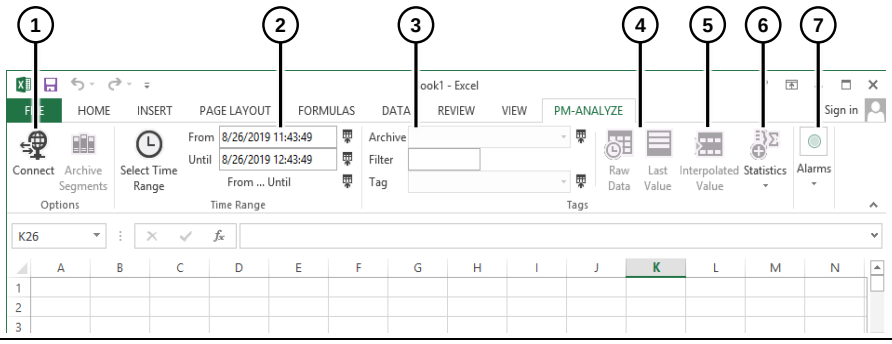
Table 11-1

No.	Action
1.	In the File tab, click on Options. 
2.	Click on the Add-Ins category. 

© Siemens AG 2019 All rights reserved

No.	Action
3.	Click the Browse button. 
4.	The Excel Add-In is located by default in the directory C:\\Program Files(x86)\\Siemens\\PM\\PMANALYZE\\bin Select the PM-ANALYZE.ExcelAddIn Excel Add-In. Click OK. 

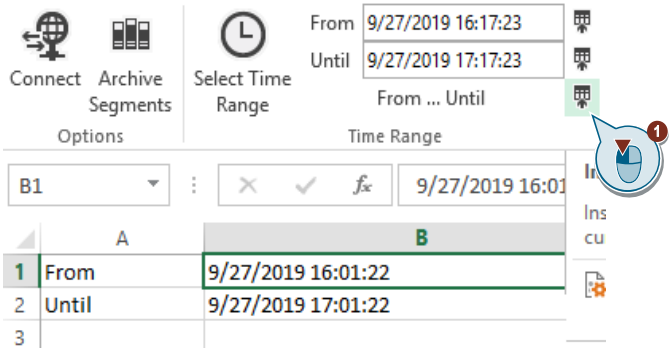
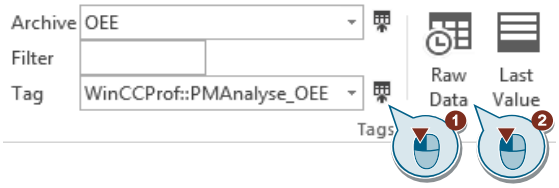
© Siemens AG 2019 All rights reserved

No.	Action
5.	Confirm the installation of the Excel Add-In by clicking OK. 
6.	You will then see the configuration of the PM-ANALYZE Add-In. 1. Database selection 2. Time range selection 3. Selection of process value archive and tag 4. Output of raw data 5. Output of interpolated values 6. Output of statistical values 7. Output of alarms 

