



INGENIEURBÜRO FÜR
TECHNOLOGIE TRANSFER
DIPL.-ING. B. P. SCHULZ-HEISE

IBH Link UA Manual

Version 3.9

IBHsoftec GmbH
Turmstr. 77
64760 Oberzent / Beerfelden
Tel.: +49 6068 3001
Fax: +49 6068 3074
info@ibhsoftec.com
www.ibhsoftec.com

**TTI Ingenieurbüro für
Technologie Transfer**
Dipl. Ing. B. Peter Schulz-Heise
Tel.: +49 6061 3382
Fax: +49 6061 71162
TTI@ schulz-heise.com
www.schulz-heise.com

Windows® is a registered trademark of Microsoft® Corporation.
Simatic® S5, Step® 5, Simatic® S7, Step® 7, S7-200®, S7-300®, S7-400®, S7-1200®, S7-1500® and GRAPH® 5 are registered trademarks of Siemens Aktiengesellschaft, Berlin and Munich.
Image source: © Siemens AG 2001, All rights reserved.
Product names are trademarks of their respective owners.

Contents

Contents.....	I
PLC Programs.....	VIII
Preface	1
OPC Foundation – OPC <i>Classic</i>	1
OPC-UA (OPC Unified Architecture).....	1
IBH Link UA.....	2
IBH Link UA – Construction	3
IBH Link UA Highlights	4
MQTT connection	5
Unsecured connection	5
Example	5
View of the MQTT structure in the UA Expert.....	6
1 IBH Link UA: Setup.....	1-1
1.1 Installation and connection.....	1-1
1.2 Configuration of the IP addresses (default setting).....	1-2
Standard IP-Address configuration:	1-3
Change Password.....	1-4
1.3 Network browser window.....	1-4
1.3.1 Settings Management Level.....	1-4
Management Level Settings.....	1-5
Control Level Settings	1-5
Management Level / Control Level adjustments.....	1-6
Endpoint URL	1-6
1.4 Time setting's browser window	1-7
1.5 System browser window	1-8
Saving the IBH Link UA configuration.....	1-9
Restore the IBH Link UA configuration	1-9
Firmware Update.....	1-10
1.6 IBH Link UA default factory configuration.....	1-12
1.7 Open the Wiki	1-13
1.8 Certificates	1-14
Security Configuration of the Server (Security Modes).....	1-15
Integrated client.....	1-16
Download	1-16
Firewall	1-16
Web Configuration	1-16

2	Unified Automation UaExpert - The OPC Unified Architecture Client	2-1
	Starting UaExpert	2-2
2.1	Establishing a connection to the IBH Link UA.....	2-3
	Dialog box for accepting the OPC UA server certificate	2-7
	IBH Link UA browser window System.....	2-9
2.2	Encrypted connection to the IBH Link UA	2-10
	Desired encrypted connection.....	2-11
	Create a new certificate in the IBH Link UA.....	2-12
	Trusting the IBH Link UA Certificate.....	2-13
	IBH Link UA Certificate Encryption.....	2-16
3	Project with STEP® 7 (SIMATIC® Manager) or TIA	3-1
3.1	Software PLC CPU 416-3 PN/DP	3-1
	SoftPLC Operating, Diagnostic and Configuration windows	3-1
	SoftPLC Operating and Status windows	3-2
	SoftPLC Diagnostic window	3-2
3.1.1	PLC program of the CPU 416	3-3
	PLC Program tank level Symbol Table	3-3
	PLC Program Data Block DB2 <i>Tank_level_values</i>	3-4
	Set PG/PC interface as an Ethernet interface.....	3-4
	Project OPC UA 3E S7 Tank Level – Hardware Configuration.....	3-5
3.1.2	Transferring the program (Tank level) into the PLC	3-9
3.1.3	IBH Link UA as SIMATIC PC station.....	3-11
	Configuration IBH Link UA (SIMATIC PC Station)	3-12
	Loading the configuration into the IBH Link UA.	3-13
	Connecting the CPU-416 with the IBH Link UA	3-15
	Select the symbols to be used (OPC tags)	3-17
	Save and translate the configuration, and load it into the IBH Link UA	3-20
3.1.4	UaExpert – Program Window	3-21
3.2	Complex Variable – STRUCT – in the IBH Link OPC UA Server	3-23
	Creating an additional structure in the global data block DB2	3-23
	Re-select OPC tags.....	3-24
	Save and translate the configuration, and load it into the IBH Link UA.....	3-26
	UaExpert - Program Window.....	3-28
3.2.1	Using Structure Variables	3-28
	Programs in the UaExpert window prior activating the structure variables	3-29
	Browser window System	3-29
	Display online the variable of the <i>Structure</i>	3-31
3.3	Project using TIA 15 (IBHsoftec SoftPLC).....	3-32
	CPU 416-3 PN/DP (IBHsoftec SoftPLC) - Hardware configuration	3-32
3.3.1	Software PLC CPU 416-3 PN/DP	3-32
	SoftPLC Operating, Diagnostic and Configuration windows	3-32
	SoftPLC Diagnostic window	3-33
3.3.2	PLC program of the CPU 416	3-34

Open the project <i>OPC UA 3E TIA15 Tank Level</i>	3-34
Program Tank level <i>Default tag table</i>	3-35
Loading the PLC Program <i>Tank level</i> into the CPU.....	3-35
Hardware and software compilation.....	3-36
Hardware and software compilation with warnings.....	3-36
Download the hardware and software into the CPU	3-36
SoftPLC diagnostics CPU 416-3 PN/DP	3-39
3.3.3 UaExpert Program window	3-40
3.3.4 IBH Link UA as SIMATIC PC station.....	3-40
Setting the Properties of the Communication module	3-41
Create S7 Connection IBH Link UA OPC Server – SoftPLC 416 ...	3-42
Select OPC tags (symbols) in the OPC configuration.....	3-43
Configurable global symbolic named operands	3-44
Selecting all OPC tags (symbols) in the OPC configuration	3-45
Compiling the OPC Server configuration	3-45
Load the configuration into the IBH Link UA OPC server	3-46
The selection of the interface is shown	3-46
A check is carried out prior loading.....	3-47
UaExpert - Program window	3-47
3.4 Complex variable – STRUCT –.....	3-48
Creating an additional structure in the global data block DB2	3-48
Re-select OPC tags	3-49
Selecting all OPC tags (symbols) in the OPC configuration	3-51
Compiling the OPC Server configuration	3-51
Load the configuration into the IBH Link UA OPC server	3-52
A check is carried out prior loading.....	3-52
UaExpert - Program window	3-53
3.4.1 Using Structure Variables	3-53
Browser window System	3-54
Programs in the UaExpert window prior activating the structure variables	3-54
Display online the variable of the <i>Structure</i>	3-55
4 Historical Data - IBH Link UA.....	4-1
OPC Historical Data Access selection	4-2
The historical data of values	4-3
5 IBH Link UA - OPC UA client function	5-1
Transfer the S7 Program <i>Temperature Air Cond</i> to the PLC.....	5-2
Opening of the Hardware Configuration	5-2
Select Node Address	5-4
5.1.1 IBH Link UA as SIMATIC PC station.....	5-6
Configuration IBH Link UA (SIMATIC PC Station).....	5-7
Loading the configuration into the IBH Link UA	5-8
NetPro Window	5-9
Connecting the CPU-416 with the IBH Link UA.....	5-10
Re-select OPC tags	5-11
Starting the external OPC UA server	5-12
Creating OPC clients in the IBH Link UA	5-12
Add a Server	5-12

Add Read Variable	5-14
Connect to Variables	5-14
Connect to External OPC server.....	5-16
Confirming the Certificate.....	5-17
Status OB1 - PLC program CPU-416.....	5-17
5.2 In Practice: Value – Status – TimeStamp	5-18
Example: Transferring TimeStamp and Status code Project: <i>OPC UA 5E S7 Client Function</i>	5-18
Configure the Network.....	5-20
Connecting Variables	5-22
Connection to external OPC server.....	5-23
PLC program: Air Conditioner/CPU 416-3 PN/DP	5-24
Status FB22 - PLC program Air Conditioner/CPU 416-3 PN/DP	5-24
Status OB1 - PLC program Air Conditioner /CPU 416-3 PN/DP	5-25
6 IBH Link UA - TIA Portal connecting a CPU 312.....	6-1
Example: Tank Level	6-1
IBH Link UA configuration with the TIA Portal.....	6-2
Configuration of the IBH Link S7++	6-3
6.1 TIA Example: IBH Link UA S7-312 routed via IBH Link S7++	6-4
Online Access to the PLC (MPI = 2)	6-4
Advanced Upload dialog box.....	6-6
6.2 Inserting the IBH Link S7++ as CPU 412-2 PN into the project	6-8
Insert the power supply in IBH Link S7++	6-9
MPI interface of the CPU 412 (MPI interface IBH Link S7++)	6-9
Ethernet interface of the CPU 412	6-10
Deleting blocks (IBH Link S7++ / CPU 412).....	6-10
Hardware and software (IBH Link S7++ / CPU 412).....	6-11
Download hardware to the device (IBH Link S7++ / CPU 412)	6-11
Loading the hardware configuration into the device (IBH Link S7++ / CPU 412)	6-12
The loading of the hardware configuration is completed.....	6-13
6.3 Creating an MPI connection between PC_1 (CPU 312) and IBH Link S7++ (CPU 412-2 PN).....	6-14
6.4 Inserting IBH Link UA as SIMATIC PC station	6-15
Inserting the communication module into the IBH Link UA	6-15
Setting properties of the Communication module	6-16
Loading the Hardware of the communication module into the IBH Link UA	6-16
Load the hardware configuration into the device (IBH Link UA)	6-17
S7 connection from the OPC server to the CPU 312.....	6-18
Select OPC tags (symbols) in the OPC configuration	6-19
6.4.1 Setting the IBH Link UA	6-21
6.4.2 UaExpert - Program window	6-22
6.5 Diagnosis	6-24
6.6 IBH Link UA Diagnostics	6-24

6.7	IBH Link S7++ Diagnostics.....	6-24
7	IBH Link UA - Connection of an S5 CPU 103U	7-1
7.1	Example using the STEP 7 – Simatic Manager.....	7-1
	IBH Link S5++	7-1
	IBH Link UA configuration using the SIMATIC Manager STEP 7	7-2
	S5 PLC Program: Tank Level S5.....	7-3
7.2	Creating the project in STEP 7 - Simatic Manager	7-3
	Delete PLC Block OB1; Create PLC Block DB 2	7-6
	DB 2 of the IBH Link S5++ at S5 CPU (IM115-8 PN/DB CPU V3.2)	7-6
	Insert S7 Symbolic Operand Names.....	7-7
7.2.1	Insert the IBH Link UA as a SIMATIC PC station	7-7
	Configuration IBH Link UA (SIMATIC PC Station)	7-8
	Save and compile the IBH Link UA configuration	7-9
	NetPro window – Insert new connection	7-9
	Showing the S7 connection in the NetPro window	7-11
	Set PG/PC interface as an Ethernet interface	7-12
	Save and translate the configuration, and load it into the IBH Link UA.....	7-12
	Save and Compile the configuration	7-15
	OPC tags in the UaExpert window.....	7-16
7.3	Project S5 CPU to OPC UA in the TIA portal	7-17
	IBH Link S5++	7-17
	IBH Link UA configuration using the TIA 15 portal.....	7-17
	S5 PLC Program: Tank level S5	7-18
7.4	Creating the project in the TIA 15 Portal.....	7-19
	Insert the IM115-8 PN / DB CPU V3.2 device into the project.....	7-20
	IBH Link S5++ (IM 115-8 PN/DP CPU) property configuration.....	7-20
	Set OPC tags (symbols) in the Default tag table	7-21
	Delete PLC Block OB1	7-22
	Creating Data Block DB 2	7-23
	Hardware (IBH Link S5++) compilation.....	7-24
	Insert the IBH Link UA as SIMATIC PC station	7-24
	Insert the communication module into the IBH Link UA	7-25
	Set the Communication module properties	7-25
	Loading the hardware configuration of the communication module in IBH Link UA	7-26
	Loading the hardware configuration into the IBH Link UA	7-27
	S7 connection from the OPC server to the IBH Link S5++ (IM115-8 PN / DB CPU)	7-28
	Select OPC symbols (tags) in the OPC configuration.....	7-29
	Define all OPC tags.....	7-31
	Compiling the configuration of the OPC server.....	7-31
	Load the configuration of the OPC server in IBH Link UA	7-32
	UaExpert - Program Window	7-33
8	IBH Link UA – Integrated SoftPLC.....	8-1
8.1	Activating the integrated SoftPLC.....	8-2

8.2 SoftPLC Status and Settings.....	8-2
8.3 Configuring SoftPLC with STEP® 7 (SIMATIC Manager)....	8-3
8.3.1 PLC CPU 416 Program (IBHsoftec SoftPLC)	8-3
Symbol Table Air Conditioner Temp	8-4
Data Block DB5 – <i>Data_of_WinLC_RTX</i> –	8-4
8.3.2 Transferring the program (Air Conditioner Temp) into the PLC	8-4
Configuration of the CPU 416-3 PN/DP Setting / Checking.....	8-5
8.3.3 Configuration of the IBH Link UA as SIMATIC PC station	8-7
Configuration IBH Link UA (SIMATIC PC Station)	8-7
Loading the configuration into the IBH Link UA.	8-9
Connecting the CPU-416 with the IBH Link UA	8-11
8.3.4 Select the symbols to be used (OPC tags)	8-12
Add a Server.....	8-15
Add Read Variable	8-15
Connect to Variables	8-16
8.3.5 Inserting a SoftPLC as SIMATIC WinAC RTX in the SIMATIC PC Station (IBH Link UA)	8-17
8.3.6 Creating the S7 program for SoftSPS WinLC RTX.....	8-18
8.3.7 The PLC program for the SoftPLC of the IBH Link UA	8-18
Parameters of the Block SFB 8 (USEND) - ID = 65400 (hex FF78)	8-19
Client Function of SFB 8 (USEND)	8-19
OPC Variable Definitions.....	8-21
Function block FB 20 – USEND Call.....	8-22
Data block DB 10 – <i>Data_from_EX_Server</i>	8-24
Functions FC 8 and FC 1 – Fahrenheit_to_Celsius	8-24
Data block DB 5 – Show_Time_Temperature_St	8-24
Organization block OB 1 – Start_OB.....	8-24
Organization block OB 100 – COMPLETE RESTART.....	8-24
8.3.8 Insert the S7 Connection with NetPro	8-25
Save and Compile the configuration	8-27
8.3.9 Select the OPC tags	8-27
Save and Compile the configuration with the OPC Tags	8-29
Load the configuration into the IBH Link UA	8-29
The SoftSPS (WinLC RTX) appears in the UA Expert Window	8-30
8.3.10 Read OPC Server variables from SoftSPS (WinLC RTX).....	8-30
Connect to Variables	8-31
8.3.11 Display of the transferred variables	8-32
8.4 Configuring the SoftPLC in the IBH Link UA with the TIA Portal	8-33
8.4.1 Activating the integrated SoftPLC	8-33
8.4.2 PLC program of the SoftPLC 416 [CPU 416-3 PN/DP]	8-34
Open the project <i>OPC UA 9E TIA15 SoftPLC T-S.</i>	8-34
Data Block DB5 – <i>Data_of_WinLC_RTX</i> –	8-34
8.4.3 Hardware Configuration CPU 416-3 PN/DP	8-35
Loading the Hardware and Software into the CPU 416-3 PN/DP ...	8-36
8.4.4 IBH Link UA as SIMATIC PC station	8-38
Setting the Properties of the Communication module.....	8-39
8.4.5 S7 Connection IBH Link UA OPC Server – SoftPLC 416.....	8-39
Select OPC tags (symbols) in the OPC configuration	8-40

Compiling the OPC Server configuration	8-42
Load the configuration into the IBH Link UA OPC server	8-42
The selection of the interface is shown	8-42
Add a Server	8-44
Add Read Variable	8-44
Connect to Variables	8-45
8.4.6 Inserting a SoftPLC as SIMATIC WinAC RTX in the SIMATIC PC Station (IBH Link UA).....	8-46
8.4.7 The PLC program for the SoftPLC of the IBH Link UA.....	8-46
Parameters of the Block SFB 8 (USEND) - ID = 65400 (hex FF78).....	8-47
Client Function of SFB 8 (USEND)	8-48
OPC Variable Definitions	8-49
Function block FB 20 – Calling_USEND.....	8-51
DI_USEND – Instance Data Block DB 8	8-52
Data_from_EX_Server – Data block DB 10	8-52
COMPLETE RESTART – Organization block OB100	8-52
Fahrenheit to Celsius – FC 1 and DT_TOD – FC 8 Functions	8-53
Main – Organization block OB1	8-53
Show_Time_Temperature_Status Data block – DB 5	8-53
8.4.8 S7 Connection –OPC Server-IBH Link UA – SoftPLC IBH Link UA.....	8-54
Select OPC tags (symbols) in the OPC configuration.....	8-54
Compiling the IBH Link UA Hardware and Software	8-56
Load the Hardware and Software into the IBH Link UA.....	8-56
8.4.9 Read OPC Server variables from SoftSPS (WinLC RTX)	8-57
Connect to Variables	8-58
8.4.10 Display of the transferred variables [CPU 416-3 PN/DP]	8-59
8.4.11 Display of the transferred variables [WinLC RTX].....	8-59
8.4.12 External OPC server Connection.....	8-60
9 IBH Link UA – Alarms and Conditions	9-1
Example – OPC UA 10E TIA 15 Tank Alarm.....	9-2
Activate the integrated SoftPLC	9-2
IBHsoftec SoftPLC 416 Program <i>Tank level</i> [CPU 416-3 PN/DP]....	9-3
Configuring the hardware and software of the CPU 416-3 PN/DP ...	9-4
Hardware and software compilation with warnings	9-4
Download the hardware and software into the CPU	9-4
SoftPLC diagnostics CPU 416-3 PN/DP	9-6
9.1 IBH Link UA Hardware Setup	9-6
9.1.1 IBH Link UA SoftPLC SPS Programm	9-7
9.1.2 Configuring PLC messages	9-9
Opening the Program alarms window	9-10
Structure of associated values in alarms	9-10
9.1.3 S7 Connection IBH Link UA OPC Server – SoftPLC 416.....	9-12
The established S7 connection is shown	9-12
9.1.4 S7 Connection –OPC Server-IBH Link UA – SoftPLC IBH Link UA.....	9-13
Alarms and OPC connection establishment settings	9-13
9.1.5 Select OPC tags (symbols) in the OPC configuration.....	9-14
Compiling the IBH Link UA Hardware and Software	9-17

Load the Hardware and Software into the IBH Link UA.....	9-17
Creating an OPC clients in the IBH Link UA	9-18
Add a Server.....	9-18
Add Variable to Read	9-18
Connect Variables	9-19

PLC Programs

OPC UA 3E S7 Tank Level	Project from chapter 3. STEP® 7 (SIMATIC® Manager V5.6); CPU 416-3 PN/DP.
OPC UA 3E TIA 15 Tank Level	Project from chapter 3. TIA 15 Portal; CPU 416-3 PN/DP.
OPC UA 5E S7 Client Function	Project from chapter 5. STEP® 7 (SIMATIC® Manager V5.5); CPU 416-3 PN/DP.
OPC UA 6E TIA 15 CPU312	Project from chapter 6; TIA 15 Portal; CPU 312, IBH Link S7++.
OPC UA 7E S7 S5-CPU	Project from chapter 7. STEP® 7 (SIMATIC® Manager V5.5); S5 CPU 103U, IBH Link S5++.
OPC UA 7E TIA 15 S5-CPU	Project from chapter 7; TIA 15 Portal; S5 CPU 103U, IBH Link S5++.
S5 Programs Folder with the PLC programs.	Examples from chapter 7. Tank Level SW5.S5 – S5 program in S5W format. TANKLEST.S5D – S5 Program in the SIMATIC S5 format.
OPC UA 9E S7 SoftPLC T-S	Project from chapter 9. STEP® 7 (SIMATIC® Manager V5.5); CPU 416-3 PN/DP, IBH Link UA SoftPLC (Compatible with Siemens.WinAC RTX.)
OPC UA 9E TIA 15 SoftPLC T-S	Project from chapter 9; TIA 15 Portal; CPU 416-3 PN/DP, IBH Link UA SoftPLC (Compatible with Siemens.WinAC RTX.)
OPC UA 10E TIA 15 Tank Alarm	Project from chapter 10. TIA 15 Portal; CPU 416-3 PN/DP.

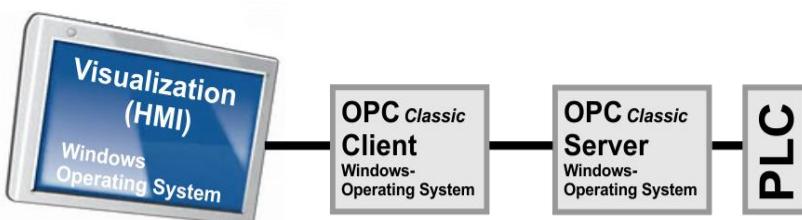
Preface

OPC Foundation – *OPC Classic*

In the mid-nineties, several companies of the automation world formed a task force to create a standardized, cross-manufacturer interface for data transmission. From this task force - OPC Task Force - the OPC Foundation formed later.

Due to the cooperation of the OPC task force with Microsoft, the OLE / COM / DCOM technologies were developed as the standard for accessing real-time data in the Windows operating systems.

This Windows-based interface, referred to as the ***OPC Classic***, is now widely used as an important communication standard for the problem-free, standardized data exchange between components of the automation technology (PLC, HMI, etc.).



Machine Control



IBHsoftec has an OPC server for linking visualizations to the SIMATIC PLC in the delivery program.

OPC-UA (OPC Unified Architecture)

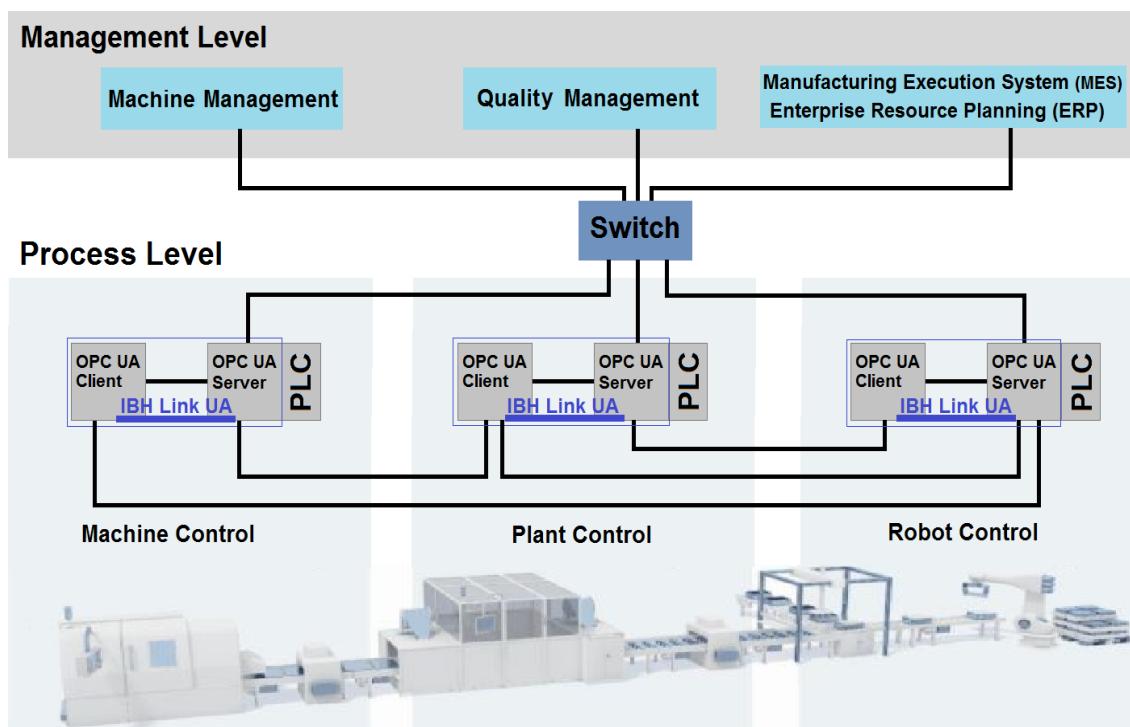
The new OPC UA specifications of the OPC Foundation differ considerably from their predecessors. It was determined that machine data (process values, measured values, parameters, etc.) cannot only be transported, but can also be described semantically in a machine-readable form.

The two OPC UA transport profiles ***UA-Binary*** and ***UA-XML*** have been specified independent of the operating system.

The UA-Binary transport profile is optimized for speed and throughput, while the UA-XML transport profile based on HTTP and SOAP protocol can be classified as firewall-friendly.

OPC UA aims to establish a comprehensive standard for **Machine-to-Machine** communication (**M2M**). Different devices and tools exchange data via a common communication platform

The PLC is no longer at the center of the automation solution. Rather OPC UA acts as a communication backbone in the machinery (process level) as well as an interface for all tools in the management level.



IBH Link UA

Since in the existing machine systems not all control components are equipped with OPC UA interfaces, the **IBH Link UA** is used.

The IBH Link UA is an OPC UA server / client module with firewall for SIMATIC® S5 and SIMATIC® S7 controllers.

Communication with an SIMATIC® PLC takes place via TCP / IP.

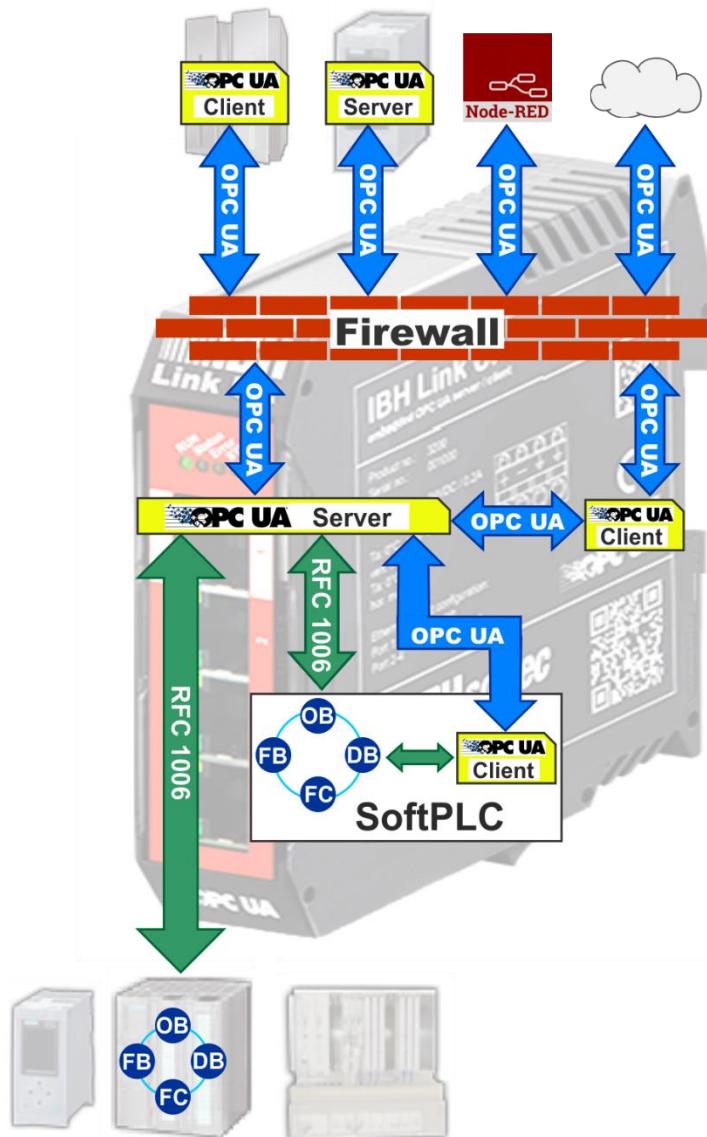
If the controller does not have an Ethernet connection, this is realized via the IBH Link S7 ++ or IBH Link S5 ++ communication adapters.

Three Ethernet ports for the process level (machine level) and an Ethernet port for the management level, which only allows OPC accesses, are integrated.

There is a firewall between the two layers.

The OPC client function enables data exchange between OPC servers.

IBH Link UA – Construction



The IBH Link UA is a server / client module. The OPC client function allows data exchange between OPC servers.

Via this function, other devices with OPC UA from a different manufacturer may exchange data. The client function is configured via the web browser.

OPC Data Access allows real-time access to data. The OPC Historical Access, also called OPC HDA, supports access to already stored data. From simple data logging systems to complex SCADA systems, historical data can be queried in a standardized way.

The historical data function is activated via the web browser.

The IBH Link UA also hosts a SoftPLC. This SoftPLC can read and write variables from the OPC UA server. The integrated SoftPLC is used for data preprocessing and is programmed with STEP® 7 using LAD, FBD, STL, SCL or S7-GRAFH®.

IBH Link UA Highlights

- OPC UA Server for easy connection to MES, ERP and SAP systems and visualizations
- OPC UA Client functions for data exchange between different OPC UA Servers
- Certified from the OPC Foundation
- Integrated SoftPLC for data preprocessing
- 4 Ethernet Ports with Firewall for clean separation of machine and supervision level
- Scalable security levels through exchange of digitally signed certificates
- Connection to S7-PLCs over S7 TCP/IP or IBH Link S7++
- Connection to S5-PLCs over IBH Link S5++
- Comfortable configuration with the IBH OPC Editor, Siemens STEP7 or the TIA Portal
- Handles up to 31 projects simultaneously
- Administration via web browser
- Historical Data
- Alarms & Conditions
- No Runtime Licenses required

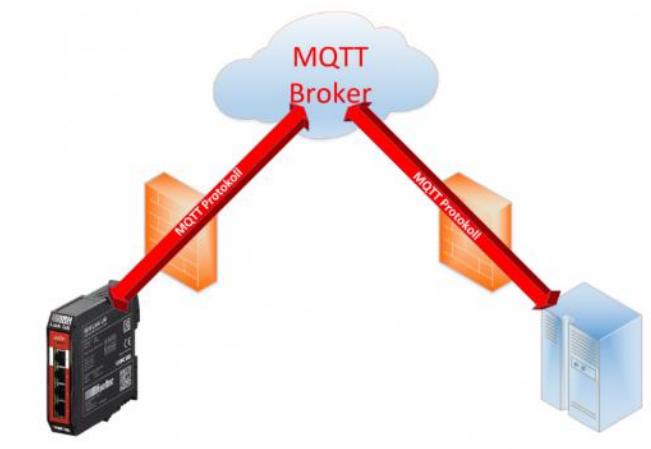
The workshop examples demonstrate the use of the IBH-Link UA functions.

The setup of the IBH-Link UA is accomplished via its integrated web interface by using a web browser. The visualization of the transferred data is done using the **OPC Unified Architecture Client** software (**UaExpert**) from Unified Automation.

The original Siemens Software TIA Portal (V13 / V14 / V15) or STEP® 7 SIMATIC® Manager V5.5 / V5.6 is used to adapt SIMATIC® S5- or SIMATIC® S7-CPUs.

The configuration of the data to be transferred to the IBH-Link UA Server by using the **IBH OPC Editor** without any software from Siemens is also demonstrated.

MQTT connection



The configuration takes place via an XML file, which is read in via the web interface under "Client". Multiple connections to different MQTT brokers can be made simultaneously.

Unsecured connection

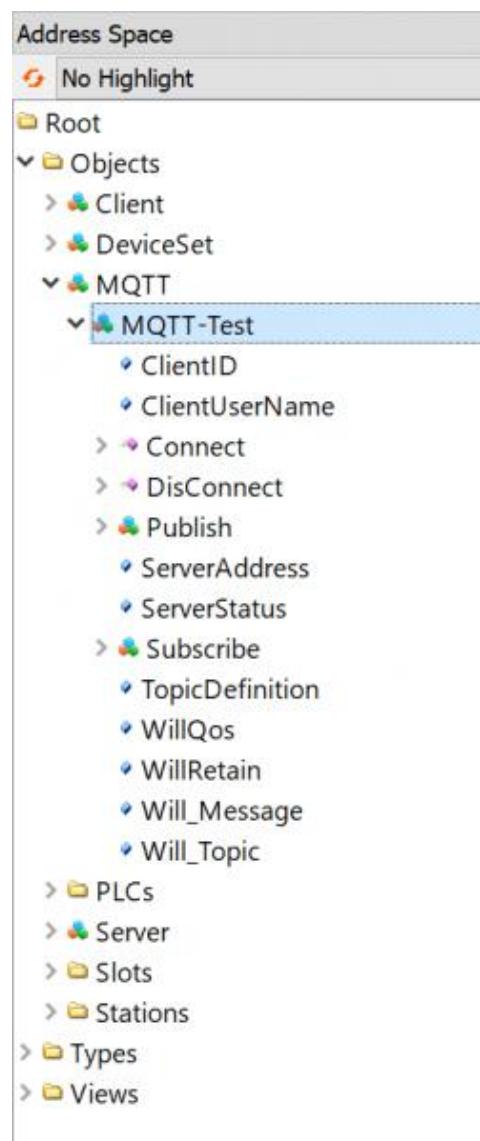
```
<MQTTConfiguration>
  <MQTTSERVER
    MQTTServerAddress="mqtt.brokeradresse.com:1883"
    MQTTClientID="beliebiger Servername"
    MQTTClientUserName="Benutzername im MQTT Broker"
    MQTTClientPassword="password">
    <MQTTTopicDefinition>
      <publish>
      </publish>
      <subscribe>
      </subscribe>
    </MQTTTopicDefinition>
  </MQTTSERVER>
</MQTTConfiguration>
```

Example

```
<MQTTConfiguration>
  <MQTTSERVER
    MQTTServerAddress="mqtt.ibhsoftec.com:1883"
    MQTTClientID="MQTT-Test"
    MQTTClientUserName="axel"
    MQTTClientPassword="password">
    <MQTTTopicDefinition>
      <publish>
      </publish>
      <subscribe>
      </subscribe>
    </MQTTTopicDefinition>
  </MQTTSERVER>
</MQTTConfiguration>
```

An MQTT connection to the MQTT Broker [RabbitMQ](http://www.rabbitmq.com) (<http://www.rabbitmq.com>) will be established on mqtt.ibhsoftec.com. In parallel, the structure "MQTT-Test" is set up in the OPC UA server with its own namespace under MQTT.

View of the MQTT structure in the UA Expert



1 IBH Link UA: Setup

1.1 Installation and connection

The IBH Link UA is designed for DIN rail mounting:



The IBH Link UA has two (2) interfaces, which are separated by a firewall, which are designed for data exchange within the management level or in the process level.

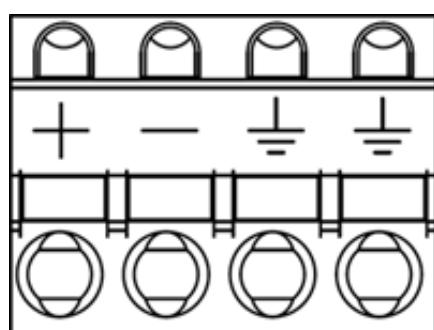
The interface of the process level consists of a 3-port switch.

The power is supplied via the included plug.



ATTENTION!

A supply voltage of 12V to 36V is to be used for the operation of the IBH Link UA. A higher supply voltage may destroy the device.



Power supply: **24VDC / 0.2A**

1.2 Configuration of the IP addresses (default setting)

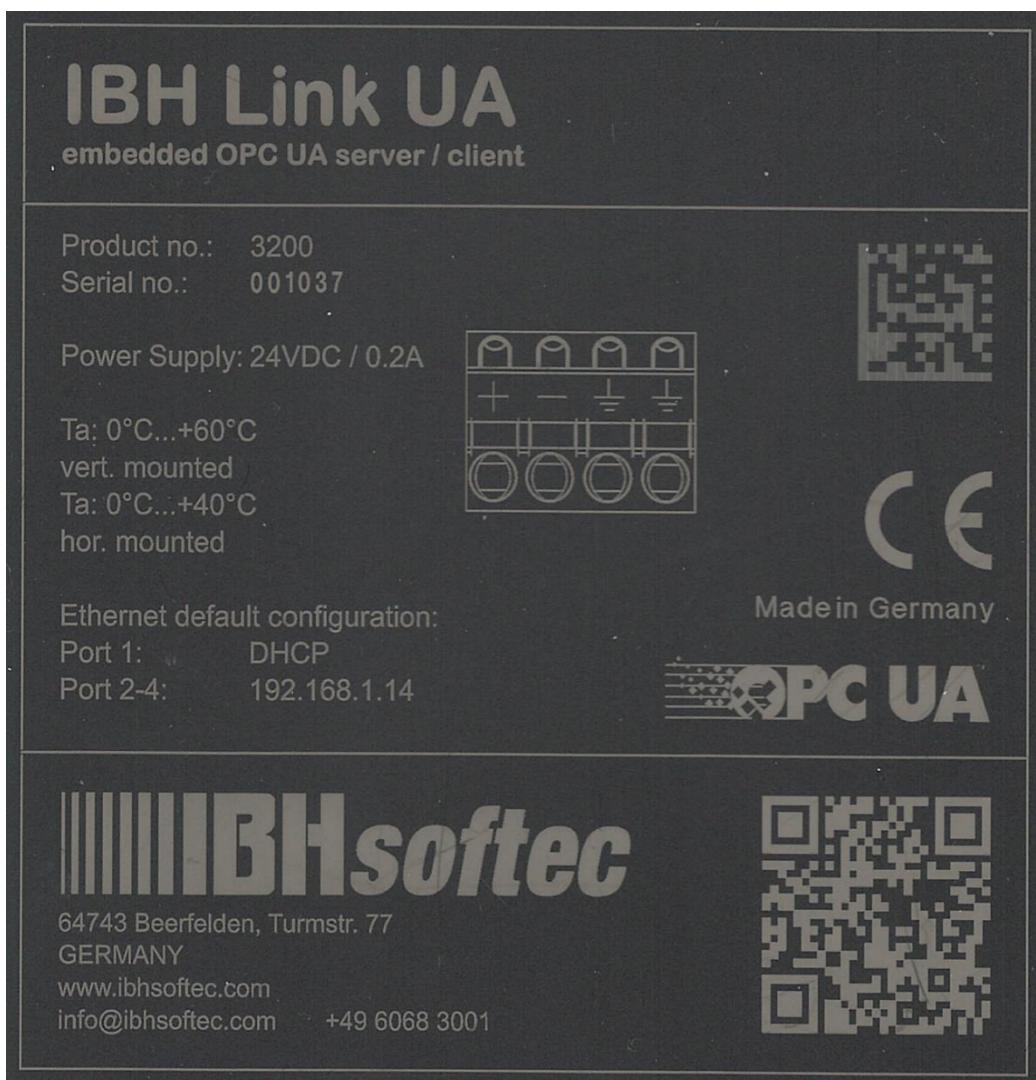
If the IBH Link UA is in its default factory setting the configuration can be done with an up-to-date web browser via the Ethernet ports 2 to 4 using the IP address 192.168.1.14.

The Ethernet port 1 can only be used to configure the IBH Link UA if a DHCP server assigns the IP address, and a DNS server resolves the name by specifying the hostname

http://ibhlinkua_<serial number>
(Example: http://ibhlinkua_001037)

No additional applications or drivers are required.

The following information is printed on the IBH Link UA housing.



Default logon data

Username: admin
Password: admin

Standard IP-Address configuration:

Level	Port	Address
Management level	Port 1	Hostname: ibhlinkua_<serial number>
Control level	Port 2 - 4	192.168.1.14



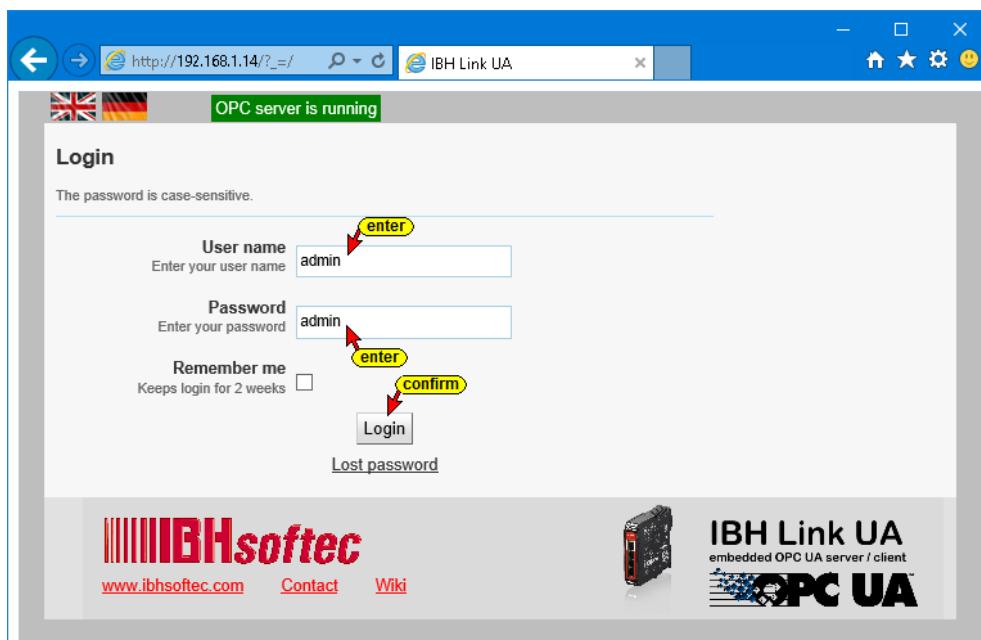
Note:

In the IBH Link, UA default factory setting the configuration may be accessed using an Internet browser (Internet Explorer, FireFox, etc.) as followed:

Via the management level (port 1) with the host name, if the port is connected to a network with a DHCP server and DNS server.

Via the ports of the machine level, it is only possible if the connected network has the sub-address 192.168.1.nn.

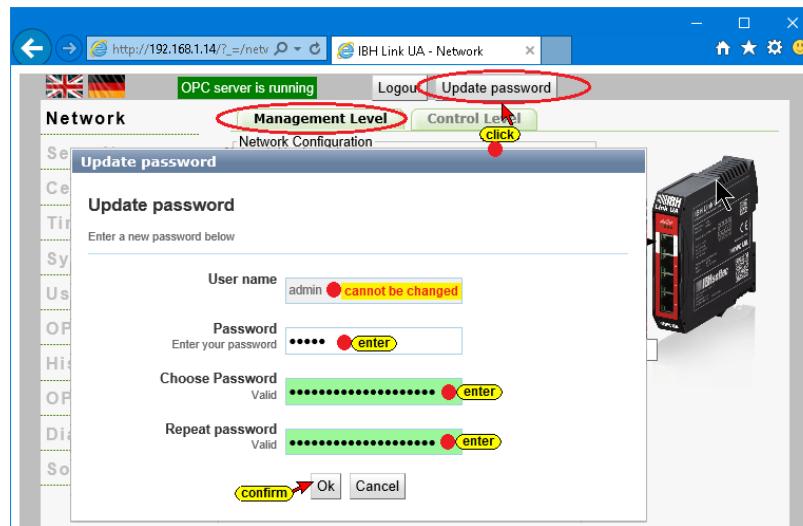
Otherwise, a fixed IP address from the subnet 192.168.1.nn (e.g., 192.168.1. 10) must be provided to the connected PC.



Change Password

For security reasons, the password should be changed. The username may also be changed.

In the open browser window **Management level / control level** click the button **Update password**.



If the password is not long enough or if you have not entered enough different characters (A - Z; 0 - 9; special characters), the background is "red". For security reasons, the password must be 12 or 16 characters long.

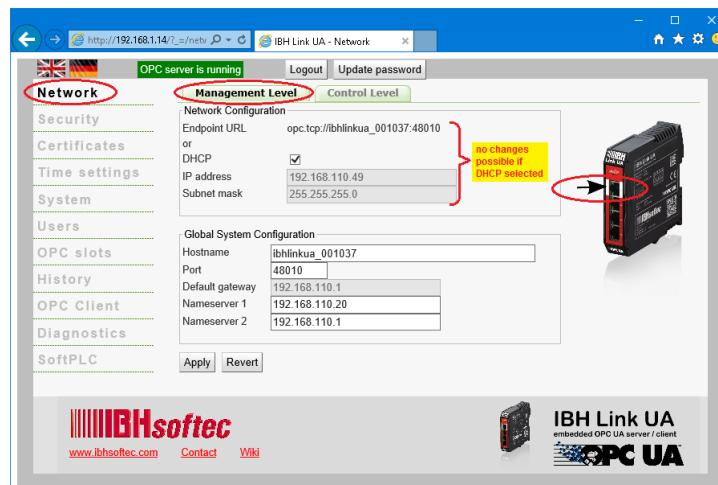
Choose Password
Too short

The browser access username cannot be changed.

1.3 Network browser window

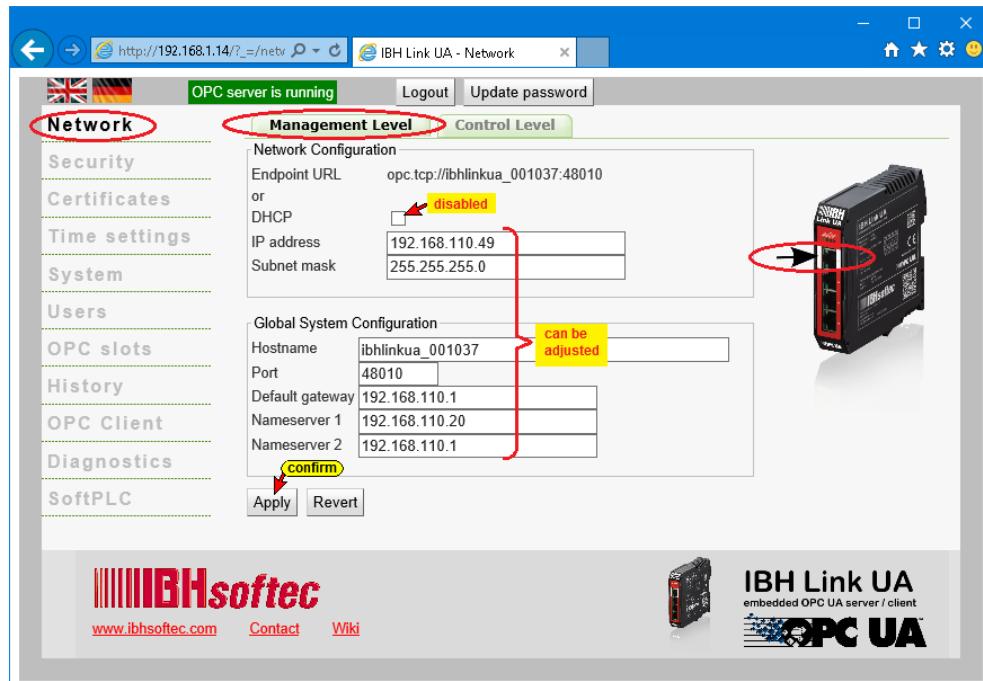
1.3.1 Settings Management Level

Port 1 **Network Configuration** and **Global System Configuration**



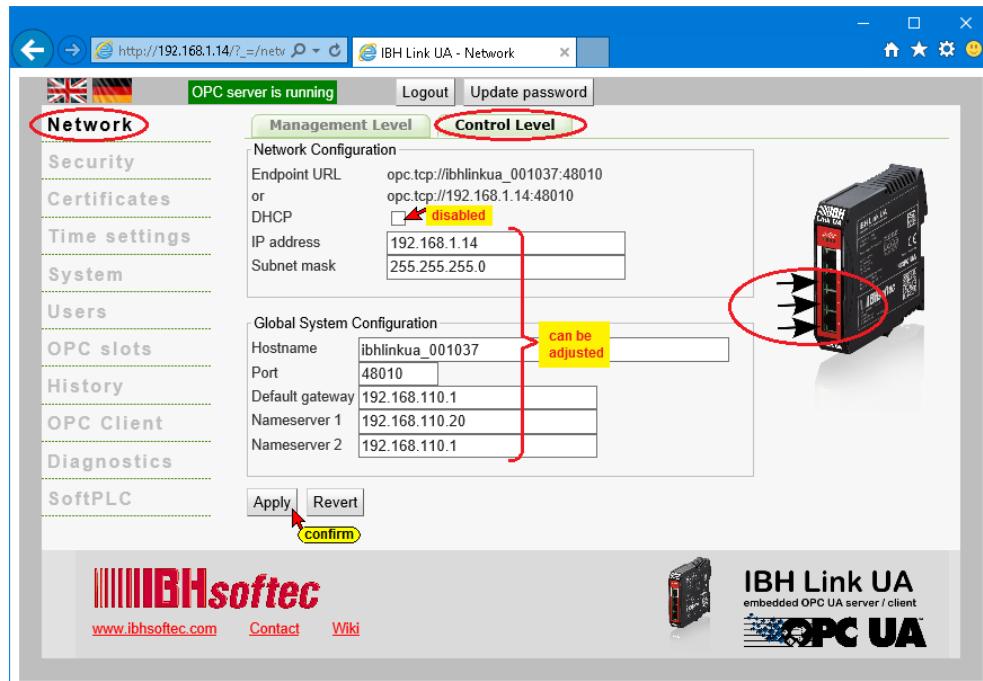
Management Level Settings

If DHCP is disabled, the **Network Configuration** and **Global System Configuration** may be modified. The hostname can always be adjusted.



Control Level Settings

Ports 2 to Port 4 Control Level **Network Configuration** and **Global System Configuration**.

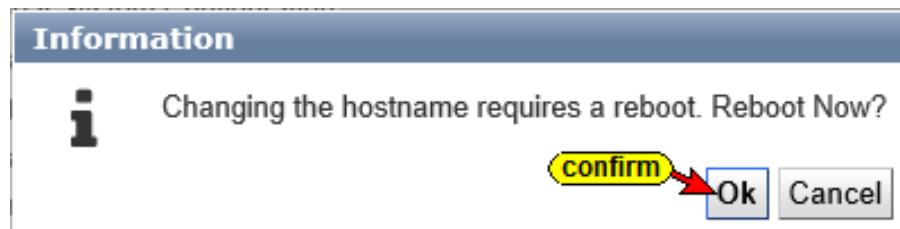
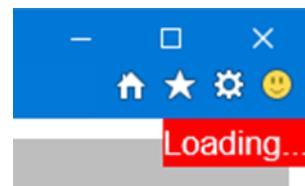


If DHCP is disabled, the **Network Configuration** and **Global System Configuration** may be modified. The hostname can always be adjusted.

Management Level / Control Level adjustments

If adjustments have been done in the Management- or Control Level the **Apply** button should be clicked for each level separately.

The transfer of the adjusted settings is displayed in the upper right corner of the browser window. Since the changes require a restart of the IBH Link UA, a corresponding information is displayed



Note:

The management level (port 1) must have a different subnet address than the control level (port 2 to port 4) to clearly identify the belonging of the port to the Ethernet interface.

Endpoint URL

The **Endpoint URL** is displayed in the **Management Level** and in the **Control Level**. The endpoint URL is generated by the IBH Link UA based on the settings. The endpoint URL consists of the protocol: // hostname: port.

Management Level	Control Level
<hr/>	
Network Configuration	
Endpoint URL	opc.tcp://Test_001037:48010
or	opc.tcp://192.168.110.49:48010

Management Level	Control Level
<hr/>	
Network Configuration	
Endpoint URL	opc.tcp://Test_001037:48010
or	opc.tcp://192.168.1.14:48010

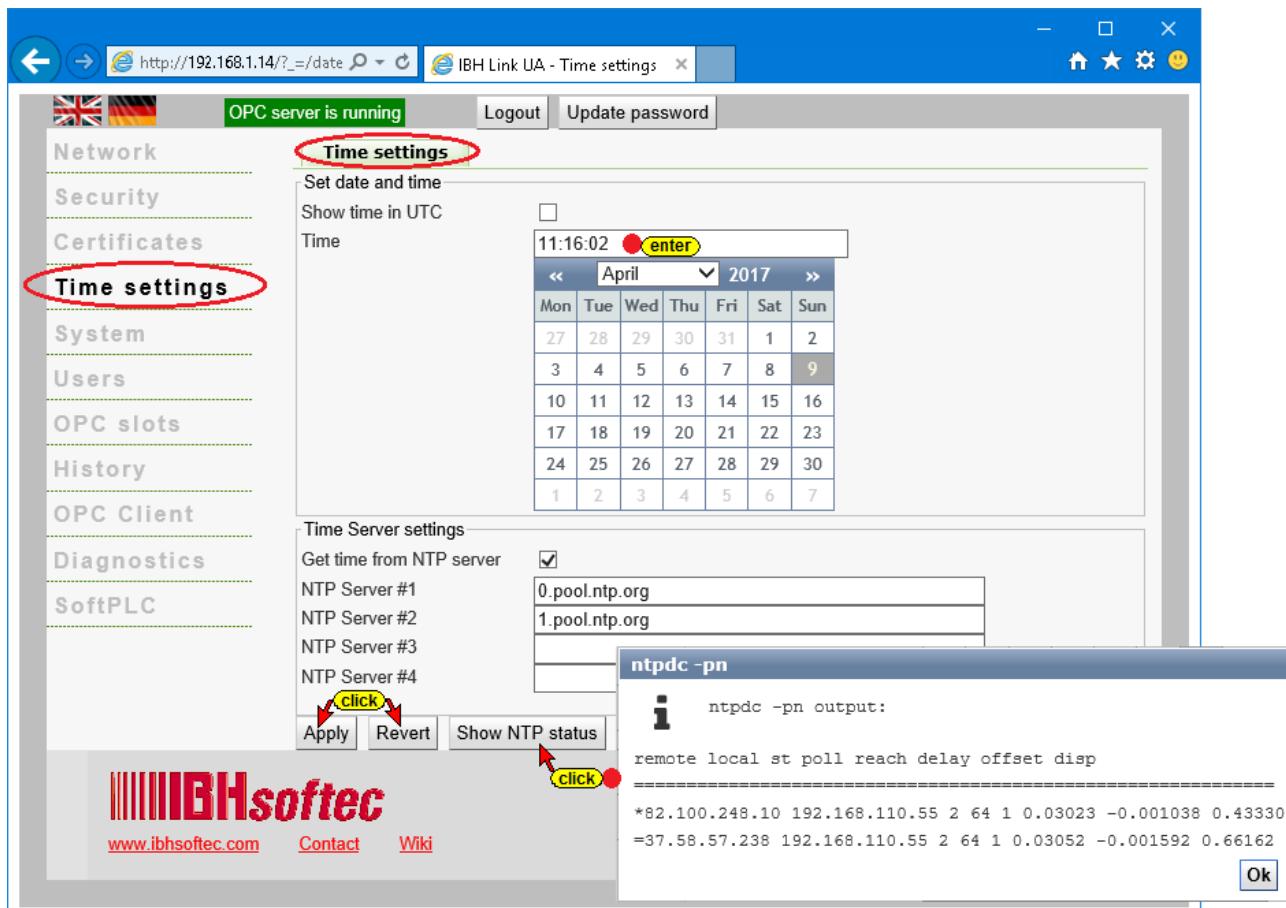
This **Endpoint URL** is required to set an OPC UA client.

1.4 Time setting's browser window

For the correct allocation of certificates, the date and time of the IBH Link UA must correspond exactly to the actual values.

The date and time can be entered manually or automatically via the time server.

Two-timeservers are already specified.



Clicking on **NTP status** displays the status of the transmitting time servers with their IP address.

Note:



The date and time must be set correctly, since OPC UA works with time stamps.

Certificates lose their validity in case of incorrect time comparison.

A correct time for communication between server and client is, therefore, very important.

1.5 System browser window

The system browser window lists information about the IBH Link UA.

The configuration of the IBH Link UA can be saved in a file. This file may be used to restore the configuration later.

From this window, the download and transferred of new firmware for the IBH Link UA can be initiated. The IBH Link UA can be restarted and OPC UA options can be specified.

The screenshot shows the 'System' tab of the IBH Link UA configuration interface. The left sidebar includes links for Network, Security, Certificates, Time settings, System (which is selected), Users, OPC slots, History, OPC Client, Diagnostics, and SoftPLC. The main content area has several sections:

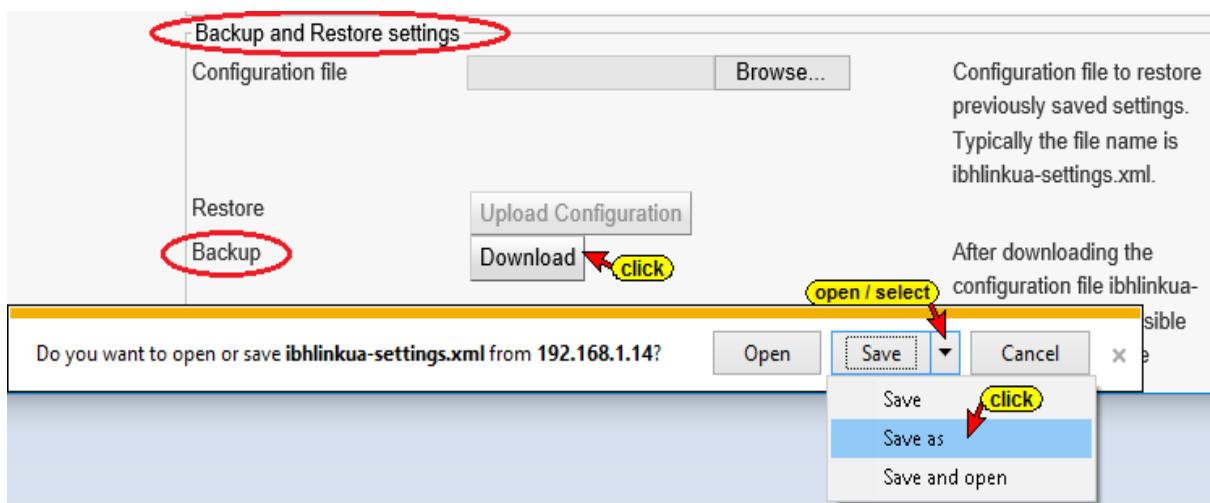
- Device information:** Firmware: IBH Link UA V3.03 Feb 14 2017 12:04:22, Version: 1037, HW revision: 1.1.0, Board ID: 20140000000000211, MAC address: 68-C9-0B-88-9E-C9, CPU load (%): 3.6, Memory usage: 8.7 (%), Temperature (°C): 37.5, VAUX2: 3.30V, V3_3D: 3.23V, V1_2SWITCH: 1.24V, VBAT_5V: 5.07V, VIN_24: 17.86V. To the right is a 'CERTIFIED FOR COMPLIANCE' logo from the OPC Foundation.
- Backup and Restore settings:** Configuration file input field with 'Browse...' button, and a note explaining it's for restoring previously saved settings (ibhlinkua-settings.xml).
- Firmware Update:** Select firmware File input field with 'Browse...' button, and a note explaining it's for performing an update (fw-update-vXXX.tar).
- Restart IBH Link UA:** Reboot button with a note explaining it restarts the device, interrupting communication with PLCs and OPC UA Clients.
- OPC UA options:** Two checkboxes: 'Build structure variables' and 'Update Source Timestamp only on change'. A note explains that building structure variables requires more memory and is applied on restart; updating timestamps only on change refreshes them less frequently.

At the bottom, there are links for **BHsoftec**, **Contact**, **Wiki**, and images for **IBH Link UA** and **OPC UA**.

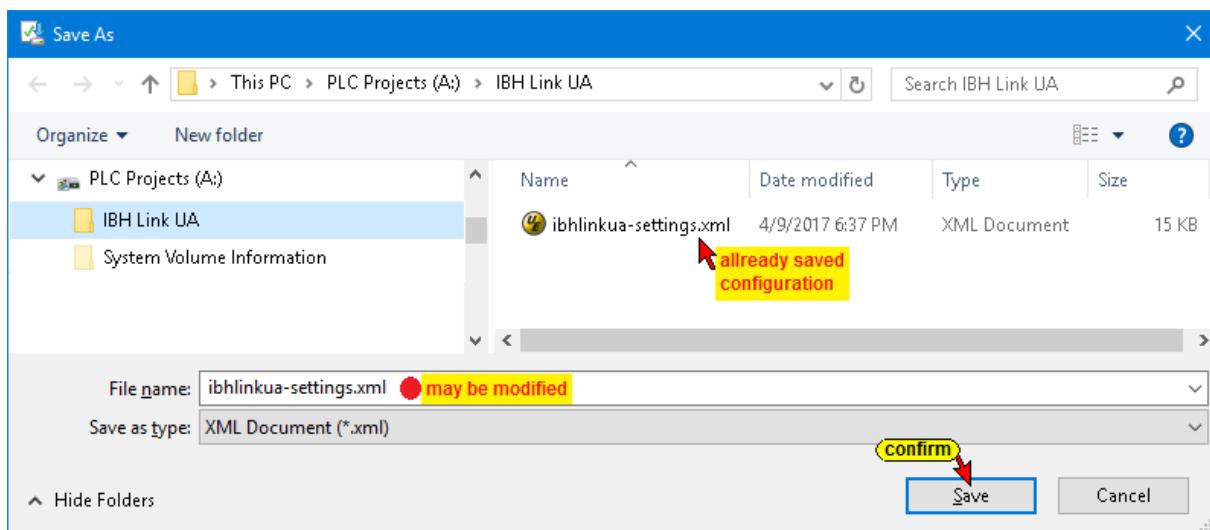
Saving the IBH Link UA configuration

Click on the button **Download** and select **Save As** from the open dialog box.

Download



Specify the path and filename in the **Save As** dialog box and confirm by clicking **Save**.



This procedure saves the existing settings.

Restore the IBH Link UA configuration

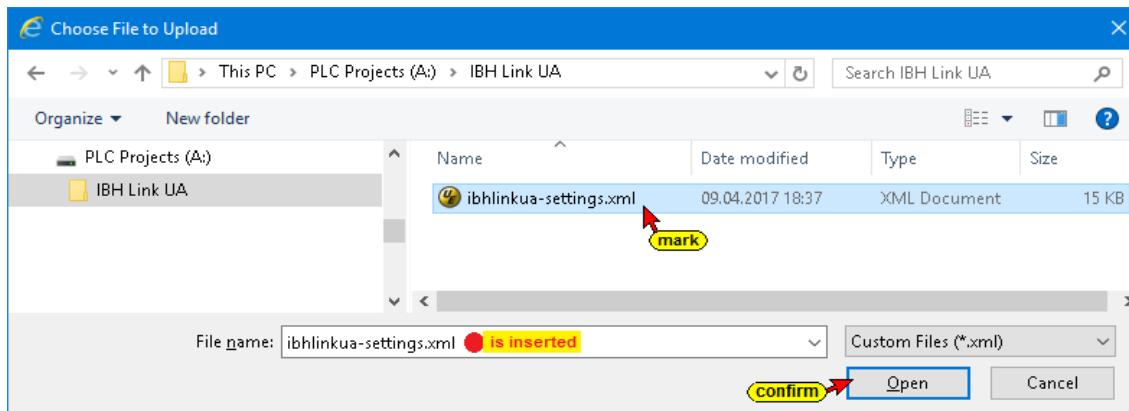
An already saved configuration can be restored.



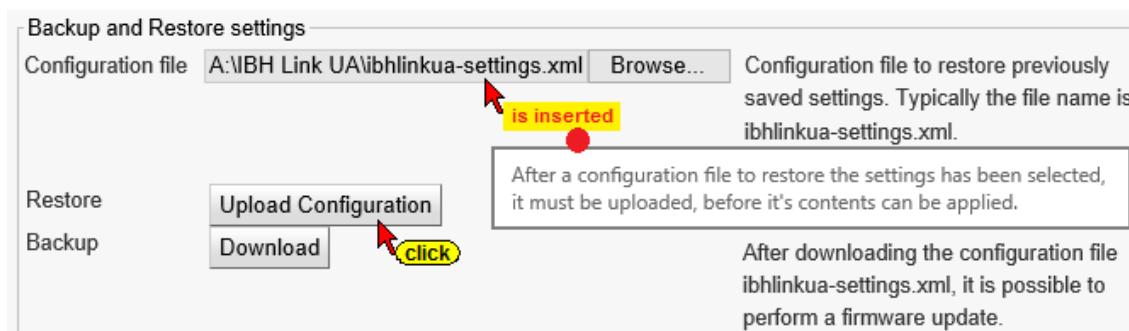
Click the Browse button.

Browse...

The **Select file to Upload** dialog box opens.



Close the **Choose File to Upload** dialog box and click the **Upload Configuration** button.

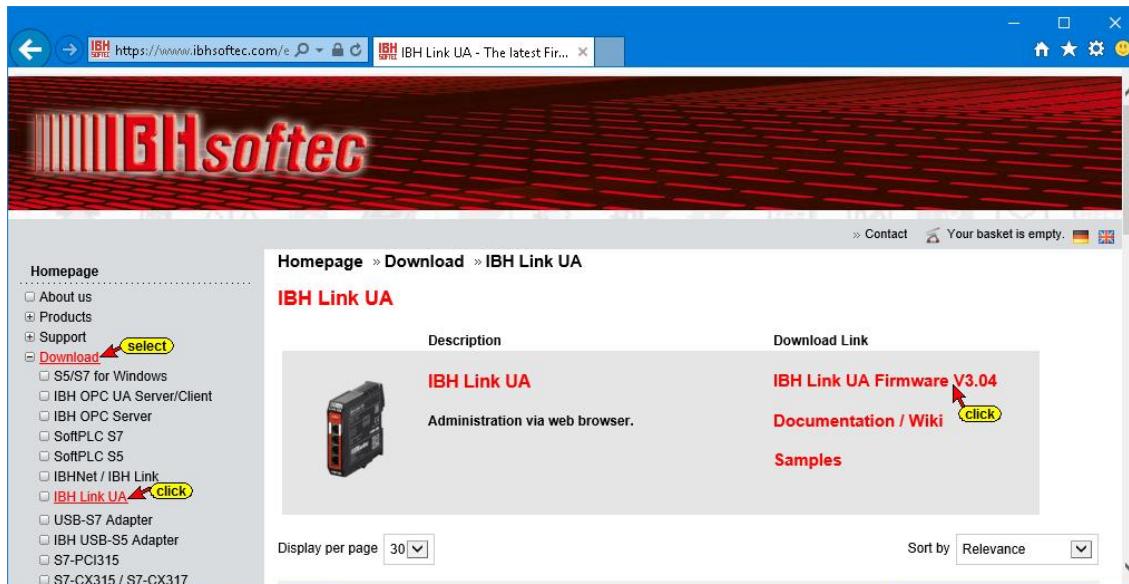


The successful restore of the configuration is displayed.

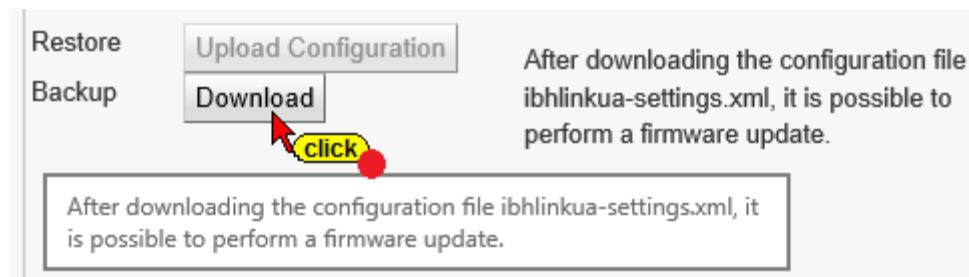


Firmware Update

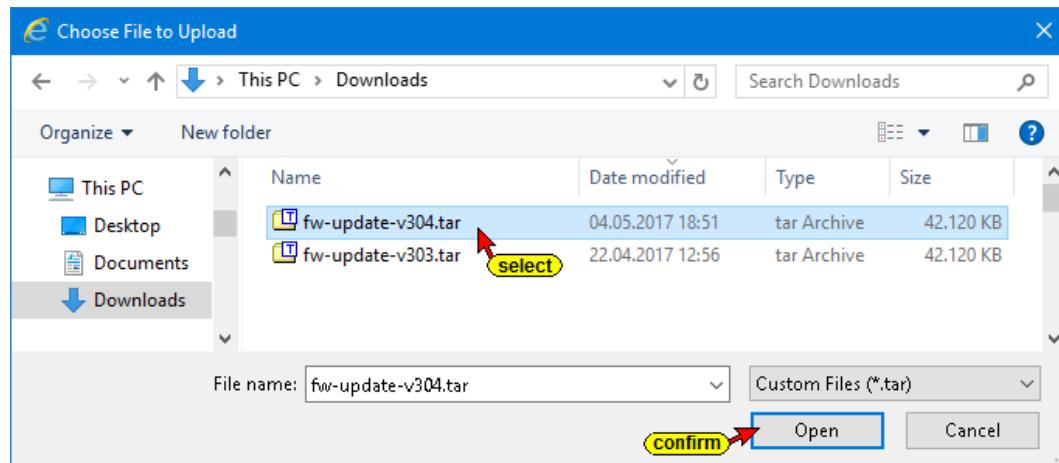
From the IBHsoftec home page download the firmware for the IBH Link UA.



Click the **Download** button to save the current configuration of the existing firmware.



Click on the **Browse** button to select the firmware file *.tar for uploading



The firmware file *.tar is displayed in the **IBH Link UA** browser window.

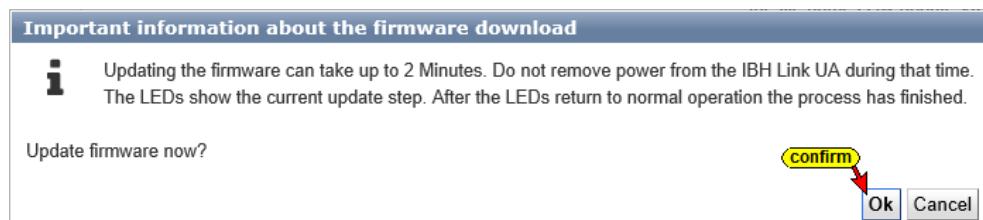


Click the **Upload Firmware** button to load the new firmware into the IBH Link UA. The new firmware is not yet accepted (updated).

The progress of loading the firmware update is displayed.



Click the button **Apply new firmware and reboot** and confirm the information about the firmware update.

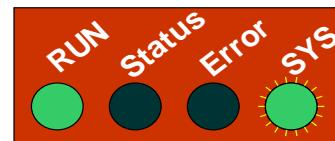


Upload Firmware (Update)

The loading / updating of the firmware is indicated in the upper-right corner of the browser window.

If the LEDs show normal operation, the browser window of the **IBH Link UA** must be reopened and the firmware updates is completed.

In normal operation, the **RUN** LED is lit, the **SYS** LED flashes and the LED's **Status** and **Error** are off.



Device information	
Firmware	IBH Link UA V3.04 Apr 3 2017 13:45:20
Version	
Serial number	1037
HW revision	1.1.0
Board ID	201400000000000211
MAC address	68-C9-0B-88-9E-C9
CPU load (%)	4.5
Memory usage	8.8 (%)

1.6 IBH Link UA default factory configuration

The button to reset the software to the default factory configuration is located on the printed side of the IBH Link UA, behind the middle ventilation slot below the QR code. The reset procedure reset the IBH Link UA to the default factory configuration with the current firmware loaded into the device.

Procedure:

- Power down the IBH Link UA
- Press and hold the reset button
- Power up the IBH Link UA
- Wait until all four LEDs turn red and go off again
- Release the reset button



1.7 Open the Wiki

IBHsoftec GmbH maintains a **WIKI site** on the Internet. An extra section for the **IBH Link UA** is provided. Here the use of the **IBH Link UA** is described in detail.

If your PC is connected to the Internet, the WIKI page can be directly called from the **IBH Link UA**.

