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APPLICATION EXAMPLE

Virtual Commissioning with Plant Simulation and OPC UA

TIA Portal

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1. Introduction

Virtual Commissioning uses simulation of a planned or existing system for functional validation of the automation system. This allows proposed changes and enhancements to be tested before they are implemented on the real plant.

Simulation software allows us to observe how the solution will work. It also helps us understand how all the elements will interact with each other, providing a more intuitive representation of real-life scenarios.

1.1. Application description

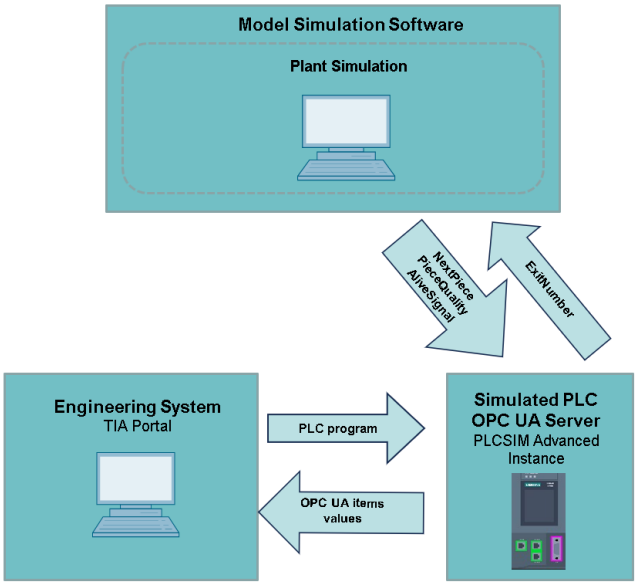


Figure 1-1

This application example demonstrates how Plant Simulation facilitates virtual commissioning of PLC code by representing the behavior of a production system. In this case, the PLC will control the machinery of a small inspection line by sending and receiving control signals.

Within Plant Simulation a simple example line is modeled to simulate real world plant equipment. In this case, a quality inspection station is implemented alongside the sensor information for the PLC.

On the other hand, the Plant Simulation model is connected via OPC UA to a PLCSIM Advanced instance (a simulated PLC) that evaluates the sensor information from the model and controls the acceptance or rejection of the received pieces.

Finally, the TIA Portal is used as the engineering environment to download the PLC program to the simulated PLC and to monitor the values of its tags and signals.

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Plant Simulation model

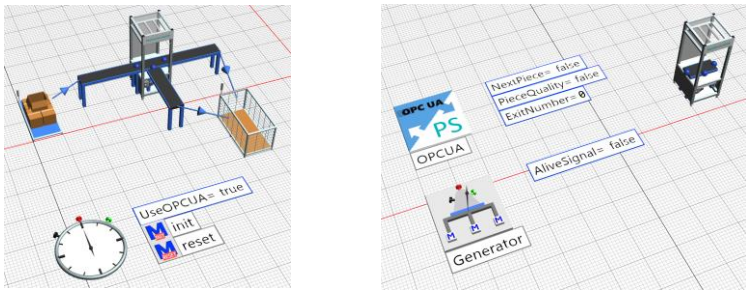


Figure 1-2

In the figure above the content of the Plant Simulation model is shown. The most relevant elements of it will be described in order of the events:

1. **Quality inspection station:** This station classifies the received pieces depending on the decision made by the PLC. It can let the piece continue its path to the next conveyor or divert it to the "rejection" conveyor, which is transversal to the normal pat

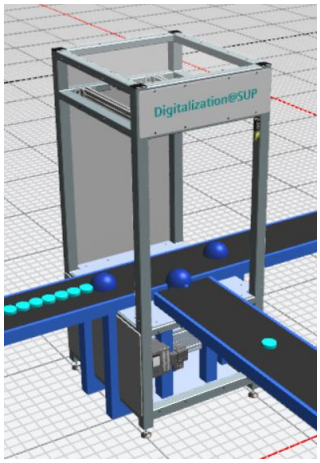


Figure 1-3

2. **OPC UA model interface:** Is the model object that will be in charge of interconnecting the simulation model with the PLC. This interface will act as a OPC UA client, while the PLC hosts the OPC UA server.



Figure 1-4

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Simulated PLC: PLCSIM Advanced instance as OPC UA server

For this example, the PLCSIM Advanced instance will act as the OPC UA server. Here, all tags are defined and the PLC program will also determine the value of the tags to control the quality inspection station. The control is summarized in the next figures:

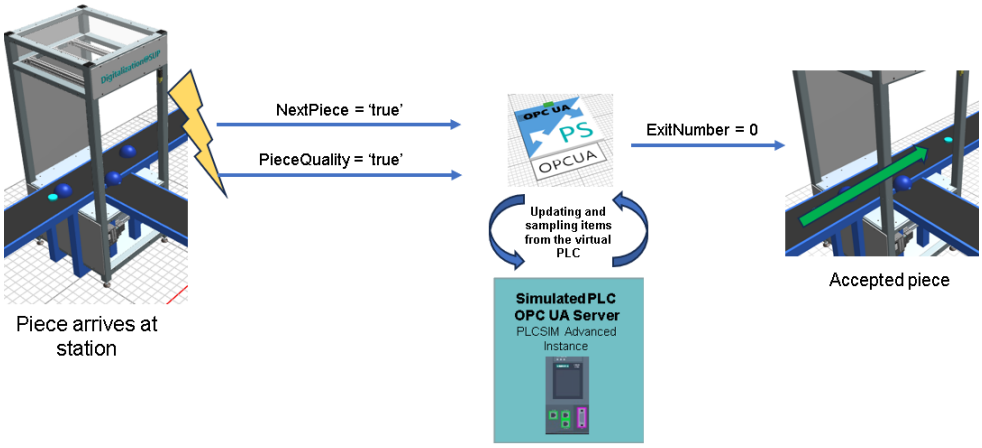


Figure 1-5: Piece quality OK

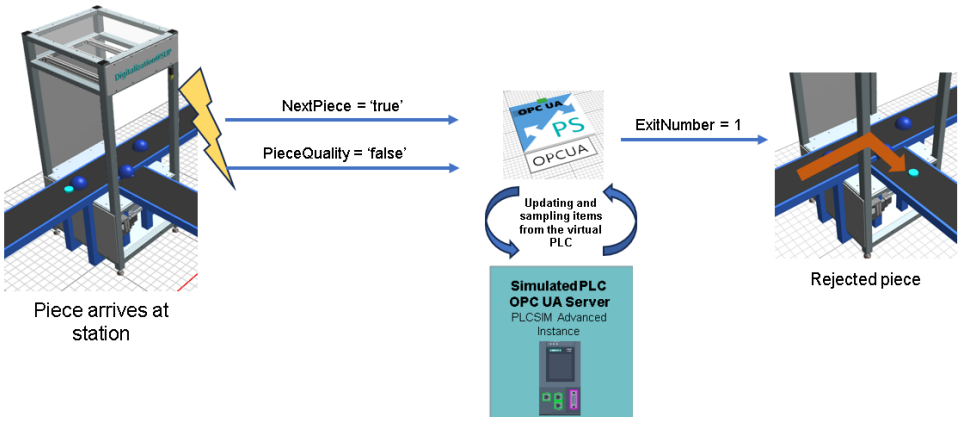


Figure 1-6: Piece quality NOK

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1.2. Components used

This application example has been created with the following hard- and software components:

Component	Number	Article Number	Note
STEP 7 Basic V18	1	6ES7822-0AE08-0YA5	-
Tecnomatix Plant Simulation 2302	1	-	-
Plant Simulation Interface Package	1	-	-
S7-PLCSIM Advanced V5.0	1	6ES7823-1FA04-0YA5	-

Table 1-1

You can purchase these components from the Siemens Industry Mall.

This application example consists of the following components:

Component	File name	Note
Documentation	109975137_VC_PlantSimulation_OPCUA_DOC_V10_en.pdf	-
Tecnomatix Plant Simulation project and TIA Portal Project	109975137_VC_PlantSimulation_OPCUA_GettingStarted_V10.zip	• QualityStation_OPCUA.spp • QualityStation_OPCUA_V18.ap18 for PLCSIM Advanced connection

Table 1-2

Requirements

Basic knowledge of TIA Portal and Plant Simulation is needed to understand this application example.

Basics of TIA Portal can be found in the Siemens Industry Online Support (SIOS) platform by searching for the article number shown in Table 1-1.

