S7 Communication between S7 CPU and PC station

S7 server services with SIMATIC NET OPC UA server

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Table of contents

1 Introduction

1.1 Overview

SIMATIC NET OPC server communication functions for OPC UA

The OPC server provides standardized access to the SIMATIC NET industrial communications networks.

The SIMATIC NET OPC Server supports the interfacing of applications with any automation components networked over PROFIBUS or Industrial Ethernet. SIMATIC NET OPC server offers the following communication functions for OPC UA:

- S7 communication
  - S7 OPC UA server (see chapter 4.1.1)
  - S7OPT OPC UA server (see chapter 4.1.2)
- Open communication services (SEND/RECEIVE)
  - SR OPC UA server (see chapter 4.1.3)
- PROFIBUS DP
  - DP OPC UA server (see chapter 4.1.4)

Services of the communication functions

The SIMATIC NET OPC server communication functions for OPC UA support the following services, among others:

- Variable services
- Buffer-oriented services
- Block services
- Server services

Server service via S7 communication

Note The server services only function over standard S7 connections to S7 CPUs.

This application example demonstrates how to use the server service to exchange data between PC station and S7 CPU. This service is supported by the following communication functions:

- S7 communication

The following components are used in this application example:

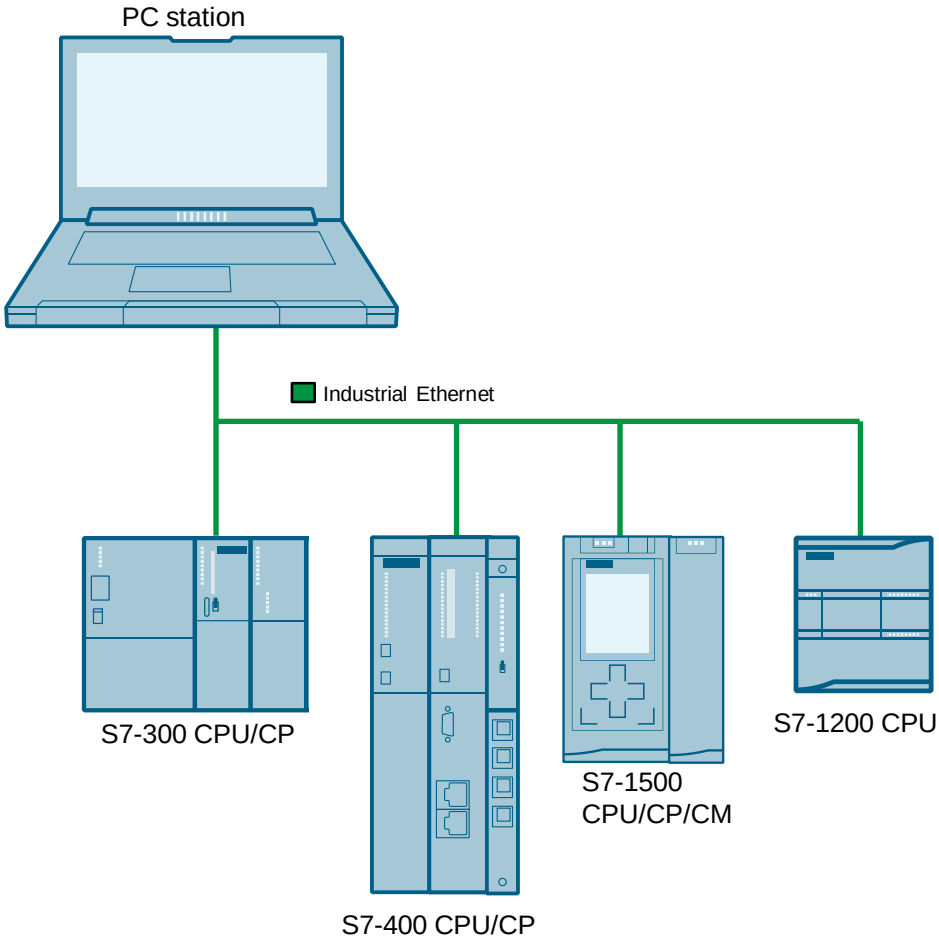
- SIMATIC NET OPC UA server on the PC station
  - S7 OPC UA server
- S7-300 CPUs, S7-400 CPUs, S7-1200 CPUs or S7-1200 CPUs

1.2 Plant configuration

The following figures show typical plant configurations for Industrial Ethernet and PROFIBUS in which the data communication between S7 CPU and PC station is implemented using S7 server services via standard S7 connections.

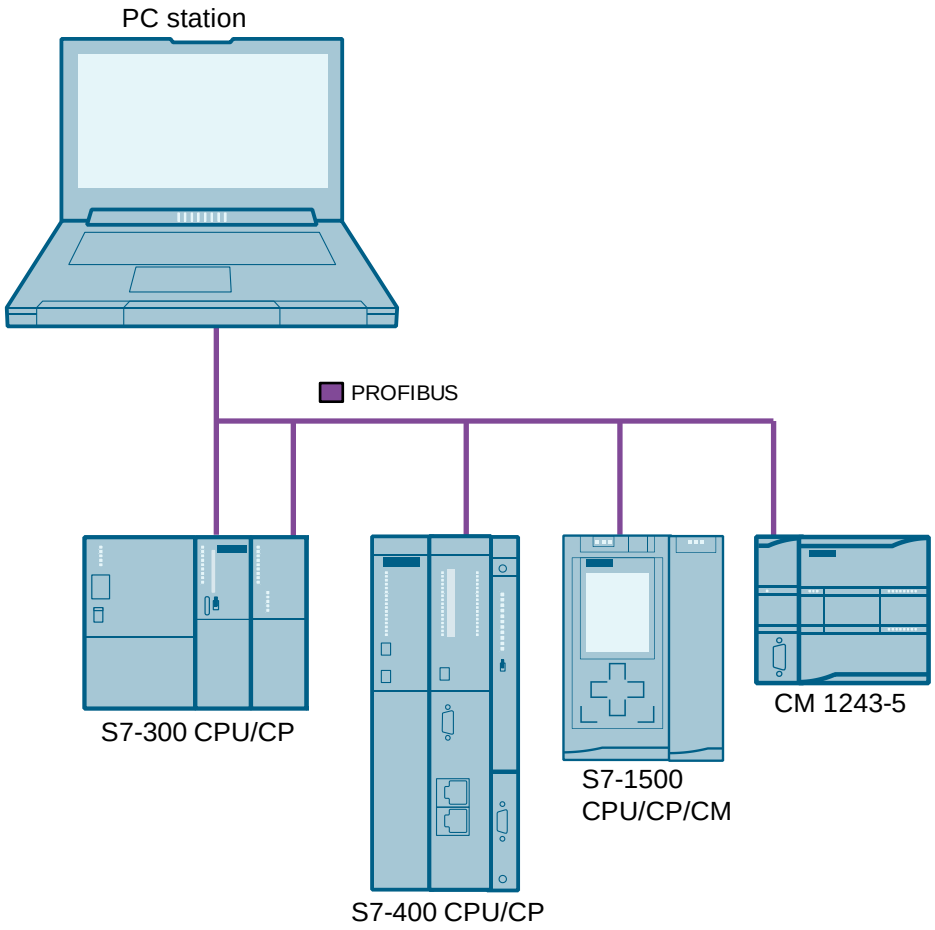
Industrial Ethernet

Figure 1-1



PROFIBUS

Figure 1-2



1.3 Principle of Operation

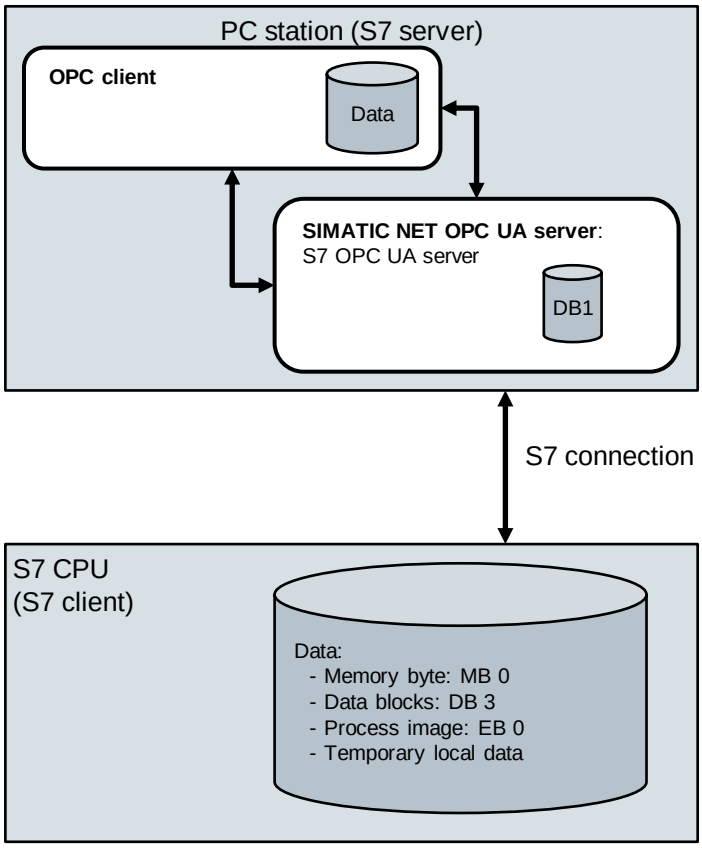
1.3.1 S7 Server services

The PC station with an active OPC server for the S7 protocol (S7 OPC UA server) provides the S7 data block DB1 for reading and writing, thereby becoming an S7 server. The S7 data block (DB 1) is 65535 bytes long. There are no symbolic names nor structuring of the data block according to tags.

An S7 connection must be configured for reading and writing. As an S7 client, the S7 CPU actively establishes the S7 connection. The PC station, as an S7 server, is a passive participant while the S7 connection is established.

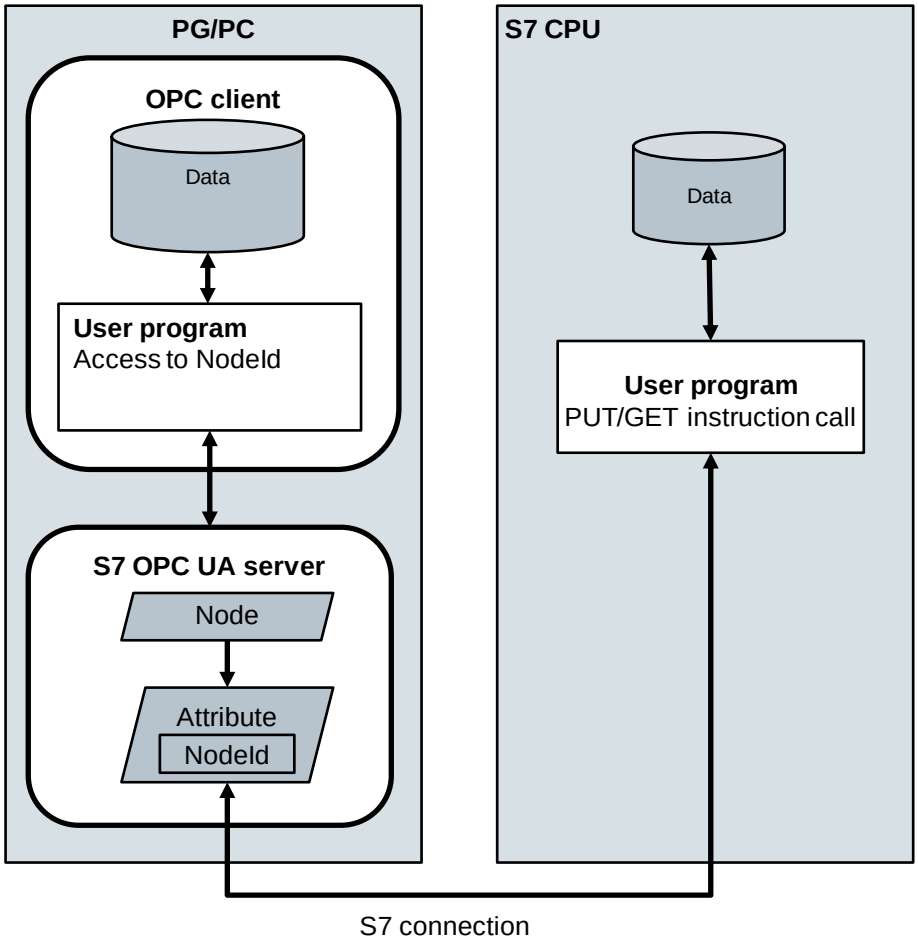
The following figure shows an overview of the application example.

Figure 1-3



Note The application example provides an introduction to using the S7 server service with the SIMATIC NET S7 OPC UA server. Details are described in the SIMATIC NET manuals (see \3\, \4\ and \5\).

Figure 1-4



OPC UA accesses objects and their sub-objects. Data tags, for example, are sub-objects of an S7 connection object.

The following S7 connection objects exist:

- Productive S7 connections
  These are used for data exchange between S7 CPU and PC station and are generally configured with STEP 7.
- DEMO connection
  This is used only for testing.
- @LOCALSERVER connection
  This provides the local S7 data blocks for the S7 server functionality.

Attributes define the objects in greater detail. Each individual access to an object, sub-object and attribute uses its NodeId.

The OPC client accesses attributes of the data tags.

1. When using the S7 server services, the OPC client access the attributes of the data tags in the S7 data block DB1 with the following commands:
   - Read
   - Write
2. Nodes are defined in the namespace of the S7 OPC UA server in order to organize the objects and sub-objects.
3. In STEP 7 (TIA Portal), a user program is created for the S7 CPU in order to access the S7 data block DB1 in the PC station. Call the "PUT" and "GET" instructions in the S7 CPU user program in order to execute the following commands:
   - "PUT":
     The S7 CPU, as S7 client, writes data to the PC station (S7 server).
   - "GET":
     As an S7 client, the S7 CPU reads data from the PC station (S7 server).

1.3.2 As an S7 client, S7 CPU reads data from the PC station (S7 server)

The following figure shows how the S7 CPU, as an S7 client, reads data from the PC station (S7 server).

Figure 1-5

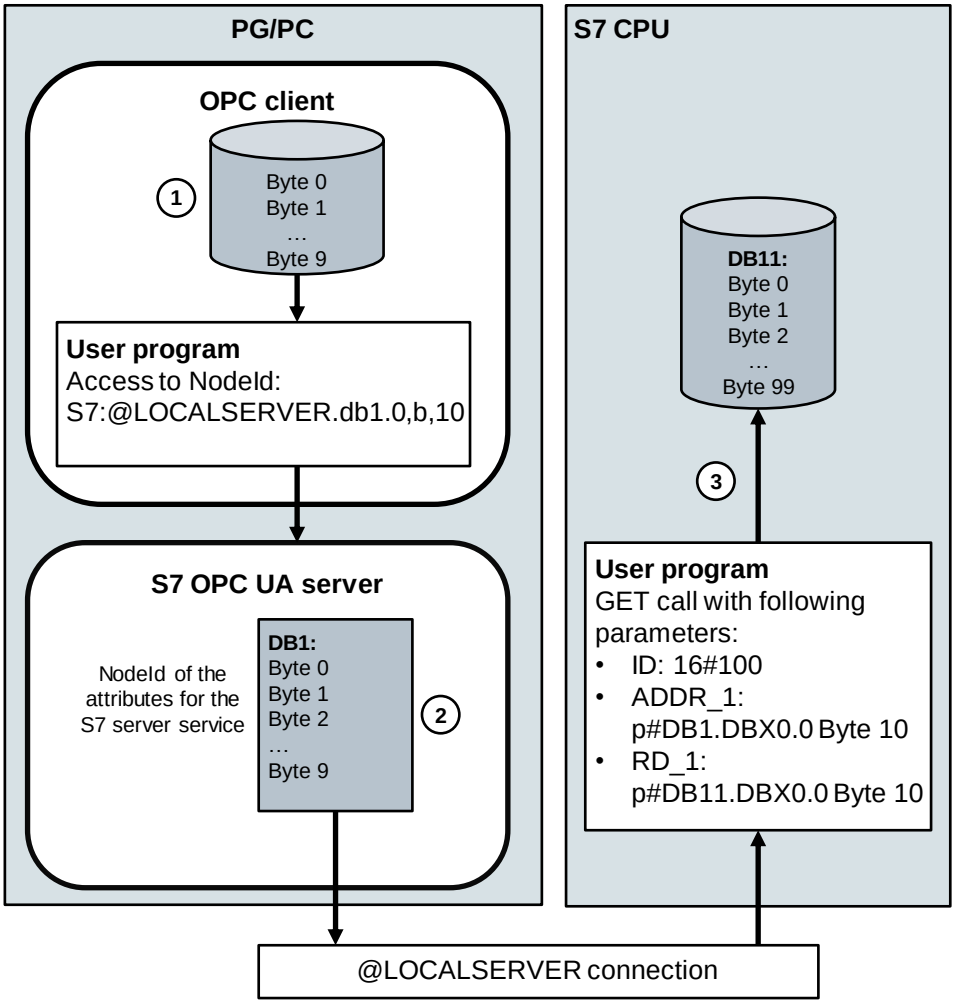


Table 1-1

No.	Description
1.	The OPC client writes to the attributes of the data tags in the S7 data block DB1. The attributes are accessed via the NodeId.
2.	The entire S7 block DB1 or parts of the S7 data block DB1 are mapped to the NodeId.
3.	The "GET" instruction is called in the S7 CPU user program. The "GET" instruction reads data from the source range, specified at the parameter "ADDR_1": • Source range: S7 data block DB1 in the PC station The instruction enters the data into the target range, specified at parameter "RD_1": • Target range: DB11 in the S7 CPU

1.3.3 S7 CPU, as S7 client, writes data to the PC station (S7 server)

The following figure shows how the S7 CPU, as an S7 client, writes data to the PC station (S7 server).

Figure 1-6

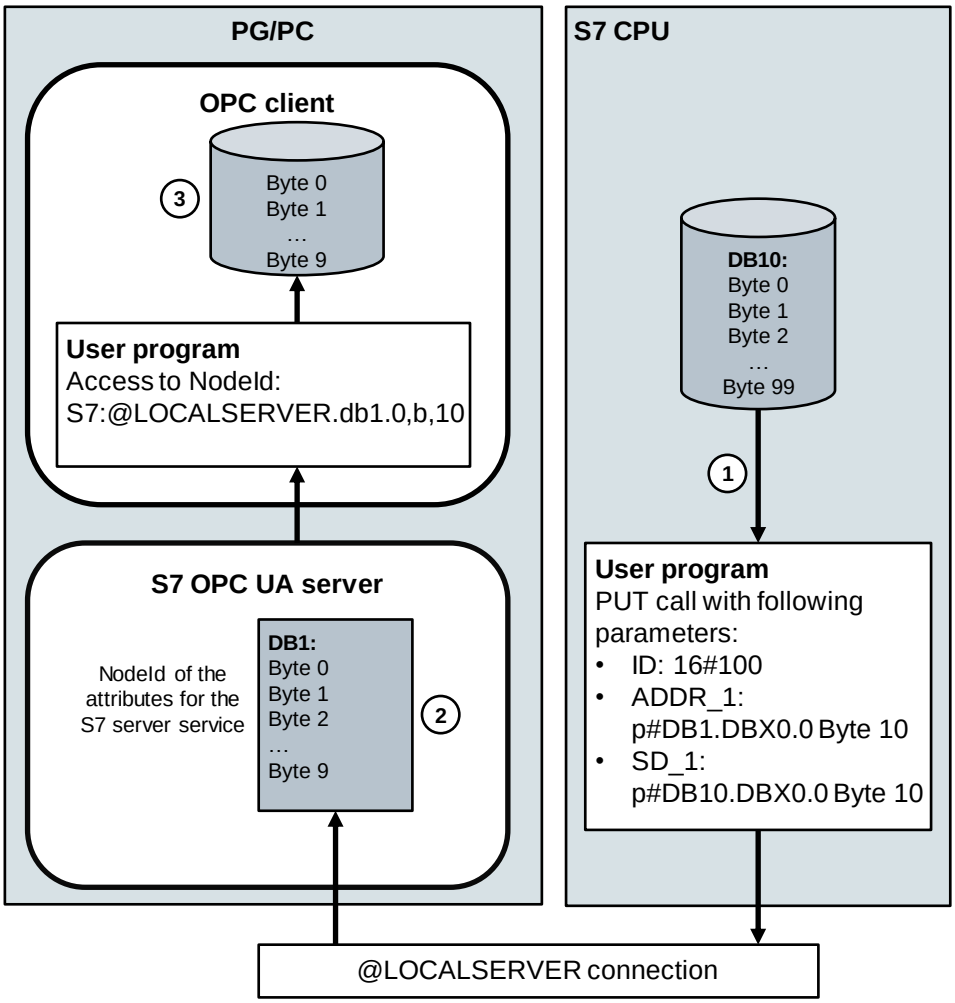


Table 1-2

No.	Description
1.	The "PUT" instruction is called in the S7 CPU user program. The "PUT" instruction the data from the source range, specified at parameter "SD_1". • Source range: DB10 in the S7 CPU The "PUT" instruction writes data to the target range, specified at parameter "ADDR_1". • Target range: S7 data block DB1 in the PC station
2.	The entire S7 block DB1 or parts of the S7 data block DB1 are mapped to the NodeId.
3.	The OPC client reads the attributes of the data tags in the S7 data block DB1. The attributes are accessed via the NodeId.

1.3.4 NodeId for access to the attributes of the data tags in S7 data block DB1

The following figure shows the NodeId for access to the attributes of the data tags in the S7 data block DB1.

Figure 1-7

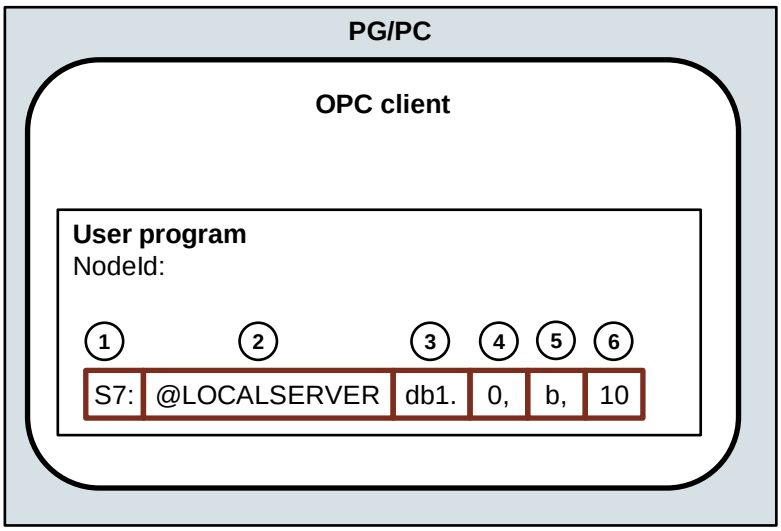


Table 1-3

No.	Description	Value
1.	Namespace URI	S7
2.	Local connection (within the PC station)	@LOCALSERVER
3.	Object	DB1
4.	Start address	0
5.	Data type	b (bytes)
6.	Quantity	10

1.4 Components used

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

Table 1-4

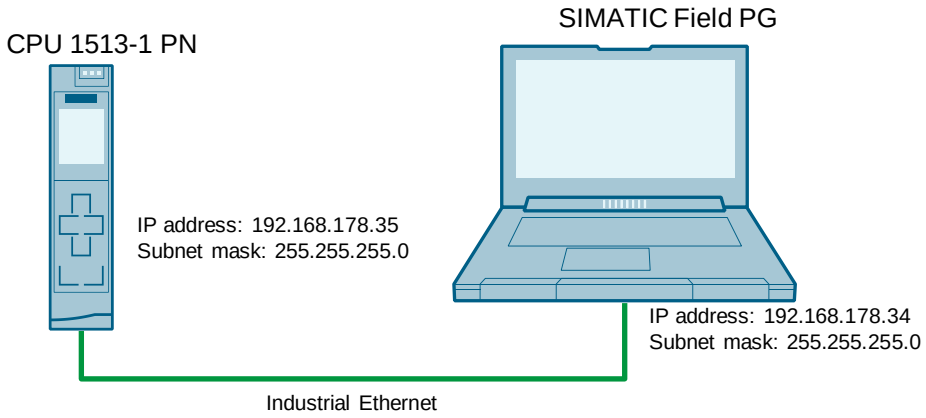
Components	Quantity	Item number	Note
CPU 1513-1PN	1	6ES7513-1AL01-0AB0	Alternatively, you can use one of the following components: • S7-1500 CPU • S7-1200 CPU • S7-300 CPU • S7-400 CPU • ET 200SP CPU • ET 200S CPU • ET 200pro CPU • CP/CM
CPU 315-2 PN/DP	1	6ES7315-2EH14-0AB0	
SIMATIC NET DVD V16	1	6GK1704-1LW16-0AA0	In the Sales and Delivery Release you will find the article numbers for the SIMATIC NET products (see article 109775589).
STEP 7 V16	1	Package: 6ES7822-1AA06-0YA5 Download: 6ES7822-1AE06-0YA5	

2 Engineering

2.1 Hardware setup

The following figure shows the structure of the application example.

Figure 2-1



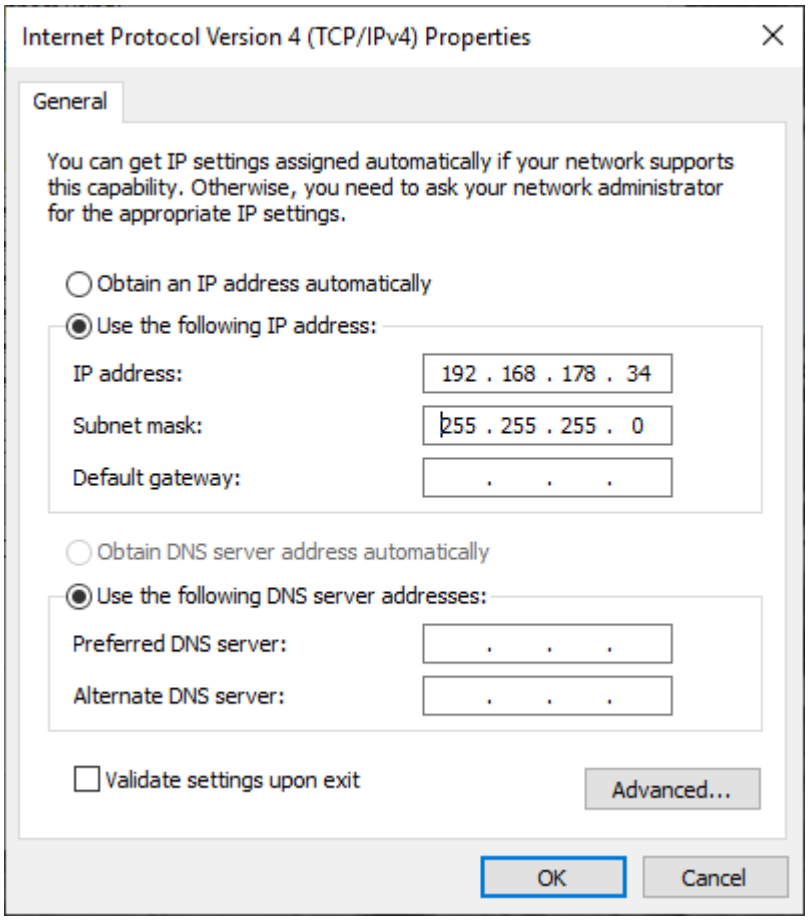
The SIMATIC Field PG is deployed as a PC station, i.e. the SIMATIC NET PC software is installed on the SIMATIC Field PG. The SIMATIC NET OPC server provides the S7 data block DB1 on the PC station. Using the S7 server services "PUT" and "GET", the S7 CPU access the S7 data block DB1 in the PC station.

2.2 Setting IP addresses and subnet mask

2.2.1 IP address and subnet mask for the PC station

In the Windows properties for the network adapter through which the PC station is connected with the S7 CPU, set the IP address and subnet mask for the PC station.

Figure 2-2



1. In the "Control Panel", open the "Network and Sharing Center" under "Network and Internet".
2. Select the function "Change adapter settings".
3. Right-click on the corresponding network adapter and select the "Properties" context menu.
   The Properties dialog for network adapter opens.
4. Select the "Internet Protocol Version 4 (TCP/IPv4)" element and click the "Properties" button.
   The Properties dialog box for the "Internet Protocol Version 4 (TCP/IPv4)" element will open.

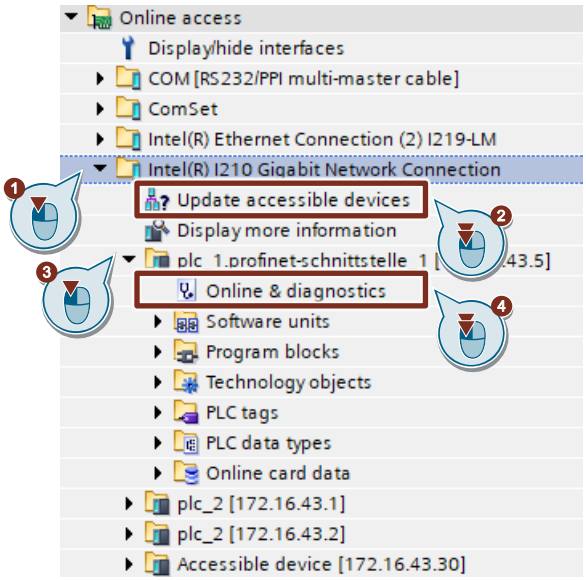
5. Set the IP address and subnet mask and apply the settings with "OK".
   - IP address: 192.168.178.34
   - Subnet mask: 255.255.255.0

Note You will configure the IP address and subnet mask later during hardware configuration for STEP 7.

2.2.2 IP address and subnet mask for the S7 CPU

Opening the "Online & diagnostics" dialog

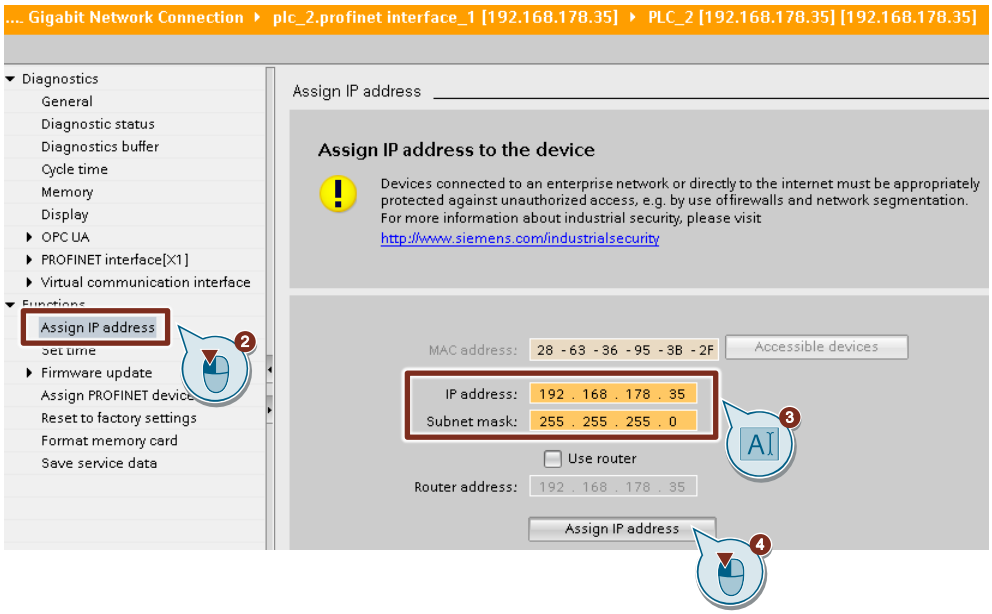
Figure 2-3



1. In the "Project tree" under "Online access" click the arrow to the left of the network adapter that is connected with your S7 CPU.
2. Double-click the "Update accessible devices" command.
   All devices available to the network adapter will be shown.
3. Click the arrow to the left of the S7 CPU to which you wish to assign an IP address and subnet mask.
4. Double-click the command "Online & diagnostics".
   The "Online & diagnostics" dialog will open.

Assigning IP address and subnet mask

Figure 2-4



1. Switch the S7 CPU to "STOP" mode.
2. Under "Functions", click "Assign IP addresses".
3. Enter the following IP address and subnet mask:
   - IP address: 192.168.178.35
   - Subnet mask: 255.255.255.0
4. Click "Assign IP address" to carry over the parameters.

Note

- You will enter the IP address and subnet mask later during configuration.
- If you have an S7-1500 CPU, you can also set the IP address and subnet mask on the display.

2.3 "Communication settings".

Open the program "Communication Settings" via the Windows Start Menu "Siemens Automation > Communication Settings".