The top window shows the configuration interface for the IBH Link UA. It includes tabs for Management Level and Control Level, and sections for Network Configuration (Endpoint URL, DHCP, IP address, Subnet mask) and Global System Configuration (Hostname, Port, Default gateway, Nameserver 1, Nameserver 2). A sidebar lists various configuration options like Security, Certificates, Time settings, and Users. The bottom window shows the IBHsoftec Wiki page for the IBH Link UA, featuring a thumbnail of the device, a navigation bar with Contact and Wiki links, and a list of topics including Description, Startup operations, Configuration with TIA Portal, Configuration with STEP7, Consistent Reading/Writing arrays and structures, Loading multiple projects into the IBH Link UA, Configuration with IBH OPC Editor, Logo8 Configuration with IBH OPC Editor, Variable Syntax, Client functions, Integrated S7 SoftPLC, IBH Link UA with WinCC 7, Technical data, and Reset button.

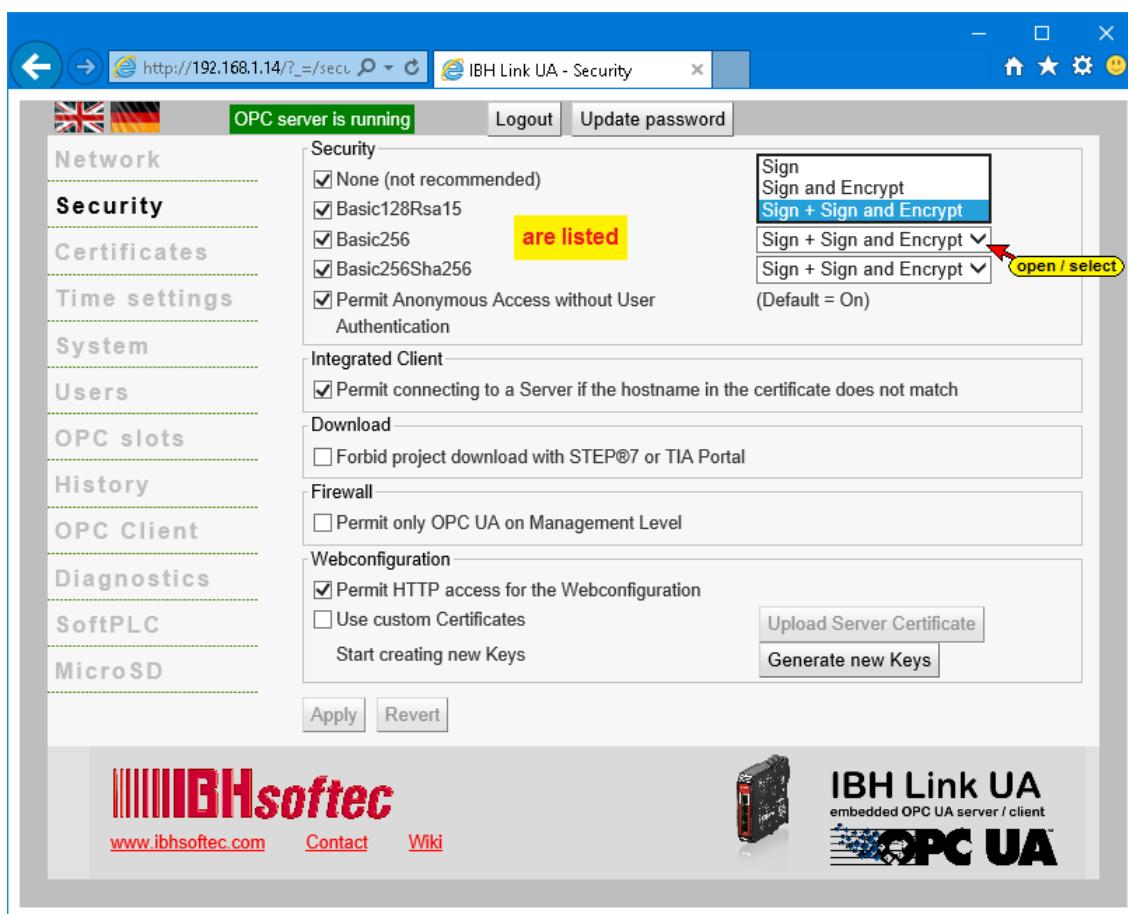
1.8 Certificates

To establish a connection between an OPC UA client and an OPC UA server, security settings must be performed.

The IBH Link UA has a certificate management to enable a secure communication defined by OPC UA (**SecureChannel**). A web browser is used to configure the security levels and manages the certificates.

The mechanisms defined by the OPC Foundation are used as a base. OPC UA Security includes authentication and authorization, encryption and data integrity by signing. This allows the control system to be protected against uncontrolled access via a higher-level system.

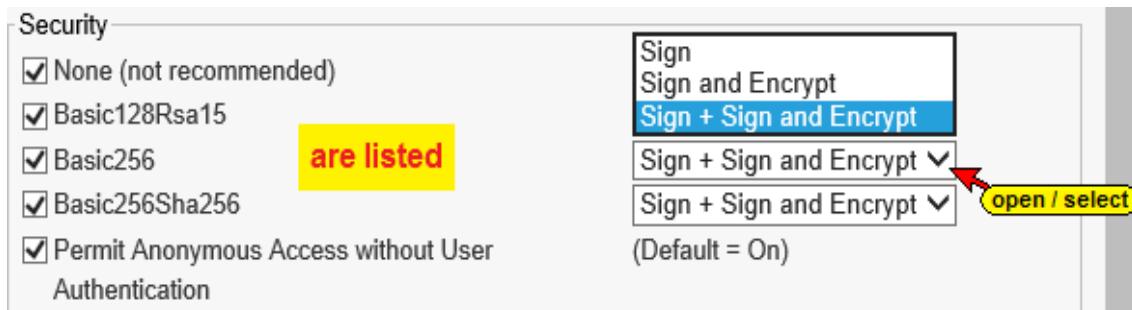
In the IBH Link UA Browser Security window, the security levels offered by OPC UA are listed for selection.



The security configuration of the server is requested by the client via the **SecureChannel** to set up the communication channel. This guarantees the security (confidentiality) and integrity of the transferred messages.

Note:

For non-trusted third parties, it is difficult or nearly impossible to read the contents of Encrypted messages exchanged between the OPC client and the OPC server.

Security**Security Configuration of the Server (Security Modes)**

The different encryption levels:

None (not recommended) No encryption

Basic128Rsa15 128 bit encryption

Basic256 256 bit encryption

Basic256Sha256 256 bit encryption

Permit anonymous access without user authentication

(Default = On)

The IBH Link UA supports the level **Sign** and **Sign and Encrypt**

None No security level, fastest data transfer.
The message is not secured.

Sign The messages contain safety signs.

The message is signed with the corresponding **Private Key** of the **Application Instance Certificate** of the OPC UA client. Signed messages can detect whether a received message has been manipulated by an untrustworthy third party.

Sign and Encrypt The messages contain security identifiers and are encrypted.

The message is also encrypted with the **Public Key** of the **Application Instance Certificate** of the OPC server.

The anonymous access, without user authentication, is allowed by default and can be disabled.

Integrated client

Integrated Client

Permit connecting to a Server if the hostname in the certificate does not match

It is preferred to use a hostname to connect to a server. If no **DHCP server** is available, no hostname is available.

If the option is enabled, the absolute IP address can be used to connect to the server.

Download

Download

Forbid project download with STEP®7 or TIA Portal

Downloading STEP® 7 or TIA Portal projects can be disabled.

Firewall

Firewall

Permit only OPC UA on Management Level

The firewall can be instructed to allow OPC UA connections on the management level only.

Web Configuration

Webconfiguration

Permit HTTP access for the Webconfiguration

Use custom Certificates

Start creating new Keys

Upload Server Certificate

Generate new Keys

If the access to the configuration of the IBH Link UA via a secure transport encryption (**HyperText Transfer Protocol Secure – HTTPS**) is only permitted, the option **Allow HTTP access to the web configuration** must be disabled.

Every IBH Link UA had the same parameter set for negotiating the keys for encryption. This normally causes no problems. However, it is possible to create a new parameter set for the encryption.

Note:

The generation of a parameter set for negotiating keys for encryption may take several hours.

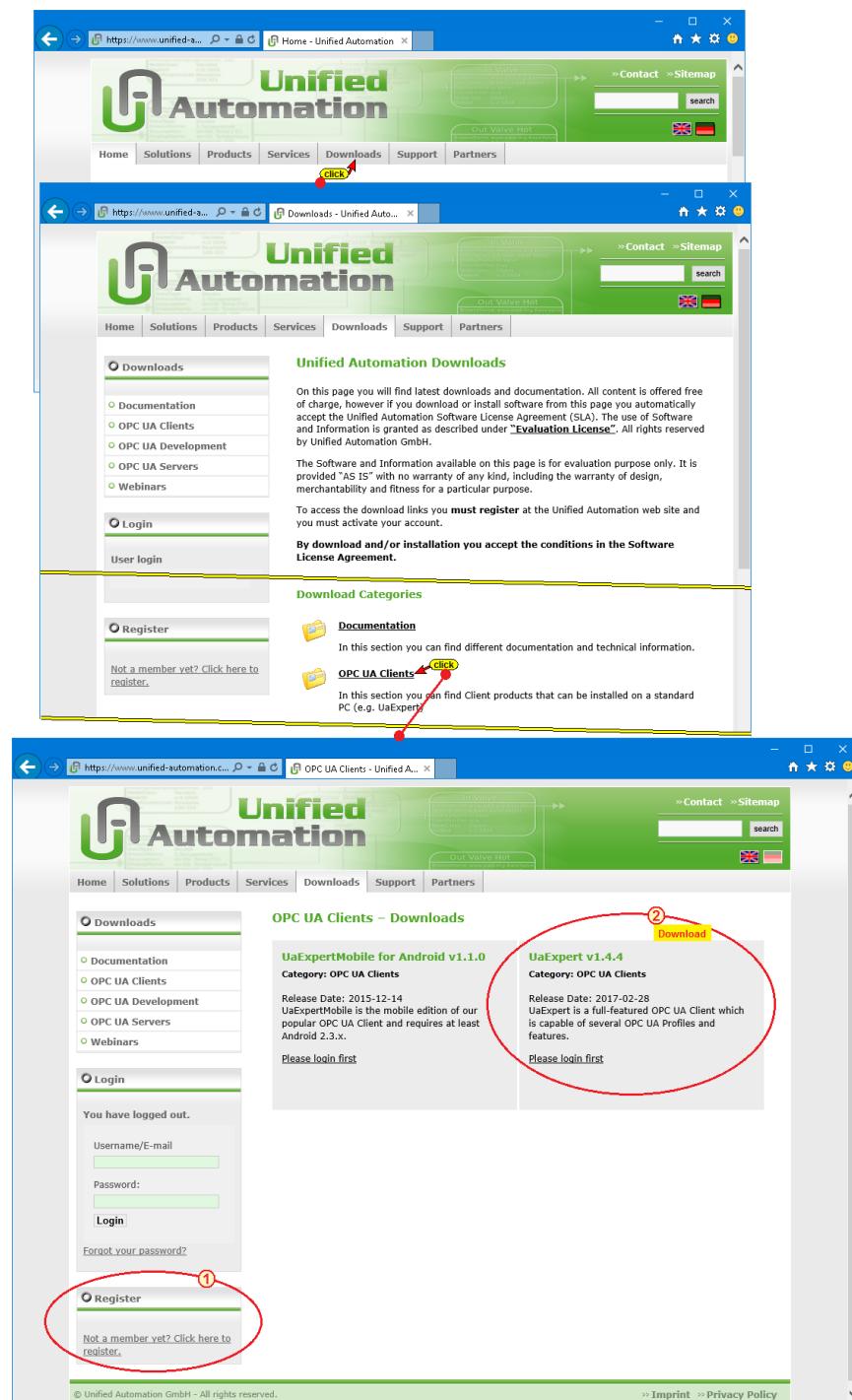
2 Unified Automation UaExpert - The OPC Unified Architecture Client

To demonstrate the work of the IBH Link UA, it is helpful to have an OPC client program running on the PC. It is recommended to use the OPC UA client program UaExpert from Unified Automation.

This can be downloaded via:

<http://www.unified-automation.com>

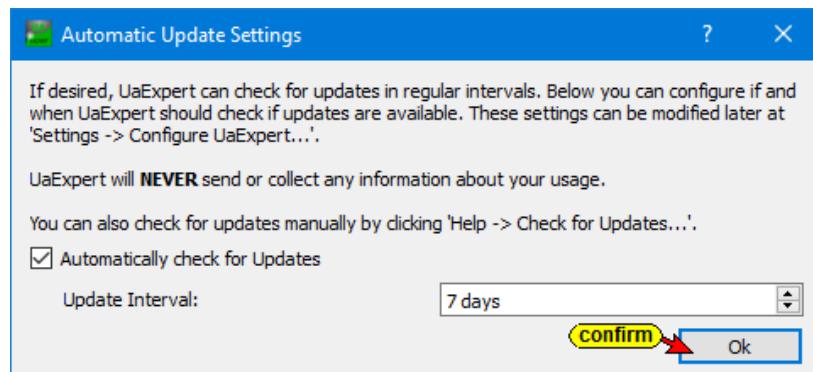
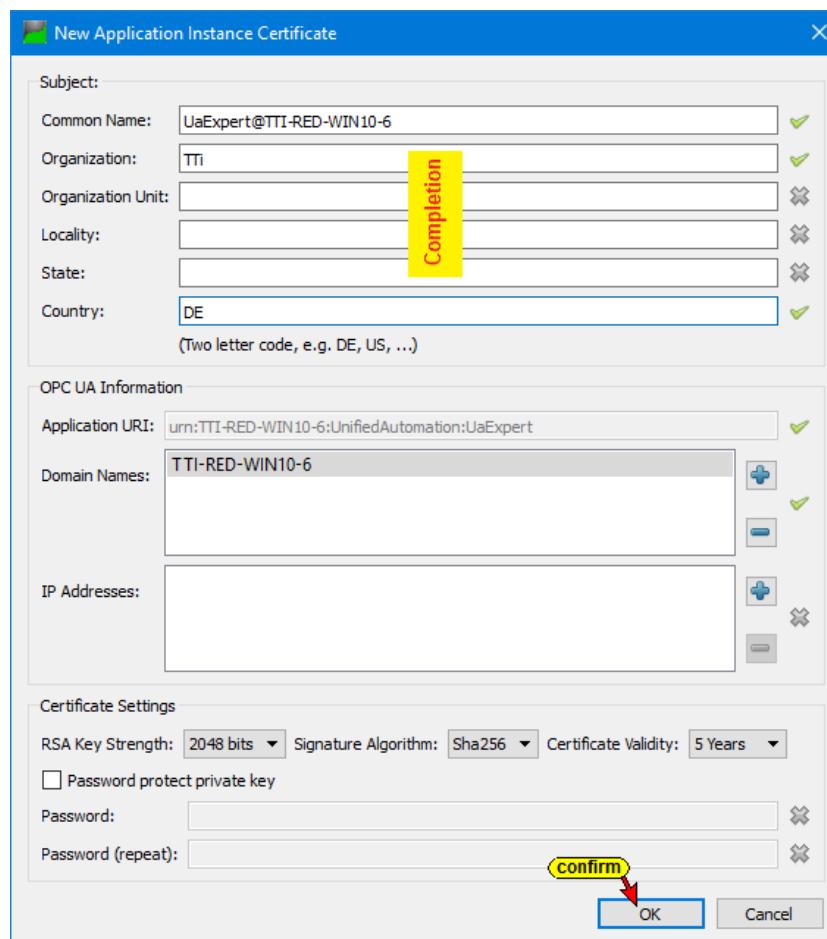
Free download requires Unified Automation registration.



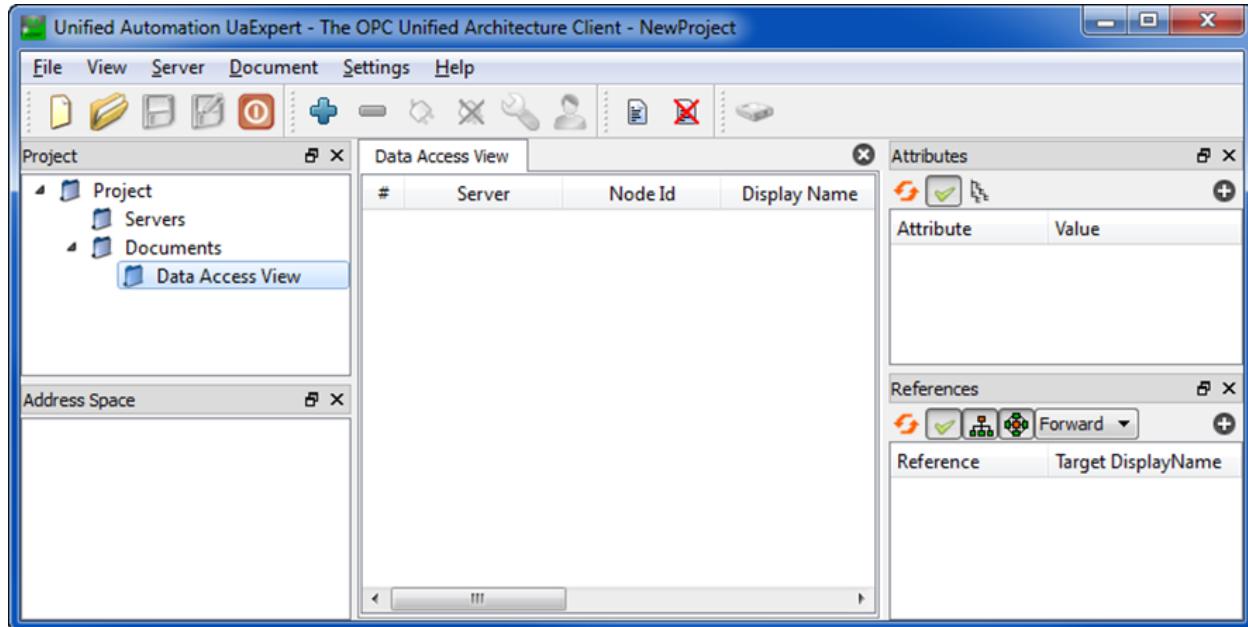
Starting UaExpert

After download and installation of the software, a UaExpert icon double-click starts the program.

Several presets are to be made and confirmed.

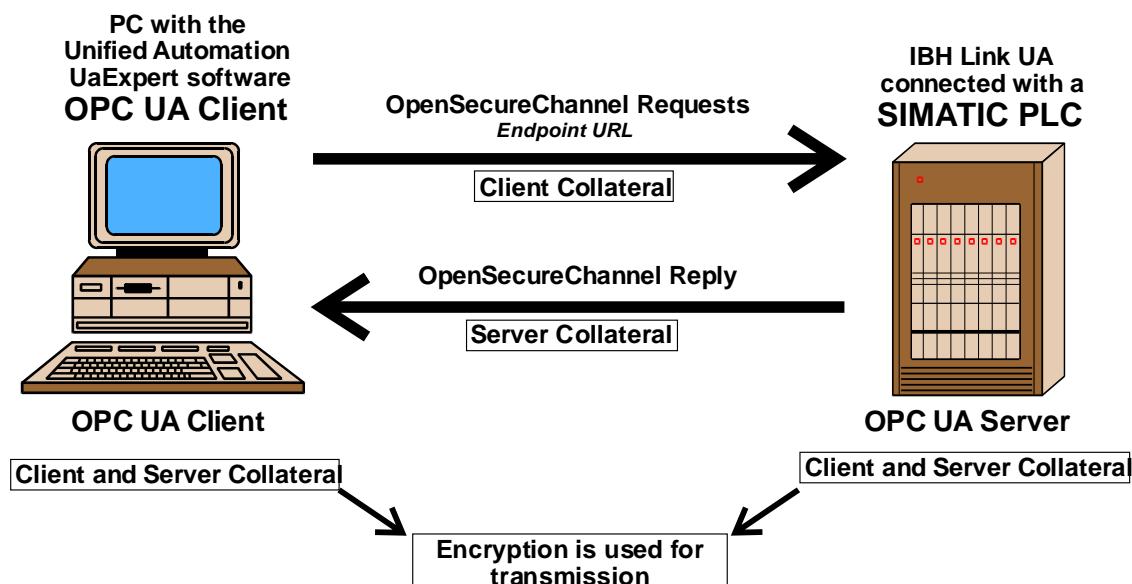


After confirming the Features, the UaExpert program window opens. All necessary tools to establish a connection to an OPC UA server (IBH Link UA) to display the security options and the transferred data are available.



2.1 Establishing a connection to the IBH Link UA

Several steps are necessary to establish the connection between an OPC UA client and an OPC UA server. The connection is only possible if the server and the client have identical certificates.

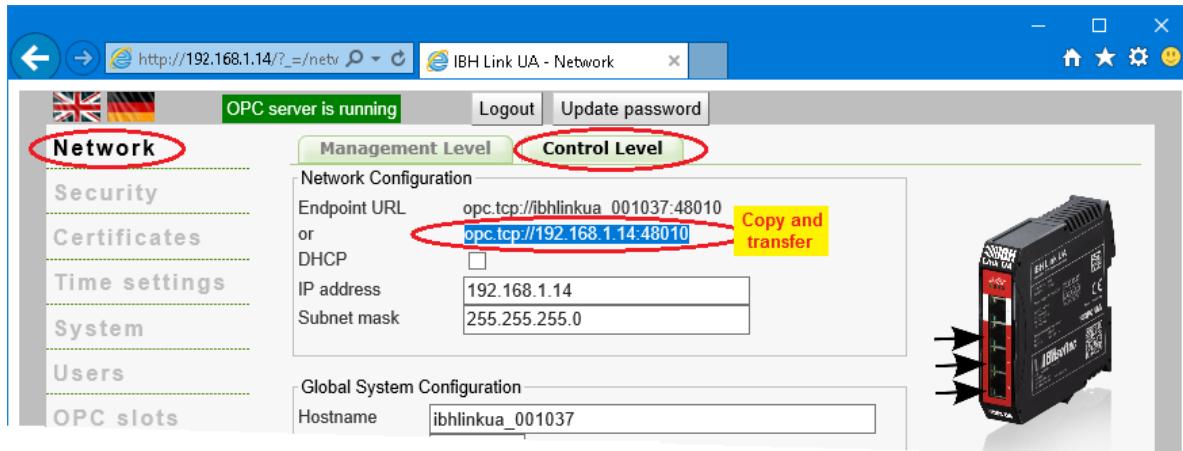


To establish a connection to the IBH Link UA, the ***Endpoint URL***, from the IBH Link UA browser window ***Network / Control Level*** must be entered.

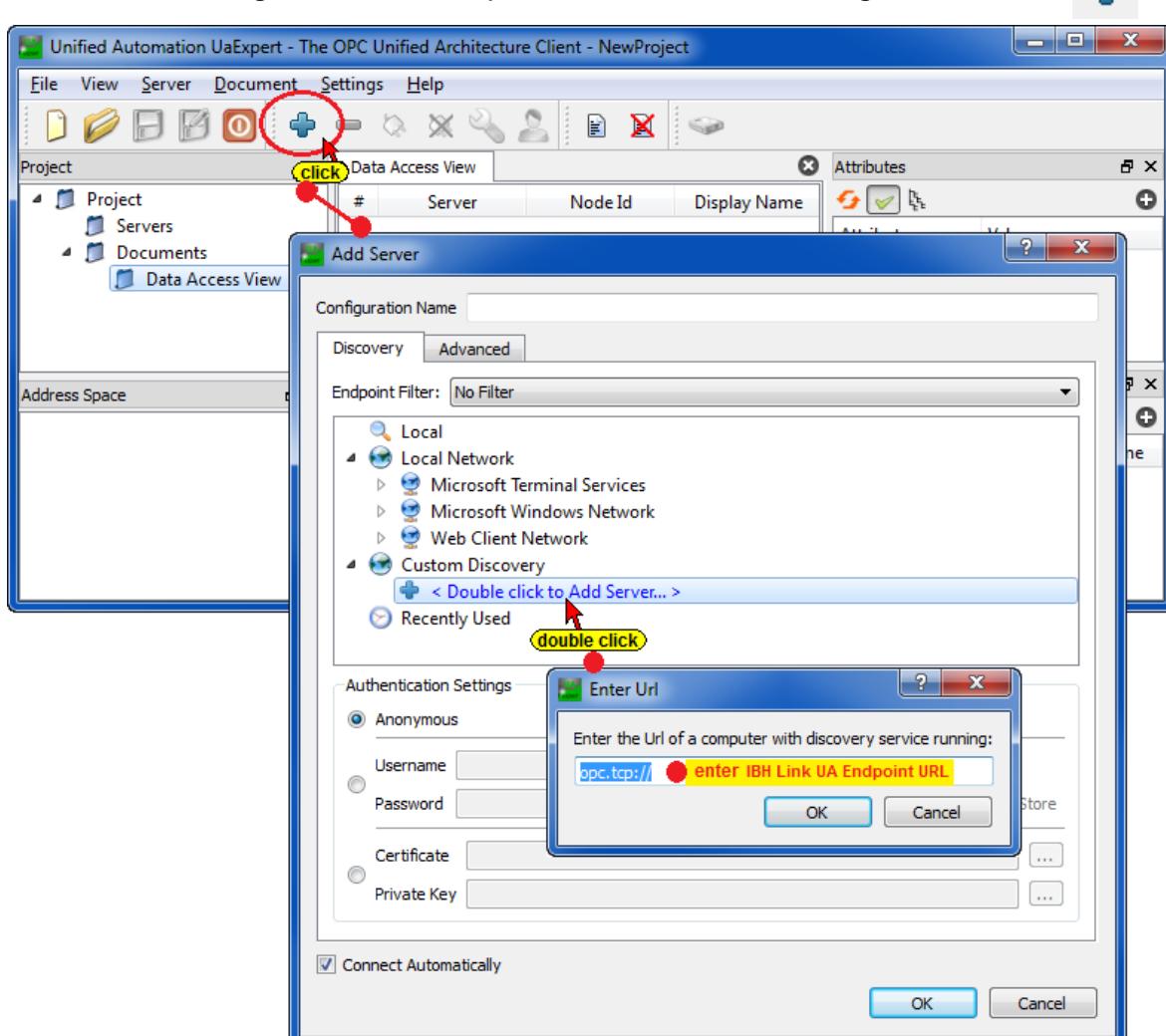
Preferably, the **Endpoint URL** with the hostname should be used to enable the client to validate the names of the endpoints and the names in the certificate.

Since no DNS server is available in the workshop, the absolute IP address is used as an exception.

In this case, the absolute **Endpoint URL** is copied from the browser window to the clipboard.



Clicking the Plus icon opens the **AddServer** dialog box.



A double-click on
<Double click to Add Server ...>



opens the **Enter URL** dialog box.

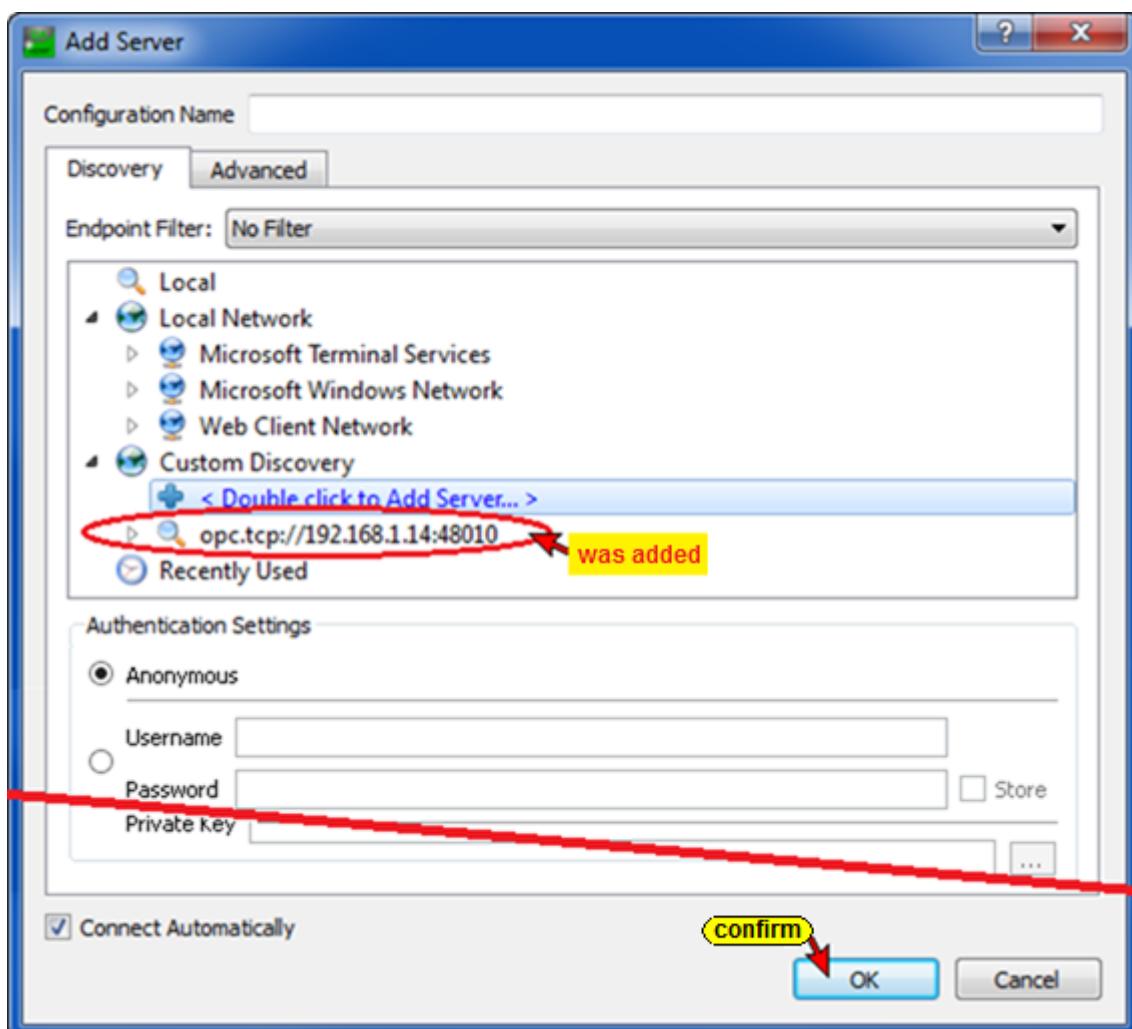
Here the **Endpoint URL** from the IBH Link UA browser window **Network / Control Level** must be entered.

Preferably, the **Endpoint URL** with the hostname should be used to enable the client to validate the names of the endpoints and the names in the certificate.

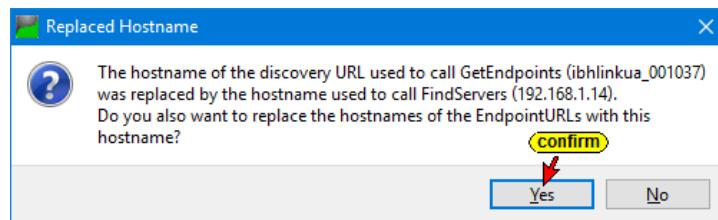
Endpoint URL copied and transferred to the Enter URL dialog box.



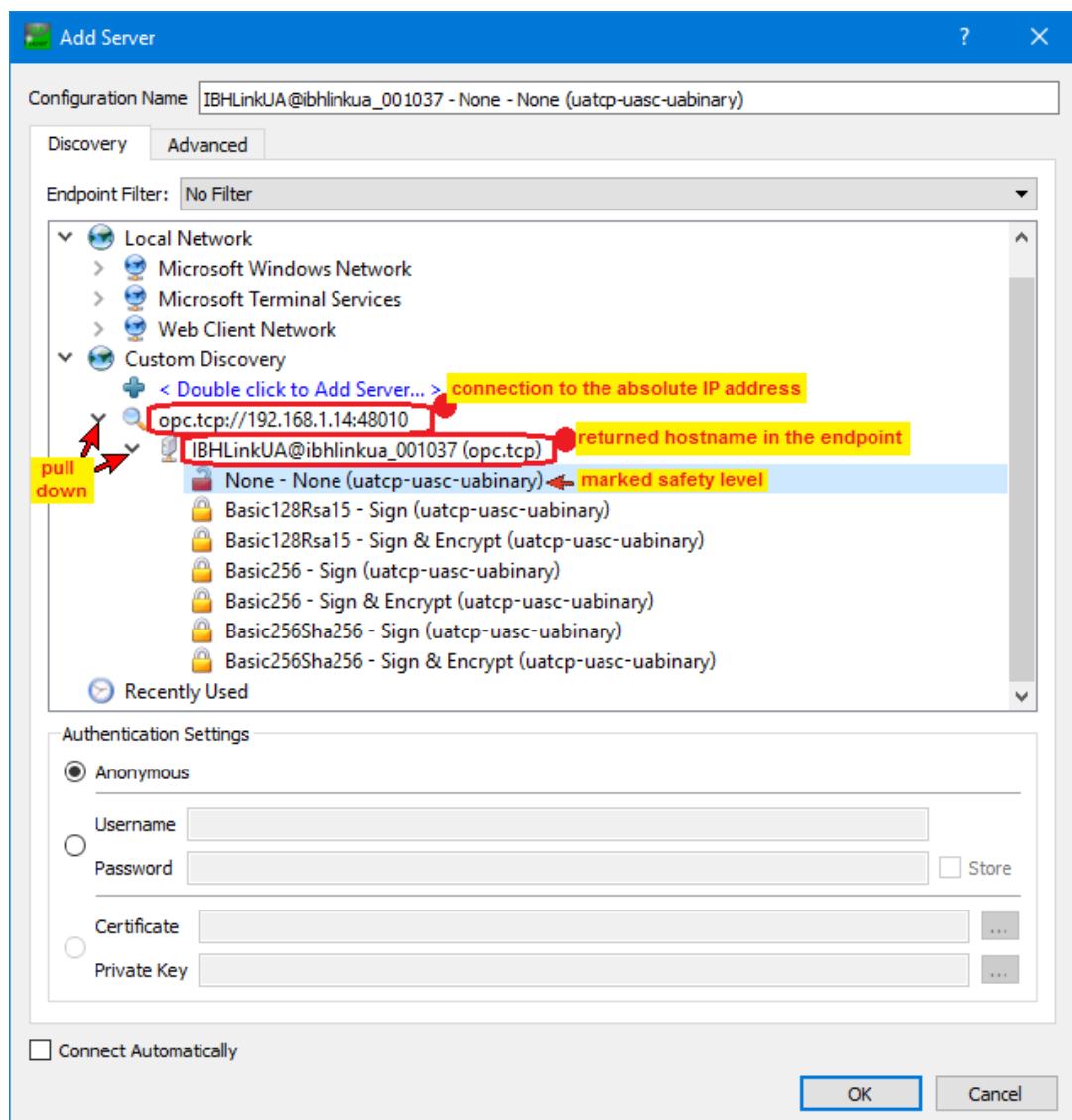
The **Endpoint URL** has been accepted and is displayed in the **AddServer** dialog box.



A double click on **IBHLinkUA @ ibhlinkua_001416 (opc.tcp)** opens a message stating that the requested URL Endpoint hostname does not match the returned URL endpoint hostname. This is clear because the requested URL endpoint was an absolute address and a symbolic address was returned.

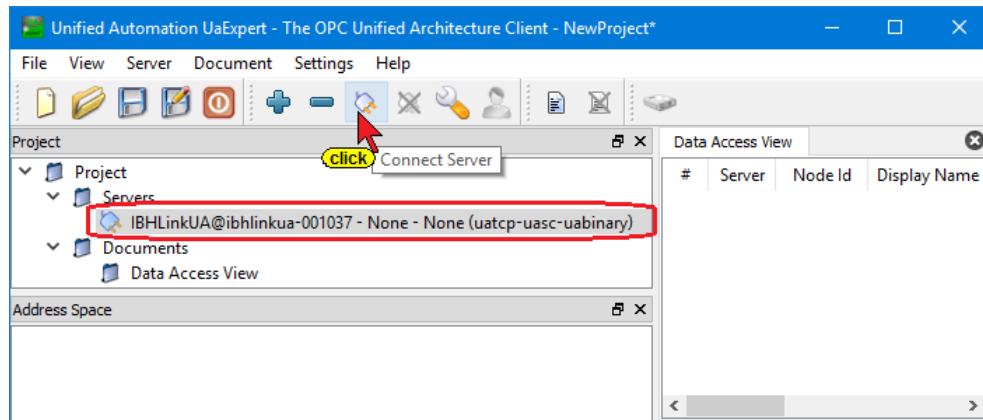


By confirming the message, the security levels marked in the IBH Link UA browser window **Security / Security** are listed.



Clicking the listed security level **None (uatcp-uasc-uabinary)** in the **AddServer** dialog box sets the security level and the **AddServer** dialog box is closed.

The connected server with the defined security level is displayed in the opened ***UaExpert program window***.

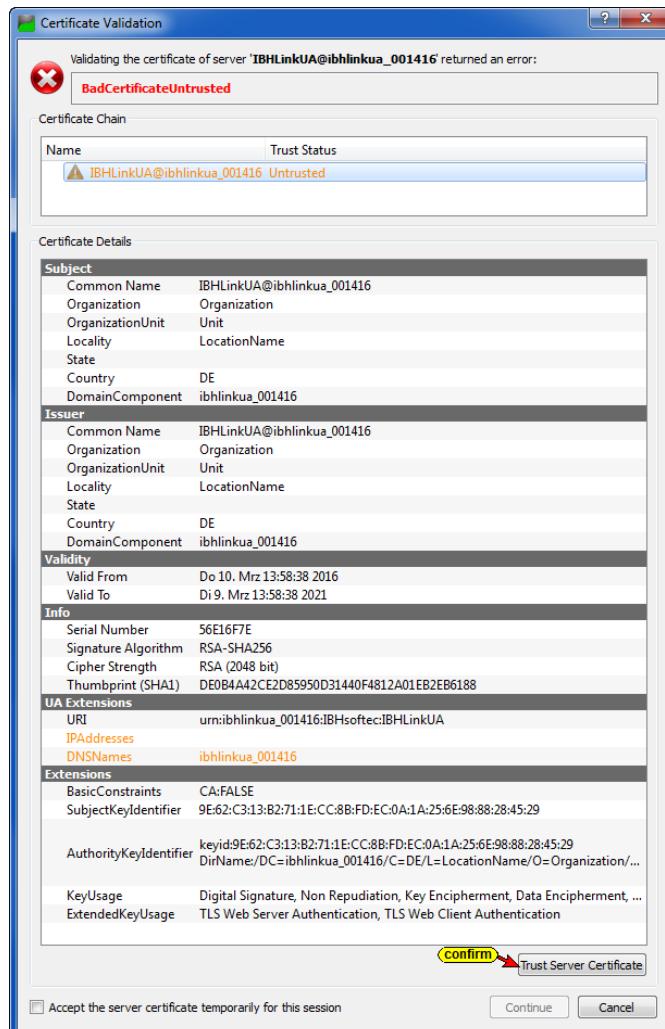


Clicking **Connect Server** opens the dialog box to accept the OPC UA server certificate.



Dialog box for accepting the OPC UA server certificate

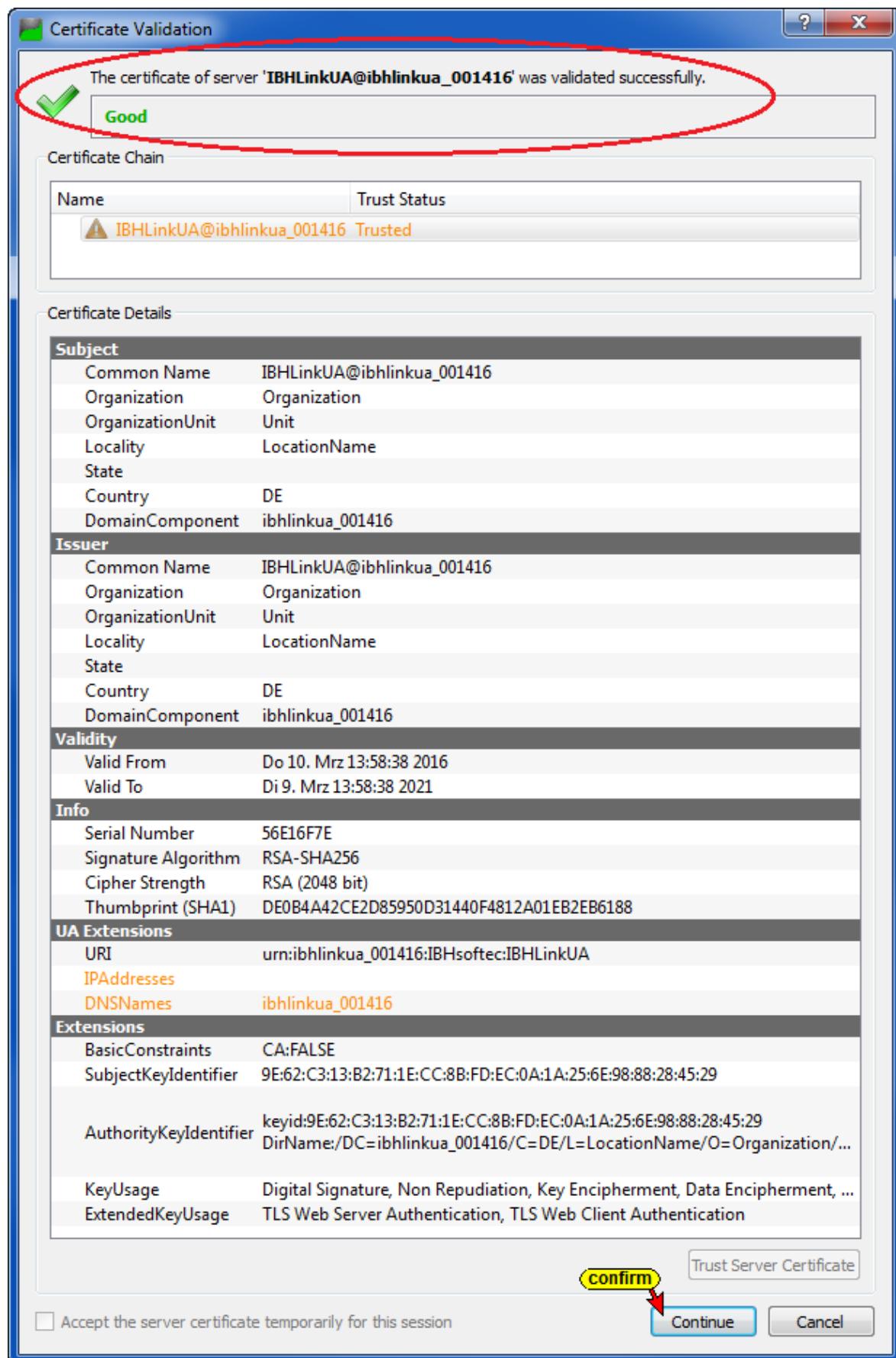
Certificate Validation



Click the **Trust Server Certificate** button to confirm the selected certificate.

Trust Server Certificate

The IBH Link UA confirmed server certificate is displayed.

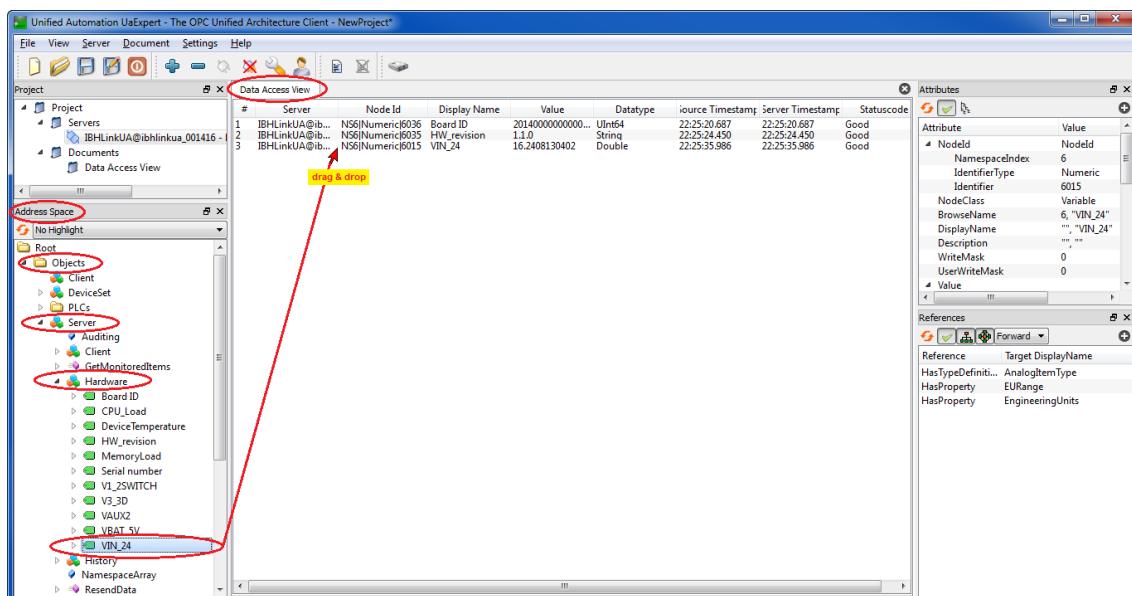


Clicking the **Continue** button closes the dialog box.

Continue

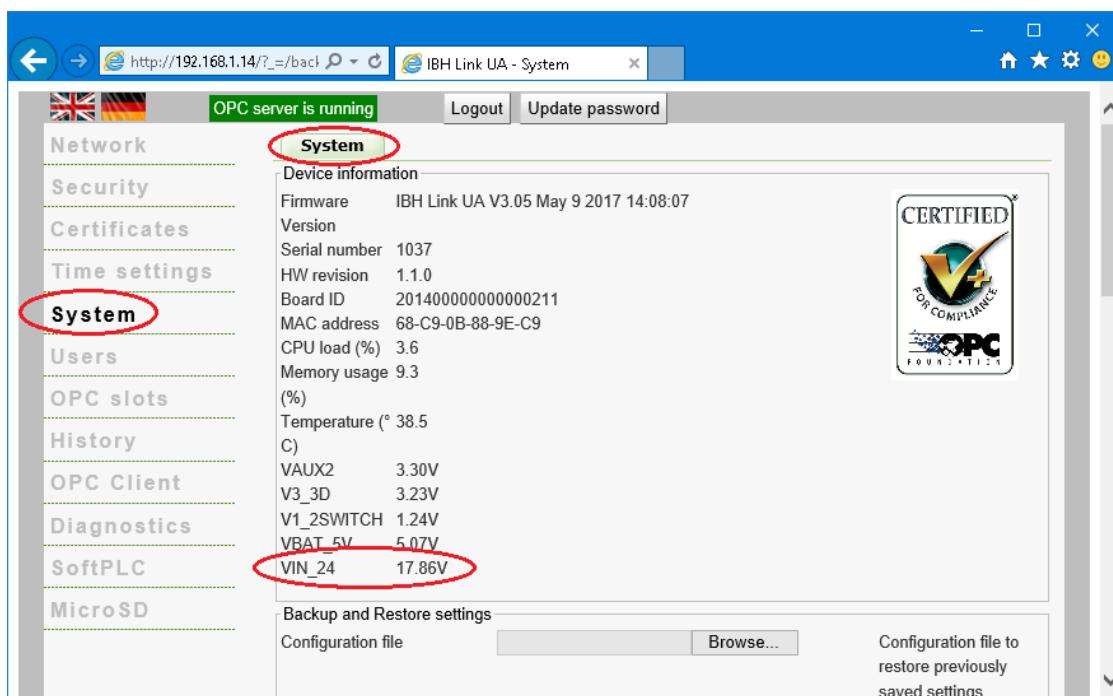
AddressSpace in the **UaExpert** program window, displays information about the connected server. Pull down **Server / Hardware** to list the information from the IBH Link UA browser window **System**.

Drag & drop an information (for example, VIN_24) into the **Data AccessViewer** window. Details of VIN_24 (voltage supply of the IBH Link UA) are displayed. With **drag & drop** any number of information can be pulled from the **AddressSpace** window into the **DataAccess Viewer** window to show details.



IBH Link UA browser window **System**

The following information are displayed in the **Address Space** window.



2.2 Encrypted connection to the IBH Link UA

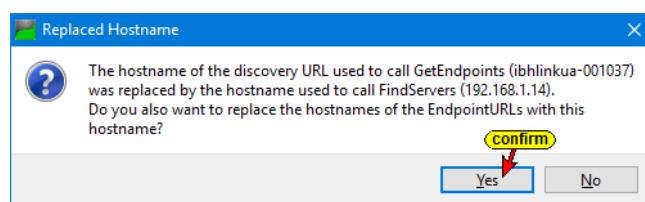
Click the Plus icon in the Unified Automation **UaExpert** window to open the **AddServer** dialog box.

A double-click on

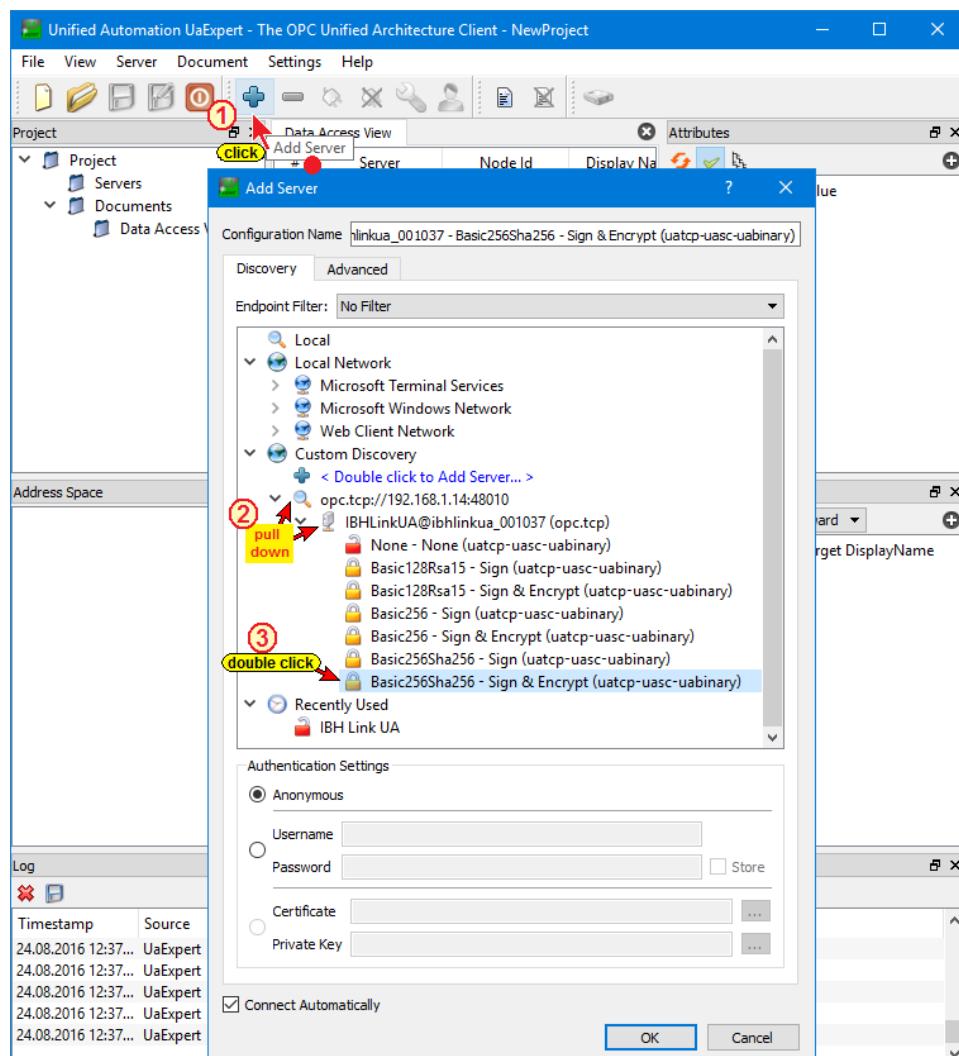
IBHLinkUA@ibhlinkua_001416 (opc.tcp)

IBHLinkUA@ibhlinkua_001416 (opc.tcp) displays a message to indicate that the requested URL endpoint hostname does not match the returned URL endpoint hostname.

This is understandable since the requested Endpoint URL had an absolute address and a symbolic address was returned



Confirming this message to display the security levels marked in the IBH Link UA Browser Window **Security / Security**.

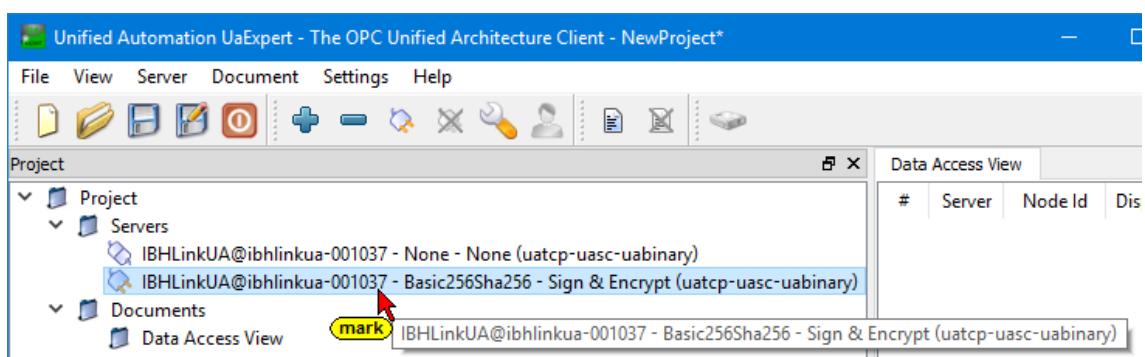


Desired encrypted connection

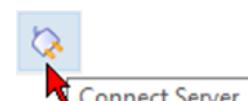
In the **AddServer** dialog box double-click the desired encrypted connection.



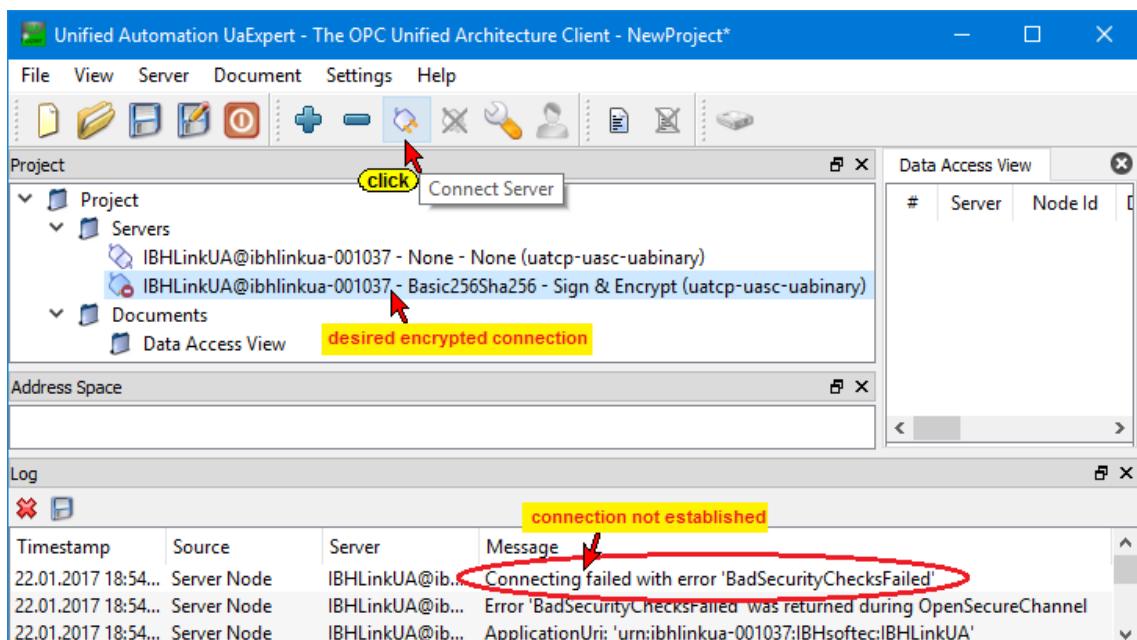
The **Add Server** dialog box is closed, and the selected encrypted connection is displayed under **Project / Servers** in the **Unified Automation UaExpert** window.



Clicking **Connect Server** opens the dialog box to accept the OPC UA server certificate.



The connection to the OPC UA server cannot be established yet.



Create a new certificate in the IBH Link UA

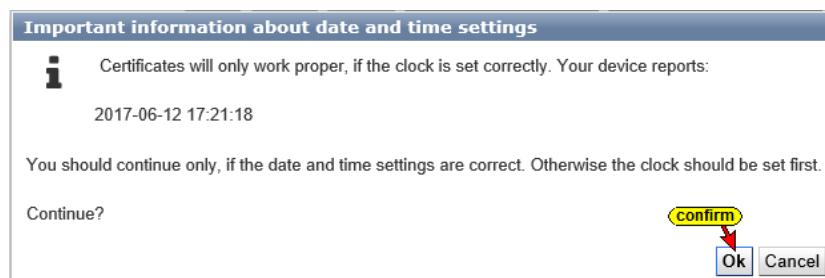
In the IBH Link UA a certificate for the OPC Client (UaExpert@TTI-Yellow) must be created to establish an encrypted connection.

The screenshot shows the 'Certificates' section of the IBH Link UA web interface. A table lists one certificate entry:

Status	Name	Valid From	Valid To	Organization	Organization Unit	Locality
IBH Server	IBHLinkUA@ibhlinkua_001037	05/13/17 14:54:27	05/12/22 14:54:27	Organization	Unit	LocationName

Below the table are several buttons: Trust, Reject, Delete, New Server Certificate, Upload Server Certificate, Download Client Certificate, and a 'click' button. A tooltip above the 'click' button says: "Upload a server certificate (*.DER, *.CER) or a certificate revocation list (*.CRL) from a certificate authority."

Clicking on **New Server Certificate** displays the message that all devices must have the same time settings.



Confirming the message opens a form for the new certificate. The subject fields must be completed.



New Certificate

Subject:

- Common Name: IBHLinkUA@ibhlinkua_001037
- Organization: Organization
- Organization Unit: Unit
- Locality: LocationName
- State: He
- Country: DE

(Two letter code e.g. DE,US, ...)

OPC UA Information

- Application URI: urn:ibhlinkua_001037:IBHsoftec:IBHLinkUA
- Domain Names: ibhlinkua_001037
- IP Addresses:

Certificate Settings

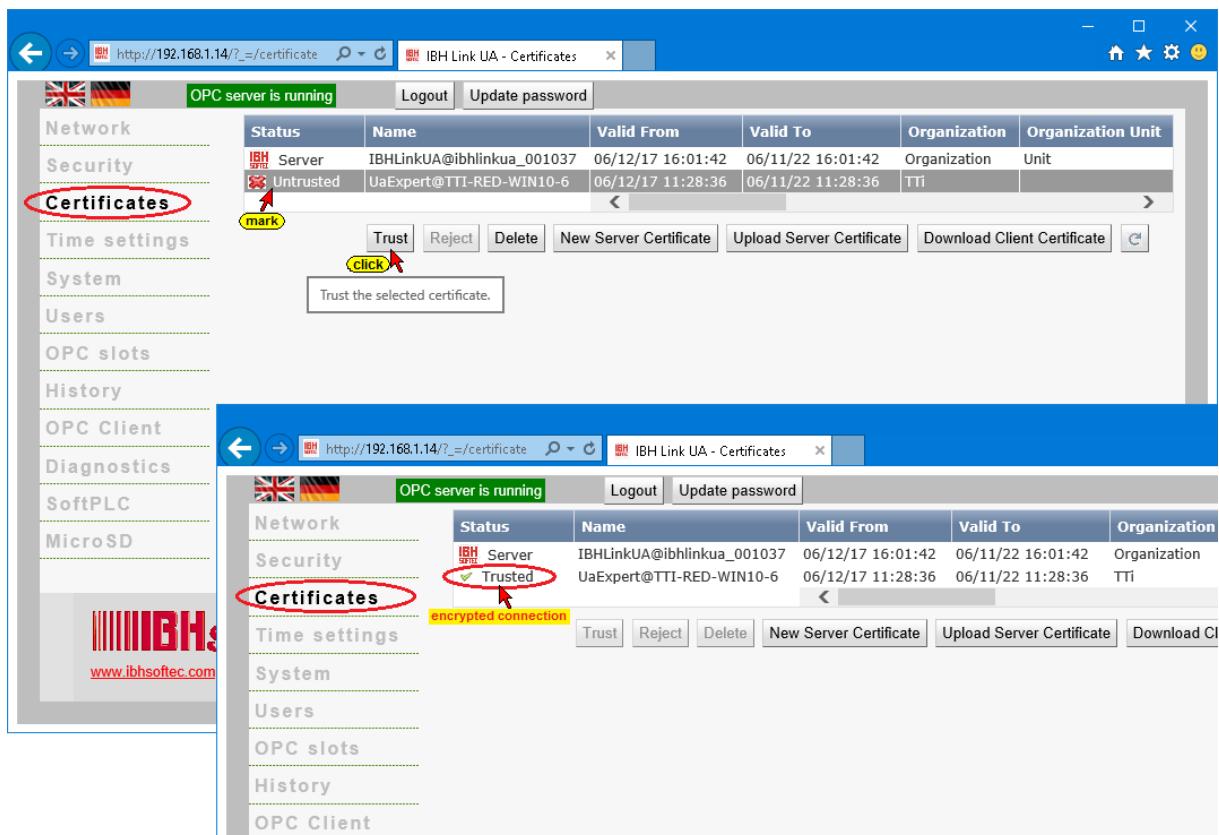
RSA Key Strength: 2048 bits Certificate Validity: 5 years Signature algorithm: SHA256

confirm **OK** **Cancel**

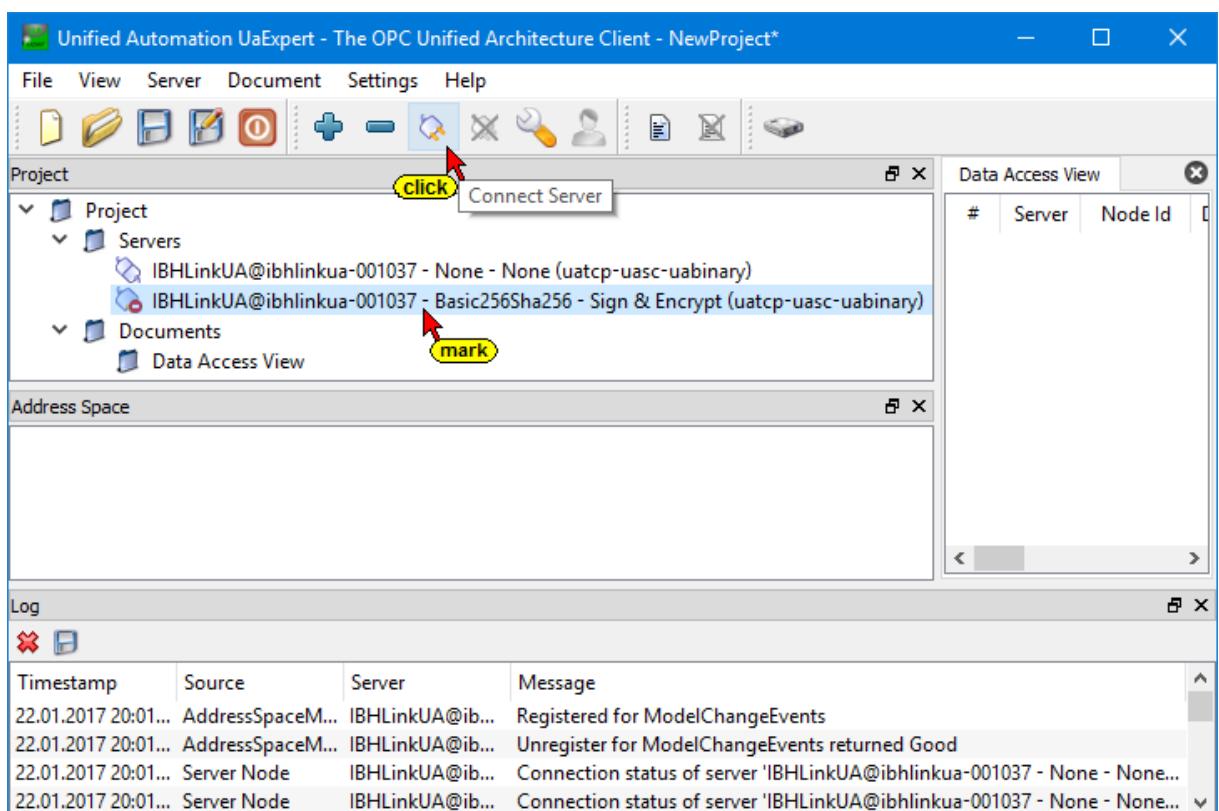


Trusting the IBH Link UA Certificate

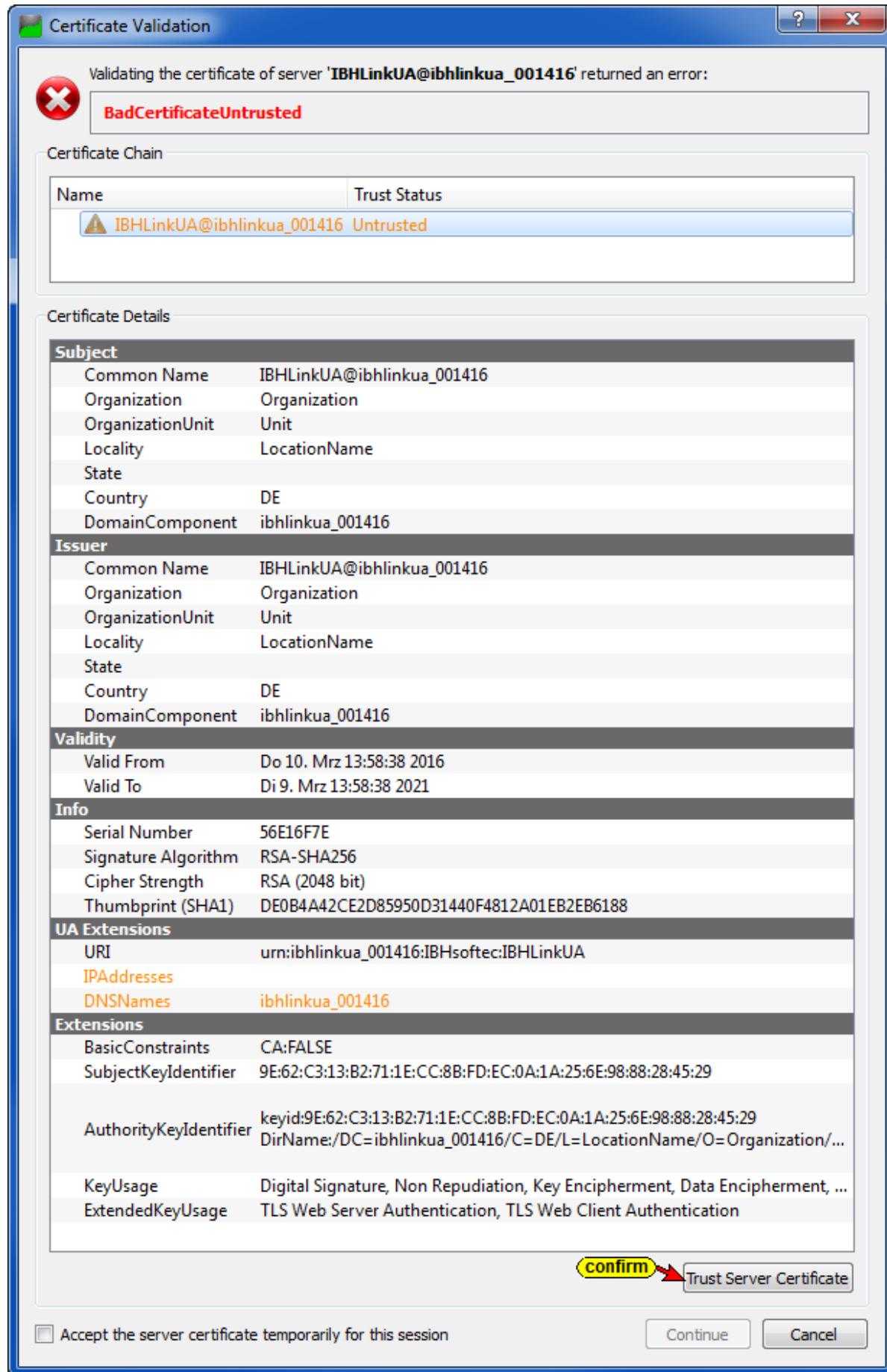
In the IBH Link UA the certificate for the encrypted connection must be trusted.



After trusting the certificate, in the UaExpert client the validation of the certificate can take place.



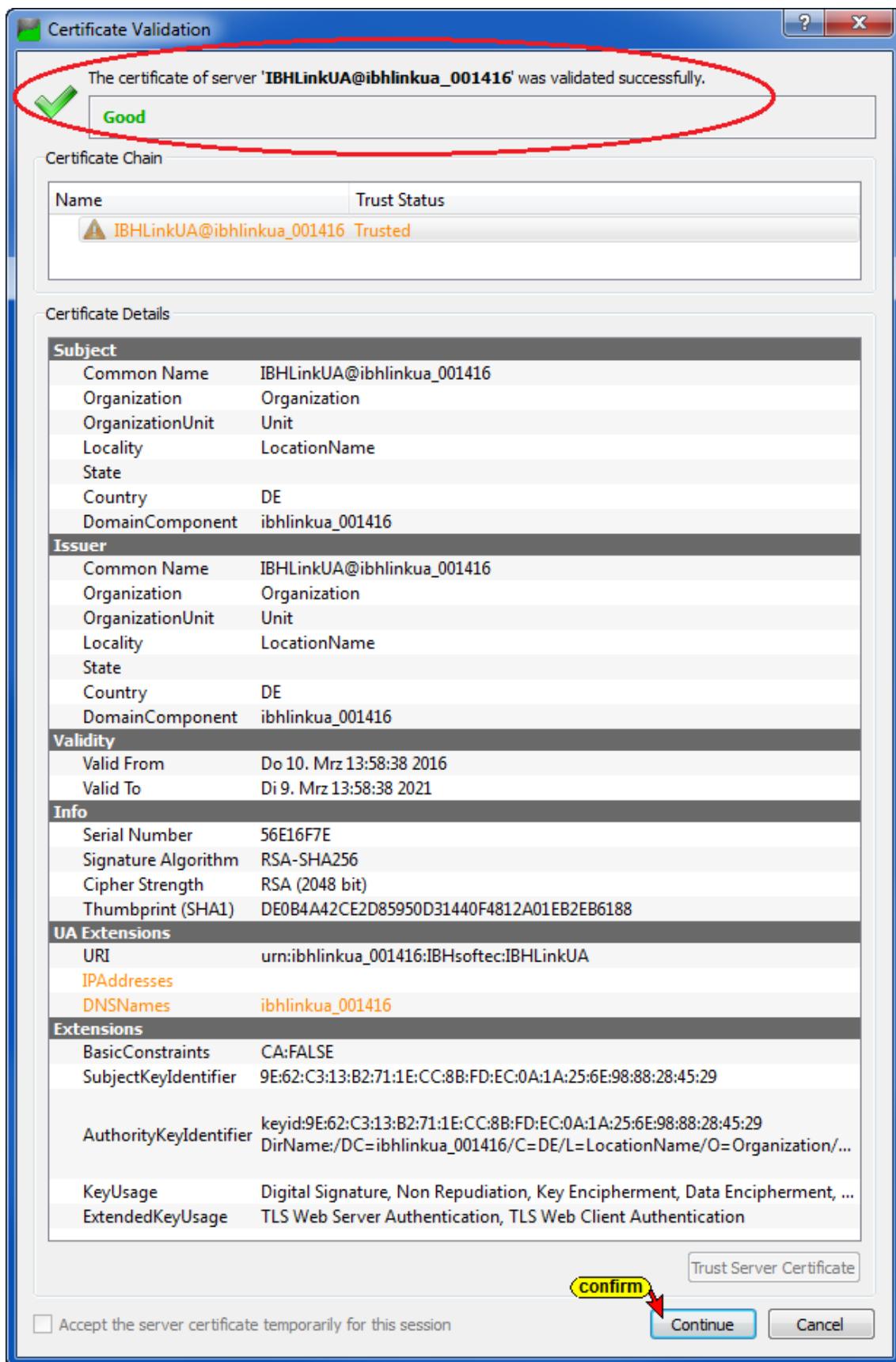
The **Certificate Validation** dialog box to accept the OPC UA server certificate is opened.