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2. Software Setup

Download the following files from Siemens Industry Online Support

https://support.industry.siemens.com/cs/ww/en/view/109975137

Unzip the .zip file. The provided folder contains:

- TIA Portal project: "QualityStation_OPCUA_V18.zap18"
- Plant Simulation project: "QualityStation_OPCUA.spp"
- This document as Step-by-step Guide

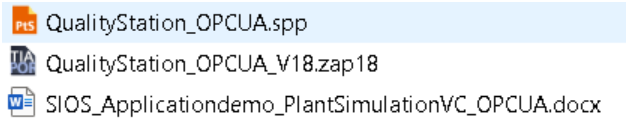


Figure 2-1

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2.1. PLCSIM Advanced

To start PLCSIM Advanced, follow the steps:

1. Start the Runtime Manager for PLCSIM Advanced.
2. In the Online Access options: choose "TCP/IP" and "Single Adapter". Also, select "<Local>" in the TCP/IP communication dropdown list.
3. Select PLC type "Unspecified CPU 1500".
4. Define the Instance name of the PLC.
5. Specify IP address information.
6. Start the PLC .
7. Note the Port number of the Runtime Manager.

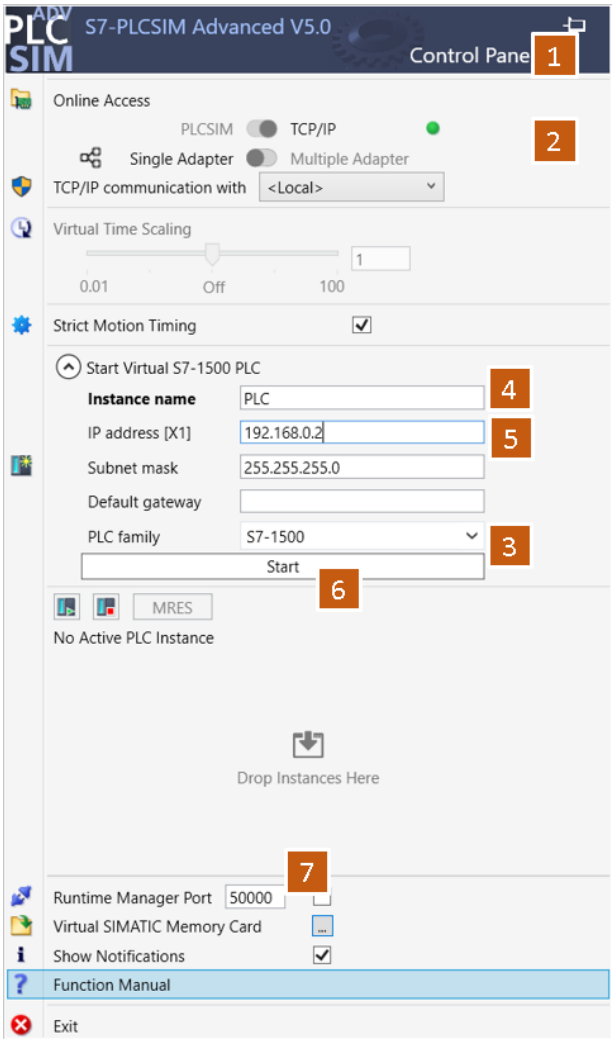


Figure 2-2

NOTE IP address might differ from Figure above. Just make sure that it matches what is in the properties of the PLC's PROFINET interface X1, in the hardware configuration.

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2.2. TIA Portal

Proceed as follows to use the provided TIA Portal project.

1. Open the file "QualityStation_OPCUA_V18.zap18"
2. Switch to the project view

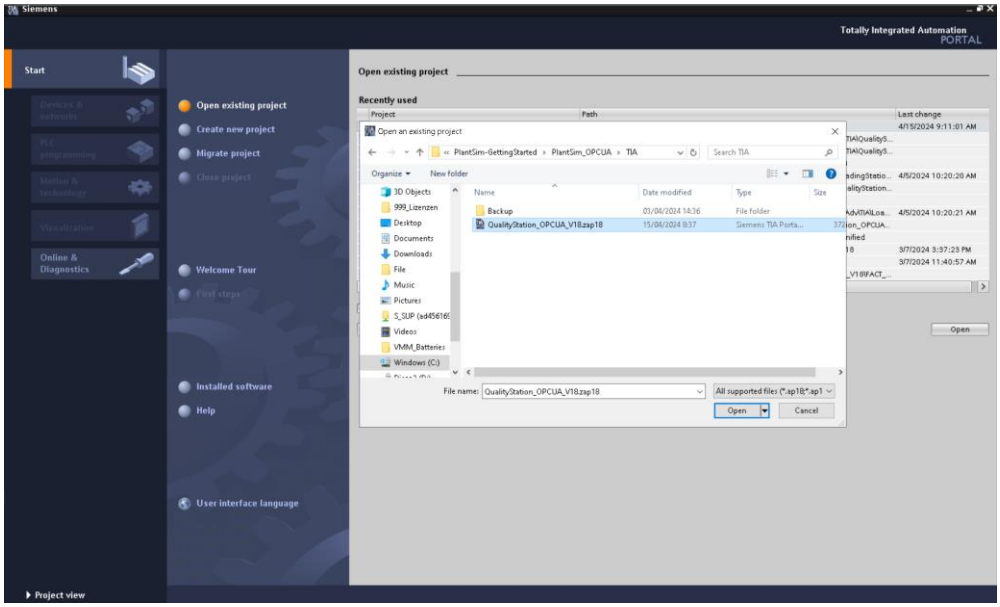


Figure 2-3

3. Select the PLC in the Project tree and click Download to device.

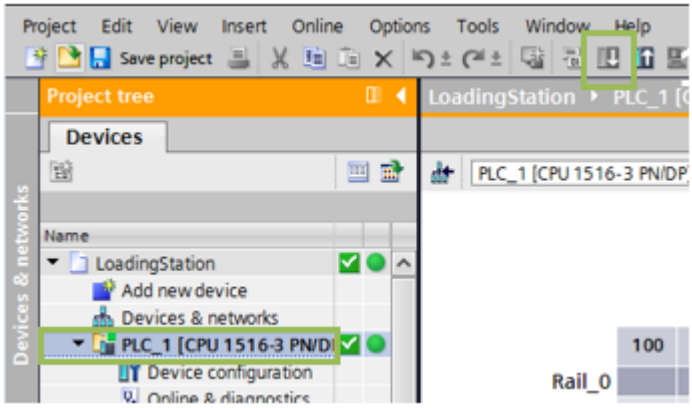


Figure 2-4

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4. In the pop-up window, set the type of PG/PC interface as "PN/IE" and the PG/PC interface as "Siemens PLCSIM Virtual Ethernet Adapter". Also, select the "1X1" interface of the PLCSIM Advanced instance. Then, click on Start search.