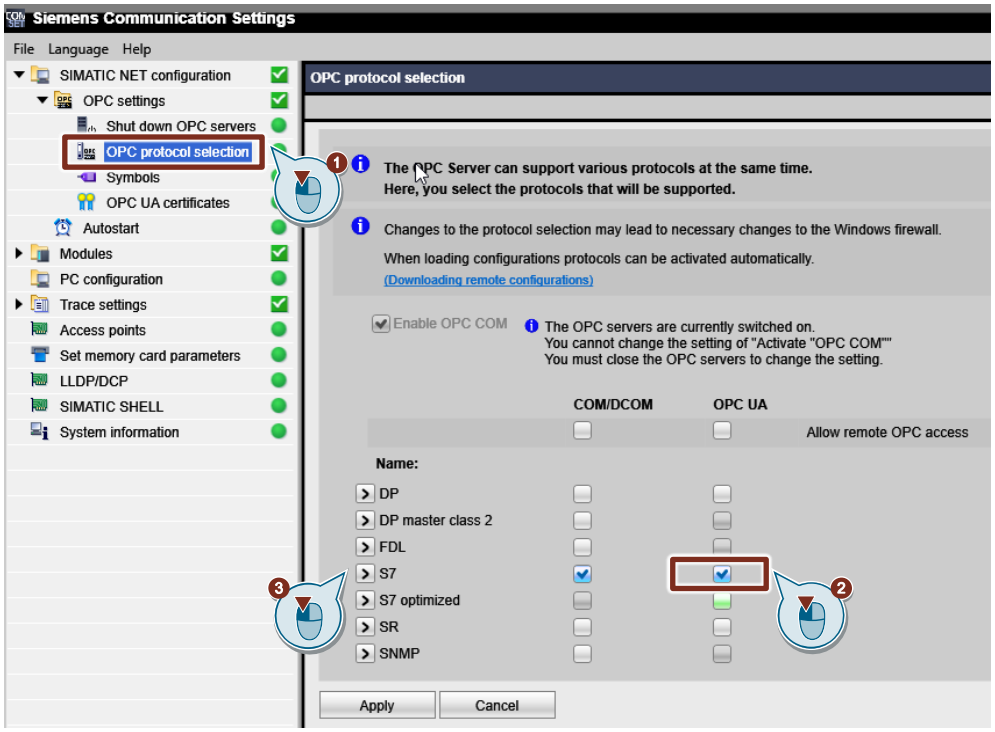
The "Communication Settings" program provides a number of ways to configure and diagnose PC hardware components, PC user programs and the SIMATIC NET OPC server.

Enabling protocols for the OPC server

The SIMATIC NET OPC server supports various protocols to the controller level. All protocols are activated in the initial configuration.

You can disable protocols that you don't want to use.

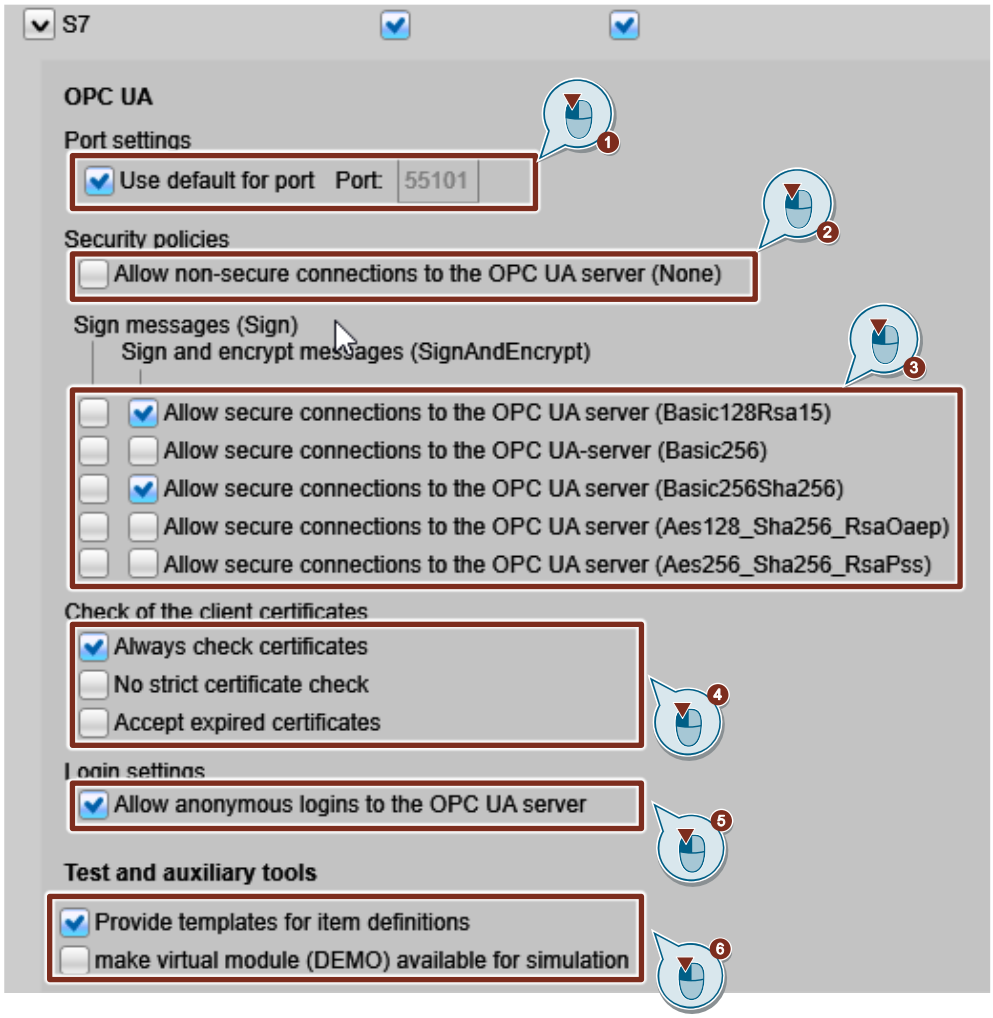
Figure 2-5



1. In the navigation area, navigate to "SIMATIC NET configuration > OPC Settings > OPC protocol selection".
2. Enable the protocol "S7" for OPC UA.
   - "S7": SIMATIC S7 communication via PROFIBUS and Industrial Ethernet
3. Click the arrow icon next to the protocol "S7" to reach the advanced parameter list for that protocol.

Setting parameters for the protocols

Figure 2-6



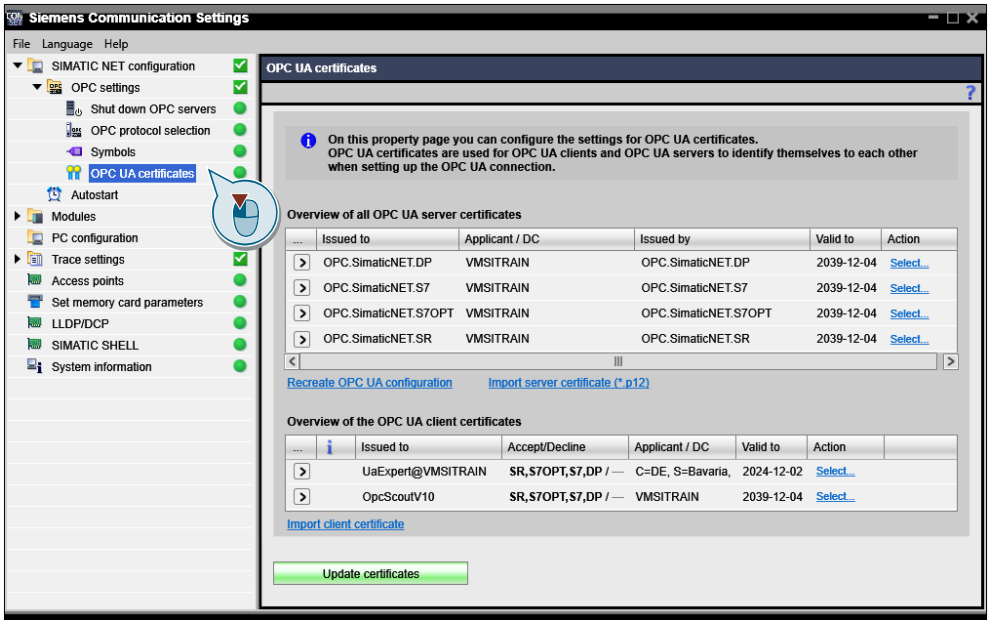
1. Port settings:
   - If the checkbox is selected, the default setting is used for the specified port.
   - If the checkbox is not selected, you can edit the input field for the port.
2. Security policies:
   - If the checkbox is selected, unsecured connections (none) to the OPC server are allowed.
   - If the checkbox is not selected, no unsecured connections (none) to the OPC server will be allowed.

3. Define which connections to the OPC server will be allowed and determine whether the messages will be signed (Sign) or signed and encrypted (SignAndEncrypted):
   - secured connections based on the security policy "Basic128Rsa15"
   - secured connections based on the security policy "Basic256"
   - secured connections based on the security policy "Basic256Sha256"
   - secured connections based on the security policy "Aes128_Sha256_RsaOaep"
   - secured connections based on the security policy "Aes256_Sha256_RsaPss"
4. Check of the client certificates
   - Always check certificates
     Enabled: The certificates will always be checked.
     Disabled: The certificates will not be checked.
   - No strict certificate check
     Enabled: Certain certificate checks will be ignored, e.g. CertificateRevocationUnknown, CertificateIssuerRevocationUnknown, NonceLengthCheck, TokenPolicyIdCheck.
     Disabled: The certificates will be fully checked.
   - Accept expired certificates
     Enabled: The certificates will be accepted even if the time stamp of the certificate is invalid, i.e. the certificates are not yet valid or have already expired.
     Disabled: The certificates are only accepted if the time stamp is valid.
5. Login settings
   - If the checkbox is selected, the SIMATIC NET OPC server allows anonymous login of OPC UA clients.
   - If the checkbox is not selected, anonymous logins are not allowed. User authentication with Windows login and password is then required.

   Note
   The SIMATIC NET OPC server uses the Windows user management for user authentication. In the OPC client, log in to the SIMATIC NET OPC server with your Windows user name and password.
6. Test and auxiliary tools
   - Provide templates for item definitions:
     If the checkbox is selected, the OPC server creates templates for item definitions in its namespace, which can be used to easily define a new Item.
   - Make virtual module (Demo) available for simulations:
     The SIMATIC NET OPC server gives you the ability to use the OPC interface for tests, presentations and development work without a communication module. For this purpose, the OPC server provides a virtual module or "DEMO" connection, depending on the protocol (CP simulation). This option enables activation of the simulation function depending on the protocol.

"OPC UA certificates"

Figure 2-7



1. In the navigation area, navigate to "SIMATIC NET configuration > OPC settings > OPC UA certificates".
   Here, the certificates of the local OPC UA server and the certificates the OPC clients used to identify themselves to the servers are displayed and managed.
2. Accept the OPC client certificate, if applicable.

2.4 Overview

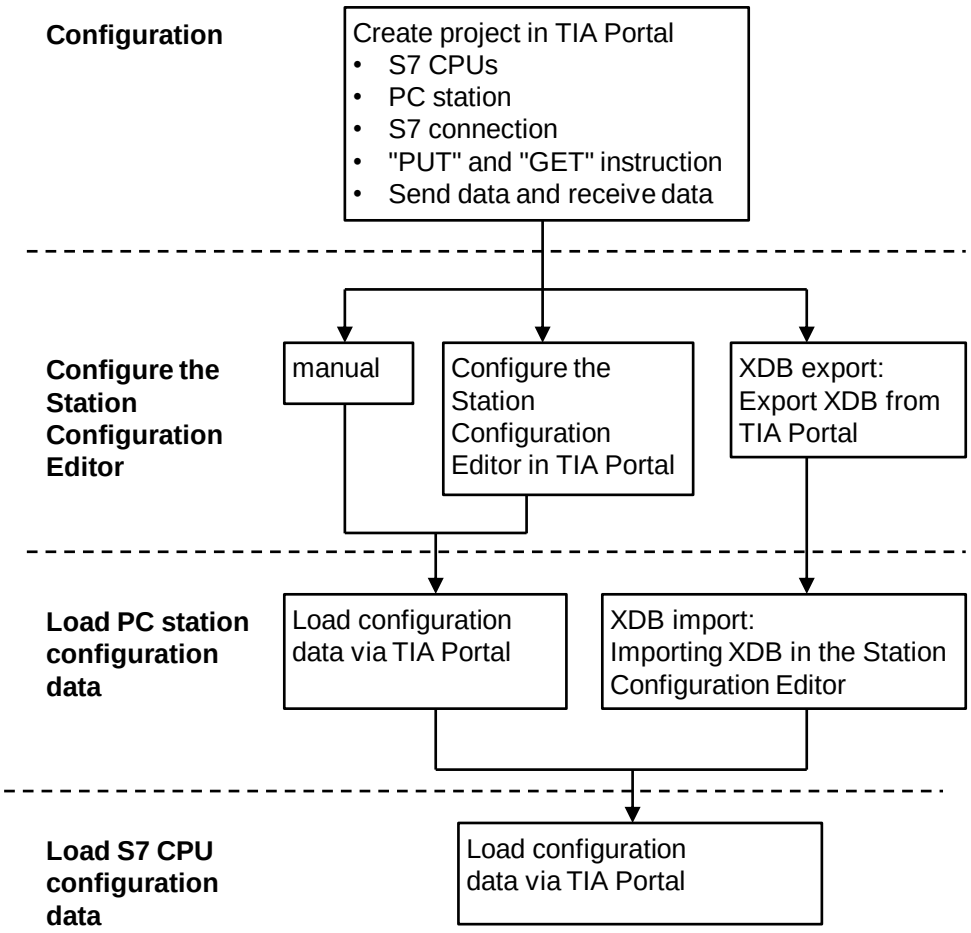
The following figure shows an overview of the steps performed during the engineering stage.

- Configuration
- Configure the Station Configuration Editor
- Load PC station configuration data
- Load S7 CPU configuration data

There are multiple ways of performing the engineering step when configuring the Station Configuration Editor and loading the PC station configuration data. Performing either one of the options for the engineering step is sufficient.

This application example describes all possibilities for the engineering steps.

Figure 2-8



2.5 Configuration

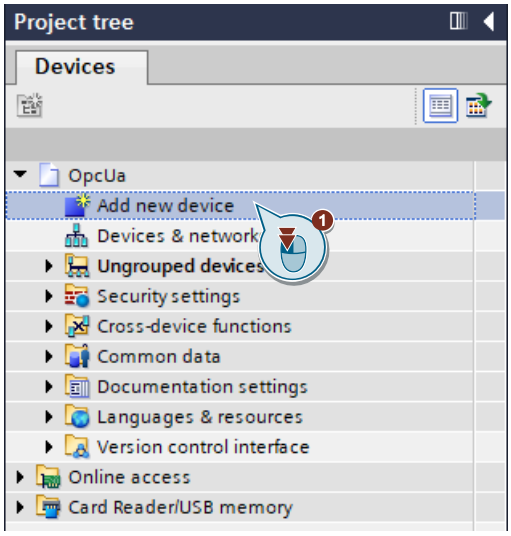
2.5.1 Create S7 CPU in STEP 7 (TIA Portal)

Requirements

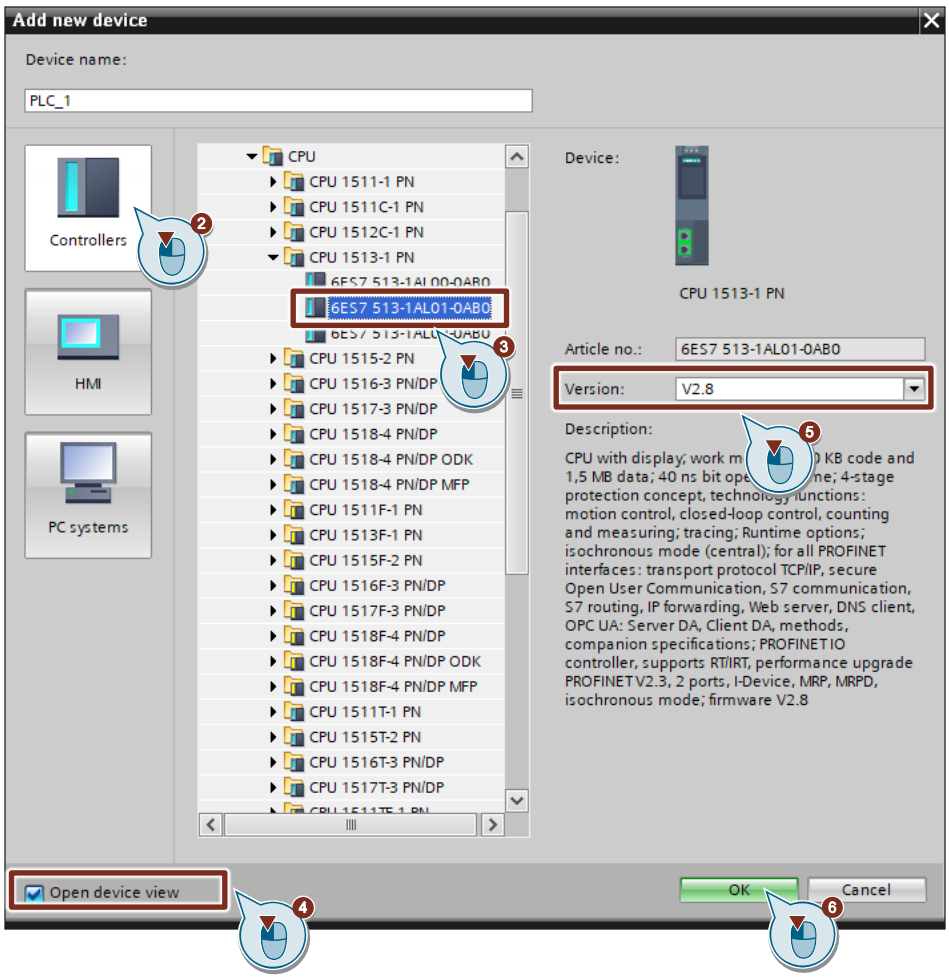
- STEP 7 (TIA Portal) is open.
- A new project is created, or an existing project is opened.

Insert device

1. Double-click the command "Add new device" in the "Project tree".



The dialog box "Add new device" opens.

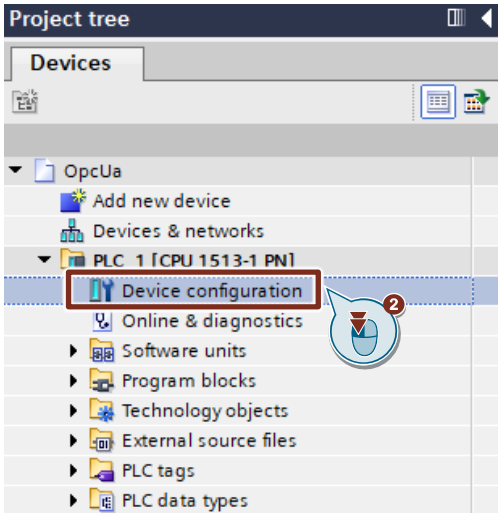


2. Click the "Controllers" button.
3. Select the S7 CPU according to your hardware setup, e.g. CPU 1513-1 PN.
4. Enable the option "Open device view".
5. Under Version, select the firmware version of the S7 CPU.
6. Click the "OK" button.
   The selected S7 CPU will be added.

Note If you enabled the option "Open device view", the "Device view" for the S7 CPU will open automatically in the hardware and network editor.

Opening the device view

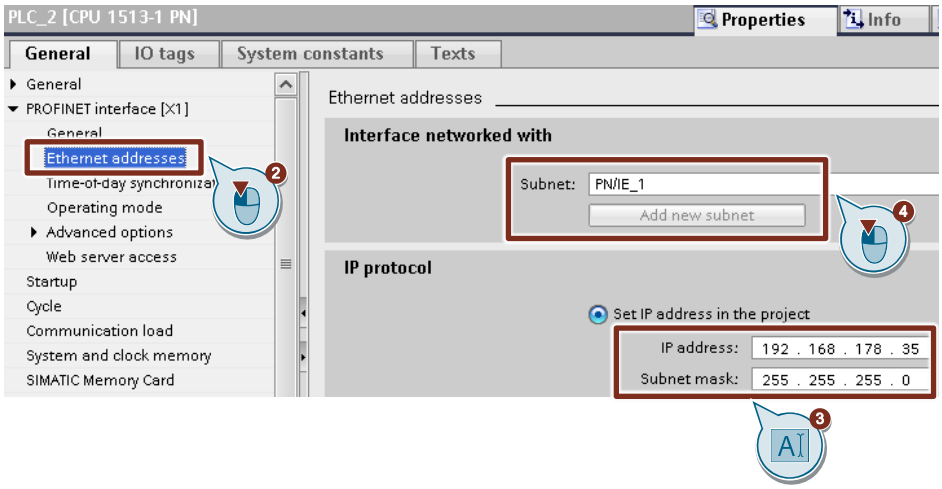
1. In the "Project tree", open the device folder of the S7 CPU.
2. Double-click on the "Device configuration" command.



The "Device view" of the S7 CPU opens in the hardware and network editor.

Setting address parameters

1. Select the S7 CPU in the device view.
   The properties of the S7 CPU are displayed in the Inspector window.

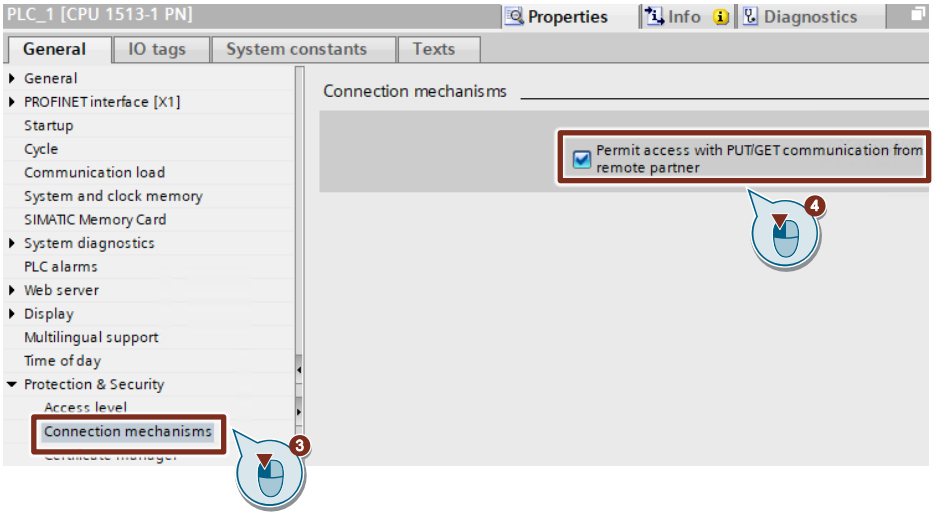


2. In the "General" tab, navigate to "PROFINET interface [X1] > Ethernet addresses".
3. Enter the following address parameters:
   - IP address: 192.168.178.35
   - Subnet mask: 255.255.255.0
4. Click on the "Add new subnet" button to create a new subnet, or select an existing subnet.

Allow access via PUT/GET communication from a remote partner

For the S7-1500 CPUs and S7-1200 CPUs, it is necessary to allow access via PUT/GET communication from a remote partner.

1. Open the device view of the S7 CPU.
2. Select the S7 CPU in the device view.
   The properties of the S7 CPU are displayed in the Inspector window.

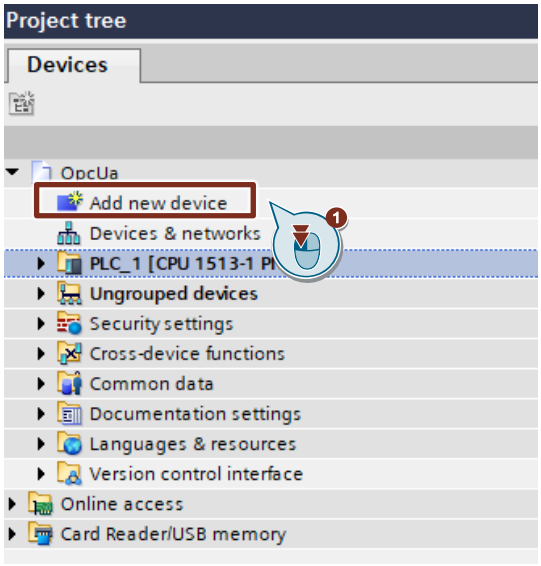


3. In the "General" tab, navigate to "Protection & Security > Connection mechanisms".
4. Enable the function "Permit access with PUT/GET communication from remote partner".

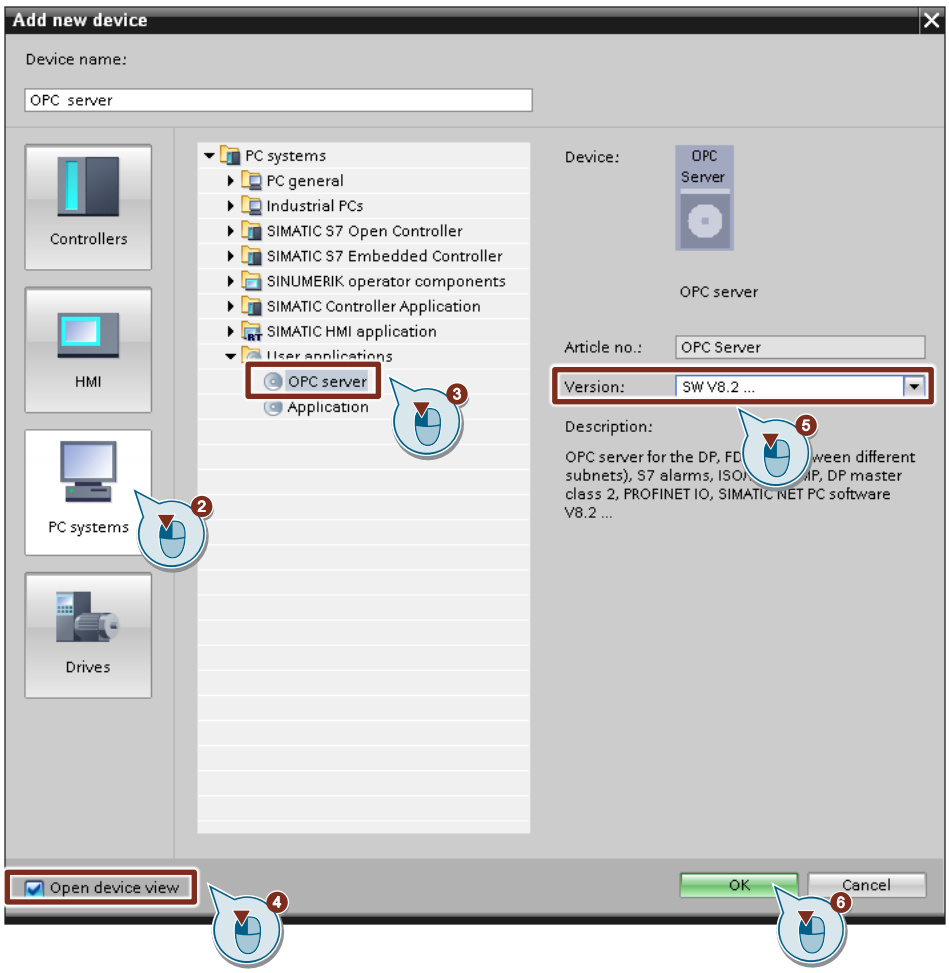
2.5.2 Create PC station in STEP 7 (TIA Portal)

Insert device

1. Double-click the command "Add new device" in the "Project tree".



The dialog box "Add new device" opens.

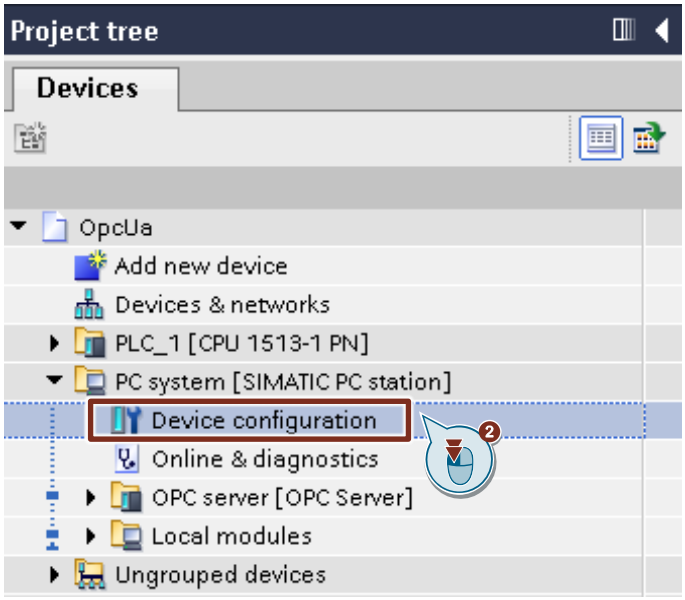


2. Click the "PC systems" button.
3. Select the user application "OPC server".
4. Enable the option "Open device view".
5. Set the version "SW V8.2..." for the user application "OPC server" in order to enable a standard S7 connection to S7-1500 CPUs and S7-1200 CPUs (firmware V4 or higher).
6. Click the "OK" button.
   A PC station with the user application "OPC server" will be added.

Note If you enabled the option "Open device view", the "Device view" for the PC station will open automatically in the hardware and network editor.

Opening the device view

1. In the "Project tree", open the device folder of the PC station
2. Double-click on the "Device configuration" command.

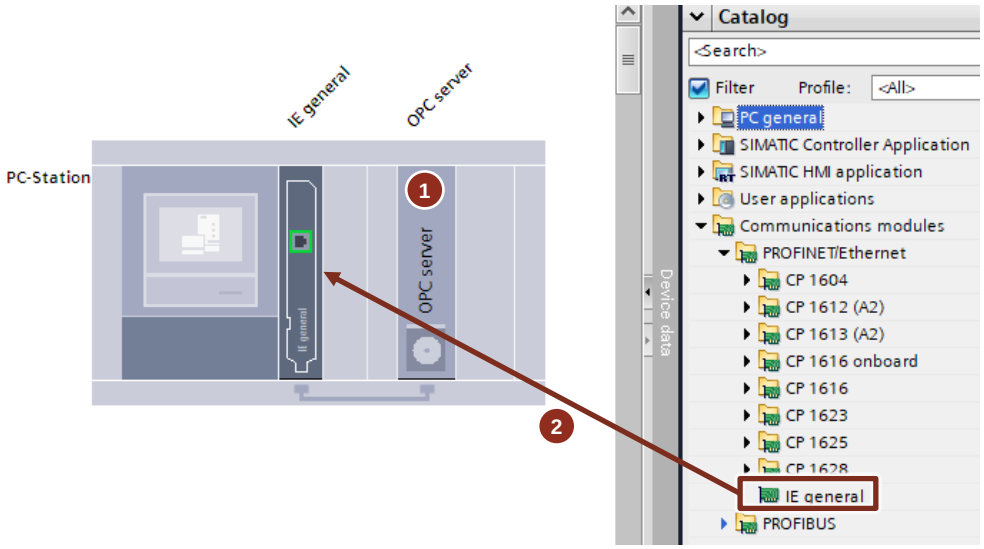


The "Device view" of the PC station opens in the hardware and network editor.

Configuring the PC station

Configure the PC station in the device view.

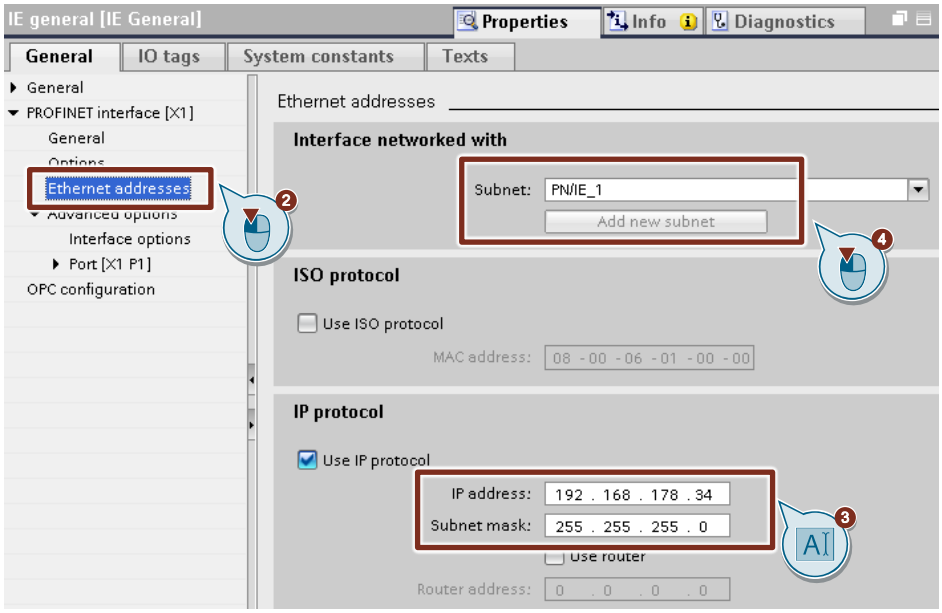
Figure 2-9



1. The OPC server has been automatically added in slot 2.
2. Insert a communications module, e.g. "IE general", into slot 1 of the PC station by dragging and dropping.

Setting address parameters

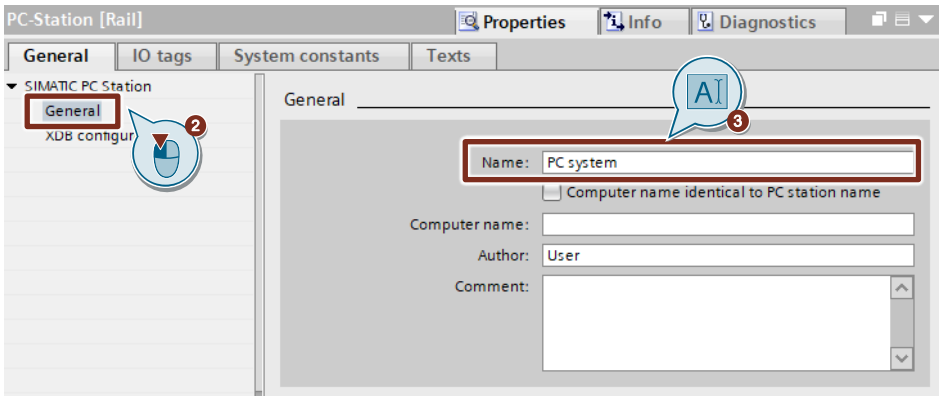
1. In the device view, select the communications module "IE general".
   The properties of the communications module are displayed in the Inspector window.