Click the **Trust Server Certificate** button to confirm the selected certificate.

Trust Server Certificate

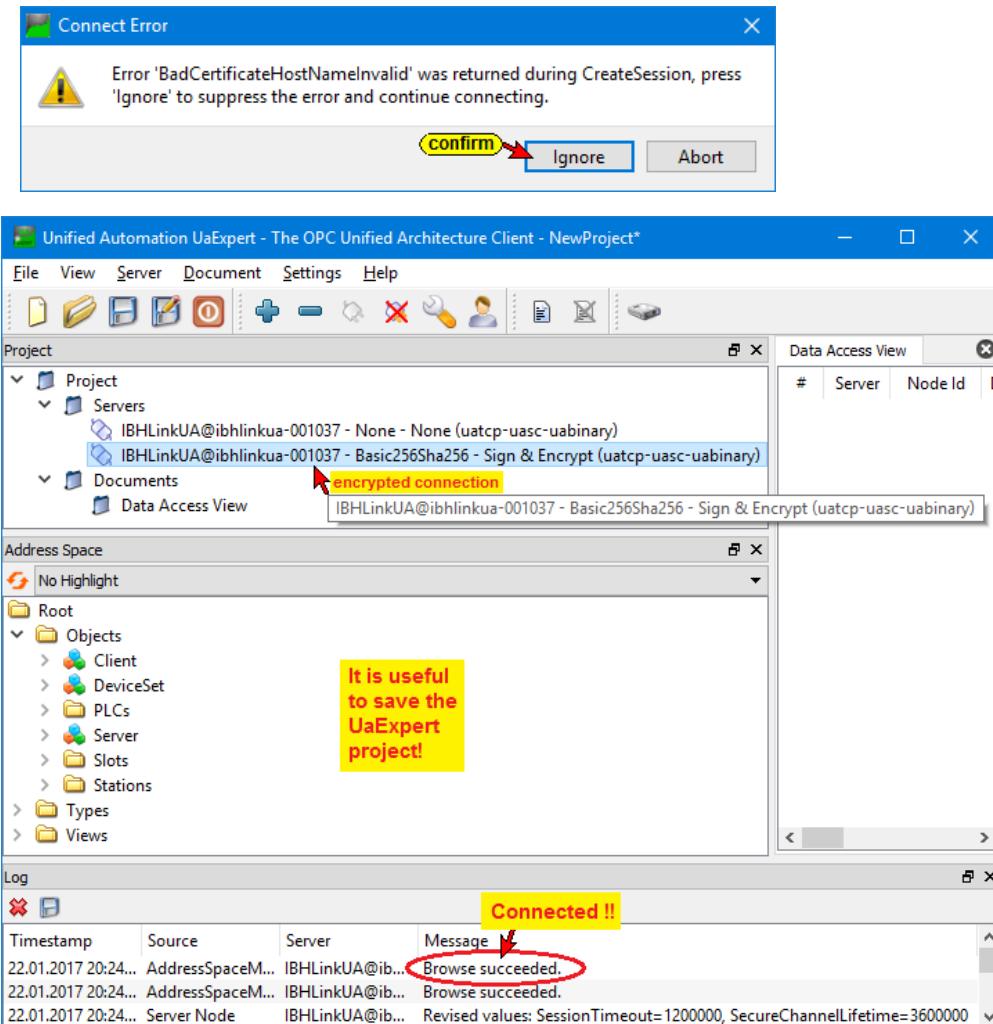
The confirmed server certificate from the IBH Link UA is displayed



Clicking the Continue button closes the dialog box.

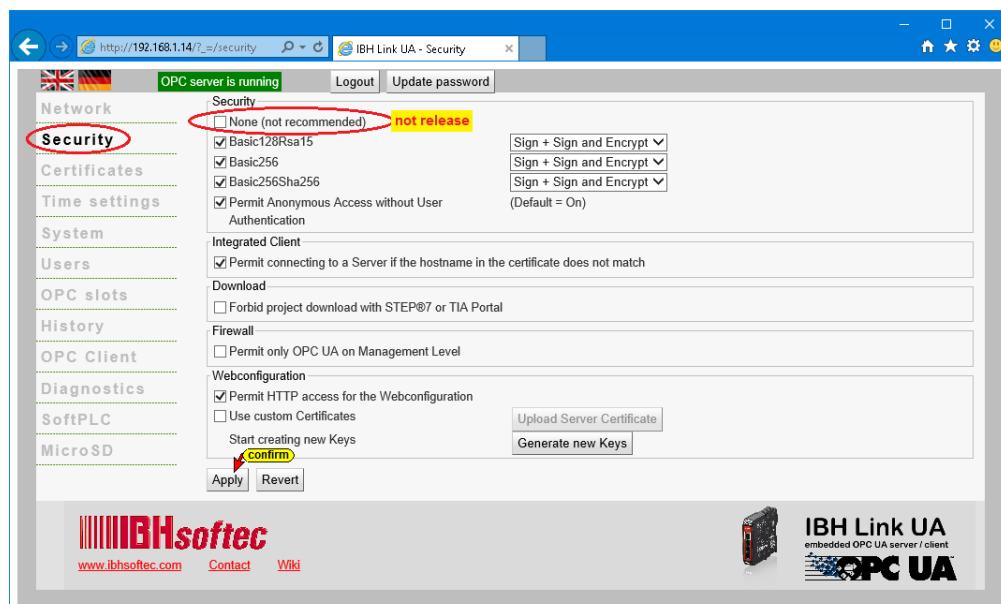
Continue

A warning is indicated that the requested endpoint URL was an absolute address and a symbolic address has been returned.



IBH Link UA Certificate Encryption

Only encrypted connections should be allowed to prevent unauthorized access to the OPC server.



3 Project with STEP® 7 (SIMATIC® Manager) or TIA

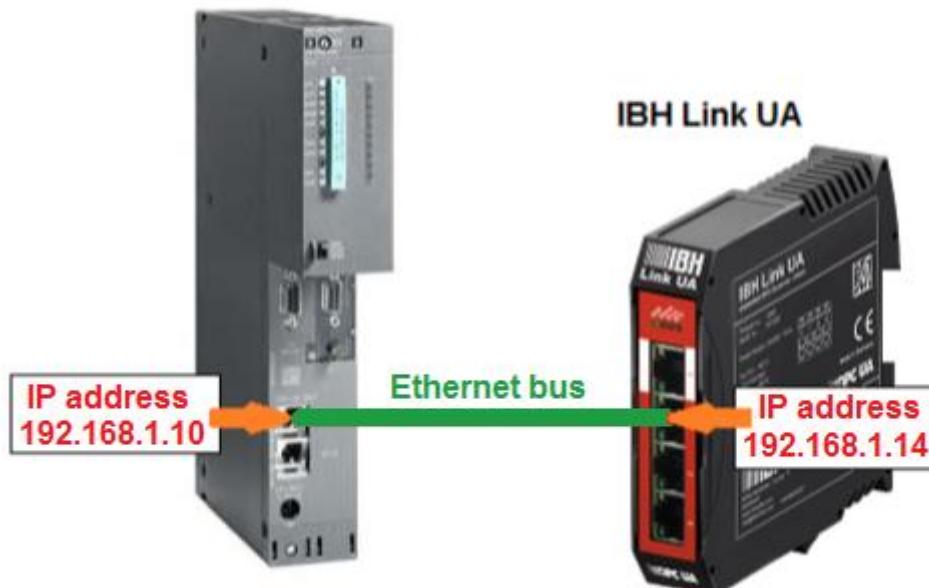
The following example shows a project with STEP® 7 (SIMATIC® Manager V5.5 / V5.6) connecting a CPU 416 and the IBH Link UA via Ethernet.



A CPU having an Ethernet port has been selected.

CPU 416-3 PN/DP

also available as SoftPLC



PLC Project: OPC UA 3E S7 Tank Level

3.1 Software PLC CPU 416-3 PN/DP

The example uses a CPU available as a software PLC from IBHsoftec (already installed on the PC).



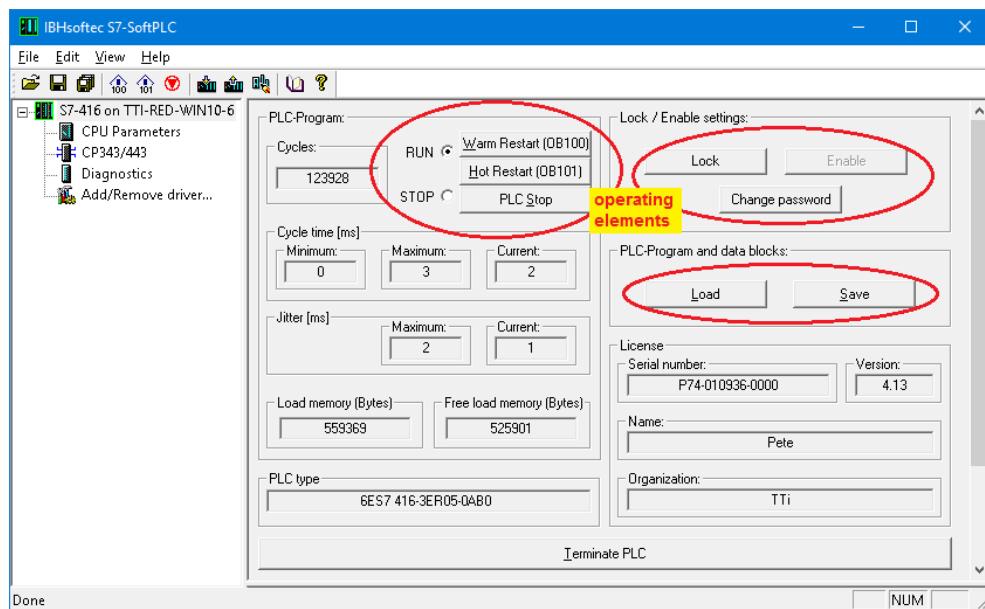
The PG / PC interface (TCP IP) must be selected accordingly.

The SoftSPS CPU 416-3 PN/DP from IBHsoftec is installed on the PC and running. A right-clicking on the SoftSPS icon in the taskbar opens the IBHsoftec S7-SoftPLC window for configuring and diagnosing the SoftPLC.

SoftPLC Operating, Diagnostic and Configuration windows

In the status bar right-click the SoftPLC icon to open the window to configure and operate the SoftPLC. This window displays the status of the CPU and diagnostic elements are presented.

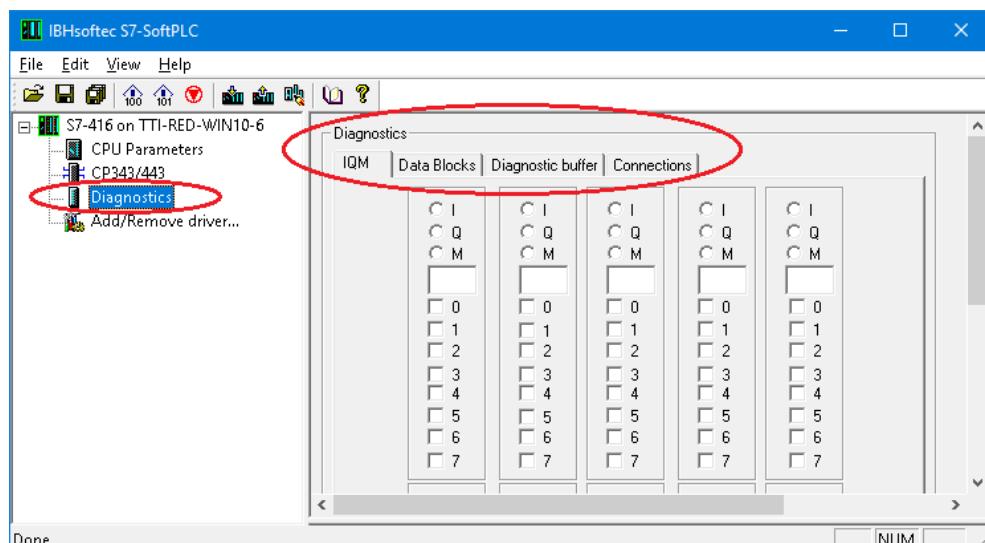
SoftPLC Operating and Status windows



SoftPLC Diagnostic window

The diagnosis provides four tabs.

- **IQM** Status display of individual bits of an operand. The status of freely selectable inputs (In._), outputs (Qn._) or flags (M n._) are displayed and changeable in these ten fields.
- **Data blocks** The status of existing, freely selectable data blocks can be displayed and its values can be changed as a byte, word or double word.
- **Diagnostic buffer** The diagnostics events of the CPU are listed in clear text with explanations in the order of their occurrence.
- **Connections** The connections of the CPU with ID, status, type etc. are displayed.



3.1.1 PLC program of the CPU 416

The project **OPC UA 3E S7 Tank Level** with the SIMATIC 400 Station **CPU 416** provides the S7 program **Tank level**.

It simulates the filling and emptying of a tank with the following characteristics:

The tank is filled up to reach a **Max_value** (Tank filled more than 90%) and is emptied to reach **Min_value** (Tank filled less than 10%).

The filling and emptying are controlled via an **Down** (Output valve) and **Up** (Input valve).

The variable **Value** (Tank level value) delivers an integer number to the CPU. The variables **Max** and **Min** are only used internally.

In the Data Block **DB2** (Tank_level_values) the integer number of the minimum and maximum tank level are stored.

The PLC block FC5 is used to control the up and down of the tank level.

The input valve (**Up**) is open when the tank content is between 0% and **Max_value**.

When **Max_value** is reached, the input valve is closed and the output valve (**Down**) is opened until the tank level drops to the **Min_value**.

Now the output valve is closed again, and the input valve is opened, so that the tank reaches the **Max_value** again.

When the **Max_value** is reached, the input valve is closed, and the output valve is opened, etc., etc.

The variable **ON** (Control ON) enables the level control. If the control is switched off, the tank level remains at its current value.

The PLC symbols listed in the **Symbols table** and the data defined in the Data Block **DB2** (Tank_level_values) will be routed via the **IBH Link S7++** to the OPC-Server **IBH Link UA** (OPC tags).

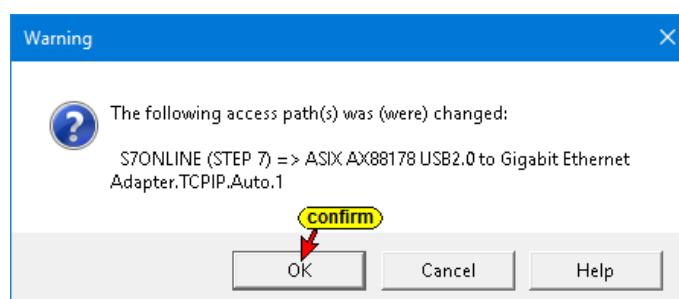
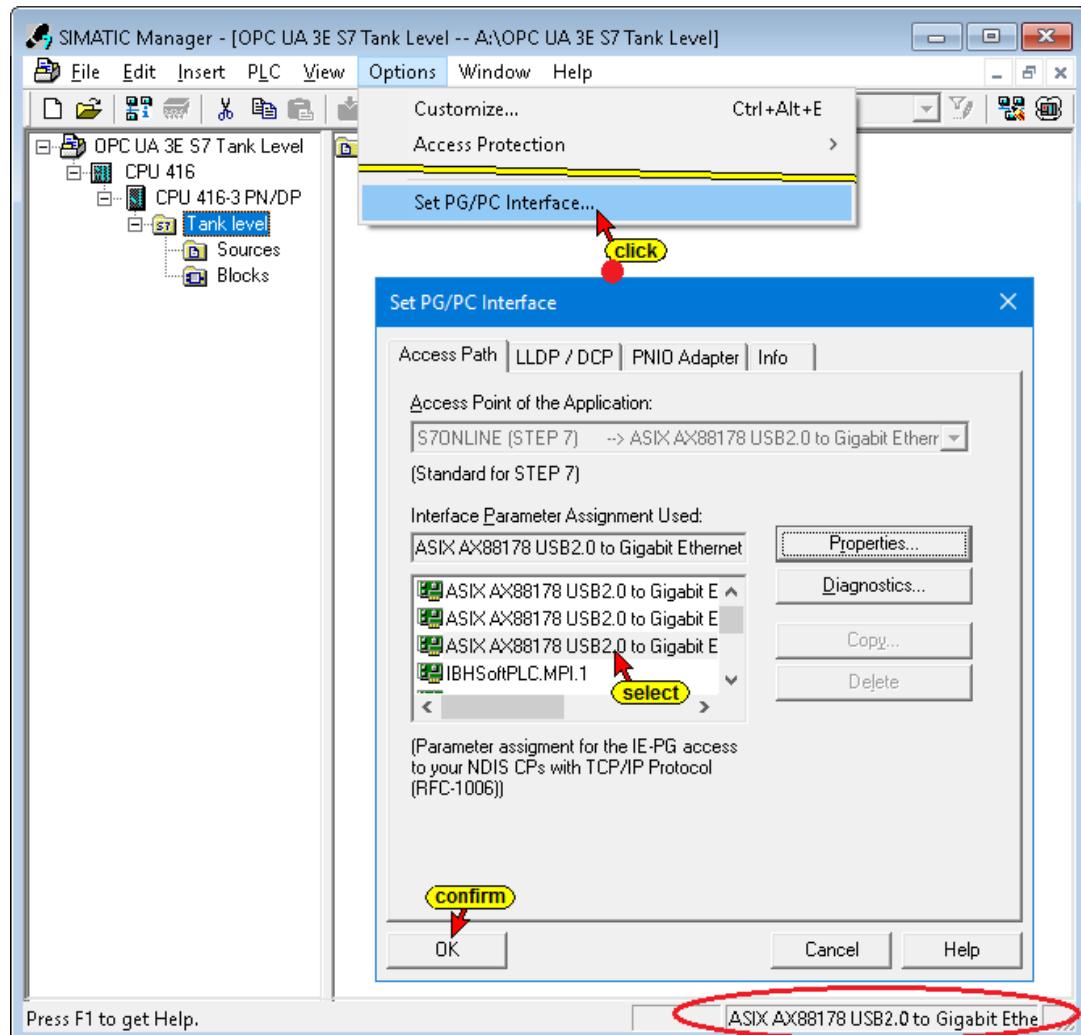
PLC Program tank level Symbol Table

	Status	Symbol	Adresse	Data type	Comment
1		Tank_level_values	DB 2	DB 2	Tank Values DB 2
2		Tank_level_control	FC 5	FC 5	Tank level controll FC 5
3		On	I 0.0	BOOL	Control ON
4		Max	M 1.2	BOOL	Maximum reached
5		Min	M 1.3	BOOL	Minimum reached
6		Value	MW 2	INT	Tank level value
7		Cycle	OB 1	OB 1	Cycle OB1
8		Down	Q 2.5	BOOL	Output valve
9		Up	Q 2.6	BOOL	Input valve
10		Tank Operands	VAT 1		Tank level control
11					

PLC Program Data Block DB2 *Tank_level_values*

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Min_value	INT	100	Tank filled less than 10%
+2.0	Max_value	INT	10000	Tank filled more than 90%
+4.0	Dummy	INT	0	Dummy
+6.0	Tank_level	INT	0	Tank level value
+8.0	Structure	STRUCT		Complex variable - STRUCT -
+0.0	CurrentTemp	REAL	0.000000e+000	Current Temperature
+4.0	SetTemp	REAL	0.000000e+000	Requested Temperature
=8.0		END_STRUCT		Currently not used
=16.0		END STRUCT		

Set PG/PC interface as an Ethernet interface



Note:

The connection to be selected depends on the Ethernet interface present in the PC.

The name is made up as follows:

PC Ethernet interface.TCPIP.Auto.1 <Active>

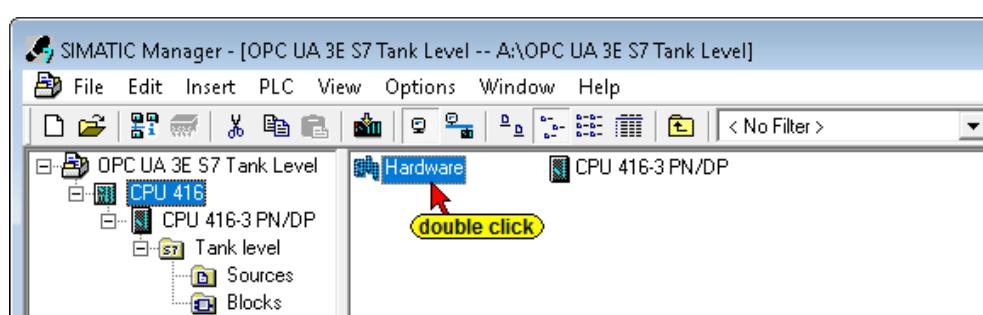
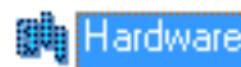
ASIX AX88178 USB2.0 to Gigabit Ethernet Adapter.TCPIP.Auto.1 <Active>

Project OPC UA 3E S7 Tank Level – Hardware Configuration

The project OPC UA 3E S7 Tank Level was created as follows:

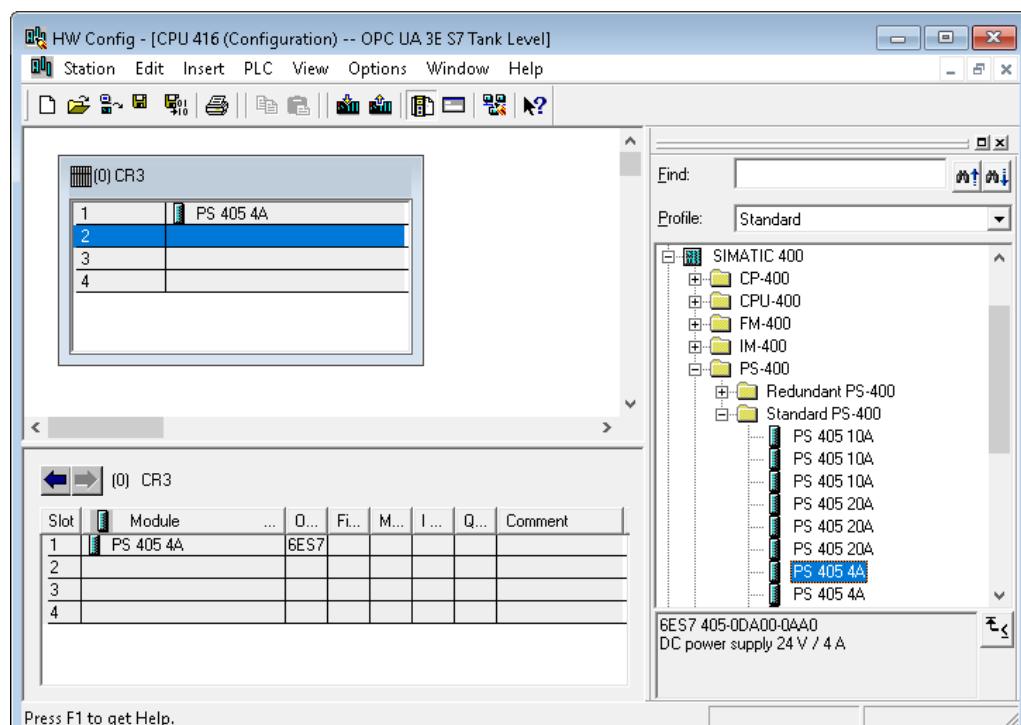
A SIMATIC 400 station, which has been renamed in **Tank level**, has been inserted as a new object.

Double-click **Hardware** to open the HW Configuration window.



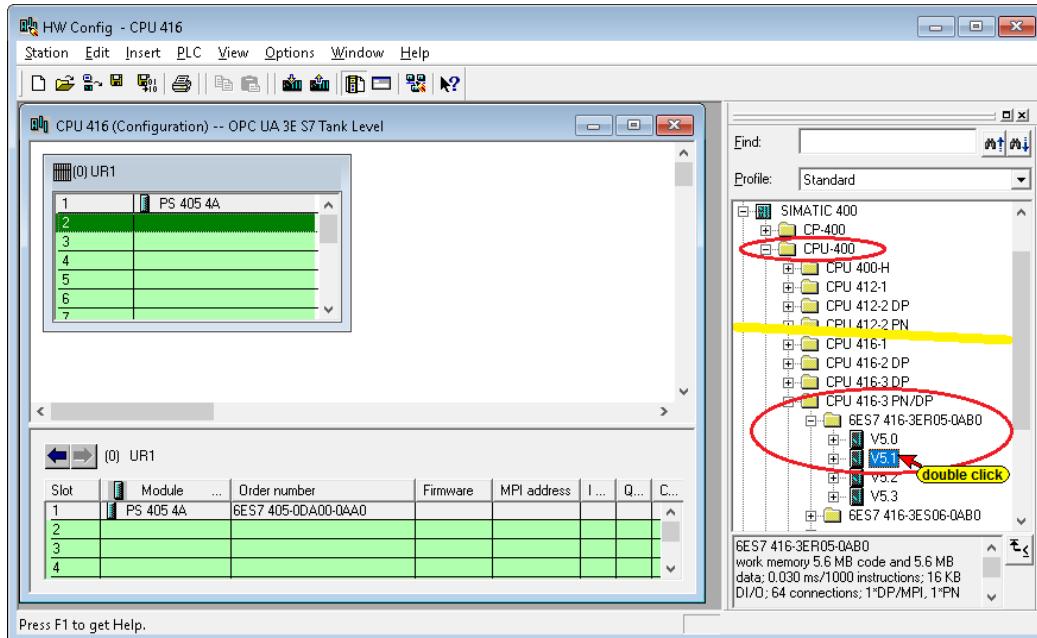
Next, the Rack 400 / CR 3 (with 4 slots) was inserted.

The standard PS-400 / PS 405 4A (position 1) power supply was inserted into the rack.



Next, a CPU having an Ethernet port is inserted.

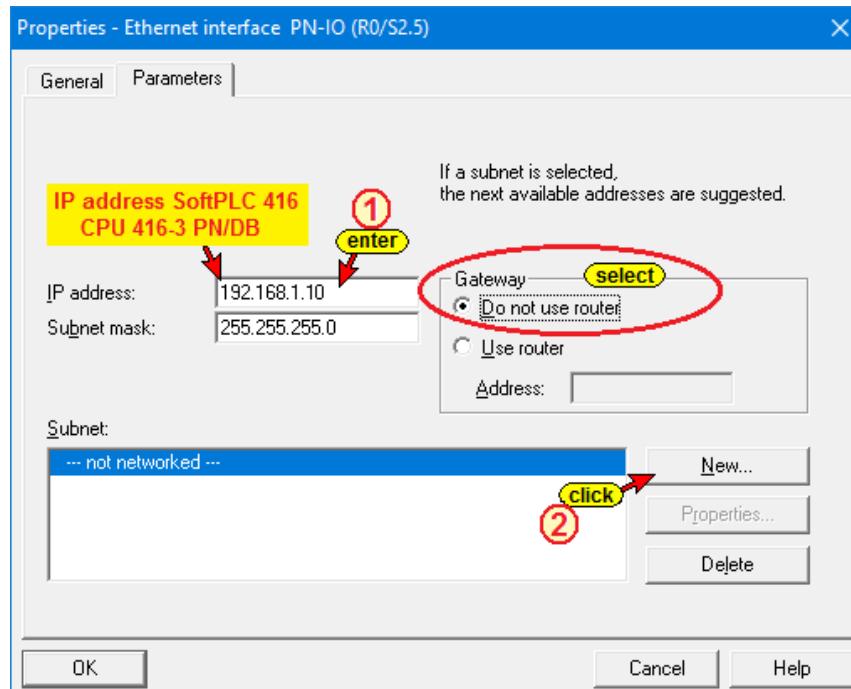
In the example, the **CPU 416-3 PN/DP (6ES7 416-3ER05-0AB0)** firmware version V5.1 is used, which is also available as a software PLC from IBHsofttec (already installed on the PC).



The dialog box **Properties - Ethernet interface PN-IO (R0/S2.5) / Parameters** is opened by double-clicking on **V5.1** of the CPU 416-3 PN/DP.

The required IP address is specified under **Parameters**. In the example, the IP address of the PC is - **192.168.1.10** (other PCs in may have another address).

The Ethernet connection is direct without a router.

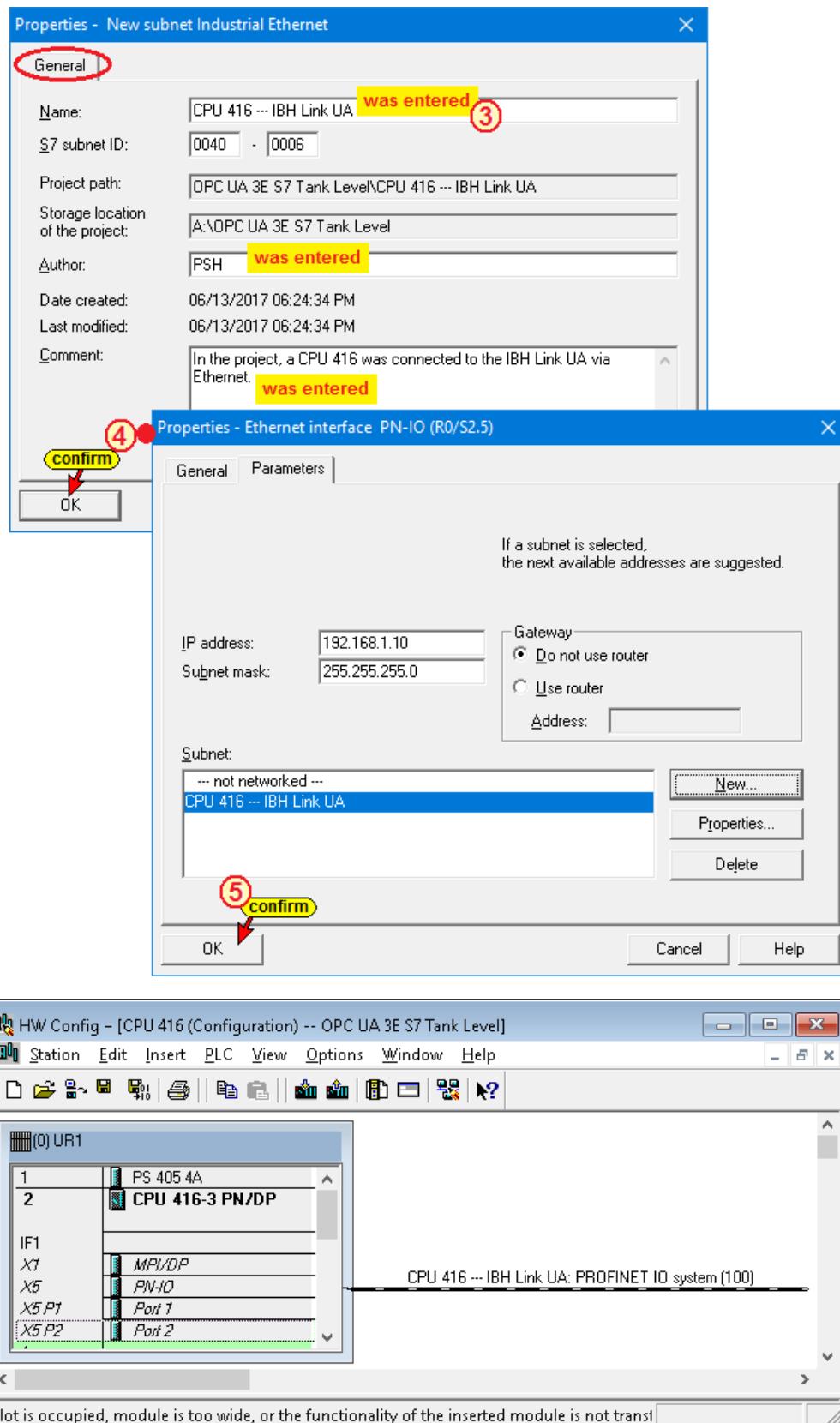


Clicking on the **New** button opens a dialog box to add the properties of the Ethernet connection.

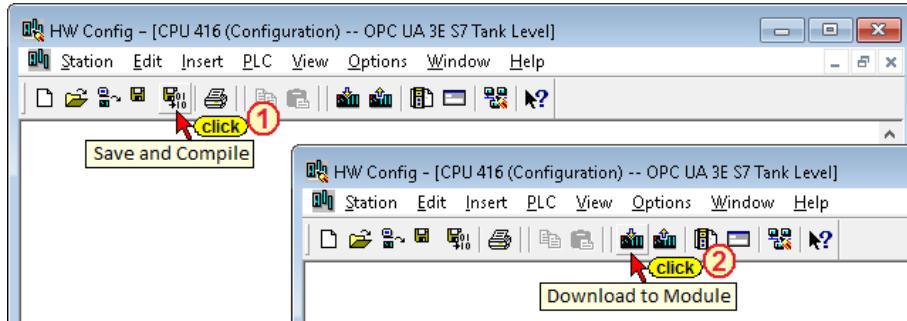
Neu...

Confirming the dialog boxes insert the CPU into the PLC rack.

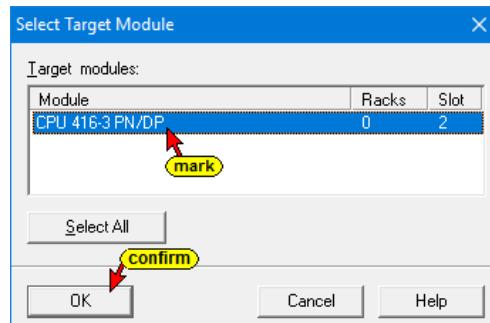
It is useful to enter additional information to allow the project to be tracked later.



Clicking on the **Save and Compile** icon and then on the icon **Download to Module** takes the configuration and starts the transfer of the configuration to the CPU.

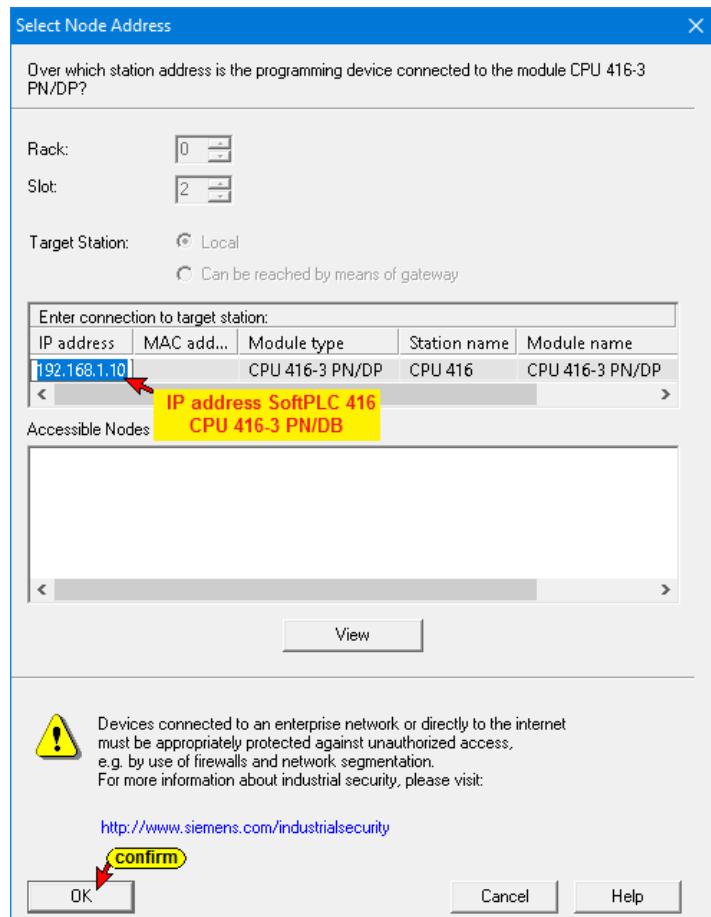


A dialog box to select the CPU to transfer the configuration to is opened.

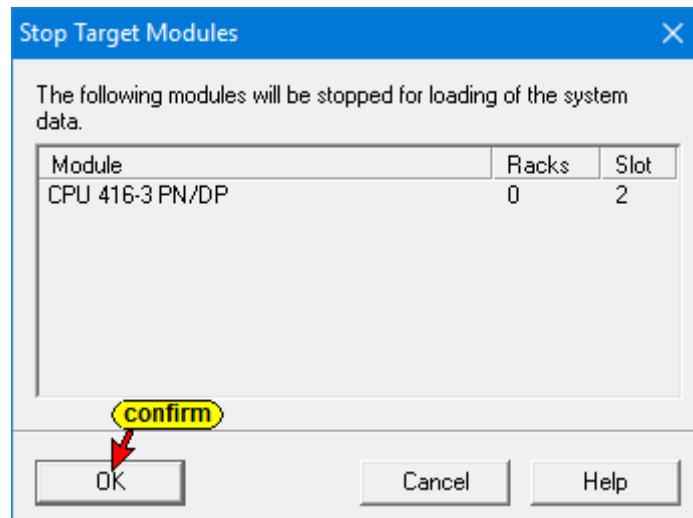


Confirming the **Select Target Group** dialog box opens the **Select participant address** dialog box.

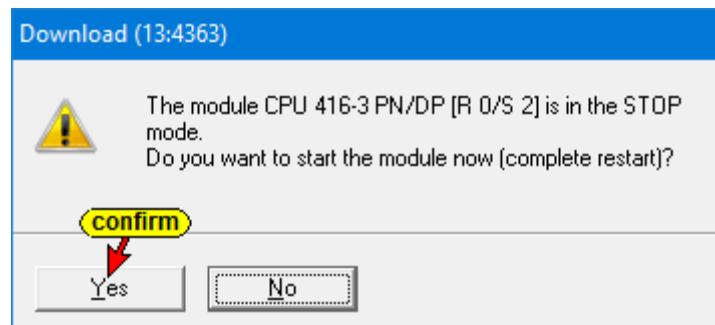
It might take quite a while to connect the CPU 416-3 PN/DP



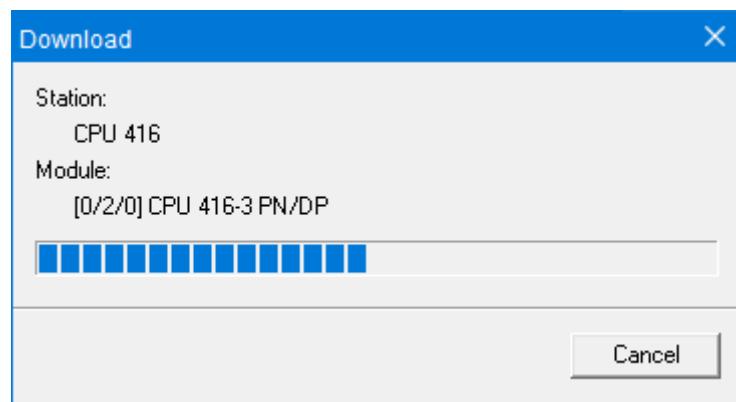
If the desired information is correct, confirm with **OK**.



The configuration can only be transferred in the CPU is in its STOP mode.



The progress of loading is displayed.

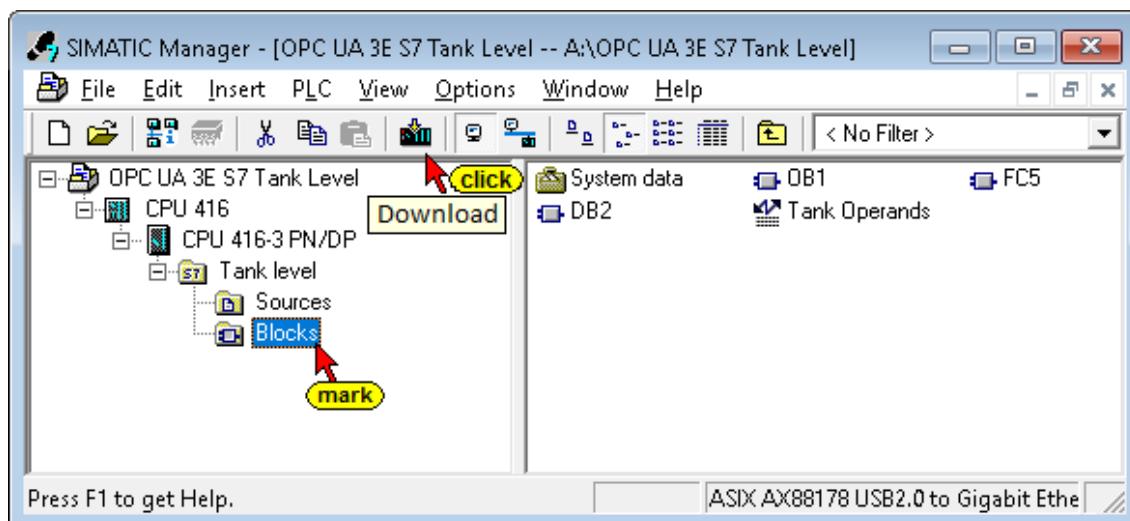


3.1.2 Transferring the program (Tank level) into the PLC

The connection from the PC to the CPU 416-3 PN/DP is made via the Ethernet interface of the PC. The PG/PC interface must be selected accordingly in SIMATIC Manager.

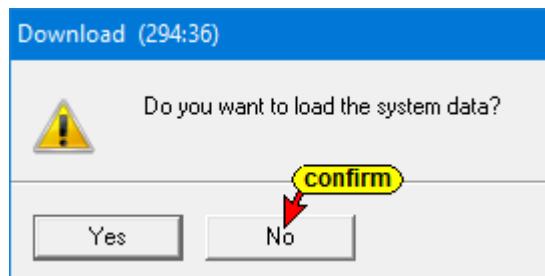
The name of the Ethernet connection may vary depending on the network card used in the PC.

Transfer of PLC Blocks into the CPU 416-3 PN/DP

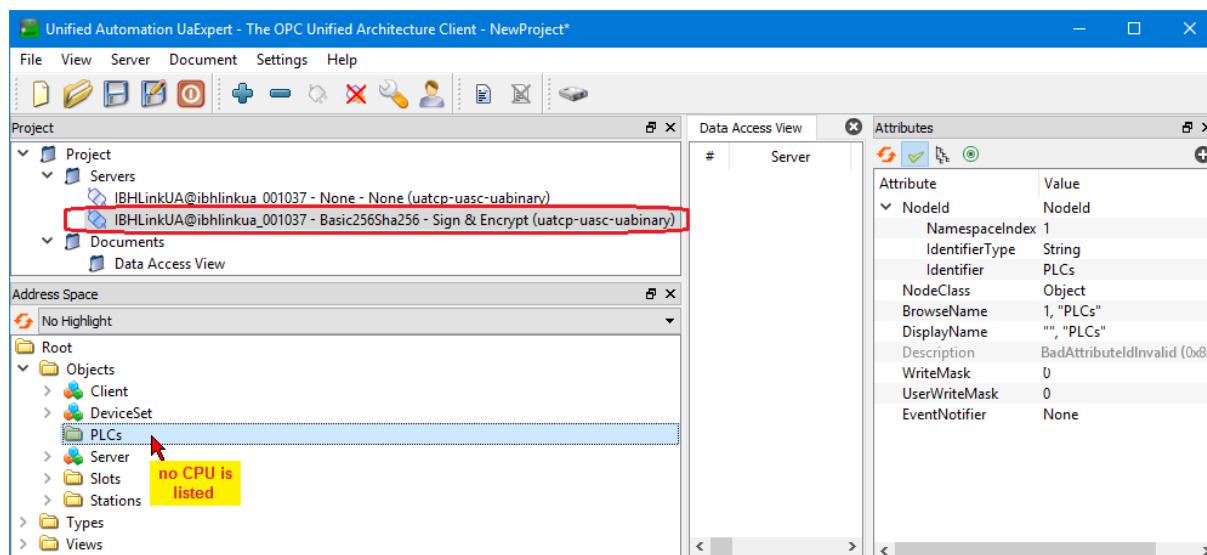


Transfer System Data is not required.

The Hardware configuration of the CPU 416-3 PN/DP does not need to be transferred again



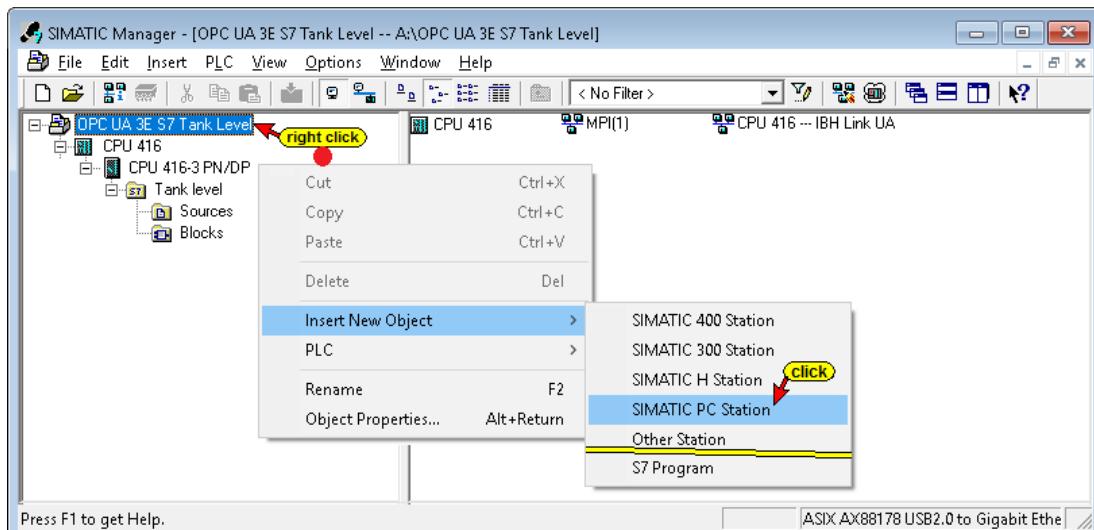
The CPU 416 is not yet available in the UaExpert program window, since an Ethernet connection (S7 connection) has not yet been established.



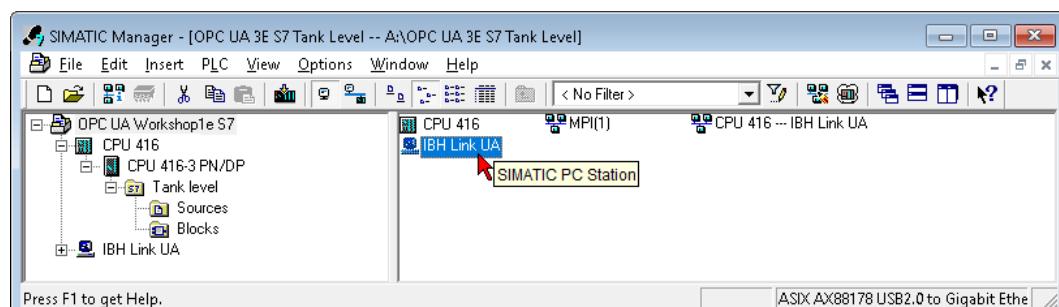
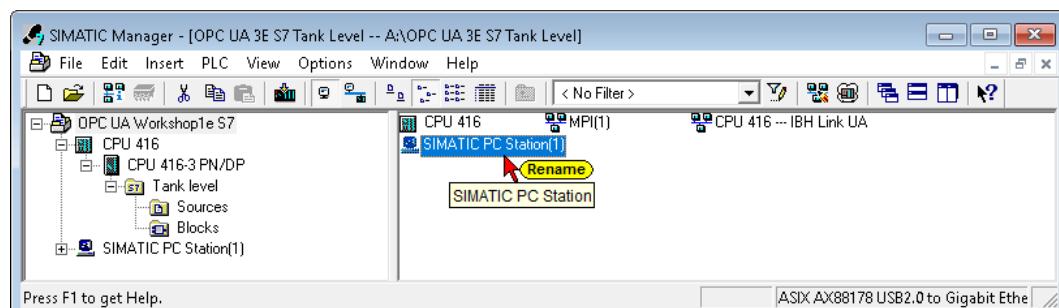
If the UaExpert program window was still active (see chapter 2) in the PC background, the connection to the IBH Link UA must be interrupted and restarted.

3.1.3 IBH Link UA as SIMATIC PC station.

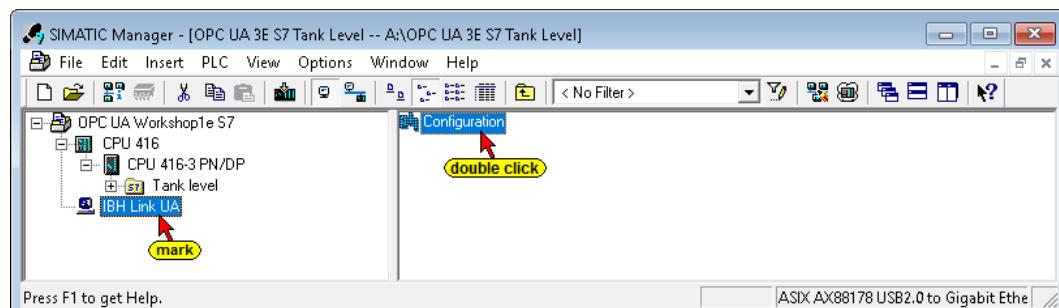
A right-click on the Project Name **Workshop** will initiate the command **Insert New Object / Activate SIMATIC PC Station**.



Rename the inserted SIMATIC PC station (1) to **IBH Link UA**.



Double-click the renamed SIMATIC PC Station **IBH Link UA** in the left window and a double click on **Configuration** in the right window opens the hardware configurator.

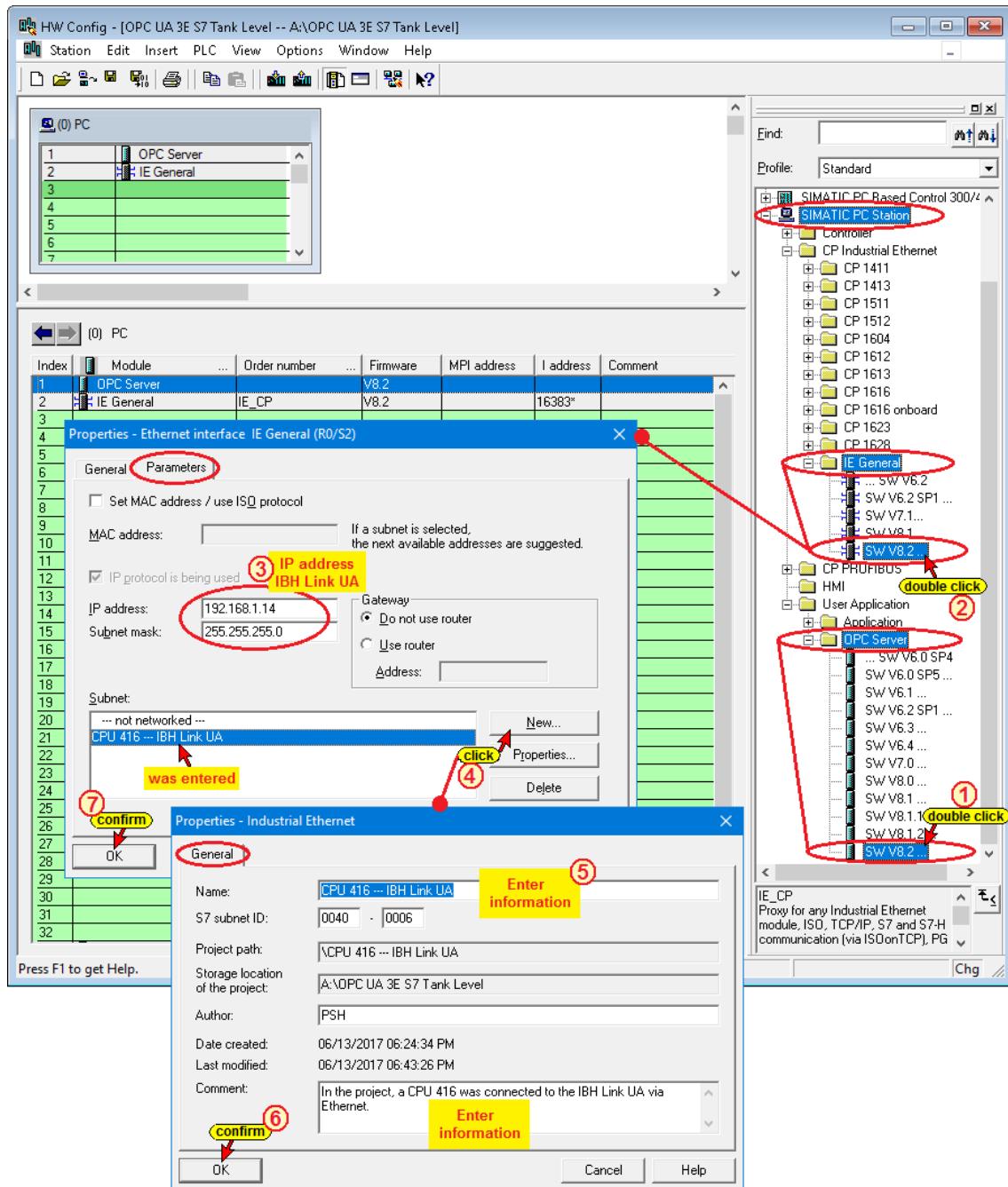


Configuration IBH Link UA (SIMATIC PC Station)

Note:

The Siemens **OPC Server SW V8.2...** and the CP Industrial Ethernet interface **IE General SW V8.2...** are available in the hardware catalogs of **STEP7 SIMATIC Manager, TIA V13, TIA V14** and **TIA V15**.

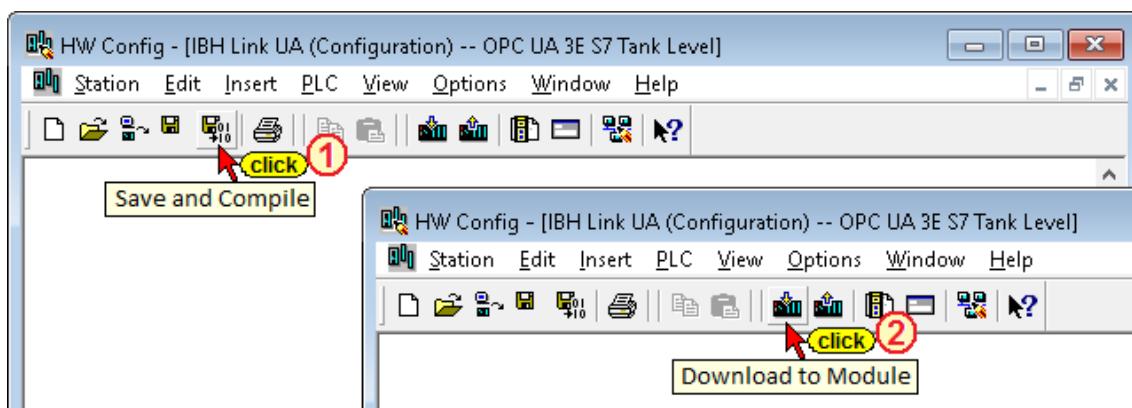
Double-clicking on <**SW V8.2...**> ① takes the OPC server into the PC station. Double click on <**IE General**> <**SW V8.2...**> ② opens the dialog box **Properties - Ethernet Interface IE General (R0 / S2)**.



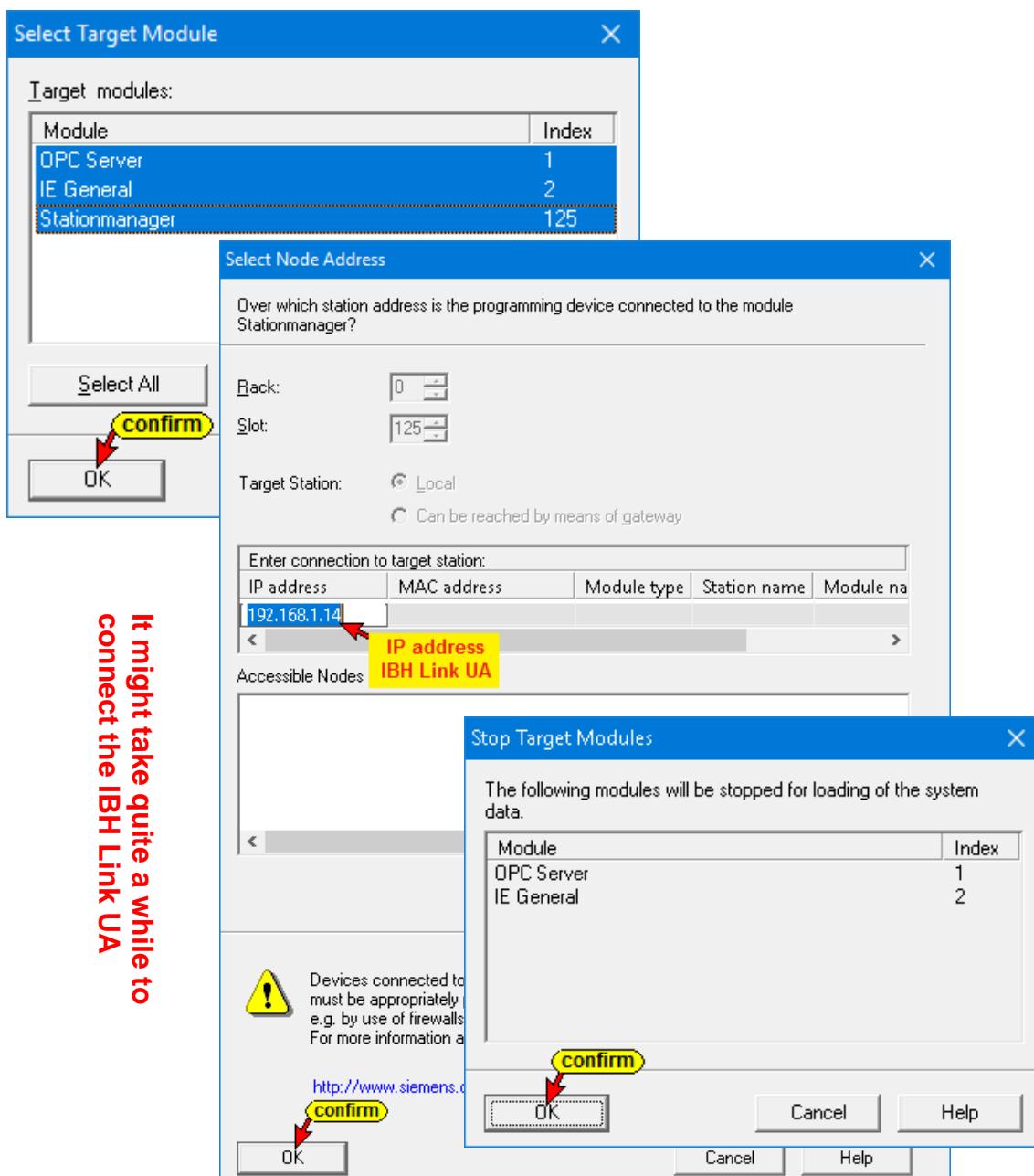
By clicking the subnet **Ethernet(1) ③ – ⑦**, the IP address and the subnet mask of the IBH Link UA, which were entered during configuration, are accepted.

Loading the configuration into the IBH Link UA.

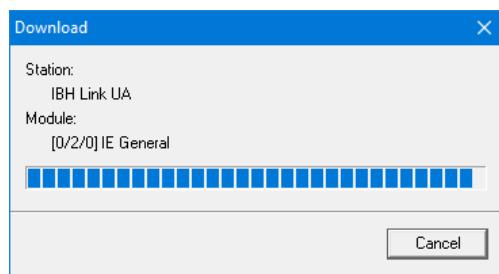
After **Save and Translate** the configuration may be loaded into the IBH Link UA.



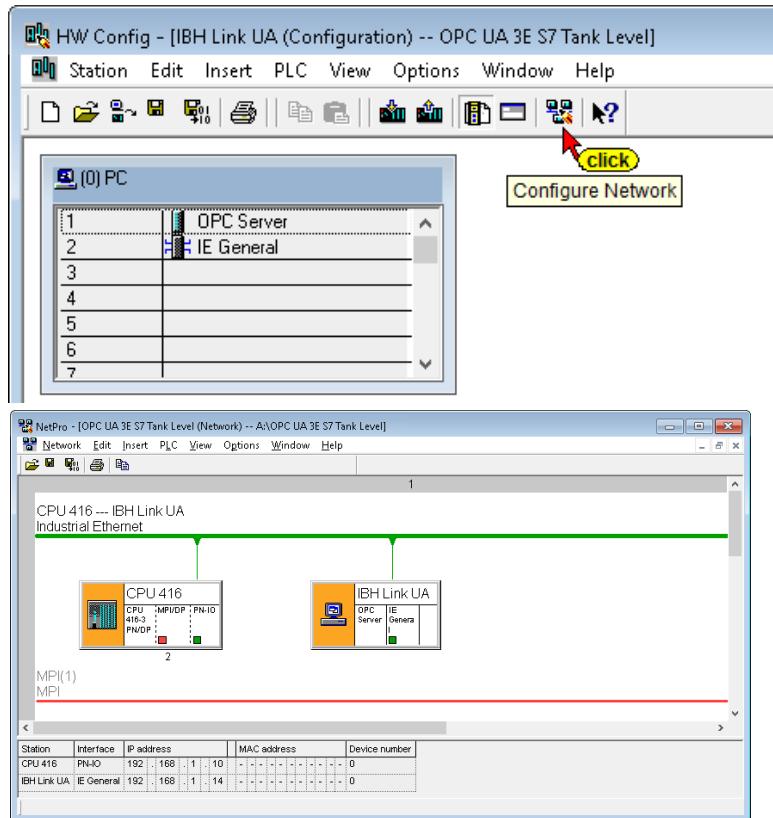
Loading into the IBH Link UA requires several steps.



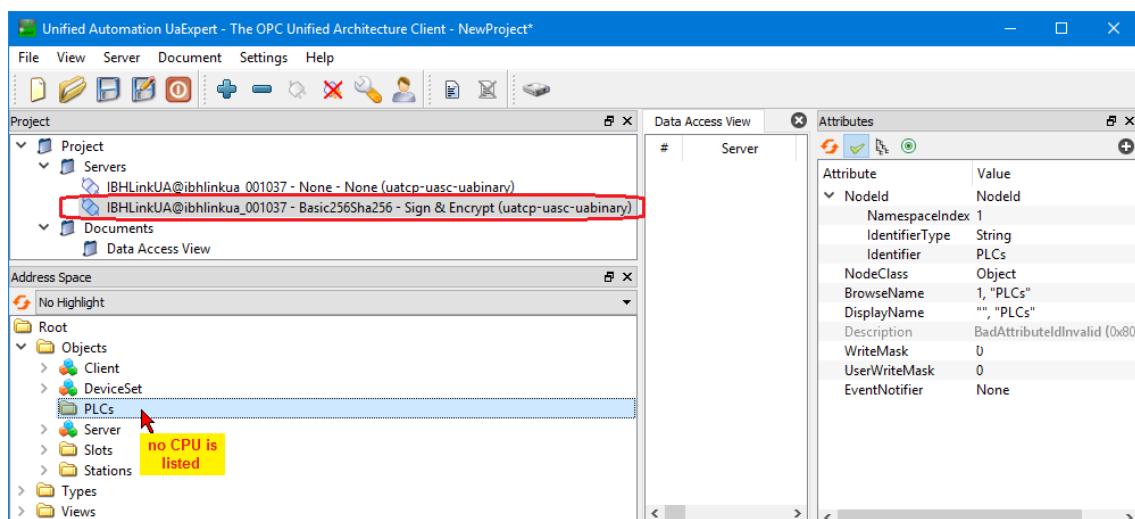
The progress of loading into the IBH Link UA is displayed.



Clicking on the **Configure network** icon displays the CPU-416 and IBH Link UA link graphically.

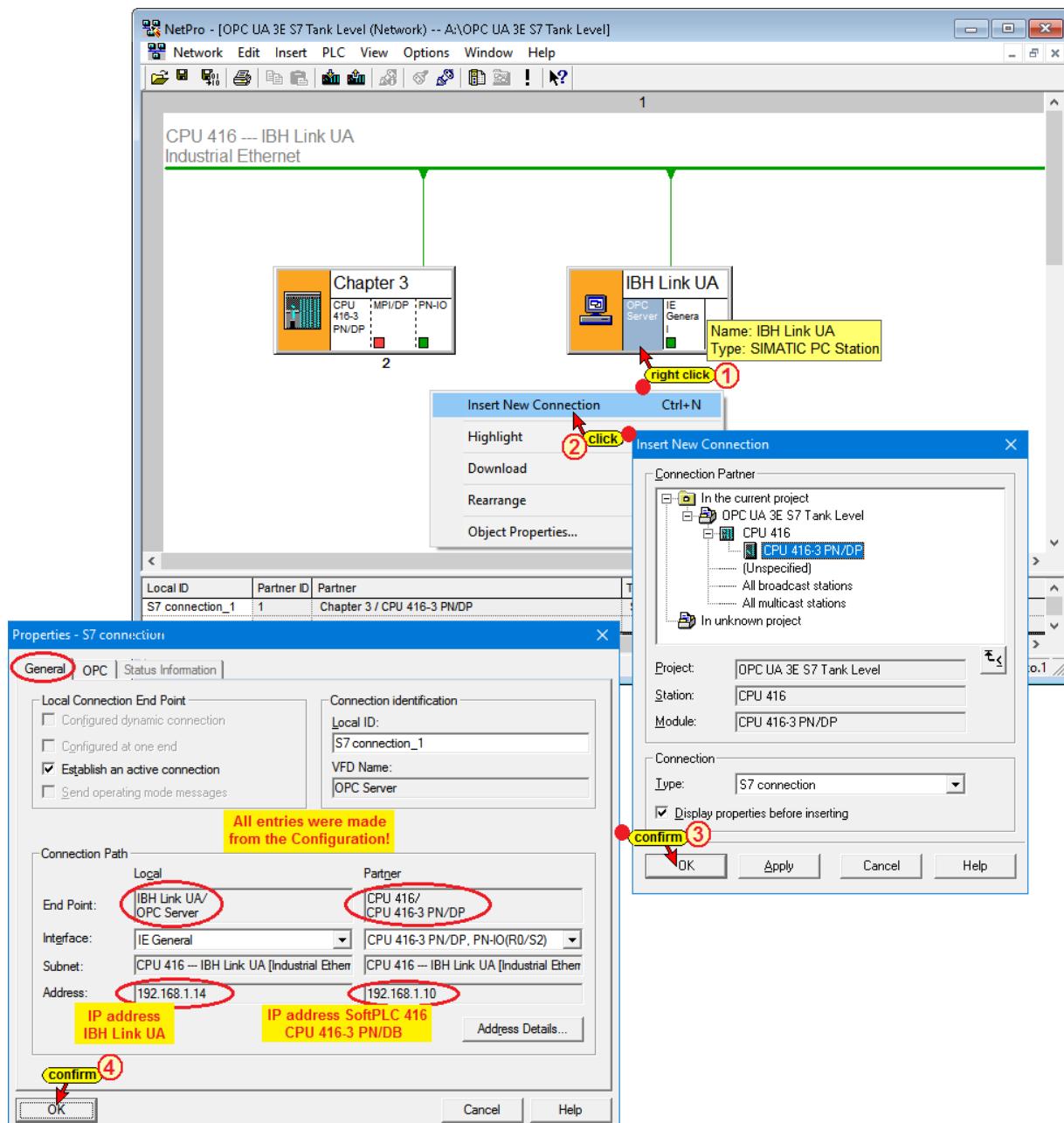


The CPU 416 is still not displayed in the **UaExpert** program window.

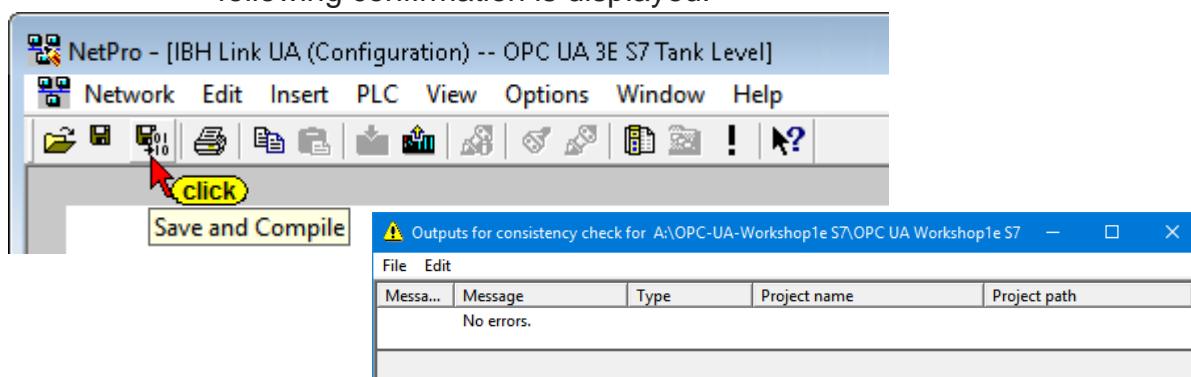


Connecting the CPU-416 with the IBH Link UA

Using the following four steps, an S7 connection is established between the **Chapter 3** (CPU-416) and the IBH Link UA.

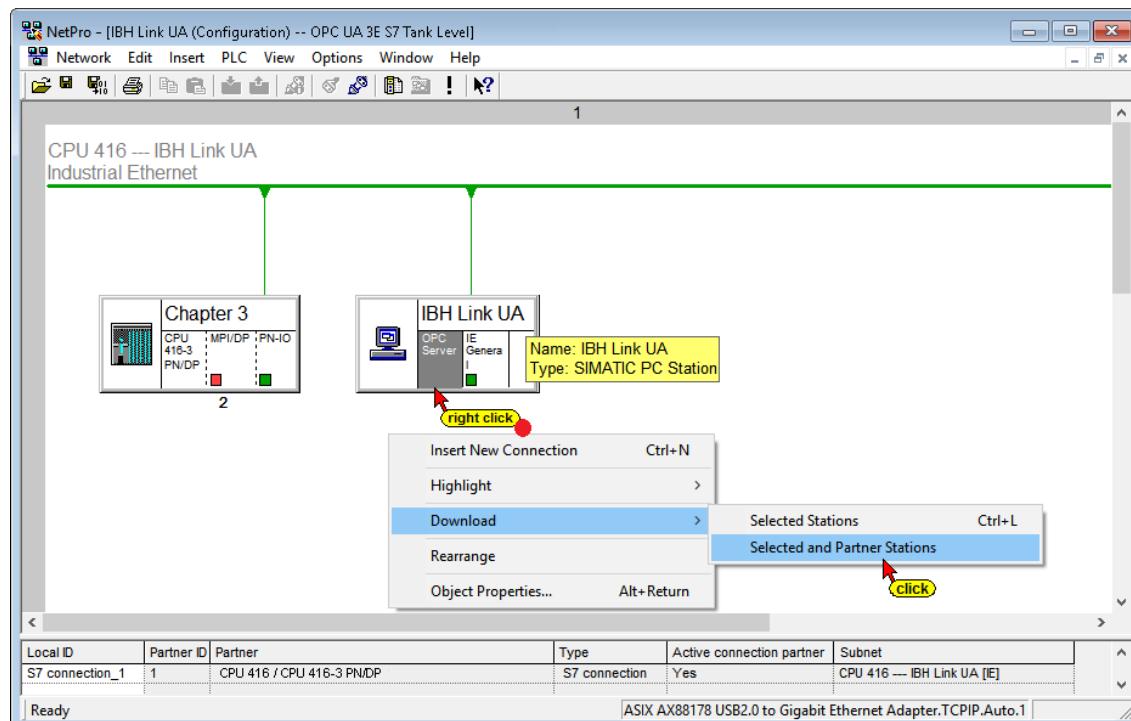


If no error has been determined with **Save and Compile**, the following confirmation is displayed.