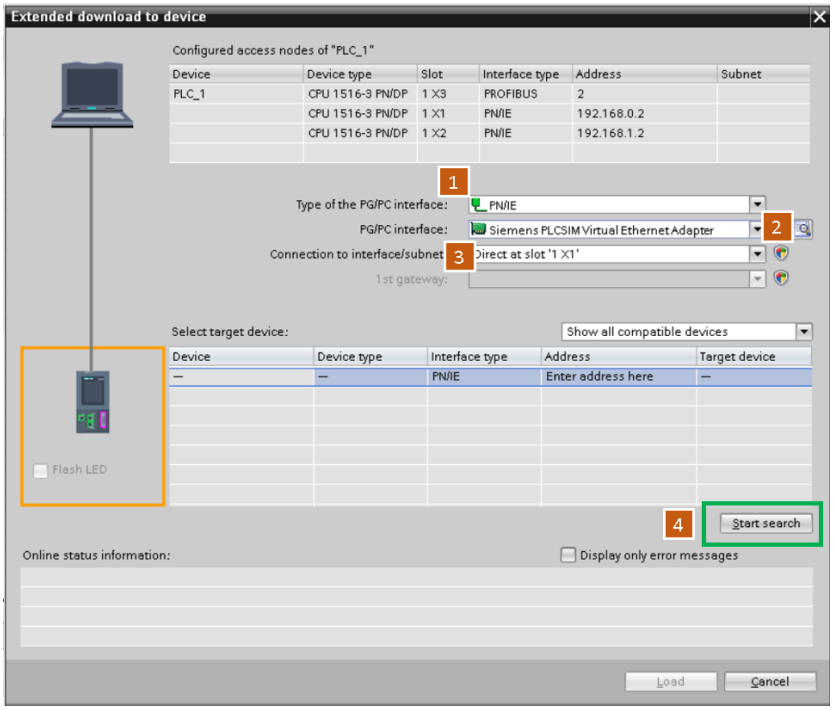


Figure 2-5

5. Select the PLC and click Load.

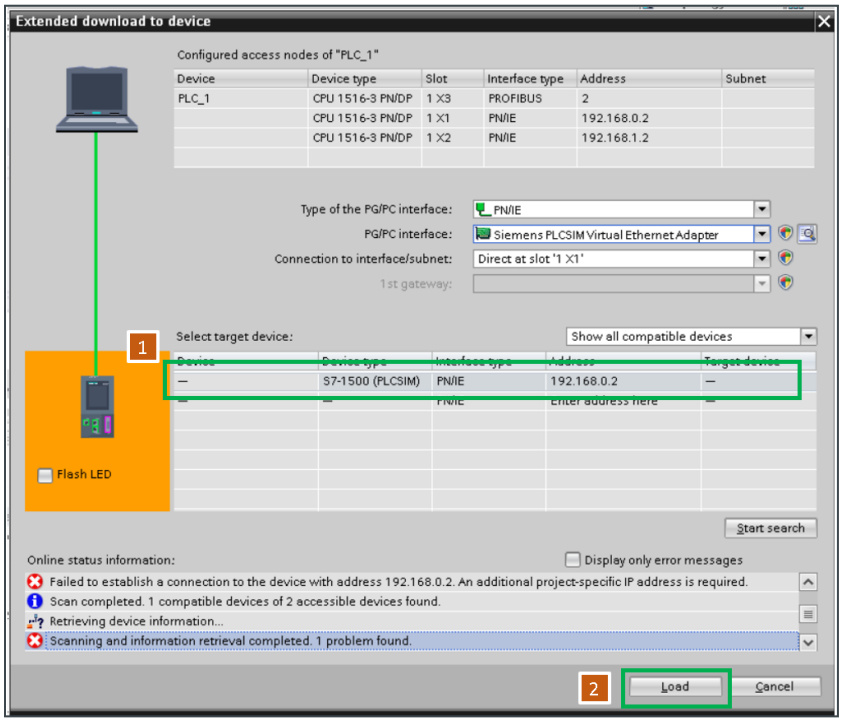


Figure 2-6

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6. A warning window may appear indicating that it's necessary to assign an IP address to the interface that our computer is using to connect to the subnet in which the PLCSIM Advance instance is. Just click on "Yes" and continue.

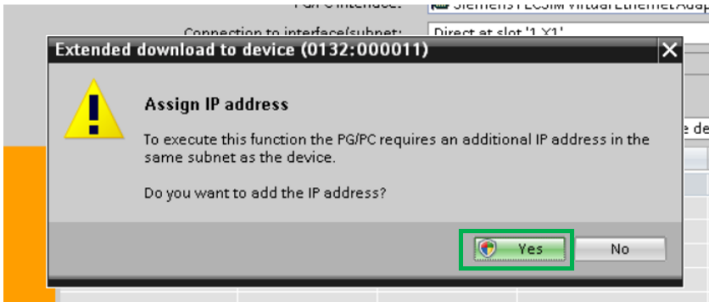


Figure 2-7



Figure 2-8

7. As it is the first time connecting to the PLC, TIA Portal will ask for confirmation to connect to it. Click on Connect to continue.



Figure 2-9

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8. In the pop-up window click Load. After that, compilation of the PLC program and download will begin. It will take some time to finish this process. Please wait.

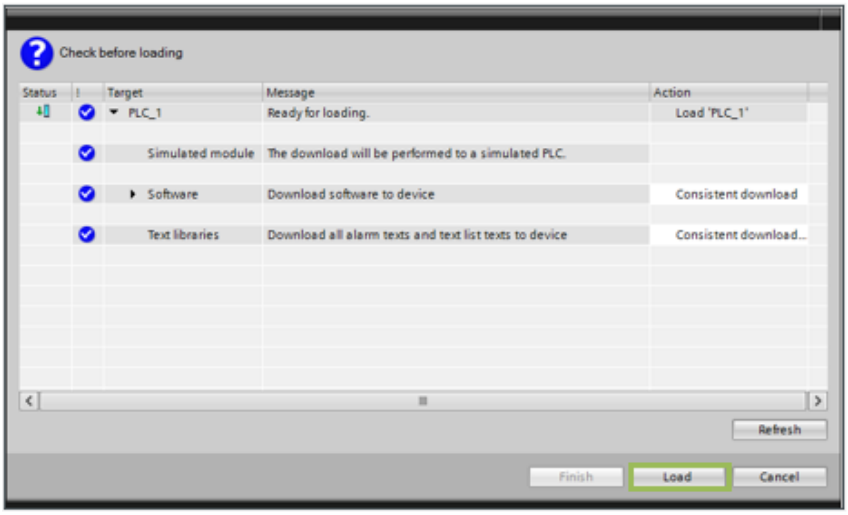


Figure 2-10

9. In the pop-up window select Start module, then click Finish.

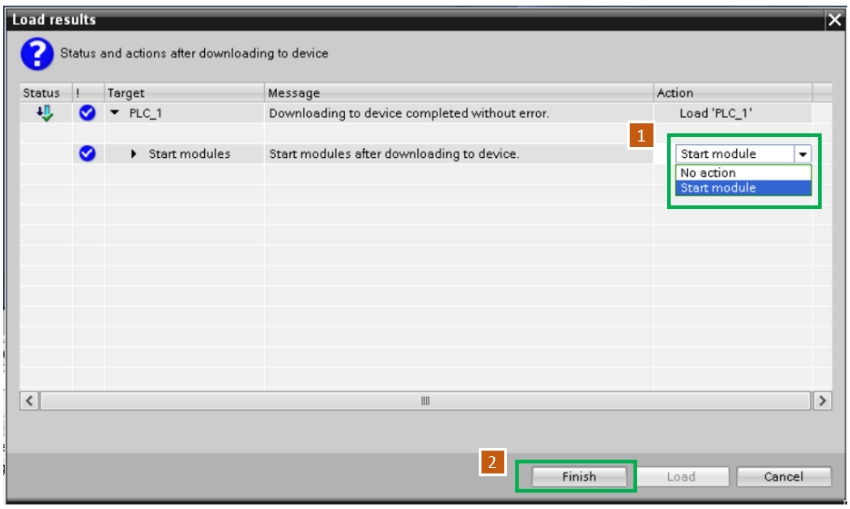


Figure 2-11

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10. Select the PLC in the project tree and click Go online.
11. After starting the simulation in Plant Simulation, open the "UA_Interface" DB and click on "Monitor all" (the goggles icon) to watch the items change their values in TIA Portal.

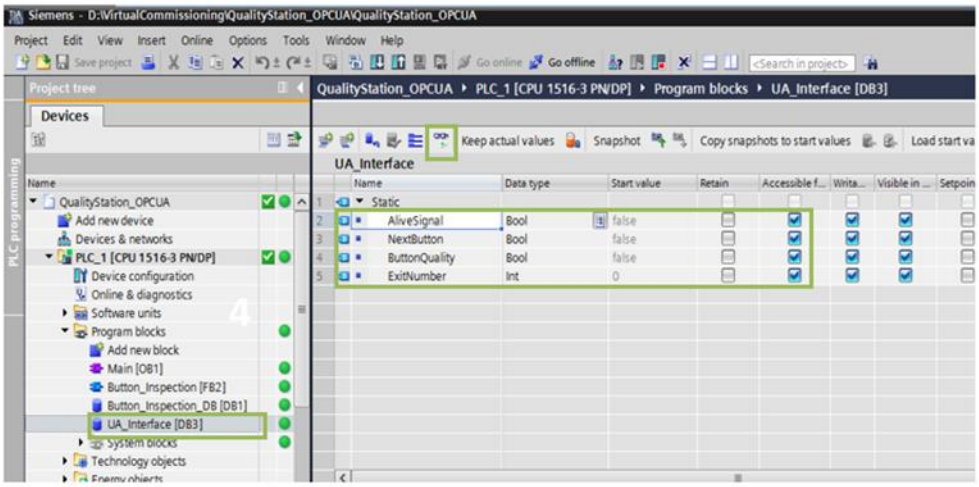


Figure 2-12

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2.3. Starting Plant Simulation

To start the provided simulation model in Tecnomatix Plant Simulation, follow the steps:

1. Start Tecnomatix Plant Simulation.
2. Open the "QualityStation_OPCUA.spp" file.

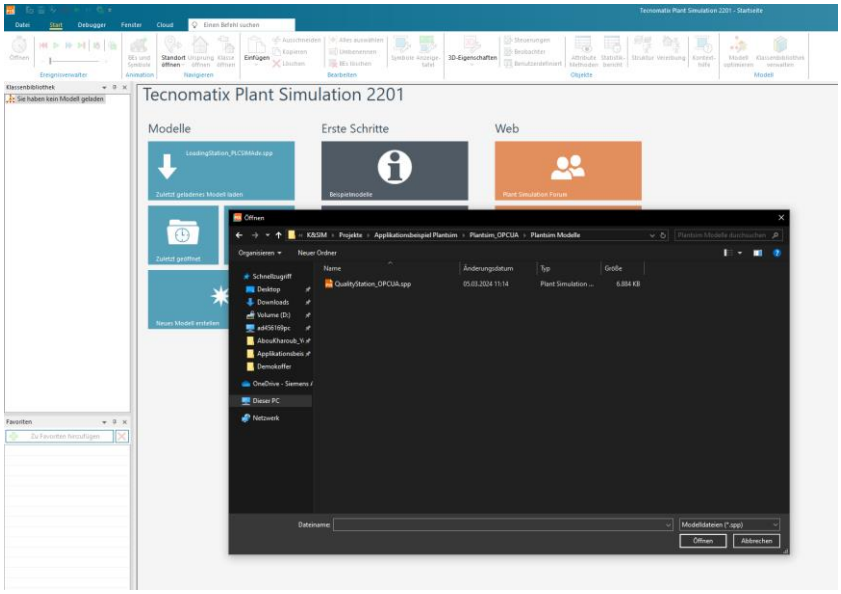


Figure 2-13

NOTE The Plant Simulation Interface Package is required. Therefore, an additional license is needed.