2. In the "General" tab, navigate to "PROFINET interface [X1] > Ethernet addresses".
3. Enter the following address parameters:
   - IP address: 192.168.178.34
   - Subnet mask: 255.255.255.0
4. Click on the "Add new subnet" button to create a new subnet, or select an existing subnet.

Setting the name of the PC station

1. Select the PC station in the device view.
   The properties of the PC Station are displayed in the Inspector window.



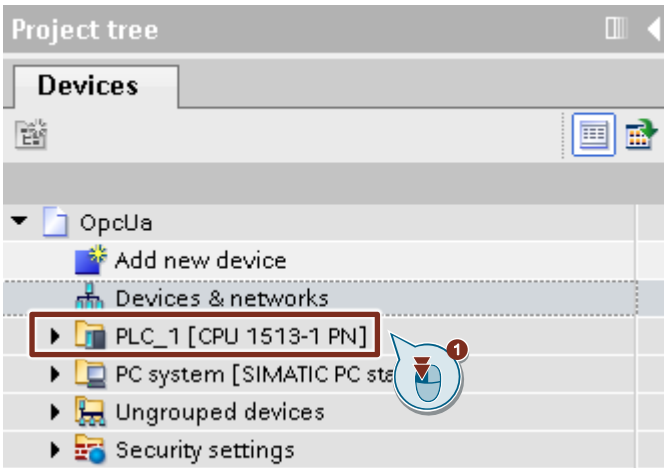
2. In the "General" tab, navigate to "General".
3. Enter the name of the PC station, e.g. "PC system".

2.5.3 Configuring a connection

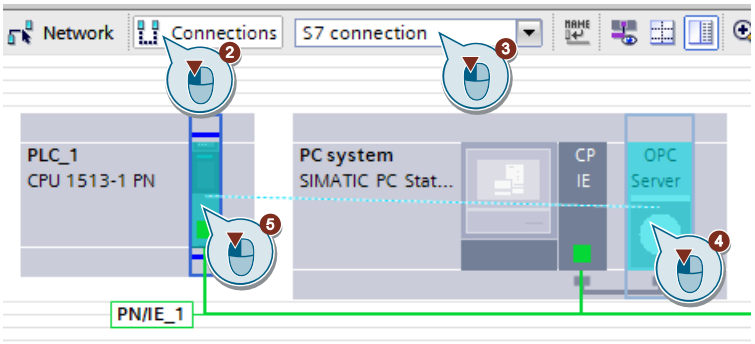
S7 CPU and PC station are created in the same project

Add S7 connection

1. Double-click "Devices & networks" in the "Project tree".



The graphical area of the "Network view" opens in the hardware and network editor.

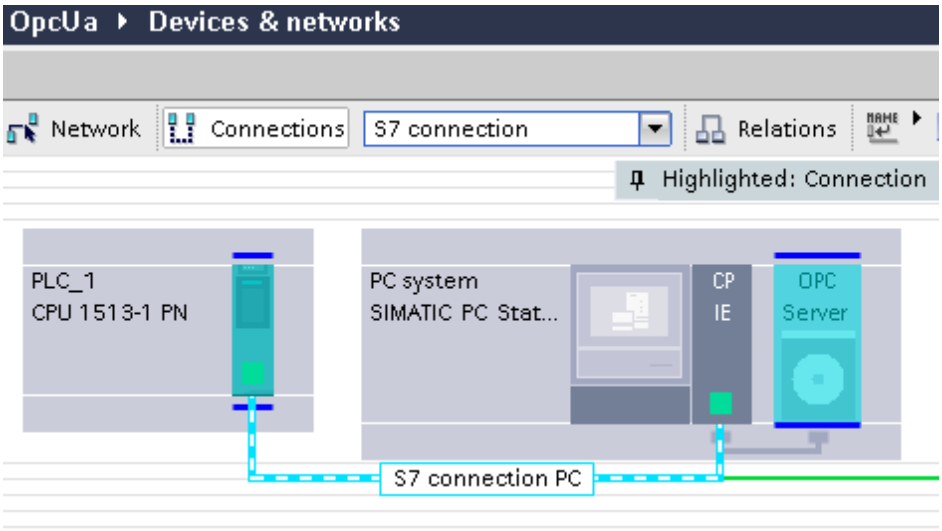


2. In the function bar, click "Connections" to enable the connection mode.
3. Select the connection type "S7 connection" in the nearby dropdown menu. All devices that are relevant to an S7 connection are highlighted in color in the "Network view".
4. Click and drag the mouse from the OPC server to the S7 CPU.
5. Release the mouse button on the target device in order to create the S7 connection between the OPC server and the S7 CPU.

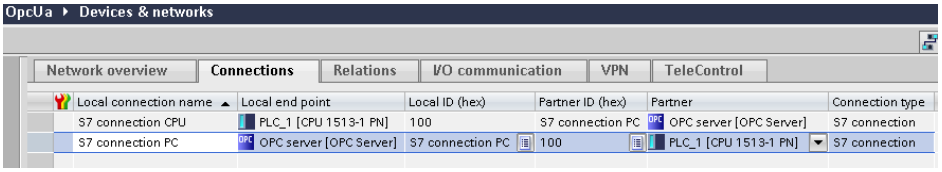
Result:

A specified S7 connection is created and is configured on both sides.

- The connection path is highlighted.



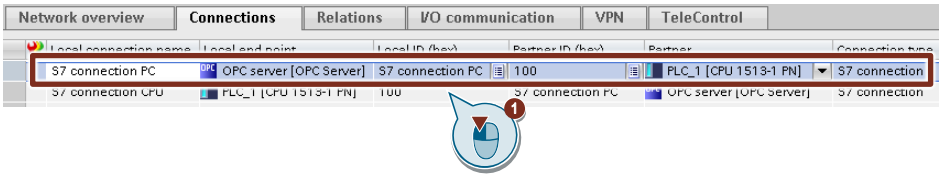
- The S7 connection is entered in the connection table.



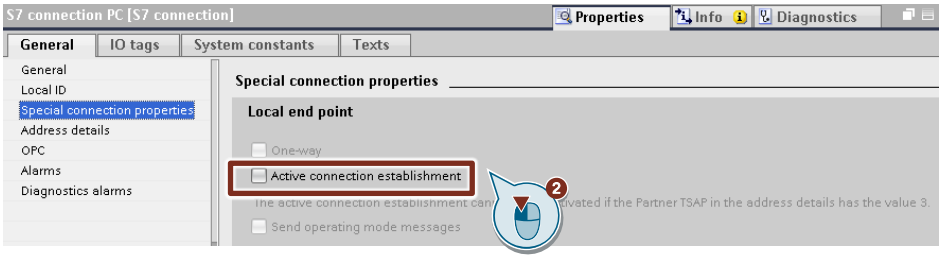
- The OPC server is a passive participant as the connection is established. The S7 CPU actively establishes the S7 connection.

Setting connection parameters:

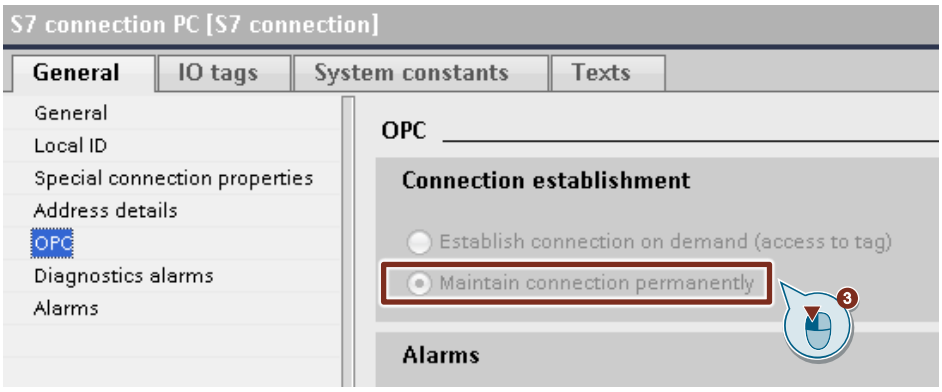
1. In the connection table, select the S7 connection that uses the OPC server as local endpoint.
   The properties of the S7 connection are displayed in the Inspector window.



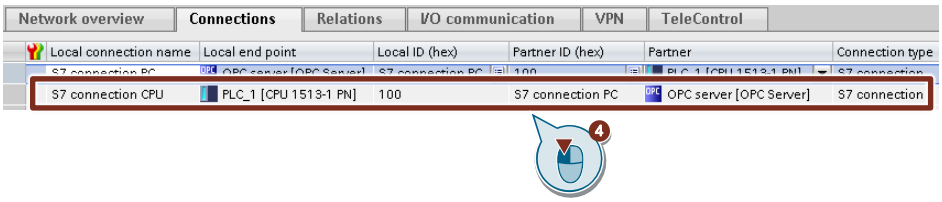
2. In the "General" tab under "Special connection properties", disable the function "Active connection establishment".



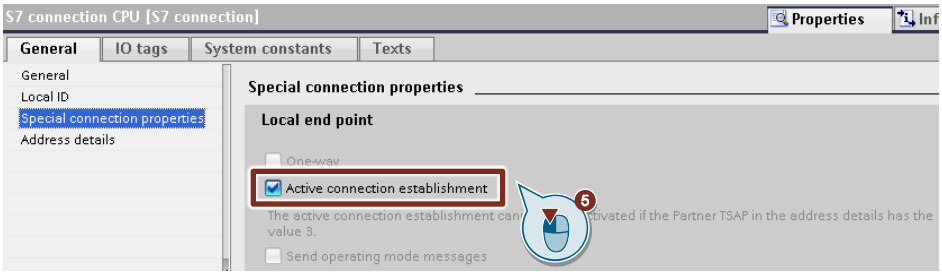
3. In the "General" tab under "OPC", the function "Maintain connection permanently" is enabled.



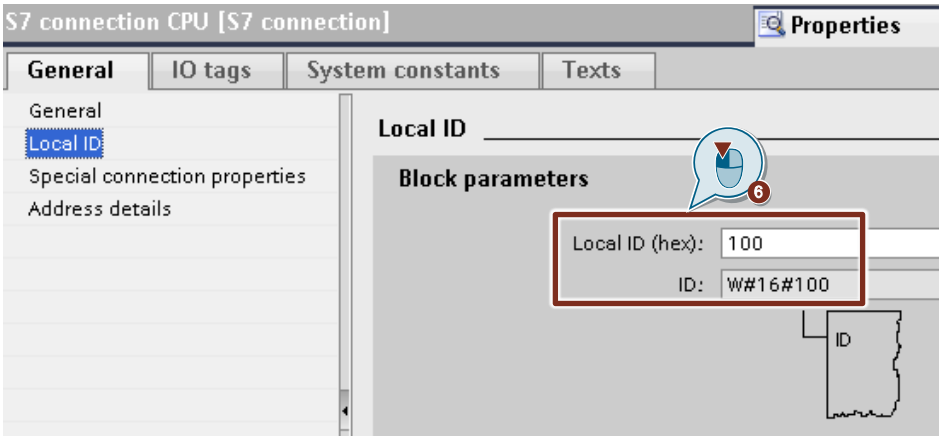
4. In the connection table, select the S7 connection that uses the S7 CPU as local endpoint.
   The properties of the S7 connection are displayed in the Inspector window.



5. In the "General" tab under "Special connection properties", enable the function "Active connection establishment".



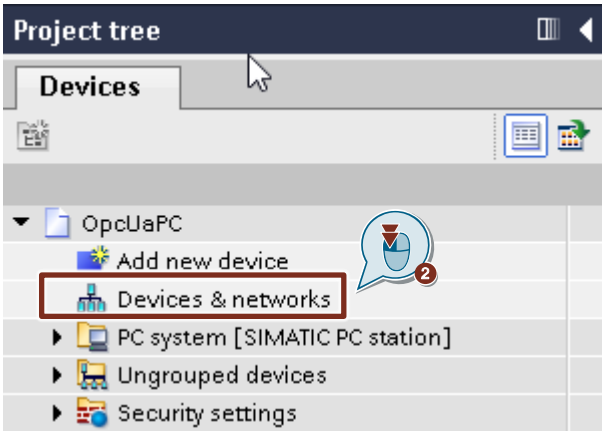
6. The local ID of the S7 connection can be modified in the "General" tab under "Local ID".
You will specify the local ID later at the "ID" input parameter for the instructions "PUT" and "GET".



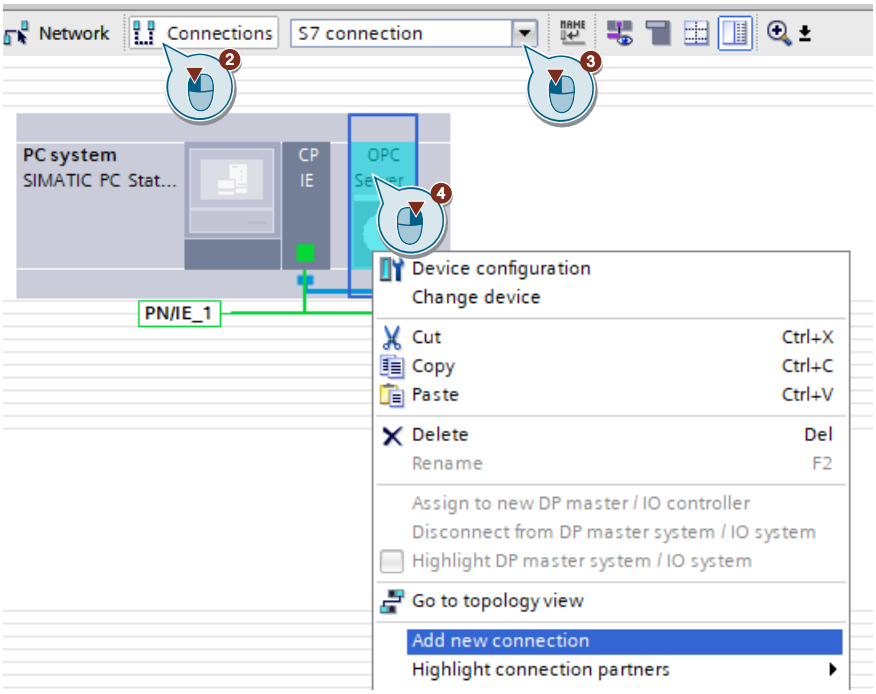
S7 CPU and PC station are created in different projects

Add S7 connection in the PC station:

1. Double-click "Devices & networks" in the "Project tree".

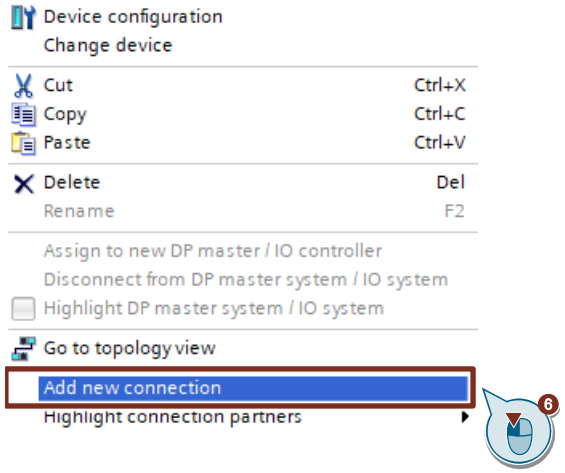


The graphical area of the "Network view" opens in the hardware and network editor.

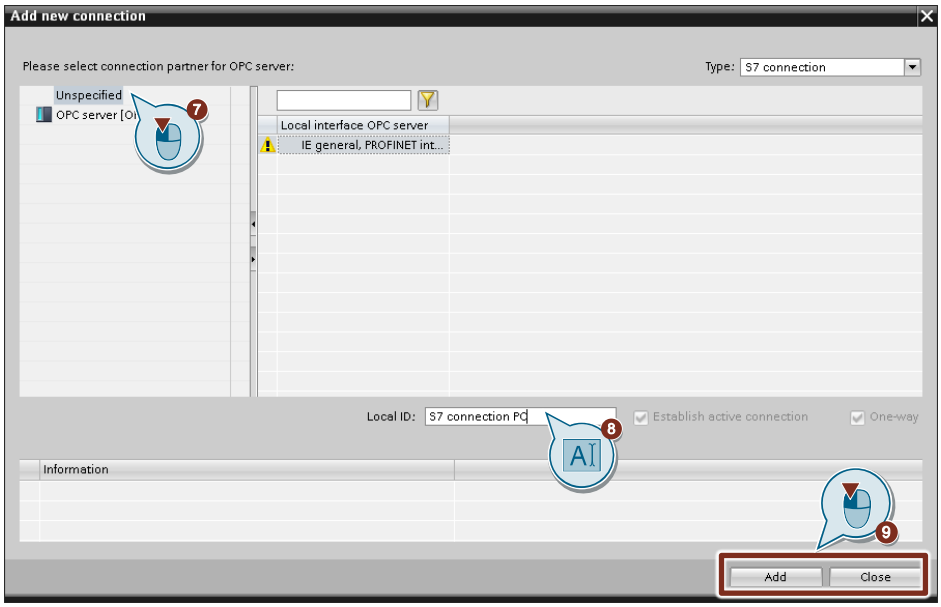


2. In the function bar, click "Connections" to enable the connection mode.
3. Select the connection type "S7 connection" in the nearby dropdown menu.
   All devices that are relevant to an S7 connection are highlighted in color in the "Network view".
4. Right click on the OPC server.
   The context menu opens.

5. Select "Add new connection".



The "Add new connection" dialog will open.

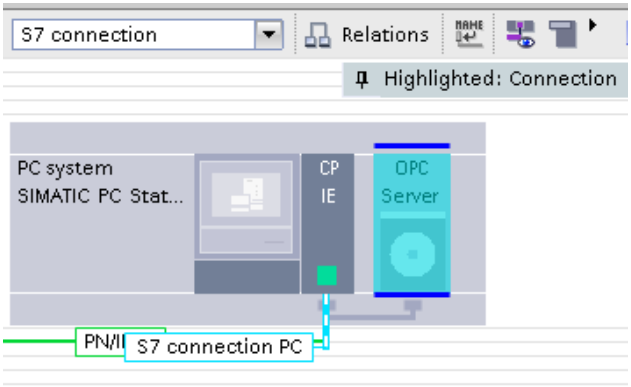


6. Specify the following connection parameters: "Unspecified".
7. Enter the local ID for the S7 connection, e.g. "S7 connection PC".
   The local ID is visible in the OPC client if the OPC client has established a connection to the SIMATIC NET OPC UA server.
8. Click "Add" to add the unspecified S7 connection; click the "Close" button to close the dialog.

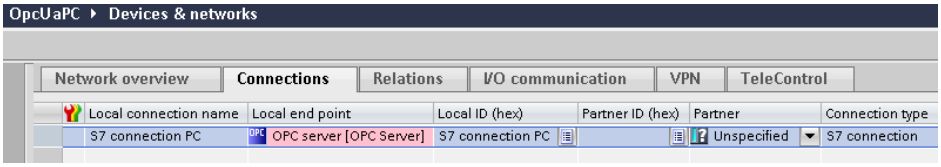
Result:

An unspecified S7 connection is created.

- The connection path is highlighted.



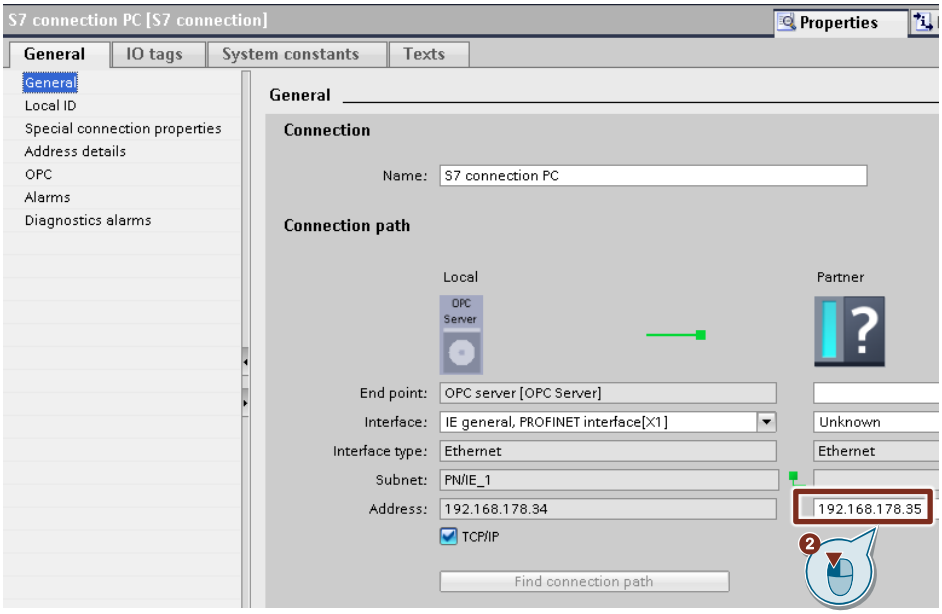
- The S7 connection is entered in the connection table.



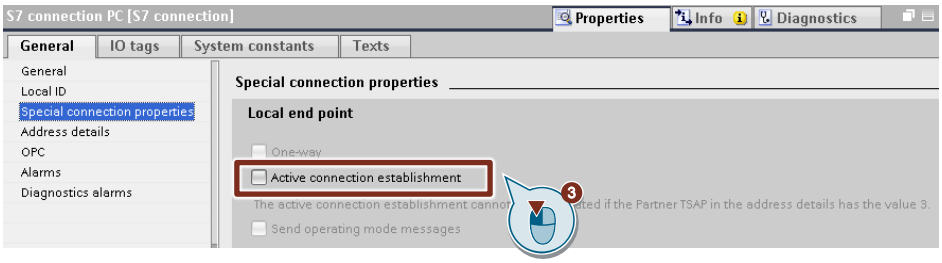
Note If the connection parameters are not yet fully set up, the S7 connection will be shown with errors in the connection table.

Setting connection parameters:

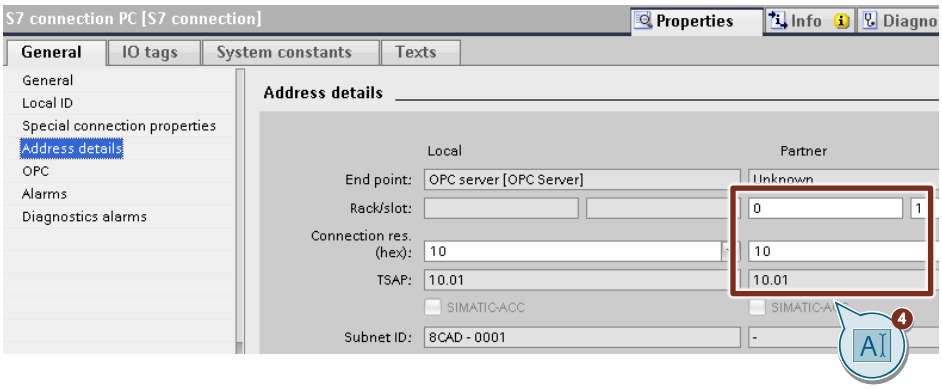
1. Select the S7 connection in the connection table.
   The properties of the S7 connection are displayed in the Inspector window.
2. In the "General" tab under "General", enter the IP address of the communication partner, e.g. 192.168.178.35 (IP address of the S7 CPU).



3. In the "General" tab under "Special connection properties", disable the function "Active connection establishment", as the PC station is a passive participant when the connection is established.

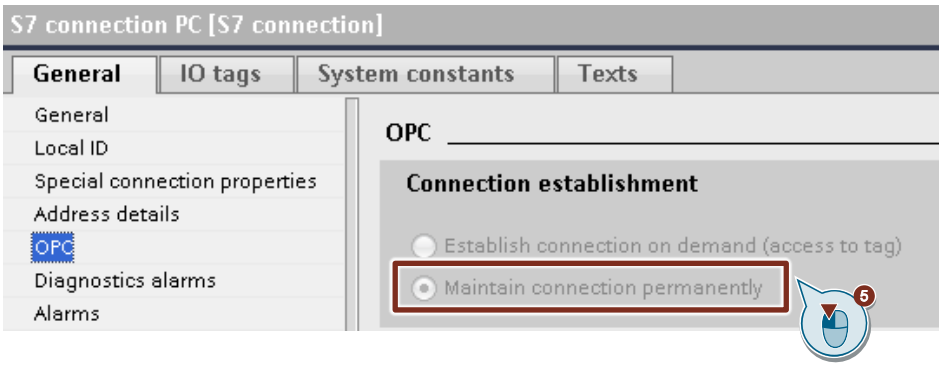


4. In the "General" tab under "Address details", define the partner TSAP.
   The partner TSAP is composed as follows:
   - "Connection res. (hex)", e.g. 10.
   - CPU slot, e.g.:
     S7-1500 CPU / S7-1200 CPU: 1
     S7-300 CPU: 2
     S7-400 CPU: 3



Note
For partner TSAP, use the local TSAP of the S7 CPU.
When configuring the connection in the S7 CPU, enter the local TSAP of the SIMATIC NET OPC server as partner TSAP.

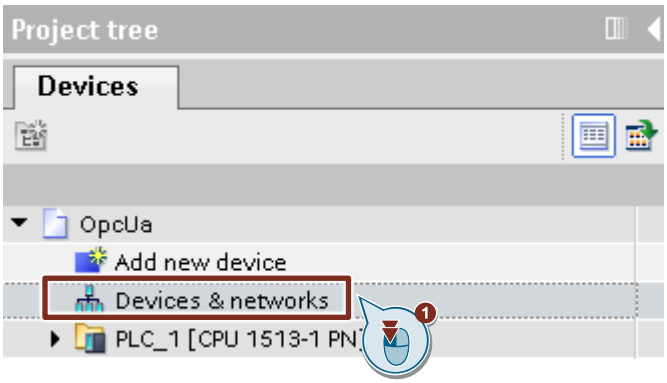
5. In the "General" tab under "OPC", the function "Maintain connection permanently" is enabled.



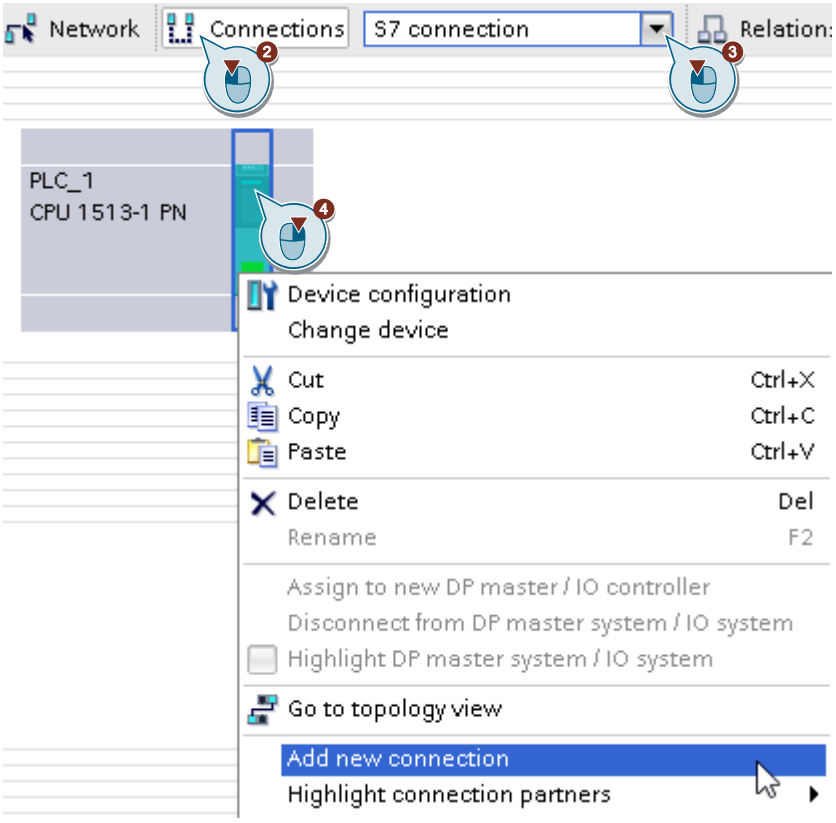
Add S7 connection in the S7 CPU

1. Double-click "Devices & networks" in the "Project tree".

Figure 2-10



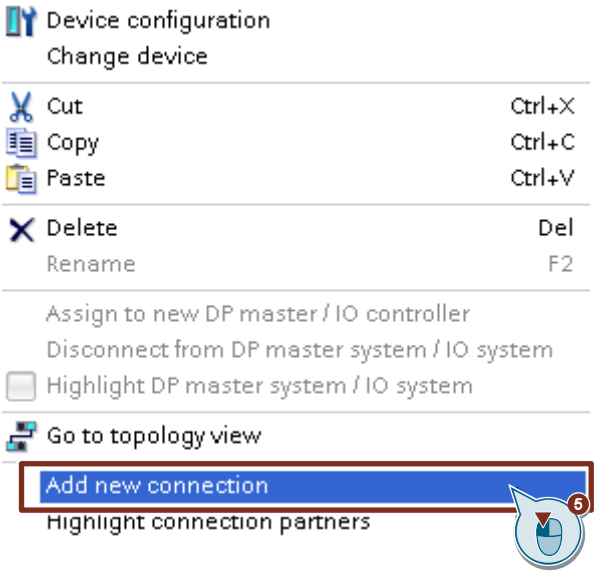
The graphical area of the "Network view" opens in the hardware and network editor.



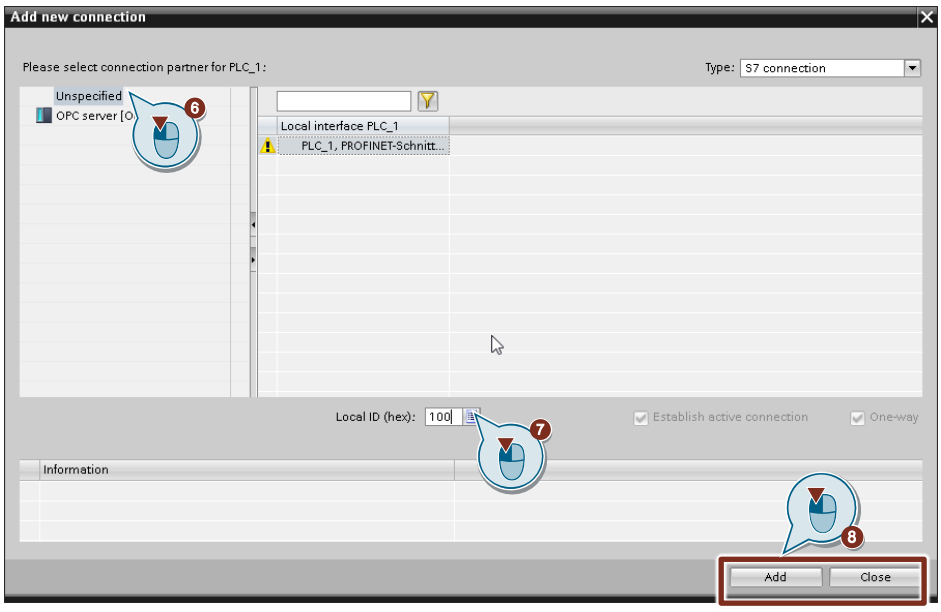
2. In the function bar, click "Connections" to enable the connection mode.
3. Select the connection type "S7 connection" in the nearby dropdown menu.
   All devices that are relevant to an S7 connection are highlighted in color in the "Network view".
4. Right-click on the S7 CPU.
   The context menu opens.

5. Select "Add new connection".

Figure 2-11



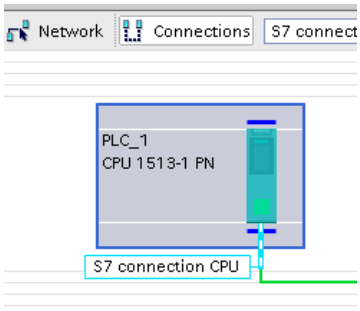
The "Add new connection" dialog will open.



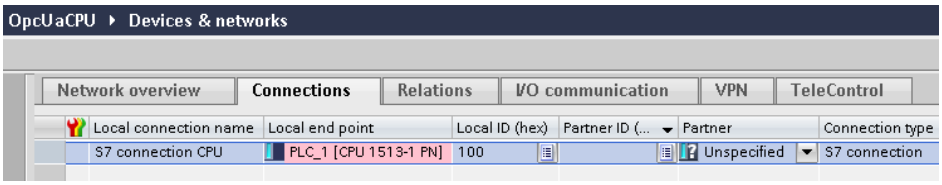
6. Specify the following connection parameters: "Unspecified".
7. Select the local ID for the S7 connection, e.g. 100 (hex).
   You will specify the local ID later at the "ID" input parameter for the instructions "PUT" and "GET".
8. Click "Add" to add the unspecified S7 connection; click the "Close" button to close the dialog.

Result:
An unspecified S7 connection is created.

- The connection path is highlighted.