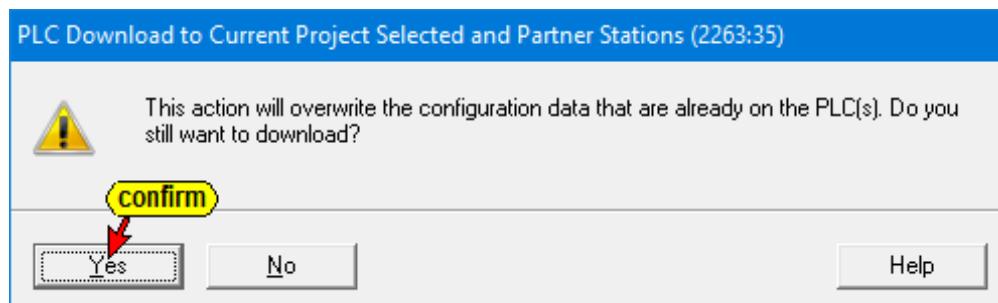
Download of the configurations

Now the configuration can be loaded into the IBH Link UA and the CPU-416.

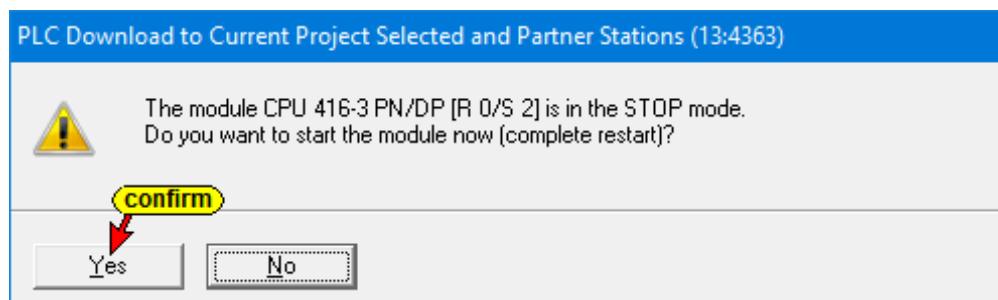


Loading into the PLC 416 and the IBH Link UA requires several steps.

- The PLC configuration is overwritten, identified and stopped

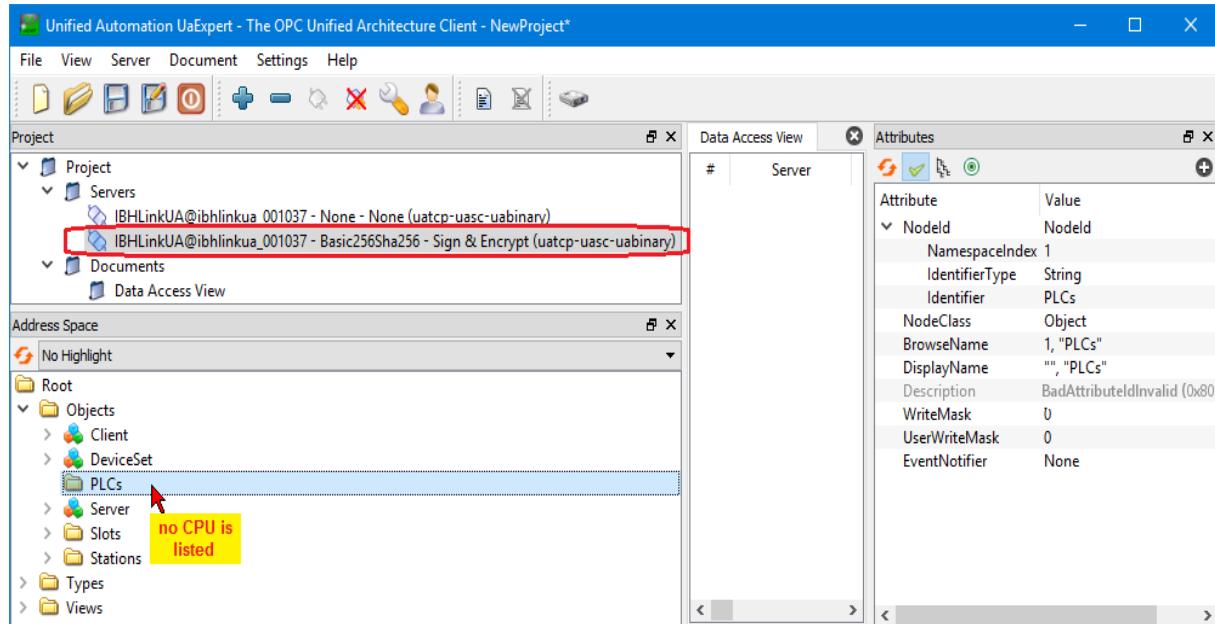


- The loading into the IBH Link UA (OPC Server / IE General) is started.
- After loading the configuration into the PLC 416 the CPU must restarted.

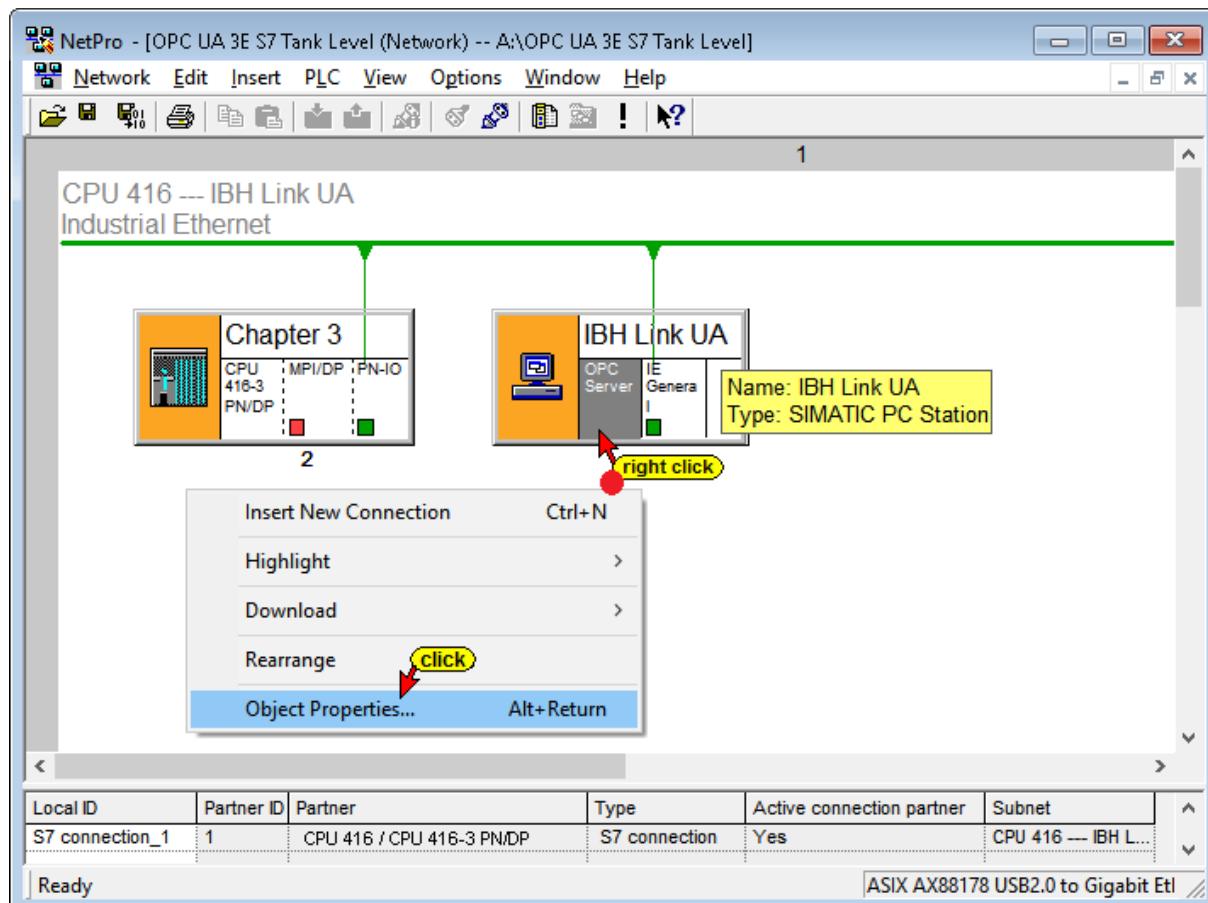


UaExpert Program Window

The CPU 416 is still not displayed in the **UaExpert** program window.



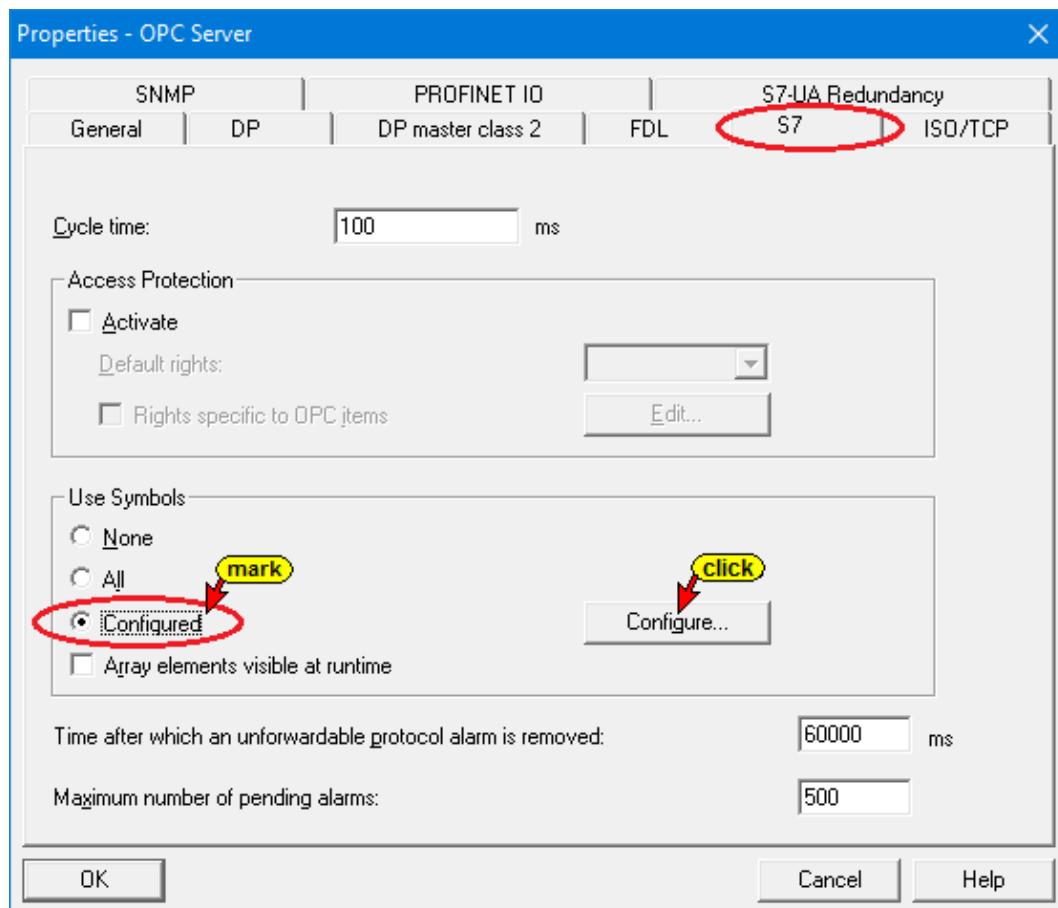
Select the symbols to be used (OPC tags)



Clicking the **Object Properties** command starts the opening of several dialog boxes to define the symbols to be used for the S7 connection.

Properties - OPC Server

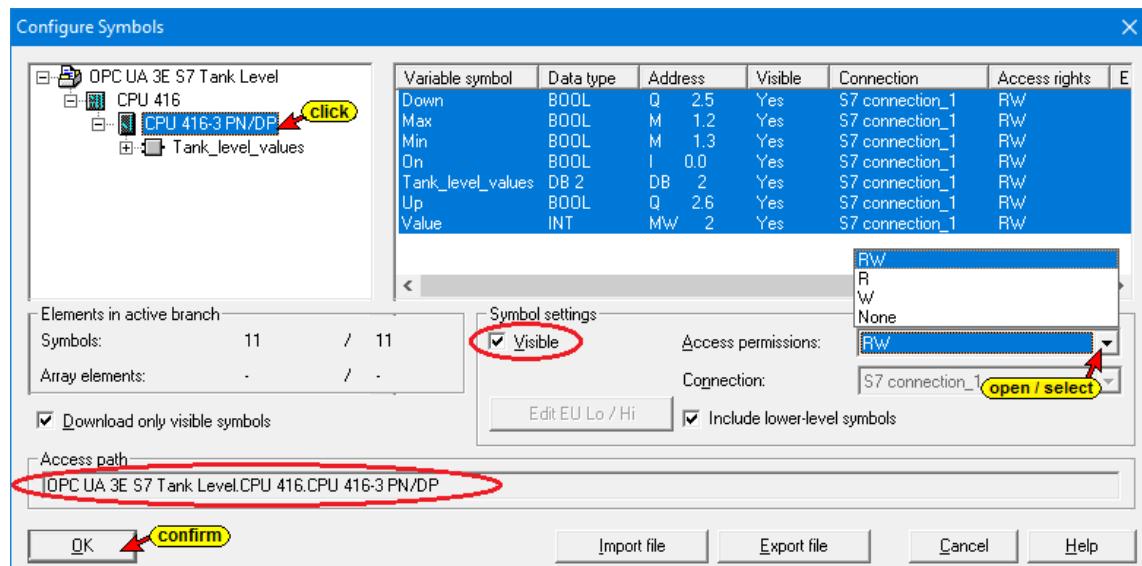
The tab S7 defines whether symbols should be used.



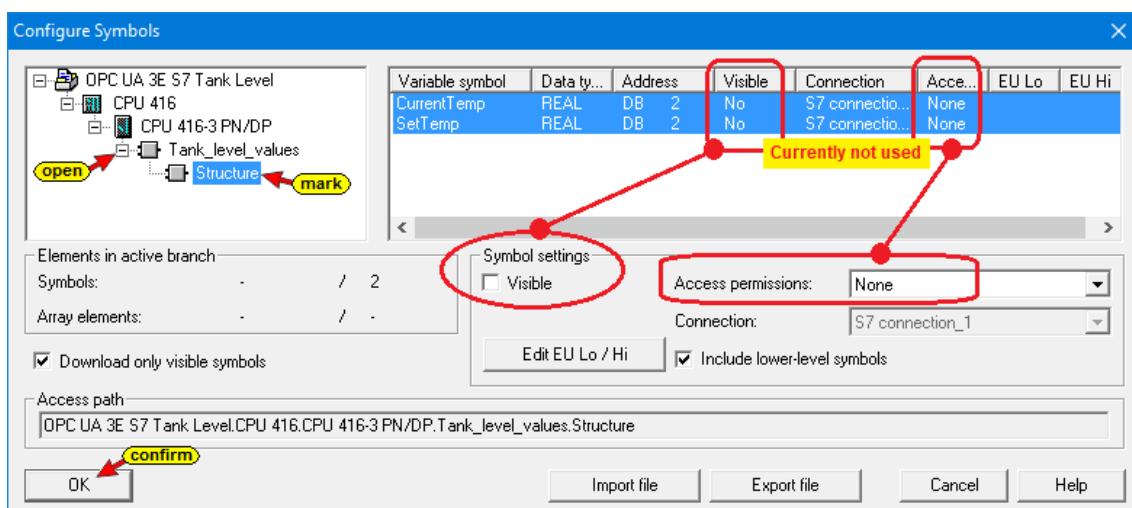
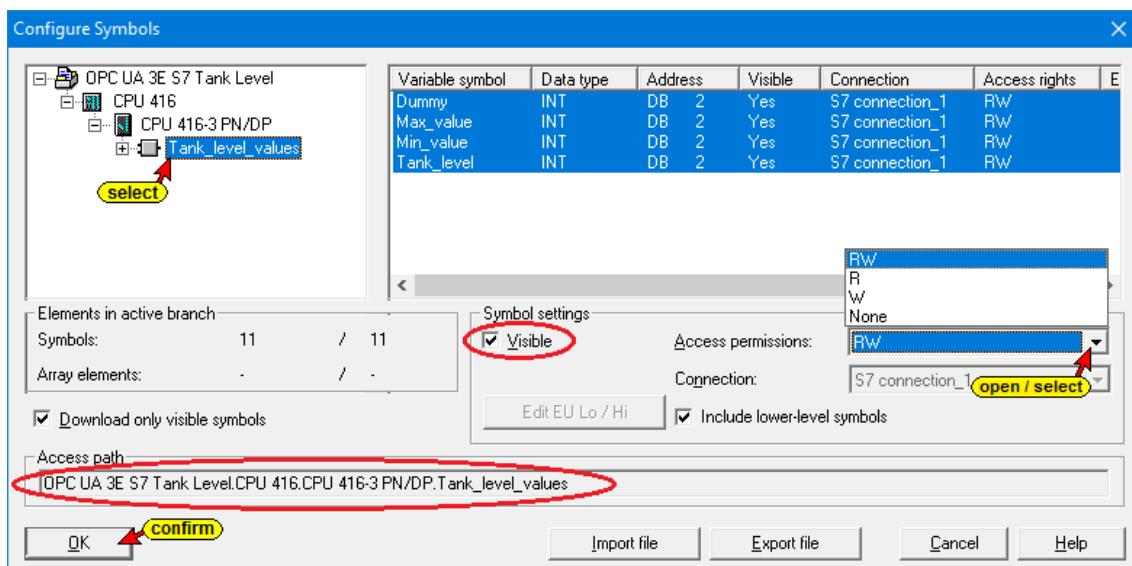
The **Configure** button opens a dialog box listing the operands defined in the symbol table or the data from the data block

Tank_level_values. These operands can be selected as OPC tags.
Due to the previously configured S7 connection the PLC knows the variables.

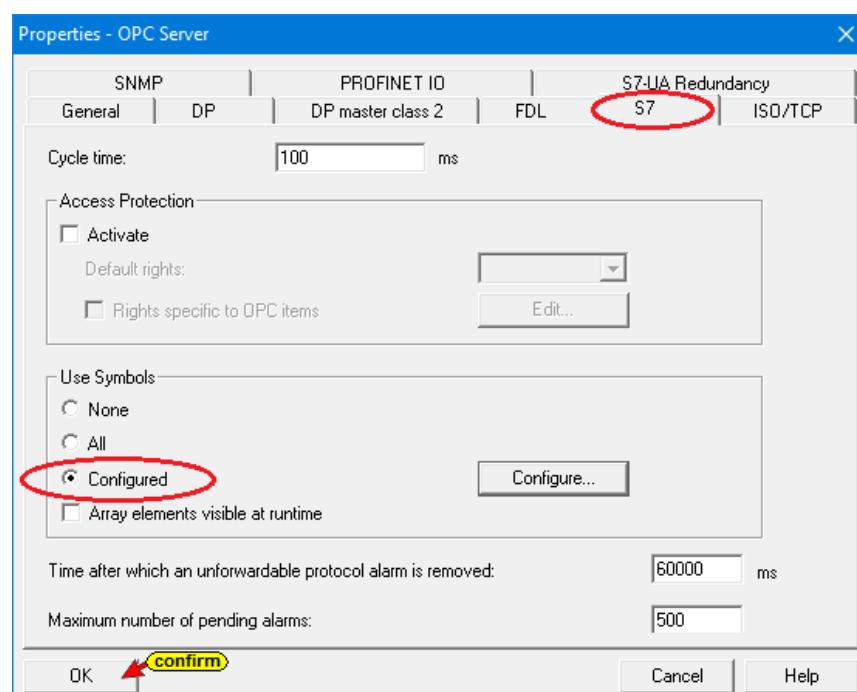
Configurable global symbolic named operands



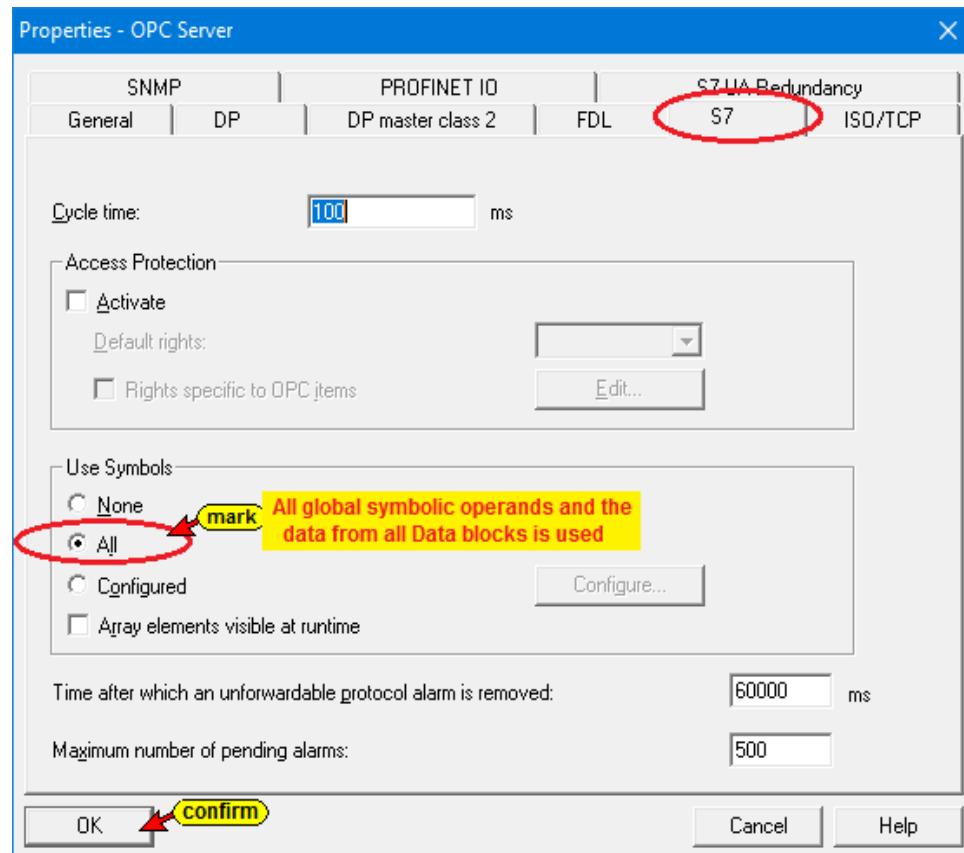
Data from data block DB 2 Tank_level_values



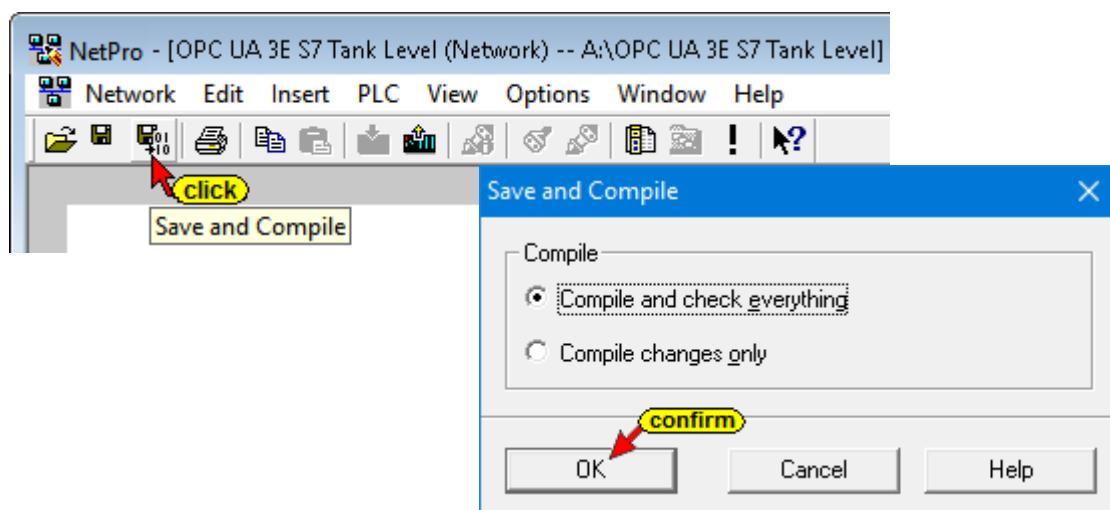
Click **OK** to close the **Properties – OPC Server / S7** dialog box.



If all global symbolic operands and the data from all Data blocks should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.



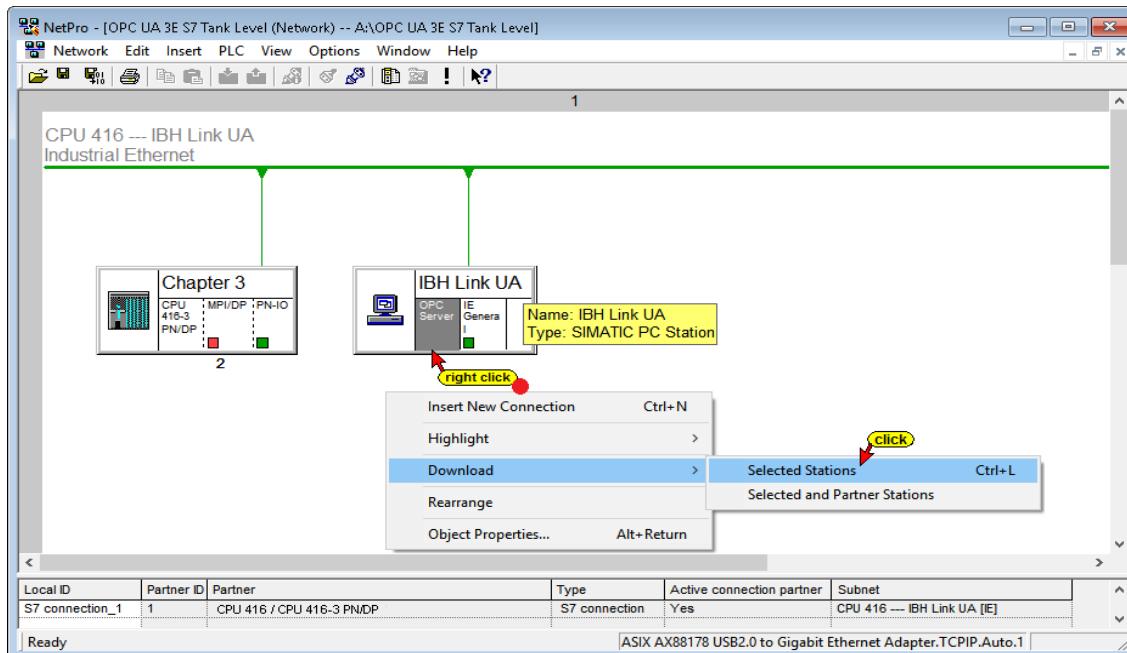
Save and translate the configuration, and load it into the IBH Link UA



The successful compiling and saving is displayed.



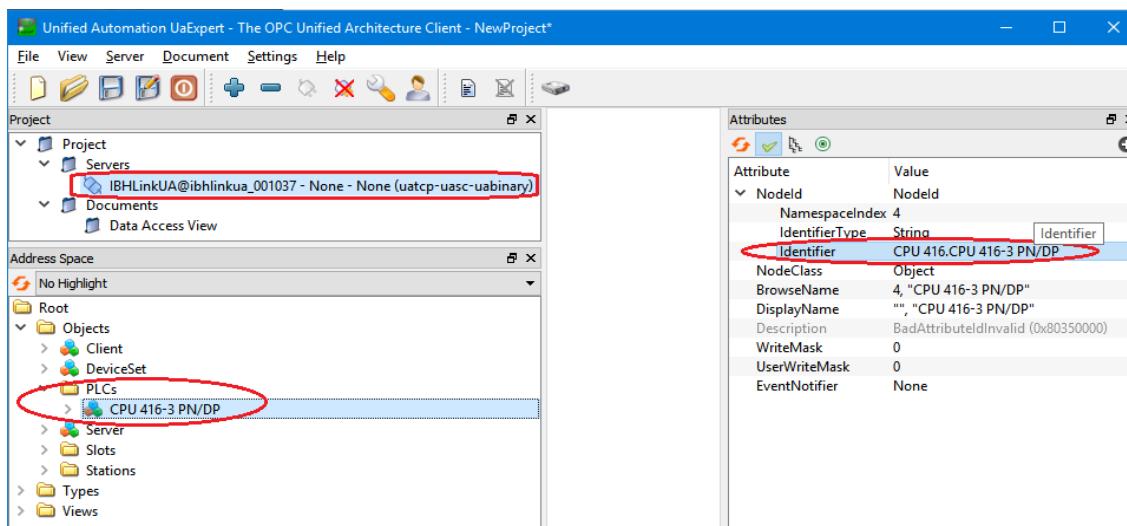
If **Save and Compile** does not show any errors the configuration can be loaded into the IBH Link UA.



Several information must be confirmed to complete the download.

3.1.4 UaExpert – Program Window

The CPU 416 is now displayed in the **UaExpert** program window.



If the UaExpert program window was still active in the background of the PC, the connection to the IBH Link UA must be interrupted and restarted.

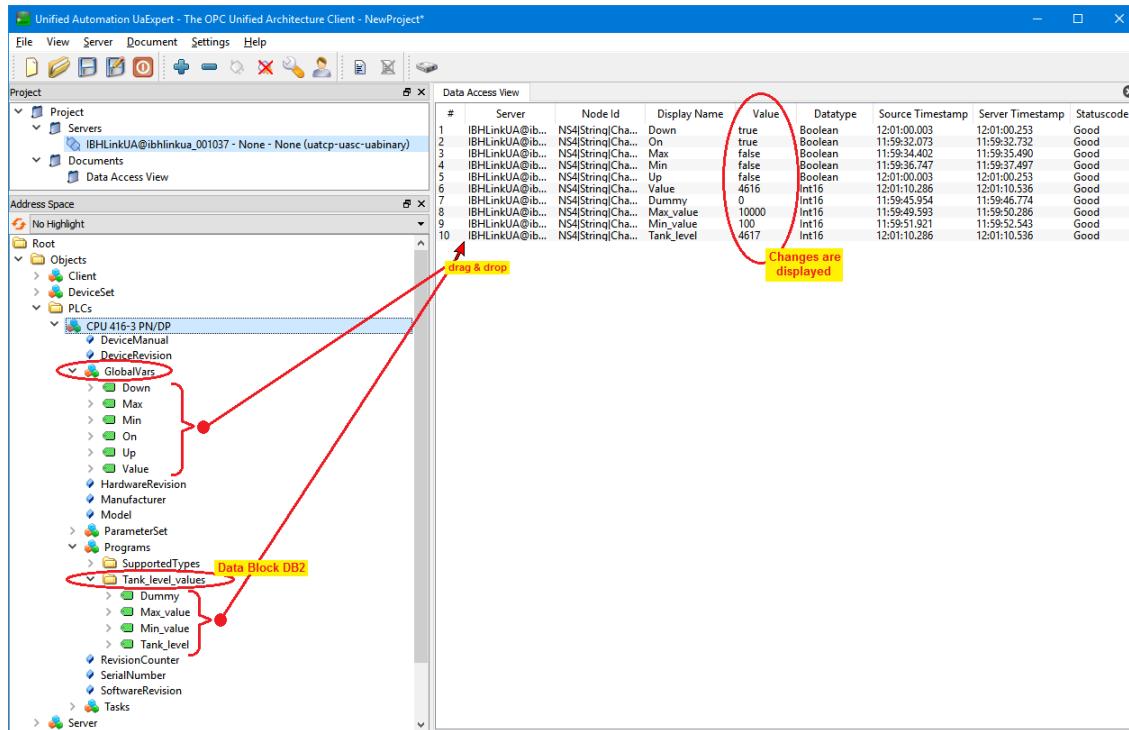
Disconnect the IBH Link UA Server



Connecting to the IBH Link UA Server

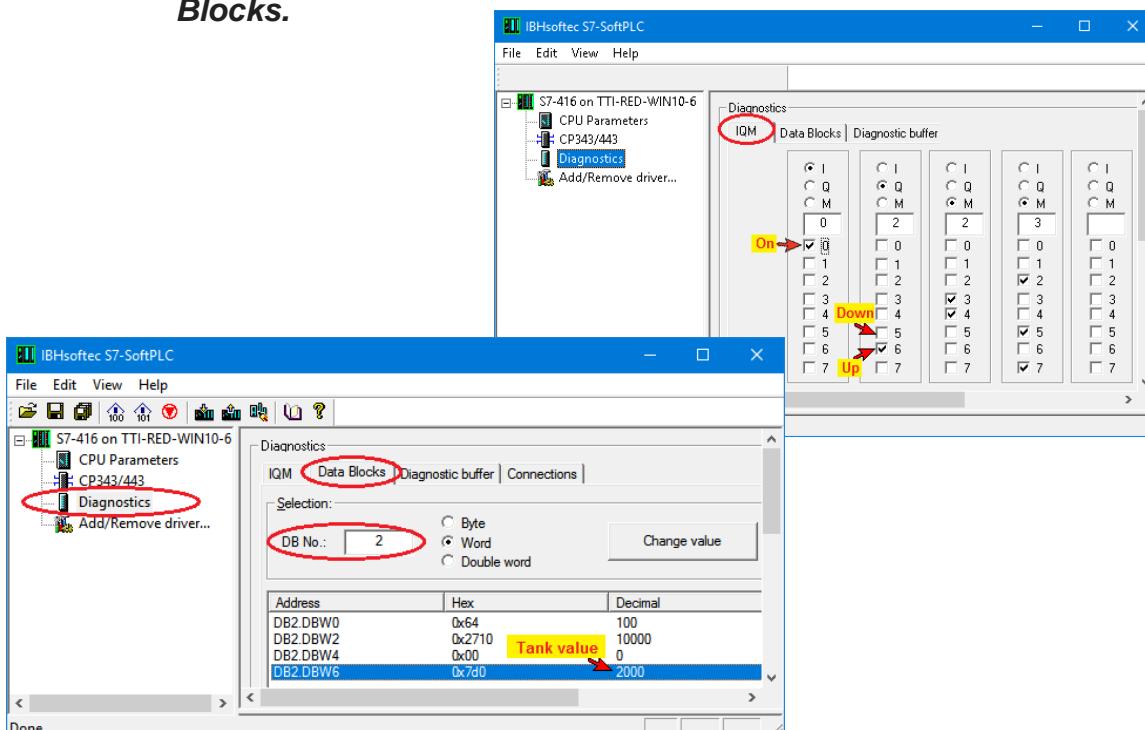


The operands defined in the symbol table and the data from the **Data Block DB2 – Tank_level_values** –, which have been defined as OPC tags, are listed under **GlobalVars** and **Programs**. Using Drag&Drop the status of the tags can be displayed in the **Data Access View**.



If the PLC program **Tank Level** is processed, the changes are displayed in the **Data Access View / Value** window.

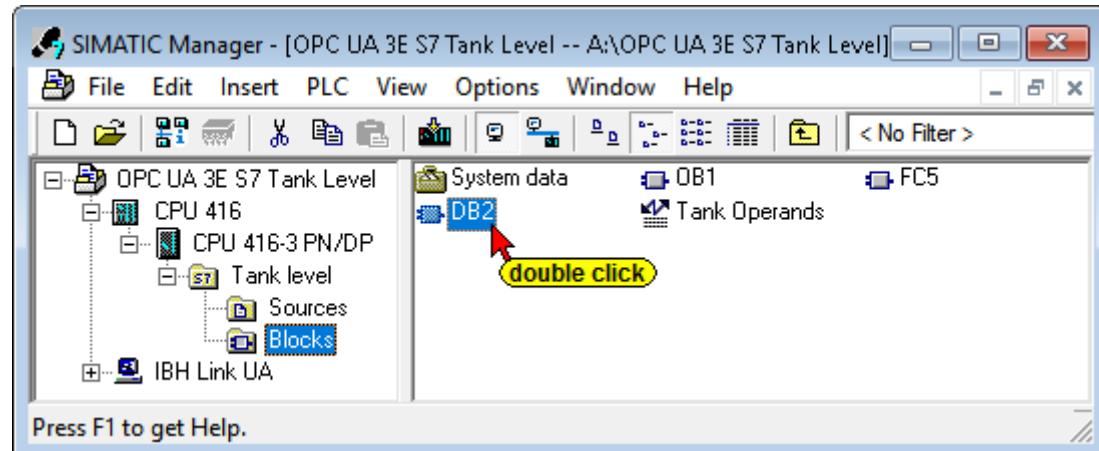
The program **Tank Level** can be started in the SoftPLC **Diagnostics / IQM** window. The status of the values is displayed in the tab **Data Blocks**.



3.2 Complex Variable – STRUCT – in the IBH Link OPC UA Server

Creating an additional structure in the global data block DB2

The symbolic name of the data block DB2 is **Tank_level_values**.



The screenshot shows the LAD/STL/FBD editor with the title 'LAD/STL/FBD - [DB2 -- "Tank_level_values" -- OPC UA Workshop1e S7\Chapter 3\CPU 416-3 PN/DP\...\.DB2]'. It displays a table of data block fields:

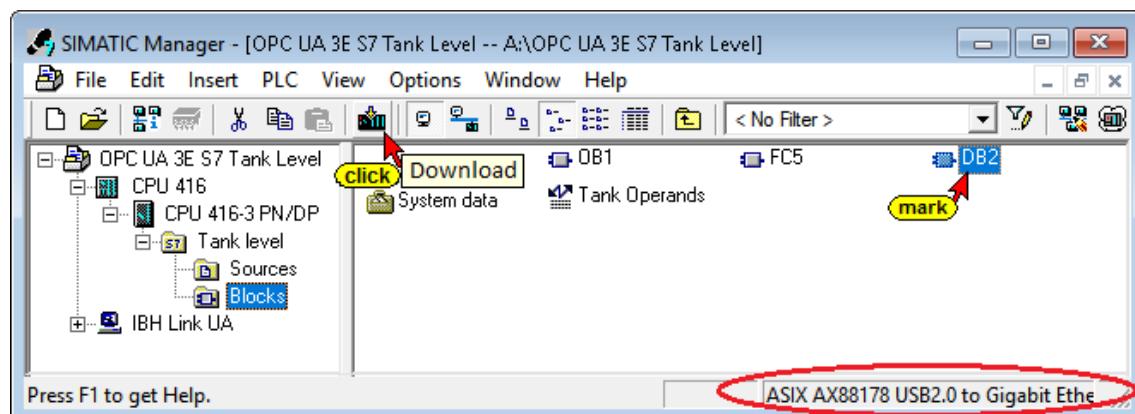
Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Min_value	INT	100	Tank filled less than 10%
+2.0	Max_value	INT	10000	Tank filled more than 90%
+4.0	Dummy	INT	0	Dummy
+6.0	Tank_level	INT	0	Tank level value
+8.0	Structure	STRUCT		Complex variable - STRUCT -
+0.0	CurrentTemp	REAL	0.000000e+000	Current Temperature
+4.0	SetTemp	REAL	0.000000e+000	Requested Temperature
=8.0		END_STRUCT		
=16.0		END_STRUCT		

A red box highlights the 'Structure' row, and another red box highlights the entire row for 'CurrentTemp'.

A structure was created in the data block DB2 **Tank_level_values**.

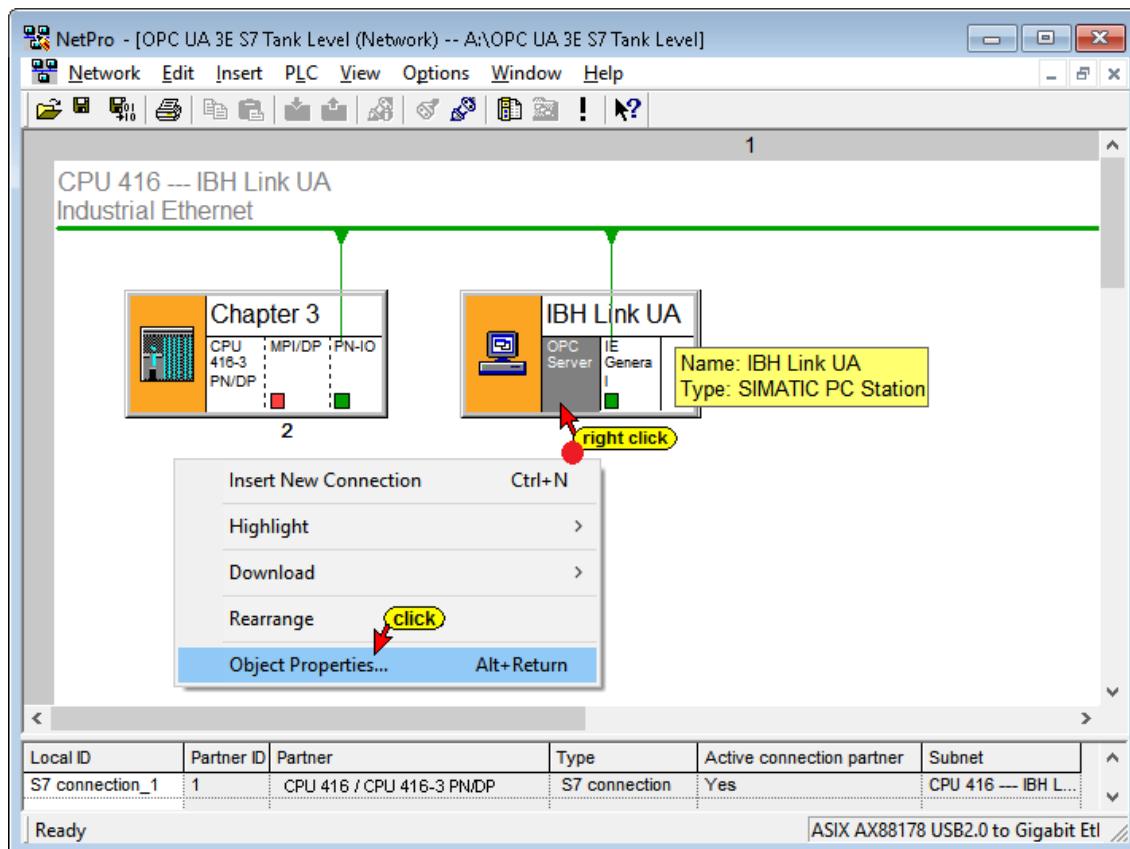
The DB has been defined in the symbol table.

The modified Data Block must be loaded into the CPU.



Re-select OPC tags

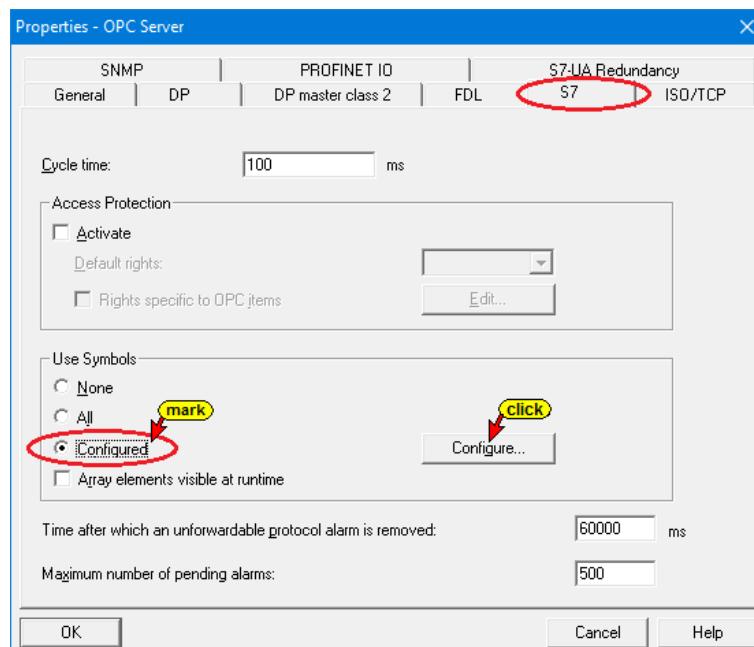
The graphical network configuration is opened.



Clicking the ***Object Properties*** command starts the opening of several dialog boxes to define the symbols to be used for the S7 connection.

Properties - OPC Server

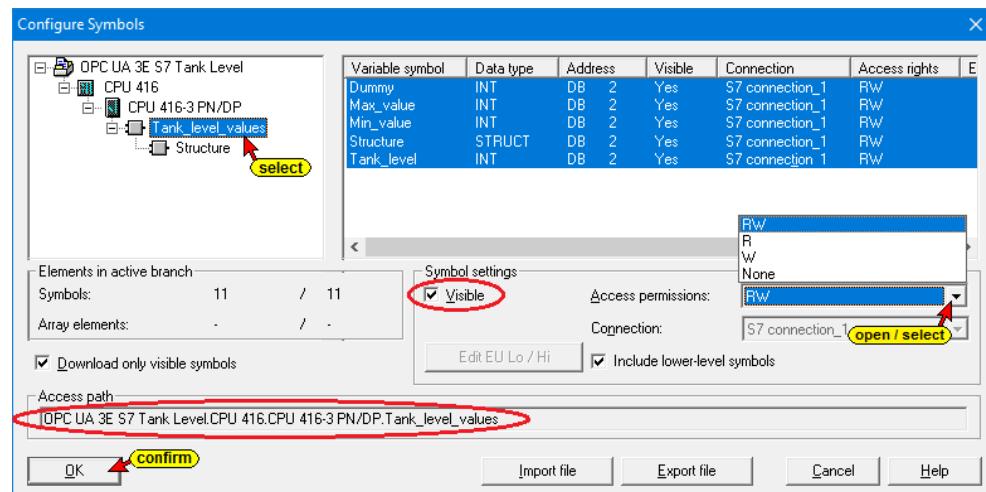
The tab S7 defines whether symbols should be used.



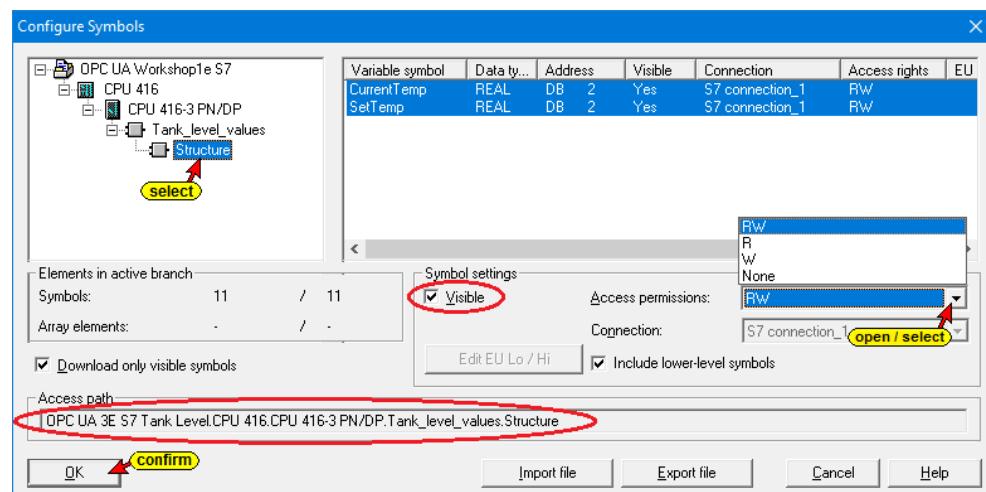
The **Configure** button opens a dialog box listing the operands defined in the symbol table and the data from data blocks.

The data in the data block **Tank_level_values** with the newly created structure must be selected as OPC tags.

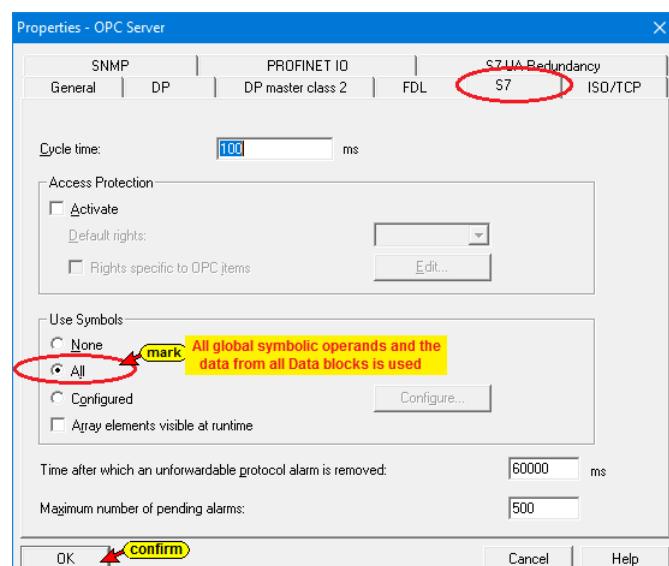
Data from data block DB 2 **Tank_level_values**



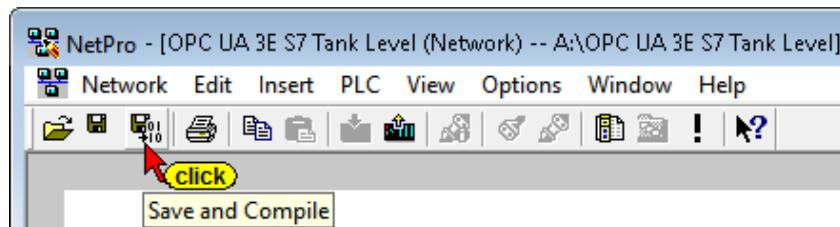
Data from the structure of data block DB 2 **Tank_level_values**



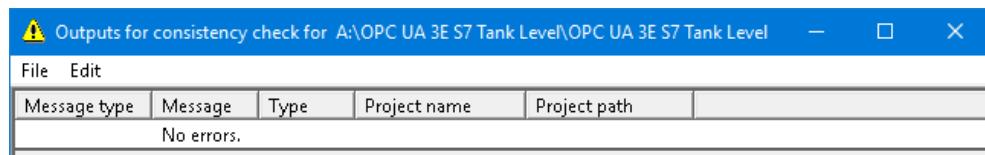
If all global symbolic operands and the data from all Data blocks should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.



Save and translate the configuration, and load it into the IBH Link UA

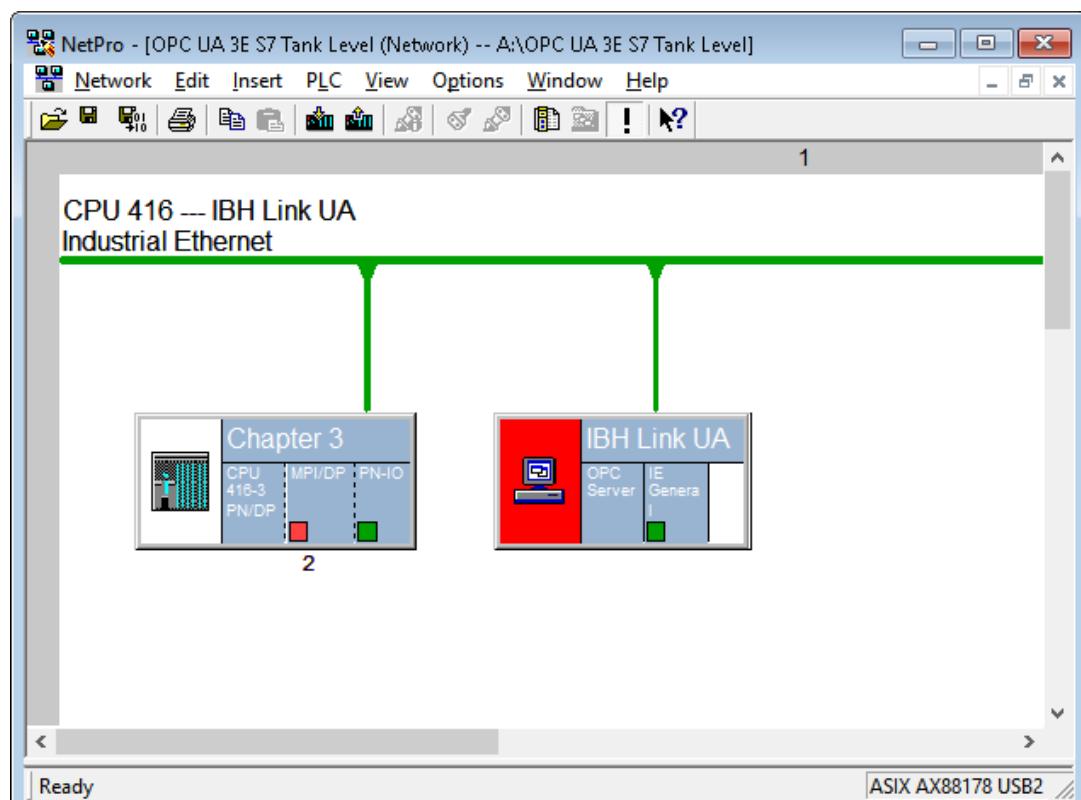
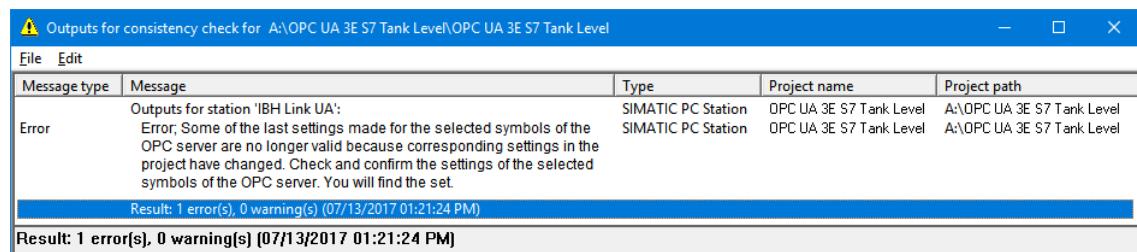


The successful compiling and saving is displayed.

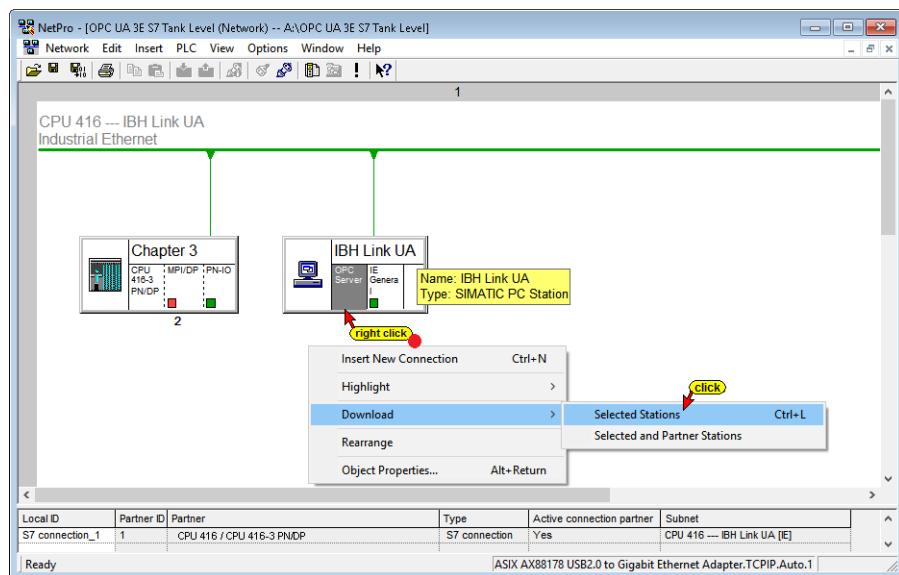


Note:

If the newly defined symbol has not been released for use in the dialog box **Properties - OPC Server**, clicking **Save and Compile** will display an error message and the faulty station is marked in red.



If **Save and Compile** does not show any errors the configuration can be loaded into the IBH Link UA.



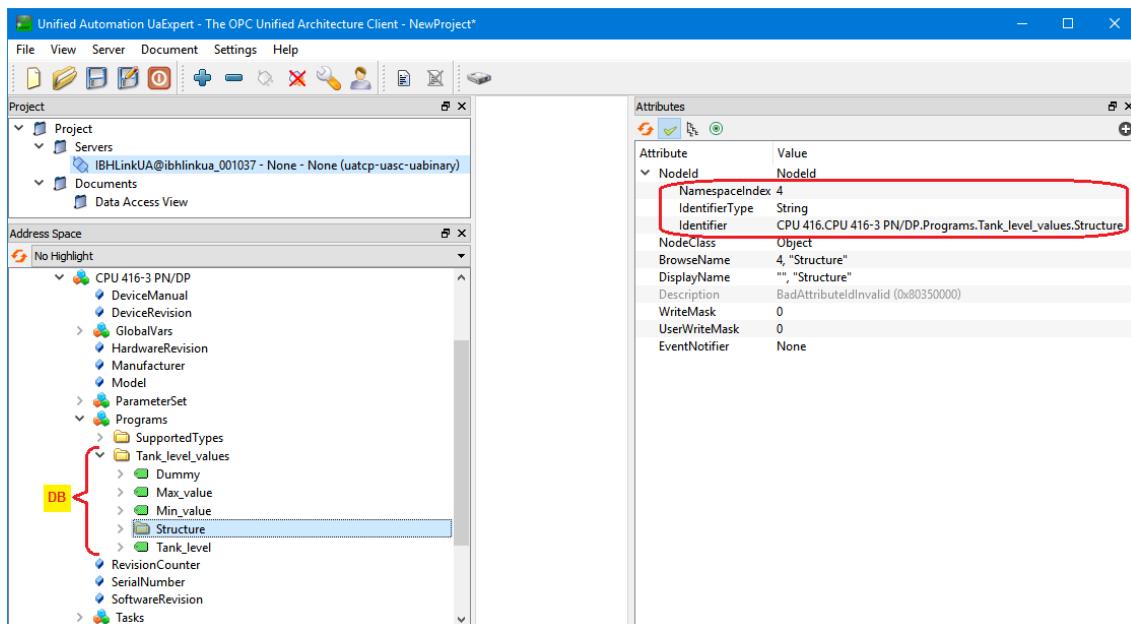
Several information must be confirmed to complete the download.

The information downloaded into the IBH Link UA is shown in the IBH Link UA browser window **OPC Slots**. Slot 1 contains the information of the **CPU 416** and Slot 2 the interface **IE General**.

Slot	Object	Description
Slot 1	CPU 416	DeviceManual, DeviceRevision, HardwareRevision, Manufacturer, Model, RevisionCounter, SerialNumber, SoftwareRevision
	Programs	SupportedTypes, Tank_level_values (Min_value, Max_value, Dummy, Tank_level), Structure (CurrentTemp, SetTemp)
	Tasks	
	ParameterSet	
	GlobalVars	Up, Down, Value, Min, Max, On
Slot 2	IE General	

UaExpert - Program Window

The DB2 **Tank_level_values** with the **structure** is displayed in the UaExpert program window. The identifier and the identifier type give a unique name that avoids a name conflict.

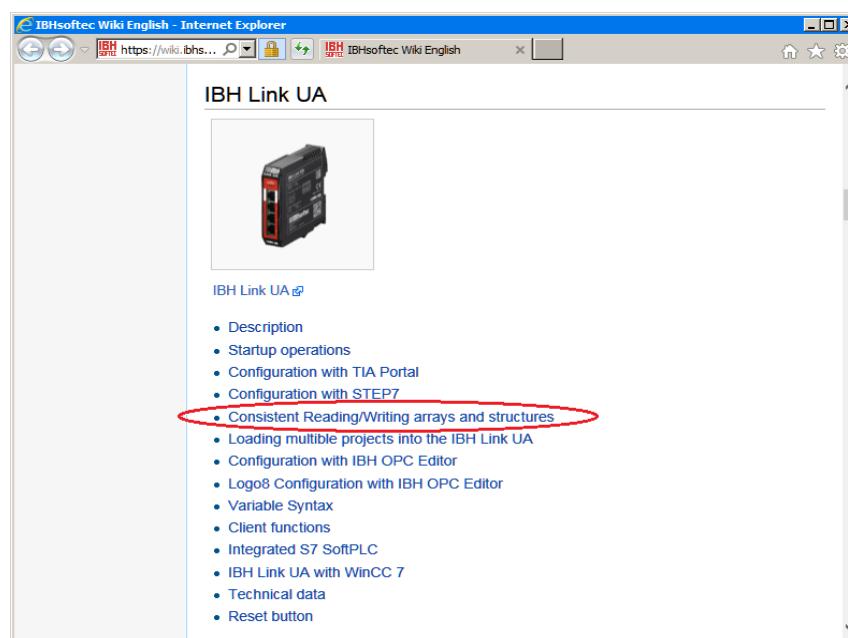


3.2.1 Using Structure Variables

Within the IBH Link browser window **System** the OPC UA option **Use Structure Variables** may be activated. With S7-300 / S7-400, 64-byte structures are consistently possible.

IBHsoftec WIKI

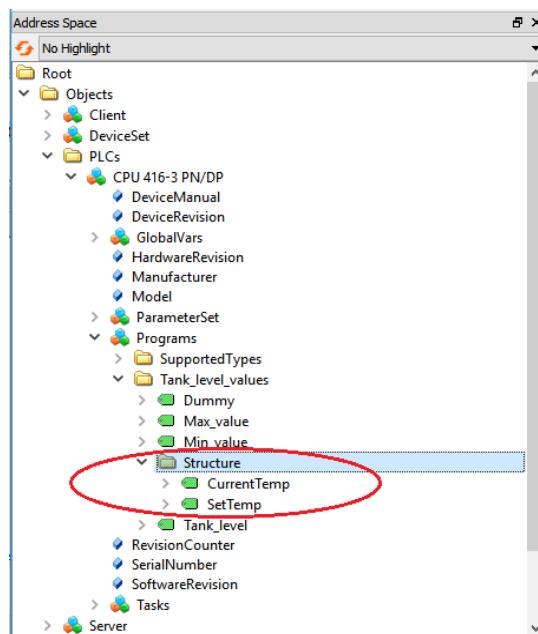
The structure variables are described in detail in IBHsoftec WIKI under the heading Consistent Reading/Writing arrays and structures.



Programs in the UaExpert window prior activating the structure variables

In the **Address Space** window, below **Programs**, the structure is listed with the variable **CurrentTemp**, and **SetTemp**.

Below **Structure**, no further information is displayed.



Browser window System

The screenshot shows the 'IBH Link UA - System' interface in a web browser. The left sidebar has a 'System' tab highlighted by a red oval. In the main content area, under 'OPC UA options', there is a checkbox labeled 'Build structure variables' which is checked. A red oval highlights this checkbox. At the bottom right, a confirmation dialog box is open, asking 'Changing the system settings requires a reboot. Reboot Now?' with 'confirm', 'Ok', and 'Cancel' buttons. The page also features an OPC UA certification logo.

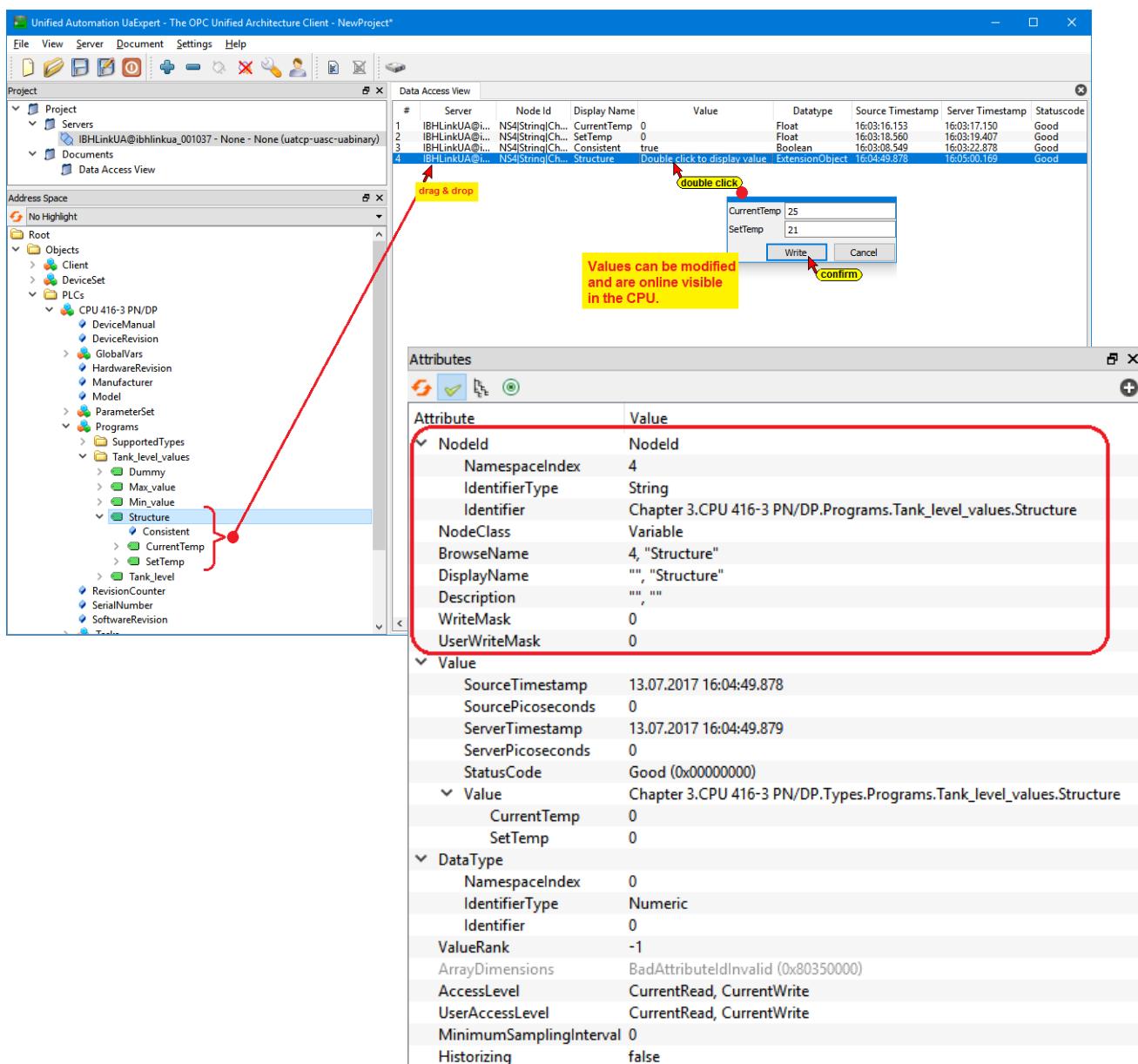
Marking the check box ***Build Structure Variables*** and additionally clicking on the ***Apply*** button and confirming it the function will be activated.

Structure variables created require additional memory

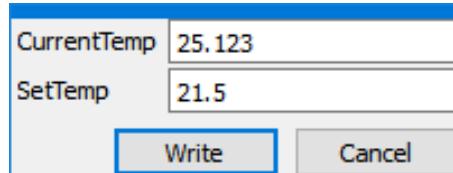
If the option ***Use Structure Variables*** is activated, the OPC server is restarted. In the ***UaExpert*** window ***Data Access View*** the variables of the structure are displayed in red while the OPC server is not running (the connection to the OPC server is interrupted).

After restarting the OPC server and restarting the connection of the UaExpert to the IBH Link UA, the system variable ***Consistent*** is displayed. If this variable is ***true***, consistent data can be read from the CPU (read) and written to the CPU (write).

Use Drag&Drop to pull ***Consistent*** and ***Structure*** into the ***Data Access View*** field.



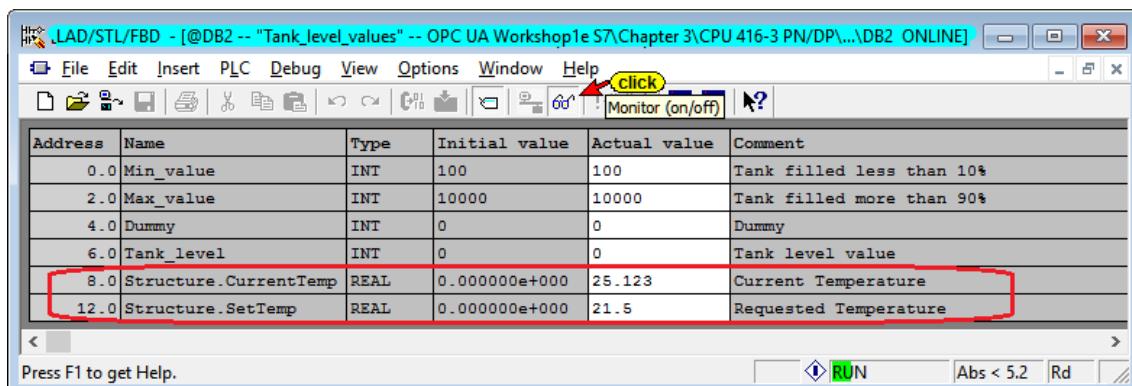
Double-clicking on the icon in the **Structure** line opens a dialog box to display and modify the variables of the **Structure**.



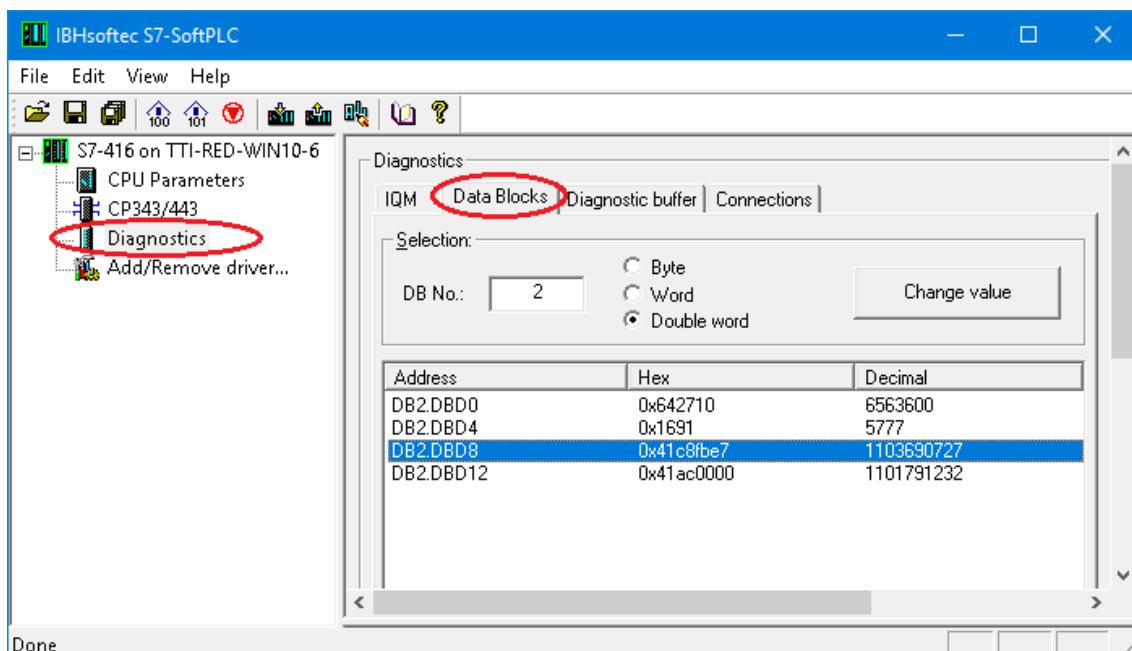
Display online the variable of the **Structure**

The modified variables can then be observed in **Tank_level_values** DB2 of the CPU-416.