3. Navigate to the OPC UA interface of the model by using the Structure tool and looking for it. Once found, double-click on it.

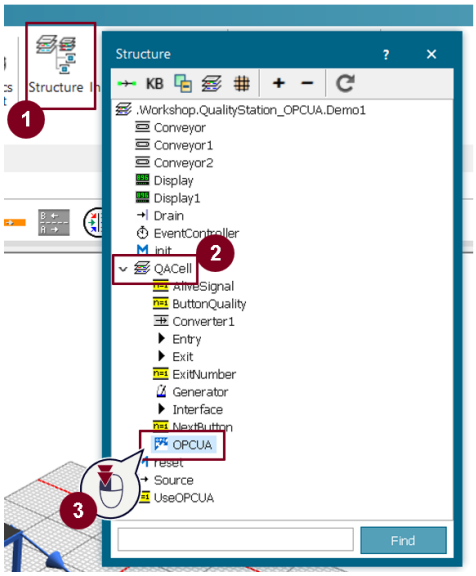


Figure 2-14

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4. To activate the interface, in the pop-up configuration window, check that the settings for the OPC UA server are correct, click in the check-box Active and on OK.

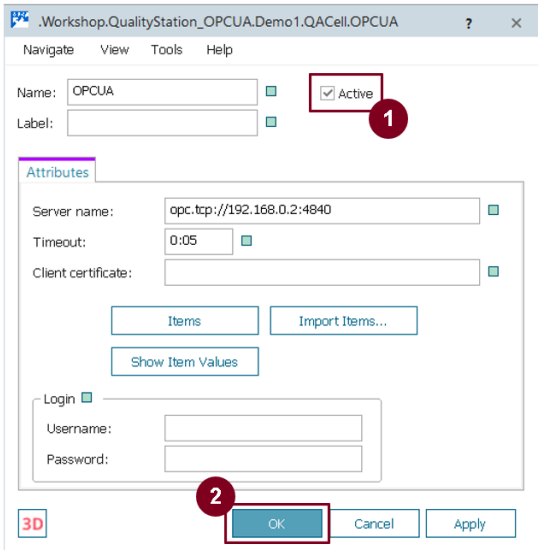


Figure 2-15

5. Start the simulation.

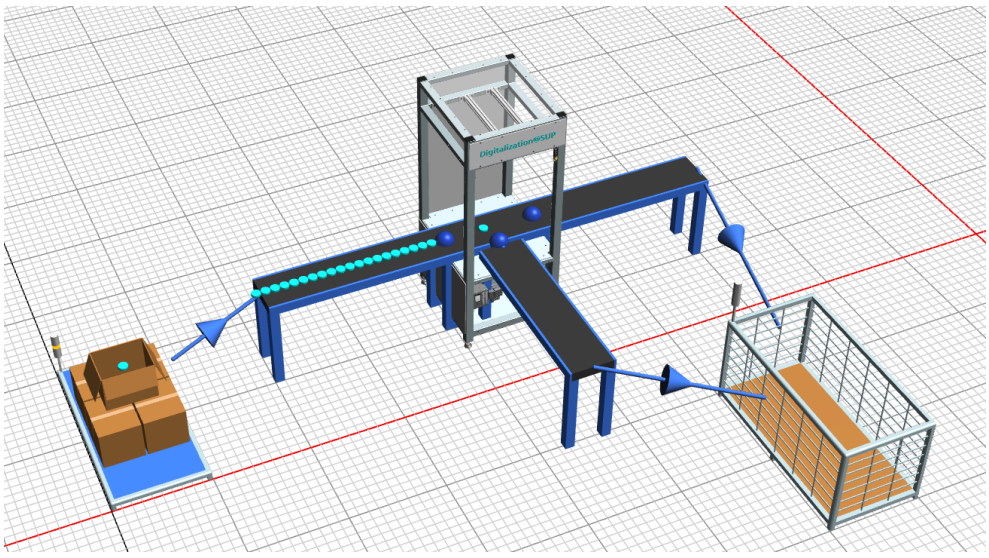


Figure 2-16

When the simulation begins, the source will start to generate pieces and move them to the entry conveyor for the station.

Once a piece enters the stations, its quality will be checked to determine whether it may continue straight (accepted) or needs to go to the transversal conveyor (rejected).

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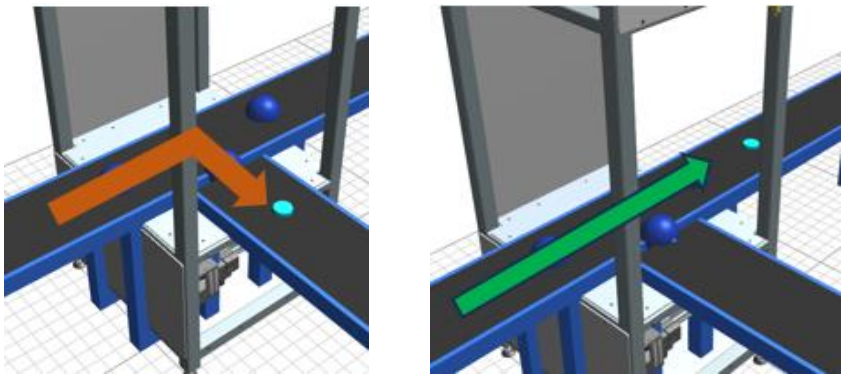


Figure 2-17

6. Monitor the current values of the signals involved. For this, firstly, double-click on the station to see its content.

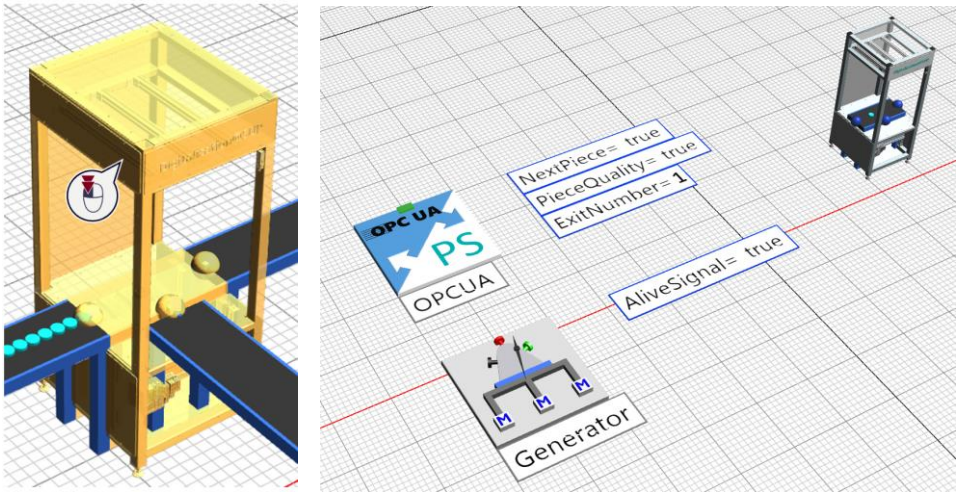


Figure 2-18

From here, we can proceed in two ways:

a. Check the values directly on the global variables defined in the model, as seen in Figure 2-18. These variables are mapped to the items of the interface, so they will display their current value.

b. Check the values on the OPC UA interface. In this case, open the interface by double-clicking on it. Then, click on Show Item Values.