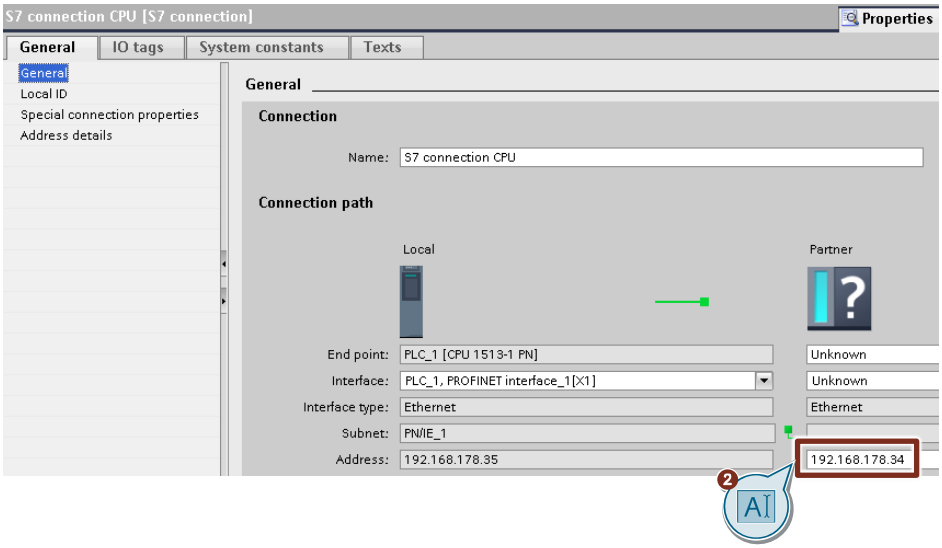
- The S7 connection is entered in the connection table.



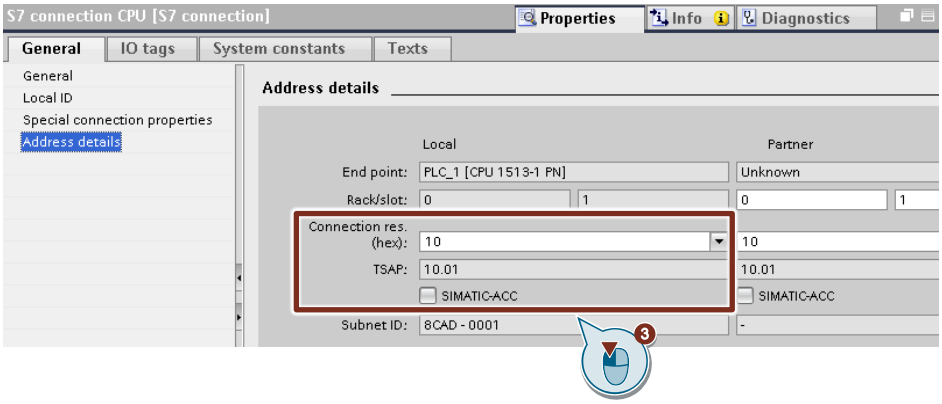
Note If the connection parameters are not yet fully set up, the S7 connection will be shown with errors in the connection table.

Setting connection parameters:

1. Select the S7 connection in the connection table.
   The properties of the S7 connection are displayed in the Inspector window.
2. In the "General" tab under "General", enter the IP address of the communication partner, e.g. 192.168.178.34 (IP address of the PC station).

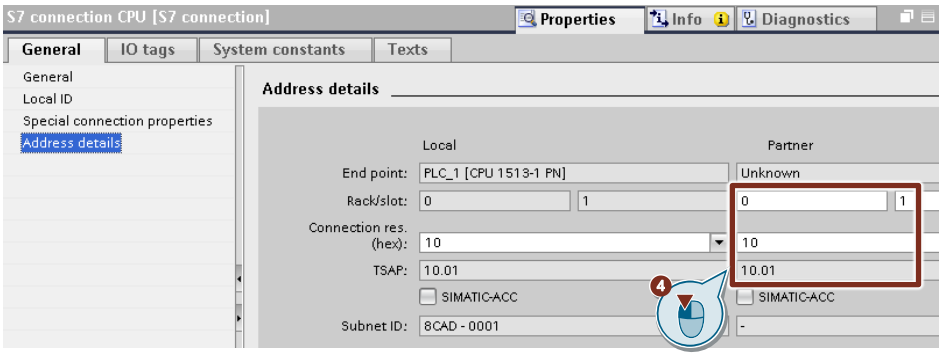


3. In the "General" tab under "Address details", disable the option "SIMATIC-ACC" and select the local connection resource, e.g. 10.



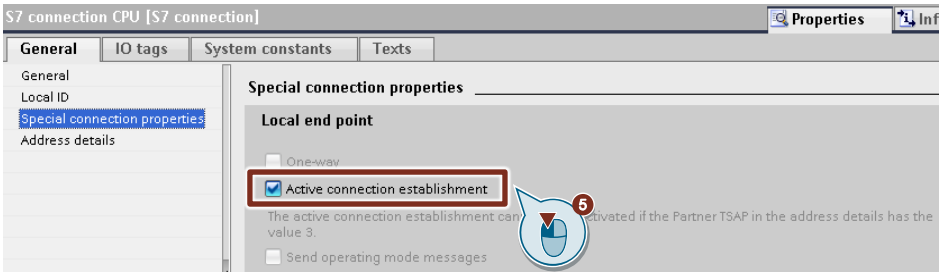
Note
When configuring the connection in the PC station, enter the local TSAP of the S7 CPU as partner TSAP.

4. In the "General" tab under "Address details", enter the partner TSAP.

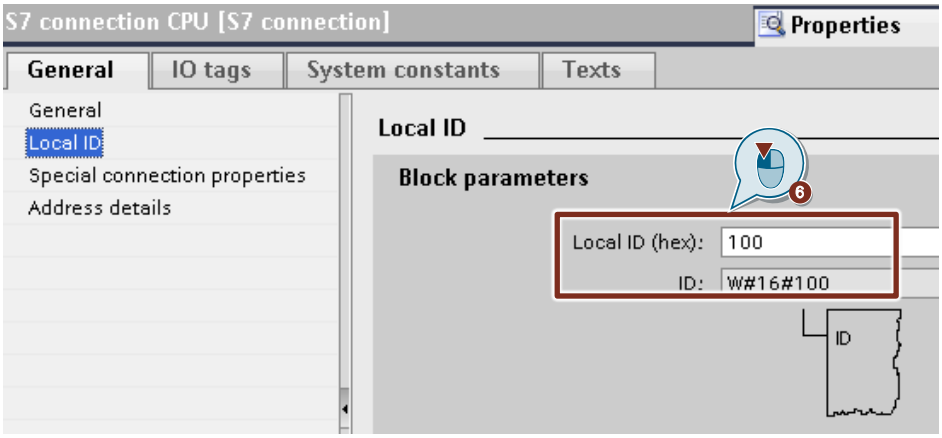


Note
For partner TSAP, use the local TSAP of the SIMATIC NET OPC server.

5. In the "General" tab under "Special connection properties", enable the function "Active connection establishment" so that the S7 CPU will actively establish the connection.



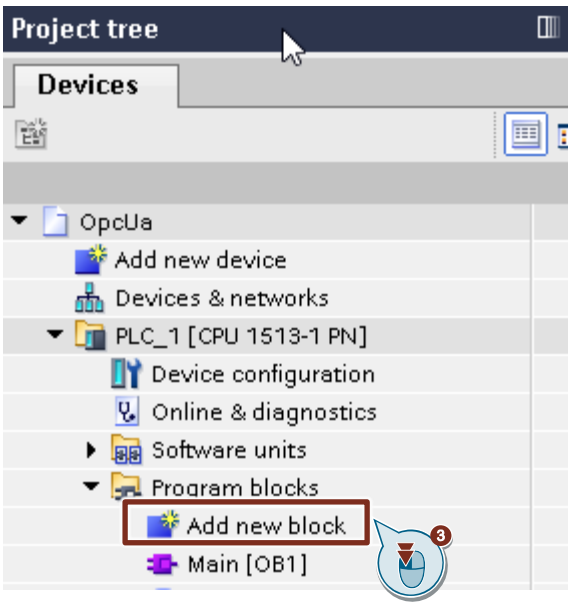
6. The local ID of the S7 connection can be modified in the "General" tab under "Local ID".
You will specify the local ID later at the "ID" input parameter for the instructions "PUT" and "GET".



2.5.4 Creating tags for the parameters of the instructions "PUT" and "GET"

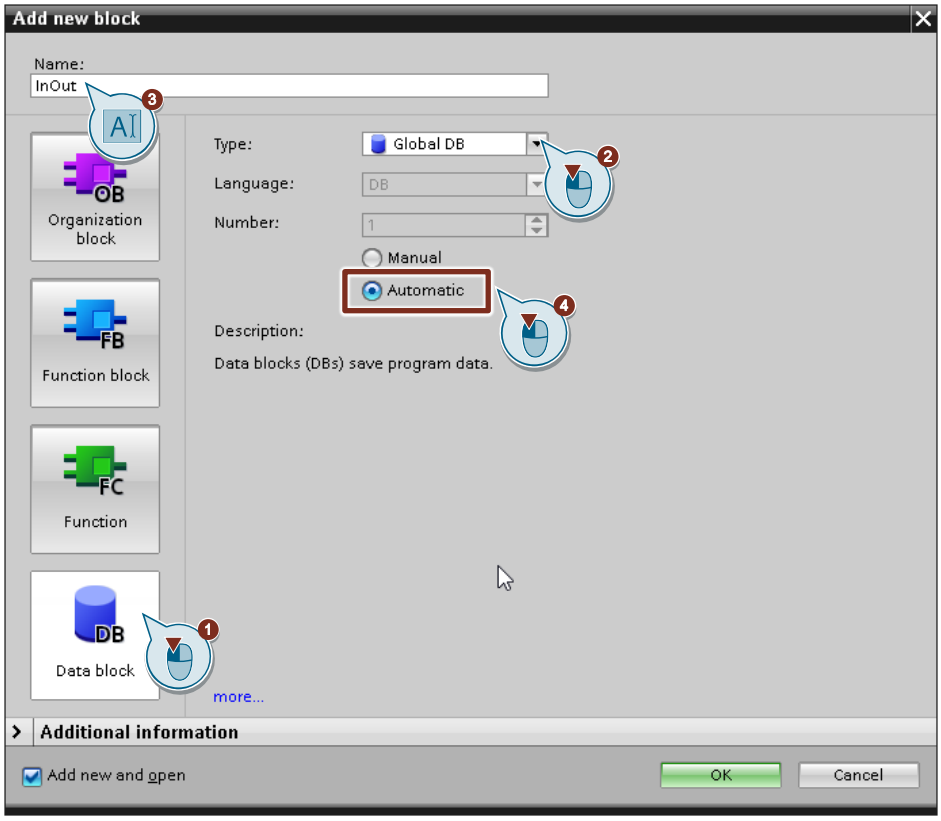
Insert a data block (DB) with the following tags in order to enter parameters for the instructions "PUT" and "GET".

1. Navigate in the "Project tree" to the device folder of the S7 CPU.
2. Open the "Program blocks" folder.
3. Double-click the "Add new block" command.



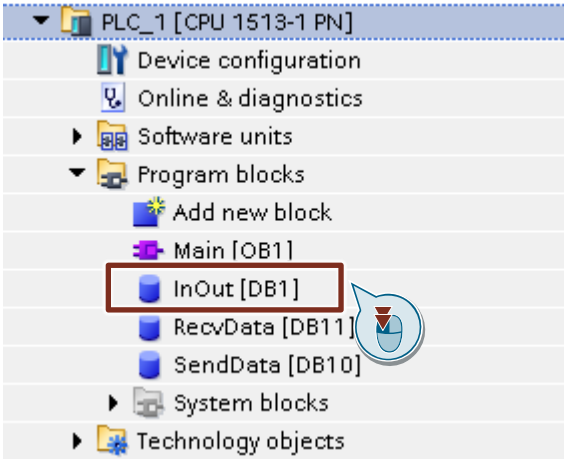
The dialog "Add new block" opens.

4. Make the following settings and then confirm your entries with the "OK" button.



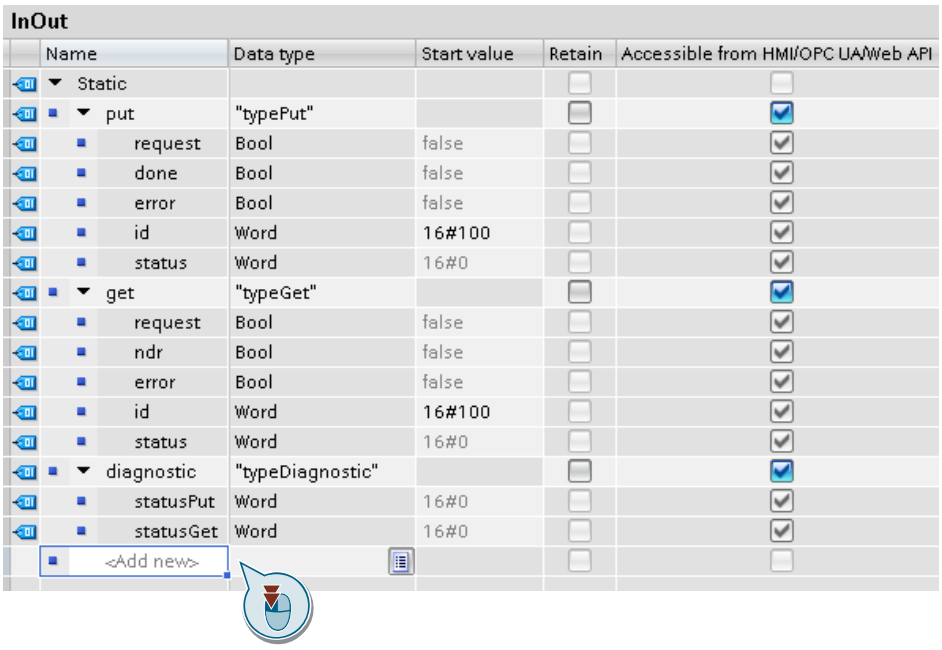
- Click the "Data block" button.
- Select the "Global DB" type.
- Enter the name of the DB, e.g. "InOut".
- Activate the "Automatic" radio button for automatic number assignment. The number of the global DB is assigned by TIA Portal.

5. Double-click the newly inserted global DB "InOut".



The data block opens.

6. Double-click "<Add new>" to create tags.



7. Create the following tags to populate the input/output parameters of the "PUT" and "GET" instructions. The following PLC data types are used.

Table 2-1

Tag	PLC data type	Description
put	typePut	Tags for parameter entry of the "PUT" instruction
get	typeGet	Tags for parameter entry of the "GET" instruction
diagnostic	typeDiagnostic	Tags to save the status of the "PUT" and "GET" instructions in the event of an error.

PLC data type "typePut"

The following table shows the structure of the "typePut" PLC data type.

Table 2-2

Parameter	Data type	Start value	Description
request	Bool	false	Control parameter for the "PUT" instruction
done	Bool	false	State parameter
error	Bool	false	State parameter
id	Word	16#0	Addressing parameter to specify the connection to the communication partner.
status	Word	false	State parameter

PLC data type "typeGet"

The following table shows the structure of the "typeGet" PLC data type.

Table 2-3

Parameter	Data type	Start value	Description
request	Bool	false	Control parameter for the "GET" instruction
done	Bool	false	State parameter
error	Bool	false	State parameter
id	Word	16#0	Addressing parameter to specify the connection to the communication partner.
status	Word	false	State parameter

PLC data type "typeDiagnostic"

The following table shows the structure of the "typeDiagnostic" PLC data type.

Table 2-4

Parameter	Data type	Start value	Description
statusPut	Word	16#0	Parameter to save the status of the "PUT" instruction in the event of an error.
statusGet	Word	16#0	Parameter to save the status of the "GET" instruction in the event of an error.

2.5.5 Create send/receive data range

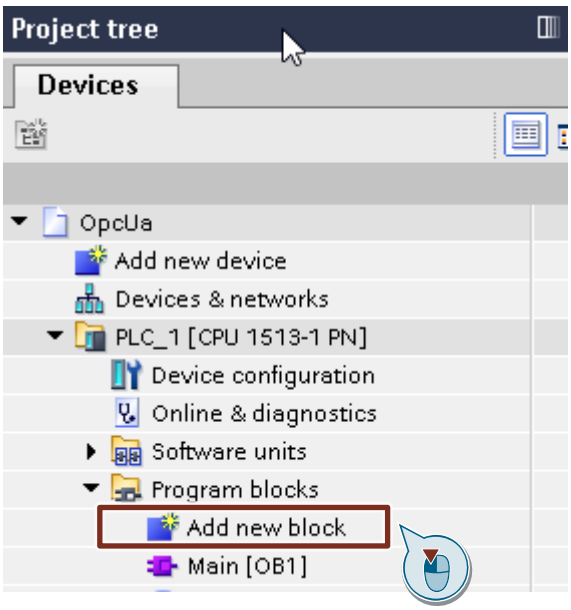
Overview

The following tags are created in the S7 CPU.

- Data block (DB) with standard access in order to save the data (receive data area) that are read from the PC station
- Data block (DB) with standard access in which the data written to the PC station are saved (send data area)

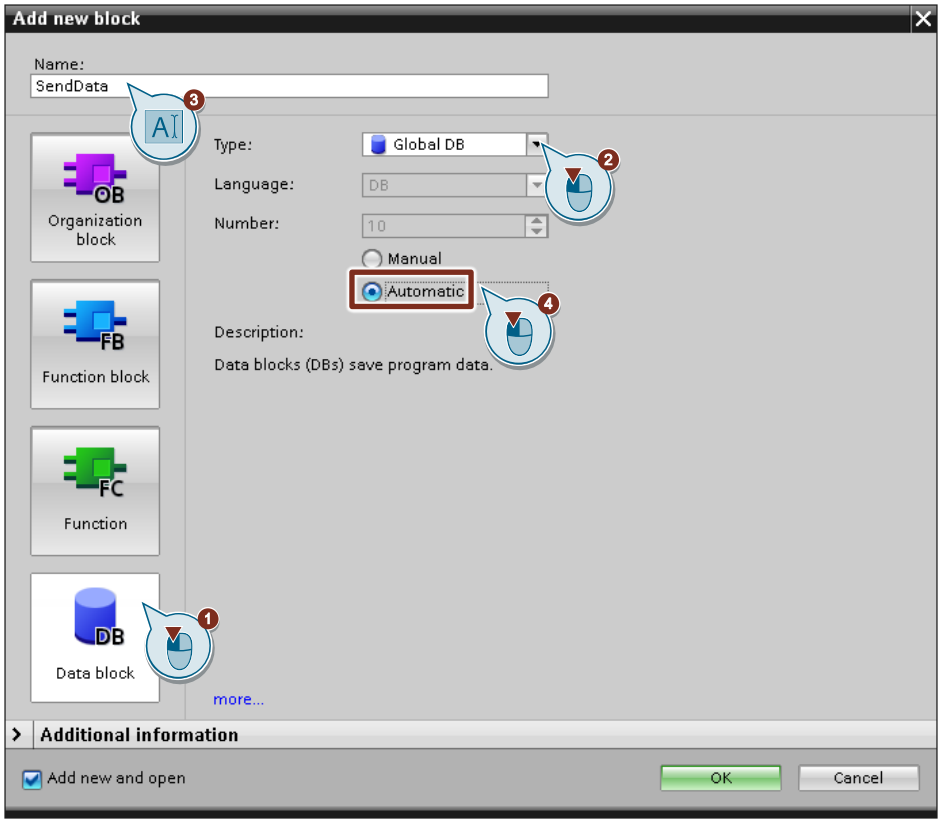
Add data block (DB) with standard access for send data

1. Navigate in the "Project tree" to the device folder of the S7 CPU.
2. Open the "Program blocks" folder.
3. Double-click the "Add new block" command.



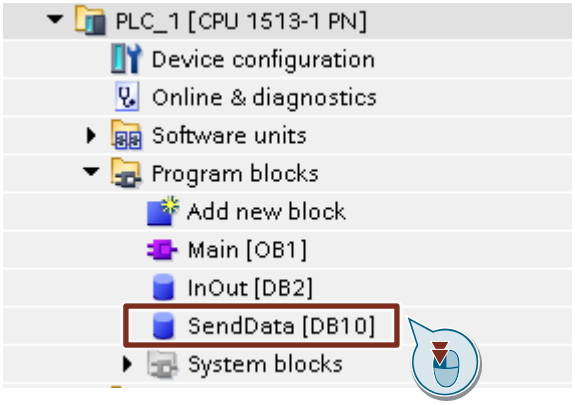
The dialog "Add new block" opens.

4. Make the following settings and then confirm your entries with the "OK" button.



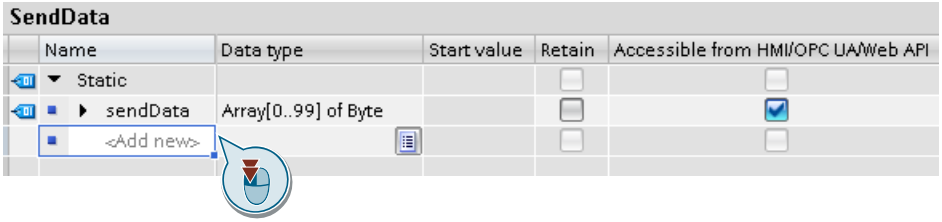
- Click the "Data block" button.
- Select the "Global DB" type.
- Enter the name of the DB, e.g. "SendData".
- Activate the "Automatic" radio button for automatic number assignment. The number of the global DB is assigned by TIA Portal.

5. Double-click the newly inserted global DB "SendData".



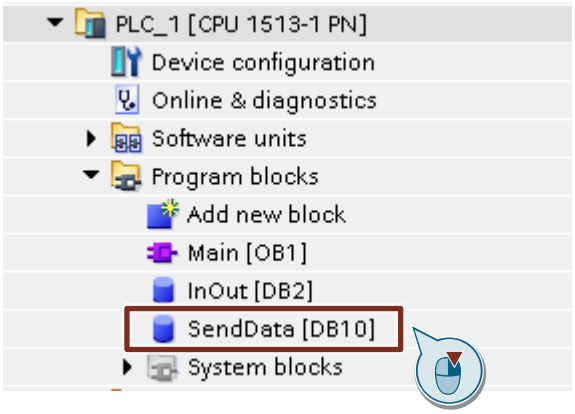
The data block opens.

6. Double-click "<Add new>" to create tags.



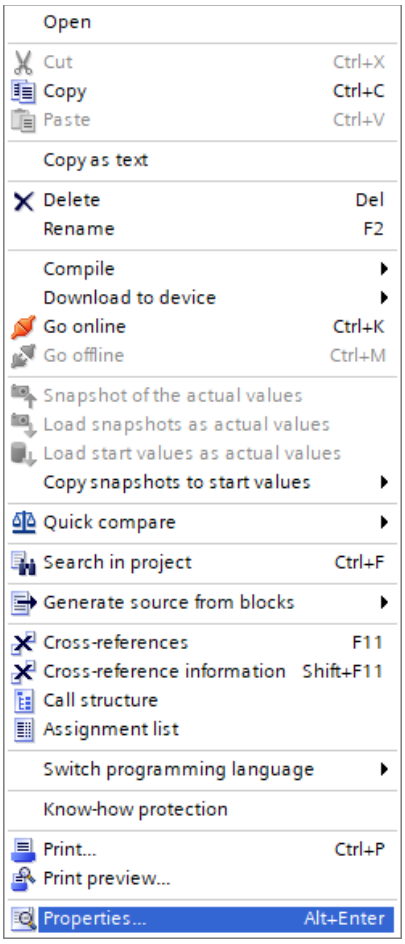
7. Create a tag of data type "Array".
An "Array" is a data structure which consists of a fixed number of components of the same data type. This application example uses the data type "Byte" for the components.

8. In the "Project tree", right-click the newly inserted global DB "SendData".



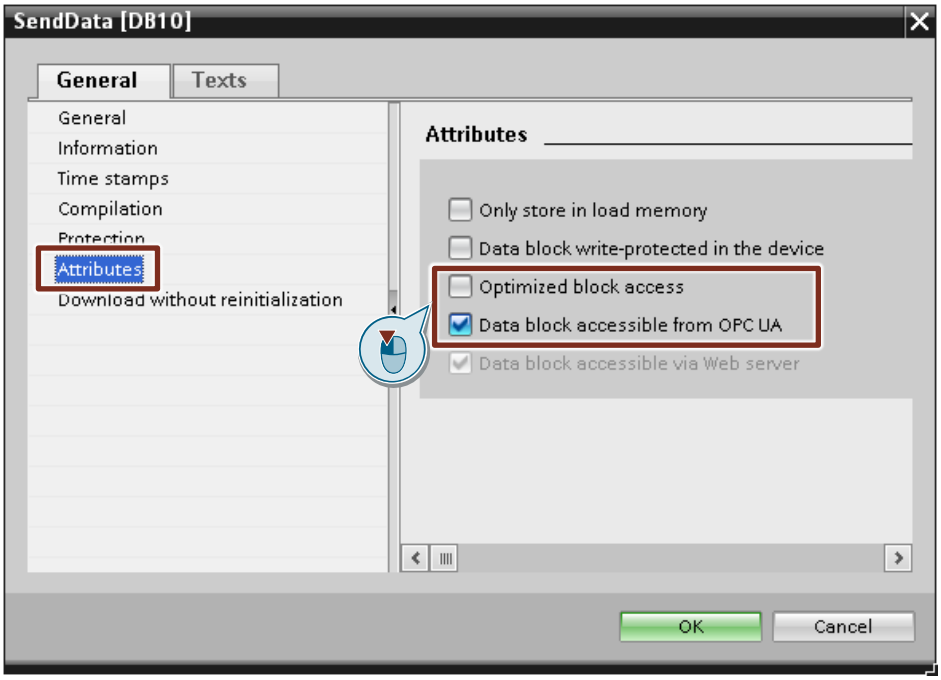
The context menu opens.

9. Select "Properties".



The Properties dialog for the DB will open.

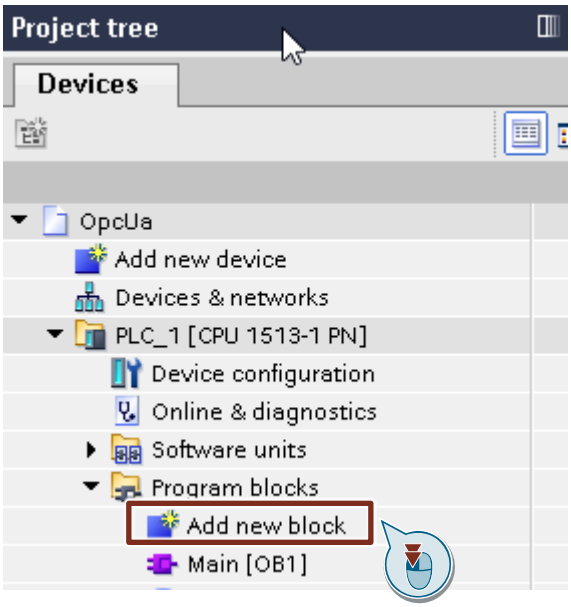
10. Make the following settings in the "General" tab under "Attributes" and then apply the settings by clicking "OK".



- Disable the function "Optimized block access".
- Enable the function "Data block accessible from OPC UA".

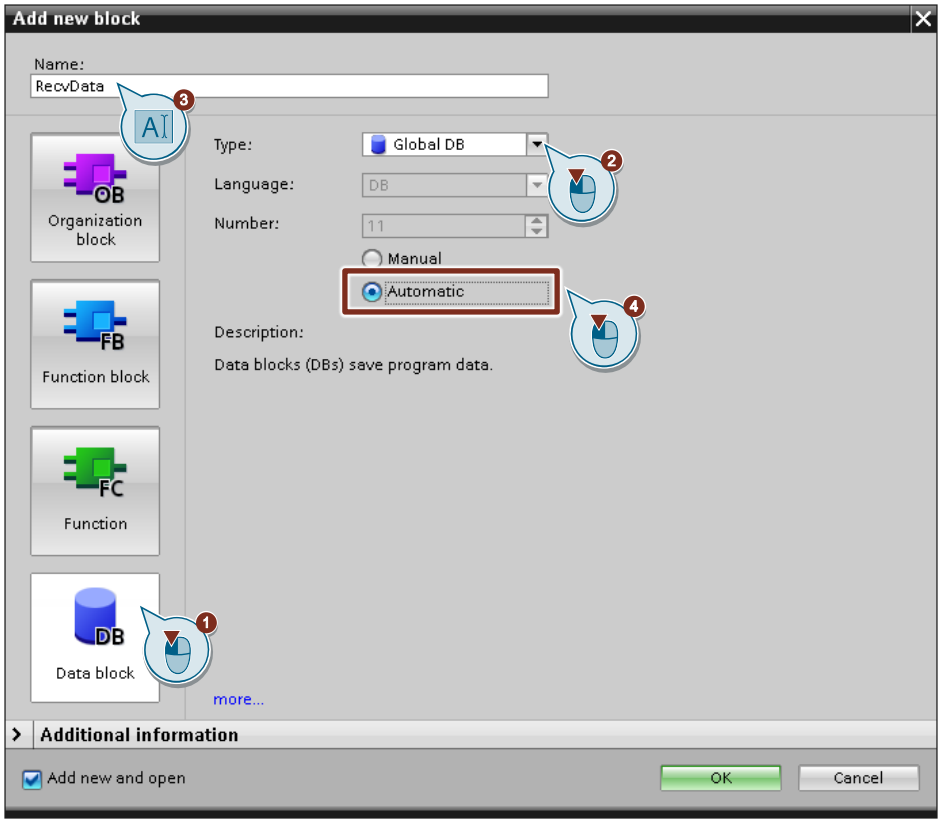
Add data block (DB) with standard access for receive data

1. Navigate in the "Project tree" to the device folder of the S7 CPU.
2. Open the "Program blocks" folder.
3. Double-click the "Add new block" command.



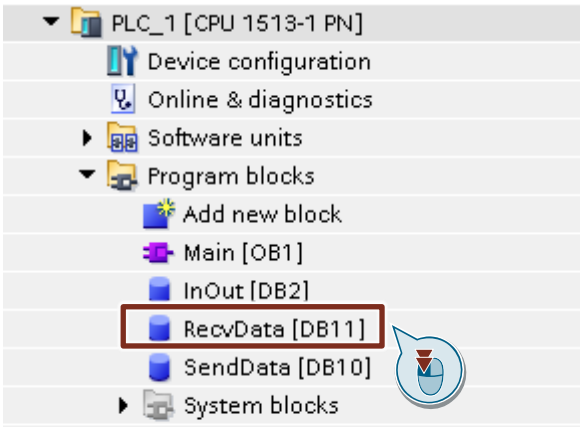
The dialog "Add new block" opens.

4. Make the following settings and then confirm your entries with "OK".



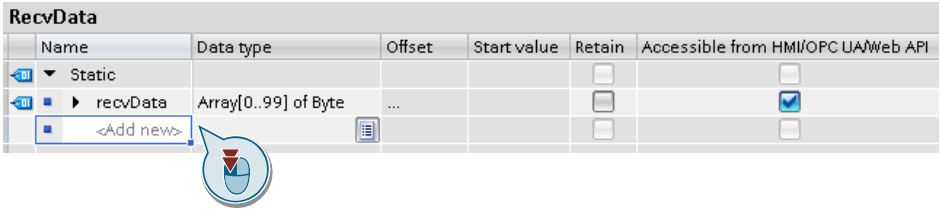
- Click the "Data block" button.
- Select the "Global DB" type.
- Enter the name of the DB, e.g. "RecvData".
- Activate the "Automatic" radio button for automatic number assignment. The number of the global DB is assigned by TIA Portal.

5. Double-click the newly inserted global DB "RecvData".

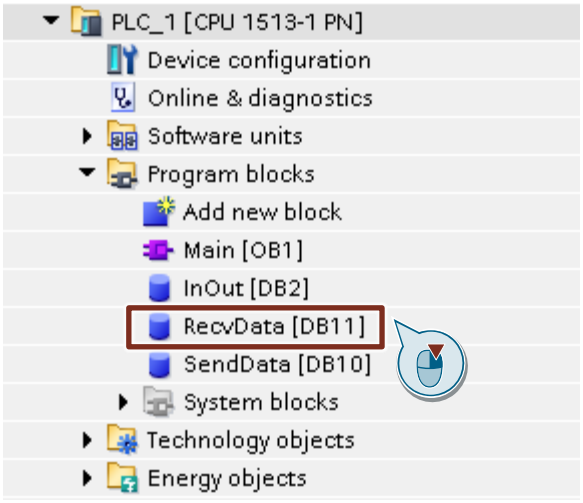


The data block opens.