DB2 online (Status) Display in SIMATIC Manager



DB2 **Tank_level_values** online Display using the SoftPLC diagnosis



3.3 Project using TIA 15 (IBHsoftec SoftPLC)

CPU 416-3 PN/DP (IBHsoftec SoftPLC) - Hardware configuration

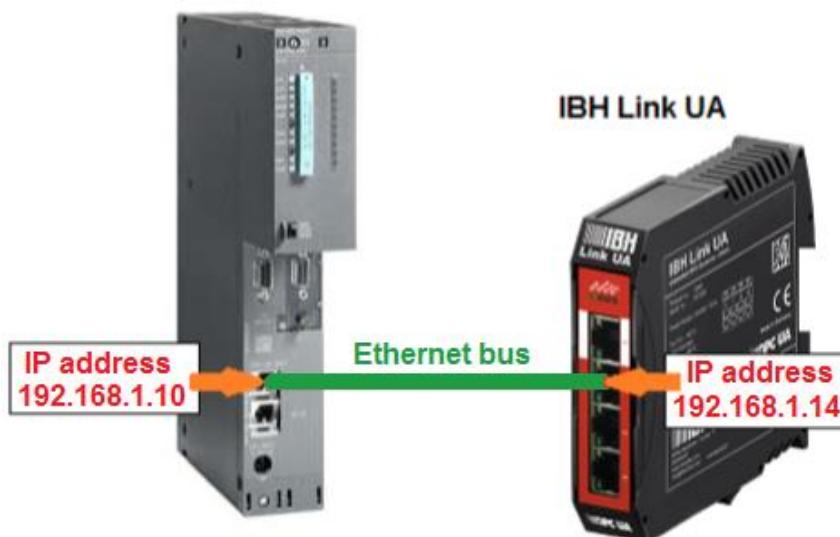
The following example shows the programming of a project using the TIA V15 portal and the connection of a CPU 416 with the IBH Link UA via an Ethernet connection.



A CPU having an Ethernet port has been selected.

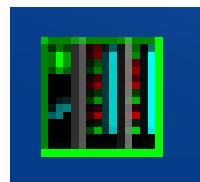
PLC Project: OPC UA 3E TIA15 Tank Level

**CPU 416-3 PN/DP
also available as SoftPLC**



3.3.1 Software PLC CPU 416-3 PN/DP

The example uses a CPU, which is also available as a software PLC from IBHsoftec (already installed on the PC).



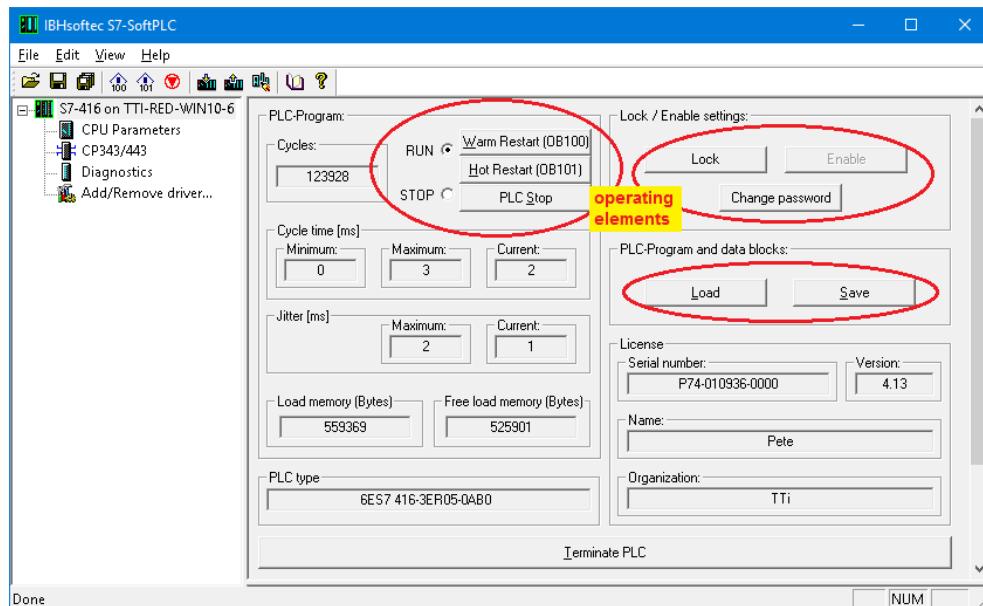
The PG / PC interface (TCPIP) must be selected accordingly.

The SoftPLC CPU 416-3 PN/DP from IBHsoftec is installed on the PC and is already running. Right-clicking on the **SoftPLC** icon in the taskbar opens the IBHsoftec S7-SoftPLC window for Configuring and Diagnosing the SoftPLC.

SoftPLC Operating, Diagnostic and Configuration windows

In the status bar right-click the SoftPLC icon to open the window to configure and operate the SoftPLC. This window displays the status of the CPU and diagnostic elements are presented.

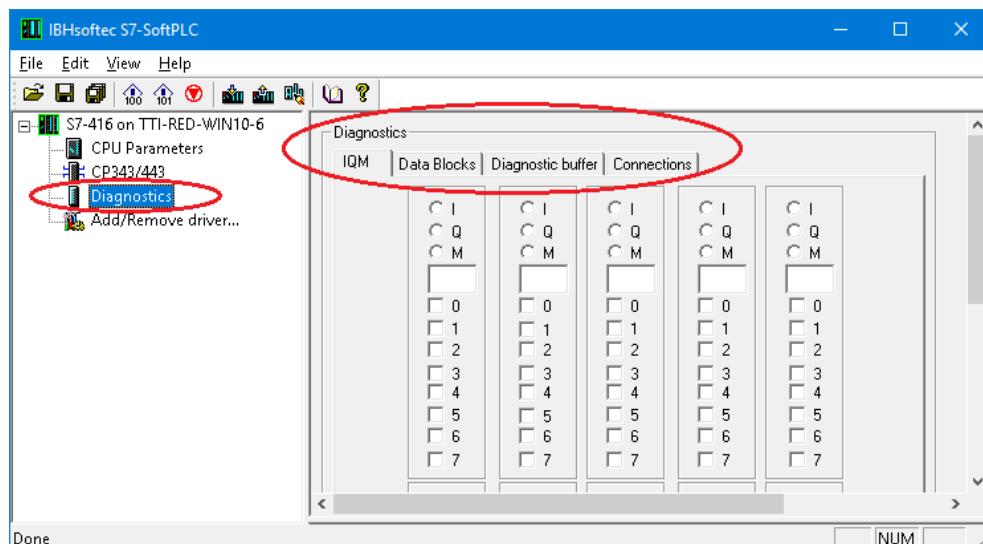
SoftPLC Operating and Status windows



SoftPLC Diagnostic window

The diagnosis provides four tabs.

- ***IQM*** Status display of individual bits of an operand. The status of freely selectable inputs (In._), outputs (Qn._) or flags (M n._) are displayed and changeable in these ten fields.
- ***Data blocks*** The status of existing, freely selectable data blocks can be displayed and its values can be changed as a byte, word or double word.
- ***Diagnostic buffer*** The diagnostics events of the CPU are listed in clear text with explanations in the order of their occurrence.
- ***Connections*** The connections of the CPU with ID, status, type etc. are displayed.



3.3.2 PLC program of the CPU 416

The project **OPC UA 3E TIA15 Tank Level** with the SIMATIC 400 Station **CPU 416** provides the S7 program **Tank level**.

It simulates the filling and emptying of a tank with the following characteristics:

The tank is filled up to reach a **Max_value** (Tank filled more than 90%) and is emptied to reach **Min_value** (Tank filled less than 10%).

The filling and emptying is controlled via an **Down** (Output valve) and **Up** (Input valve).

The variable **Value** (Tank level value) delivers an integer number to the CPU. The variables **Max** and **Min** are only used internally.

In the Data Block **DB2** (Tank_level_values) the integer number of the minimum and maximum tank level are stored.

The PLC block FC5 is used to control the up and down of the tank level.

The input valve (**Up**) is open when the tank content is between 0% and **Max_value**.

When **Max_value** is reached, the input valve is closed and the output valve (**Down**) is opened until the tank level drops to the **Min_value**.

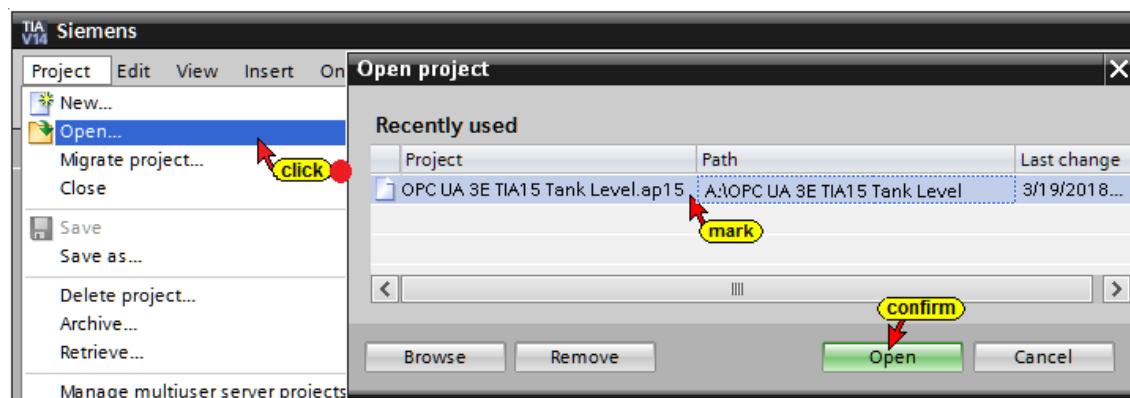
Now the output valve is closed again, and the input valve is opened, so that the tank reaches the **Max_value** again.

When the **Max_value** is reached, the input valve is closed, and the output valve is opened, etc., etc.

The variable **ON** (Control ON) enables the level control. If the control is switched off, the tank level remains at its current value.

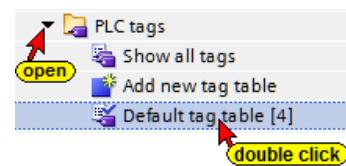
The PLC symbols listed in the **Symbols table** and the data defined in the Data Block **DB2** (Tank_level_values) will be routed via the **IBH Link S7++** to the OPC-Server **IBH Link UA** (OPC tags).

Open the project **OPC UA 3E TIA15 Tank Level**



Program Tank level *Default tag table*

Double-click on ***Default tag table*** to open the listing.



	Name	Data type	Address	Comment
1	On	Bool	%I0.0	Control ON
2	Down	Bool	%Q2.5	Output valve
3	Up	Bool	%Q2.6	Input valve
4	Max	Bool	%M1.2	Maximum reached
5	Min	Bool	%M1.3	Minimum reached
6	Value	Int	%MW2	Tank level value

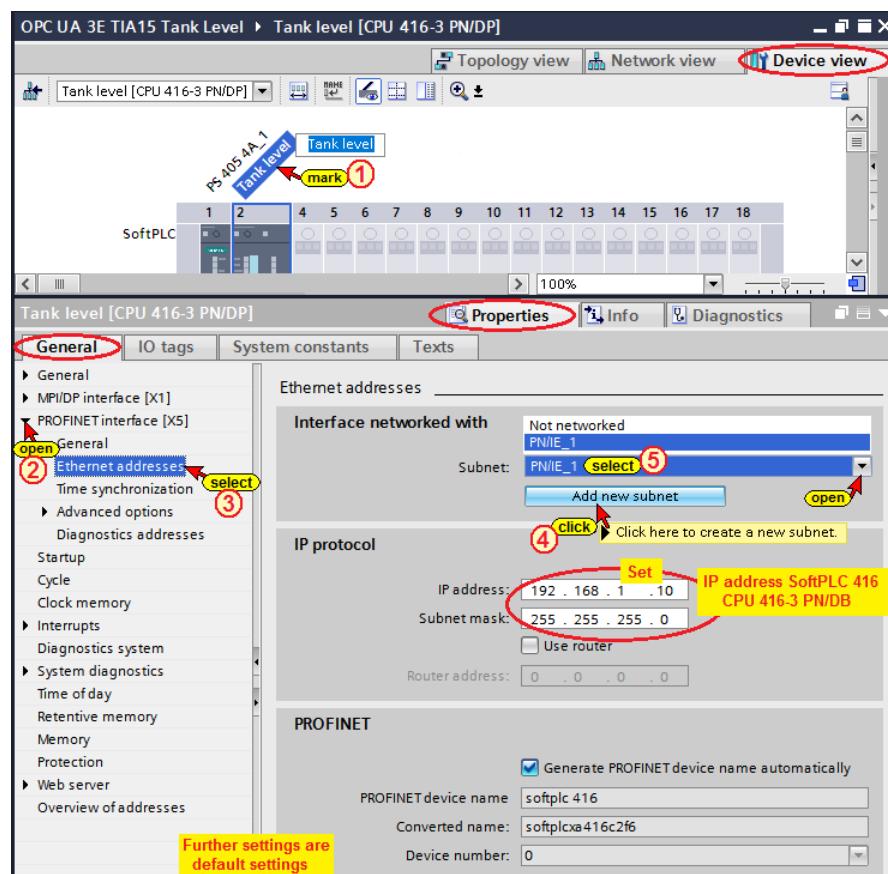
Loading the PLC Program *Tank level* into the CPU

Double-click ***Device Configuration*** to open the Device view window.



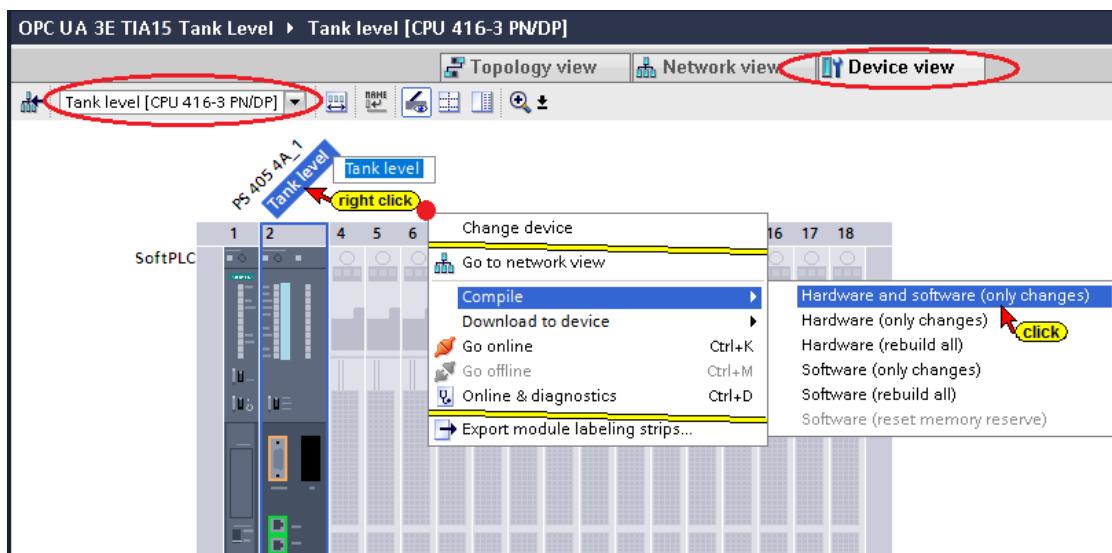
In the example, the CPU 416-3 PN/DP (6ES7 416-3ER05-0AB0) firmware version V5.1 is used, which is also available as a software PLC from IBHsoftec (already installed on the PC).

In the open field Properties, the required IP address is set under ***IP protocol***. In the example, the IP address of the PC is - 192.168.1.10 (all PCs in the workshop have this address). The Ethernet connection is direct without a router.



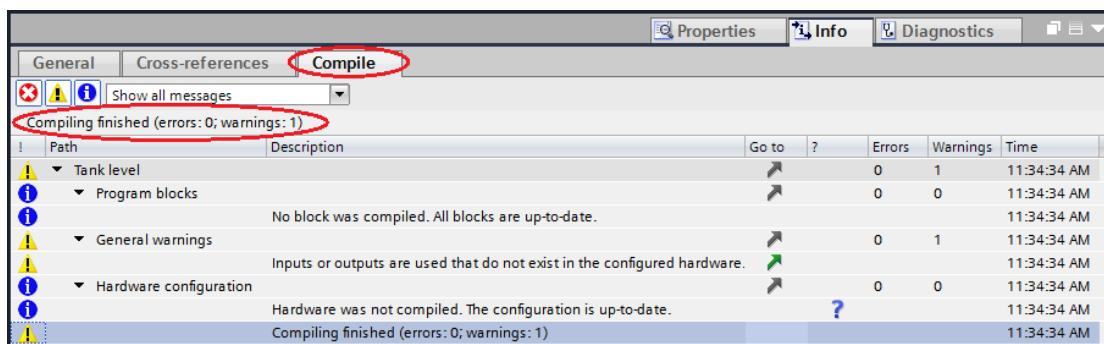
Hardware and software compilation

Use the command from the context menu to compile the software and the hardware.



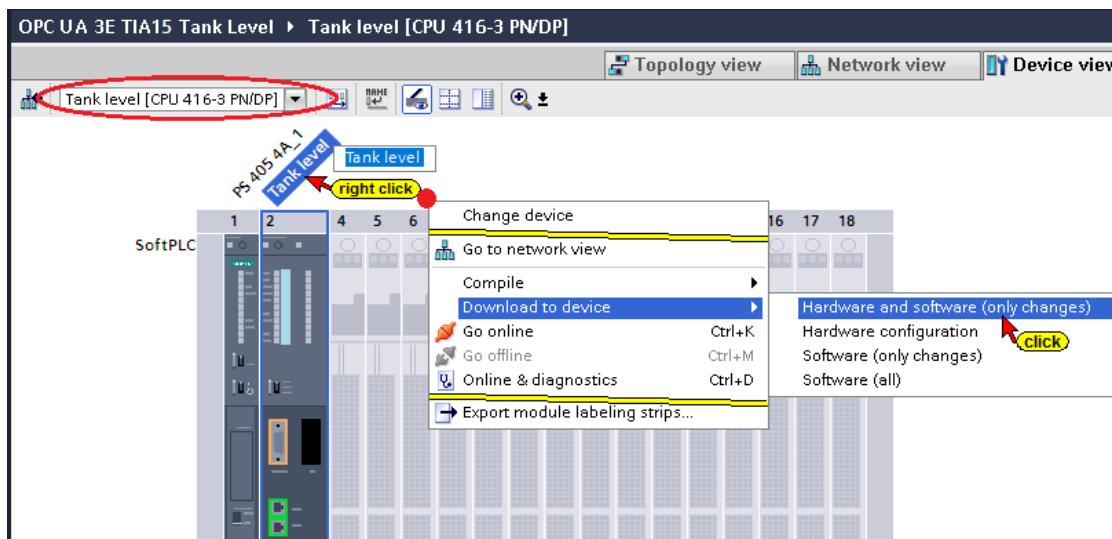
Hardware and software compilation with warnings

Ignore the warnings. The SoftPLC 416 requires no I/O modules.

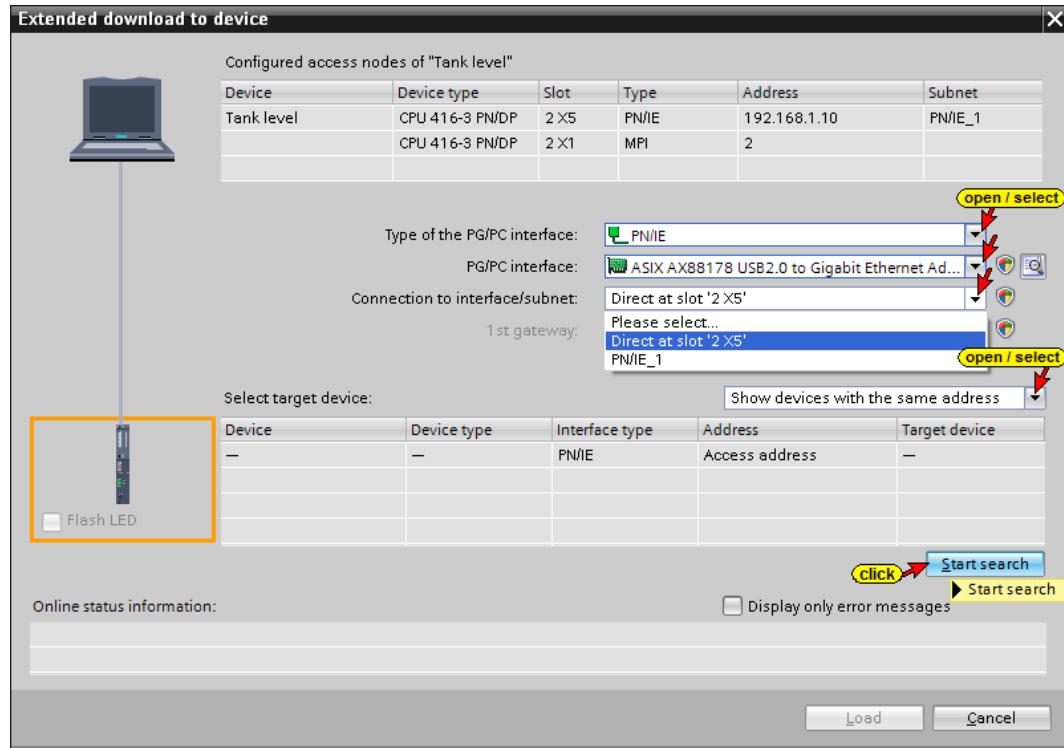


Download the hardware and software into the CPU

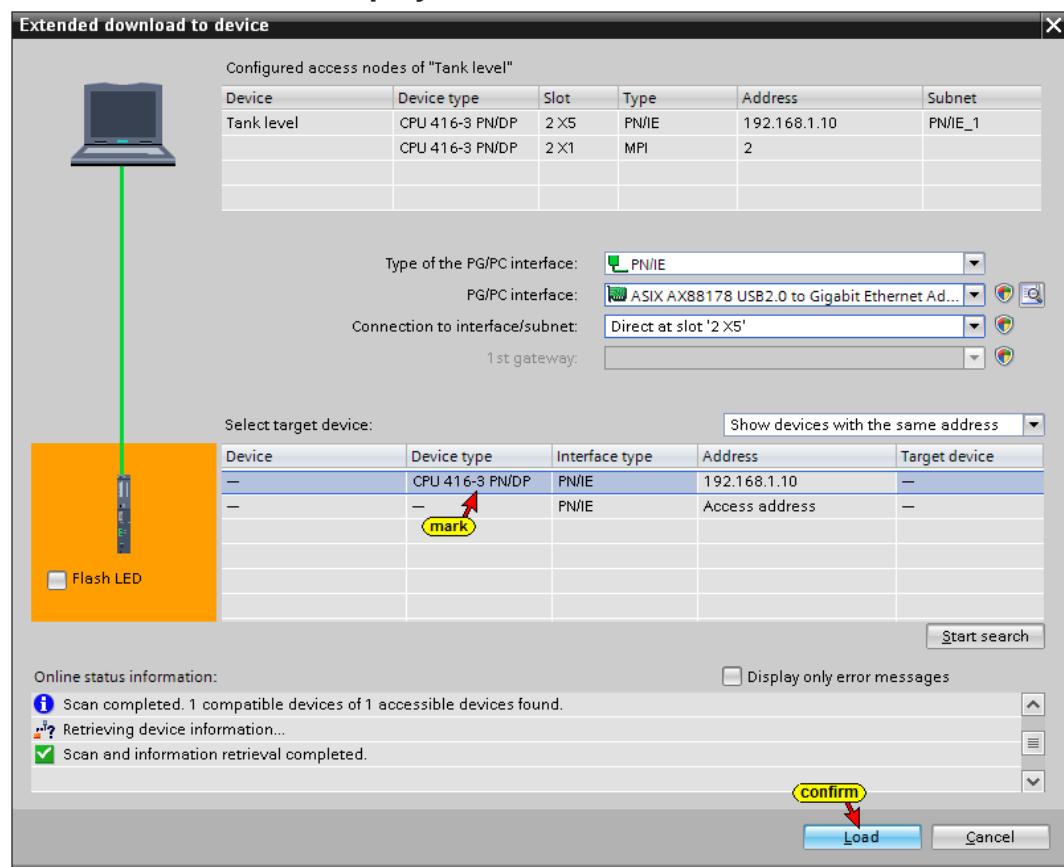
With the commands from the context menu, the software and the hardware configuration can now be loaded into the device.



The Download command opens the dialog box to set the interface for the device. Direct at slot '2 X5' must be selected because the Hardware configuration has not yet been downloaded into the CPU.

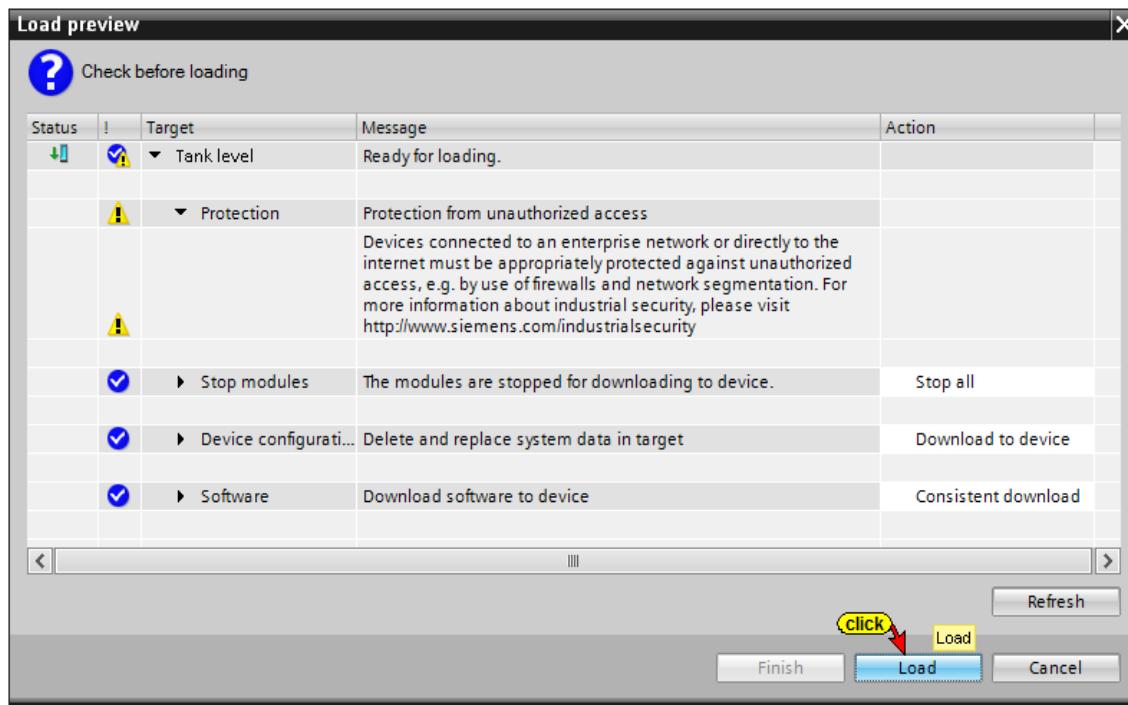


The successful search is displayed

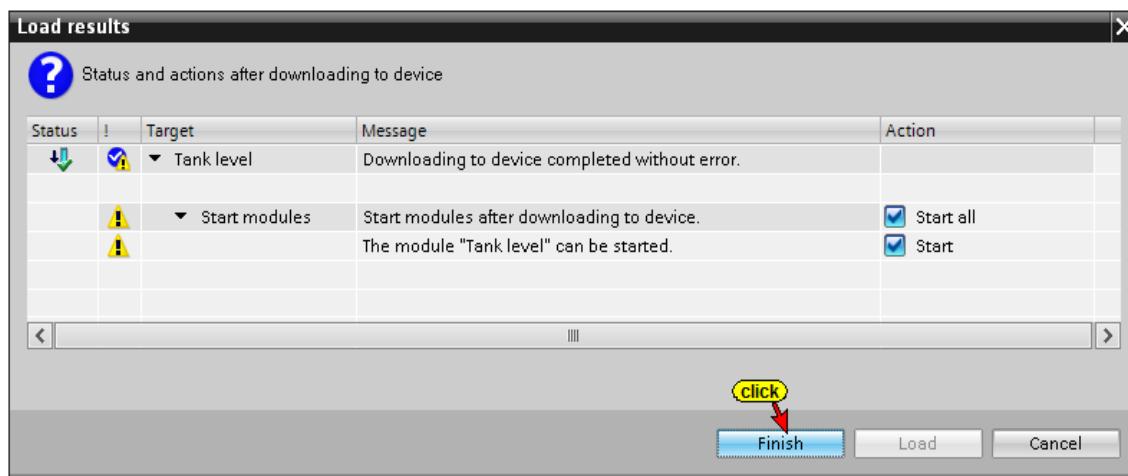


The loading process requires several confirmations of messages and dialog boxes.

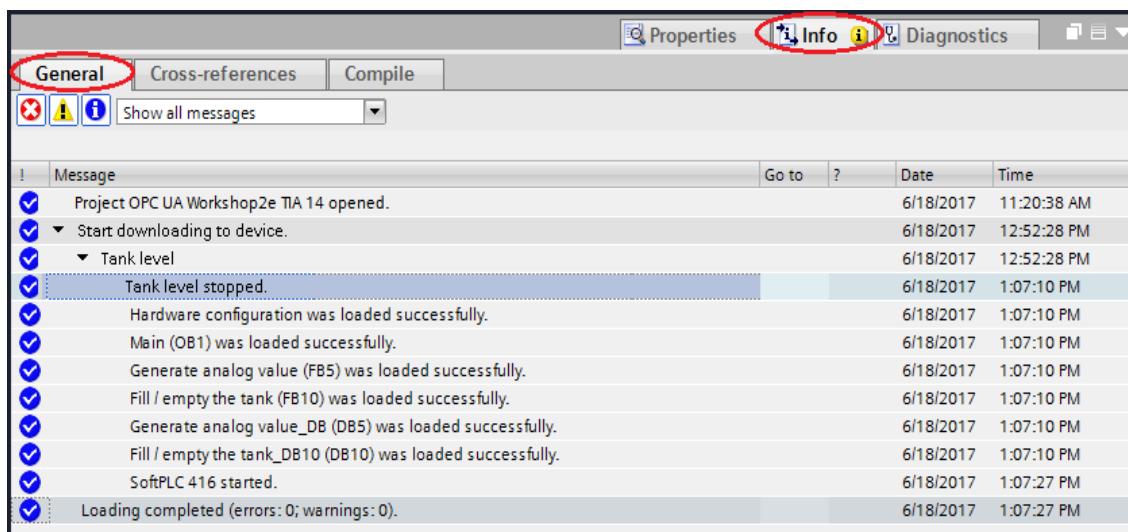
A preview of the loading is displayed.



Finish loading

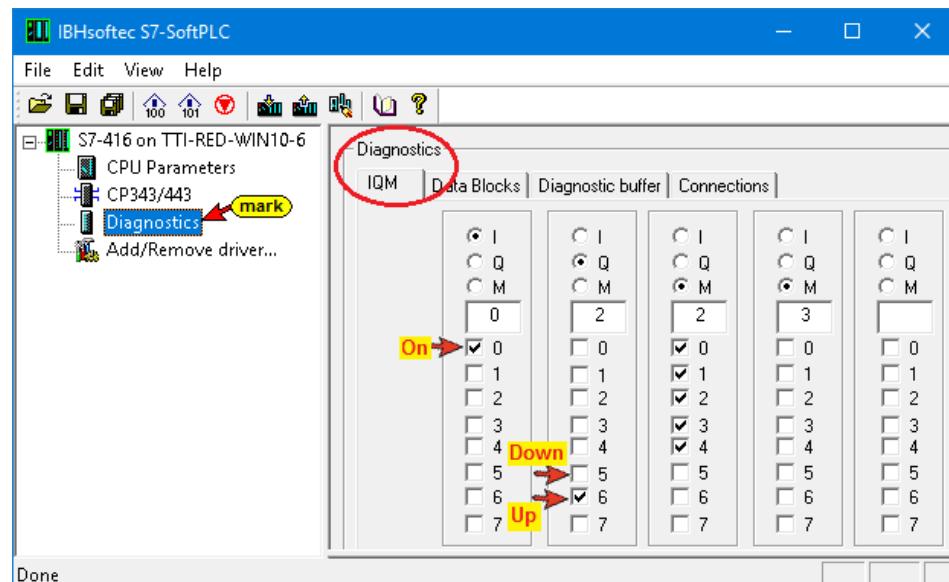


Fault-free loading is displayed



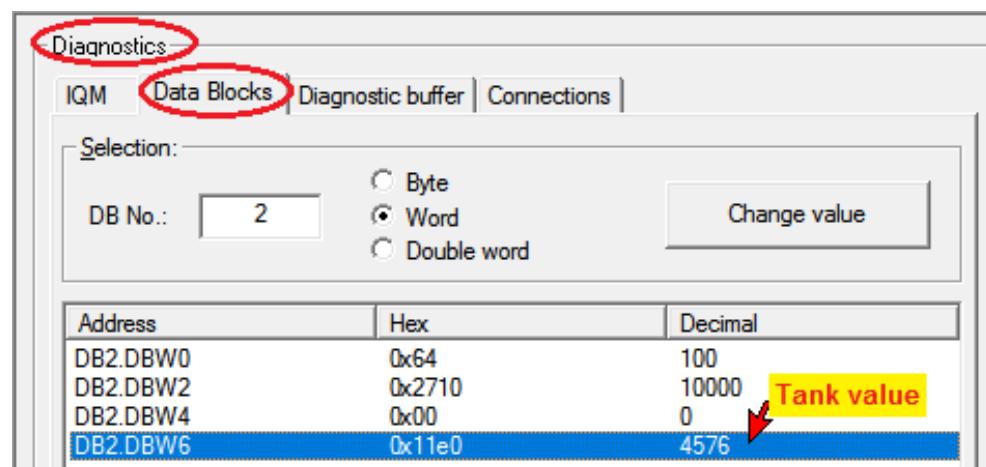
SoftPLC diagnostics CPU 416-3 PN/DP

The Input I0.0 **ON** was set in the diagnostic window IQM of the SoftPLC 416. The Outputs Q2.5 or Q2.6 indicate **Down** and **Up**. The **value** is represented by M2 and M3.



SoftPLC diagnostic window

The Data word DW6 (DB2 - Tank_level_values) displays the Tank level.

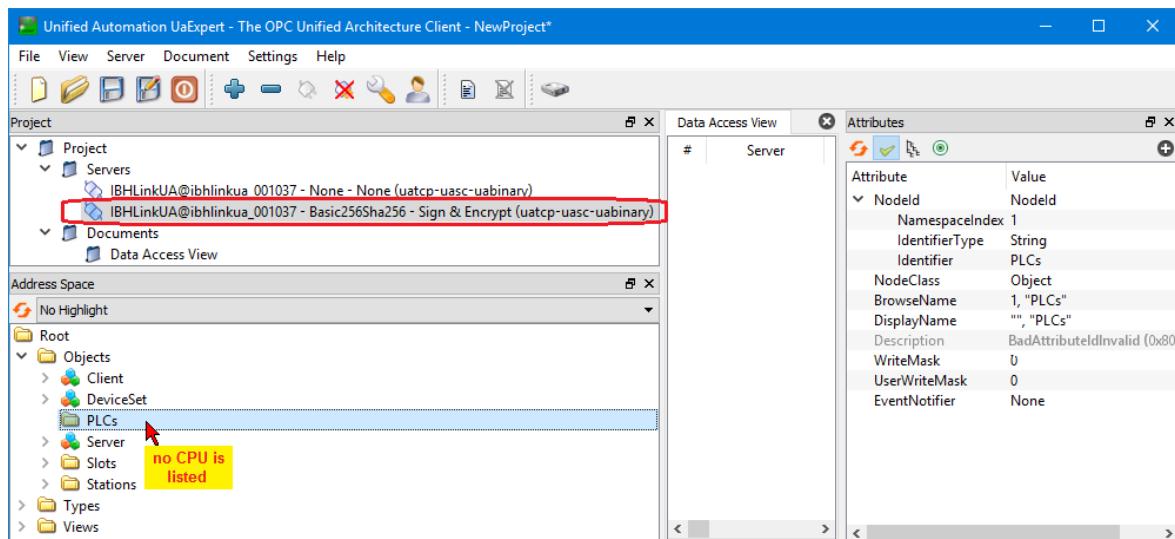


The filling and emptying of the tank can be checked Online (Tank_level_values - DB2).

...PC UA 3E TIA15 Tank Level > Tank level [CPU 416-3 PN/DP] > Program blocks > Tank_Level_values [DB2]						
<input type="checkbox"/> Keep actual values <input type="checkbox"/> Snapshot <input type="checkbox"/> Copy snapshots to start values						
Tank_Level_values						
	Name	Data type	Offset	Start value	Monitor value	Comment
1	Static					
2	Min_value	Int	0.0	100	100	Tank filled less than 10%
3	Max_value	Int	2.0	10000	10000	Tank filled more than 90%
4	Dummy	Int	4.0	0	0	Dummy
5	Tank_level	Int	6.0	0	9537	Tank level value
6	Structure	Struct	8.0			Complex variable -STRUCT -

3.3.3 UaExpert Program window

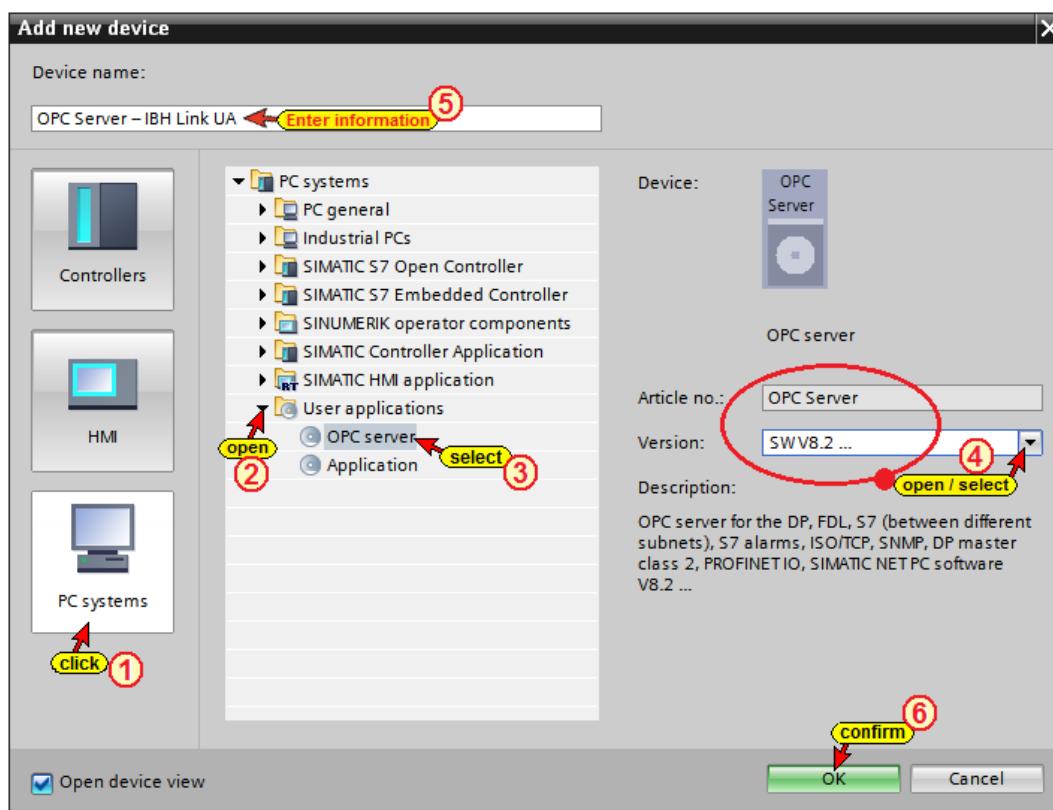
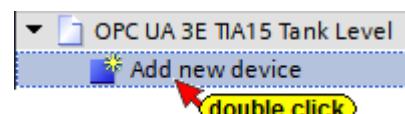
The CPU 416 is not yet available in the UaExpert program window because the IBH Link UA has not yet been inserted into the PLC program.



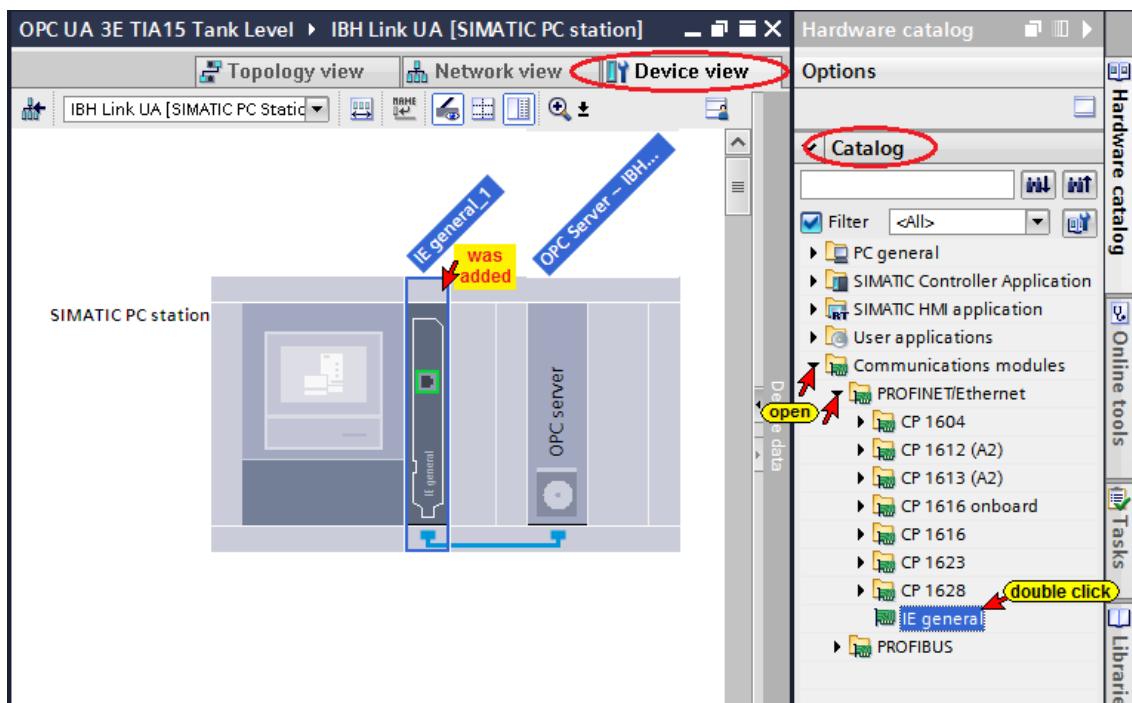
3.3.4 IBH Link UA as SIMATIC PC station

A double-click on **Add New Device** opens the Device Selection dialog box.

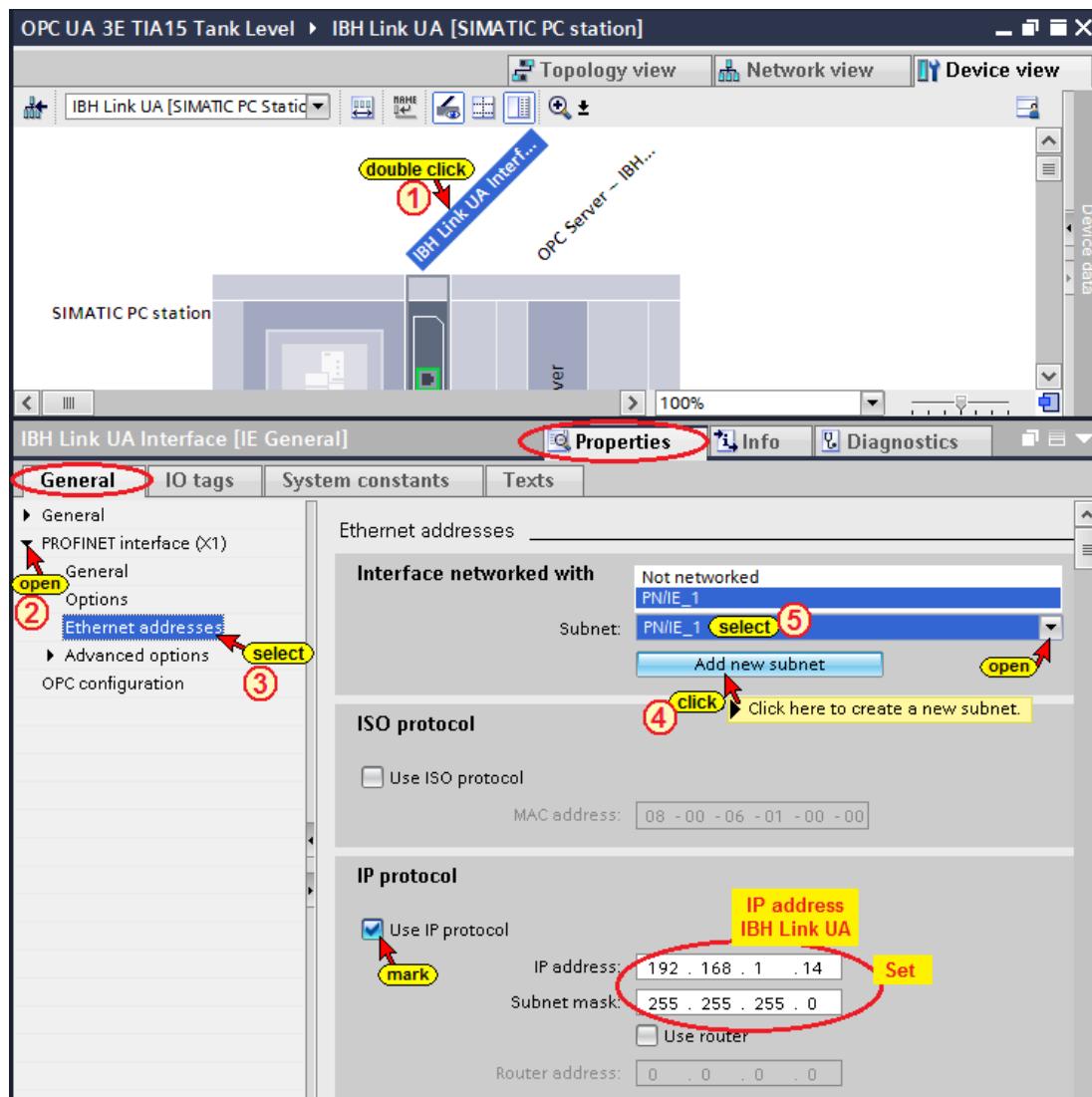
If an OPC server is inserted into the project, a SIMATIC PC station is automatically inserted.



Insert the communication module into the IBH Link UA

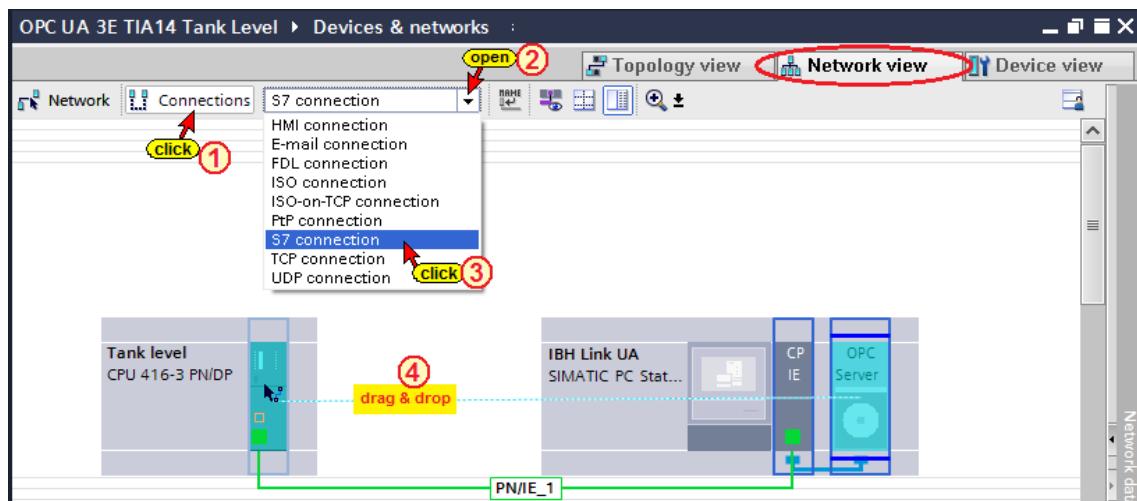


Setting the Properties of the Communication module

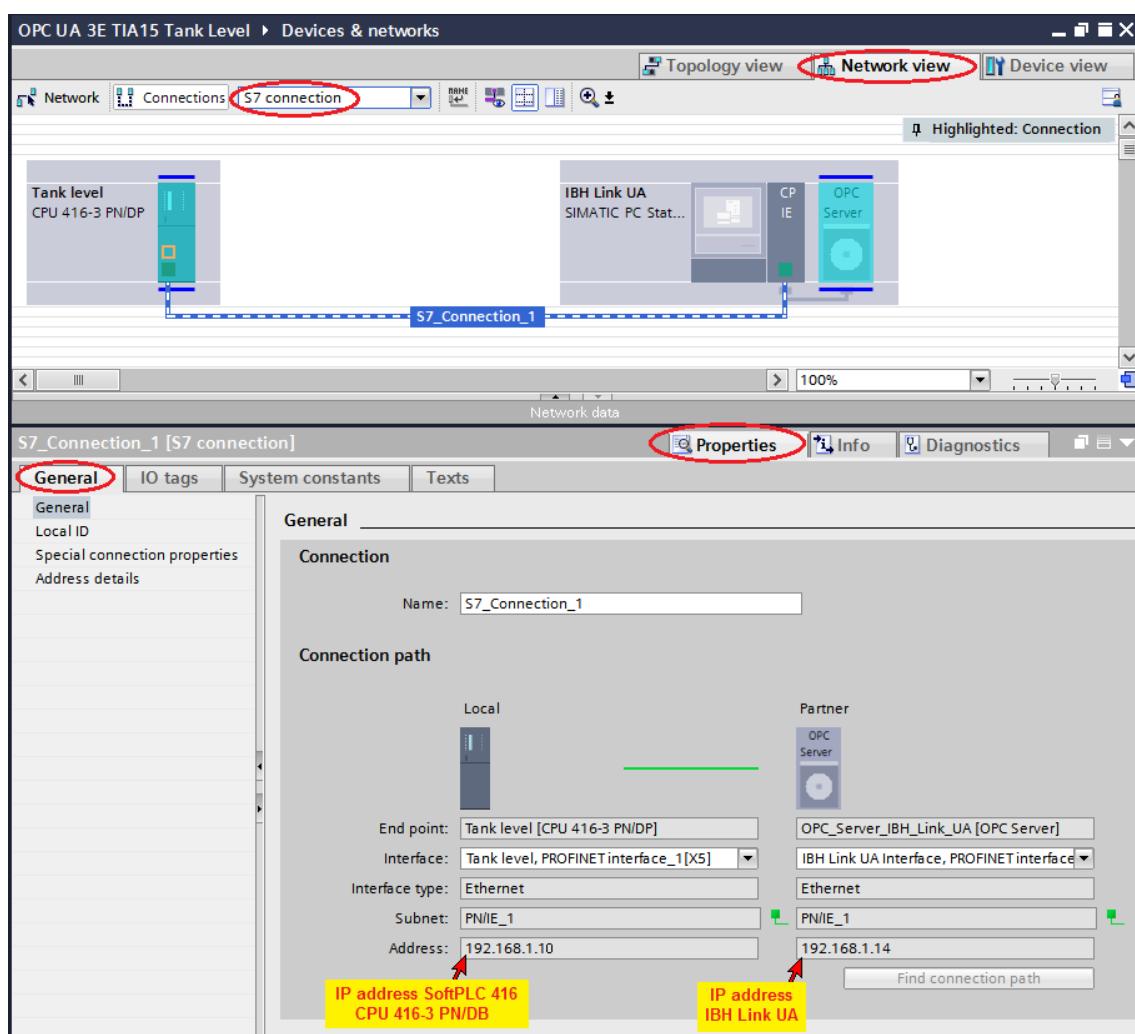


Create S7 Connection IBH Link UA OPC Server – SoftPLC 416

Use Drag&Drop to establish the S7 connection from the ***IBH Link UA OPC Server*** to the ***SoftPLC 416 (Tank level CPU 416-3PN/DP)***.



The established S7 connection is shown



OPC UA 3E TIA15 Tank Level > Devices & networks					
Network overview		Connections	I/O communication	VPN	
Local connection name	Local end point	Local ID (hex)	Partner ID (hex)	Partner	Connection type
S7_Connection_1	Tank level [CPU 416-3 PN/DP]	1	S7_Connection_1	OPC_Server_IBH_Link_UA [OPC Server]	S7 connection
S7_Connection_1	OPC_Server_IBH_Link_UA [OPC Server]	S7_Connection_1	1	Tank level [CPU 416-3 PN/DP]	S7 connection

OPC UA 3E TIA15 Tank Level > Devices & networks

Network overview

Device	Type	Address in subnet	Subnet	Master / IO system	Device number	Comment
S7-400 station_2	S7-400 station					
Tank level	CPU 416-3 PN/DP					
MPI/DP interface_1	MPI/DP interface	2		Not connected		
PROFINET interface_1	PROFINET interface	192.168.1.10		PN/E_1		
Port_1	Port					
Port_2	Port					
IBH Link UA	SIMATIC PC Station					
OPC_Server_IBH_Link_UA	OPC server					
IBH Link UA Interface	IE general					
PROFINET interface	PROFINET interface	192.168.1.14		PN/E_1		
Port_1	Port					

OPC UA 3E TIA15 Tank Level > Devices & networks

Topology overview

Device / port	Slot	Partner station	Partner device	Partner interface	Partner port	Cable data
S7-400 station_2						
Tank level	2					
PROFINETinterface_1	2 X5					
Port_1	2 X5 P1				Any partner	---
Port_2	2 X5 P2				Any partner	---
IBH Link UA						
IBH Link UA Interface	2					

Select OPC tags (symbols) in the OPC configuration

Open the OPC Server / Property configuration.

OPC UA 3E TIA15 Tank Level > IBH Link UA [SIMATIC PC station]

Device view

IBH Link UA [SIMATIC PC Station] *(open / select)*

IBH Link UA Interface *(double click)*

OPC_Server_IBH_Link_UA

OPC Server IBH Link UA [OPC Se... Properties

Properties

General **IO tags** **System constants** **Texts**

OPC symbols

None

All

Configured *(mark)*

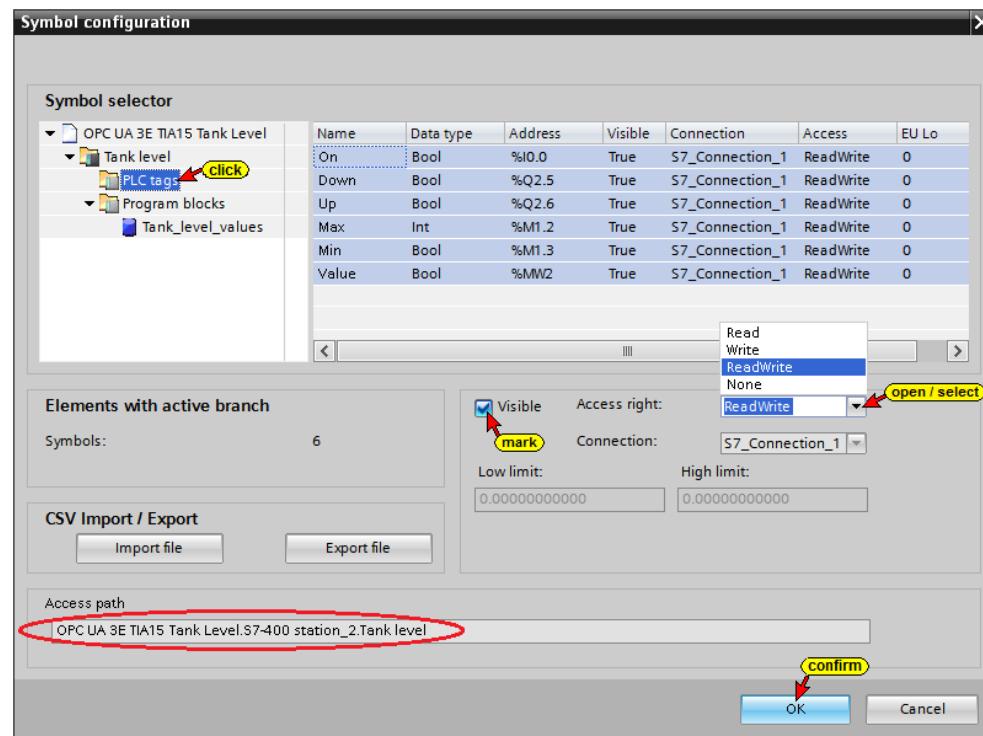
Configuring...

Field elements visible during runtime *(click)* **Configuring...**

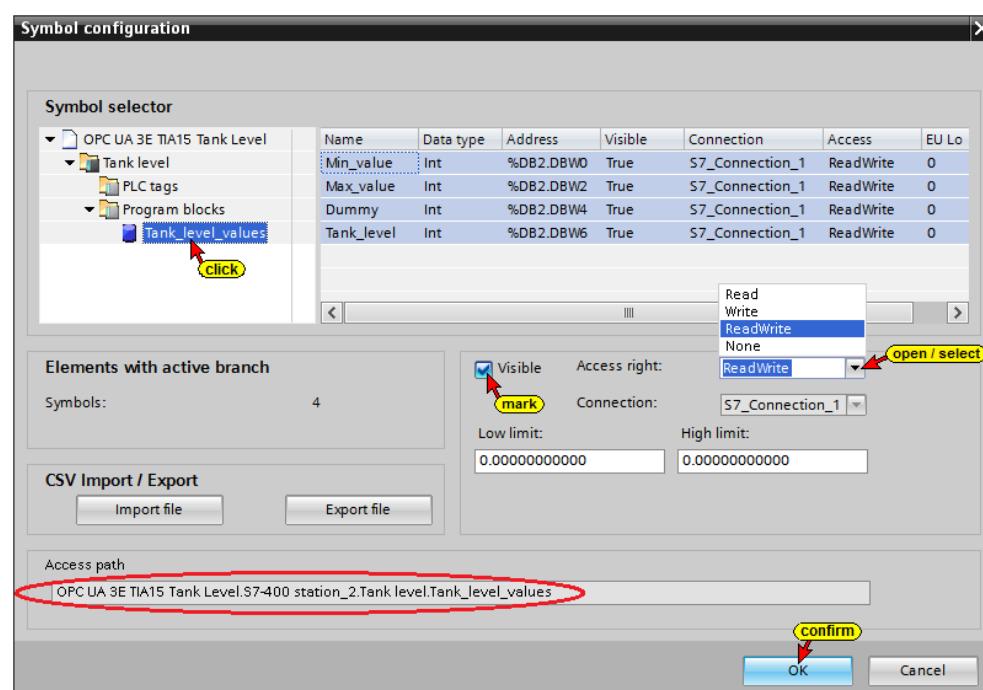
The **Configure** button opens a dialog box listing the operands defined in the symbol table or the data from the data block **Tank_level_values**. These operands can be selected as OPC tags. Due to the previously configured S7 connection the PLC knows the variables.

The access rights **Read / Write etc.** can be assigned to the individual operands (OPC tags).

Configurable global symbolic named operands

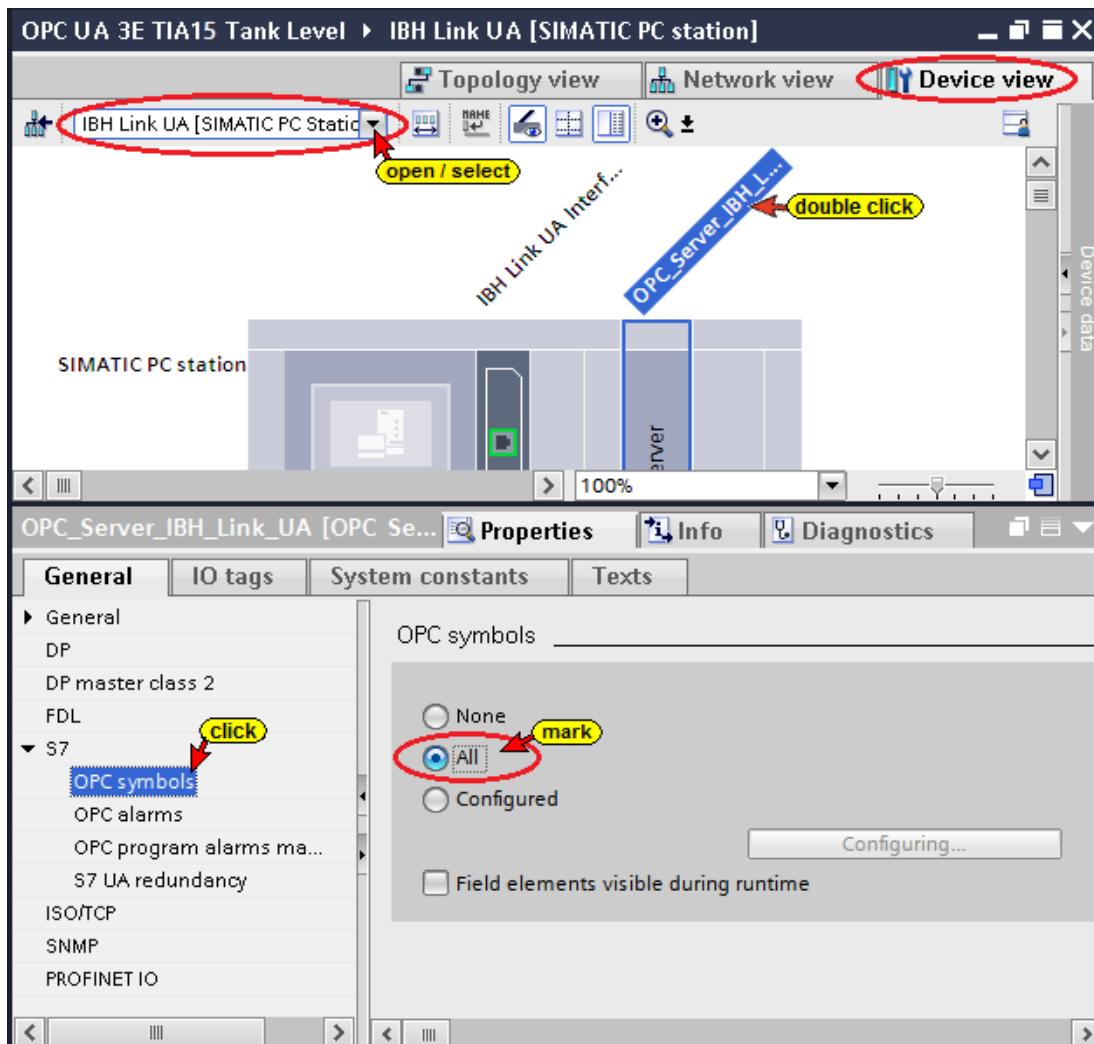


Data from data block DB 2 **Tank_level_values**

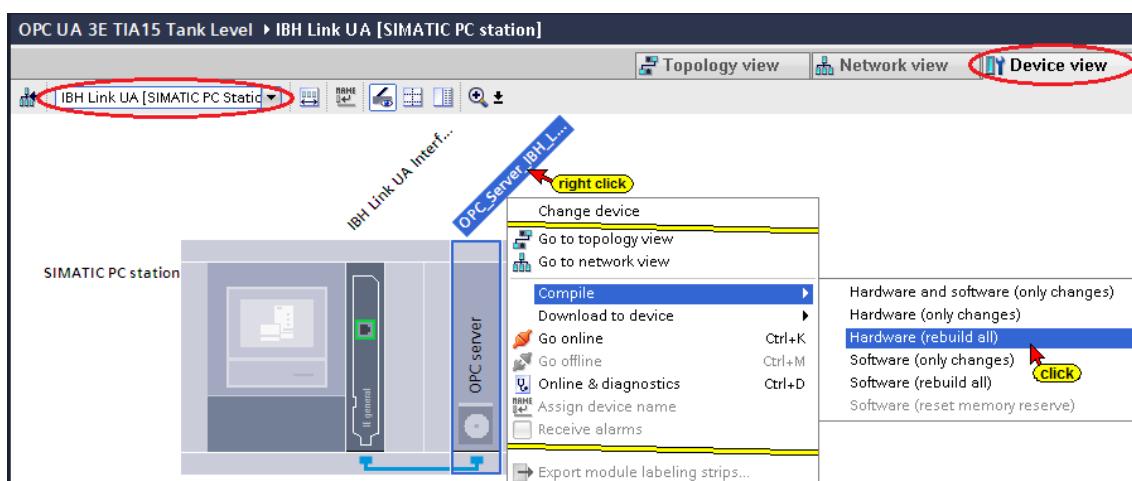


Selecting all OPC tags (symbols) in the OPC configuration

If all global symbolic operands and the data from all Data blocks should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.

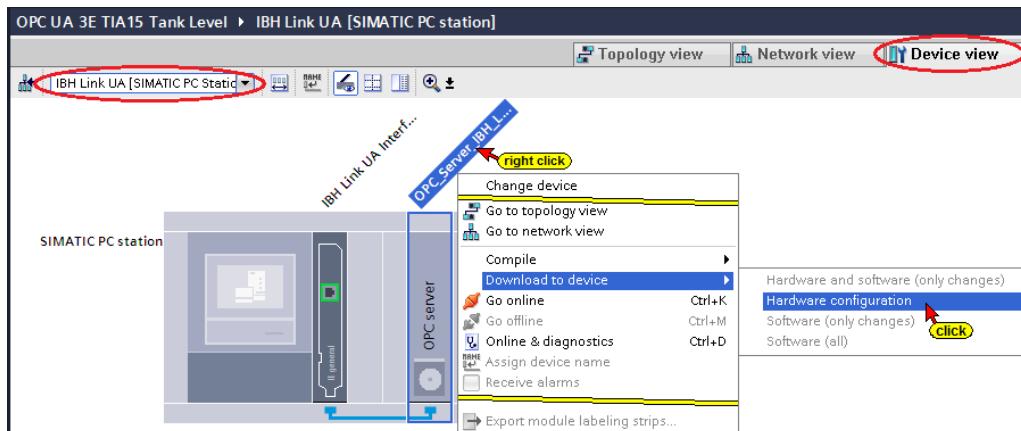


Compiling the OPC Server configuration

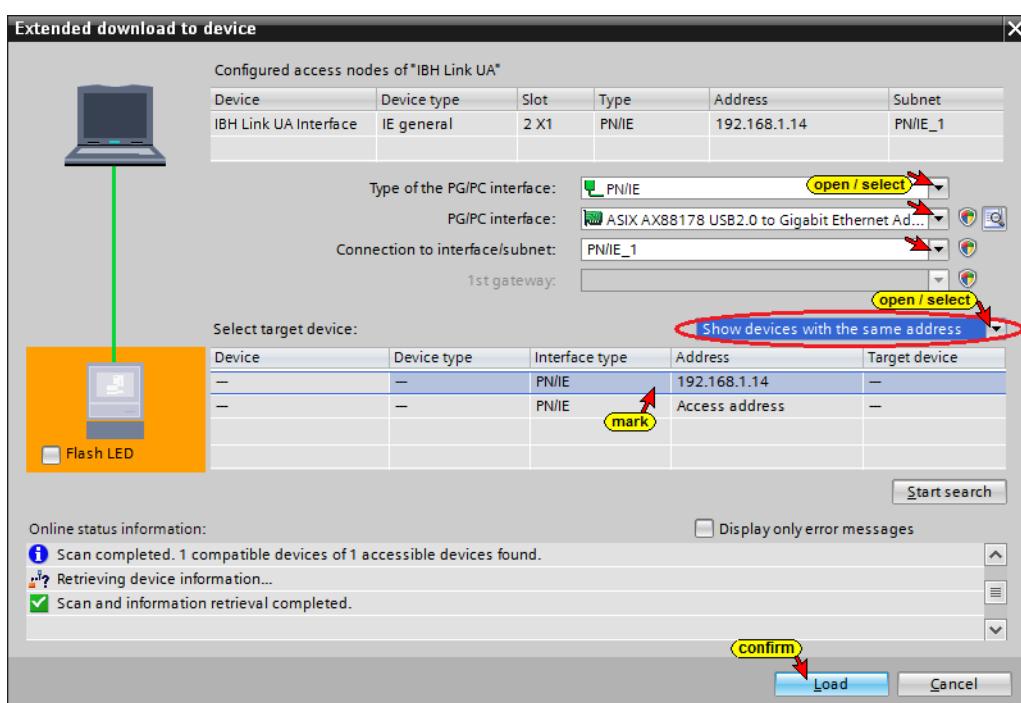
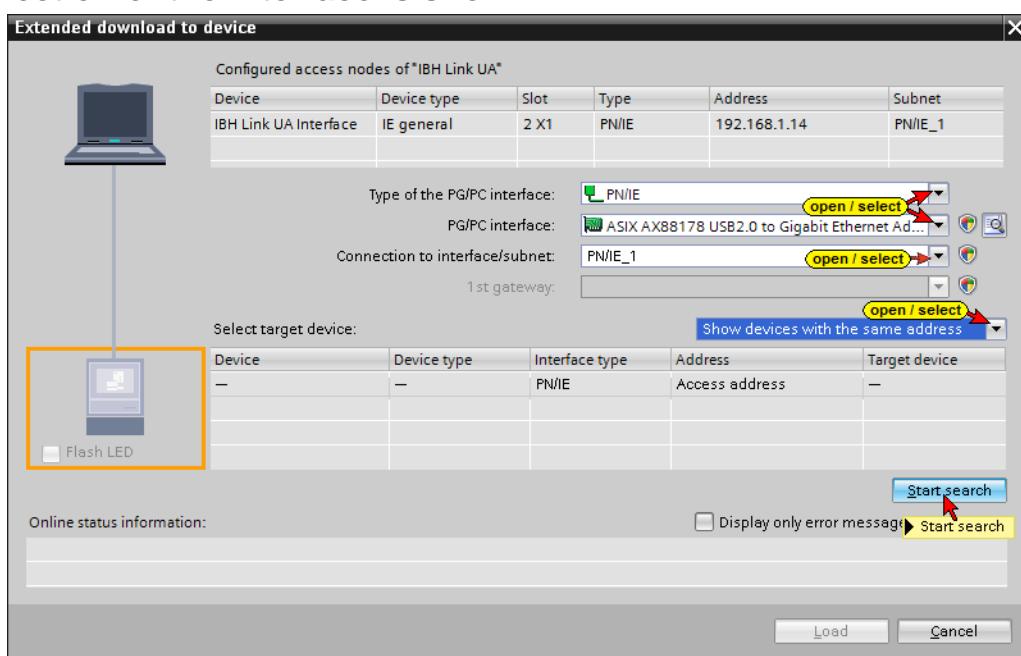


If no error occurs during the hardware compilation, the hardware can be loaded into the IBH Link UA OPC server.