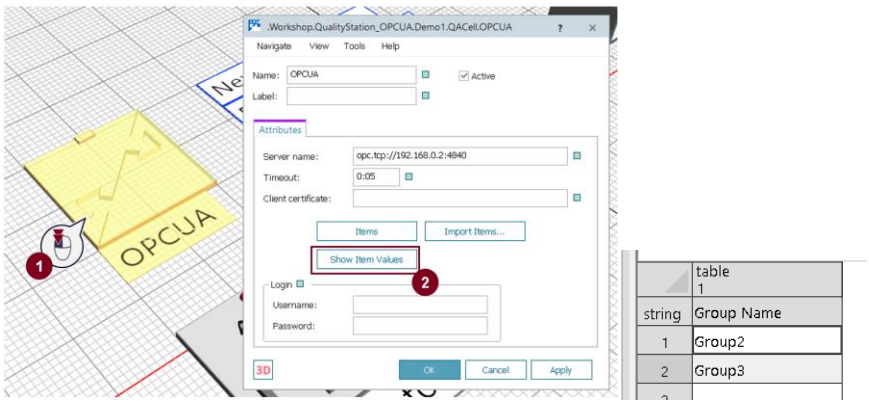
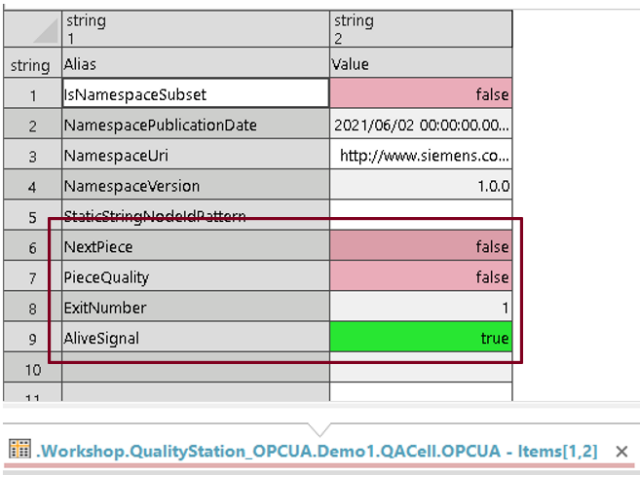


Figure 2-19

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As we can see in Figure 2-19, a new table view will open. This table view groups all the OPC UA items contained in the OPC UA server (the simulated PLC). The grouping depends on which nodes of the server the items are.

If we access to the content of Group3 by double-clicking on it, we will get to see, among other items, the ones that our model uses to be controlled.



	string 1	string 2
string	Alias	Value
1	IsNamespaceSubset	false
2	NamespacePublicationDate	2021/06/02 00:00:00.00...
3	NamespaceUri	http://www.siemens.co...
4	NamespaceVersion	1.0.0
5	StaticStringNodeIdPattern	
6	NextPiece	false
7	PieceQuality	false
8	ExitNumber	1
9	AliveSignal	true
10		
11		

.Workshop.QualityStation_OPCUA.Demo1.QACell.OPCUA - Items[1,2]

Figure 2-20

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3. Application

The delivered Plant Simulation model contains the finished model with implemented interface and is setup for the application.

3.1. Model Setup with Plant Simulation, TIA Portal, PLCSIM Adv., OPCUA

3.1.1. Description of interface

The figures below show the interface between the software used for a better understanding of how the application works.

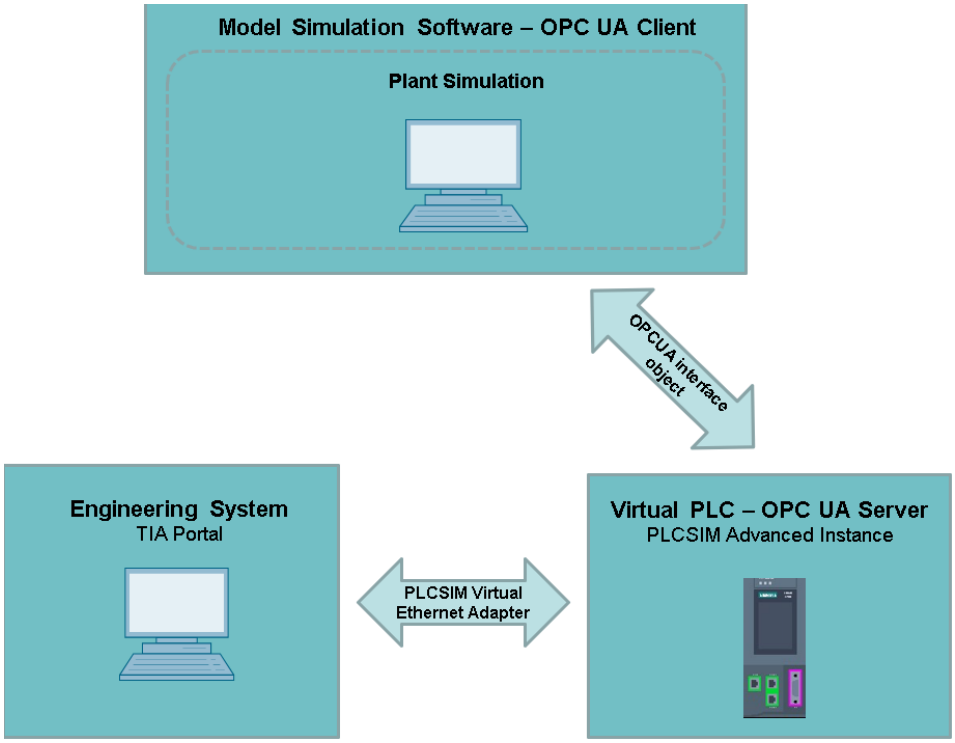


Figure 3-1

In real life, a PLC would act as the OPC UA server that hosts the signals for the machines of our plant. For this application example, these tasks will be carried out by a simulated PLC, which is a PLCSIM Advanced instance. This simulated PLC will emulate the functions of a real PLC and process the signals that the elements in our Plant Simulation model need.

This simulated PLC is connected to the TIA Portal through the PLCSIM Virtual Ethernet Adapter as seen in Figure 2-2 and Figure 2-5 (in the Interface field). With this adapter, we are able to load the program from the TIA project to the simulated PLC and to read/write the values of the OPC UA items, in case we go online in the TIA Portal and we try to monitor or force them.

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On the other hand, our Plant Simulation connects to the OPC UA server through the OPC UA interface. This interface samples the values of the OPC UA items for the model to consult or modify them. The values of the signals are stored in the interface and we can use several technique to access them:

- Method-based access to defined signals via the PLCSIM Advanced interface:
  - Direct value assignment to alias names
  - Using method calls "setItemValue" and "getItemValue".
- Signal mapping via the items table:
  - Mapping to global variables in the model
  - Mapping to standard or user-defined attributes
- Defining callback methods for further processing of changed signal values.

At the same time, this interface updates the items that have been modified by the model.

In this application example we are recreating a "Software in the Loop" case, but it could be possible to convert it to a "Hardware in the Loop" case just by using a real PLC as the OPC UA server instead of a simulated PLC.

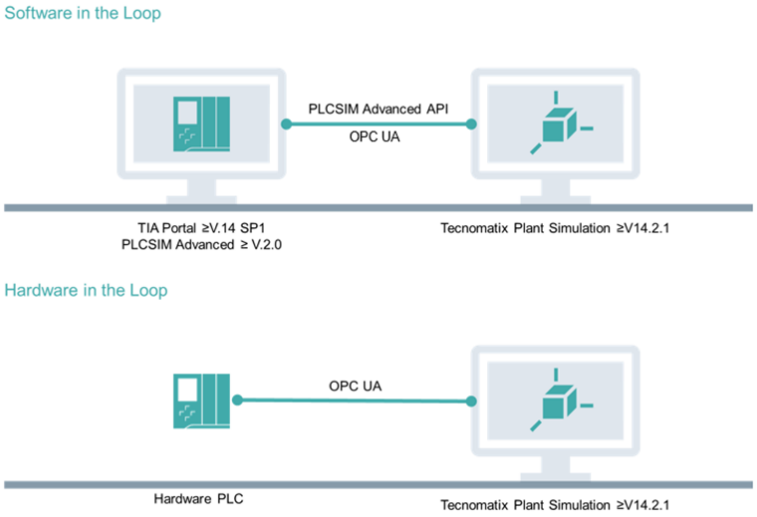


Figure 3-2

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3.1.2. TIA Portal

In this section, we will explain some of the most important settings that can be configured in TIA Portal when working with OPC UA and what is the workflow followed by the program blocks of the PLC program.

Enabling the OPC UA Server on the PLC

If we are to use a PLC as an OPC UA server, the OPC UA Server needs to be activated in the PLC hardware settings. For this, navigate the "OPC UA" settings of the PLC and click on the corresponding checkbox to activate it.

The server addresses that appear are the ones that must be used by OPC Clients to connect to it.