6. Double-click "<Add new>" to create tags.

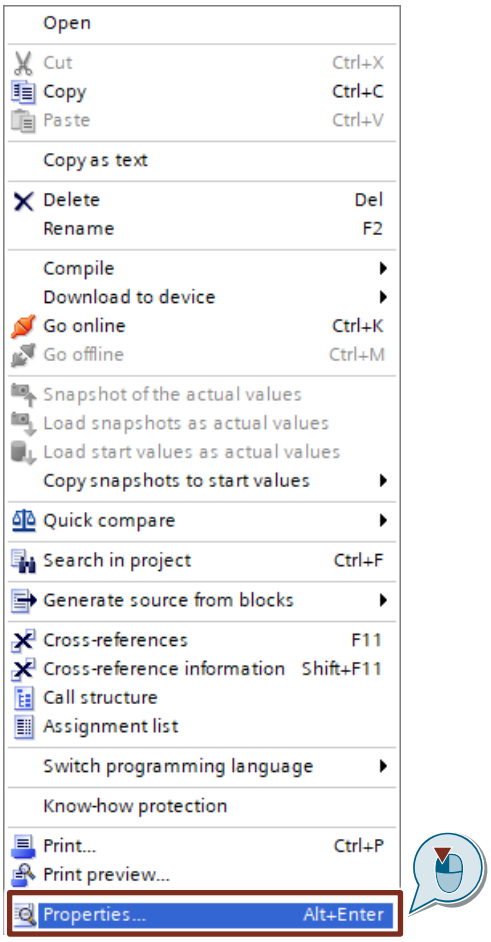


7. Create a tag of data type "Array".
   An "Array" is a data structure which consists of a fixed number of components of the same data type. This application example uses the data type "Byte" for the components.
8. In the "Project tree", right-click the newly inserted global DB "RecvData".



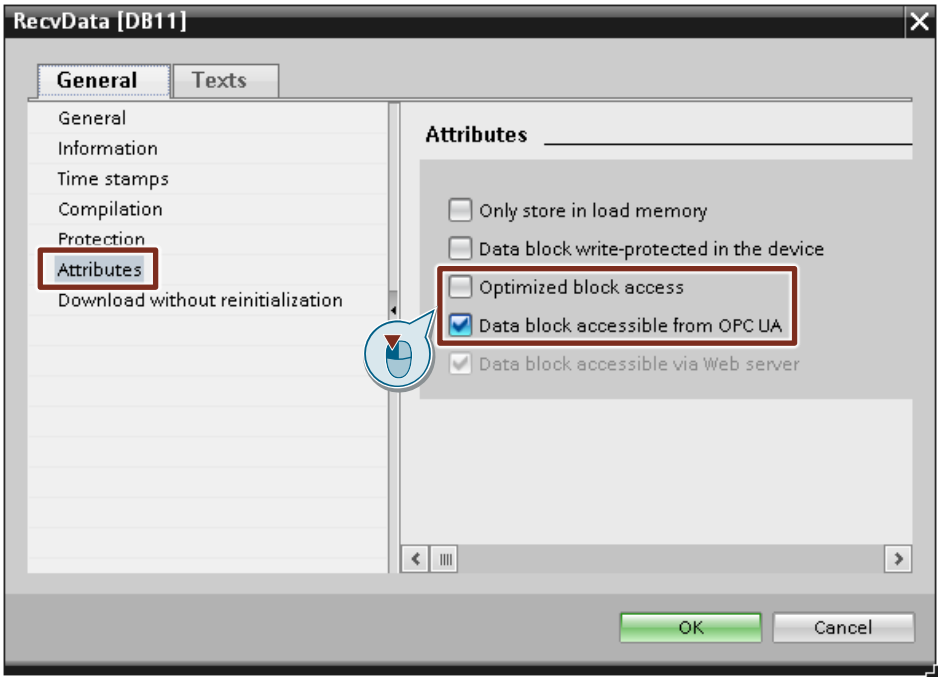
The context menu opens.

9. Select "Properties".



The Properties dialog for the DB will open.

10. Make the following settings in the "General" tab under "Attributes" and then apply the settings by clicking "OK".

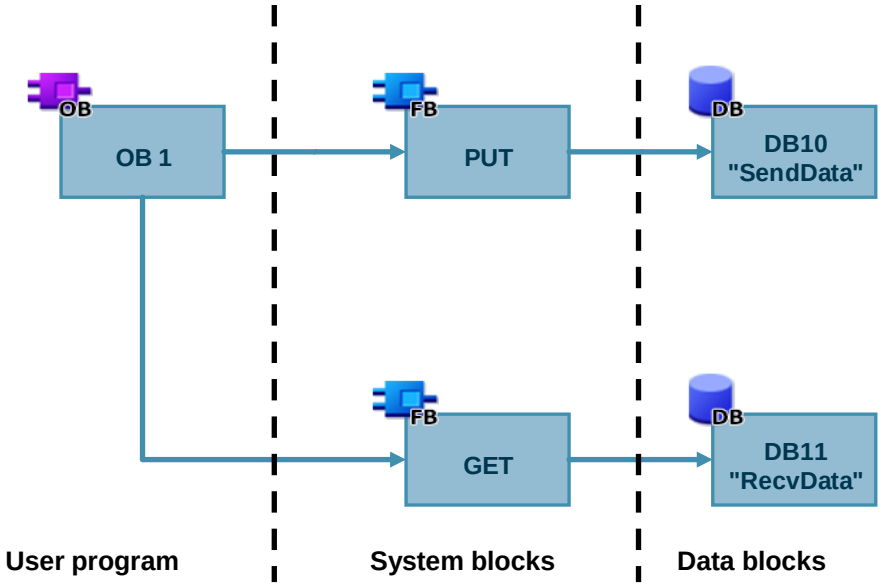


- Disable the function "Optimized block access".
- Enable the function "Data block accessible from OPC UA".

2.5.6 User program of the S7-CPU

The following figure shows an overview of the user program in the S7 CPU.

Figure 2-12

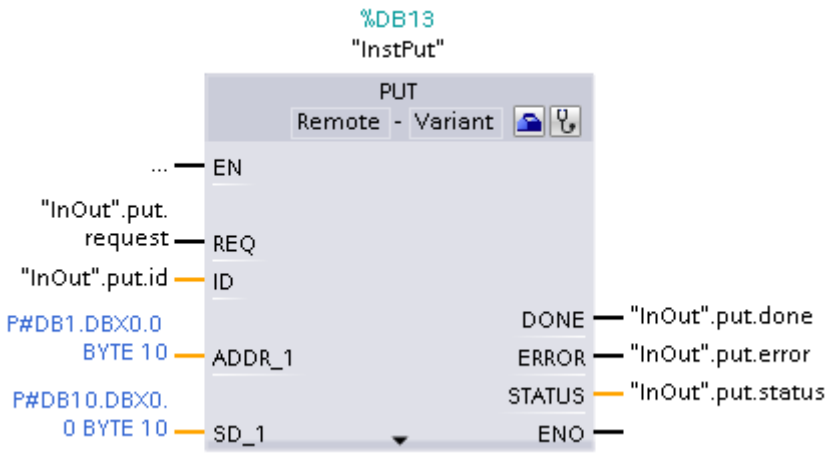


Parameter assignment for "PUT"

In order to receive data to the S7 data block DB1 in the PC station, call the "PUT" instruction in the user program of the S7 CPU, e.g. in OB 1.

The following figure illustrates the call of the instruction "PUT" in OB 1.

Figure 2-13



The following table shows the parameters of the instruction "PUT".

Table 2-5

Parameter	Declaration	Data type	Start value	Description
REQ	Input	Bool	false	Control parameters: Enables data exchange at rising edge
ID	Input	Word	16#100	Addressing parameter to specify the connection to the communication partner (S7 OPC UA server).
ADDR_1	InOut	Remote	P#DB1.DBX0.0 byte 10	Pointer to the range in the communication partner that should be written to. Because the remote pointer accesses the S7 data block DB1 in the PC station, DB1 must be specified.
SD_1	InOut	Remote	P#DB10.DBX0.0 byte 10	Pointer to the range in the CPU containing the data to be sent.
DONE	Output	Bool	false	Additional parameters: • 0: The request has not yet been started or is still being executed. • 1: Job completed with no errors.
ERROR	Output	Bool	false	Additional parameters: • 0: There is neither a warning nor an error. • 1: There is an error. The "STATUS" parameter provides detailed information on the type of error.
STATUS	Output	Word	16#0	State parameter Detailed information is available in the manual SIMATIC STEP 7 Basic/Professional V16 and SIMATIC WinCC V16 or in the TIA Portal Online Help.

Fill the parameters of the "PUT" instruction with the tags created in chapter 2.5.4.

The following table lists the assignment of the parameters of the "put" tags to the parameters of the "PUT" instruction.

Table 2-6

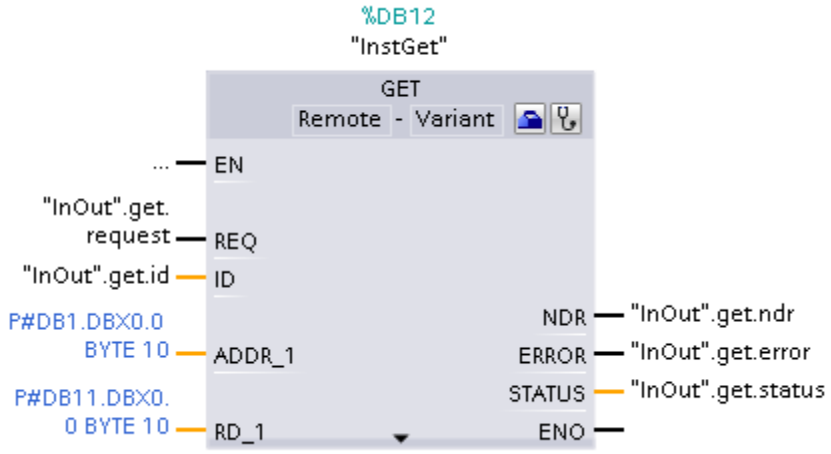
Parameters, "PUT" instruction	Parameters of the "get" tags	Start value	Note
REQ	request	false	Set the "request" parameter to "TRUE" in order to start a request to write data. The write request is started at a rising edge. Reset the "request" parameter to "FALSE" if the write request was completed with "DONE" = "1" or "ERROR" = "1" in order to be able to start a new write request.
ID	id	16#100	Enter the local ID of the connection that you defined when configuring the connection.
ADDR_1	–	P#DB1.DBX0.0 byte 10	Pointer to the range in the communication partner that should be written to. Because the remote pointer accesses the S7 data block DB1 in the PC station, DB1 must be specified.
SD_1	–	P#DB10.DBX0.0 byte 10	Pointer to the range in the CPU containing the data to be sent.
DONE	Bool	false	State parameter
ERROR	Bool	false	State parameter
STATUS	Word	false	State parameter

Parameter "GET"

In order to read data from S7 data block DB1 in the PC station, call the "GET" instruction in the user program of the S7 CPU, e.g. in OB 1.

The following figure illustrates the call of the instruction "GET" in OB 1.

Figure 2-14



The following table shows the parameters of the instruction "GET".

Table 2-7

Parameter	Declaration	Data type	Start value	Description
REQ	Input	Bool	false	Control parameters: Enables data exchange at rising edge
ID	Input	Word	16#100	Addressing parameter to specify the connection to the communication partner (S7 OPC UA server).
ADDR_1	InOut	Remote	P#DB1.DBX0.0 byte 10	Pointer to the range in the communication partner that should be read. Because the remote pointer accesses the S7 data block DB1 in the PC station, DB1 must be specified.
SD_1	InOut	Remote	P#DB10.DBX0.0 byte 10	Pointer to the range in the CPU in which the data that are read will be stored.
NDR	Output	Bool	false	Additional parameters: • 0: The request has not yet been started or is still being executed. • 1: Job completed with no errors.

Parameter	Declaration	Data type	Start value	Description
ERROR	Output	Bool	false	Additional parameters: • 0: There is neither a warning nor an error. • 1: There is an error. The "STATUS" parameter provides detailed information on the type of error.
STATUS	Output	Word	16#0	State parameter Detailed information is available in the manual SIMATIC STEP 7 Basic/Professional V16 and SIMATIC WinCC V16 or in the TIA Portal Online Help.

Fill the parameters of the "GET" instruction with the tags created in chapter 2.5.4.

The following table lists the assignment of the parameters of the "get" tags to the parameters of the "GET" instruction.

Table 2-8

Parameters, "GET" instruction	Parameters of the "get" tags	Start value	Note
REQ	request	false	Set the "request" parameter to "TRUE" in order to start a request to read data. The read request is started at a rising edge. Reset the "request" parameter to "FALSE" if the read request was completed with "NDR" = "1" or "ERROR" = "1" in order to be able to start a new read request.
ID	id	16#100	Enter the local ID of the connection that you defined when configuring the connection.
ADDR_1	–	P#DB1.DBX0.0 byte 10	Pointer to the range in the communication partner that should be read. Because the remote pointer accesses the S7 data block DB1 in the PC station, DB1 must be specified.
SD_1	–	P#DB10.DBX0.0 byte 10	Pointer to the range in the CPU in which the data that are read will be stored.
DONE	Bool	false	State parameter
ERROR	Bool	false	State parameter
STATUS	Word	false	State parameter

2.6 Configuring the "Station Configuration Editor"

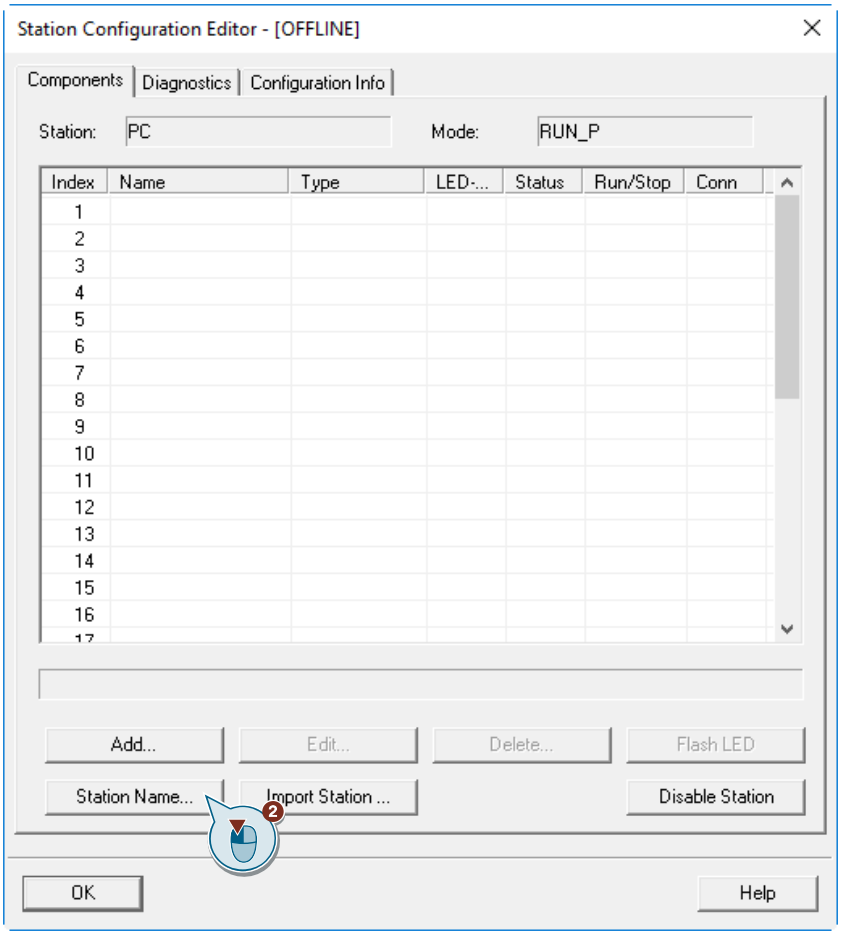
2.6.1 Manual configuration

Note

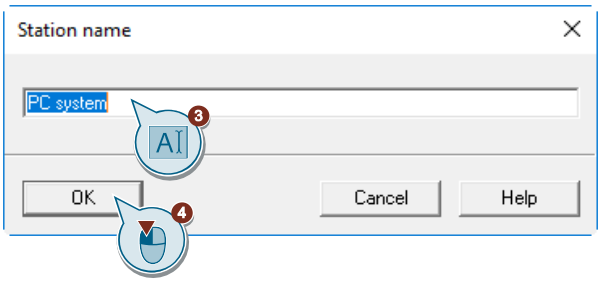
Insert the components in the same order as in the component image that you created in TIA Portal in the PC station "Device view". If the configuration differs from the list, the configuration data that you download from TIA Portal to the PC station will not be adopted correctly.

When configuring for the first time it is necessary to enter the station name.

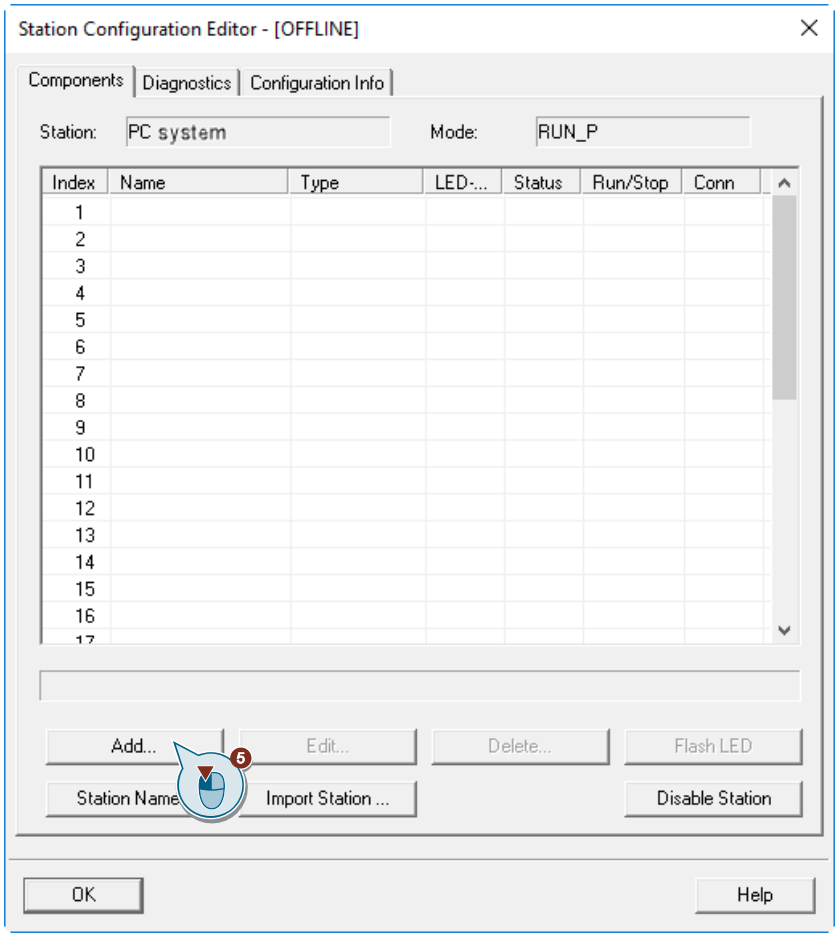
1. Double-click the corresponding icon on your desktop to start the "Station Configuration Editor".
2. Click the "Station Name" button.



The "Station name" dialog will open.

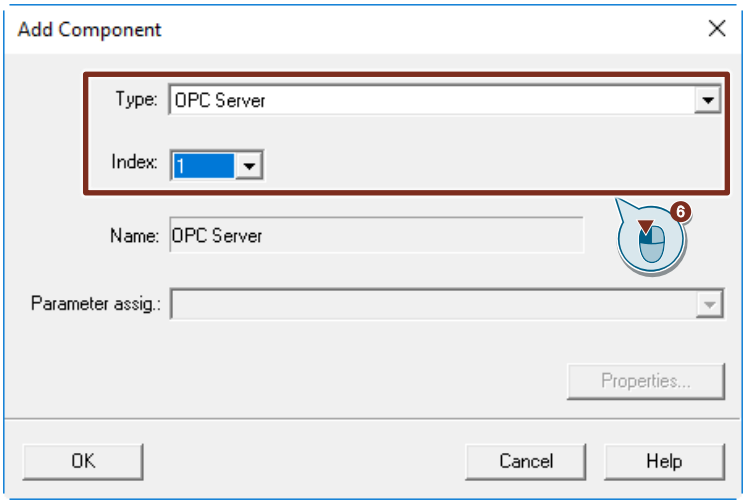


3. Enter the station name, e.g. "PC system".
   It is imperative that the name in the "Station Configuration Editor" matches the name that you assigned when configuring the PC station with TIA Portal.
4. Click "OK" to confirm the settings.
5. Click the "Add" button.

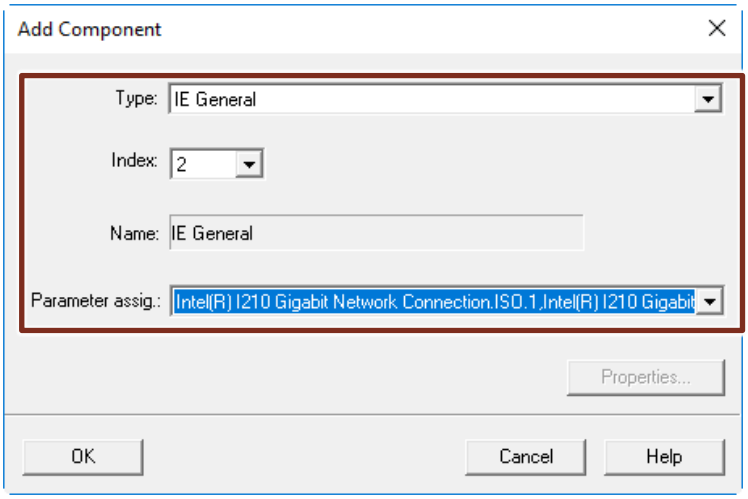


The "Add Component" dialog box opens.

6. Make the following settings in order to add the "OPC server" user application.
   - "Type": "OPC Server"
   - Index: 1



7. Make the following settings in order to add the "IE General" component.
   - "Type": "IE General"
   - Index: 2
   - "Parameter assig.":
     Select the network adapter via which the PC station is connected to communicates with the S7 CPU.

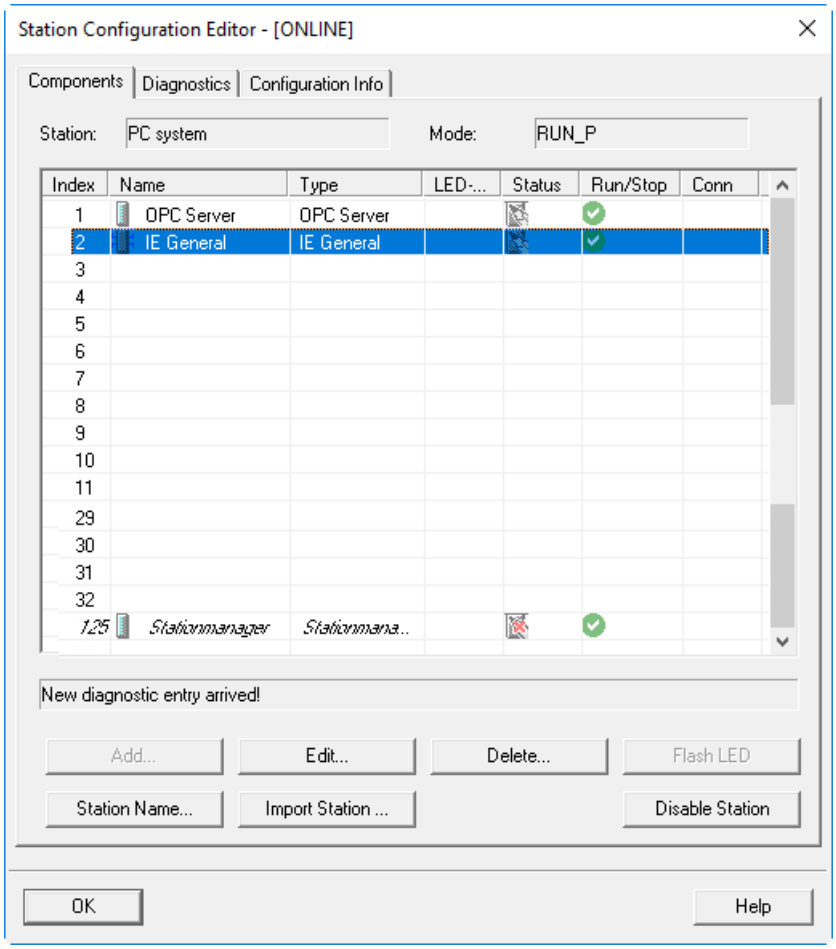


Result

The added components and the station name will be displayed in the "Station Configuration Editor":

- Station name: "PC system"
- Index 1: "OPC server"
- Index 2: "IE General"
- Index 125: "Stationmanager"
  "Stationmanager" will be automatically added at this index by the system.

Figure 2-15



The following status icons for the components show that the configuration data are not yet loaded:

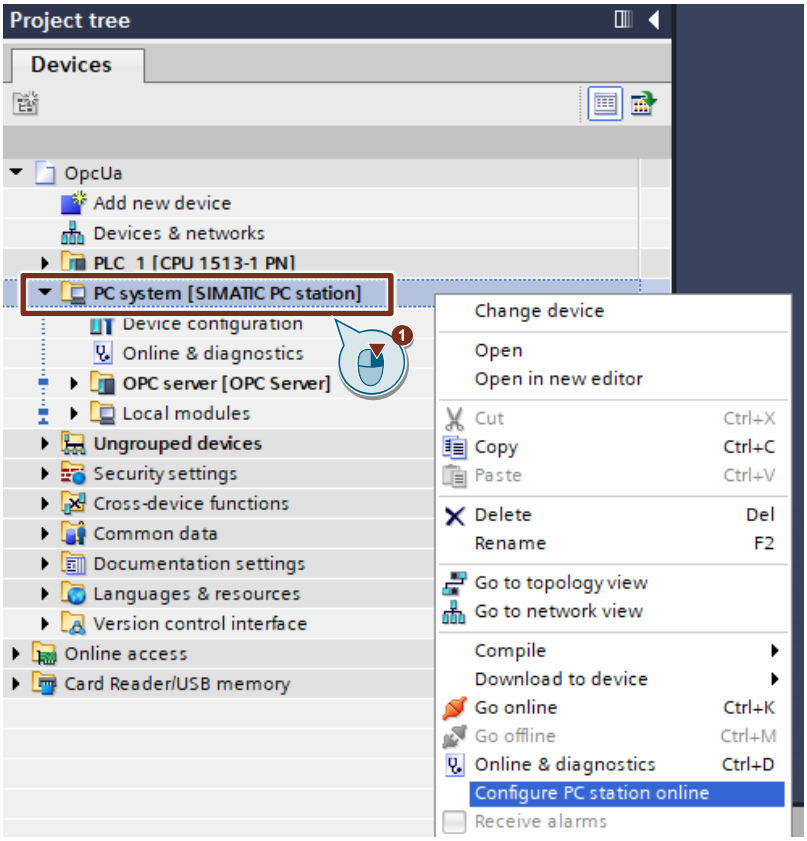
- The component is available in the current configuration of the PC station.
- The component has a configuration that is derived from a default parameter set. The default parameter set allows a component to be accessible via network without further configuration immediately after its installation. Make sure that the default parameter set you use has parameters that match the other network parameter settings.

- The component exists in the current configuration of the PC station but it was not created in the project engineering. Depending upon the intended application, the component must still be configured in STEP 7 and the configuration data must be loaded.

Once you have manually configured the "Station Configuration Editor", load the PC station's configuration data (see chapter 2.7.1).

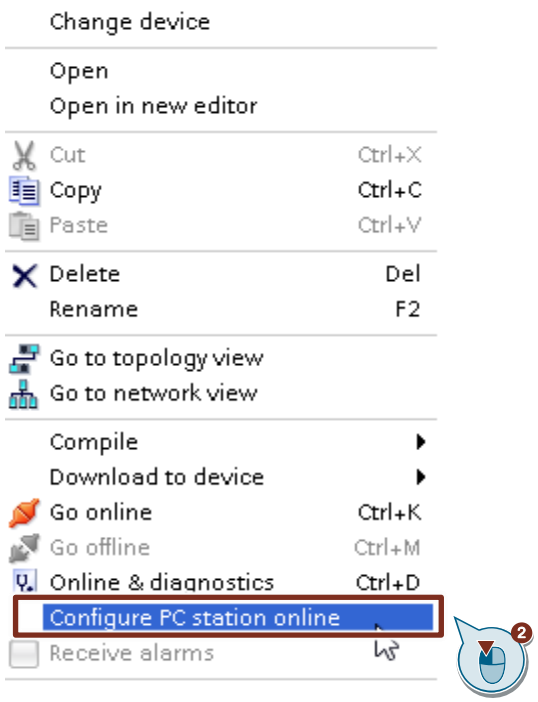
2.6.2 Configuring the "Station Configuration Editor" in TIA Portal

1. Right-click on the device folder of the PC station.

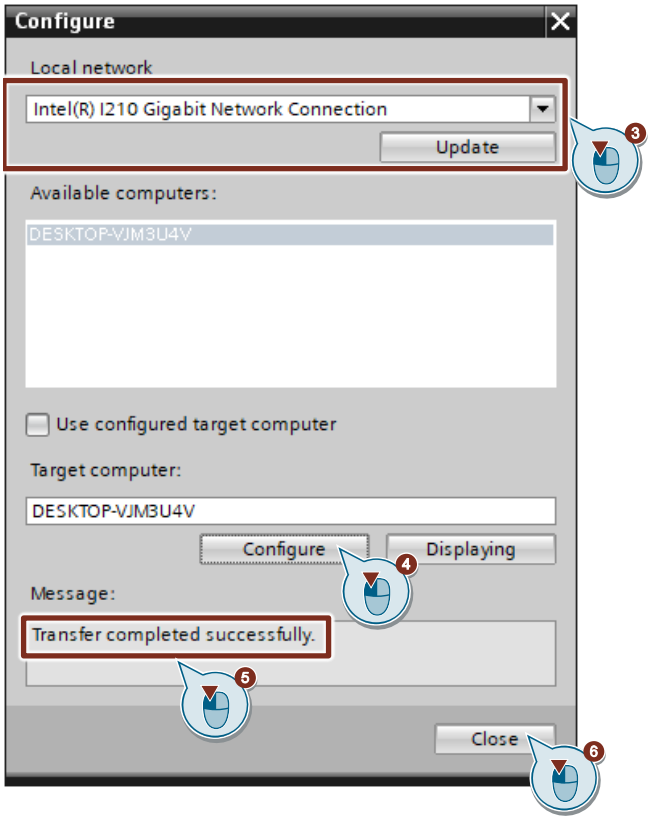


   The context menu opens.

2. Select "Configure PC station online".



The "Configure" dialog will open.



3. Select the network adapter via which the PC station communicates with the S7 CPU, then click "Update".
4. Click "Configure" in order to transfer the configuration of the PC station to the Station Configuration Editor.

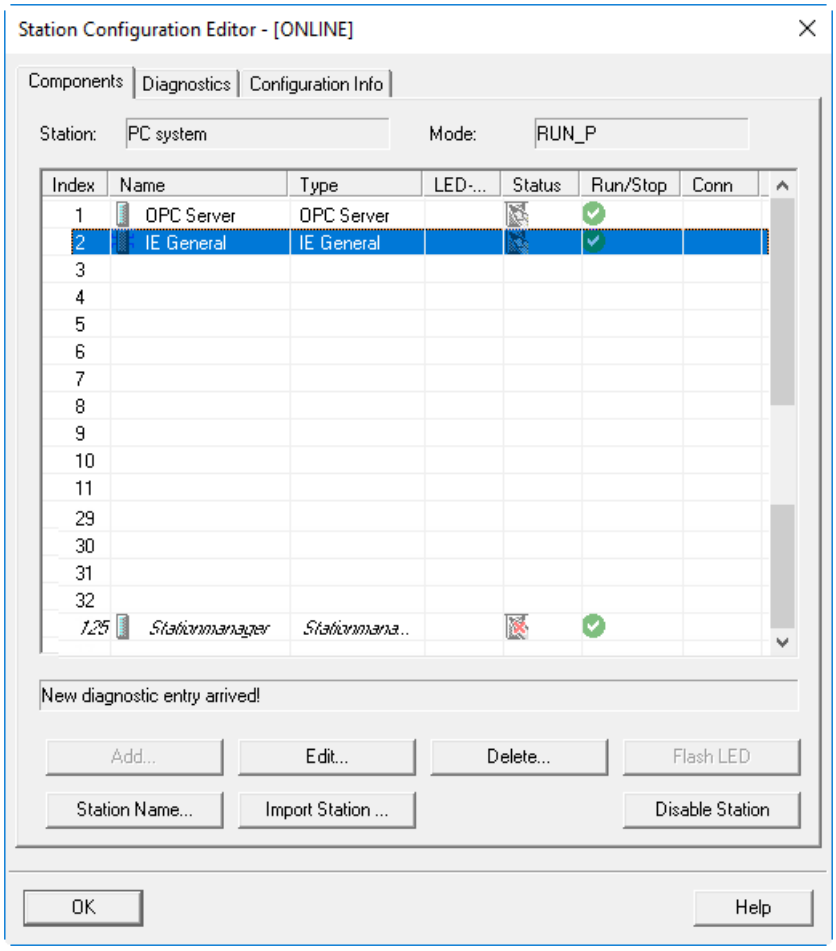
5. The message "Transfer completed successfully" will appear once the transfer has completed successfully.
6. Click "Close" to finish the dialog.

Result

In the "Station Configuration Editor", the components and the station name are created according to the configuration in TIA Portal:

- Station name: "PC system"
- Index 1: "OPC server"
- Index 2: "IE General"
- Index 125: "Stationmanager"
  "Stationmanager" will be automatically added at this index by the system.