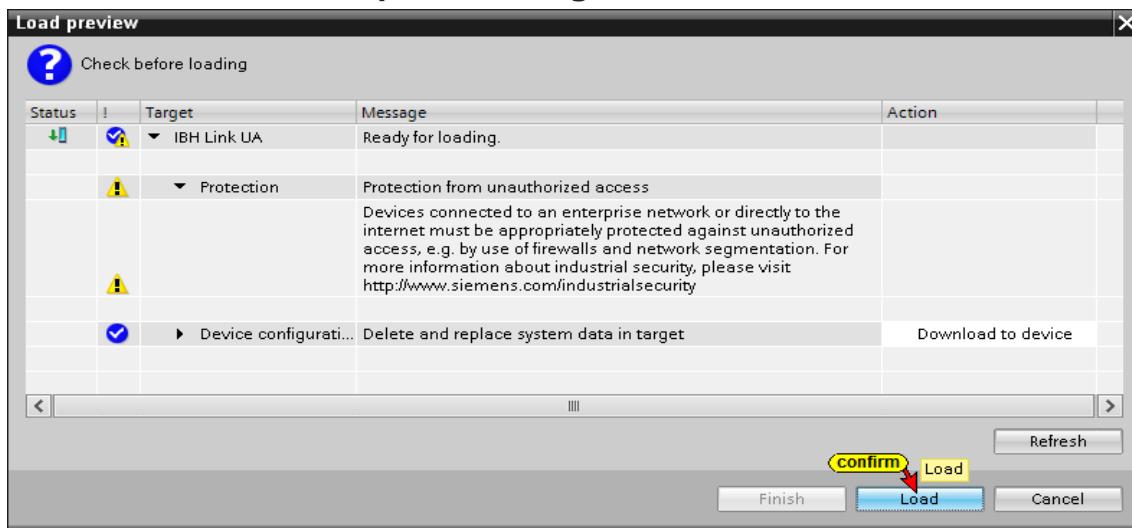
Load the configuration into the IBH Link UA OPC server



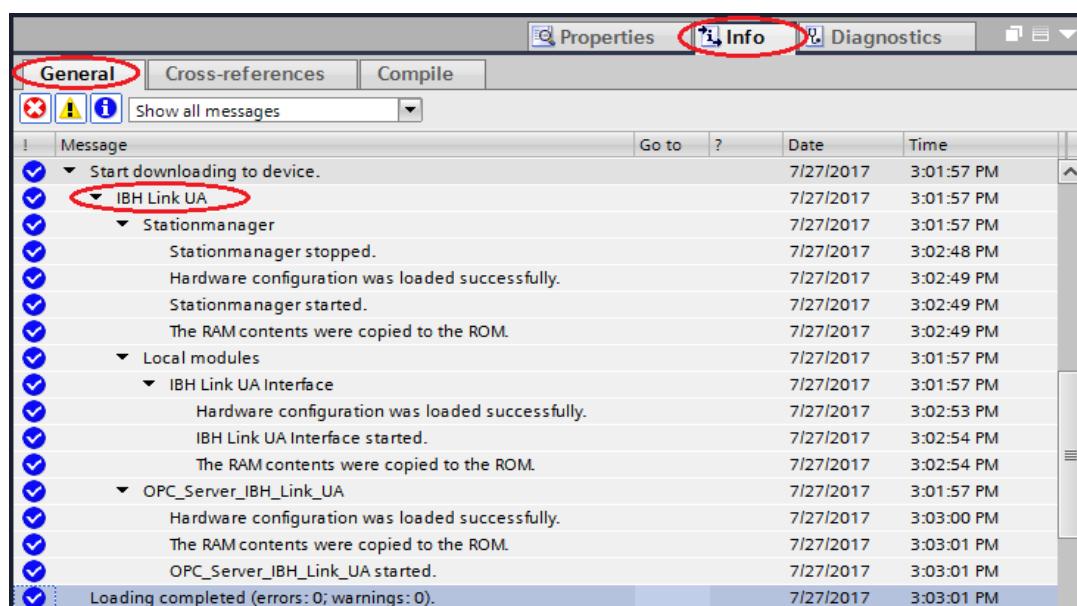
The selection of the interface is shown



A check is carried out prior loading.

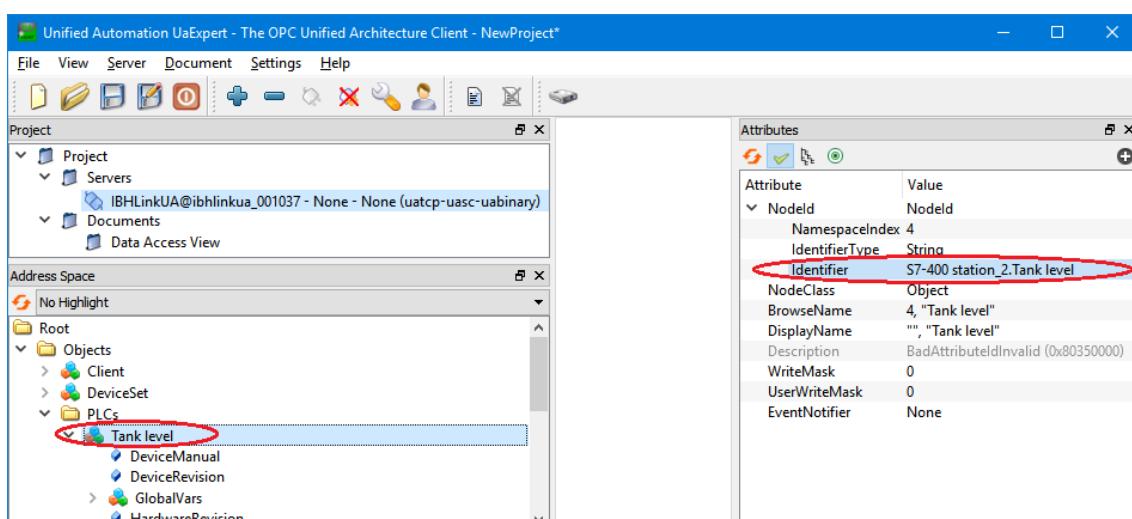


The progress of the loading process is displayed.

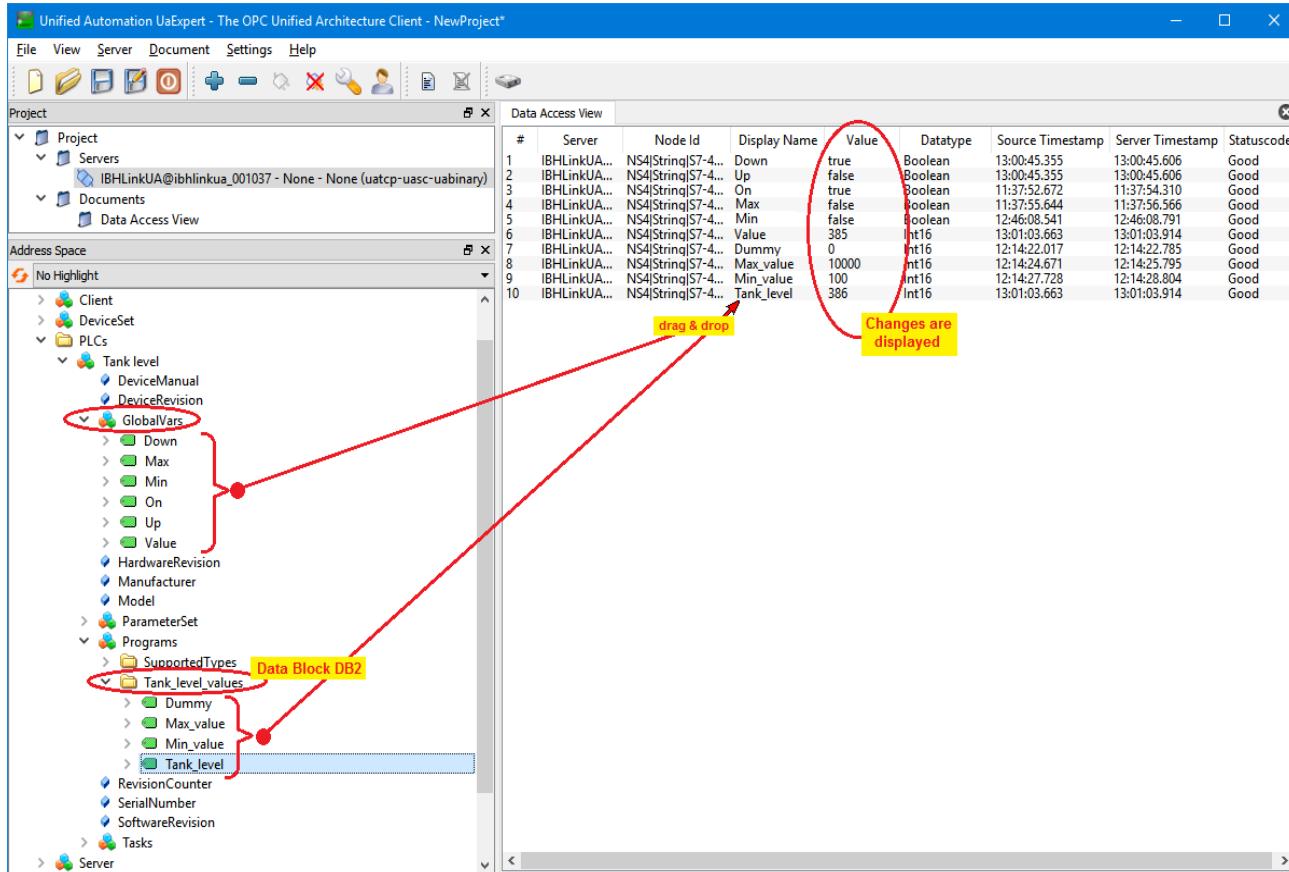


UaExpert - Program window

The SoftPLC 416 is displayed in the UaExpert program window.



The operands listed in the symbol table, defined as OPC tags, are displayed below **GlobalVars**. Using Drag&Drop they can be pulled into the **Data Access View**.



3.4 Complex variable – STRUCT –

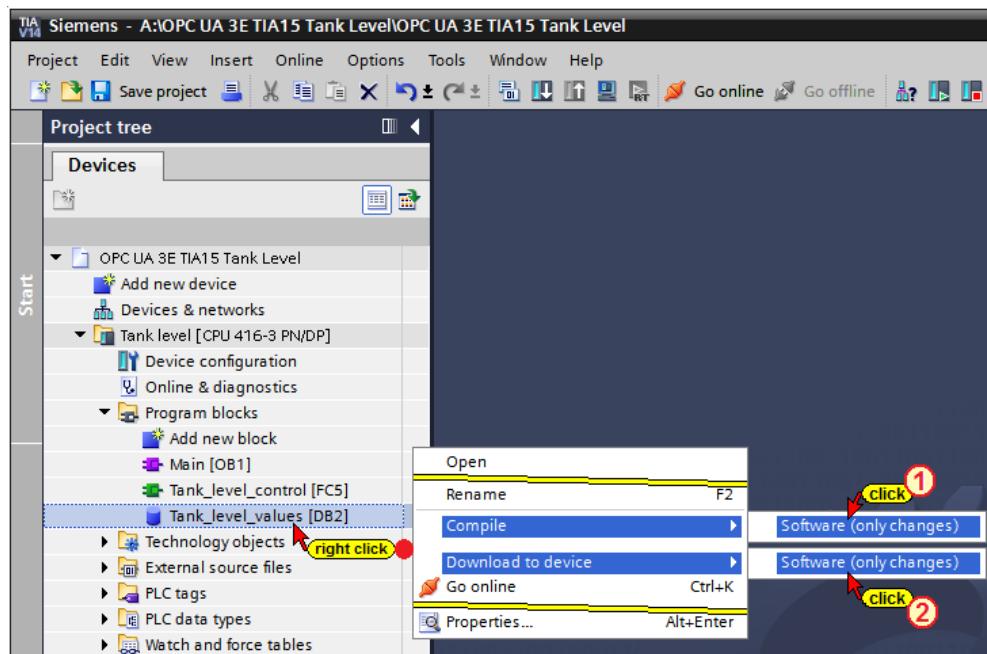
Creating an additional structure in the global data block DB2

The symbolic name of the data block DB2 is **Tank_level_values**.

... ▶ Tank level [CPU 416-3 PN/DP] ▶ Program blocks ▶ Tank_level_values [DB2]					
Keep actual values Snapshot					
Tank_level_values					
	Name	Data type	Offset	Start value	Comment
1	Static				
2	Min_value	Int	...	100	Tank filled less than 10%
3	Max_value	Int	...	10000	Tank filled more than 90%
4	Dummy	Int	...	0	Dummy
5	Tank_level	Int	...	0	Tank level value
6	Structure	Struct	...		Complex variable -STRUCT-
7	CurrentTemp	Real	...	0.0	Current Temperature
8	SetTemp	Real	...	0.0	Requested Temperature

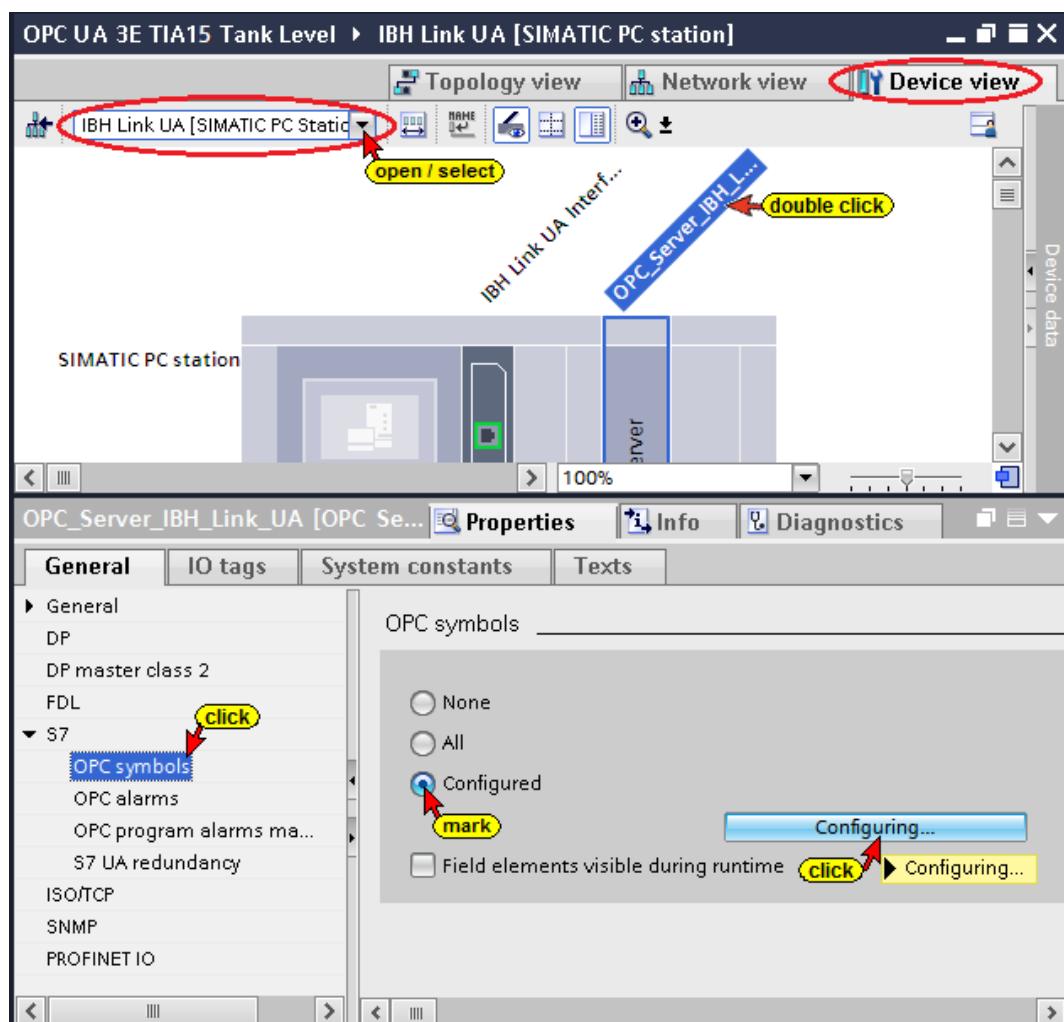
A structure was created in the data block DB2 **Tank_level_values**.

The modified Data Block must be compiled and downloaded.



Re-select OPC tags

Open the OPC Server / Property configuration.



The Configure button opens the **Symbol Configuration** dialog box.

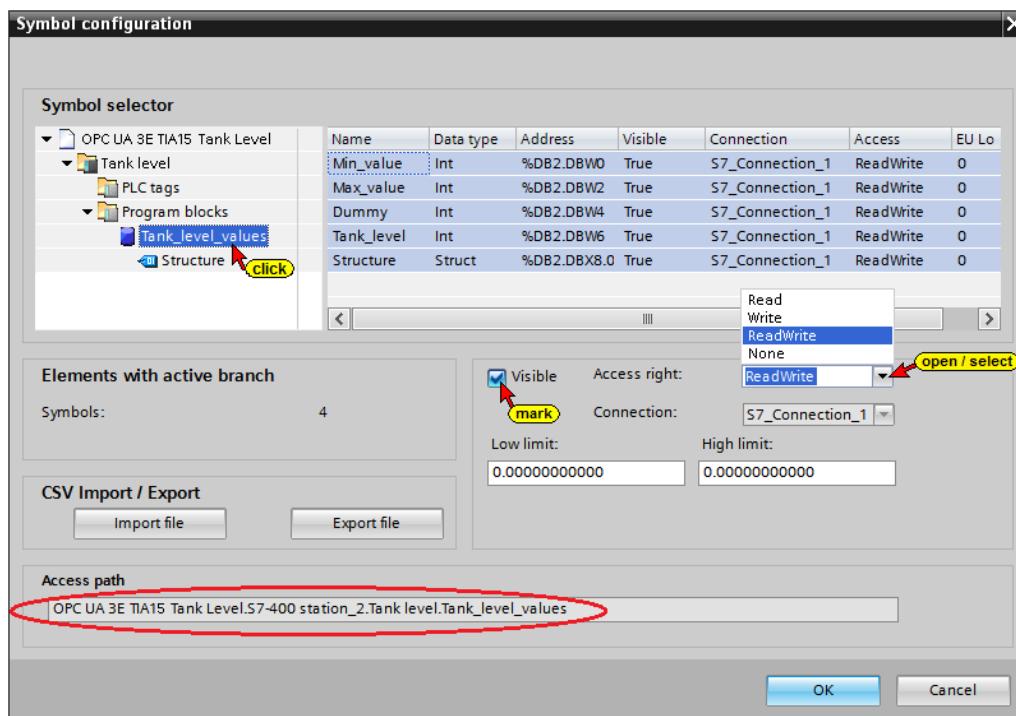
Configuring...

A note is issued by the TIA Portal to inform that it takes some time to read the entire symbol table.

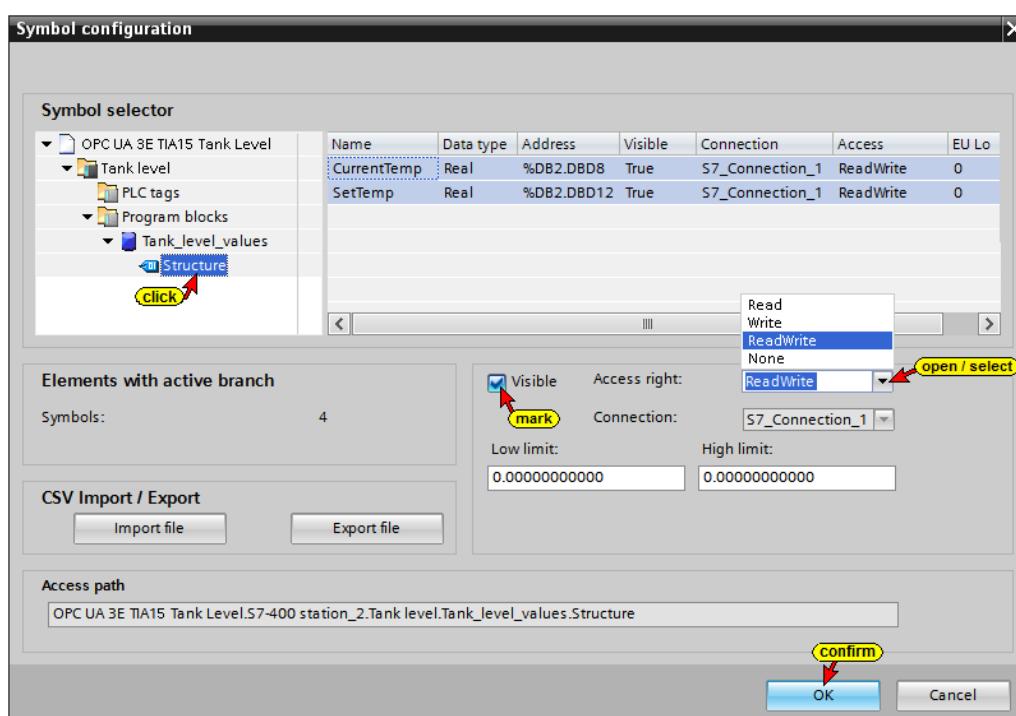
In the **Symbol Configuration** dialog box, the **Structure** defined in the Data Block **Tank_level_values** (DB2) – (PLC program Tank level) can be selected as OPC tags.

The access rights **Read / Write etc.** can be assigned to the individual operands (OPC tags).

Data from data block **Tank_level_values** (DB 2)

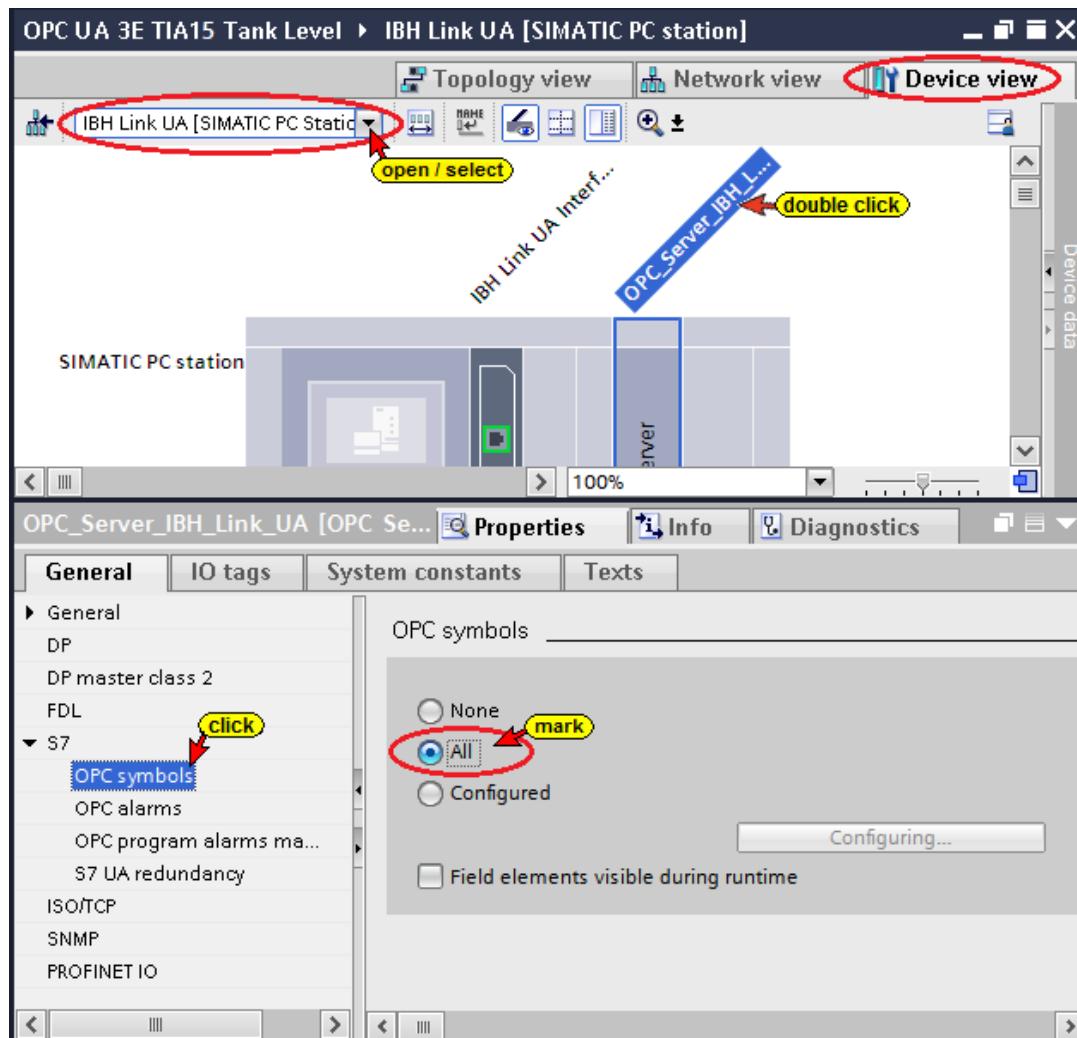


Data from the structure of data block DB 2 **Tank_level_values**

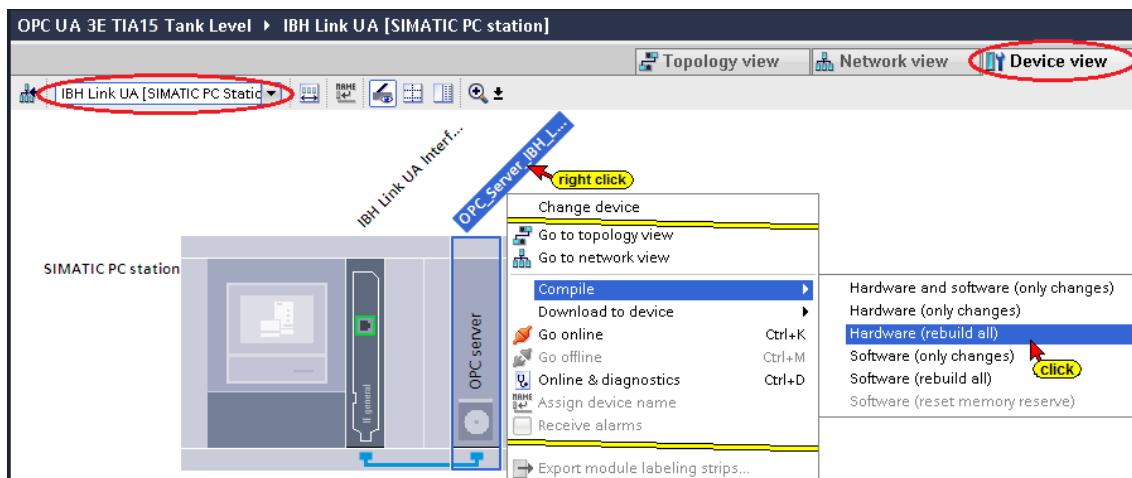


Selecting all OPC tags (symbols) in the OPC configuration

If all global symbolic operands and the data from all Data blocks should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.

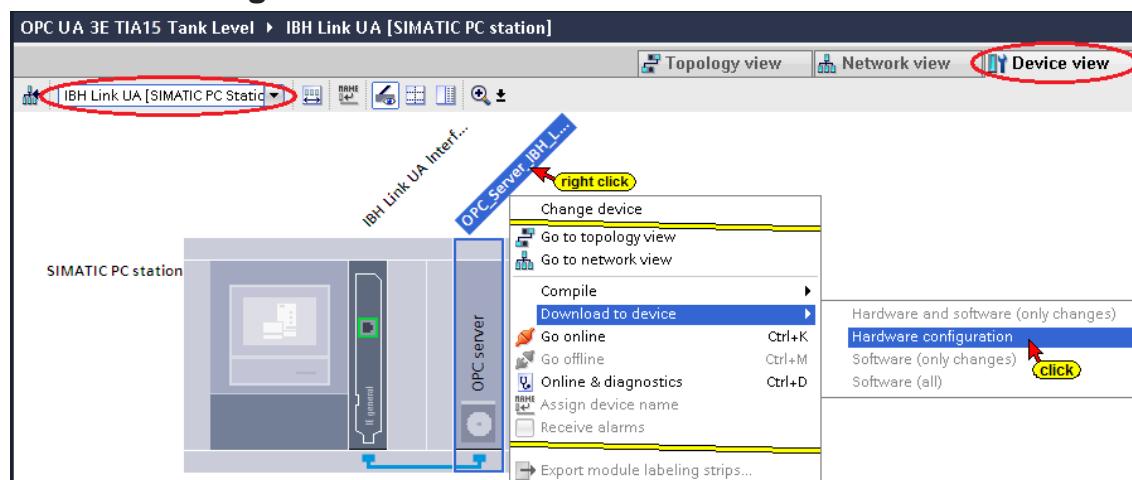


Compiling the OPC Server configuration

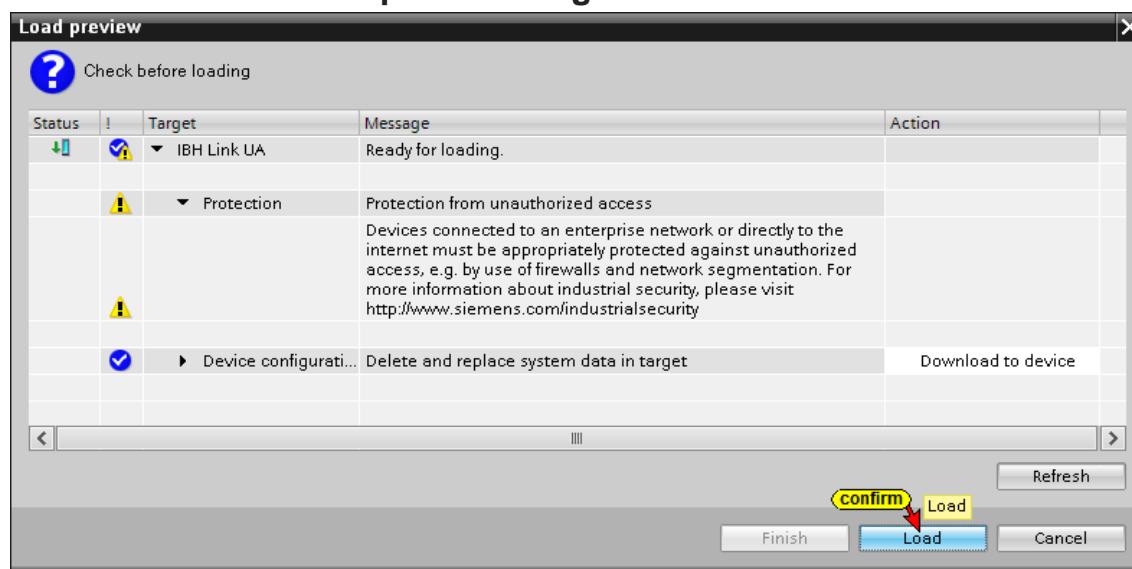


If no error occurs during the hardware compilation, the hardware can be loaded into the IBH Link UA OPC server (Warnings are OK).

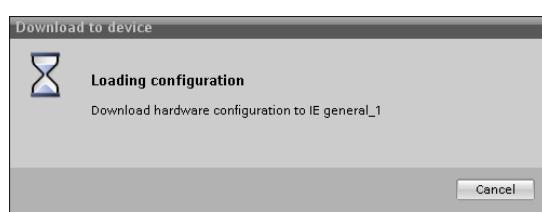
Load the configuration into the IBH Link UA OPC server



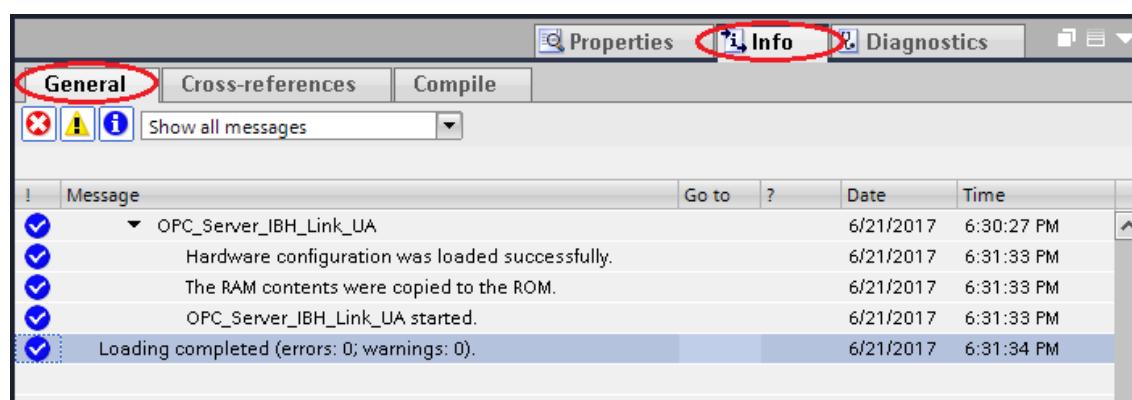
A check is carried out prior loading.



The progress of the loading process is displayed.

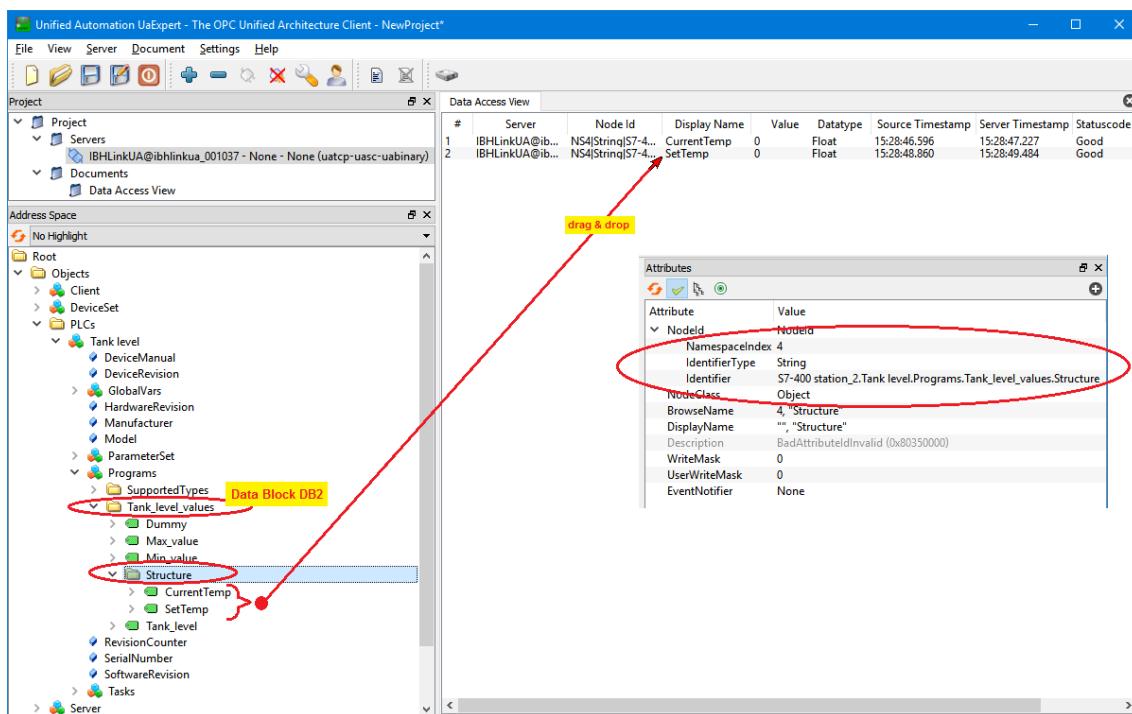


The successful loading process is displayed.



UaExpert - Program window

The **Structure** defined in the Data Block – **Tank_level_values** – (PLC program Tank level) with its data are displayed in the UaExpert program window.

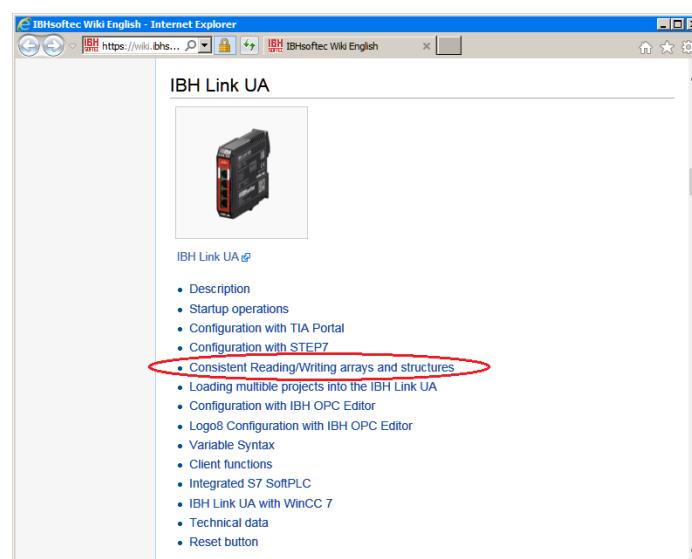


3.4.1 Using Structure Variables

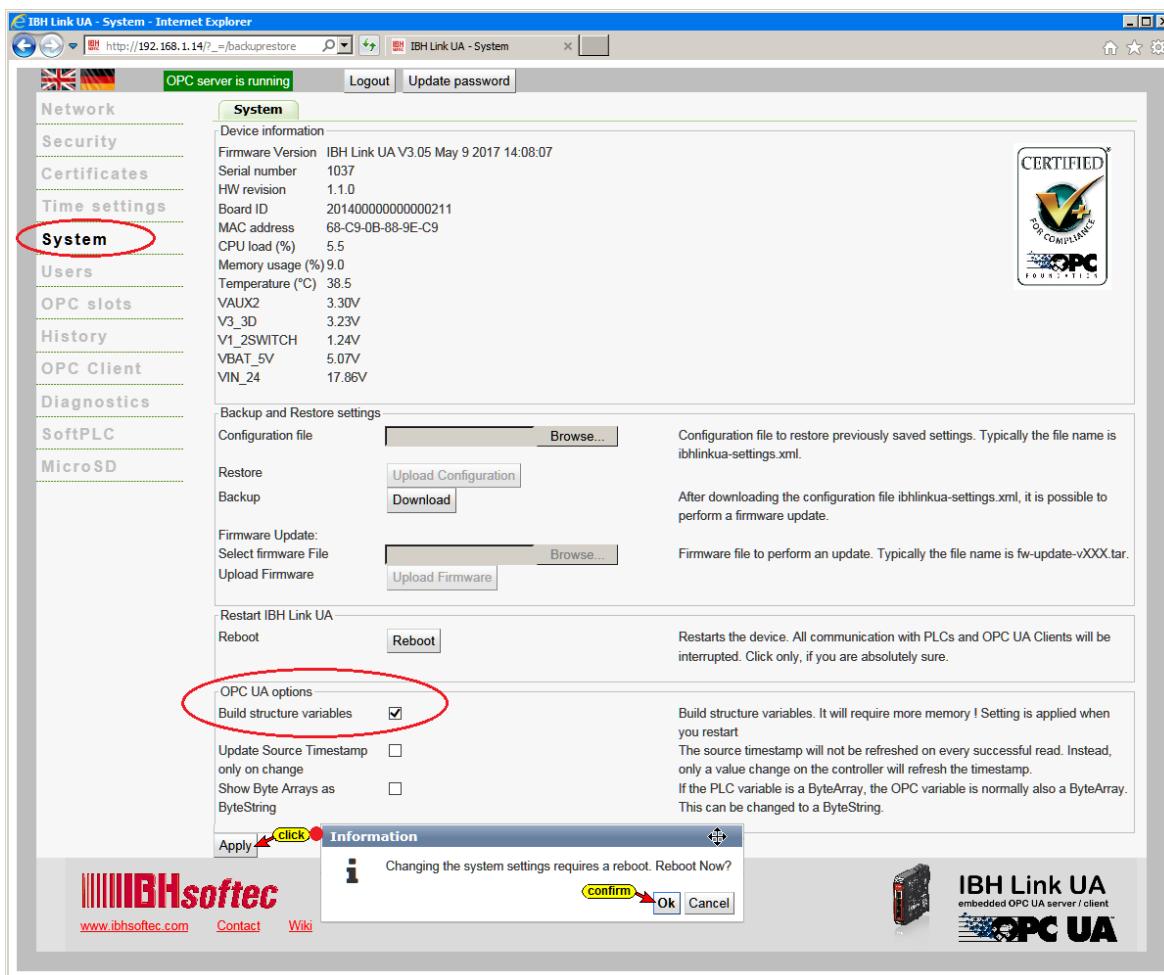
Within the IBH Link browser window **System** the OPC UA option **Use Structure Variables** may be activated. With S7-300 / S7-400, 64-byte structures are consistently possible.

The structure variables are described in detail in IBHsoftec WIKI under the heading Consistent Reading/Writing arrays and structures.

IBHsoftec WIKI



Browser window System



Marking the check box ***Build Structure Variables*** and additionally clicking on the ***Apply*** button and confirming it the function will be activated.

Structure variables created require additional memory.

Programs in the UaExpert window prior activating the structure variables

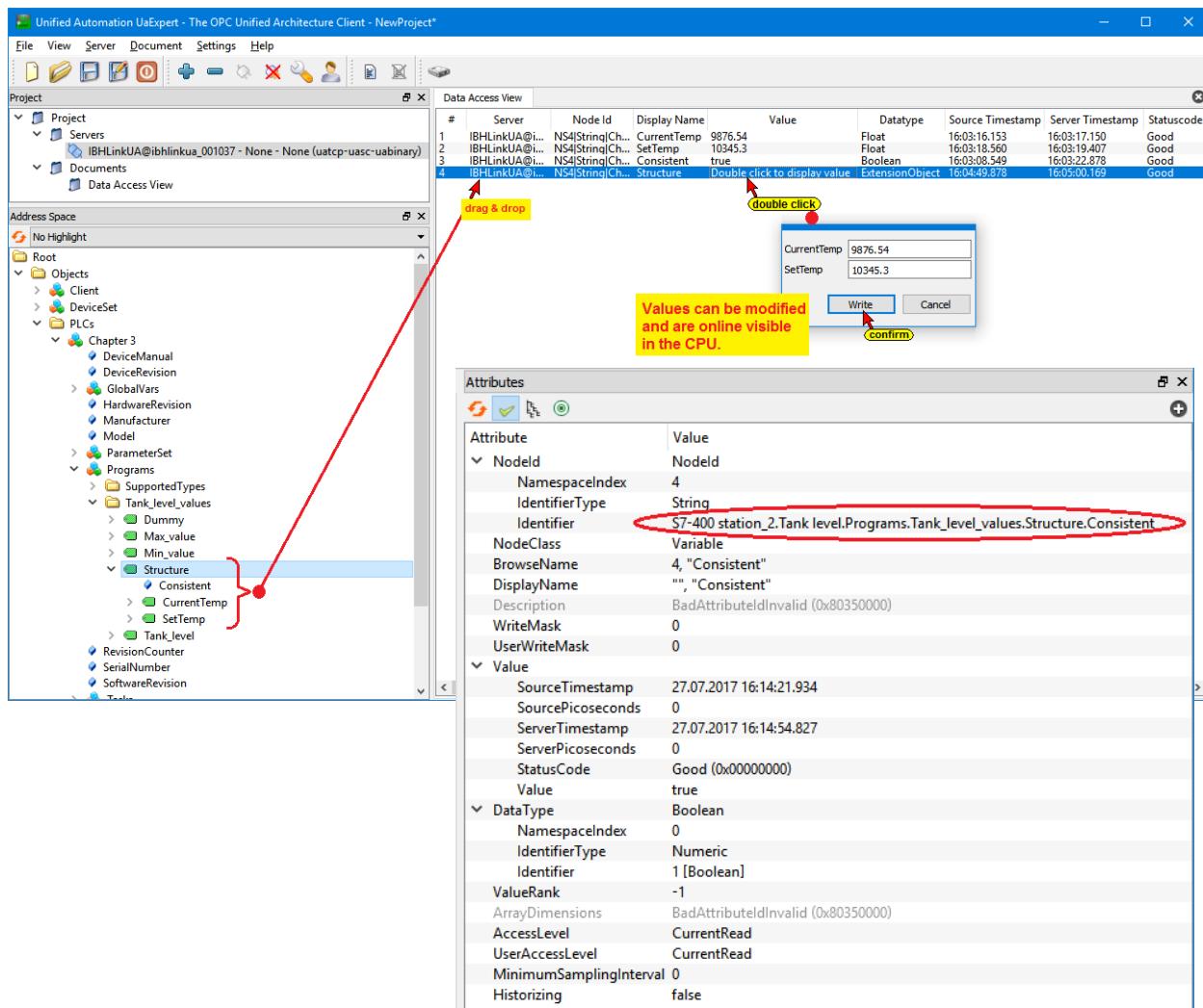
In the ***Address Space*** window, below ***Programs***, the structure is listed with the variable ***CurrentTemp***, and ***SetTemp***.

Below ***Structure***, no further information is displayed.

If the option ***Use Structure Variables*** is activated, the OPC server is restarted. In the ***UaExpert*** window ***Data Access View*** the variables of the structure are displayed in red while the OPC server is not running (the connection to the OPC server is interrupted).

After restarting the OPC server and restarting the connection of the UaExpert to the IBH Link UA, the system variable ***Consistent*** is displayed. If this variable is ***true***, consistent data can be read from the CPU (read) and written to the CPU (write).

Use Drag&Drop to pull **Consistent** and **Structure** into the **Data Access View** field.



Double-clicking on the icon in the **Structure** line opens a dialog box to display and modify the variables of the **Structure**.

Display online the variable of the Structure

The modified variables can then be observed in **Tank_level_values** DB2 of the CPU-416.

DB2 online (Status)

OPC UA 3E TIA15 Tank Level > Tank level [CPU 416-3 PN/DP] > Program blocks > Tank_level_values [DB2]						
Keep actual values Snapshot Copy snapshots to start values						
Tank_level_values						
	Name	Data type	Offset	Start value	Monitor value	Comment
1	Static					
2	Min_value	Int	0.0	100	100	Tank filled less than 10%
3	Max_value	Int	2.0	10000	10000	Tank filled more than 90%
4	Dummy	Int	4.0	0	0	Dummy
5	Tank_level	Int	6.0	0	0	Tank level value
6	Structure	Struct	8.0			Complex variable -STRUCT-
7	CurrentTemp	Real	8.0	0.0	9876.543	Current Temperature
8	SetTemp	Real	12.0	0.0	10345.34	Requested Temperature

4 Historical Data - IBH Link UA

While **OPC Data Access** allows access to data in real-time, **OPC Historical Data Access**, also called **OPC HDA**, supports access to data already stored.

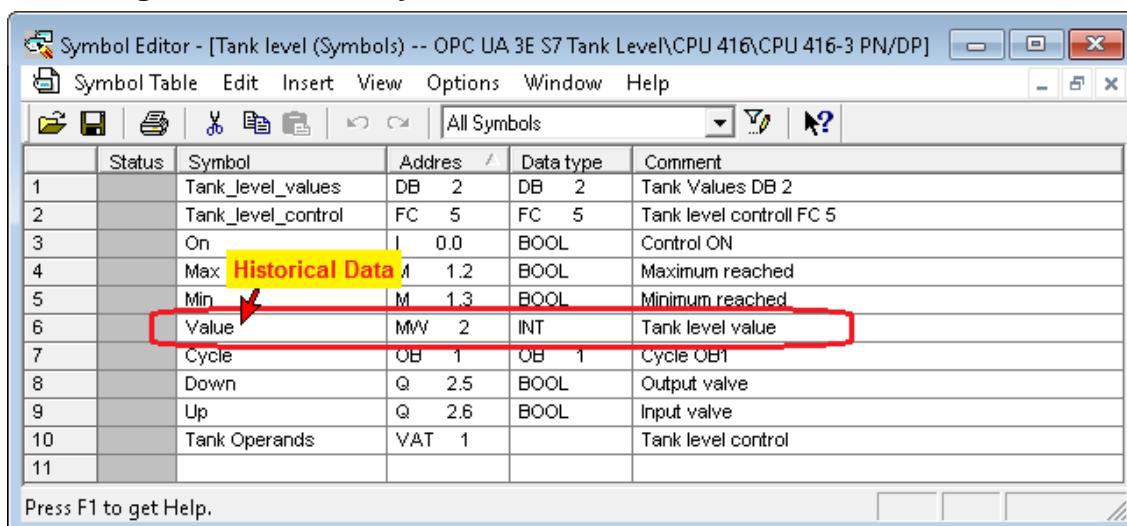
From simple data logging systems to complex SCADA systems, historical data can be queried in a standardized way.

The historical data are activated via the IBH Link UA **History** web interface. The historical data are organized in the IBH Link UA as a ring buffer in RAM.

One of the following projects are executed in the SoftPLC:

- **OPC UA 3E S7 Tank Level** with the SIMATIC 400 Station provides the S7 program **Tank level**.

PLC Program tank level Symbol Table

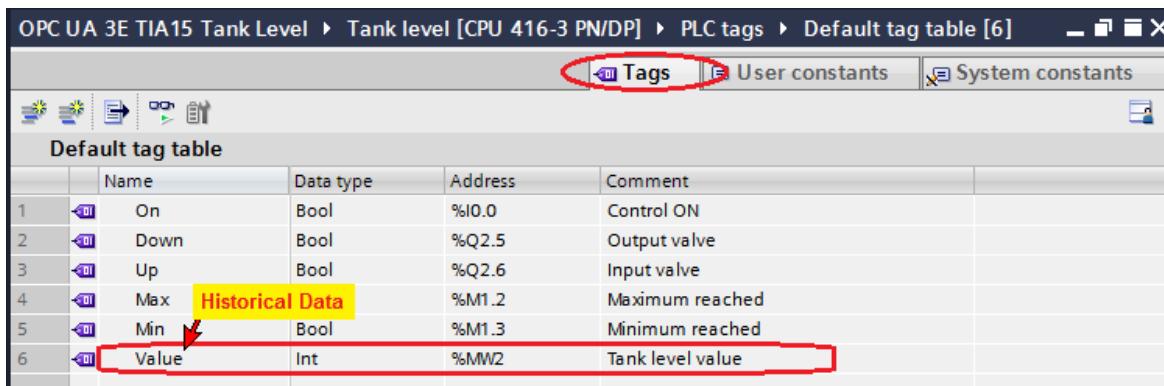


	Status	Symbol	Address	Data type	Comment
1		Tank_level_values	DB 2	DB 2	Tank Values DB 2
2		Tank_level_control	FC 5	FC 5	Tank level control FC 5
3		On	I 0.0	BOOL	Control ON
4		Max	M 1.2	BOOL	Maximum reached
5		Min	M 1.3	BOOL	Minimum reached
6		Value	MW 2	INT	Tank level value
7		Cycle	OB 1	OB 1	Cycle OB1
8		Down	Q 2.5	BOOL	Output valve
9		Up	Q 2.6	BOOL	Input valve
10		Tank Operands	VAT 1		Tank level control
11					

Press F1 to get Help.

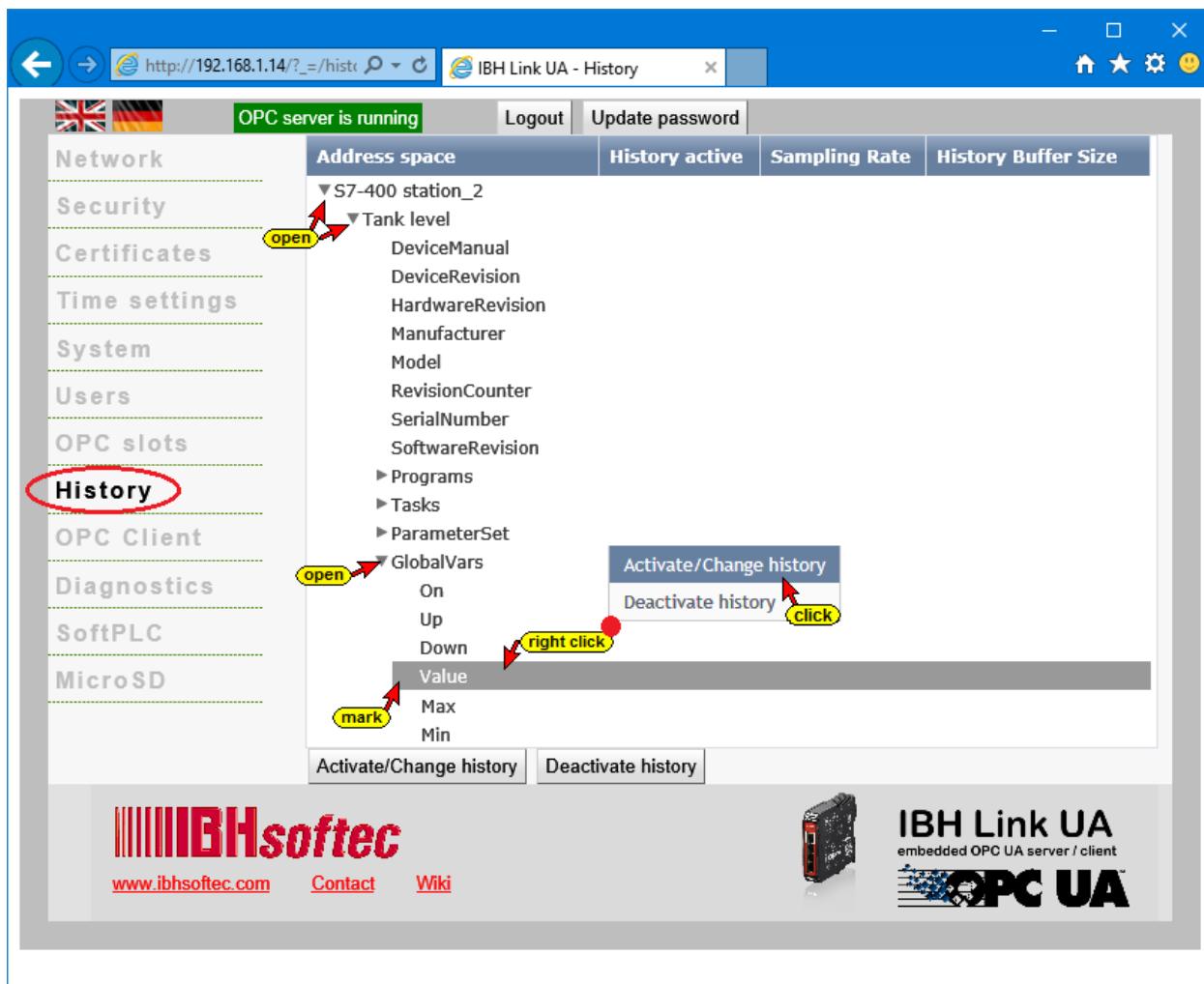
- **OPC UA 3E TIA15 Tank Level** with the SIMATIC 400 Station provides the S7 program **Tank level**.

PLC Program Tank Level Default tag table



	Name	Data type	Address	Comment
1	On	Bool	%I0.0	Control ON
2	Down	Bool	%Q2.5	Output valve
3	Up	Bool	%Q2.6	Input valve
4	Max	Historical Data	%M1.2	Maximum reached
5	Min	Bool	%M1.3	Minimum reached
6	Value	Int	%MW2	Tank level value

OPC Historical Data Access selection



Enter the required values in the opened **History Parameter** input field and confirm.

History parameter

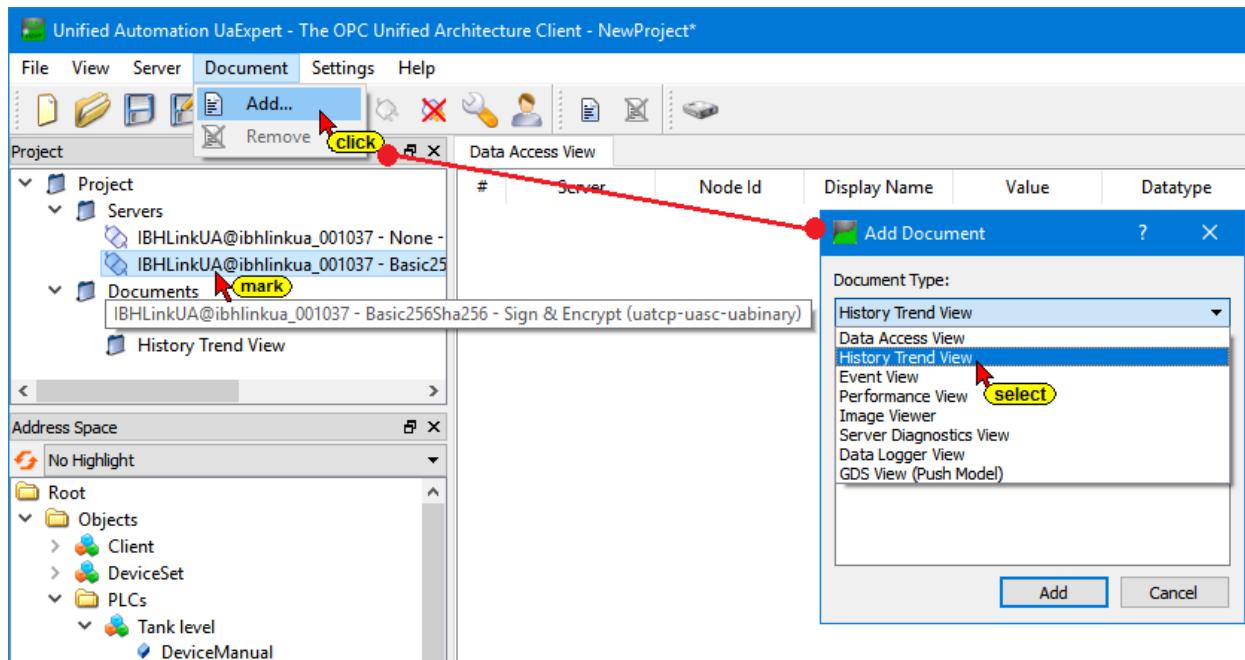
History parameter	
Enter the sampling rate [seconds]:	
0.5	Enter
Enter the history buffer size [number of values]:	
1000	Enter
<input type="button" value="OK"/> <input type="button" value="Cancel"/>	
confirm	

The sampling rate is entered in seconds.

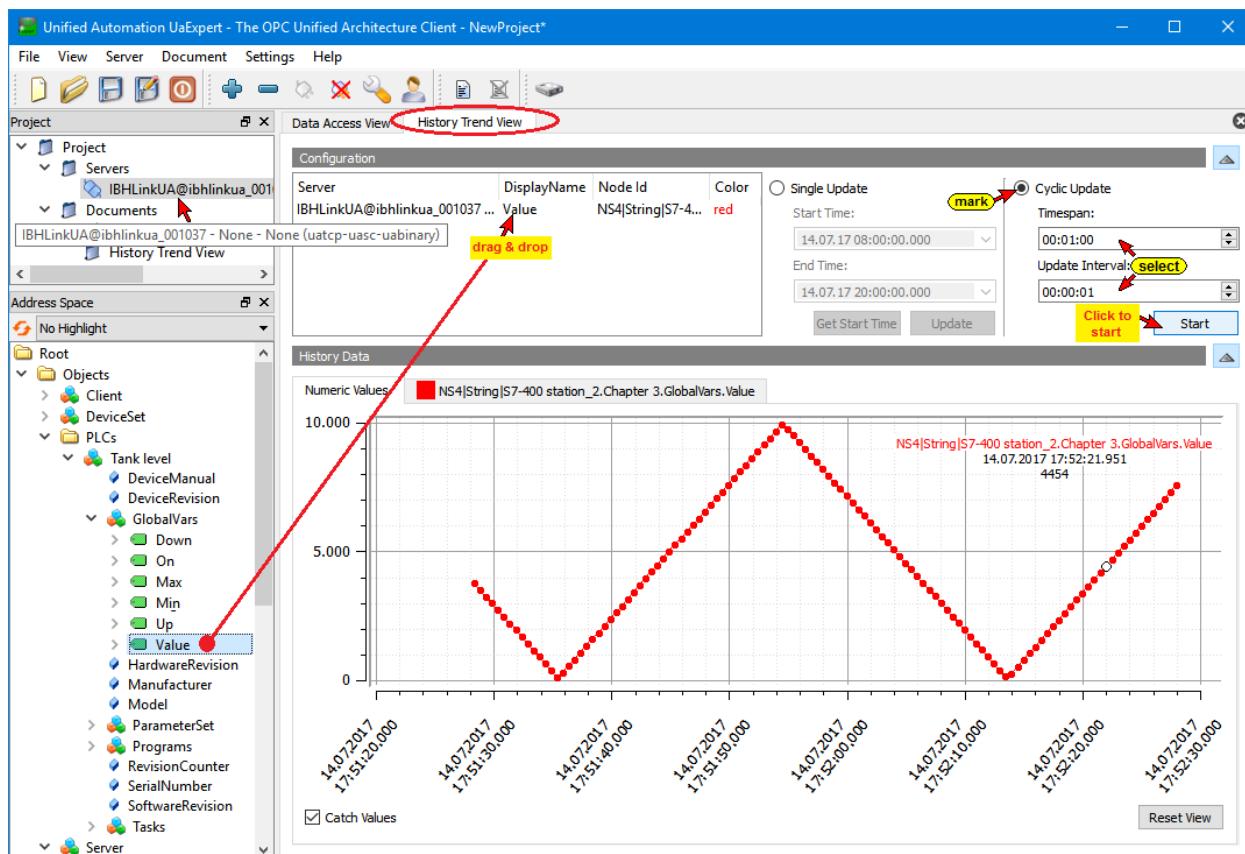
The number of values is entered per OPC tag.

Click **Document/Add** in the UaExpert Program window. Select and confirm the **History Trend View** in the **Add Document** dialog box.

UaExpert Program window



The historical data of values



5 IBH Link UA - OPC UA client function

The OPC client function reads data from an OPC server and writes data to an OPC server. This does not have to be the same OPC client/server device. IBHsoftec IBH Link UA is a server / client module. The OPC client function allows data exchange between OPC servers.

Double-clicking on the UA server icon will start the additional on the PC installed external OPC UA server.

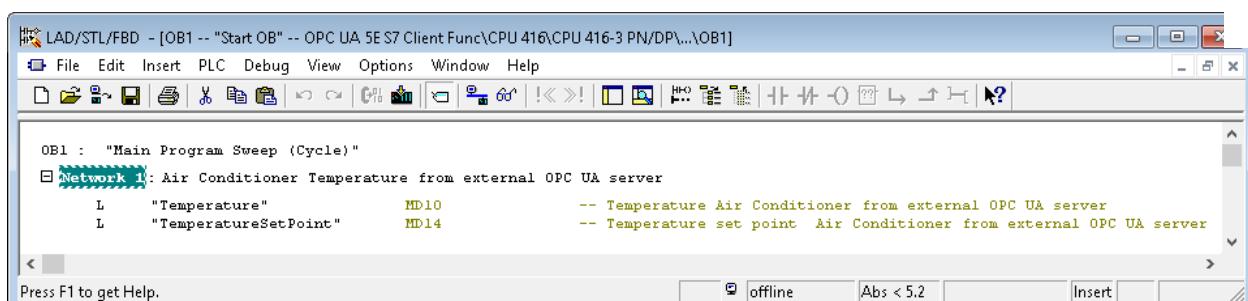


The project **OPC UA 5E S7 Client Function** with the SIMATIC 400 Station **CPU 416** provides the S7 program **Air Conditioner**.

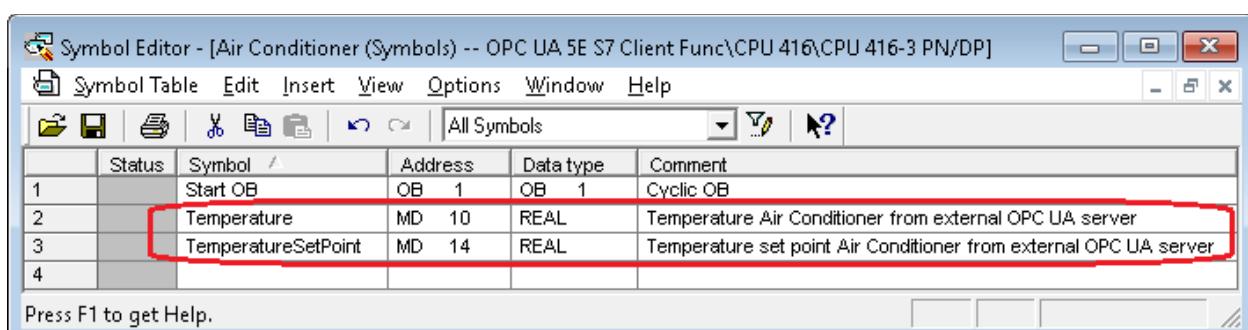
In the S7 program **Temperature Air Cond**, data of an air conditioning system are to be transferred via an external OPC UA server to the operands used in the S7 program.

External OPC UA Server	PLC Program CPU-416
Temperature	Temperature = MD10
TemperatureSetPoint	TemperatureSetPoint = MD14

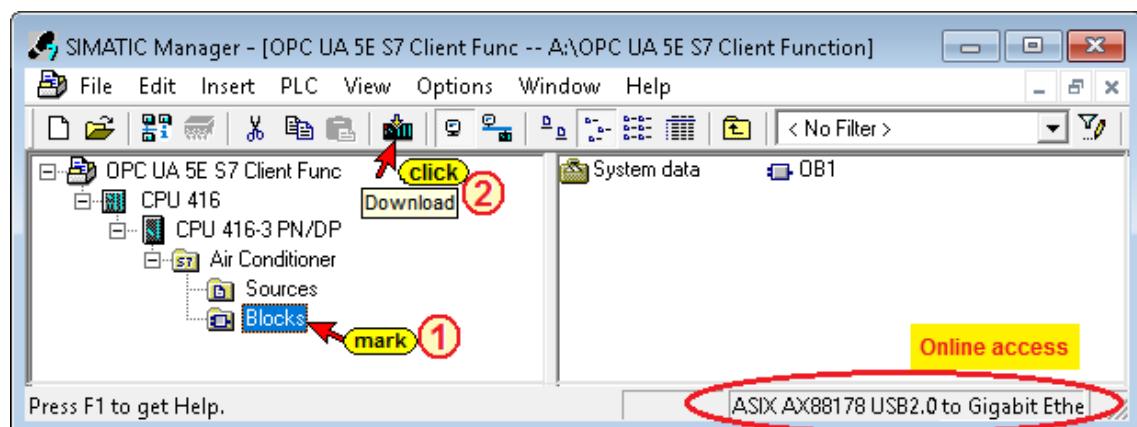
The two operands are called in the OB1 of the S7 program.



The two operands MD10 and MD14 data type REAL are defined in the symbol table.

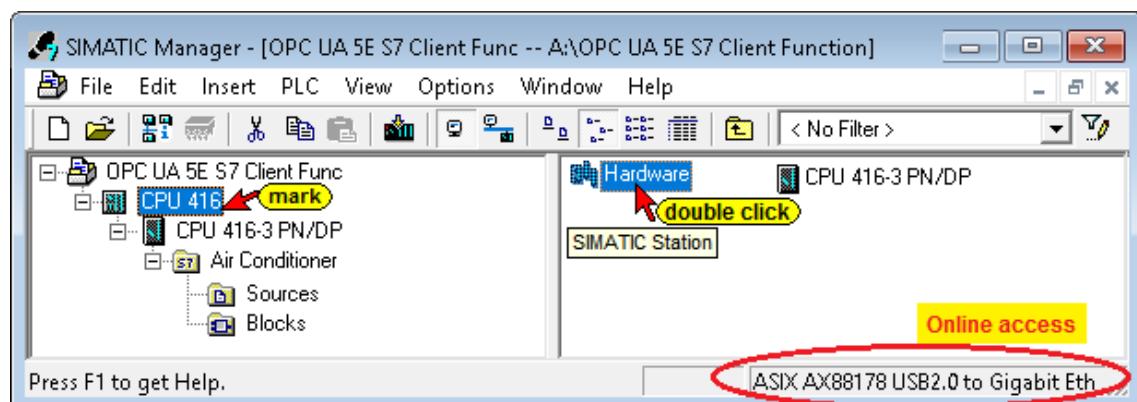


Transfer the S7 Program *Temperature Air Cond* to the PLC



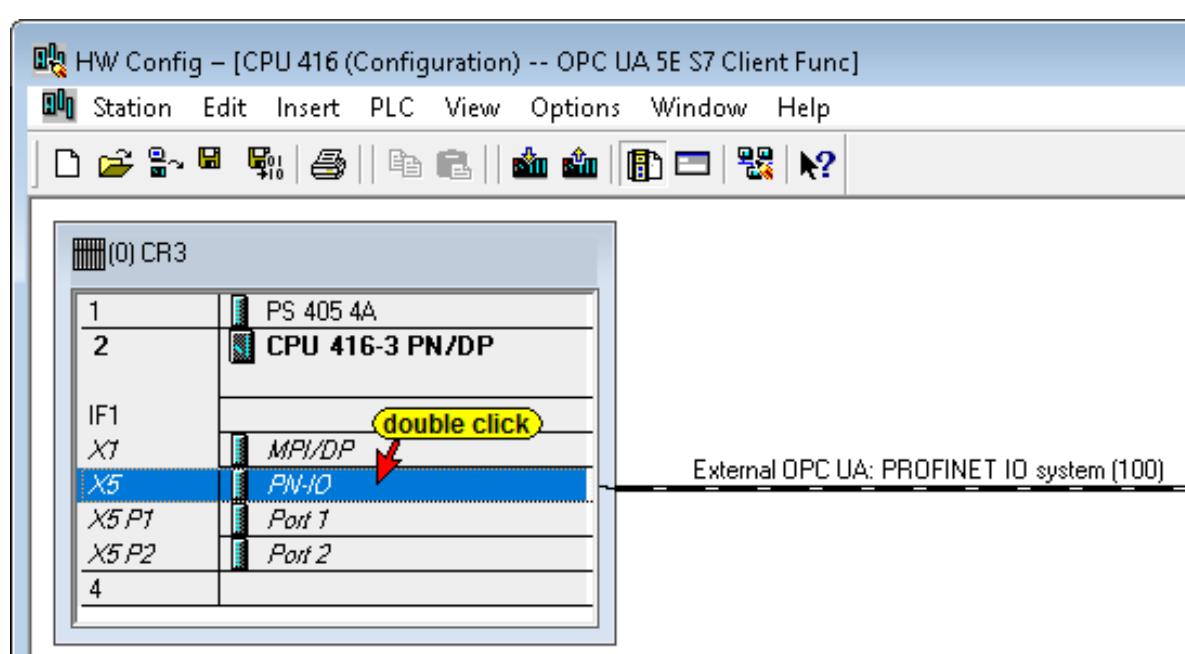
The correct online access to the CPU must be set.

Opening of the Hardware Configuration



Double-click the Hardware icon to open the ***HW Config*** window.

Double-clicking the line ***X5 PN-IO*** opens the dialog box ***Properties - Ethernet Interface PN-IO (R0 / S2.5)***.

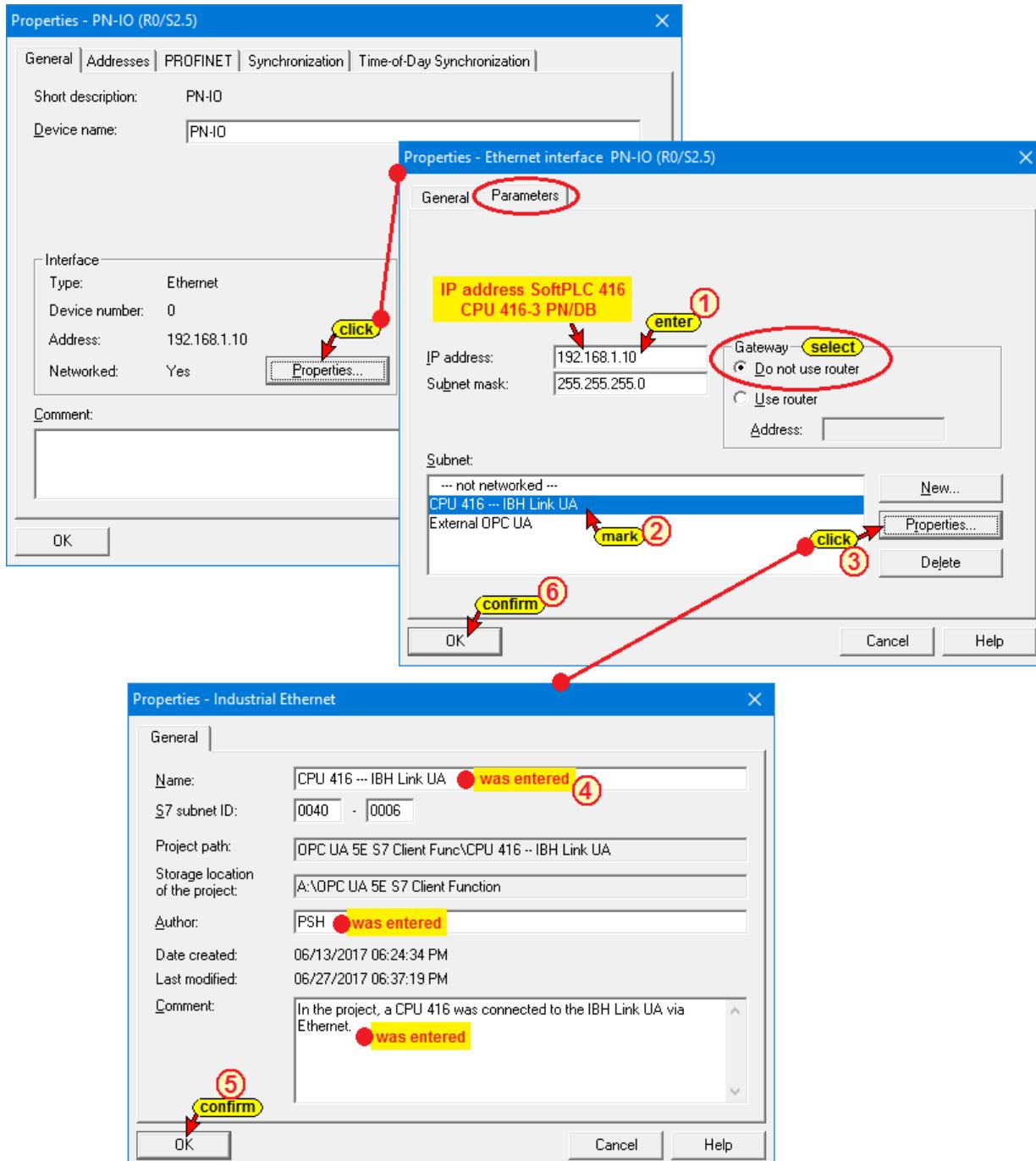


Properties - Ethernet Interface PN-IO (R0 / S2.5)

The required IP address is specified in the open tab **Parameters**.