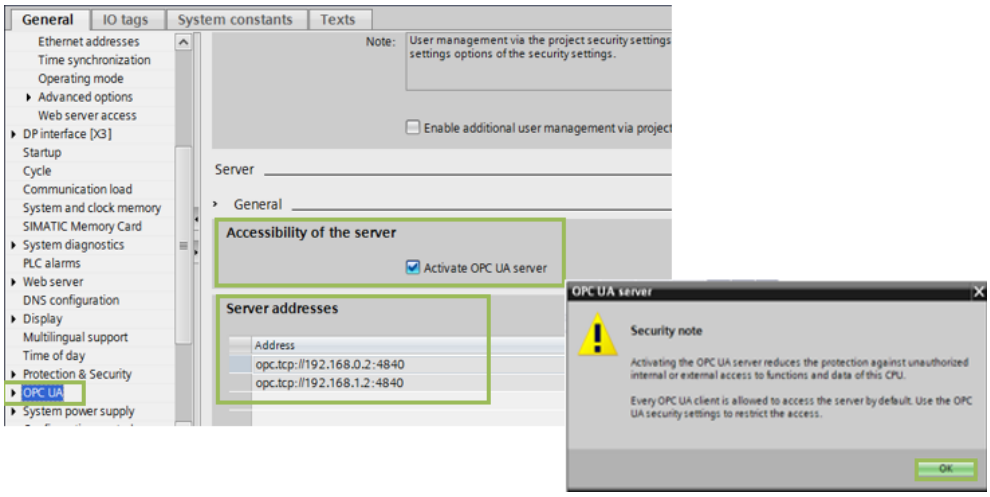


Figure 3-3

It is also needed to select the correct type of Runtime License for our PLC to be able to act as an OPC UA server. To set it just go to the "Runtime Licenses" settings, then to "OPC UA" and select the license that is being required.

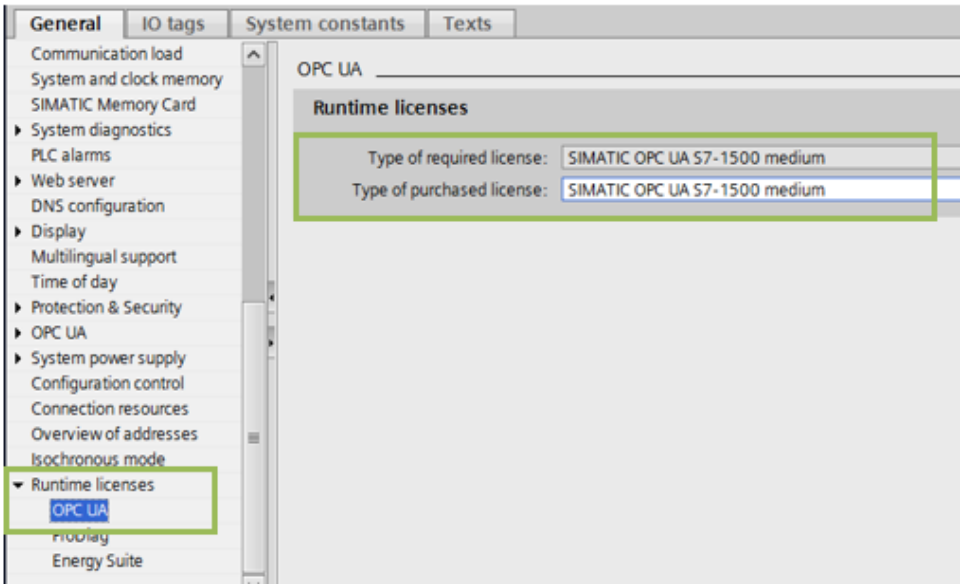


Figure 3-4

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By default, the OPC UA Server closes a connection after 30 seconds of inactivity. For this demo and to avoid unexpected timeouts, the **timeout** was set to 3600s.

NOTE It is recommended to only use this setting during testing and instead ensure that an alive bit is used.

NOTE The port number of the Server could be changed here.

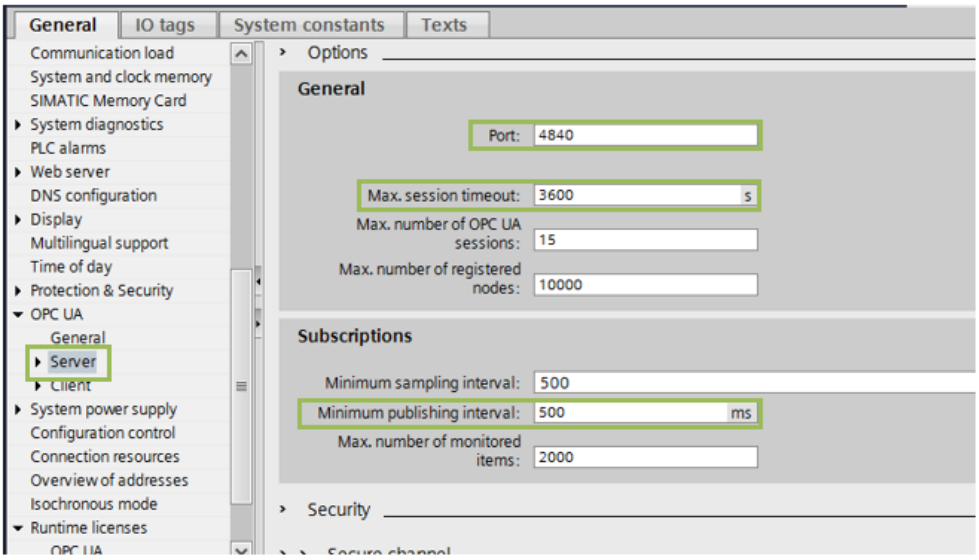


Figure 3-5

Other settings that can be relevant when using a PLC as an OPC UA server can be:

- **Max. number of OPC UA sessions:** Maximum number of clients that can connect at the same time to the same server.
- **Max. number of registered nodes:** Maximum number of nodes that the server can store for the clients to access to them.
- **Minimum sampling/publishing interval:** Frequency at which the server reads/writes the items.
- **Max. number of monitored items:** Maximum number of items that the server will keep track of.

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In regards of the workflow of the TIA Portal project contains the user program consisting of Piece Inspection FB, the Main OB, and the DB that contains the tags that would control the model.

Piece_Inspection [FB2]

The PLC program waits for the next piece and then sets the ExitNumber depending on the PieceQuality.

In case of an edge and the PieceQuality is:

- Accepted: move the value 0 to the ExitNumber variable.
- Rejected: move the value 1 to the ExitNumber variable.

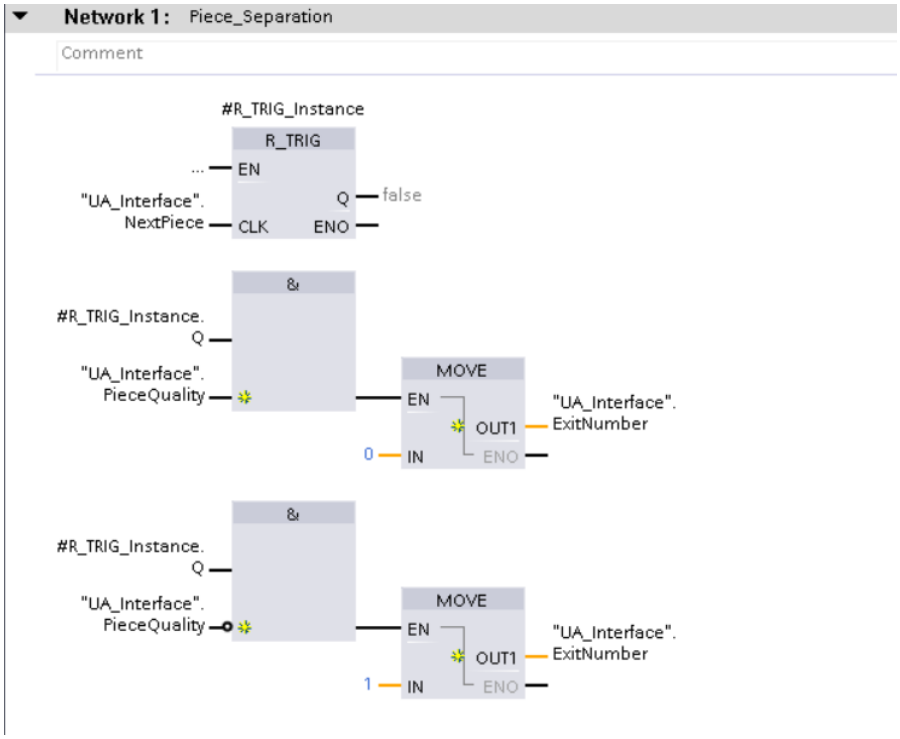


Figure 3-6

Main [OB1]

The Main OB includes the execution of the Piece_Separation FB.