© Siemens AG 2019 All rights reserved

11.2 Creating an Excel report (Report template)

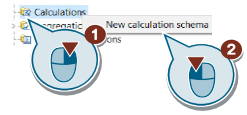
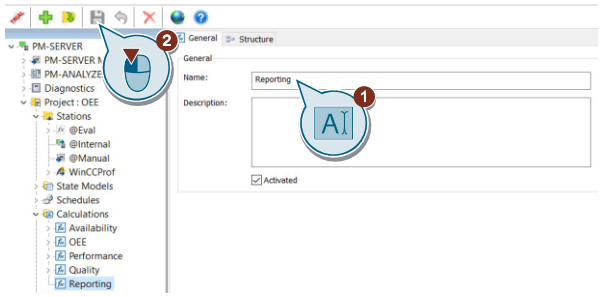
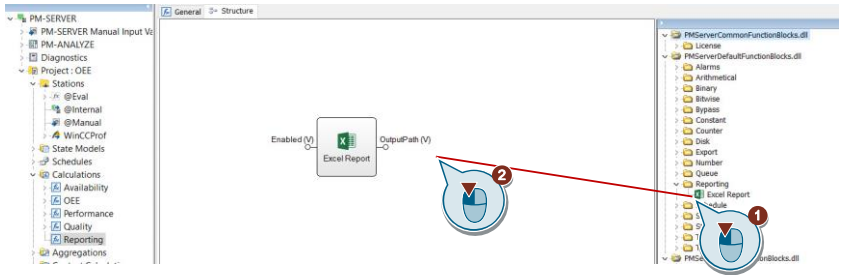
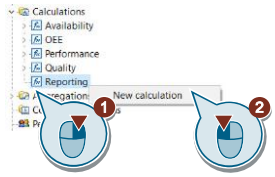
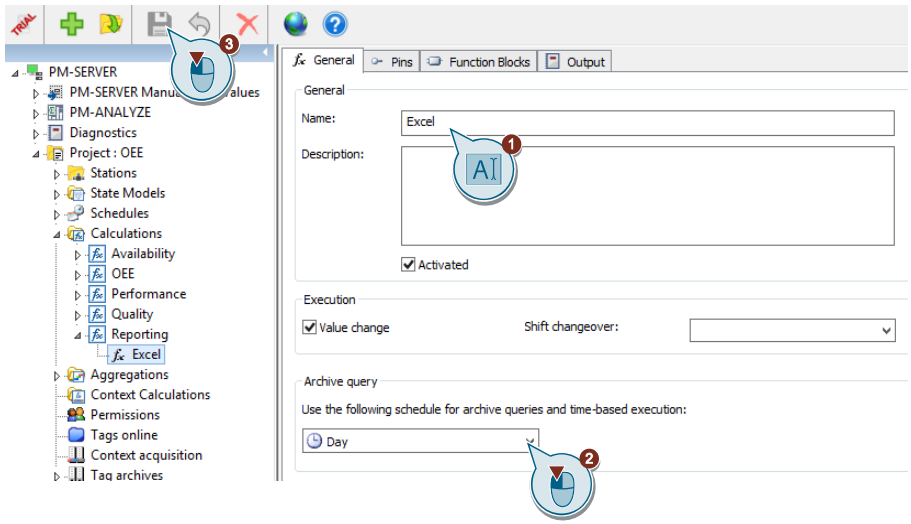
Table 11-2

No.	Action
1.	Select the time range. 
2.	Select the process value archive OEE, and the archived tag. Click the Raw data button. 
3.	The time stamp for the raw data must be adapted dynamically. {=PMA_GetTagDataRaw("OEE\WinCCProf::PMAnalyse_OEE","9/27/2019 16:18:32","9/27/2019 17:18:32",8,"M/d/yyyy h:mm")} Replace the static time stamp with dynamically generated time stamps. {=PMA_GetTagDataRaw("OEE\WinCCProf::PMAnalyse_OEE",B1,B2,8,"M/d/yyyy h:mm")}  The dynamic time ranges are later modified by the Excel report.
4.	Save the report template to a folder.