The IP address of the PC - **192.168.1.10** is used in the example (all PCs in the workshop have this address).

The Ethernet connection is directly without a router.

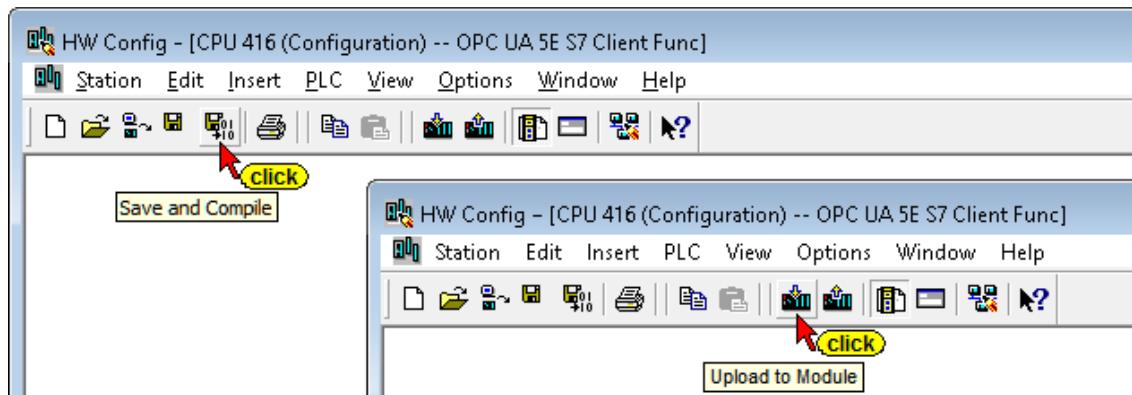


A click on the **Properties** button opens the dialog box **Properties** showing the added Ethernet connection.

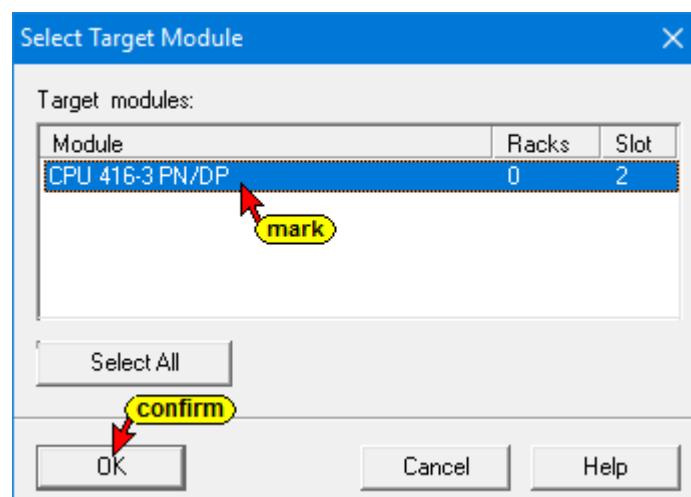


It is useful to enter additional information to allow the project to be tracked later. Confirming the entered settings with the **OK** button will close the dialog box.

A click on the **Save and Compile** icon and an additional click on the **Upload to Module** icon will take over the configuration and starts the transfer to configure the CPU.



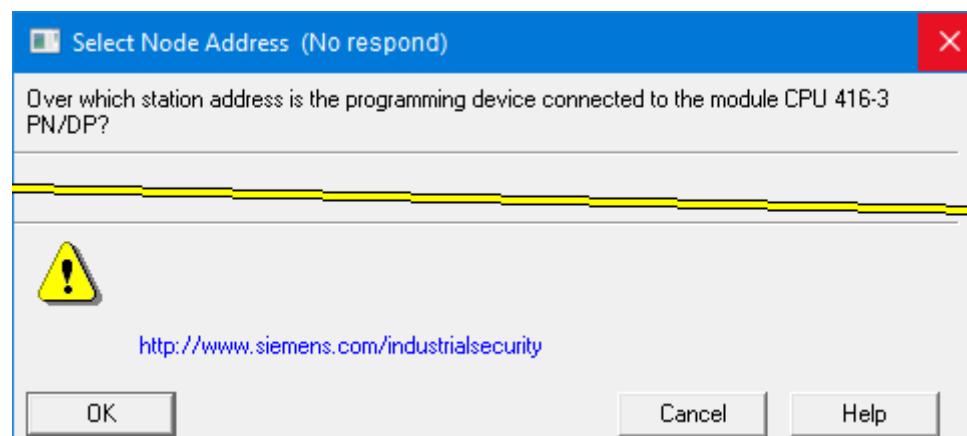
A dialog box for selecting the destination CPU the configuration is to be transferred to is opened.



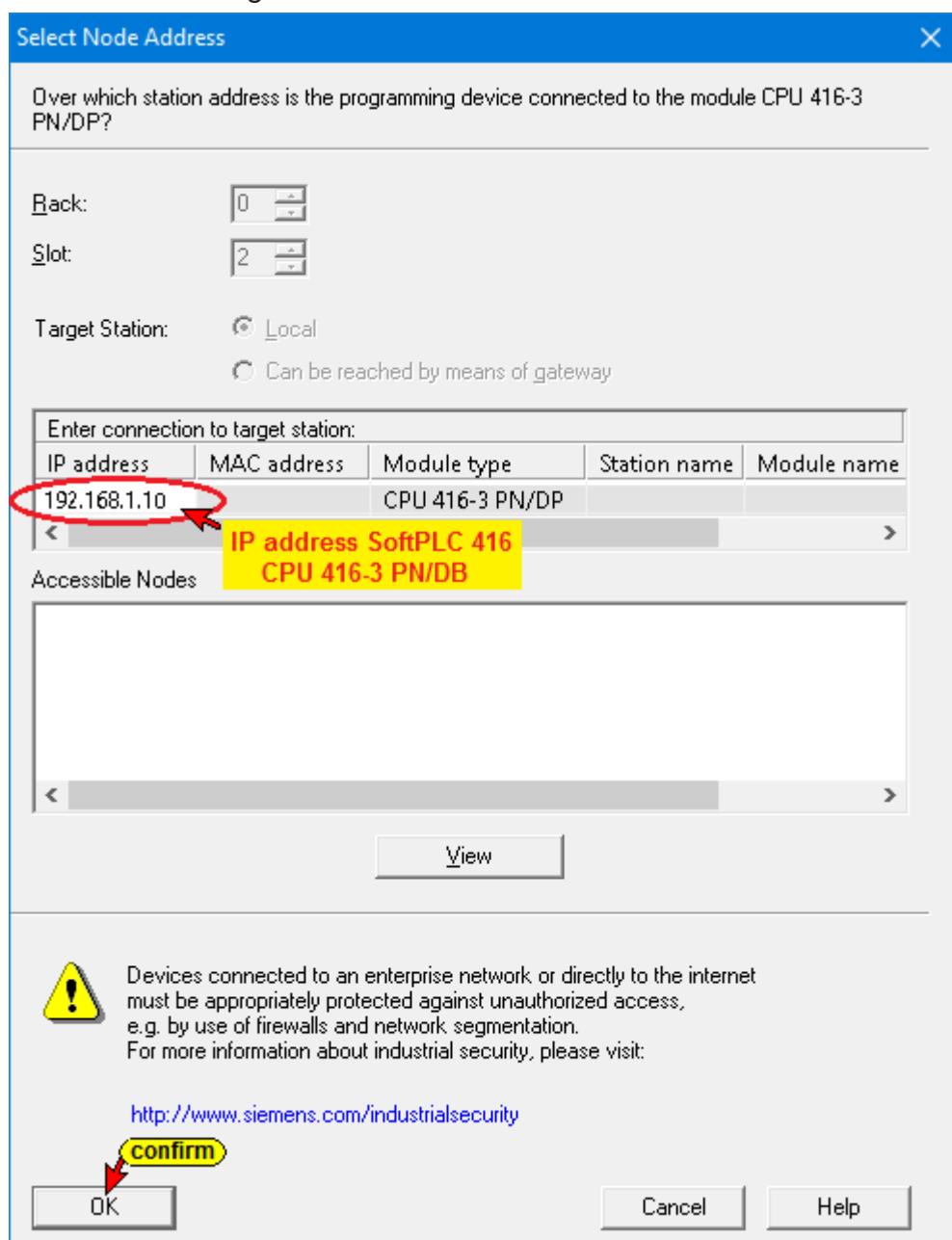
Confirming the **Select Destination** dialog box closes it and the **Select participant address** dialog box opens.

Select Node Address

It takes a while until the Select Node Address dialog box shows the required information. Meanwhile an error message is displayed.

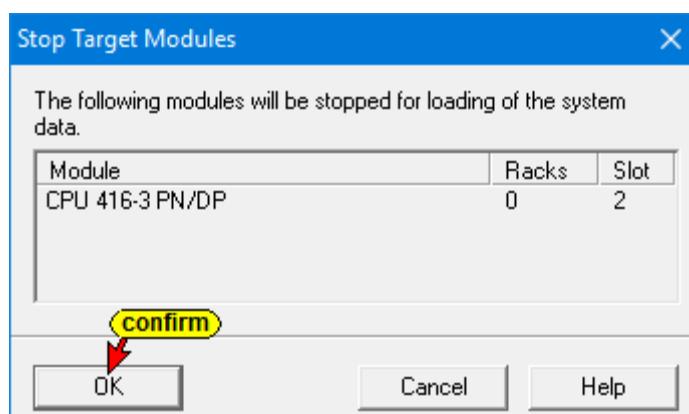


Select Node Address dialog box



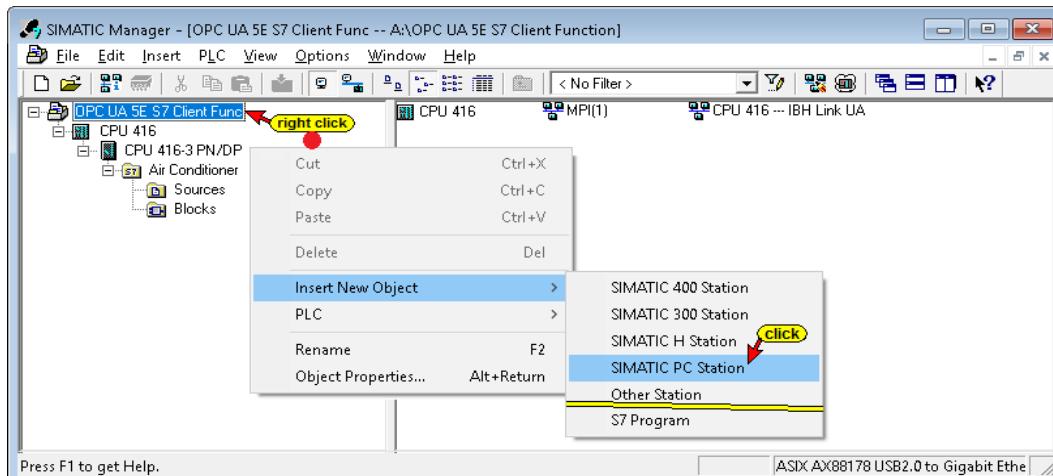
If the desired information is correct, click to confirm the settings.

The configuration can only be transferred into the CPU's if the CPU is in its STOP mode.

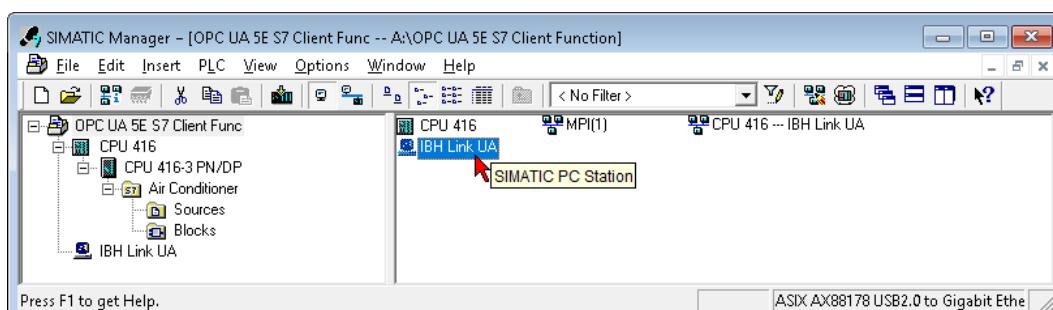
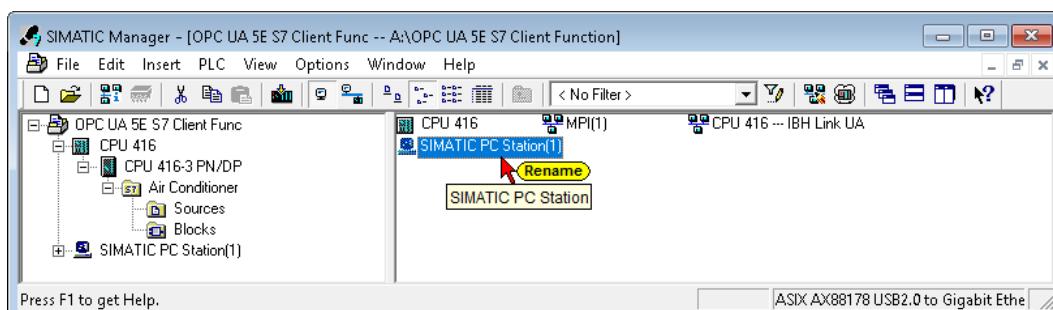


5.1.1 IBH Link UA as SIMATIC PC station.

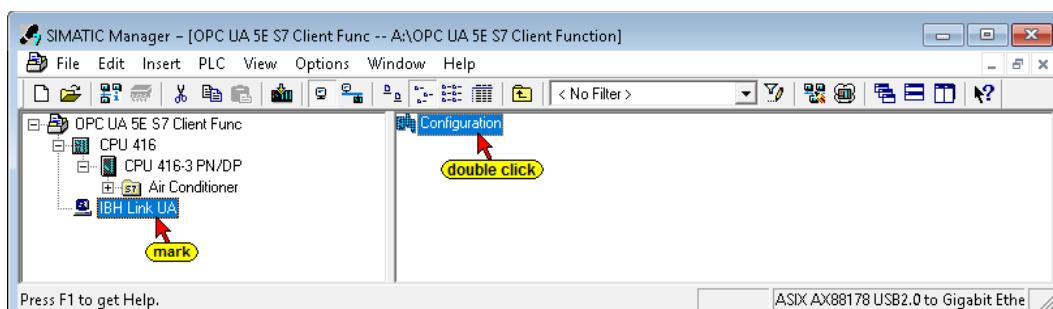
A right-click on the Project Name **OPC UA 3E S7 Client Func** will initiates the command **Insert New Object / Activate SIMATIC PC Station**.



Rename the inserted SIMATIC PC station (1) to **IBH Link UA**.



Double-click the renamed SIMATIC PC Station **IBH Link UA** in the left window and a double click on **Configuration** in the right window opens the hardware configurator.

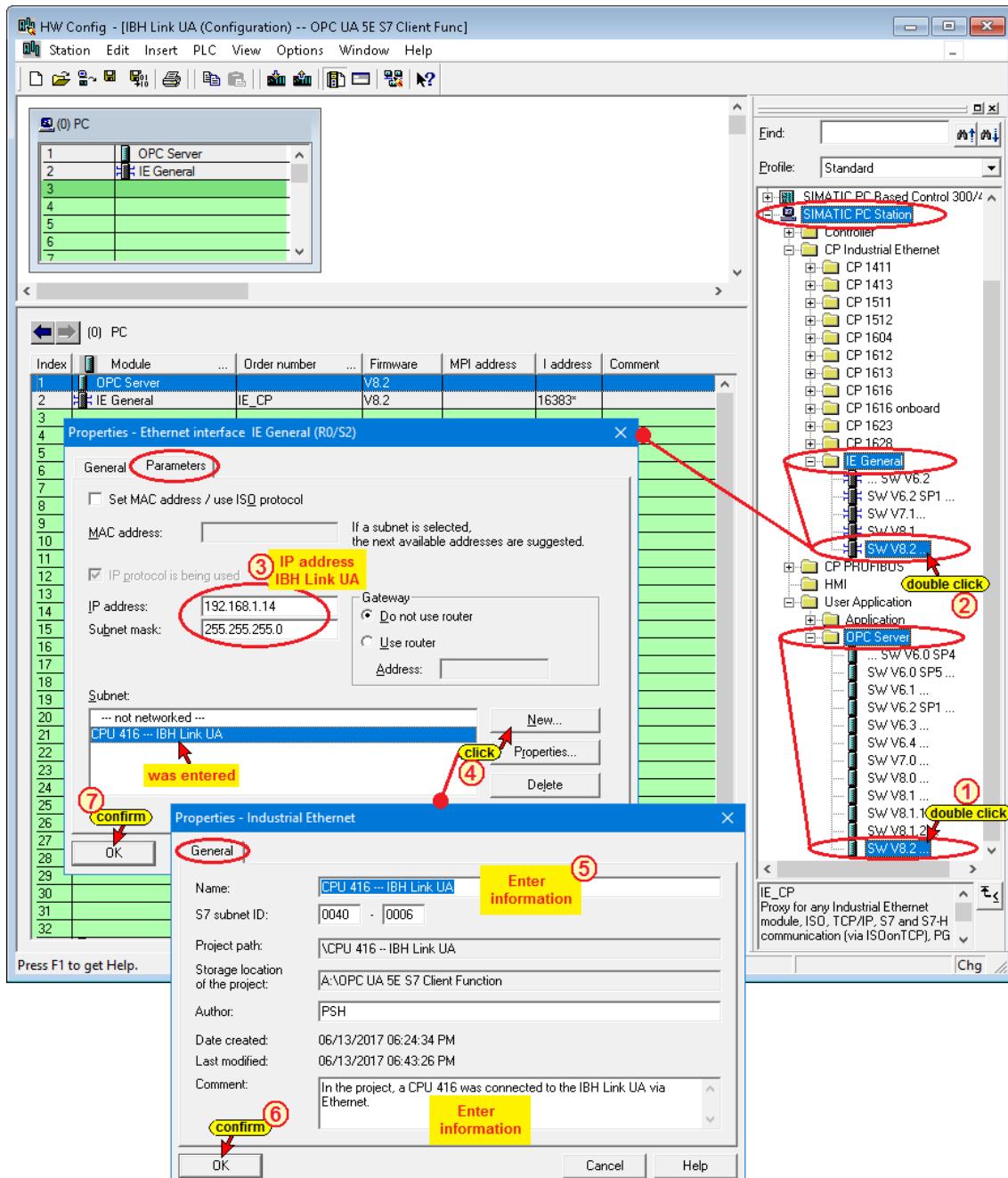


Configuration IBH Link UA (SIMATIC PC Station)

Note:

In the hardware catalogs of **STEP7 SIMATIC Manager, TIA V13 TIA V14 and TIA V15** the Siemens **OPC Server SW V8.2...** and the CP Industrial Ethernet interface **IE General SW V8.2...** are available.

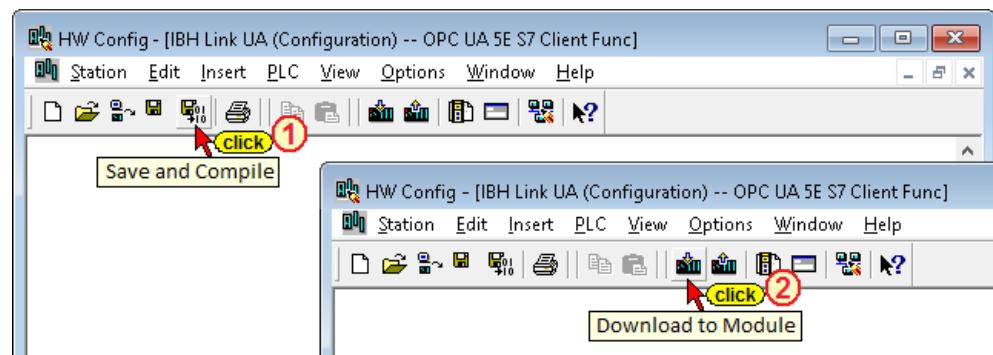
Double-clicking on <SW V8.2...> ① takes the OPC server into the PC station. Double click on <IE General> <SW V8.2...> ② opens the dialog box **Properties - Ethernet Interface IE General (R0 / S2)**.



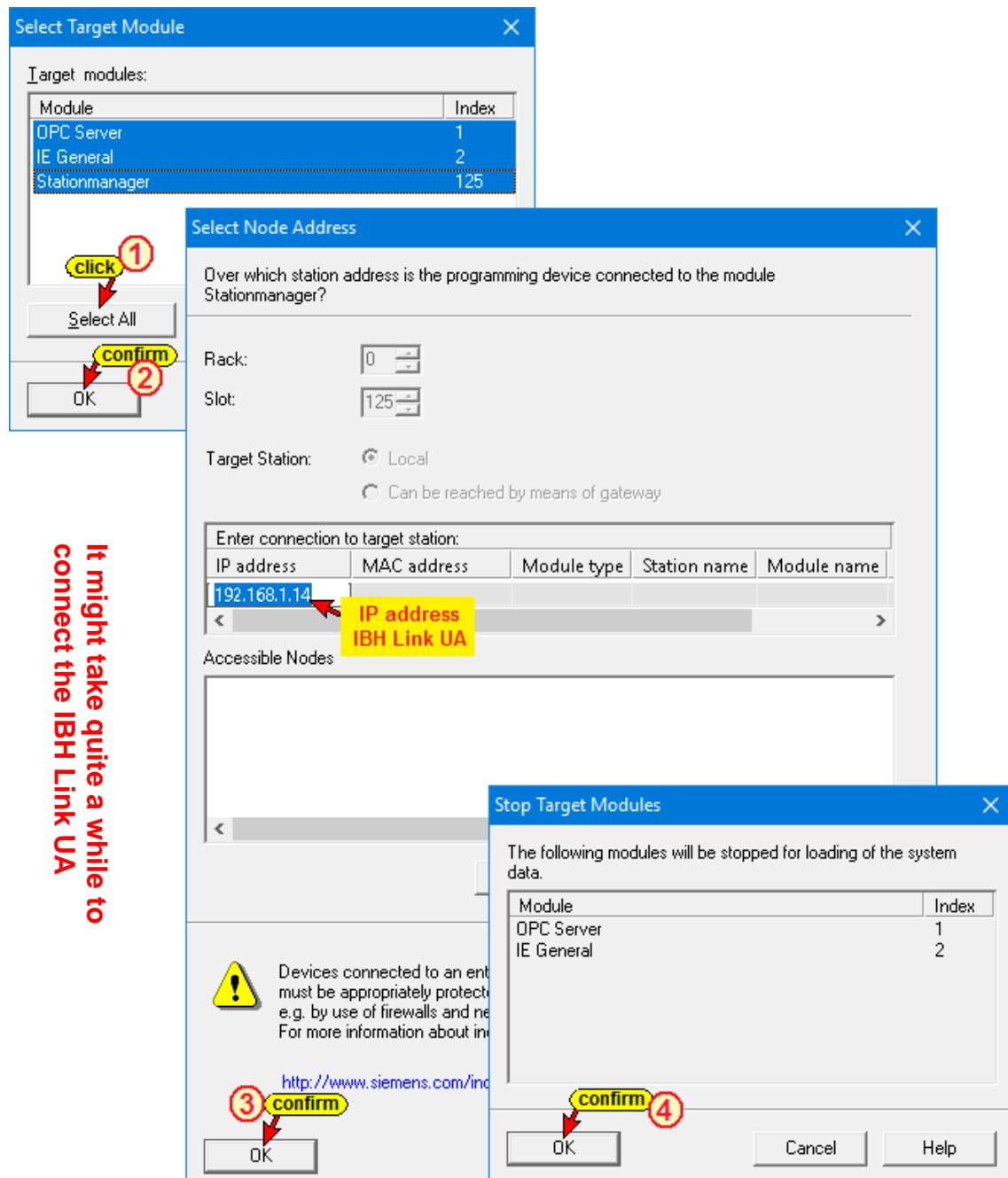
By clicking the subnet **Ethernet(1) ③ – ⑦**, the IP address and the subnet mask of the IBH Link UA, which were entered during configuration, are accepted.

Loading the configuration into the IBH Link UA

After **Save and Translate** the configuration may be loaded into the IBH Link UA.

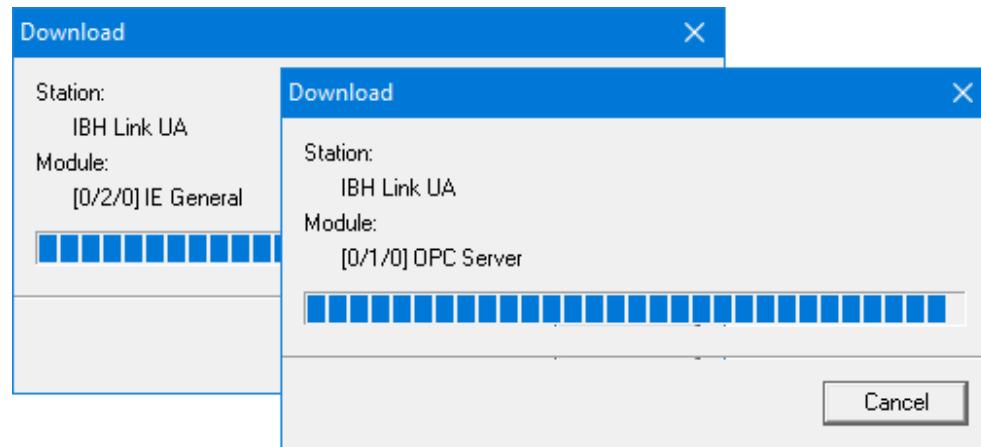


Loading into the IBH Link UA requires several steps.



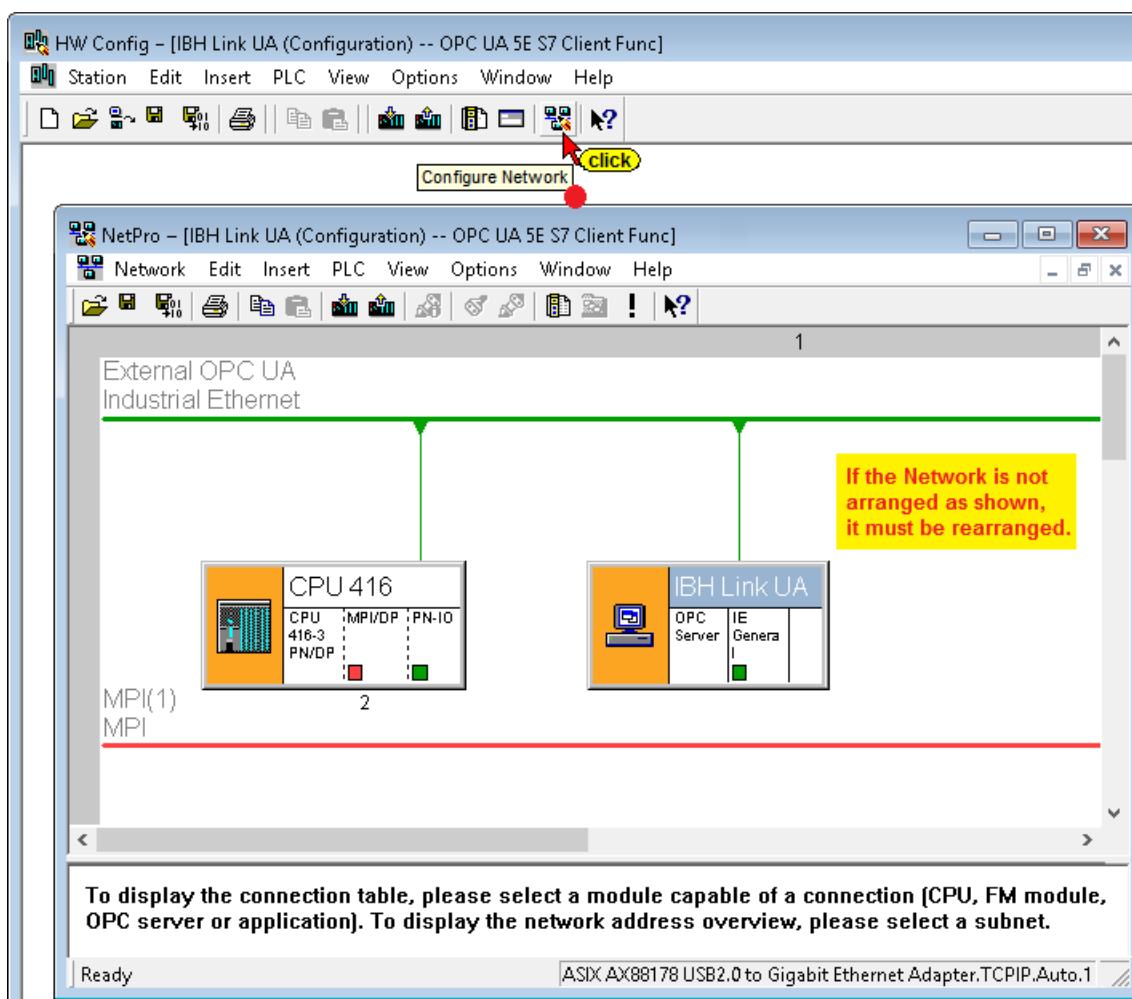
The progress of loading into the IBH Link UA is displayed. The loading takes place in two steps.

- Loading the configuration is into the IBH Link UA – IE General.
- Loading the configuration is into the IBH Link UA – OPC Server.



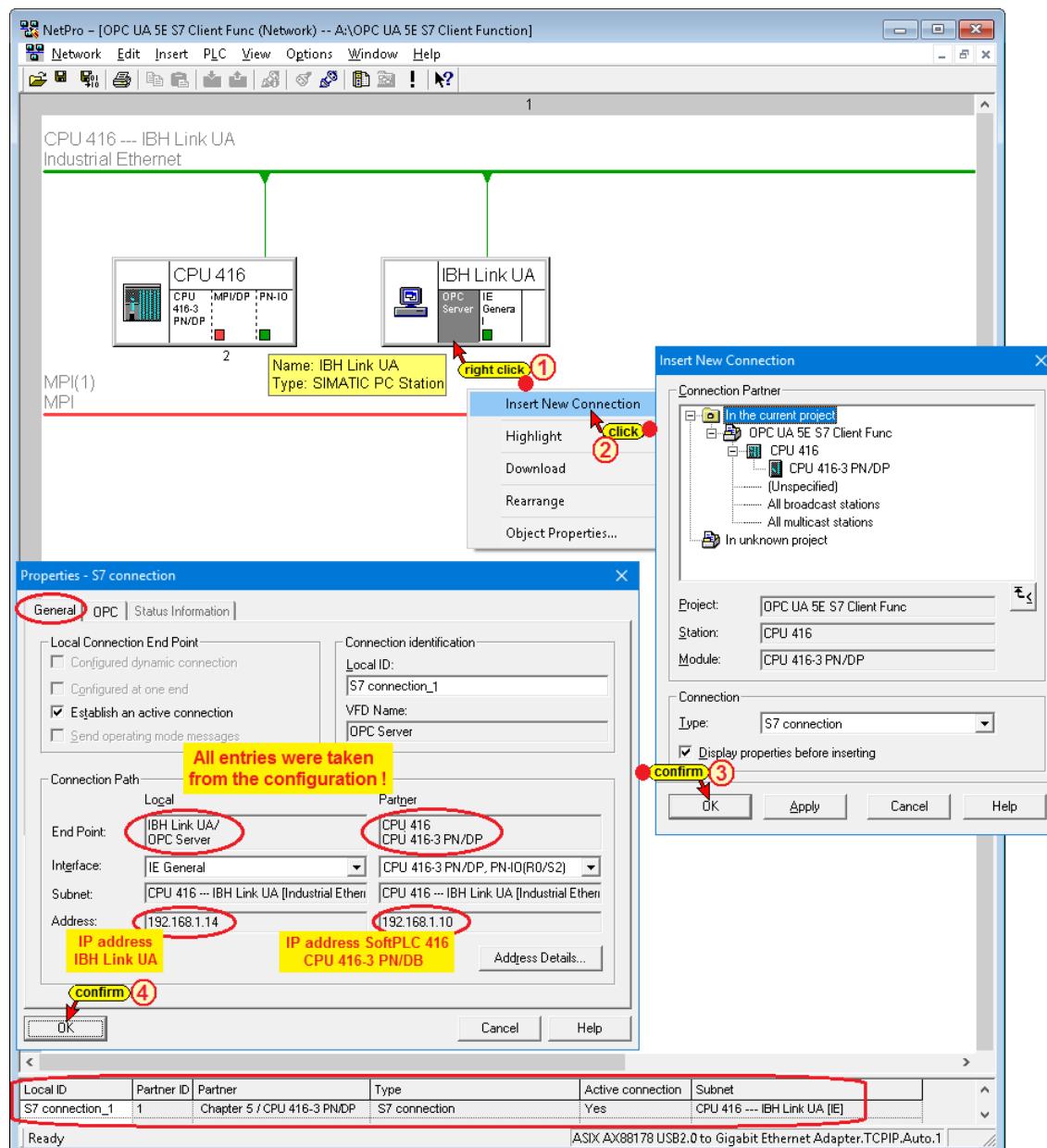
NetPro Window

The possible link between the CPU-416 and the IBH Link UA are displayed graphically by clicking on the Configure network icon.

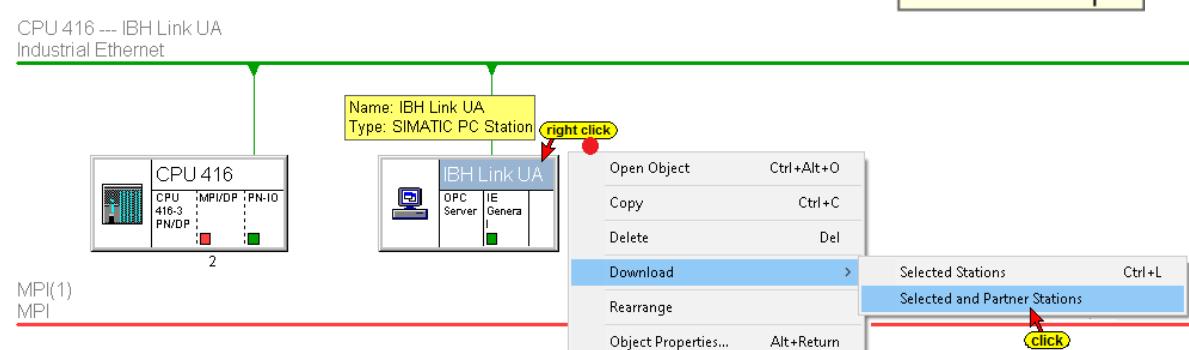


Connecting the CPU-416 with the IBH Link UA

The following four steps will establish an S7 connection between the CPU-416 and the IBH Link UA.



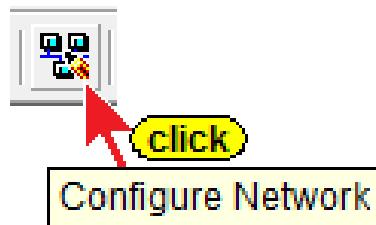
If no errors occur after clicking the **Save and Compile** icon the configuration can be loaded into the IBH Link UA and the CPU-416.



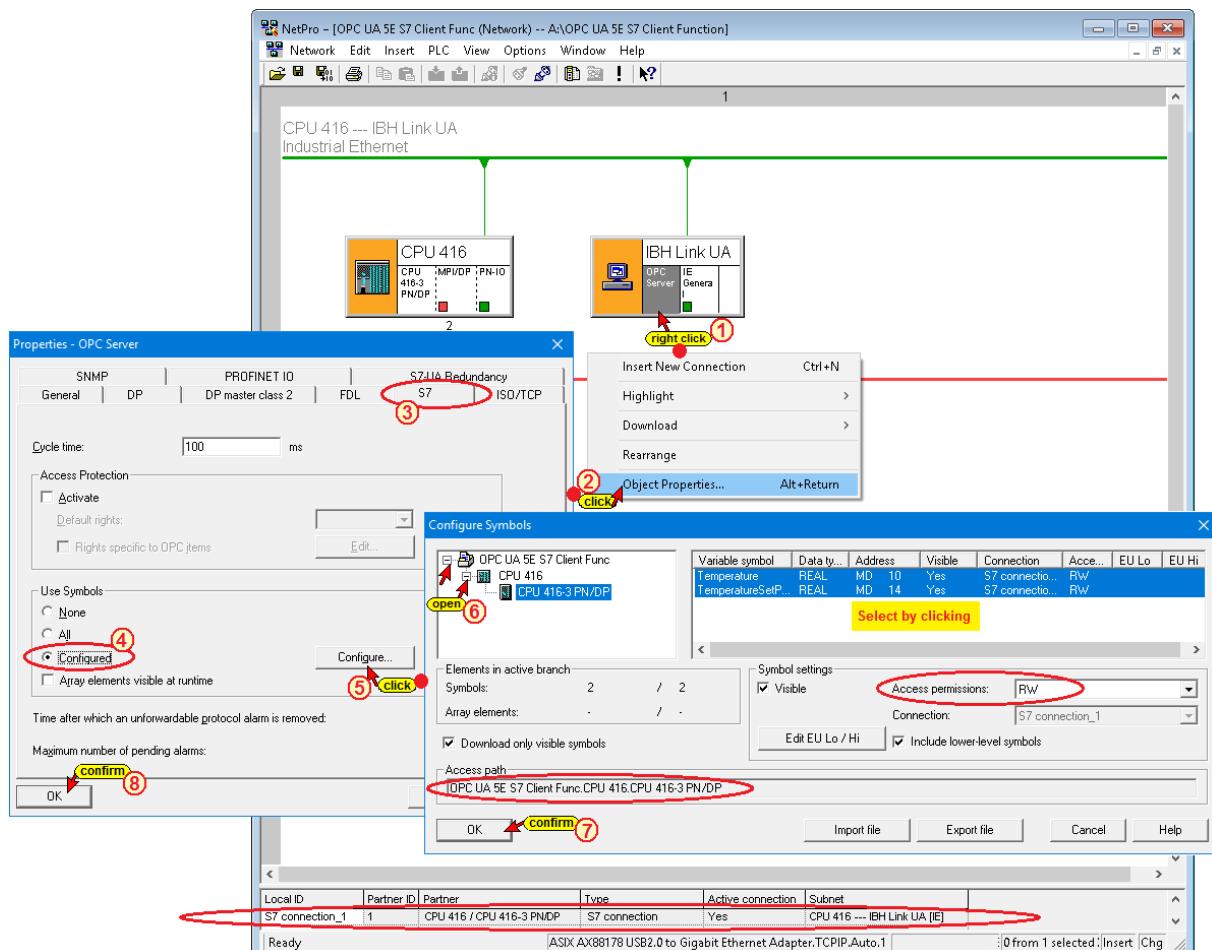
Re-select OPC tags

With a click on the **Configure Network** icon the graphical display of the network configuration is opened.

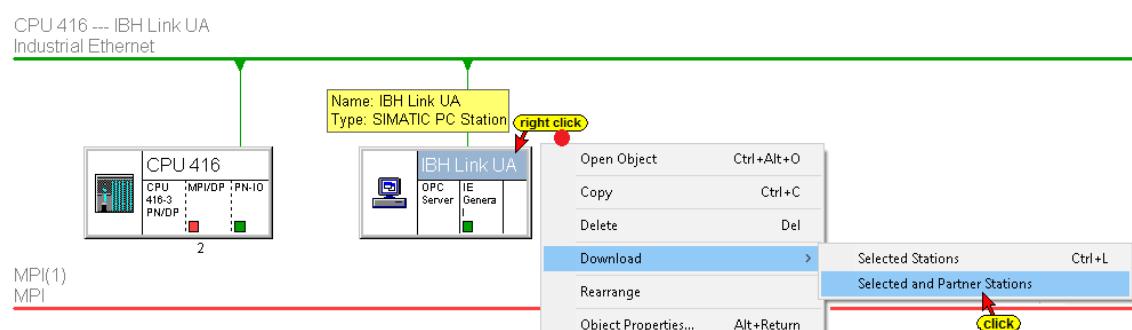
With a right click on **OPC Server** within the **Object properties...** context menu the dialog box **Properties – OPC Server** opens.



Select the **S7** tab and select **Configure** to display in the **Configure Symbols** dialog box the newly defined symbolic operand names.



If no errors occur after clicking the **Save and Compile** icon the configuration can be loaded into the IBH Link UA and the CPU-416.



Starting the external OPC UA server

```
I/O warning : failed to load external entity "file://C:/UA_Server_Beispiel/uanodesetimport.xml"
*****
Server opened endpoints for following URLs:
    opc.tcp://TTI-RED-WIN10-6:48011
*****
*****
Press x to shutdown server
*****
```

The external OPC UA server has the endpoint URL:

opc.tcp://TTI RED-WIN10-6: 48011

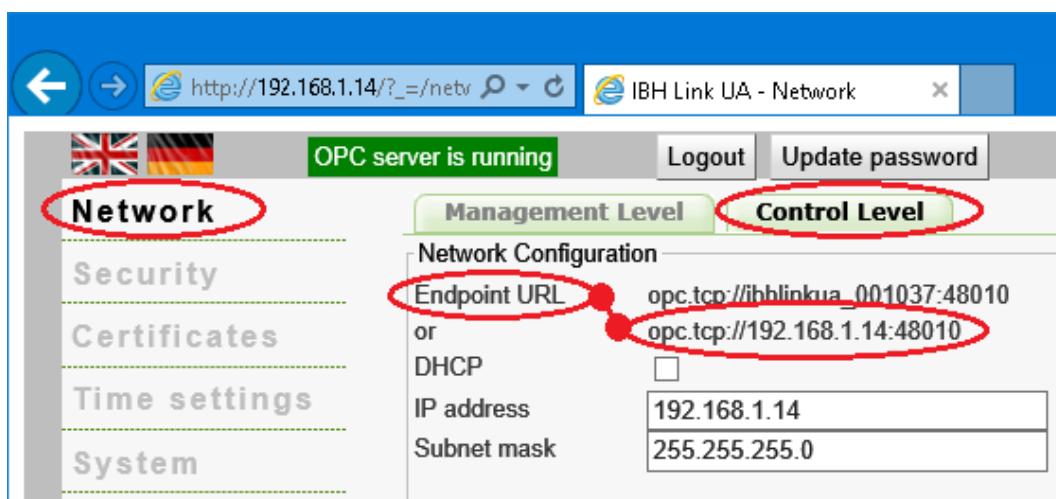
Since no **NameServer** is available, the PC name must be replaced with the absolute IP address of the PC. The endpoint URL for the connection is:

opc.tcp://192.168.1.10: 48011

Creating OPC clients in the IBH Link UA

Enter the IBH Link UA as OPC Client with **Security Mode None** in the IBH Link UA web browser window **OPC Client**.

From the IBH Link UA web browser window **Network / control level** copy the required endpoint URL (**opc.tcp://192.168.1.14: 48010**).

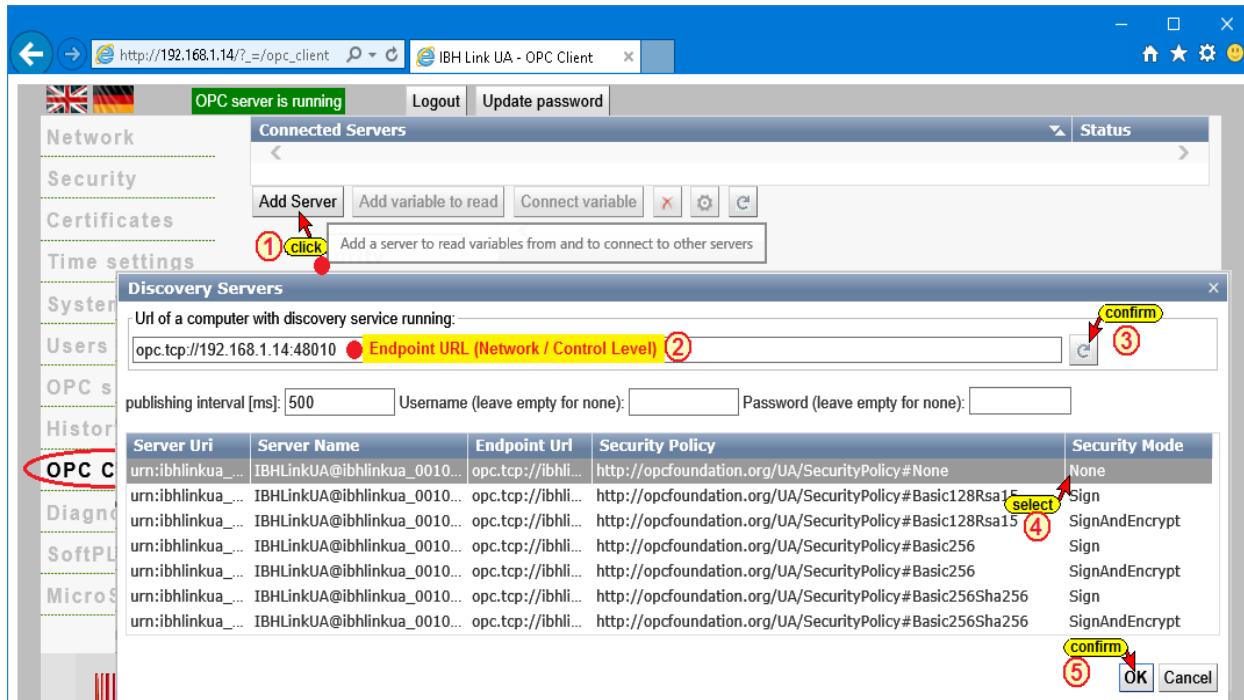


Add a Server

First set up the IBH Link UA server. To do so enter the previously copied endpoint URL **opc.tcp://192.168.1.14: 48010** into the field opened in the IBH Link UA Web browser window / OPC Client for an **external OPC UA server**.

Add a Server

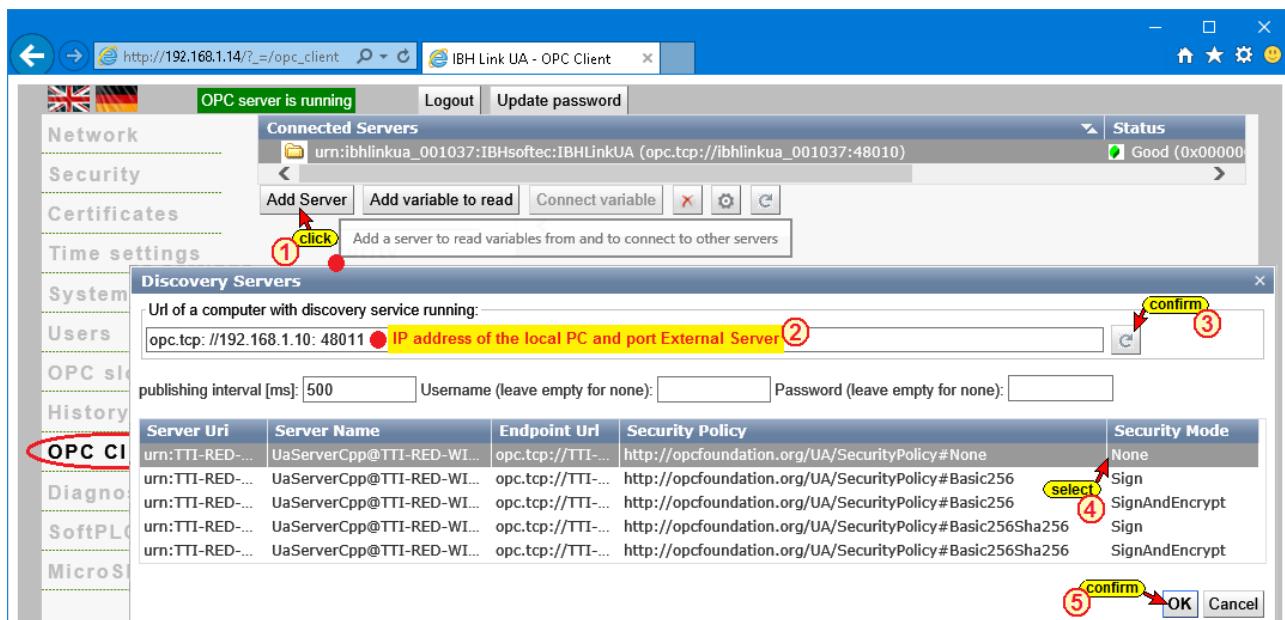
The **Security Policy None** and the **Security Mode None** have been selected for data transmission.



Second, the **External OPC UA Server** is defined. To do so the endpoint URL **opc.tcp://192.168.1.11: 48011** of the external **OPC UA Server** is enter the field opened in the IBH Link UA Web browser window / OPC Client.

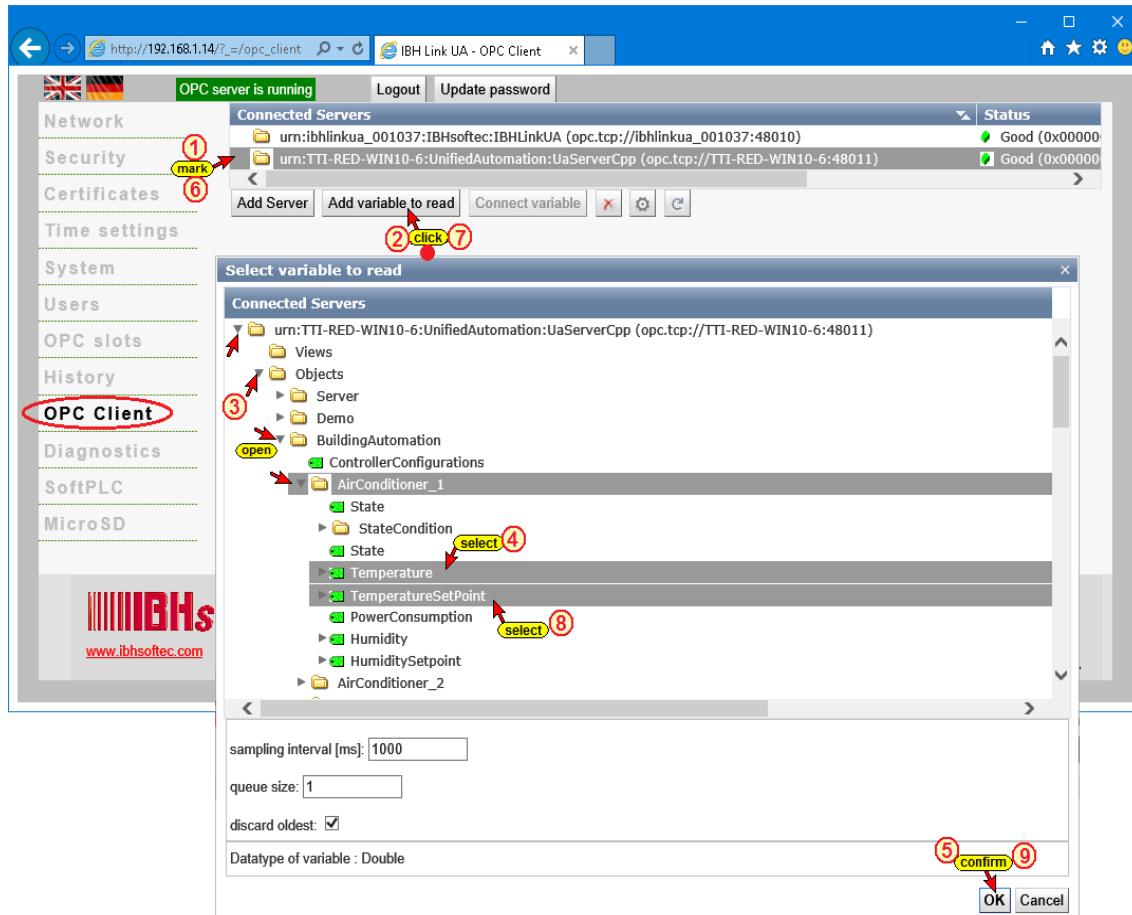
The absolute endpoint URL must be used because there is no **NameServer** available.

For data transmission, the **Security Policy None** and the **Security Mode None** have been selected.

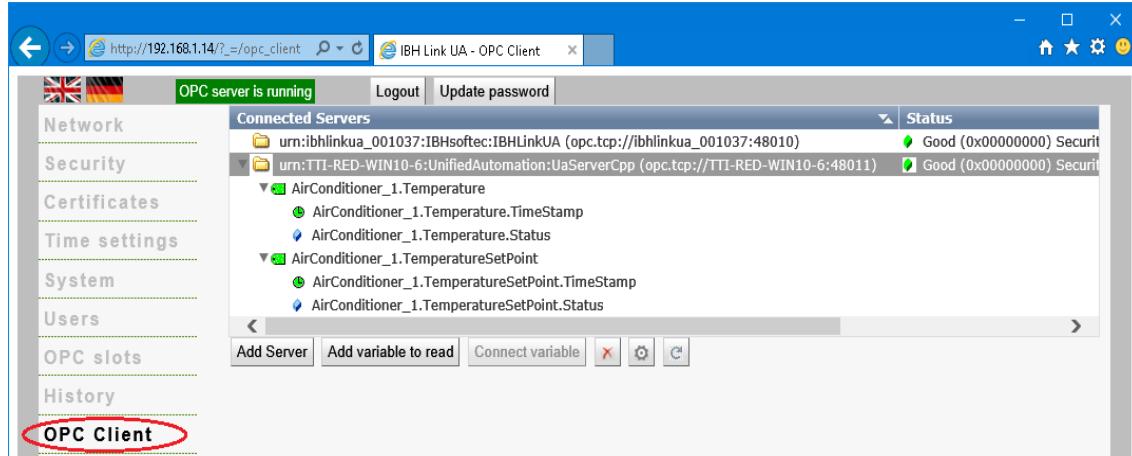


Add Read Variable

The two variables **Temperature** and **TemperatureSetPoint** from the external OPC UA Server are declared to be read variables. They are passed to the PLC program in the CPU-416 via the IBH Link UA OPC Server.



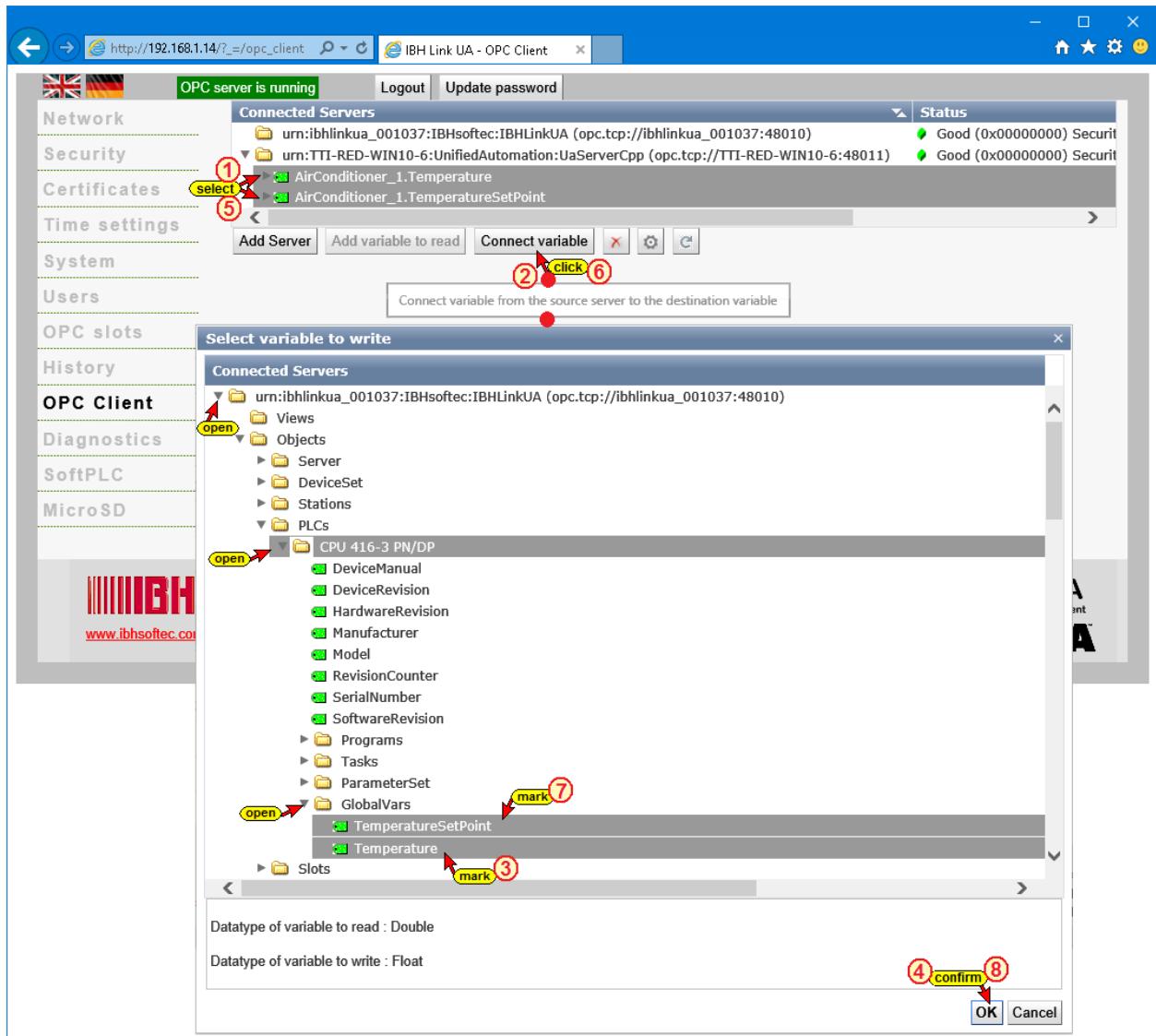
The variables to read are listed



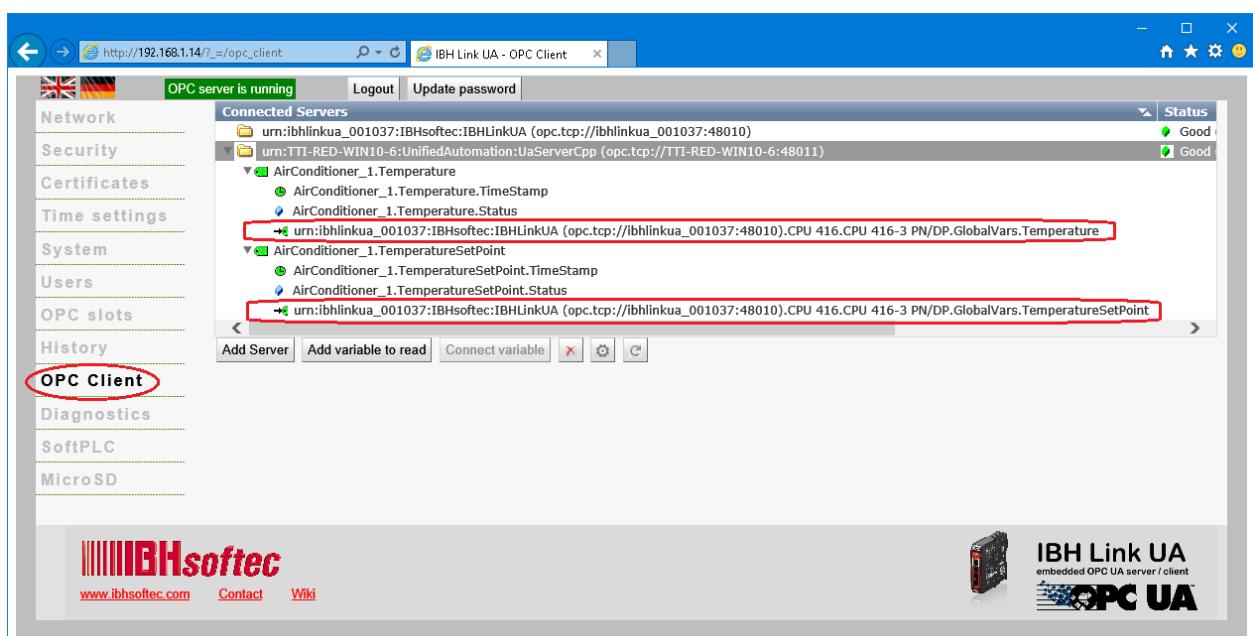
Connect to Variables

The two as read variables declared **Temperature** and **TemperatureSetPoint** are connected to the IBH Link UA OPC Server, which then feeds them to the PLC program in the CPU 416.

Connect to Variables

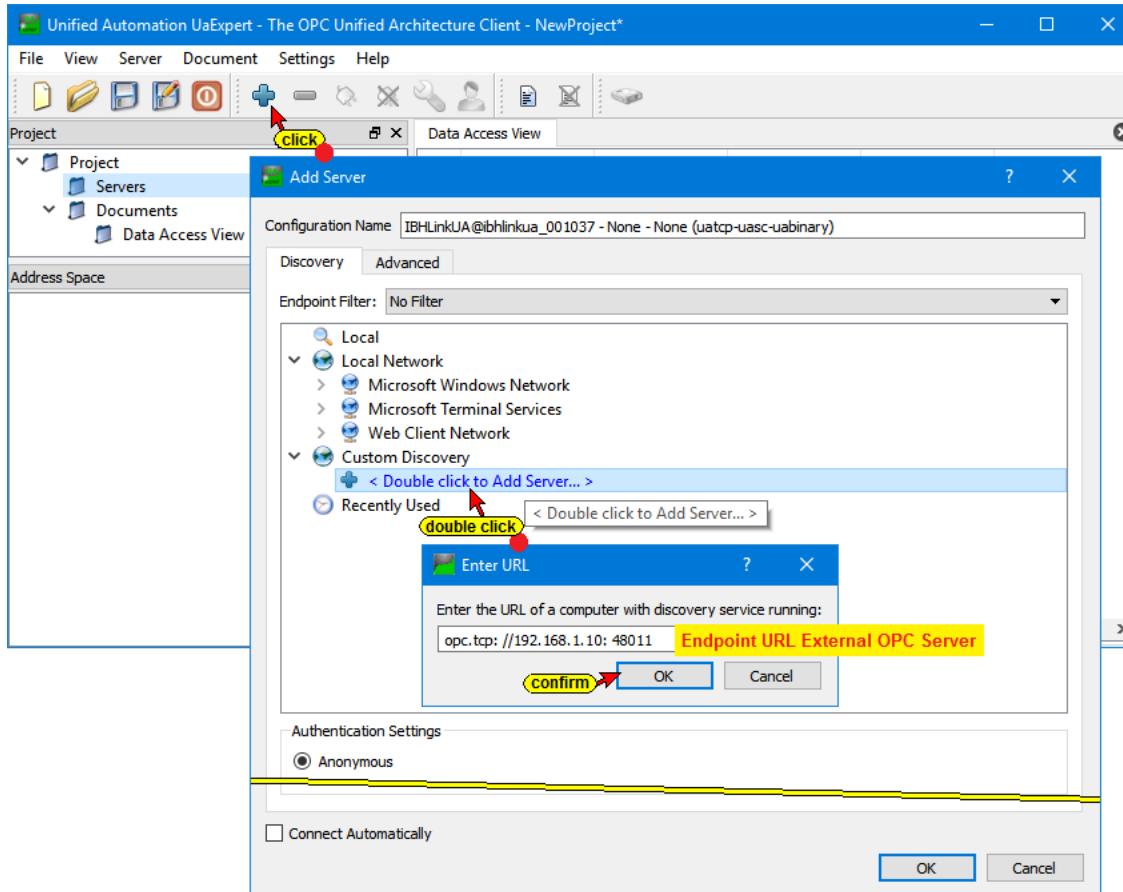


In the IBH Link UA web browser window **OPC Client** the connections are displayed.

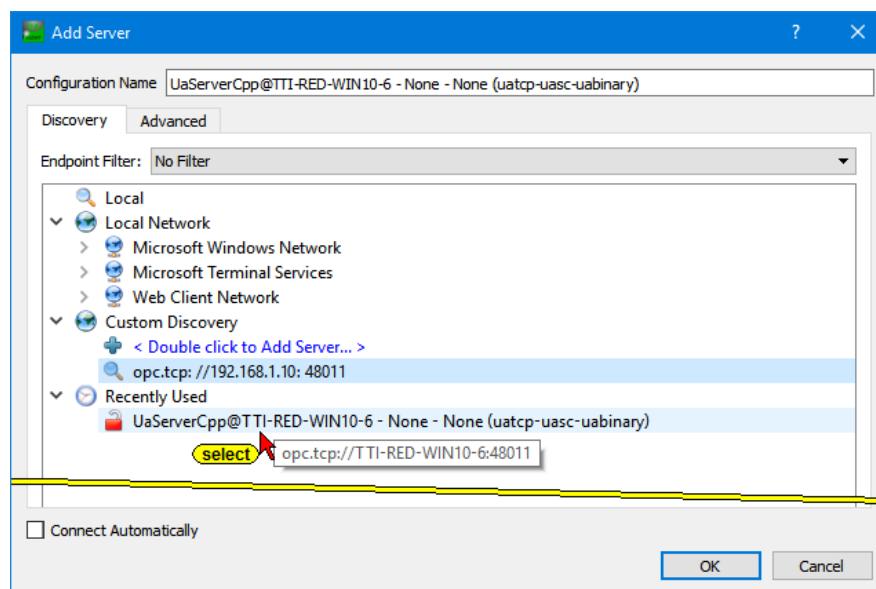


Connect to External OPC server

Clicking the Plus icon opens the **AddServer** dialog box.

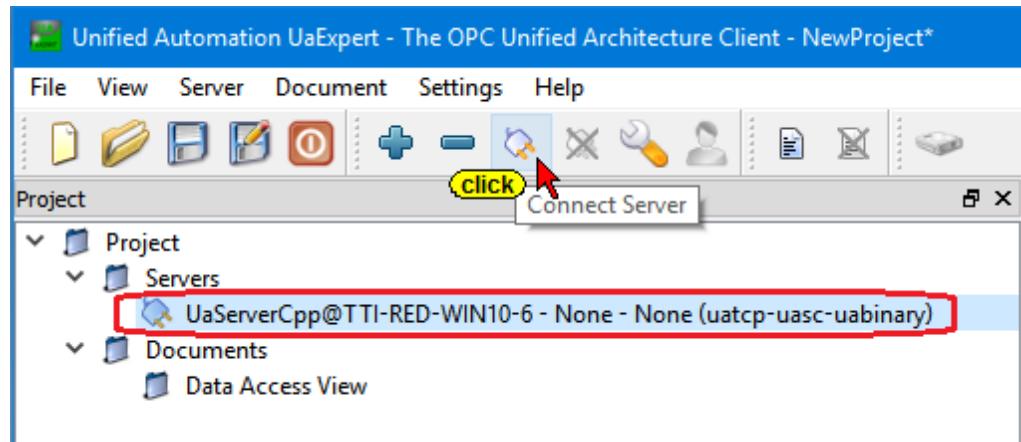


Double-clicking **Add Server** opens **< Double click to Add Server... >** the dialog box **Enter URL**. The endpoint URL with the absolute IP address of the external OPC server **opc.tcp://192.168.1.10: 48011** must be entered.



The external OPC Server **UaServerCpp@<PC-Name>** provides only the security level ***None - None (uatcp-uasc-uabinary)***.

In the opened ***UaExpert*** program window the connected server with the defined security level is displayed.



The dialog box for accepting the OPC UA server certificate are opened by clicking on the **Connect Server** button.

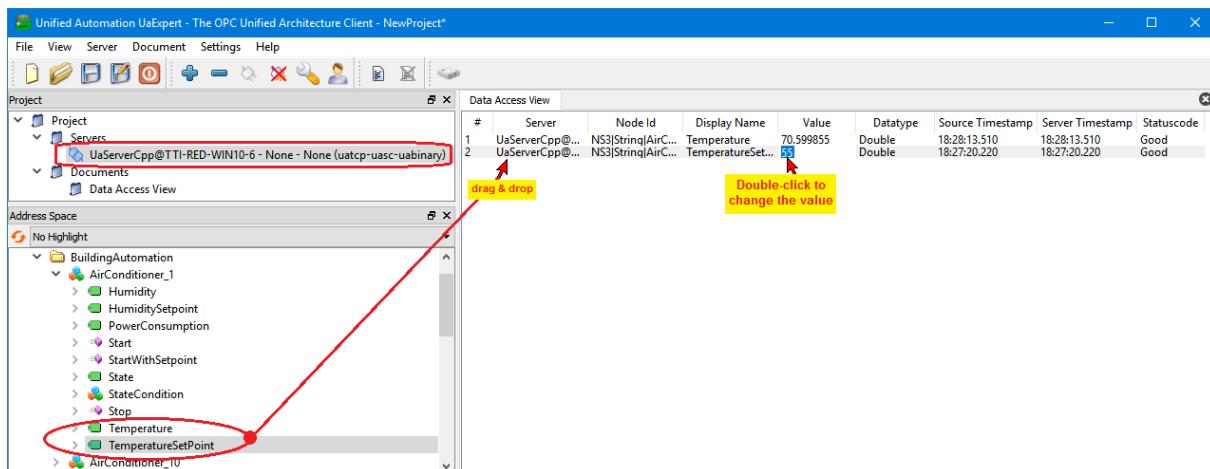


Confirming the Certificate

Confirms the selected certificate by clicking the **Trust Server Certificate** button in addition click the **Continue** button to closes the dialog box.



AddressSpace displays information about the connected external OPC server in the ***UaExpert*** program window,



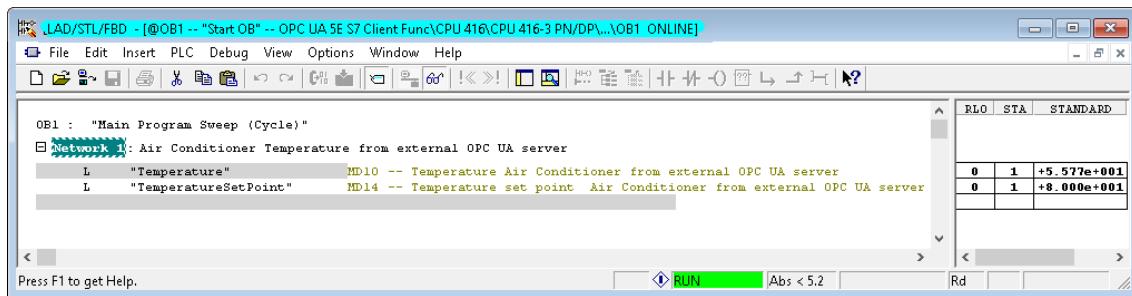
The **Temperature** and **TemperatureSetPoint** variables can be dragged and dropped from the external OPC UA server into the **Data Access Viewer** window.