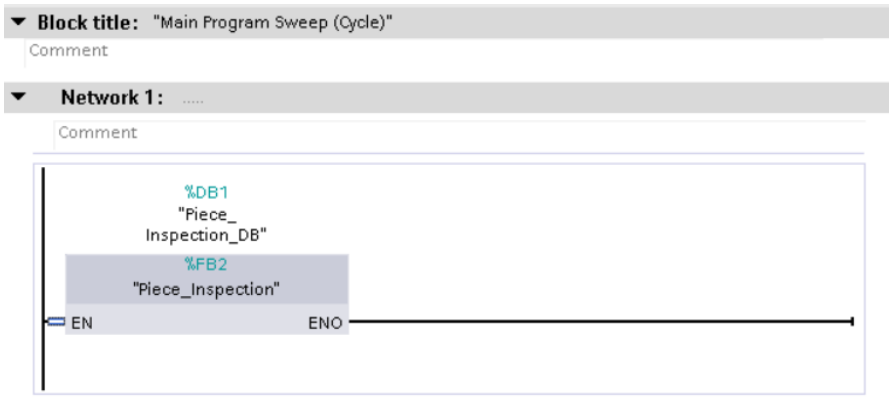
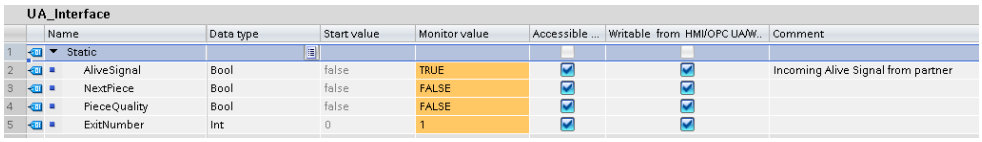


Figure 3-7

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OPC UA items

The UA_Interface DB contains the items of the OPC UA server.



UA_Interface

	Name	Data type	Start value	Monitor value	Accessible ...	Writable from HMI/OPC UA/W...	Comment
1	Static				☐	☐	
2	AliveSignal	Bool	false	TRUE	☑	☑	Incoming Alive Signal from partner
3	NextPiece	Bool	false	FALSE	☑	☑	
4	PieceQuality	Bool	false	FALSE	☑	☑	
5	ExitNumber	Int	0	1	☑	☑	

Figure 3-8

In the table below, the meaning of the different values from the tags is explained.

Item Name	Item Value	Meaning
AliveSignal	True	The value of this item is written by the simulation model. Its value will alternate between "True" and "False" following a fixed period of time to indicate that the connection between the server and the simulation is alive.
	False	
NextPiece	True	Station ready to the next piece.
	False	Station occupied.
PieceQuality	True	The quality of the received piece is correct.
	False	The quality of the received piece is deficient.
ExitNumber	0	As the quality of the piece is correct, it will continue its normal path.
	1	As the quality is deficient, the piece will be derived to the "rejection" conveyor.

Table 3-1

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3.1.3. Plant Simulation

Connection to OPC UA

The Plant Simulation model "QualityStation_OPCUA.spp" comes pre-configured with OPC UA interface ready to connect to the simulated PLC. In this section, we will see in more detail the most relevant settings used in the OPC UA interface of the model.

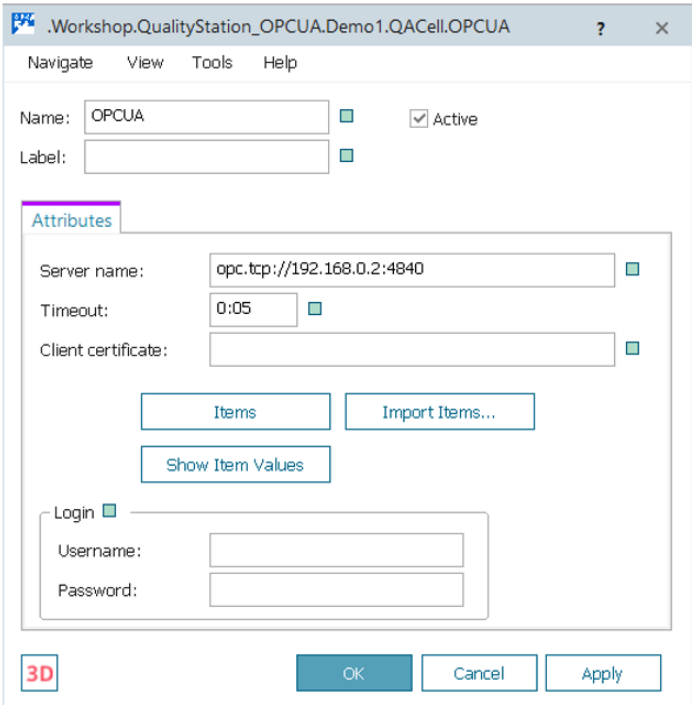


Figure 3-9

- **Name:** This is the name of the interface. It's needed to be known when calling the interface in our methods.
- **Server name:** In this field we must enter the address of the OPC UA server we want our simulation to connect to and the port of the server through which the connection will be made. This information can be taken from the configuration of the server. If the server is a Siemens PLC, this information can be consulted in TIA Portal as seen in the section where the PLC is enabled as an OPC UA server, in Figure 3-3.
- **Timeout:** Waiting time for the connection to be established with the server since the interface has been activated. Past this time, the connection will be aborted.
- **Login (Username & Password):** In case the server requires credentials to make the connection possible, here you will enter this information.

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Item import from OPC UA server

After activating the interface and making sure the connection was successful, now we can import the OPC UA server items. For this, please follow these steps:

1. Begin the import by clicking on "Import Items..."

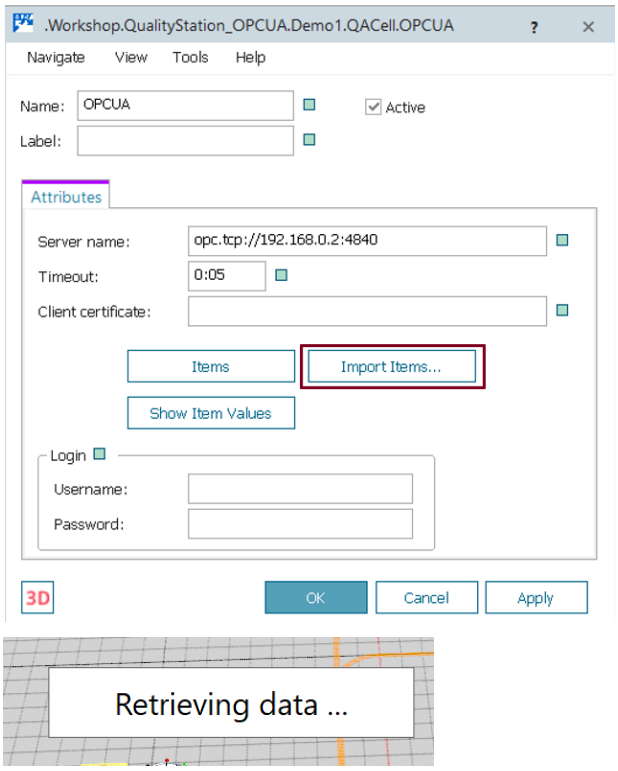


Figure 3-10

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2. After all the items have been read from the OPC UA server, a new window will display the different groups of available tags.

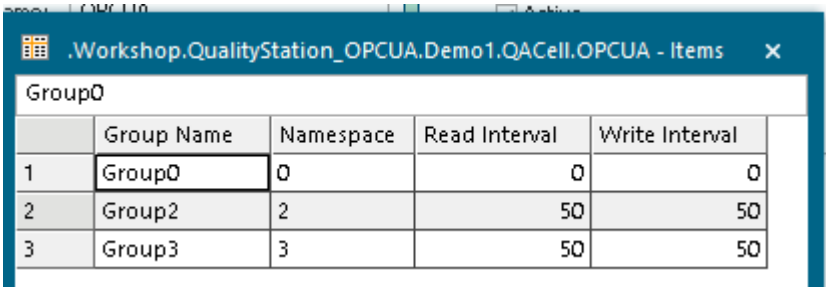


Figure 3-11

From this window we can:

- Define the read/write intervals (ms).
- See the content of the item groups by double-clicking on them.