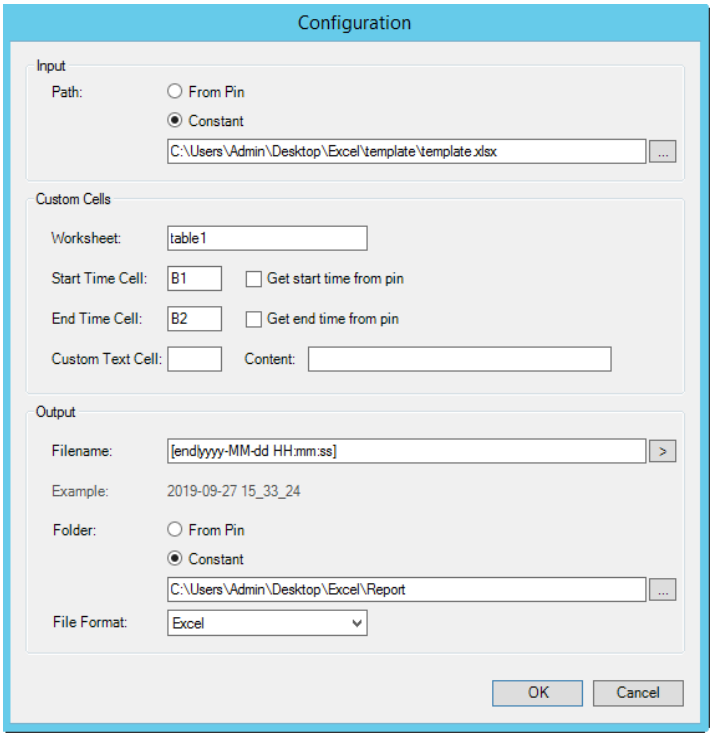
© Siemens AG 2019 All rights reserved

11.3 Automatic report generation using the Excel Report function block

Table 11-3

No.	Action
1.	Click on "Add new calculation scheme". 
2.	Name the calculation scheme "Reporting". Click "Save". 
3.	Add the Excel Report function blocks. 
4.	Click on "New calculation". 
5.	Name the instance "Excel". Assign the created "Day" schedule. 

© Siemens AG 2019 All rights reserved

No.	Action
6.	Configure the function block. The created report template is selected under the Input Folder. You can use the Properties to configure the cells in which the Excel template inserts the start time and end time for the report template. There you will also specify the Worksheet from Excel that is used. At the end of the Properties window you will specify where the report will be saved, and in what format. 

© Siemens AG 2019 All rights reserved

12 Using the application

Before putting the configuration into operation, verify how the components are linked up.

12.1 Commissioning the sample project

Table 12-1

No.	Action
1.	Extract the file "109769969_PMANALYZE_KPI.zip".
2.	Start the WinCC Runtime for the TIA Portal project.
3.	Open the PM-ANALYZE project in the PM Server.
4.	Accept the certificate for the PM-AGENT Unified Station. To achieve this, follow the steps from chapter 7.1 in sequence.

12.2 Operating the example project

The example project shows bottle production for calculating the OEE. The machinery takes a wide range of states for run time and downtimes. A camera checks whether the bottles are good or bad items.

Figure 12-1

Table 12-2

No.	Action
1.	Specify a target performance for calculating the Performance factor.

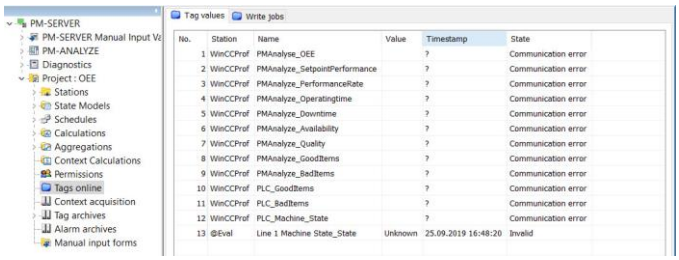
© Siemens AG 2019 All rights reserved

13 Error handling

13.1 No connection to online tags

If you have no connection to the online tags as shown in the figure, please check the steps in chapter 7.1.

Figure 13-1



© Siemens AG 2019 All rights reserved

14 Appendix

14.1 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:
https://support.industry.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts. Please send queries to Technical Support via Web form:
www.siemens.com/industry/supportrequest

SITRAIN – Training for Industry

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:
www.siemens.com/sitrain

Service offer

Our range of services includes the following:

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

You can find detailed information on our range of services in the service catalog web page:
https://support.industry.siemens.com/cs/sc

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
https://support.industry.siemens.com/cs/ww/en/sc/2067

© Siemens AG 2019 All rights reserved

14.2 Links and literature

Table 14-1

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/de/view/109769969
\3\	

14.3 Change documentation

Table 14-2

Version	Date	Change
V1.0	11/2019	First version

© Siemens AG 2019 All rights reserved