Figure 2-16



The following status icons for the components show that the configuration data are not yet loaded:

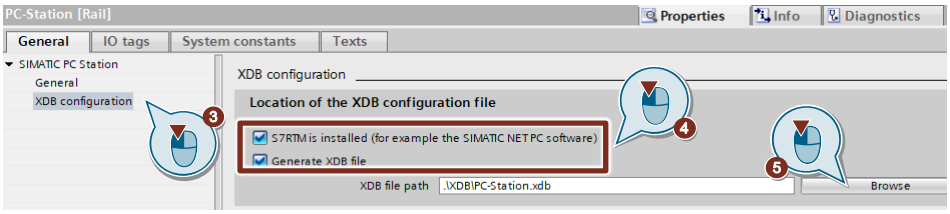
- The component is available in the current configuration of the PC station.
- The component has a configuration that is derived from a default parameter set. The default parameter set allows a component to be accessible via network without further configuration immediately after its installation. Make sure that the default parameter set you use has parameters that match the other network parameter settings.

- The component exists in the current configuration of the PC station, but it was not created in the project engineering. Depending upon the intended application, the component must still be configured in STEP 7 and the configuration data must be loaded.

Once you have configured the "Station Configuration Editor" in TIA Portal, load the PC station's configuration data (see chapter 2.7.1).

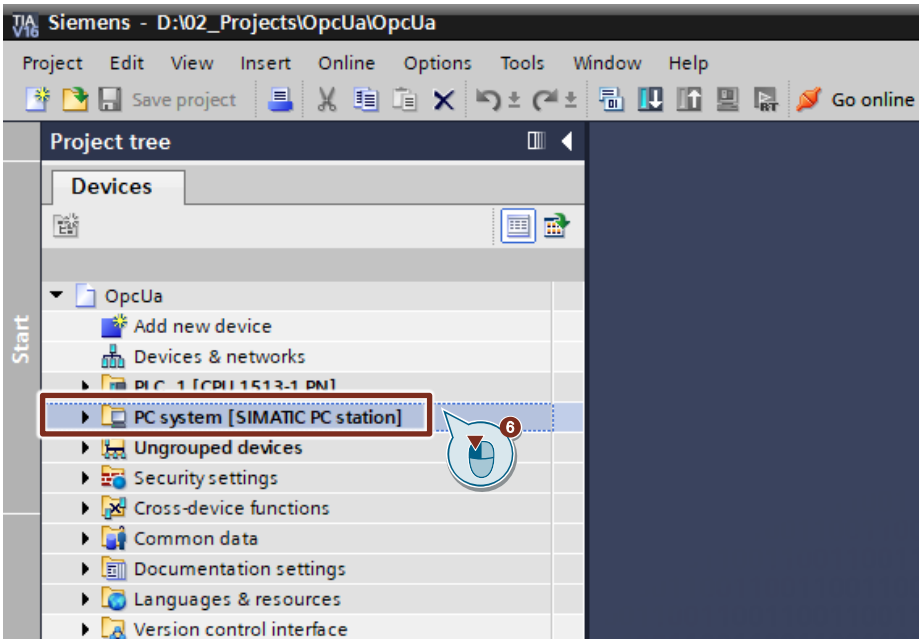
2.6.3 XDB export: Exporting XDB from TIA Portal

1. Open the "Device view" of the PC station.
2. Select the PC station.
   The Inspector window displays the properties of the PC station.

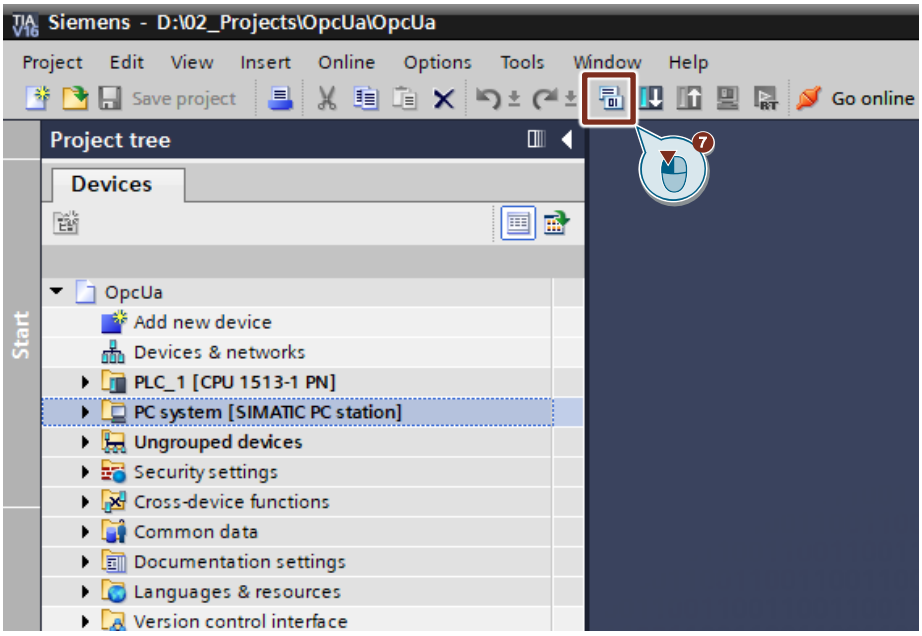


3. In the "General" tab, navigate to "XDB configuration".
4. Activate the following functions:
   - "S7RTM is installed (for example SIMATIC NET PC software)"
   - "Generate XDB file"
5. Click on the "Browse..." button to set the path where the XDB file will be stored.

6. Select the PC station in the "Project tree".



7. Click on the "Compile" button in the function bar.



Result

The XDB configuration file will be generated and saved in the directory that you set when configuring the PC station.

2.7 Loading configuration data

2.7.1 Load PC station configuration data

For productive operation, you require not only the component configuration but also the project engineering data for the communication connections and possibly also for the tag symbols. You can load the configuration data to the PC station in the following ways:

- Loading via TIA Portal in online mode
- XDB import: Importing XDB in the Station Configuration Editor

Loading via TIA Portal in online mode

The online mode allows you to download the configuration data directly to a PC station attached to the network, or to load the data to the local PC station if you are using this as the Engineering PC.

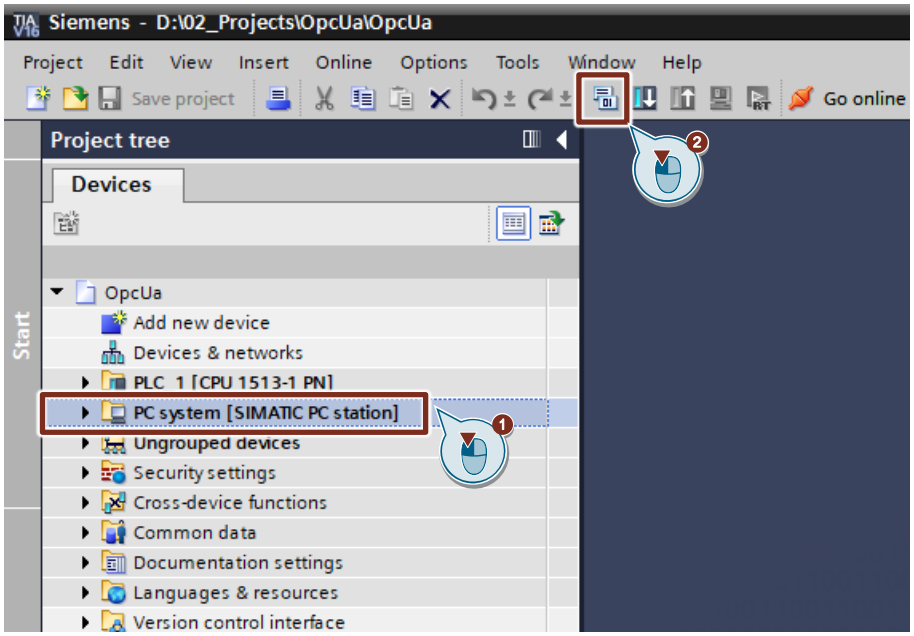
Note Loading via TIA Portal in online mode will only successfully install the communication services on your PC station if the component layout in the project engineering data is identical to the layout in the configuration data on the PC station.

Requirements:

- Engineering PC and PC station are in the same subnet.
- You set the same IP address and subnet mask for the PC station network adapter as you did in the hardware configuration (see chapter 2.2.1).

Compiling:

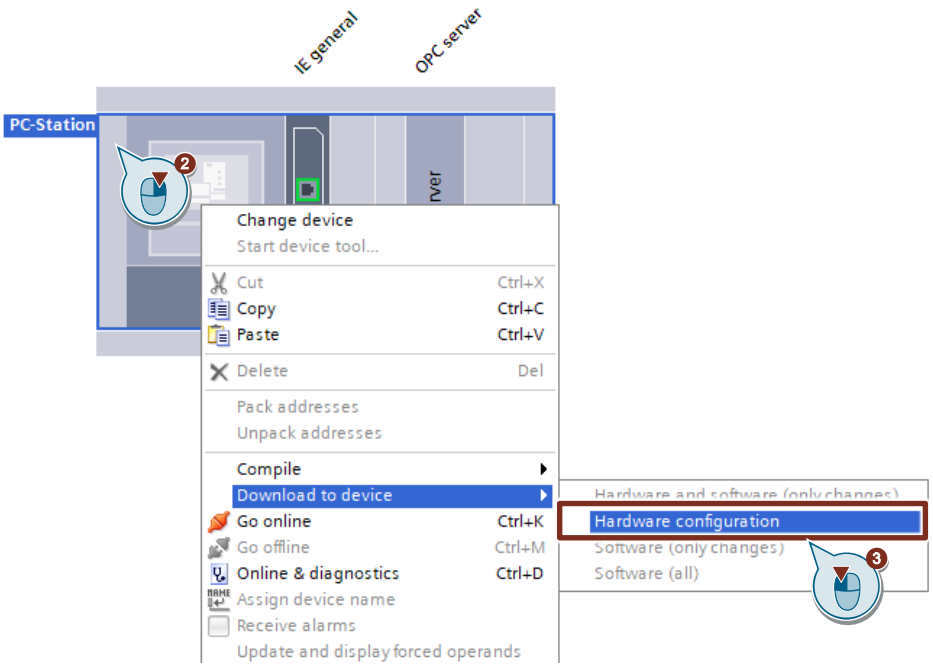
Figure 2-17



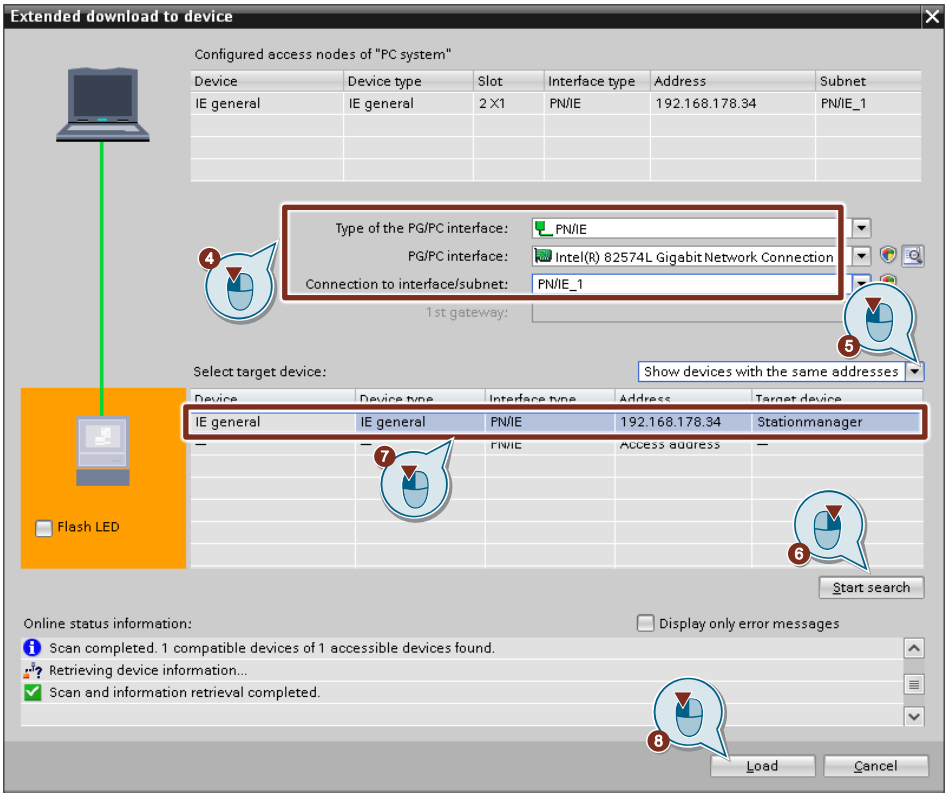
1. Select the PC station in the "Project tree".
2. Click on the "Compile" button in the function bar.

Load:

1. Open the "Device view" of the PC station.

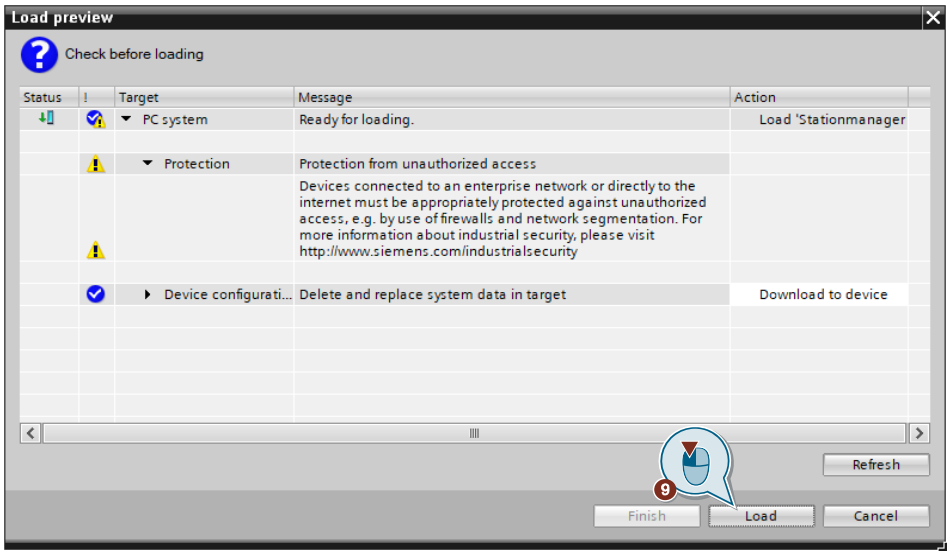


2. Right-click the PC station.
   The context menu opens.
3. Select the "Download to device > Hardware configuration" command.
   The "Extended download to device" or "Load preview" dialog opens automatically.
   Note
   The "Extended download to device" dialog is only opened automatically if the access path to the PC station has to be reset.



4. In the "Extended download to device" dialog, make the following settings:
   - Type of PG/PC interface: PN/IE
   - PG/PC interface: Network adapter of the PC station
   - Connection to interface/subnet: Subnet of the PC station, e.g. PN/IE_1
5. Select the option "Show devices with the same addresses".
6. Click the "Start search" button.
7. Select the Station Manager as target device.
8. Click "Load".
   The "Load preview" dialog window opens.

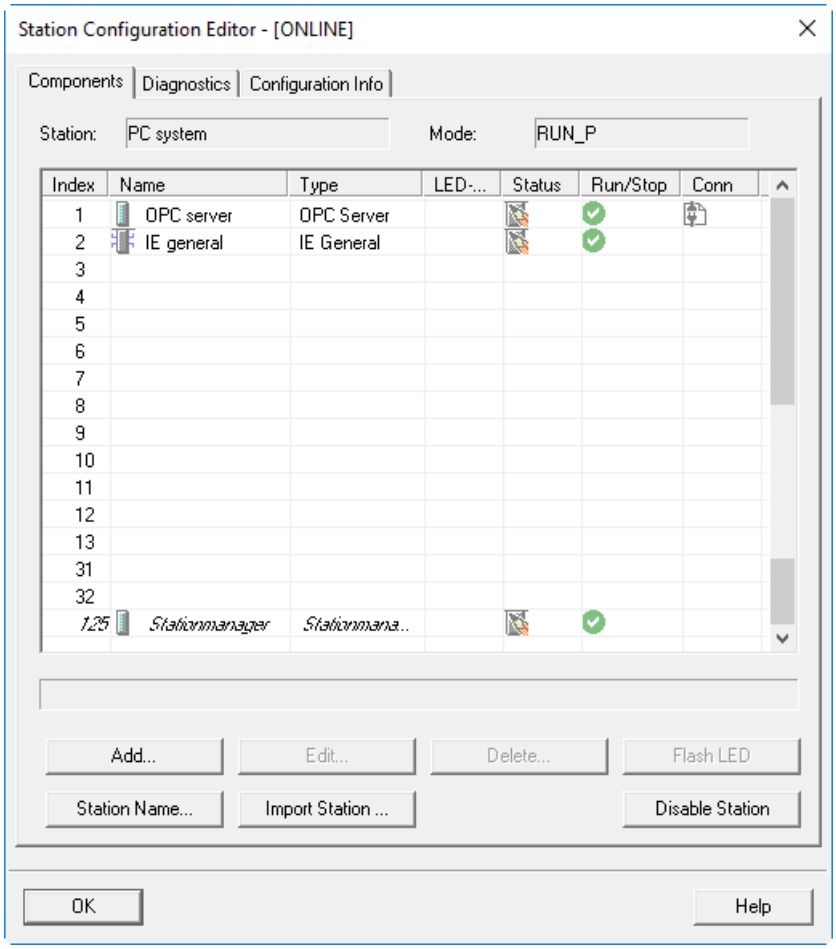
9. Click the "Load" button to start the load process.



Result:

The PC station configuration data have been loaded successfully.

Figure 2-18



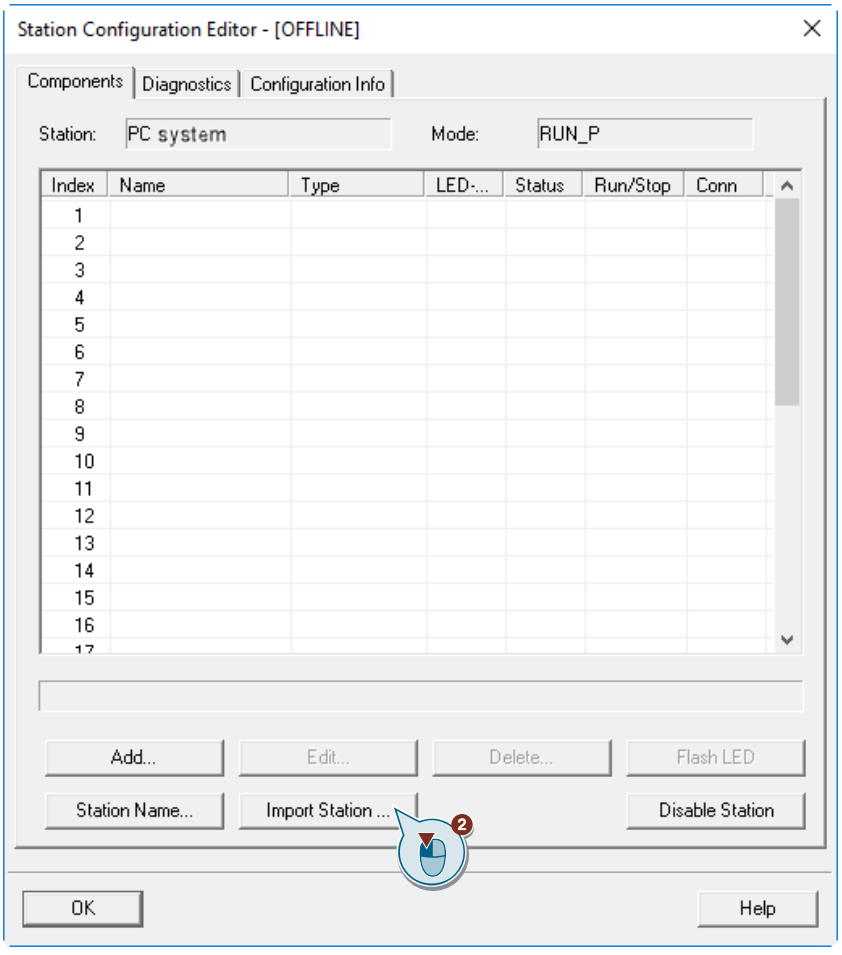
- The components are in "RUN" mode. This is shown with the icon in the "Run/Stop" column.
- The following status icon for the component shows that the configuration data have been loaded successfully.

  - The component is present and configured in the current configuration of the PC station.
  - The component is ready for operation!
- The configured S7 connection is loaded. This is shown with the icon in the "Conn" column.

XDB import: Importing XDB in the Station Configuration Editor

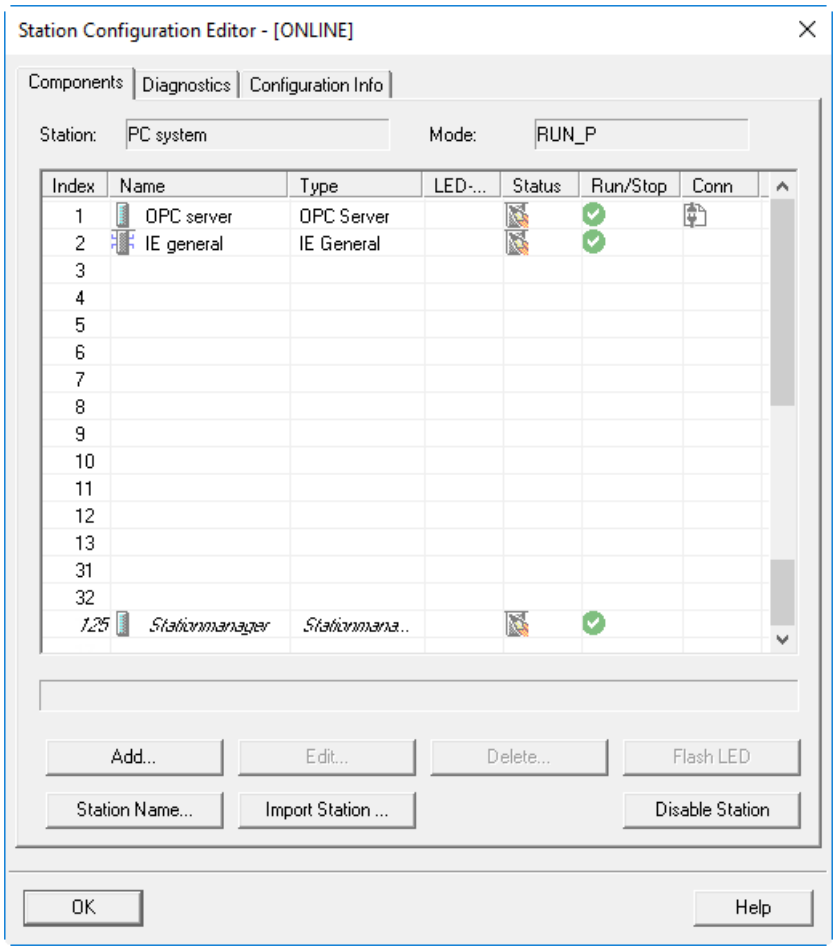
1. Open the Station Configuration Editor.
2. Click "Import Station" to download the configuration data to the PC station.



Result:

The PC station configuration data have been loaded successfully.

Figure 2-19



- The station has the same name as in the component image that you generated in TIA Portal in the "Device view" for the PC station.
- The components are in "RUN" mode. This is shown with the icon in the "Run/Stop" column.
- The following status icon for the component shows that the configuration data have been loaded successfully.

  - The component is present and configured in the current configuration of the PC station.
  - The component is ready for operation!
- The configured S7 connection is loaded. This is shown with the icon in the "Conn" column.

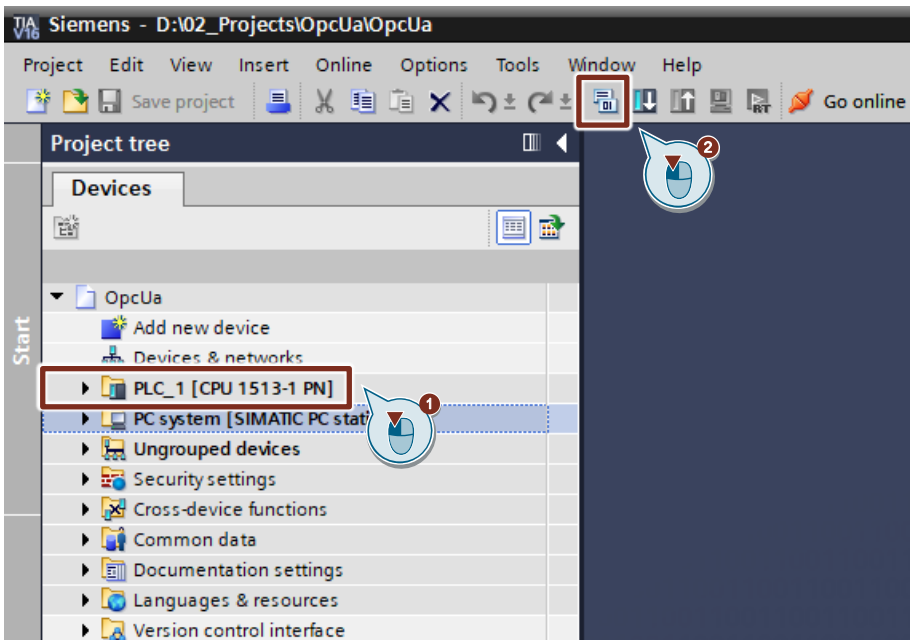
2.7.2 Load S7 CPU configuration data

Requirements

- Engineering PC and S7 CPU are in the same subnet.
- You set the same IP address and subnet mask for the S7 CPU as you did in the hardware configuration (see chapter 2.2.2).

Compiling

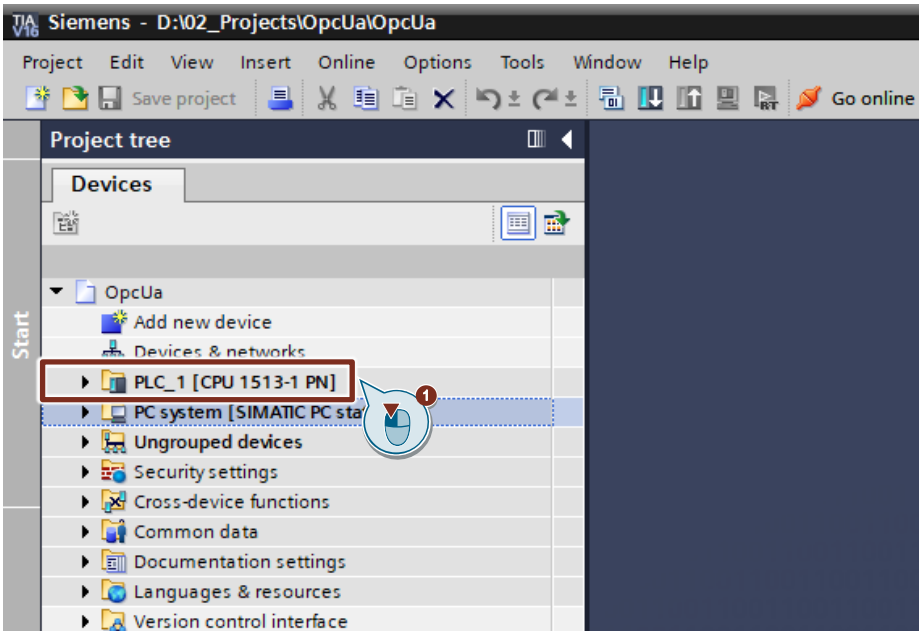
Figure 2-20



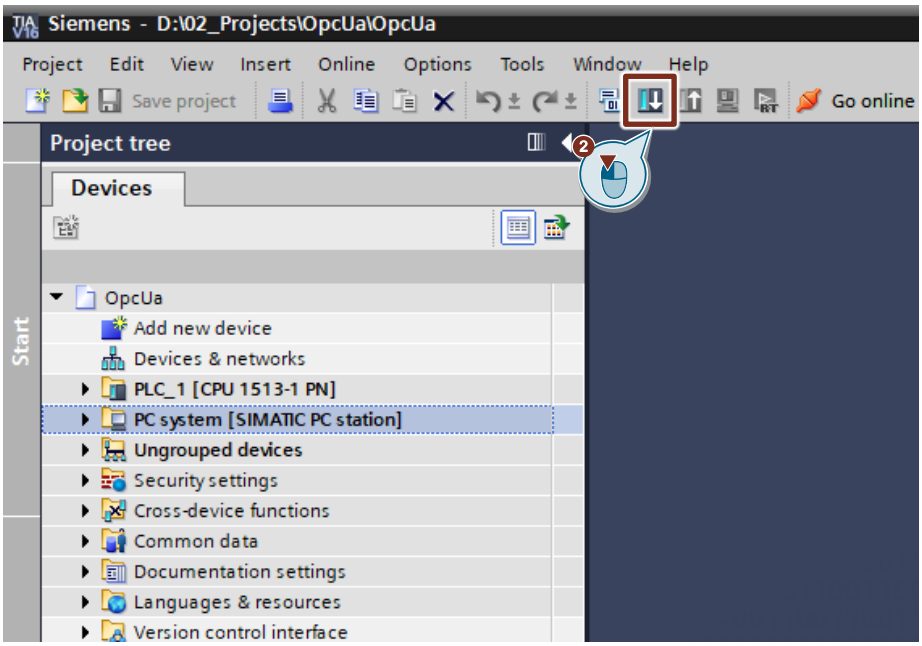
1. Select the S7 CPU in the "Project tree".
2. Click on the "Compile" button in the function bar.

Downloading

1. Select the S7 CPU in the "Project tree".



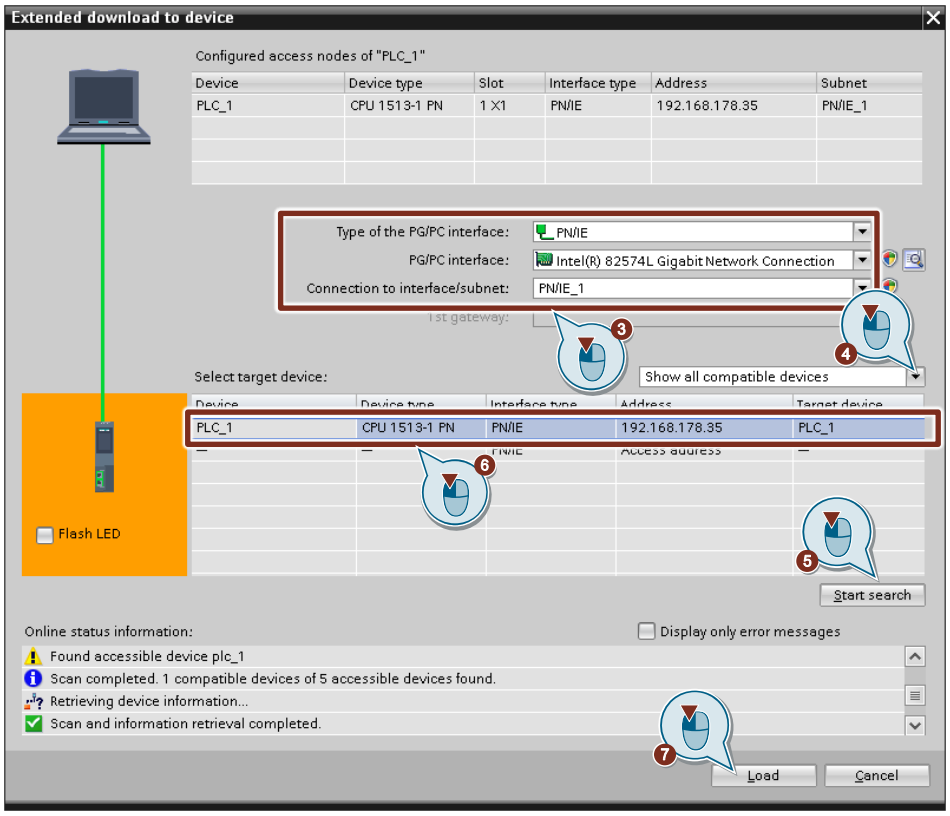
2. Click on the "Download to device" button in the function bar.



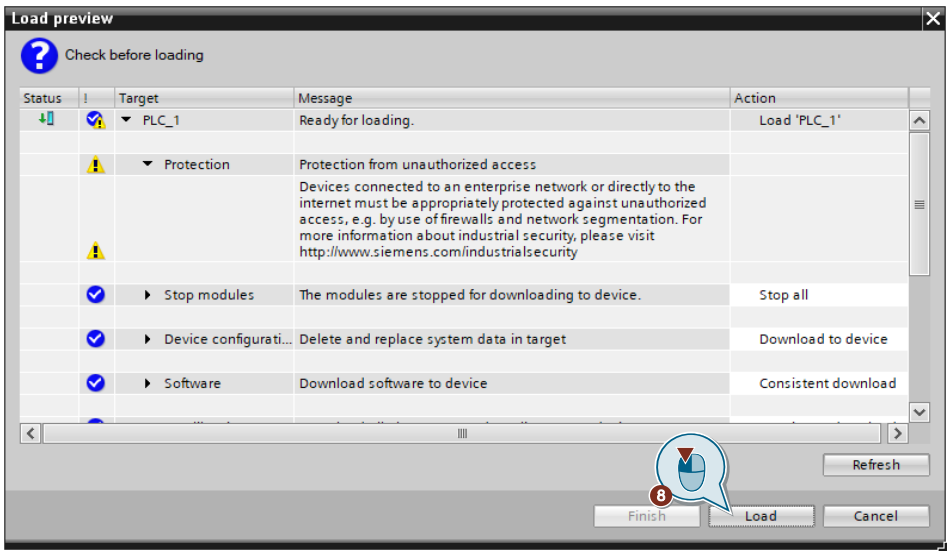
The "Extended download to device" or "Load preview" dialog opens automatically.