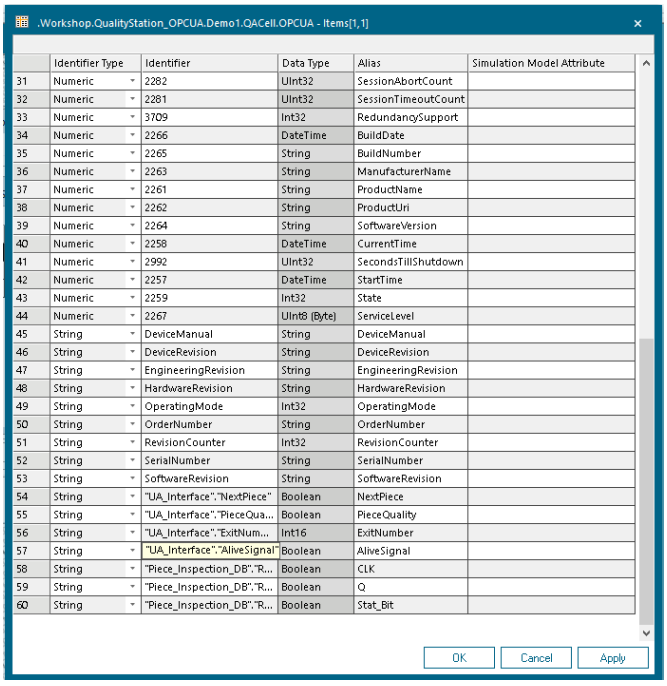


Figure 3-12

NOTE Select and delete the items and item groups that are not relevant for our case. It's highly recommended to keep the number of monitored items as low as possible.

3. Once the unnecessary items are filtered, specify the Plant Simulation tags to be linked to the OPC UA server items in the "Simulation Model Attribute" field for each item.

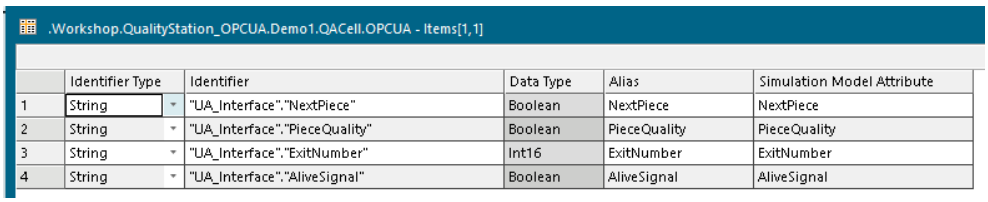


Figure 3-13

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During the execution of the simulation, the interface will update and poll the items for the OPC UA server following the read/write interval times defined previously, as seen in Figure 3-11.

Every time that a data exchange happens, the data will be read/written from/to the global variables mapped in the Simulation Model Attribute fields, as shown in Figure 3-13.

It's important to remember that data exchange (read/write) interval times should be set correctly in accordance with the OPC UA server. If not, this may lead to data loss.

Additionally, the Alias field of the item group tables of the interface will provide a name to the tag which will be used when calling that tag in a method through the interface. For instance, following Figure 3-13, if we were to try to call to the item "NextPiece" through the interface, then we should write "OPCUA.NextPiece".

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3.2. Troubleshooting

3.2.1. Compilation failure

TIA Portal project could not be compiled during the download to the PLCSIM Advanced instance "PLC".

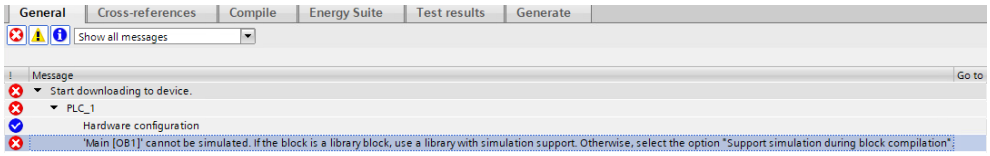


Figure 3-14

Solution: Please, make sure simulation during block compilation is supported.

1. In TIA Portal, right click on the project and open its properties.

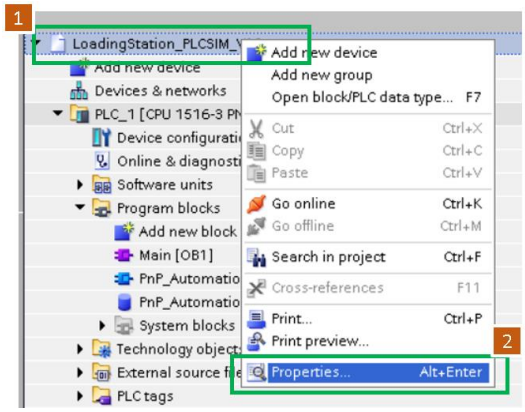


Figure 3-15

2. In the properties pop up window, go to the Protection tab and enable the support.

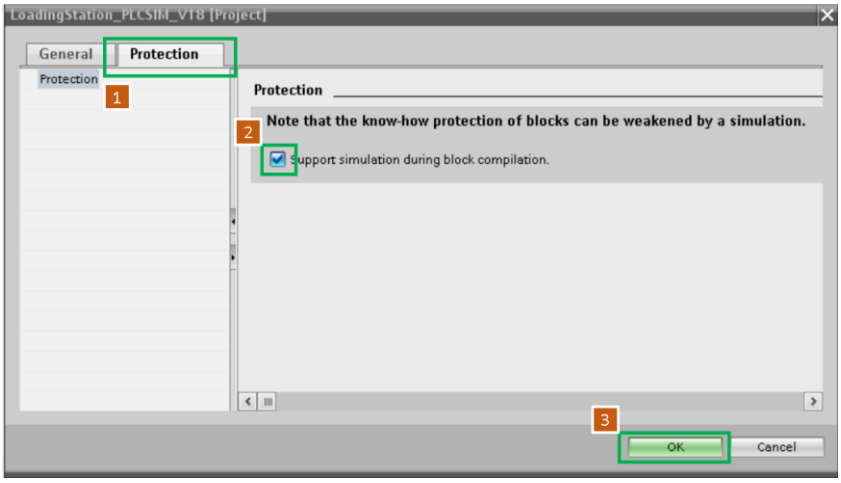


Figure 3-16

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3.2.2. Connection failure

Connection to "PLC" in PLCSIM Advanced cannot be established.

Solution: Check, in "Set PG/PC interface" setting in the Control Panel, that the access point of the application for the "Siemens PLCSIM Virtual Ethernet Adapter.TCPIP.1" interface is "S7ONLINE(STEP 7) →Siemens PLCSIM Virtual Ethernet Adapter"

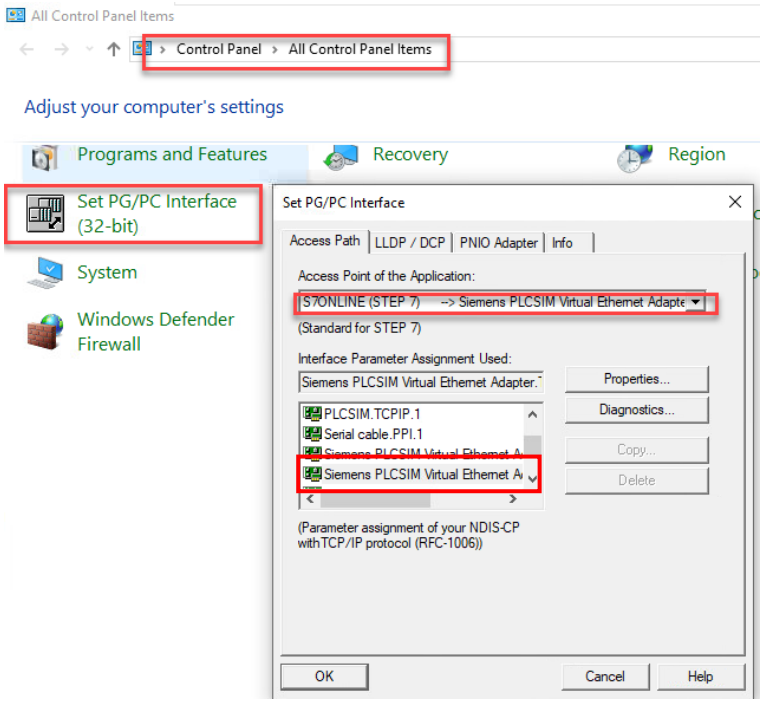


Figure 3-17

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4. Appendix

4.1. Service and support

SiePortal

The integrated platform for product selection, purchasing and support - and connection of Industry Mall and Online support. The SiePortal home page replaces the previous home pages of the Industry Mall and the Online Support Portal (SIOS) and combines them.

- Products & Services
  In Products & Services, you can find all our offerings as previously available in Mall Catalog.
- Support
  In Support, you can find all information helpful for resolving technical issues with our products.
- mySieportal
  mySiePortal collects all your personal data and processes, from your account to current orders, service requests and more. You can only see the full range of functions here after you have logged in.

You can access SiePortal via this address: sieportal.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: support.industry.siemens.com/cs/my/src

SITRAIN – Digital Industry Academy

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: siemens.com/sitrain

Industry Online Support app

You will receive optimum support wherever you are with the "Industry Online Support" app. The app is available for iOS and Android:

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4.2. Links and literature

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/109975137
\3\	

4.3. Change documentation

Version	Date	Modification
V1.0	10/2024	First version

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