Note

The "Extended download to device" dialog is only opened automatically if the access path from the PG/PC to the S7 CPU has to be reset.

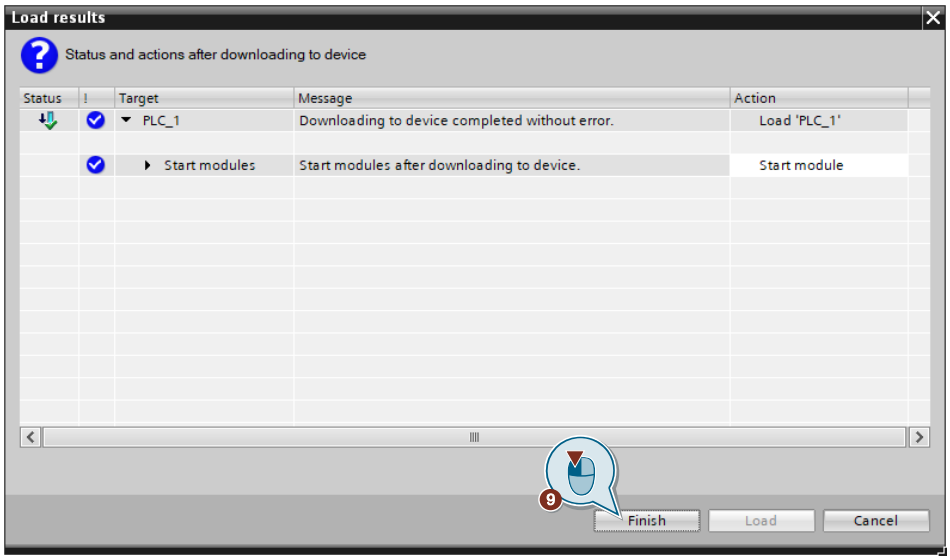


3. In the "Extended download to device" dialog, make the following settings to access the S7 CPU over TCP/IP:
   - Type of PG/PC interface: PN/IE
   - PG/PC interface: PG/PC network adapter:
   - Connection to interface/subnet: Subnet of the S7 CPU, e.g. PN/IE_1
4. Select the "Show all compatible devices" option.
5. Click the "Start search" button.
6. Select the S7 CPU as the target device.
7. Click "Load".
   The "Load preview" dialog window opens.
8. Click the "Load" button to start the load process.



The "Load results" dialog opens.

9. Click "Finish" to finish downloading.



3 Operation

3.1 Setting up SIMATIC S7 communication

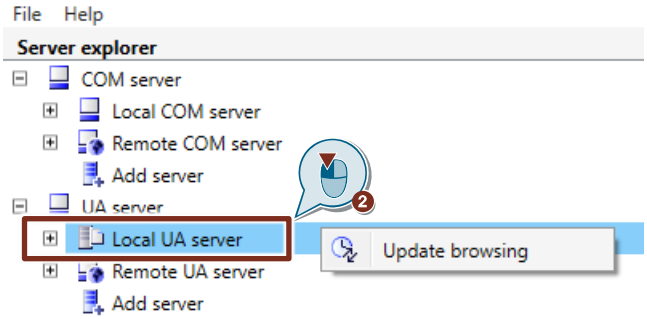
Note It is only possible to use the S7 server services via standard S7 connections to S7 CPUs.

Using the S7 server services, the S7 CPU accesses the S7 data block DB1 in the PC station over standard S7 connections.

In order to access the data that the S7 OPC UA server provides in the S7 data block, you will need an OPC client. In this example, "OPC Scout V10" from SIMATIC NET will be used as OPC client.

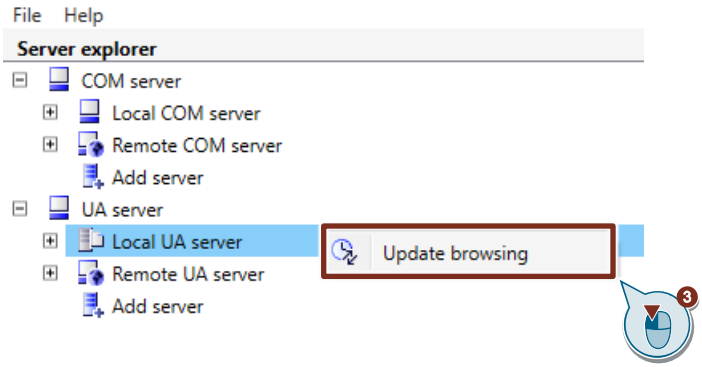
3.1.1 Establish connection to the S7 OPC UA server with OPC Scout V10

1. Start OPC Scout V10 from the Windows Start Menu item "Siemens Automation > OPC Scout V10".
2. In the "Server explorer" under "UA server", right-click "Local UA server".



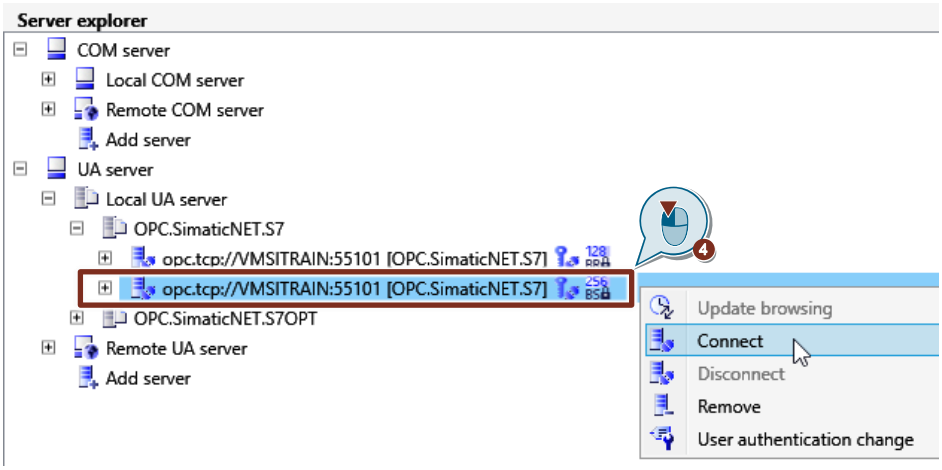
The context menu opens.

3. Click "Update browsing".



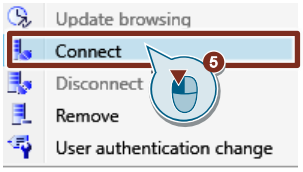
The enabled and available connections will be displayed.

4. Right-click the S7 connection under "UA server > Local UA server > OPC.SimaticNET.S7".



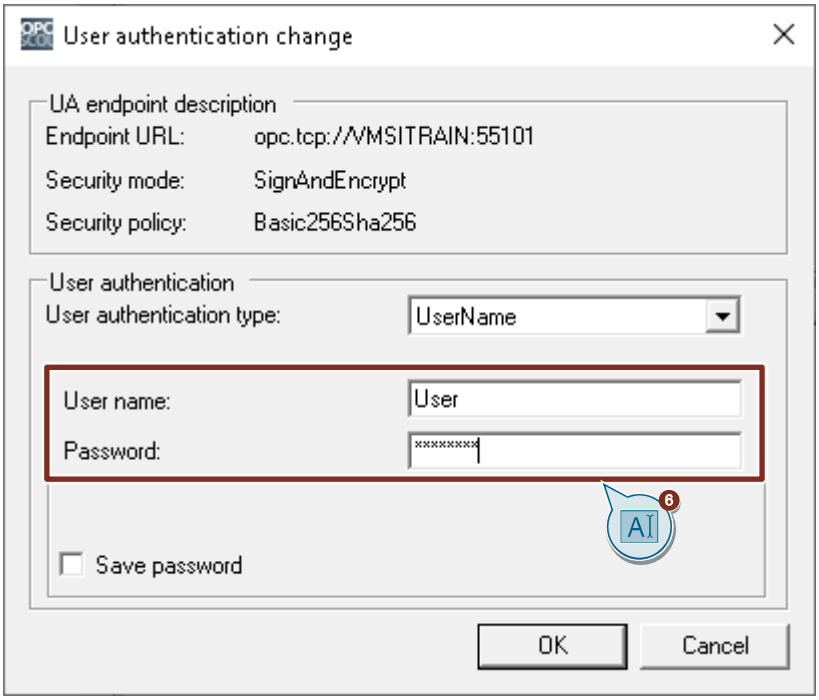
The context menu opens.

5. Click "Connect".

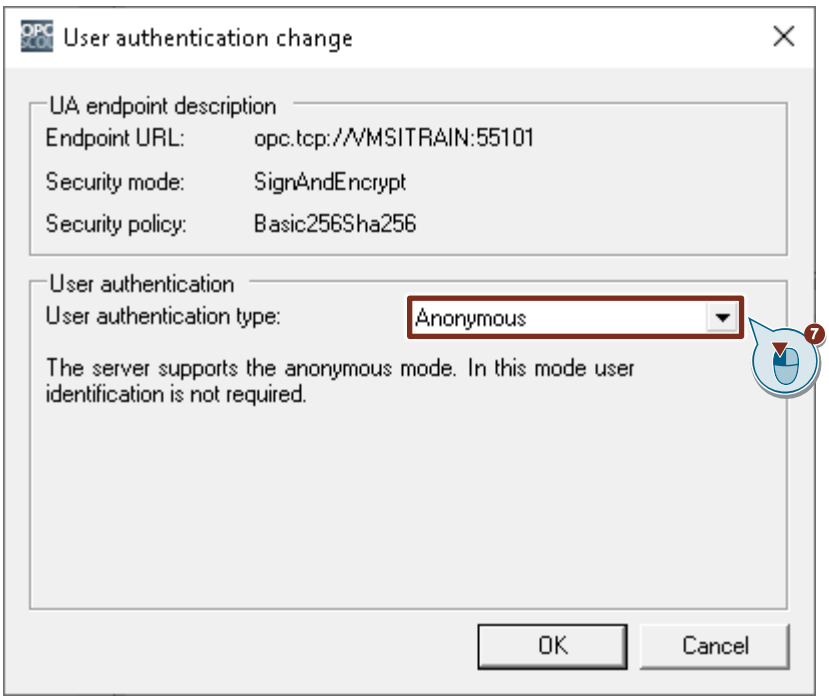


The "User authentication change" dialog opens.

6. A user authentication with Windows login and password will be needed in order to establish the S7 connection.



7. It is possible to log in anonymously if you enabled the option "Allow anonymous logins to the OPC UA server" in the "Communication settings".

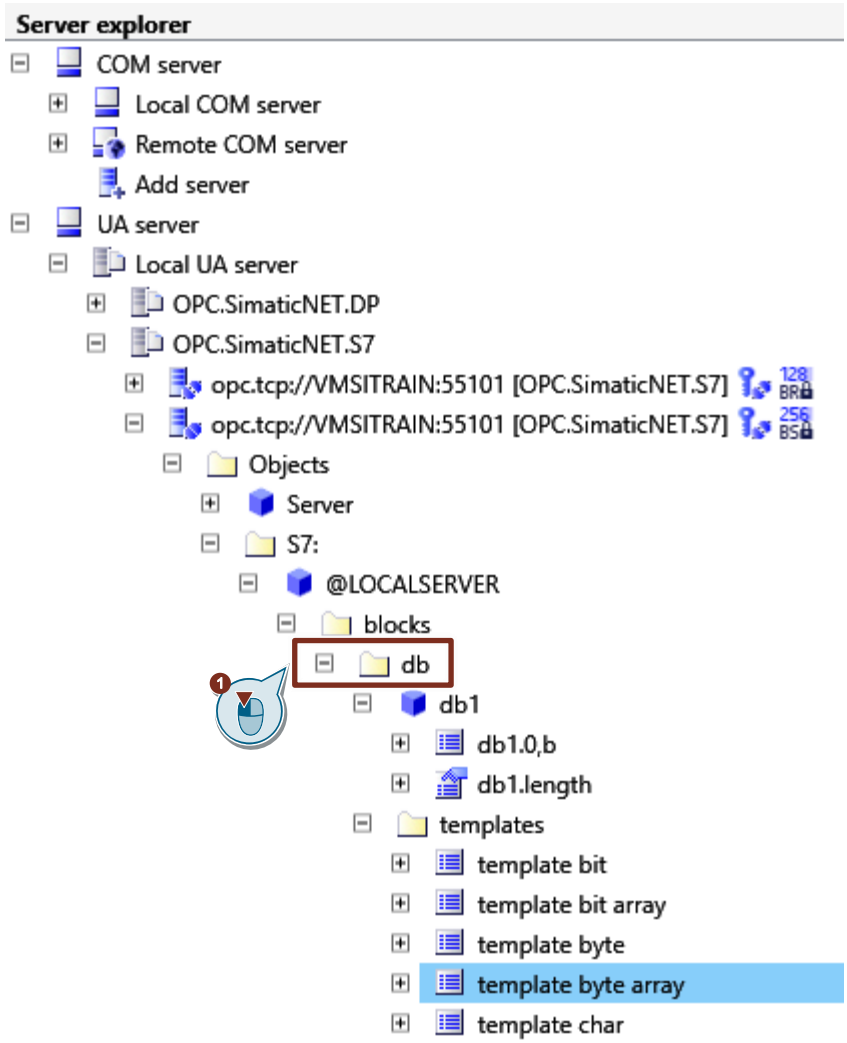


3.1.2 Setting up access to the data in S7 data block DB1 with OPC Scout

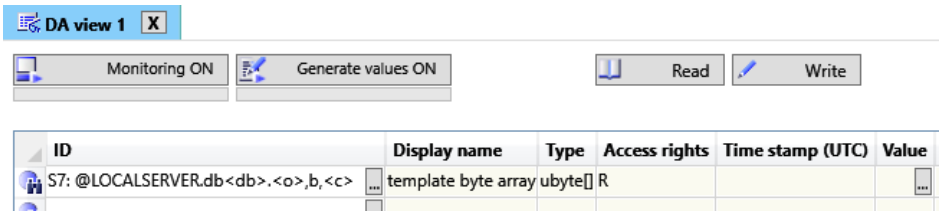
Use OPC Scout V10 to access the following nodes in the S7 OPC UA server:

- S7: @LOCALSERVER.db1.0,b,10

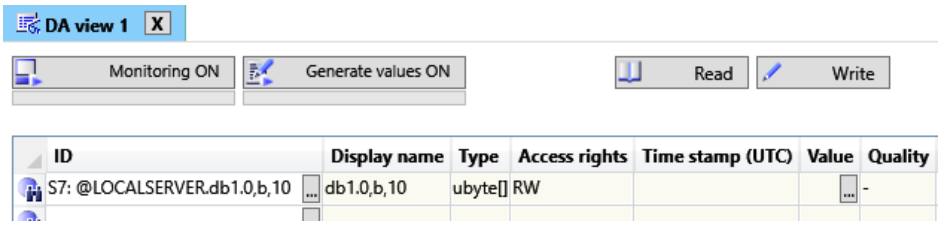
1. In the "Server explorer", navigate to "UA server > Local UA server > OPC.SimaticNET.S7 > opc.tcp://<Computer name>:550101 [OPC.SimaticNET.S7] > Objects > S7: > @LOCALSERVER > blocks > db". Templates for access to the S7 data block DB1 in the PC station will be displayed here.



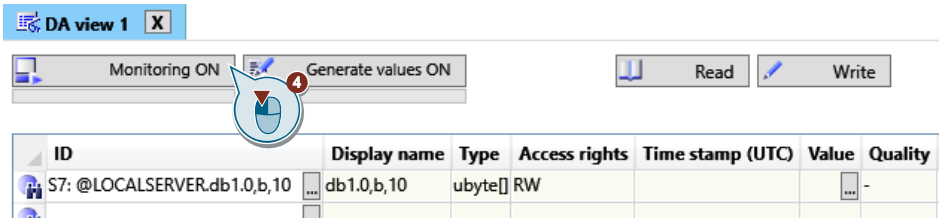
2. Drag and drop the desired template into the DA view of OPC Scout V10 to access the S7 data block DB1 in the PC station.
   This application example uses the template "template byte array".



3. Modify the template. This application example accesses 10 bytes starting at address 0 in DB1.



4. Click the "Monitoring ON" button to observe the node's data.



Note The S7 server services can only be used via standard S7 connections.

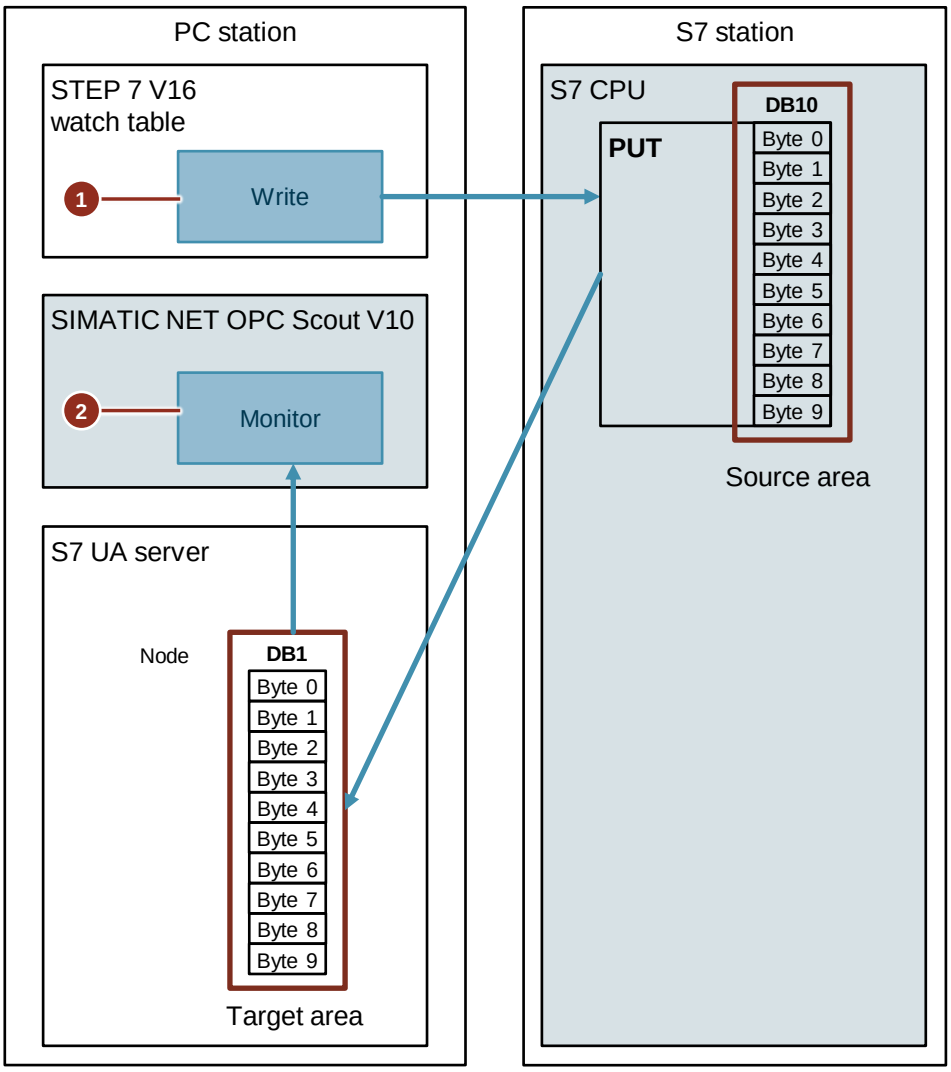
3.2 S7 CPU writes data to the PC station

Requirements

- The "PUT" instruction is called in the user program of the S7 CPU.
- The following data block (DB) is created in the user program with standard access.
  - DB10: This data block contains that data which will be written to the S7 data block DB1 in the PC station.
- You have created a watch table in STEP 7 V16 (TIA Portal) containing the tags below, and opened it.
  - Tag to control the write request
  - Tags whose values will be written to the PC station
- The connection from the PC station to the S7 CPU has been established (see chapter 3.1.1).
- Access to the data in the S7 data block DB1 with OPC Scout V10 has been set up (see chapter 3.1.2)

Overview

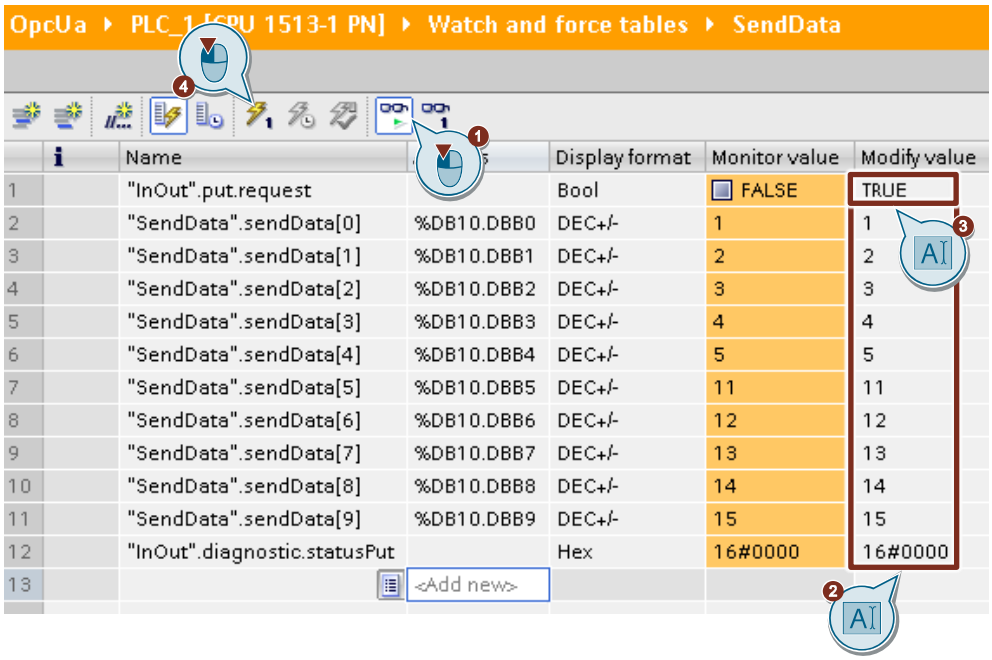
Figure 3-1



1. Write data (DB10 "SendData") to STEP 7 V16
2. Monitor node data in OPC Scout V10

Writing in STEP 7 V16 (TIA Portal)

Figure 3-2



1. Click the "Monitor all" button.
2. In the "Modify value" column, enter values that you wish to save in DB10 "SendData" (source area).
3. Set the "REQ" input of the "PUT" instruction to "TRUE" via the tag "InOut".put.request in order to start a write request.
4. Click on "Modify all selected values once and now."

Result

- The modify values are saved in DB10 "SendData" (source area). The values are displayed in the "Monitor" column.

OpcUa ▸ PLC_1 [CPU 1513-1 PN] ▸ Watch and force tables ▸ SendData

	Name	Address	Display format	Monitor value	Modify value
1	"InOut".put.request		Bool	FALSE	TRUE
2	"SendData".sendData[0]	%DB10.DBB0	DEC+/-	1	1
3	"SendData".sendData[1]	%DB10.DBB1	DEC+/-	2	2
4	"SendData".sendData[2]	%DB10.DBB2	DEC+/-	3	3
5	"SendData".sendData[3]	%DB10.DBB3	DEC+/-	4	4
6	"SendData".sendData[4]	%DB10.DBB4	DEC+/-	5	5
7	"SendData".sendData[5]	%DB10.DBB5	DEC+/-	11	11
8	"SendData".sendData[6]	%DB10.DBB6	DEC+/-	12	12
9	"SendData".sendData[7]	%DB10.DBB7	DEC+/-	13	13
10	"SendData".sendData[8]	%DB10.DBB8	DEC+/-	14	14
11	"SendData".sendData[9]	%DB10.DBB9	DEC+/-	15	15

- The vales saved in DB10 "SendData" are written to the S7 data block DB1 in the PC station (target area).

Note Reset the "REQ" input of the "PUT" instruction via the tag "InOut".put.request if the write request was completed with "DONE" = "1" or "ERROR" = "1" so that you can start a new write request.

Monitoring with OPC Scout V10

OPC Scout displays the values that were written by the S7 CPU to the S7 data block DB1 in the "Value" column.

Figure 3-3

DA view 1 X

Monitoring OFF | Generate values ON | Read | Write

ID	Display name	Type	Access rights	Time stamp (UTC)	Value
S7: @LOCALSERVER.db1.0,b,10	db1.0,b,10	ubyte[]	RW	05/18/2020 03:26:26.683 PM	{1 | 2 | 3 | 4 | 5 | 11 | 12 | 13 | 14 | 15
	-		-		

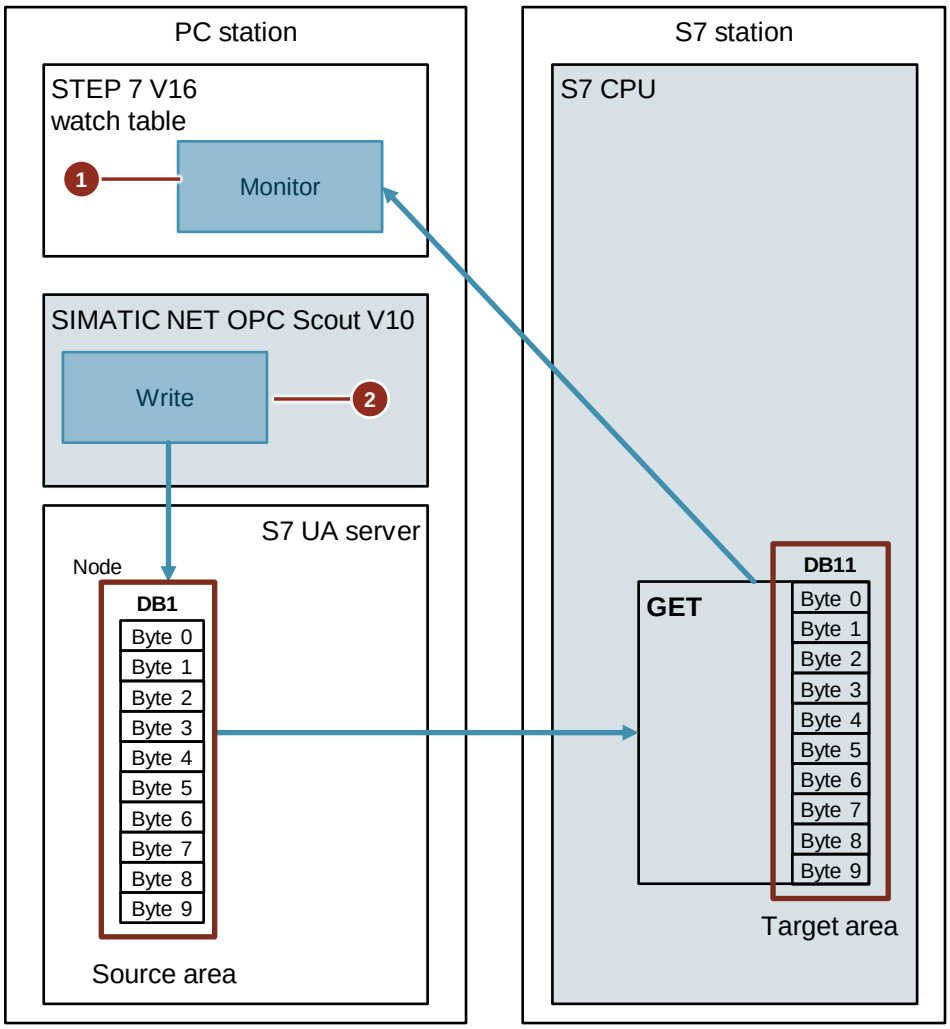
3.3 S7 CPU reads data from the PC station

Requirements

- The "GET" instruction is called in the user program of the S7 CPU.
- The following data block (DB) is created in the user program with standard access.
  - DB11: This DB stores that data that were read from the S7 data block DB1 in the PC station.
- You have created a watch table in STEP 7 V16 (TIA Portal) containing the tags below, and opened it.
  - Tag to control the read request
  - Tags where the values read from the PC station are stored
- The connection from the PC station to the S7 CPU has been established (see chapter 3.1.1).
- Access to the data in the S7 data block DB1 with OPC Scout V10 has been set up (see chapter 3.1.2)

Overview

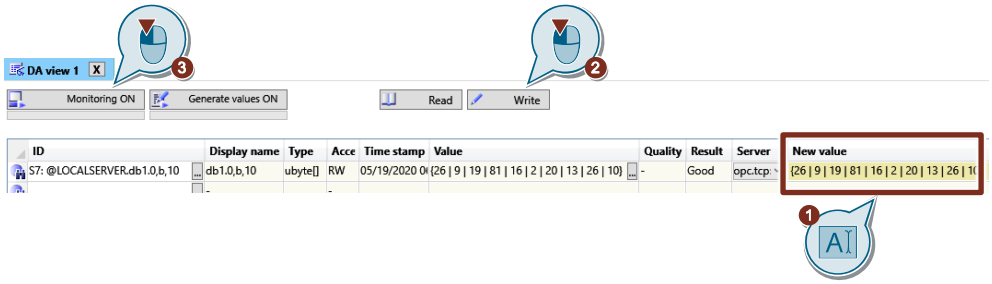
Figure 3-4



1. Write data of the node in OPC Scout V10
2. Monitor data (DB11 "RecvData") in STEP 7 V16

Writing with OPC Scout V10

Figure 3-5

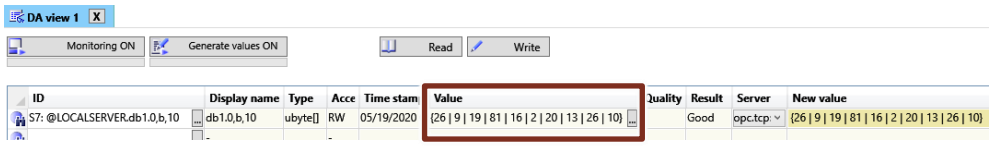


1. In the DA view of OPC Scout V10, enter new values for the node in the "New Value" column.
2. Click "Write" to write the node's data with new values.
   The values are written to the S7 data block DB1 in the PC station (source area).
3. Click the "Monitoring ON" button.

Result

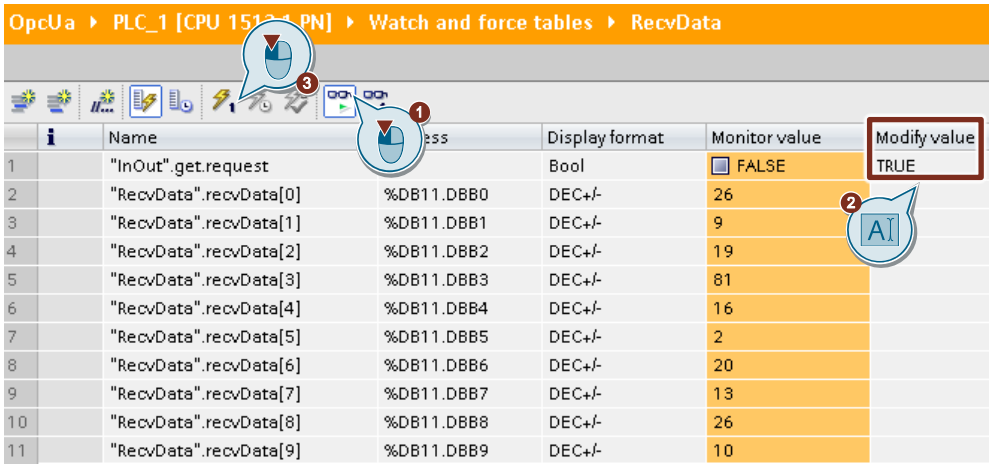
The values of the S7 data block DB1 (source area) are displayed in the "Value" column.

Figure 3-6



Monitoring in STEP 7 V16 (TIA Portal)

Figure 3-7



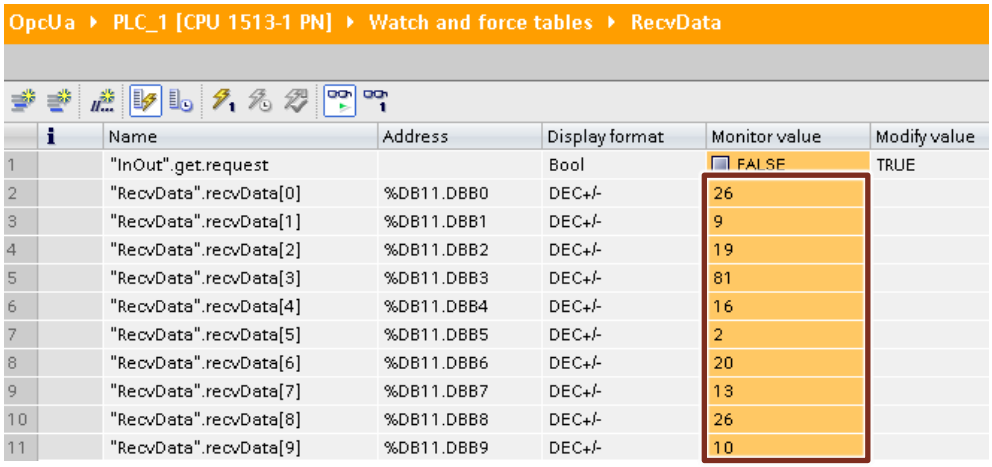
	Name	Address	Display format	Monitor value	Modify value
1	"InOut".get.request		Bool	FALSE	TRUE
2	"RecvData".recvData[0]	%DB11.DBB0	DEC+/-	26	
3	"RecvData".recvData[1]	%DB11.DBB1	DEC+/-	9	
4	"RecvData".recvData[2]	%DB11.DBB2	DEC+/-	19	
5	"RecvData".recvData[3]	%DB11.DBB3	DEC+/-	81	
6	"RecvData".recvData[4]	%DB11.DBB4	DEC+/-	16	
7	"RecvData".recvData[5]	%DB11.DBB5	DEC+/-	2	
8	"RecvData".recvData[6]	%DB11.DBB6	DEC+/-	20	
9	"RecvData".recvData[7]	%DB11.DBB7	DEC+/-	13	
10	"RecvData".recvData[8]	%DB11.DBB8	DEC+/-	26	
11	"RecvData".recvData[9]	%DB11.DBB9	DEC+/-	10	

1. Click the "Monitor all" button.
2. Set the "EN_R" input of the "GET" instruction to "TRUE" with the tag "InOut".get.request in order to start a read request.
3. Click on "Modify all selected values once and now."

Result

The values read from the S7 data block DB1 (source area) are stored in the S7 CPU in DB11 "RecvData" (target area). The values are displayed in the "Modify value" column.

Figure 3-8



	Name	Address	Display format	Monitor value	Modify value
1	"InOut".get.request		Bool	FALSE	TRUE
2	"RecvData".recvData[0]	%DB11.DBB0	DEC+/-	26	
3	"RecvData".recvData[1]	%DB11.DBB1	DEC+/-	9	
4	"RecvData".recvData[2]	%DB11.DBB2	DEC+/-	19	
5	"RecvData".recvData[3]	%DB11.DBB3	DEC+/-	81	
6	"RecvData".recvData[4]	%DB11.DBB4	DEC+/-	16	
7	"RecvData".recvData[5]	%DB11.DBB5	DEC+/-	2	
8	"RecvData".recvData[6]	%DB11.DBB6	DEC+/-	20	
9	"RecvData".recvData[7]	%DB11.DBB7	DEC+/-	13	
10	"RecvData".recvData[8]	%DB11.DBB8	DEC+/-	26	
11	"RecvData".recvData[9]	%DB11.DBB9	DEC+/-	10	

Note Reset the "REQ" input of the "GET" instruction via the tag "InOut".get.request if the read request was completed with "NDR" = "1" or "ERROR" = "1" so that you can start a new read request.

4 Useful information

4.1 SIMATIC NET OPC server

4.1.1 S7 OPC UA server

The S7 OPC UA server supports S7 communication via Industrial Ethernet and PROFIBUS.

Connection type

The S7 OPC UA server supports the following connection type:

- Standard S7 connection (see chapter 4.5.1).

Communication services

The S7 OPC UA server supports the following communication services:

Table 4-1

Communication service	Description
Variable services	Functions for reading and writing one or more S7 tags.
Buffer-oriented services	Program-controlled transfer of larger blocks of data.
Block services	Transfer of a loadable data range to and from S7.
Server functionality	The PC can be used as a server for data buffers and data blocks.
S7 password function	Setting a password for access to protected blocks.
OPC UA events, conditions and alarms	Processing of S7 messages and S7 diagnostic events.
History data on OPC UA	Access to history S7 data tags that are archived in a database for up to 360 hours.

Note The S7 OPC UA server communication services listed in Table 4-1 are available for Industrial Ethernet and PROFIBUS.

4.1.2 S7OPT OPC UA server

The S7OPT OPC UA server supports S7 communication via Industrial Ethernet with the S7-1200 (V4 onward) and S7-1500.

Connection type

The S7OPT OPC UA server supports the following connection type:

- Optimized S7 connection (see chapter 4.5.2).

Communication services

The S7OPT OPC UA server supports the following communication services:

Table 4-2

Communication service	Description
Variable services	Functions for reading and writing one or more S7 tags via standard access and access to optimized data blocks.
OPC UA events, conditions and alarms	Processing of PLC messages.
History data on OPC UA	Access to history S7OPT data tags that are archived in a database for up to 360 hours.
S7 CPU protection level concept	Setting a password for secured connection establishment and access to the S7-1200 and S7-1500 stations.

Note The S7OPT OPC UA server communication services listed in Table 4-2 are only available for Industrial Ethernet.

4.1.3 SR OPC UA server

The SR OPC UA server makes it possible to use open communication services (SEND/RECEIVE) via Industrial Ethernet with OPC UA. The SR OPC UA server is authorized for communication with S7 devices. In addition, it also enables the user to communicate with external devices.

Connection type

The SR OPC UA server supports the following connection type:

- TCP Connection
- ISO-on-TCP connection
- ISO transport connection

Type of connection

The type of SR connection methods that is possible via an SR connection is set in STEP 7. The connection can either:

- only Fetch
- only Write
- only Send/Receive

Communication services

The SR OPC UA server supports the following communication services:

Table 4-3

Communication service	Description
Tag service	Reading and writing of data tags for S5 data blocks and ranges (S5-compatible communication) requires that a Fetch or Write connection first be configured. The data tags on a Fetch connection are only read. On a Write connection, the data tags are written only. If a communication partner's data blocks must not only be read but also written, then you must configure two corresponding connections which will be managed fully independently by the OPC UA server.
Buffer send/receive service	Buffer-oriented services allow program-controlled transfer of larger blocks of data. These services are also known as SEND/RECEIVE services. Data transfer with the OPC UA server is implemented with tags: • Tags that receive blocks of data • Tags that send blocks of data A default size for the blocks of data is specified in the configuration. When sending tags, the length can be restricted. Partial access within the blocks of data is possible.

4.1.4 DP OPC UA server

The DP OPC UA server supports DP master class 1. The DP master class 1 performs cyclic communication to the DP slaves.

The DP OPC UA server supports the DP slave function DP-V0.

Process tags for the DP master with OPC UA

The DP OPC UA server for DP master mode offers process tags for the following services:

- Services for the master class 1 access and monitoring of DP inputs and outputs
- Sync/Freeze:
  Acyclic sending of control telegrams to slave groups
- Fast Logic for:
  - CP 5613 A2 and CP 5614 A2 (only DP master):
    Automatic monitoring of slave data
  - CP 5623 and CP5624 (only DP master):
    Automatic monitoring of slave data
- Diagnostic tags:
  Evaluation of static diagnostic information

Process tags for the DP slave with OPC UA

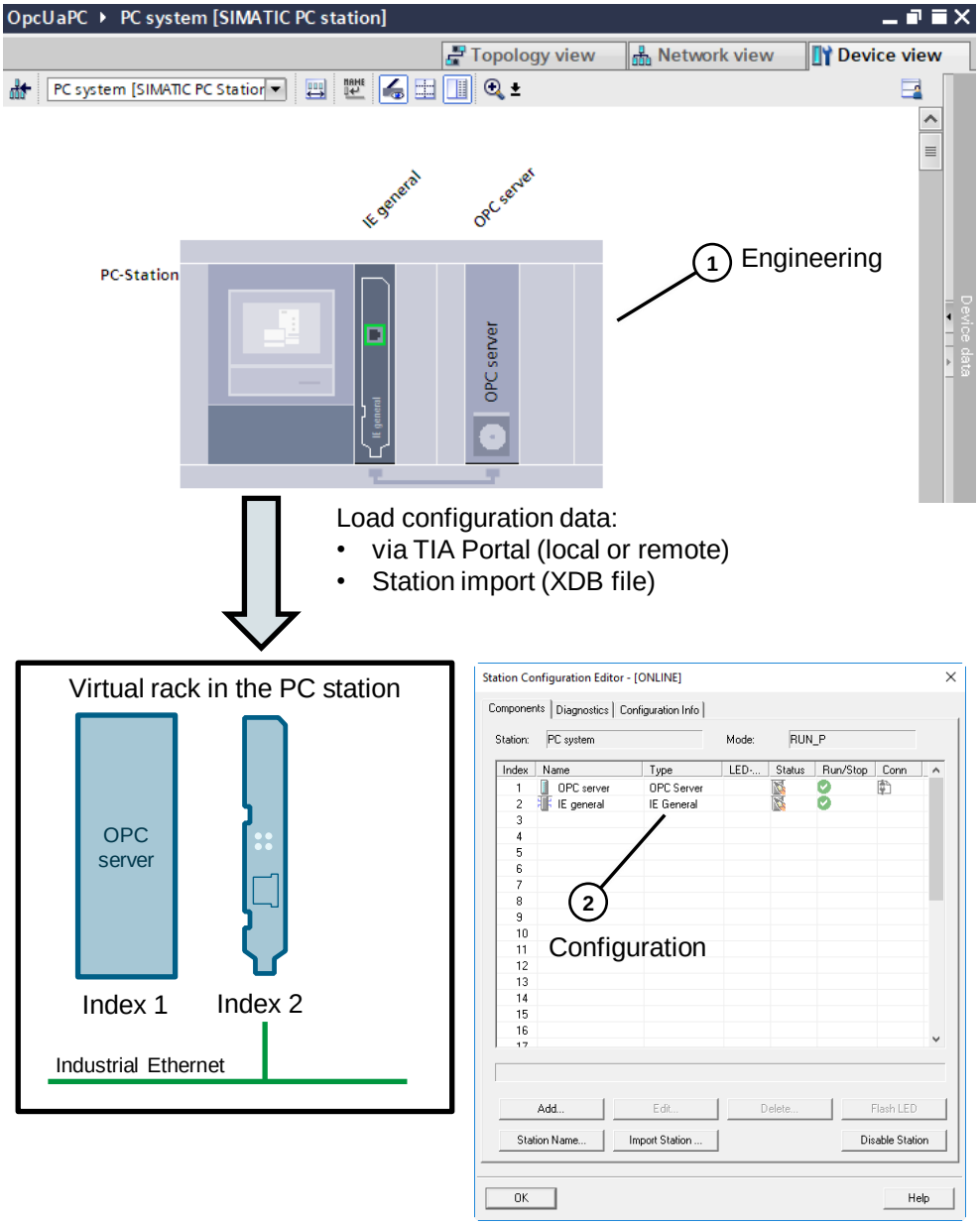
The DP OPC UA server for DP slave mode offers process tags for the following services:

- Tag services for access to local slave data, access to the inputs and outputs of the slave
- Diagnostic tags:
  Evaluation of static diagnostic information of the slave

4.2 Configuring a PC station

Overview

Figure 4-1



Engineering

In TIA Portal you will configure the PC station with the necessary components:

- Network adapter: e.g. "IE General"
- User application, e.g. "OPC Server"

Set all necessary addresses and parameters, such as IP address and subnet mask for the network adapter.

Configuration

Using the "Station Configuration Editor" you will insert the components into the virtual slots of the PC station and assign addresses and parameters to them.

To allow communication between the components in the PC station and to receive project engineering data, each component is assigned a unique identification number. The identification number for components in a PC station is the index. In much the same way as the slot of a module in an S7 CPU, the index corresponds to a virtual slot in a PC station.

4.3 "Station Configuration Editor"

Using the "Station Configuration Editor" you have access to the component management of the "Stationmanager" in the PC station.

You need the "Station Configuration Editor" for the initial configuration and project engineering as well as maintenance of a PC station.

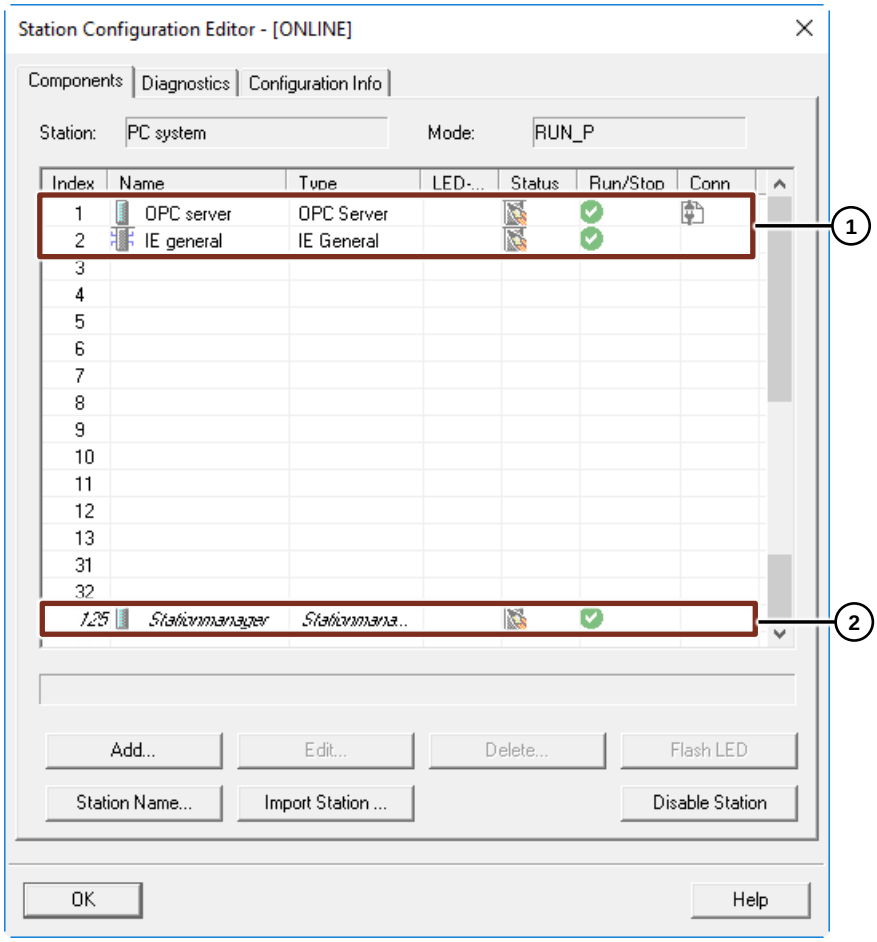
The "Station Configuration Editor" is the user interface for Station Manager.

Note The "Station Configuration Editor" is always available and running on the PC station where you installed the "SIMATIC NET PC Software".

4.3.1 Overview

The following figure shows the layout of the "Station Configuration Editor".

Figure 4-2



1. Components:
   The components are the modules and the applications involved in communications in the PC station. These components require configuration and project engineering data.
2. Station Manager:
   The Station Manager holds the configuration and project engineering data for the components in the component management (database).

Apart from component configuration, the "Station Configuration Editor" can also be used for diagnostic purposes.

4.3.2 Area of application & use cases

Initial configuration (commissioning)

When a component is put into operation for the first time, an initial configuration is necessary. This initial configuration is performed for all newly installed components. The initial configuration sets an index (the "virtual slot number") of the component.
After initial configuration of the components, the PC station is prepared to receive the project engineering data. This step can be compared to inserting the components into the rack of an S7 station.

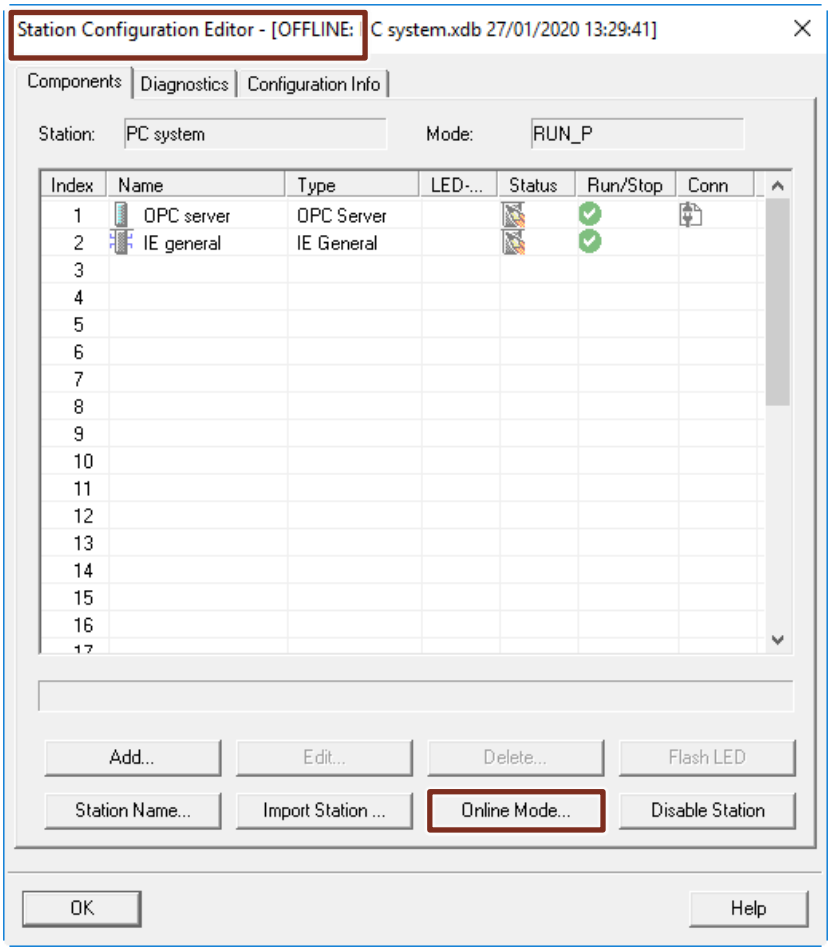
Project engineering and maintenance

Changes in the project engineering and configuration data can be downloaded to the PC station from TIA Portal (local and remote). As an alternative, it is possible to transfer data using an XDB file.
Using the "Station Configuration Editor", you can check the effects in the "Components" tab. The "Diagnostics" tab provides you with information on the operating state at all times.

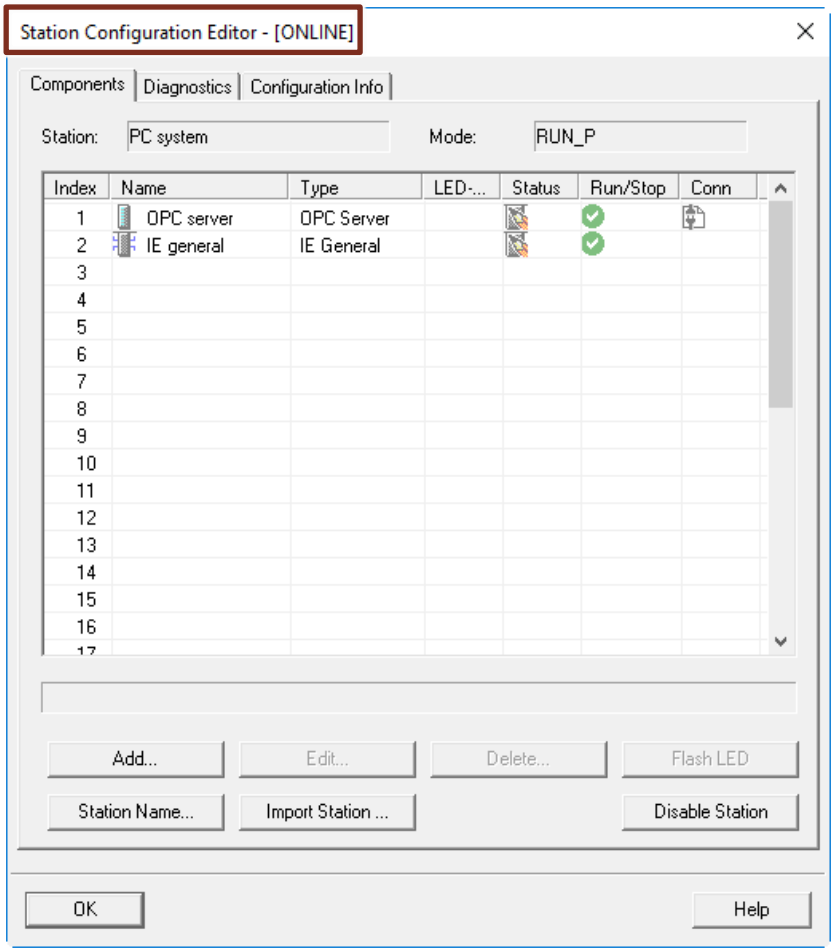
4.3.3 "Components" tab

In the "Components" tab, you will find the essential functions for configuring a PC station.

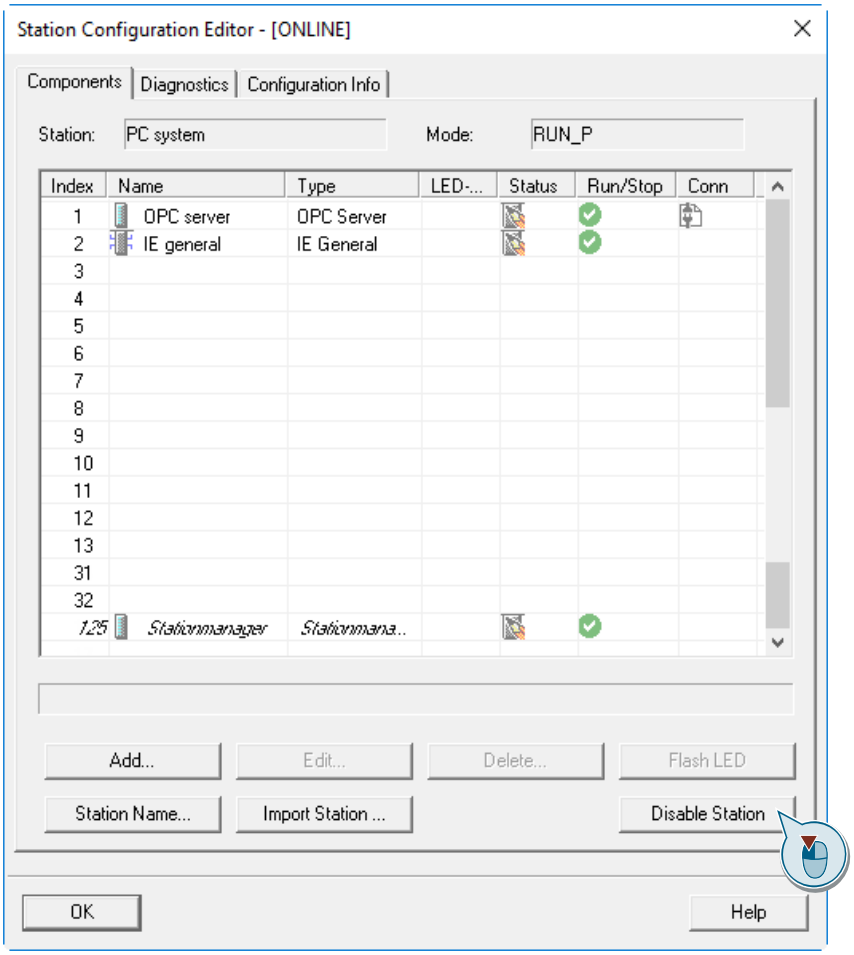
- Assigning the station name
- Creating new components
- Applying the component configuration and project engineering data
- Checks and diagnostics
- Setting the operating mode
  The current mode is displayed in the title bar of the "Station Configuration Editor".
  - Offline mode
    In offline mode, you can make changes to the configuration only by entering them directly or by importing the station (XDB file). The "Online Mode" button is visible; you can press it in order to enter online mode.



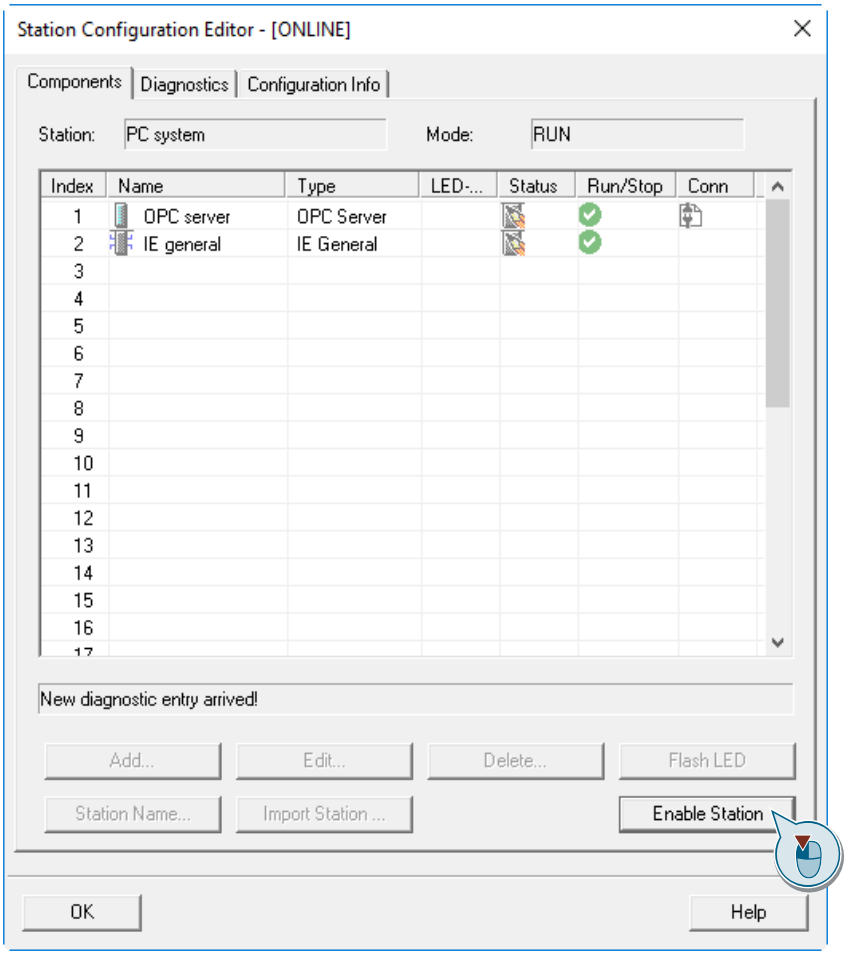
- Online mode
  In online mode, you have the ability to download project engineering data directly to the PC station using TIA Portal. You can perform an XDB import at any time. You can also specify (as an option) whether you want the "offline mode" to be set following the import.



- Disable and enable station:
  As an administrator you have the ability to secure the PC station's configuration data against changes.
  - Click the "Disable Station" button to lock the PC station.



- Click the "Enable Station" button to unlock.



It is not possible to change the configuration data while the station is locked. The following functions are locked:

- Station import (XDB file)
- Downloading the PC station via TIA Portal (local or remote)
- Modifying the PC station in the "Station Configuration Editor"

The current status is displayed in the "Mode" field.

- RUN: The PC station is disabled for changes.
- RUN_P: The PC station is enabled for changes.

4.4 Data blocks

STEP 7 (TIA Portal) offers data blocks with the following access options for S7-1500 and S7-1200 automation systems:

- Data blocks with optimized access
- Data blocks with standard access

The S7-300 and S7-400 automation systems only support data blocks with standard access.

4.4.1 Data blocks with optimized access

Data blocks with optimized access have no predefined structure. In the declaration, the data elements contain no fixed address within the data block but rather a symbolic name. The elements are arranged in the block's available storage space so that no gaps in the storage occur. This achieves optimal utilization of the storage space.

The tags in this data block are identified by their symbolic names. Enter the symbolic names of the tags in order to address them.

Optimized block access has the following advantages:

- Increase your engineering efficiency using purely symbolic addressing.
- Achieve higher performance in your automation system from optimized block access.

4.4.2 Data blocks with standard access

Data blocks with standard access have a fixed structure. In the declaration, the data elements contain a fixed address within the data block as well as a symbolic name. The address is shown in the "Offset" column.

The tags in this data block can be addressed symbolically and absolutely.

4.5 Connection types

4.5.1 Standard S7 connection

The S7 server services only function over standard S7 connections. In order to facilitate a standard S7 connection for S7-1200 CPUs and S7-1500 CPUs, you must carry out the following steps:

- In the PC station's hardware configuration, set the version "SW V8.2…" for the user application "OPC server" (see chapter 2.5.2).
- In the S7 CPU's hardware configuration, enable the function "Permit access with PUT/GET communication from remote partner" (see chapter 2.5.1).
- Disable the attribute "Optimized block access" for the data blocks (see chapter 2.5.5).

Network access with the S7 server services occurs with the "S7" protocol.

4.5.2 Optimized S7 connections

From version V12 onward, the SIMATIC NET OPC UA server can access optimized data blocks of the S7-1200 CPU (firmware V4 or higher) and of the S7-1500 CPU. Optimized data blocks no longer use absolute addresses. It is only possible to access the tags using their symbolic names. This makes optimized data blocks more generic, which reduces the possible sources of errors.

The optimized data blocks are located in the namespace of the SIMATIC NET OPC UA server in the "SYM" folder of the S7-1200 station or S7-1500 station.

Optimized data blocks are accessed over the network using the new "S7Opt" protocol.

The default setting makes all S7 connections to S7-1200 CPUs (firmware V4 or higher) and S7-1500 CPUs optimized S7 connections. S7 connections to S7-1200 CPUs and S7-1500 CPUs are configured in the same manner as with the S7-300 CPUs and S7-400 CPUs, but there are limitations:

- Optimized S7 connections and optimized data blocks can only be used via OPC UA. DCOM-based clients cannot access optimized data blocks.
- The SIMATIC NET PC software must be V12 or higher.
- Smaller quantity structure for CP1613 A2. Only 40 optimized S7 connections are possible for this CP.

4.6 OPC UA protocols

At the lowest level, the communications protocol of OPC UA is TCP-based and can therefore be used cross-platform even on embedded systems. A secure, encrypted transmission is required in all cases.

According to the standard, the following protocol options are available on the OPC UA interface:

- Simple XML/SOAP with "HTTP" via port 80 or with "HTTPS" via port 443.
- Binary TCP via port 4840 and other ports, such as port 55101 to port 55105 if other servers are involved.

The protocol can be selected using the URL address of the OPC UA server on the OPC UA user interface. You have the following two options available.

- OPC UA XML web services by specifying a URL, for example:
  - http://<hostname>:80
  - https://<hostname>:443
- Pure (native) binary TCP protocol by specifying:
  - opc.tcp://<hostname>:4840

4.6.1 XML Web services

XML can be used very easily with common development environments for OPC UA applications.

The firewall is usually already set to enable port 80 for HTTP and port 443 for HTTPS or these ports can be enabled easily in it. This means that Internet access is usually possible for the use of XML Web services without extra configuration.

4.6.2 Pure (native) binary TCP protocol

In OPC UA, the "OPC UA native binary" protocol has the highest transmission speed because data is transmitted compressed and little packaging information needs to be used. It requires the least additional effort. For example, no XML parser is required as is necessary for SOAP and HTTP.

The format is standardized down to the binary level. This stabilizes the data exchange between the OPC UA client and server since there are no degrees of freedom (such as blanks or comments in XML) present.

The specially defined TCP port 4840 is used for communication in the "OPC UA native binary" protocol, while SIMATIC NET OPC server still uses port 55101 to port 55105, depending on the protocol. These ports can be enabled or disabled in a firewall.

4.7 Structure of the namespace for OPC UA

The name space of OPC UA no longer consists of just folders, items and properties. It is a network of nodes with additional information and links.

The nodes are used both for the user data (instances) and for other information such as type descriptions of data (types). The nodes of OPC UA can be subdivided as follows:

- Types
  These are the node types specified in the OPC UA specification and, where necessary, by the relevant vendor, which are explicitly defined with respect to their properties and attributes. There are four basic types as follows:
  - ObjectTypes
  - VariableTypes
  - ReferenceTypes
  - DataTypes

  The types serve as the type description for the instances.
- Instances
  These are the instances of the objects of your real project. Depending on the type of node, they obtain their properties by referencing the various types.

The root of your OPC UA server organizes both the types and the instances. This organizing includes the definition of additional nodes.

A node can have the following properties:

- Attributes that can be read
- Methods that can be called
- Events that can be signaled

Many standard nodes are defined in the OPC UA specification. Other node types may be added by specific manufacturers. The namespace is shown as a tree structure in OPC Scout V10.

4.8 Scanning the OPC UA namespace

The "Browse" and "Read" services are available for scanning the OPC UA namespace.

The response returns the requested value (reference, property or attribute).

4.8.1 "Browse"

This service is used to obtain the references (links) of a node.

4.8.2 "Read"

This service is used to obtain one or more attributes of one or more nodes.

4.9 Reading and writing attribute values of nodes

The two services "Read" and "Write" are available to read and write the attribute values of nodes.

4.9.1 "Read"

This service is used to obtain one or more attributes of one or more nodes. With structured attribute values, whose elements are indexed as in an array, clients can read the entire set of indexed values, and they can read specific ranges or individual elements.

How up-to-date the values are is decided by the "maxAge" parameter.

4.9.2 "Write"

This service is used to write values to one or more attributes of one or more nodes. With structured attribute values, whose elements are indexed as in an array, clients can write the entire set of indexed values, and they can write specific areas or individual elements.

The service request remains pending until the values have been written or until it is recognized that the values cannot be written.

Access for "Read" and "Write" uses the NodeId of the node or nodes. The NodeId is the identifier of a node in the namespace of OPC UA.

5 Appendix

5.1 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

5.2 Links and literature

Table 5-1

No.	Subject
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the article page of the application example https://support.industry.siemens.com/cs/ww/en/view/67295801
\3\	SIMATIC NET PC Software Industrial Communication with PG/PC Volume 1 - Basics (system manual) https://support.industry.siemens.com/cs/ww/en/view/77376110
\4\	SIMATIC NET: PC software Industrial Communication with PG/PC Volume 2 - Interfaces https://support.industry.siemens.com/cs/ww/en/view/77378184
\5\	SIMATIC NET: PC software Commissioning PC Stations - Manual and Quick Start https://support.industry.siemens.com/cs/ww/en/view/77377601

5.3 Change documentation

Table 5-2

Version	Date	Change
V1.0	05/2014	First version
V2.0	06/2020	Complete revision