TemperatureSetPoint can be modified.

Status OB1 - PLC program CPU-416

In OB1of the CPU-416 PLC program, the two operands **Temperature = MD10** and **TemperatureSetPoint = MD14** are displayed.

OB1 Status



5.2 In Practice: Value – Status – TimeStamp

Each OPC UA value consists of:

- **Value – Status – TimeStamp**
- Not only should the **Value** of the source variable be transmitted, but also the **Status** code and the **TimeStamp**. With this information, the quality and age of the variables can be evaluated.

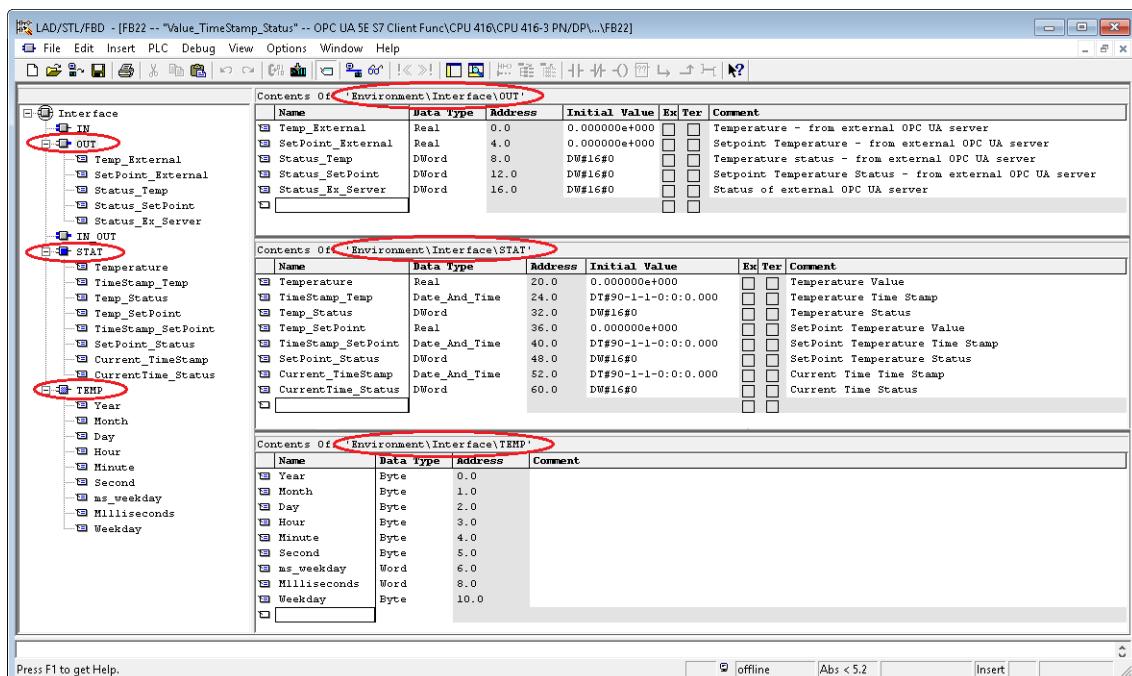
Each OPC UA server also provides the actual time (variable **CurrentTime**) to perform time comparisons.

Example: Transferring TimeStamp and Status code

Project: *OPC UA 5E S7 Client Function*

The **TimeStamps** of variables and the actual time (variable **CurrentTime**) as well as the **Status** codes of an external OPC UA server are to be displayed or made available for further processing.

Variables FB 22



Block FB 22 - Segment 1 and Segment 2 -

```

FB22 : External OPC UA Server - Temperature - SetPoint Temperature
Network 1: Display Temperature: Time Stamp - Value - Status
    L P##TimeStamp_Temp
    LAR1
    L D [AR1,P#4.0]
    L B [AR1,P#0.0]
    T #Year                #Year
    L B [AR1,P#1.0]
    T #Month               #Month
    L B [AR1,P#2.0]
    T #Day                 #Day
    L B [AR1,P#3.0]
    T #Hour                #Hour
    L B [AR1,P#4.0]
    T #Minute              #Minute
    L B [AR1,P#5.0]
    T #Second              #Second
    L W [AR1,P#6.0]
    T #ms_weekday          #ms_weekday
    SRW 4
    T #Milliseconds        #Milliseconds
    L #ms_weekday          #ms_weekday
    SLW 12
    SRW 12
    T #Weekday             #Weekday

    L #Temp_Status          #Temp_Status      -- Temperature Status
    T #Status_Temp          #Status_Temp      -- Temperature status - from external OPC UA server

    L #Temperature           #Temperature       -- Temperature Value
    T #Temp_External          #Temp_External     -- Temperature - from external OPC UA server

    L #Temp_SetPoint          #Temp_SetPoint     -- SetPoint Temperature Value
    T #SetPoint_External        #SetPoint_External -- Setpoint Temperature - from external OPC UA server

    L #SetPoint_Status         #SetPoint_Status   -- SetPoint Temperature Status
    T #Status_SetPoint         #Status_SetPoint  -- Setpoint Temperature Status - from external OPC UA server

Network 2: Display Current Time: Time Stamp - Value - Status
    L P##Current_TimeStamp
    L D [AR1,P#4.0]
    L B [AR1,P#0.0]
    T #Year                #Year
    L B [AR1,P#1.0]
    T #Month               #Month
    L B [AR1,P#2.0]
    T #Day                 #Day
    L B [AR1,P#3.0]
    T #Hour                #Hour
    L B [AR1,P#4.0]
    T #Minute              #Minute
    L B [AR1,P#5.0]
    T #Second              #Second
    L W [AR1,P#6.0]
    T #ms_weekday          #ms_weekday
    SRW 4
    T #Milliseconds        #Milliseconds
    L #ms_weekday          #ms_weekday
    SLW 12
    SRW 12
    T #Weekday             #Weekday

    L #CurrentTime_Status    #CurrentTime_Status -- Current Time Status
    T #Status_Ex_Server      #Status_Ex_Server  -- Status of external OPC UA server

```

Press F1 to get Help.

Symbol Table

	Status	Symbol	Address	Data type	Comment
1		DI-Value-TimeSt-Status	DB 22	FB 22	Instance Data Block; Value,TimeStamp, Status
2		Value_TimeStamp_Status	FB 22	FB 22	OPC UA Server external; Display: Value, Status,TimeStamp
3		Temperature	MD 10	REAL	Temperature Air Conditioner from external OPC UA server
4		TemperatureSetPoint	MD 14	REAL	Temperature set point Air Conditioner from external OPC UA server
5		Temperature_Status	MD 18	DWORD	Temperature status - from external OPC UA server
6		SetpointTemp_Status	MD 22	DWORD	Setpoint Temperature Status - from external OPC UA server
7		Status_externer_Server	MD 26	DWORD	Status of external OPC UA server
8		Start_OB	OB 1	OB 1	Cyclic OB

Press F1 to get Help.

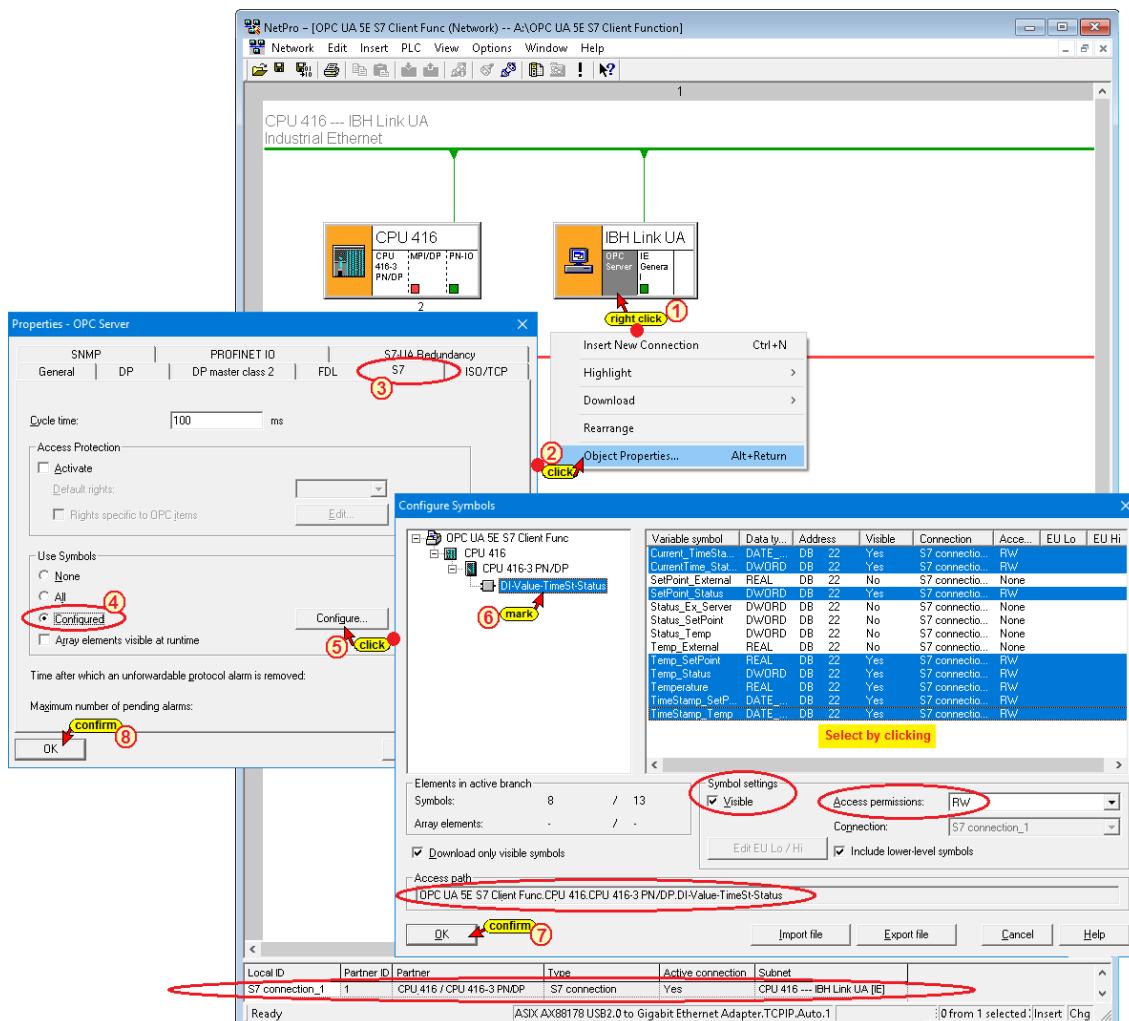
Organization Block OB1 - Segment 2 –

```
LAD/STL/FBD - [OB1 -- "Start_OB" -- OPC UA S7 Client FuncCPU 410/OPC UA 416-3 PN/DP... \OB1]
File Edit Insert PLC Debug View Options Window Help
Call TimeStamp Value = Status = External OPC UA Server

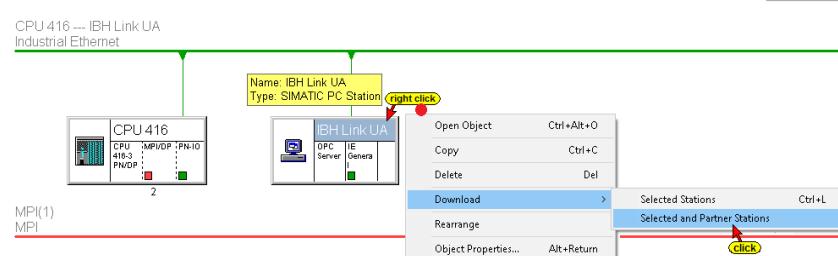
CALL "Value_TimeStamp_Status" :="DI-Value-TimeSt-Status" FB22 -- OPC UA Server external; Display Value, Status, TimeStamp / Instances Data Block; Value,TimeStamp, Status
    Temp_External := "Air_Cond_Temp"
    HD30 -- Temperature Air Conditioner from external OPC UA server via FB22
SetPoint_External := "Air_Cond_SetPoint_Temp"
    HD34 -- Temperature set point Air Conditioner from external OPC UA server via FB22
Status_Temp := "Temperature_Status"
    HD18 -- Temperature status - from external OPC UA server
Status_SetPoint := "Setpoint_Status"
    HD22 -- Setpoint Temperature Status - from external OPC UA server
Status_Ex_Server := "Status_externer_Server"
    HD26 -- Status of external OPC UA server
NOP 0
```

Configure the Network

The variables in the PLC program to receive data from the external OPC UA server are defined in the following ***ScreenShots***.

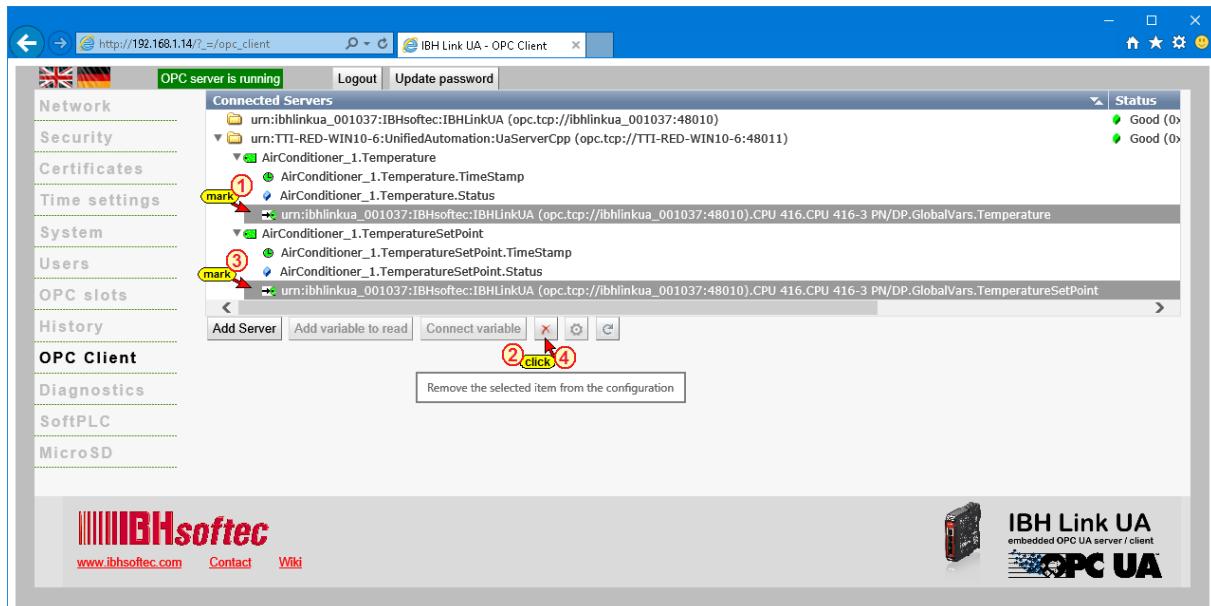


If no errors occur after clicking the **Save and Compile** icon the configuration can be loaded into the IBH Link UA and the CPU-416.

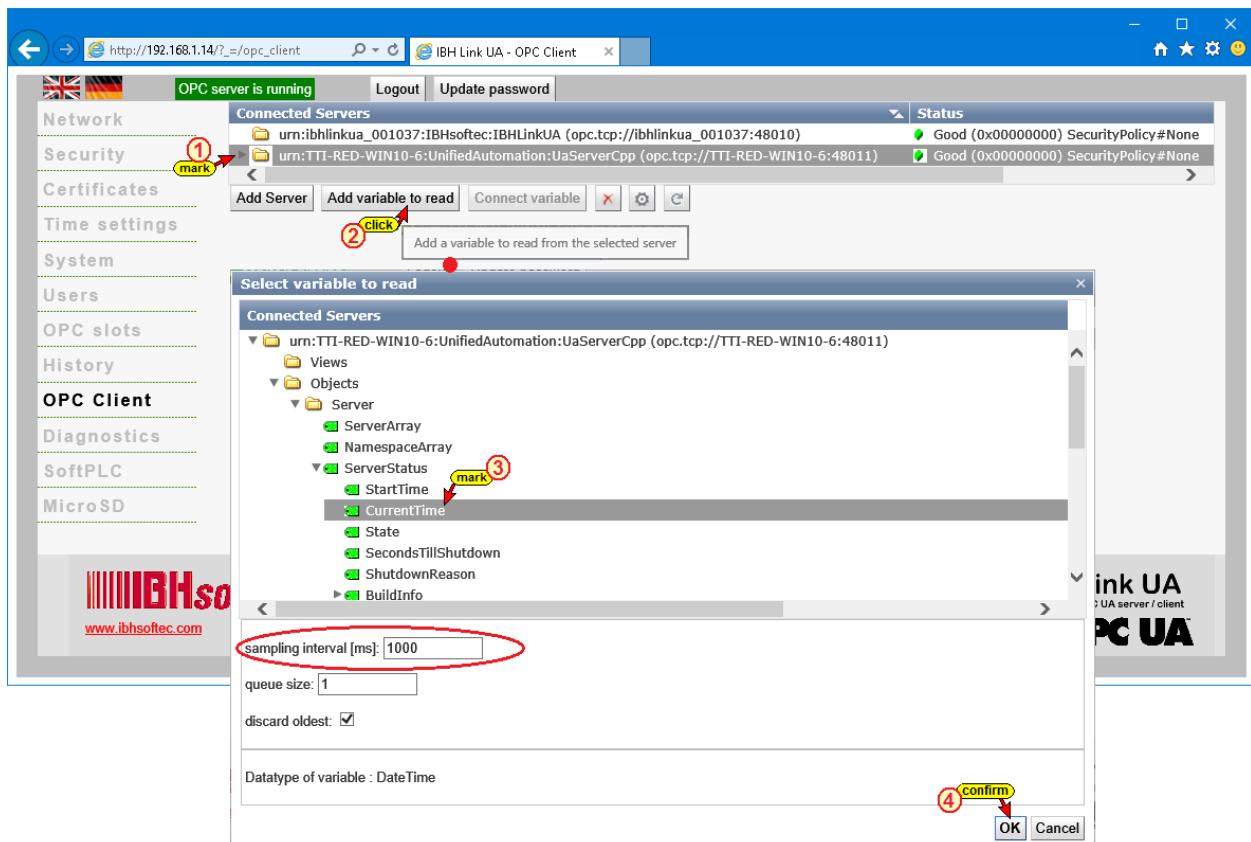


The variables **Temperature** and **TemperatureSetPoint** of the AirConditioner_1, the **OPC Client**, the external **OPC UA Server** and its **ReadVariables** have already been defined in the previous example.

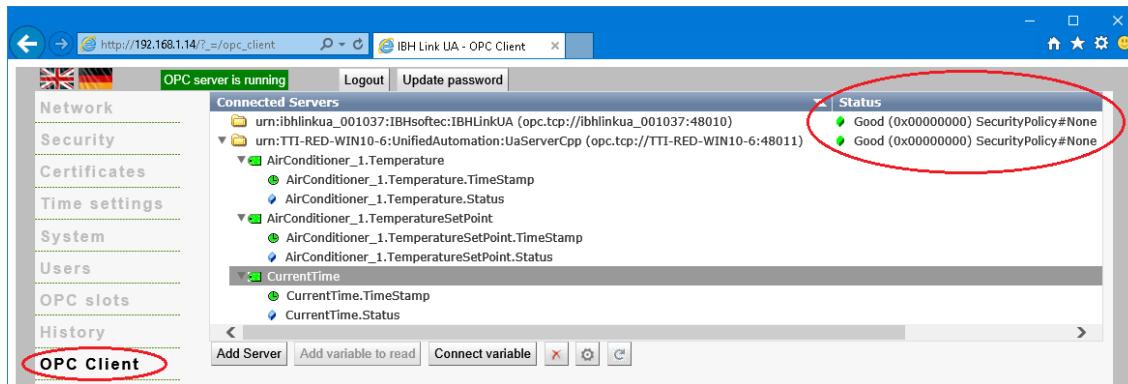
The assignment of the variable value **Temperature** and the value **TemperatureSetPoint** must be cleared.



In addition, **CurrentTime** of the external server must be added as a **Read Variable**.



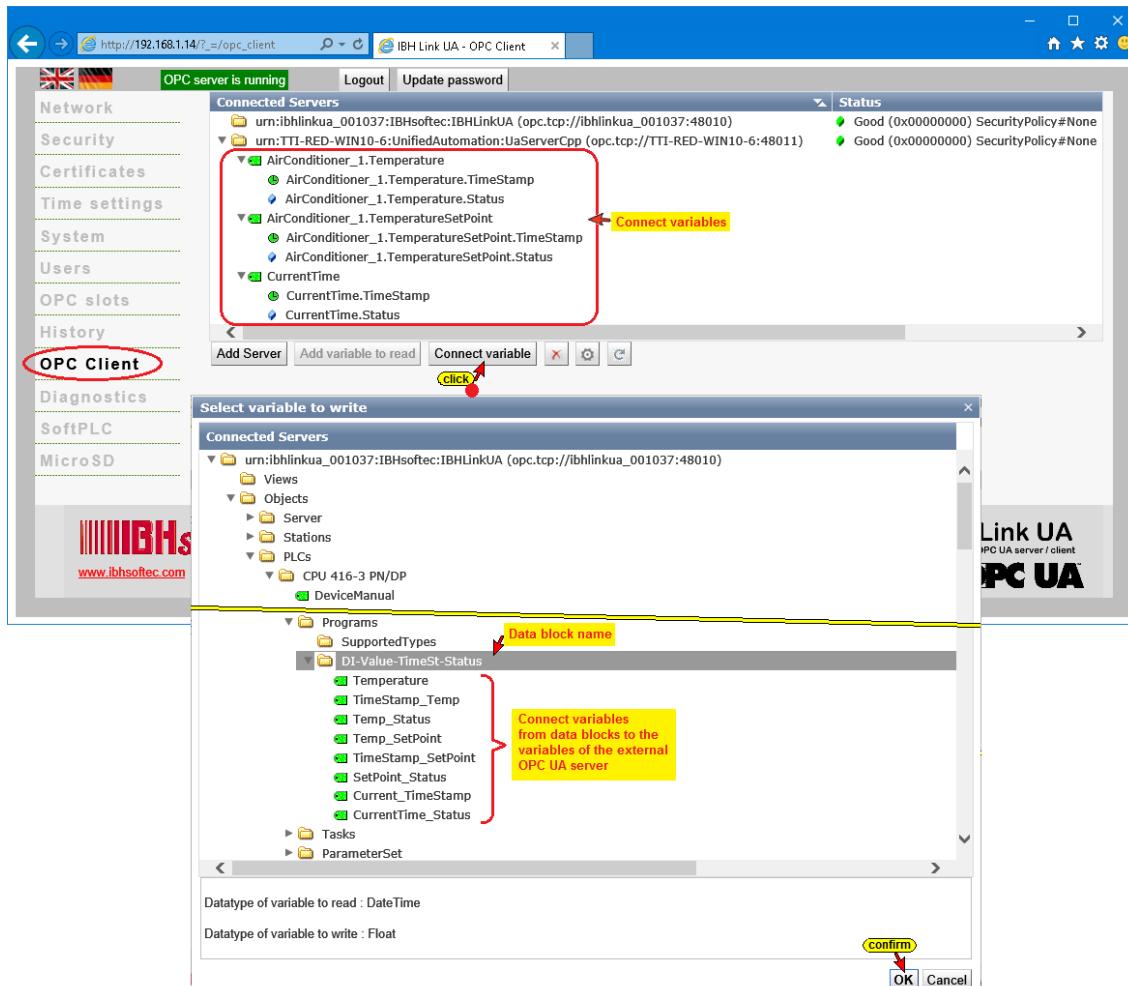
The **Read Variables** of the external OPC UA server selected are displayed.



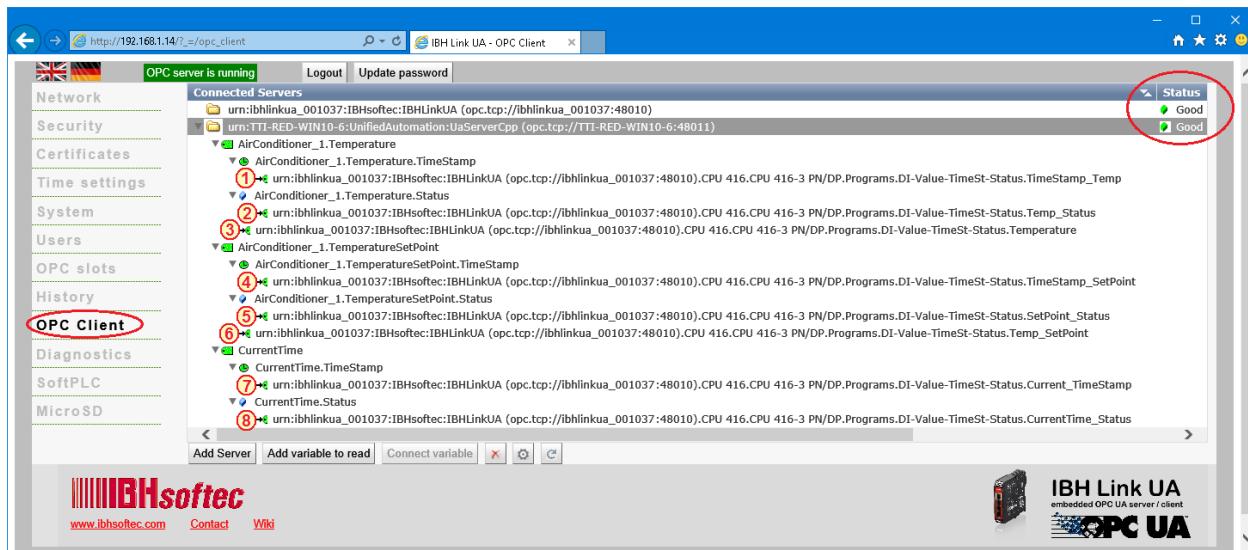
Connecting Variables

The variables **Temperature** and **TemperatureSetPoint** with the corresponding **TimeStamps** and **Status** as well as **CurrentTime** and **CurrentTime.Status**, which have been declared as **Read Variables**, are connected to the IBH Link UA OPC Server and then they are given to the PLC program in the CPU 416.

In the CPU-416 PLC program the variables are defined in a PLC data block (instance data block).

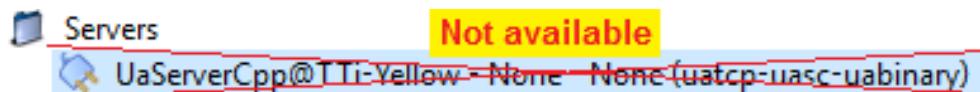


If the eight (8) variables are connected, they are displayed.

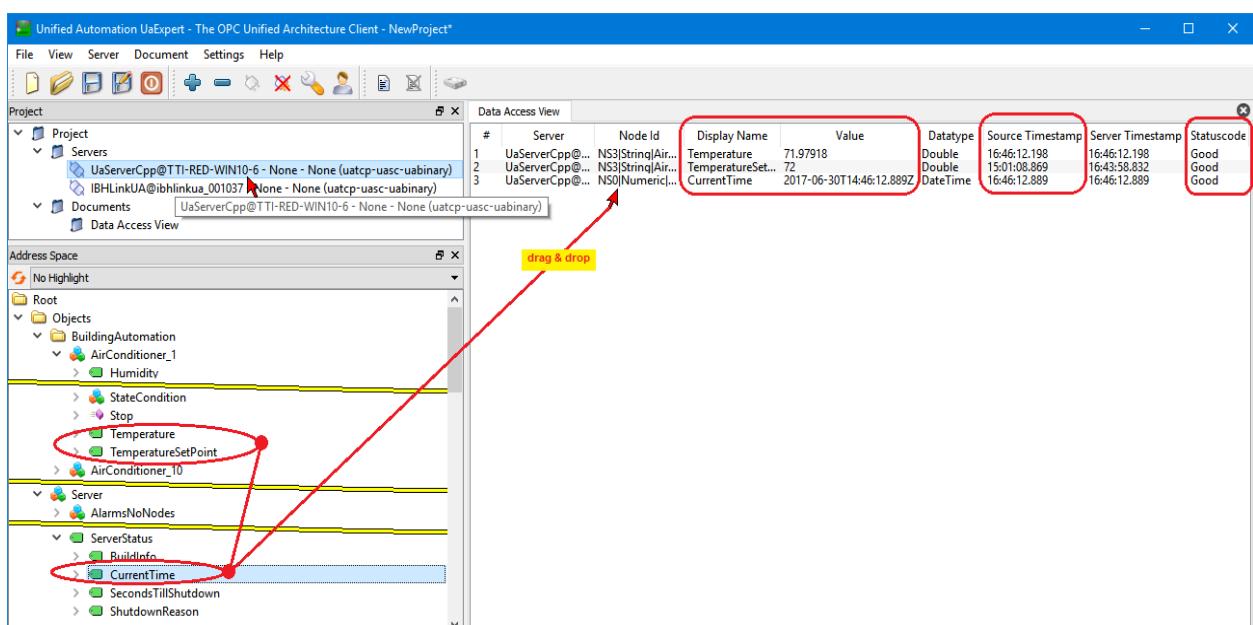


Connection to external OPC server

If the external OPC server is not displayed in the UAExpert program window, the connection must be established (see chapter 5-7 Establishing a connection to the external OPC server).



If the connection exists, **AddressSpace** displays information about the connected external OPC server.



To pull the variables **Temperature** and **TemperatureSetPoint** as well as the external OPC UA server into the **Data Access View** window by using Drag&Drop.

Double-click **TemperatureSetPoint** to modify the value.

PLC program: Air Conditioner/CPU 416-3 PN/DP

The resolved **TimeStamps** of the **Temperature** and the **TemperatureSetPoint** as well as the **Values** and the **Status** are displayed in the program of the CPU 416-3 PN/DP.

Note:

The status of the data block (DBxx; DIxx) does not display variables of the type Date and Time.

The variable must be divided into its components.

Status FB22 - PLC program Air Conditioner/CPU 416-3 PN/DP

```

FB22 : External OPC UA Server - Temperature - SetPoint Temperature
Network 1: Display Temperature: Time Stamp - Value - Status
L P##TimeStamp_Temp
LAR1
L D [ARL,P#4.0]
L B [ARL,P#0.0]
T #Year #Year
L B [ARL,P#1.0]
T #Month #Month
L B [ARL,P#2.0]
T #Day #Day
L B [ARL,P#3.0]
T #Hour #Hour
L B [ARL,P#4.0]
T #Minute #Minute
L B [ARL,P#5.0]
T #Second #Second
L U [ARL,P#6.0]
T #ms_weekday #ms_weekday
SRW 4
T #Milliseconds #Milliseconds
L #ms_weekday #ms_weekday
SLW 12
SRW 12
T #Weekday #Weekday

L #Temp_Status #Temp_Status -- Temperature Status
T #Status_Temp #Status_Temp -- Temperature status - from external OPC UA server

L #Temperature #Temperature -- Temperature Value
T #Temp_External #Temp_External -- Temperature - from external OPC UA server

L #Temp_SetPoint #Temp_SetPoint -- SetPoint Temperature Value
T #SetPoint_External #SetPoint_External -- SetPoint Temperature - from external OPC UA server

L #SetPoint_Status #SetPoint_Status -- SetPoint Temperature Status
T #Status_SetPoint #Status_SetPoint -- SetPoint Temperature Status - from external OPC UA server

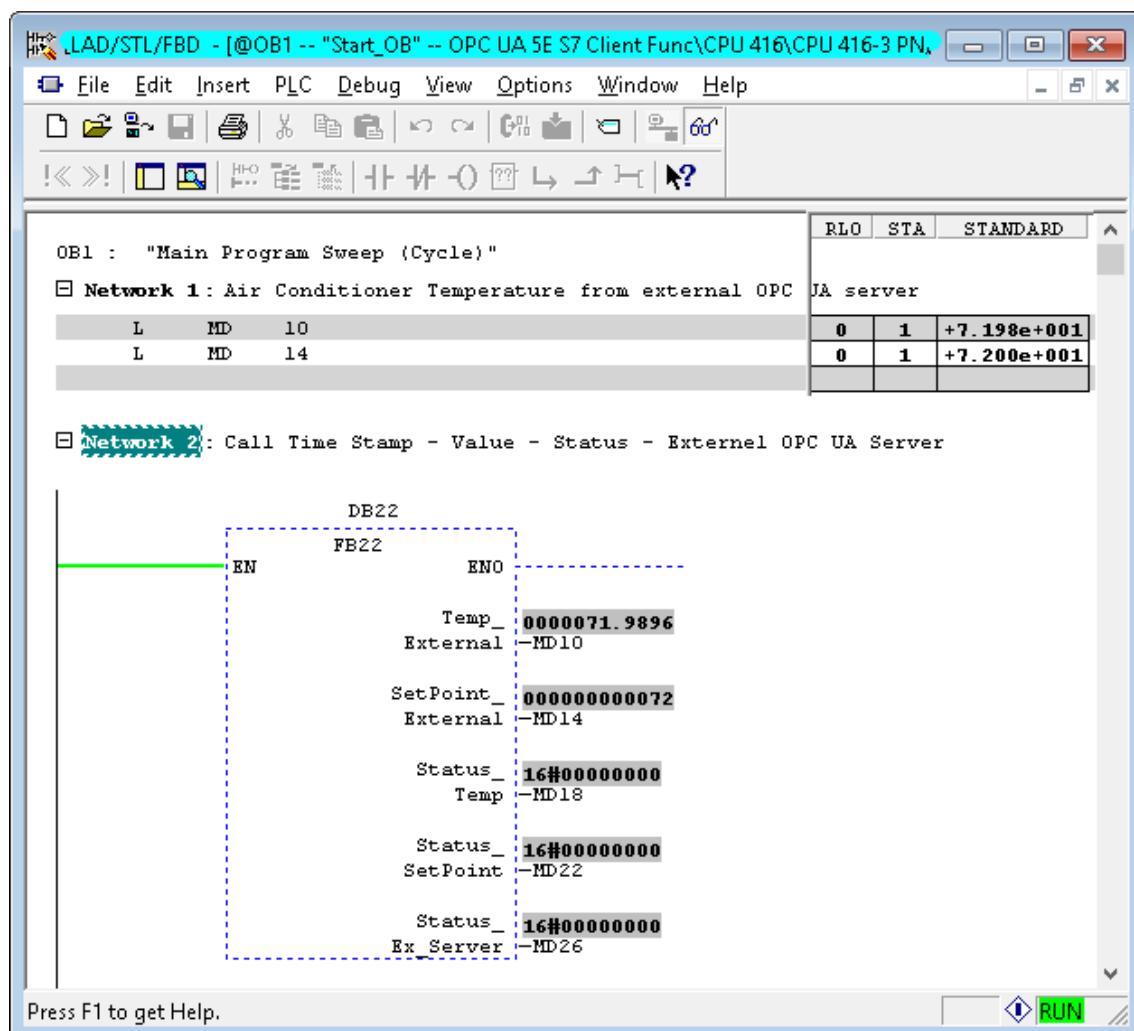
Network 2: Display Current Time: Time Stamp - Value - Status
L P##Current_TimeStamp
L D [ARL,P#4.0]
L B [ARL,P#0.0]
T #Year #Year
L B [ARL,P#1.0]
T #Month #Month
L B [ARL,P#2.0]
T #Day #Day
L B [ARL,P#3.0]
T #Hour #Hour
L B [ARL,P#4.0]
T #Minute #Minute
L B [ARL,P#5.0]
T #Second #Second
L U [ARL,P#6.0]
T #ms_weekday #ms_weekday
SRW 4
T #Milliseconds #Milliseconds
L #ms_weekday #ms_weekday
SLW 12
SRW 12
T #Weekday #Weekday

L #CurrentTime_Status #CurrentTime_Status -- Current Time Status
T #Status_Ex_Server #Status_Ex_Server -- Status of external OPC UA server

```

RLO	STA	STANDARD
0	1	850000c0
0	1	850000c0
0	1	29597296
0	1	17
0	1	17
0	1	6
0	1	6
0	1	30
0	1	30
0	1	15
0	1	15
0	1	29
0	1	29
0	1	59
0	1	59
0	1	7296
0	1	7296
0	1	729
0	1	729
0	1	6000
0	1	6
0	1	6
0	1	0
0	1	0
		+7.199e+001
0	1	428ff557
0	1	428ff557
		+7.200e+001
0	1	42900000
0	1	42900000
0	1	0
0	1	0
0	1	850001a0
0	1	31412026
0	1	17
0	1	17
0	1	6
0	1	6
0	1	30
0	1	30
0	1	15
0	1	15
0	1	31
0	1	31
0	1	41
0	1	41
0	1	2026
0	1	2026
0	1	202
0	1	2026
0	1	6000
0	1	6
0	1	6
0	1	0
0	1	0

Status OB1 - PLC program Air Conditioner /CPU 416-3 PN/DP



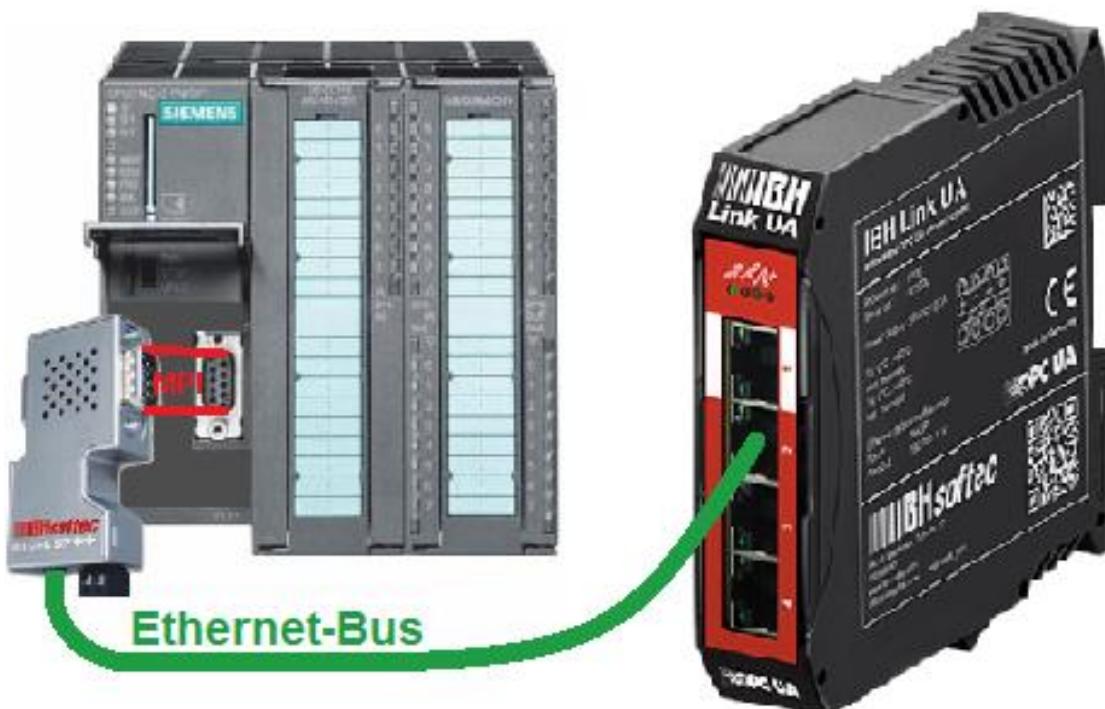
6 IBH Link UA - TIA Portal connecting a CPU 312

The following example shows the creation of a project with the TIA Portal connecting a **CPU 312 (6ES7 312-1AE13-0AB0)** with the **IBH Link UA** using as an Ethernet connection the **IBH Link S7++**.

IBH Link S7++

The IBH Link S7++ is an Ethernet converter. The protocol used is the usual standard TCP/IP. All the advantages of Ethernet are thus without any problems to the user.

The use of SimaticNet as well as the use of CP communication processors are neither necessary on the PC nor on the PLC side.



PLC Project: OPC UA 6E TIA 15 S7-300-400

Example: Tank Level

The prepared sample project **OPC UA 6E TIA 15 S7-300-400** (PLC Program **Connect S7-300**), is identical with the program tank level, as described in 3.3.2.



PLC Program **Connect-CPU 312** simulates the filling and emptying of a tank.

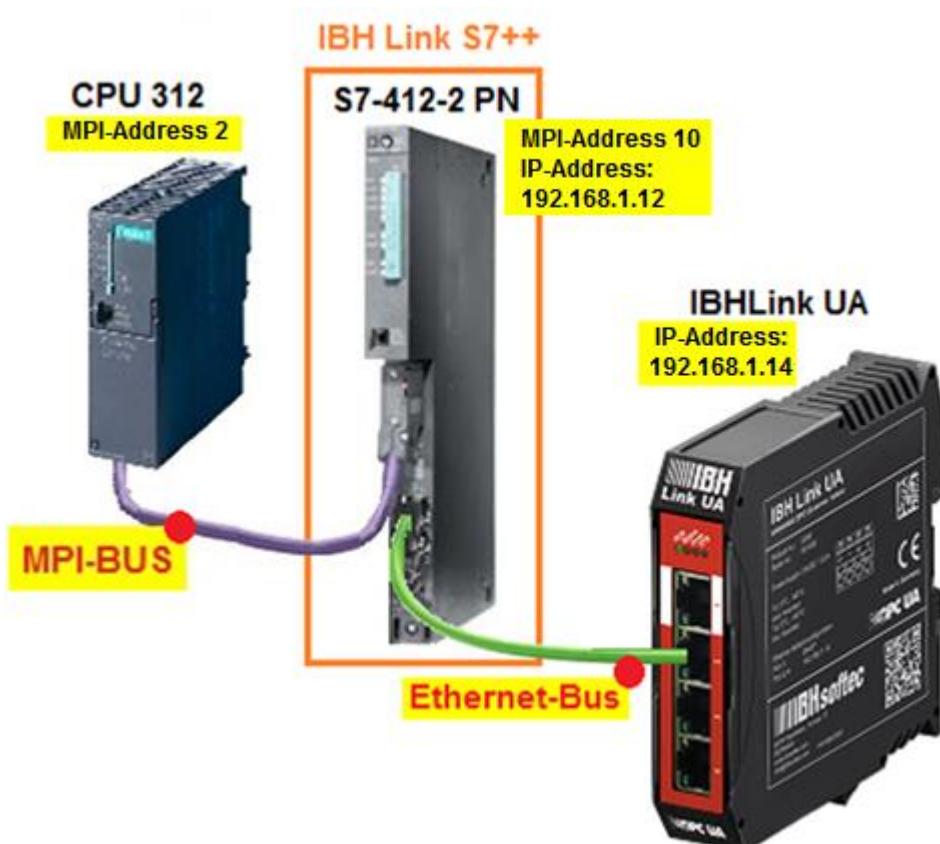
The SIEMENS PLC programming systems TIA Portal V13, V14 or V15 are used to create the network configuration.

IBH Link UA configuration with the TIA Portal

S7-300 and S7-400 Controllers not having an Ethernet connection cannot be connected directly to the IBH Link UA. To establish an Ethernet connection an IBH Link S7++ or an IBH Link S7++ HS may be used.

The routing mode must be activated in the IBH Link S7++. This mode is available from firmware version 2.142 up. In this mode, no unconfigured connections are possible via RFC1006!

Connections via the **IBHNet** driver continue to work.



Note:

The S7-412-2 PN CPU provides the **Routing** service.

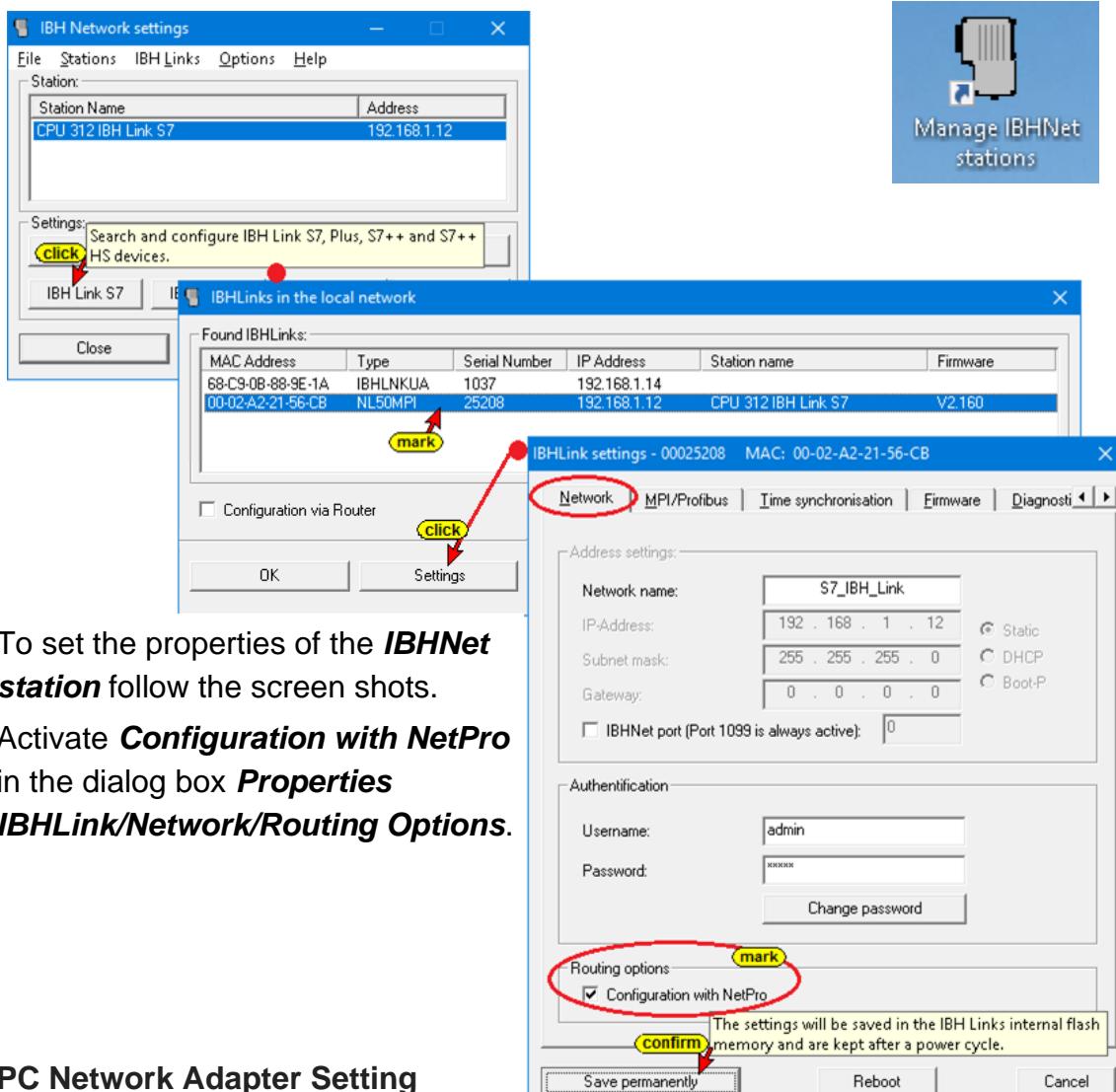
This CPU available in the hardware catalog of the TIA Portal and Step 7 (Simatic Managers).

The firmware of the IBH Link S7++ emulates the routing capabilities of the **CPU S7-412-2 PN (6ES7 412-2EK06-0AB0 V6.0)**.

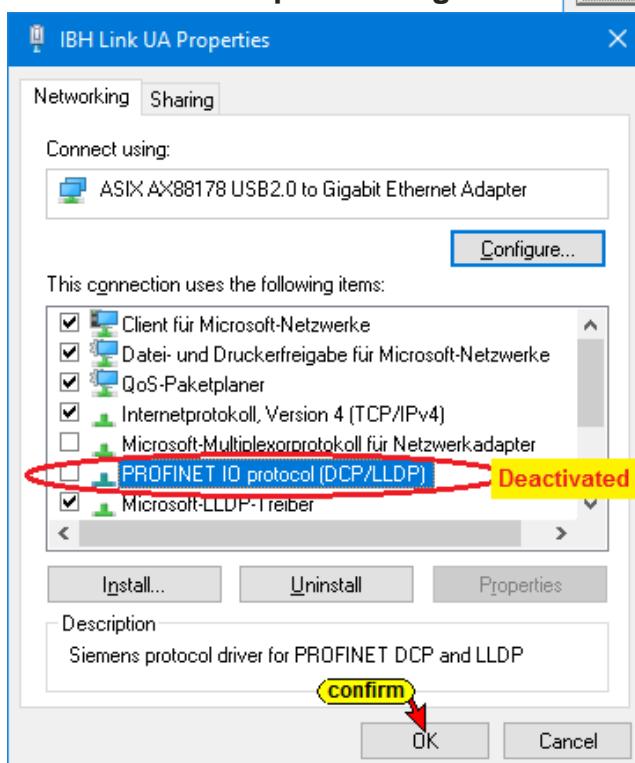
The following properties are available (compatible with the CPU S7-412-2 PN):

Interfaces / Bus	Protocols
1x MPI/PROFIBUS DP	MPI/PROFIBUS
1x PROFINET (1 Port)	ISO-on-TCP (RFC1006)

Configuration of the IBH Link S7++



PC Network Adapter Setting



The connection from the PC or IBH Link UA to the IBH Link S7++ is made via Ethernet.

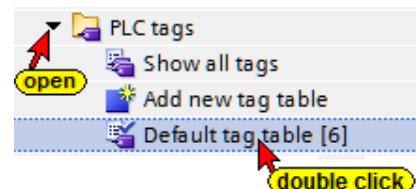
To ensure that no device search can be performed via the **PROFINET DCP** protocol, this must be deactivated in the PC.

6.1 TIA Example: IBH Link UA S7-312 routed via IBH Link S7++

The PLC Program **Connect S7-300** (Project OPC UA 6E TIA 15 S7-300-400) simulates the filling and emptying of a tank with the following characteristics:

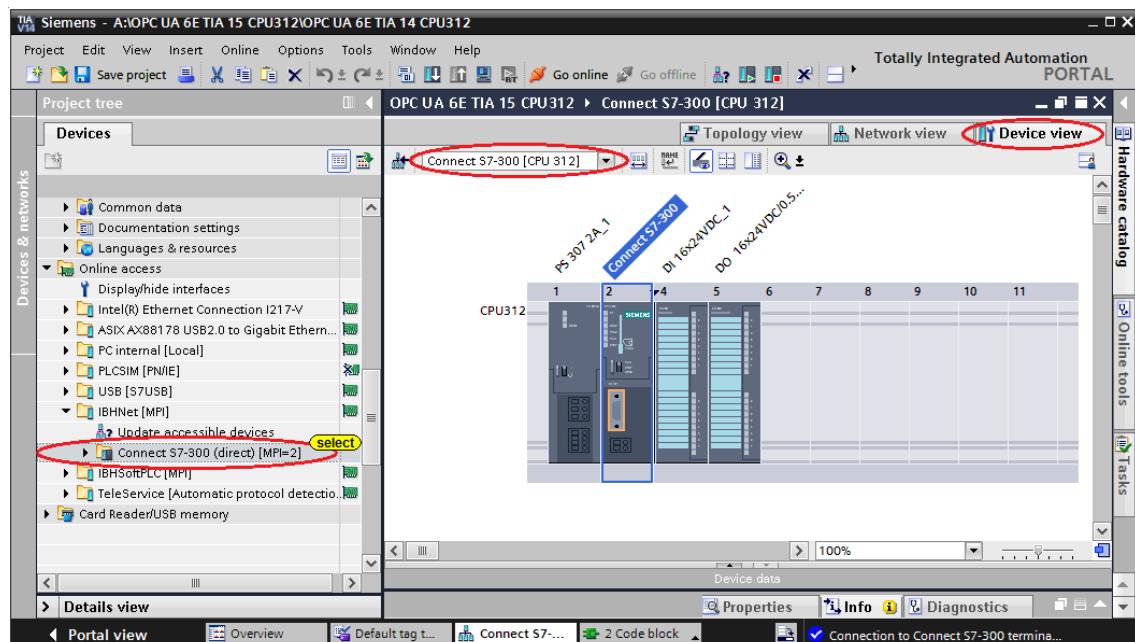
The tank is filled up to reach a **Max_value** (Tank filled more than 90%) and is emptied to reach **Min_value** (Tank filled less than 10%). The filling and emptying are controlled via an **Down** (Output valve) and **Up** (Input valve). The variable **Value** (Tank level value) delivers an integer number to the CPU. The variables **Max** and **Min** are only used internally.

The PLC tags listed in the **Default tag table** and the data defined in the Data Block **DB2** (Tank_level_values) will be routed via the **IBH Link S7++** to the OPC-Server **IBH Link UA**.



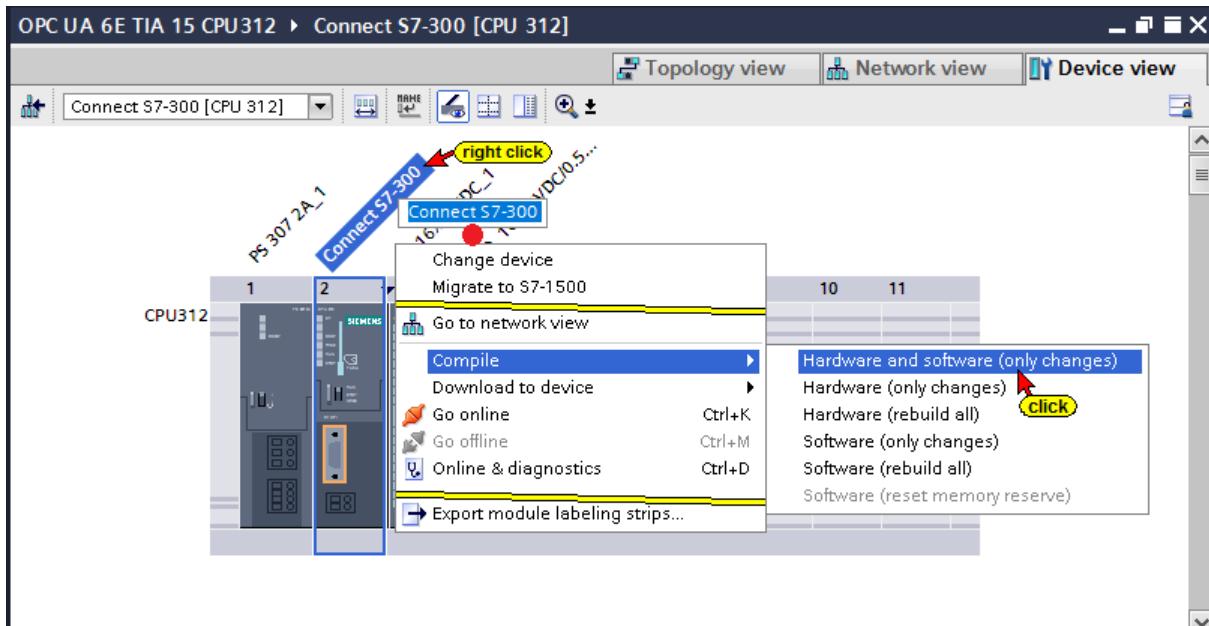
	Name	Data type	Address	Comment
1	On	Bool	%I0.0	Control ON
2	Down	Bool	%Q2.5	Output valve
3	Up	Bool	%Q2.6	Input valve
4	Max	Bool	%M1.2	Maximum reached
5	Min	Bool	%M1.3	Minimum reached
6	Value	Int	%MW2	Tank level value

Online Access to the PLC (MPI = 2)

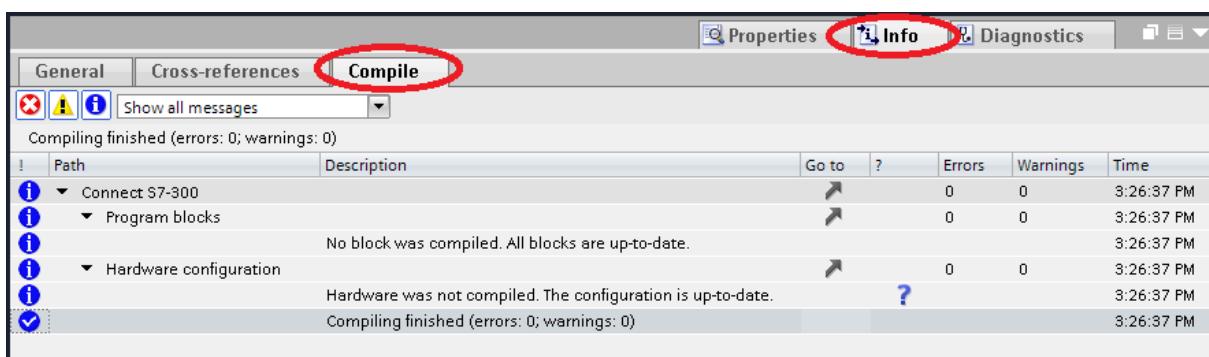


Compiling the Hardware and Software

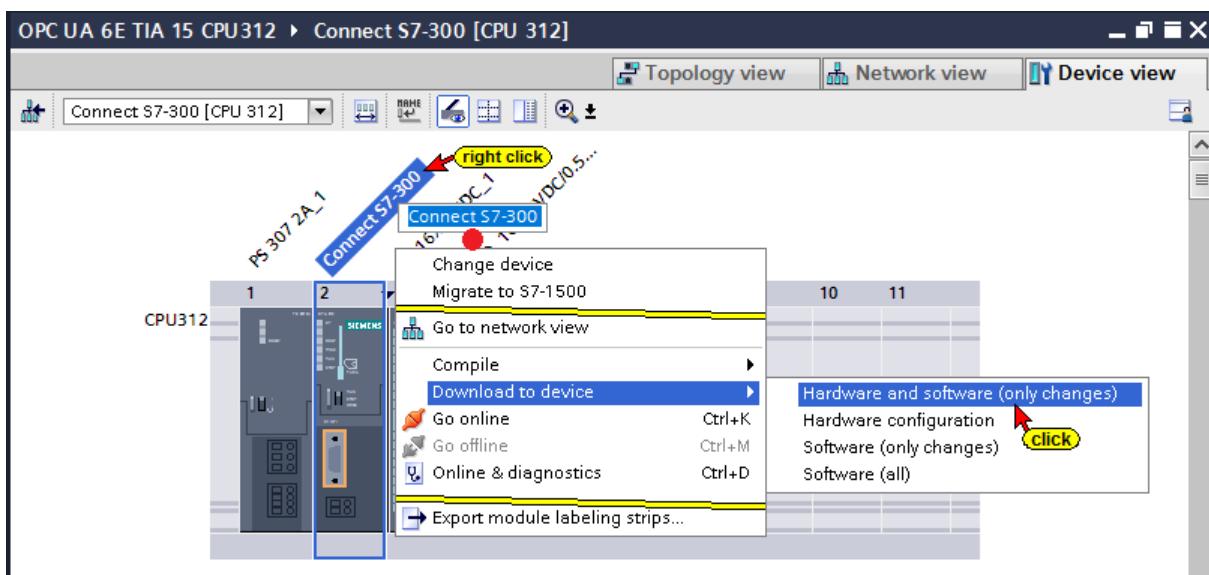
To ensure that the programmed PLC blocks are without any fault and the CPU configuration is correct, the hardware and the software should be compiled prior loading the blocks into the PLC.



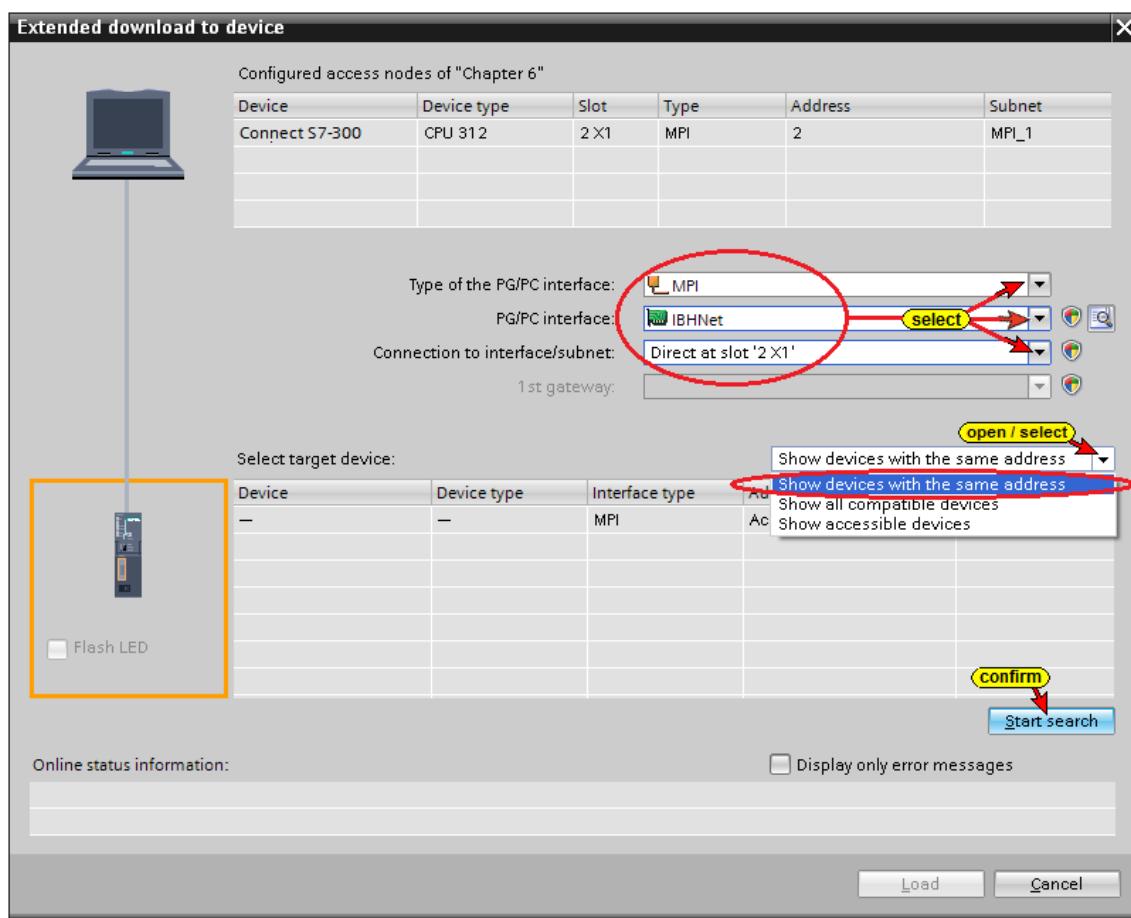
The hardware and the software have been compiled without any error



Load PLC Program Blocks and Device Configuration in CPU 312

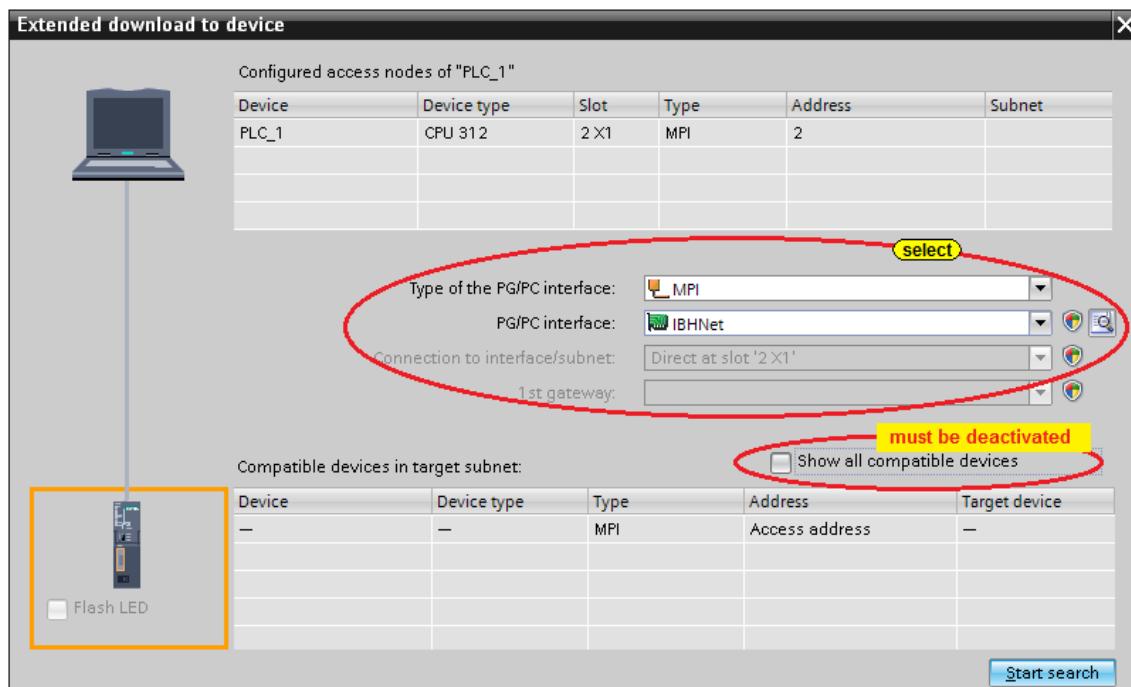


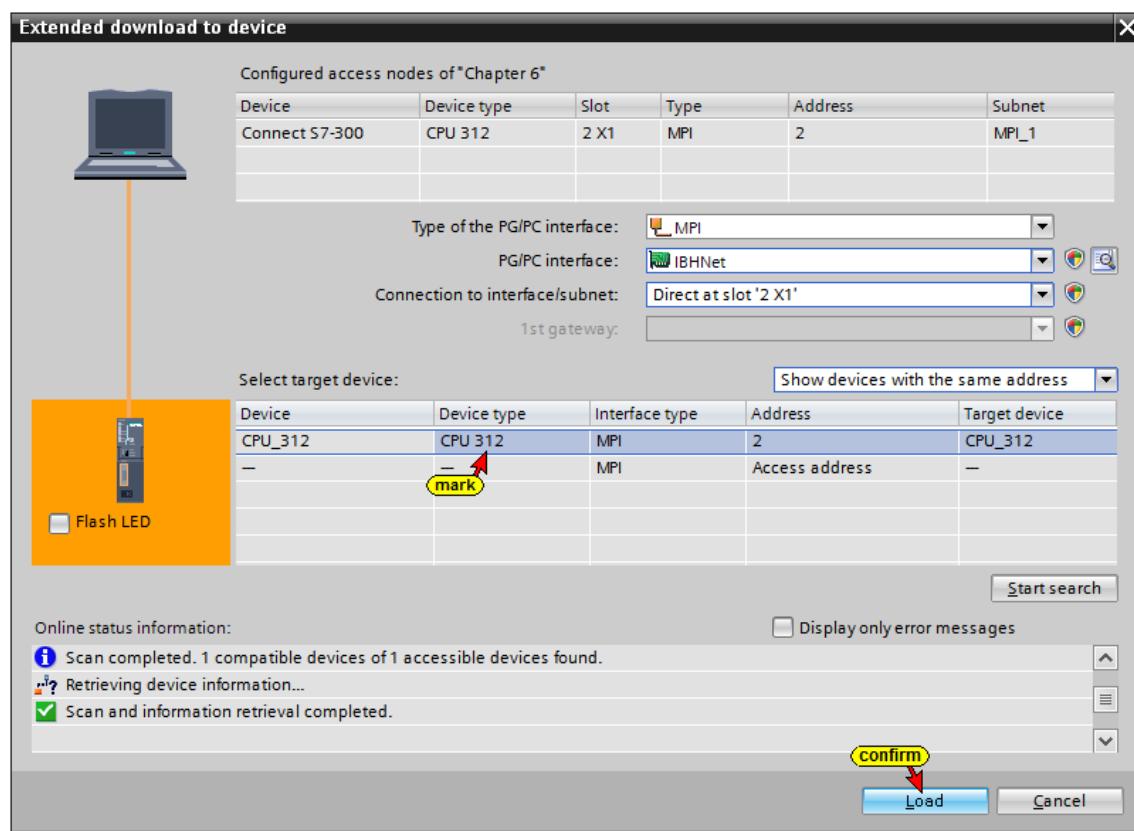
Advanced Upload dialog box



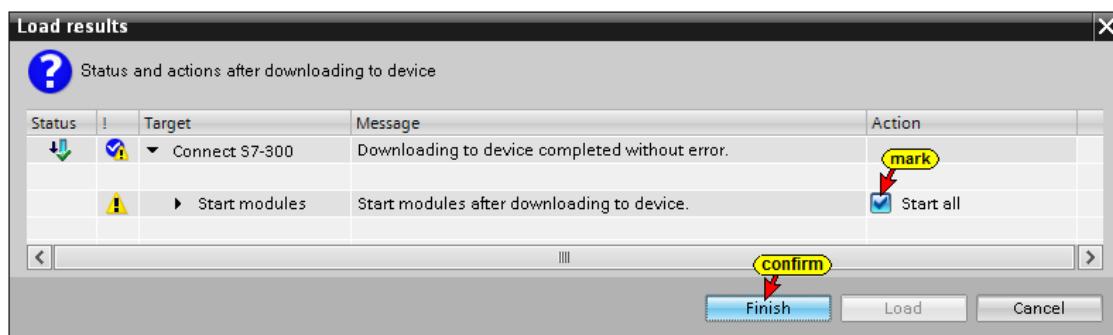
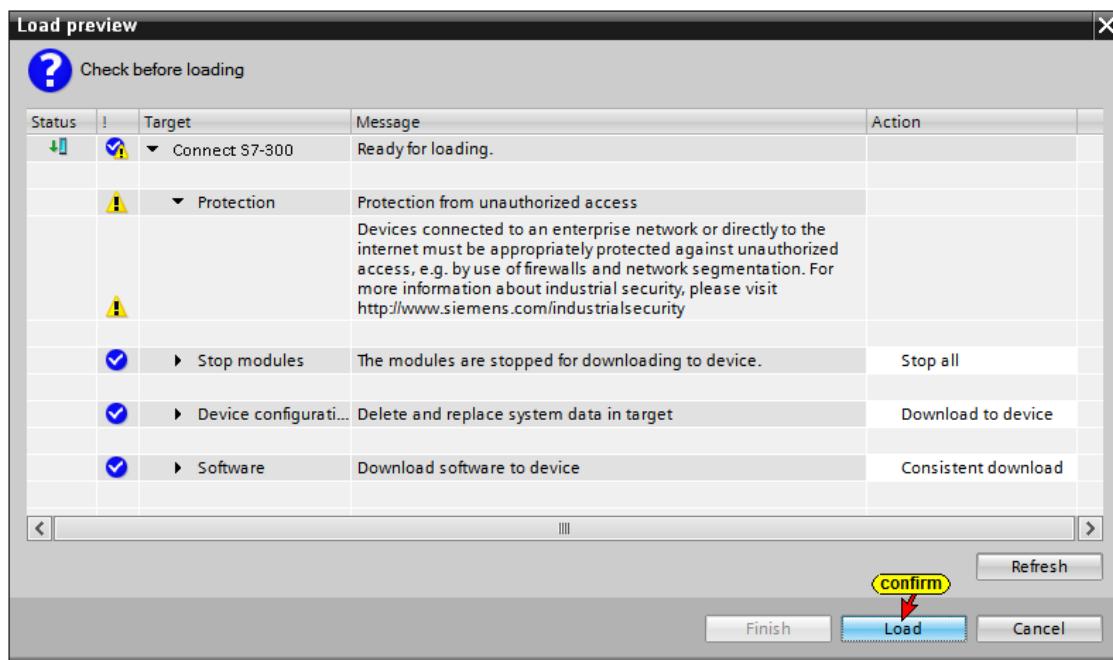
Note TIA 13

In the TIA 13 portal, in the Advanced Loading dialog box, the **Show all compatible devices** option must be deactivated. Otherwise the TIA Portal would search for devices via PROFINET DCP but could not find any PROFINET devices.





A preview of the loading process is displayed.



The filling and the emptying of the tank can be checked online.

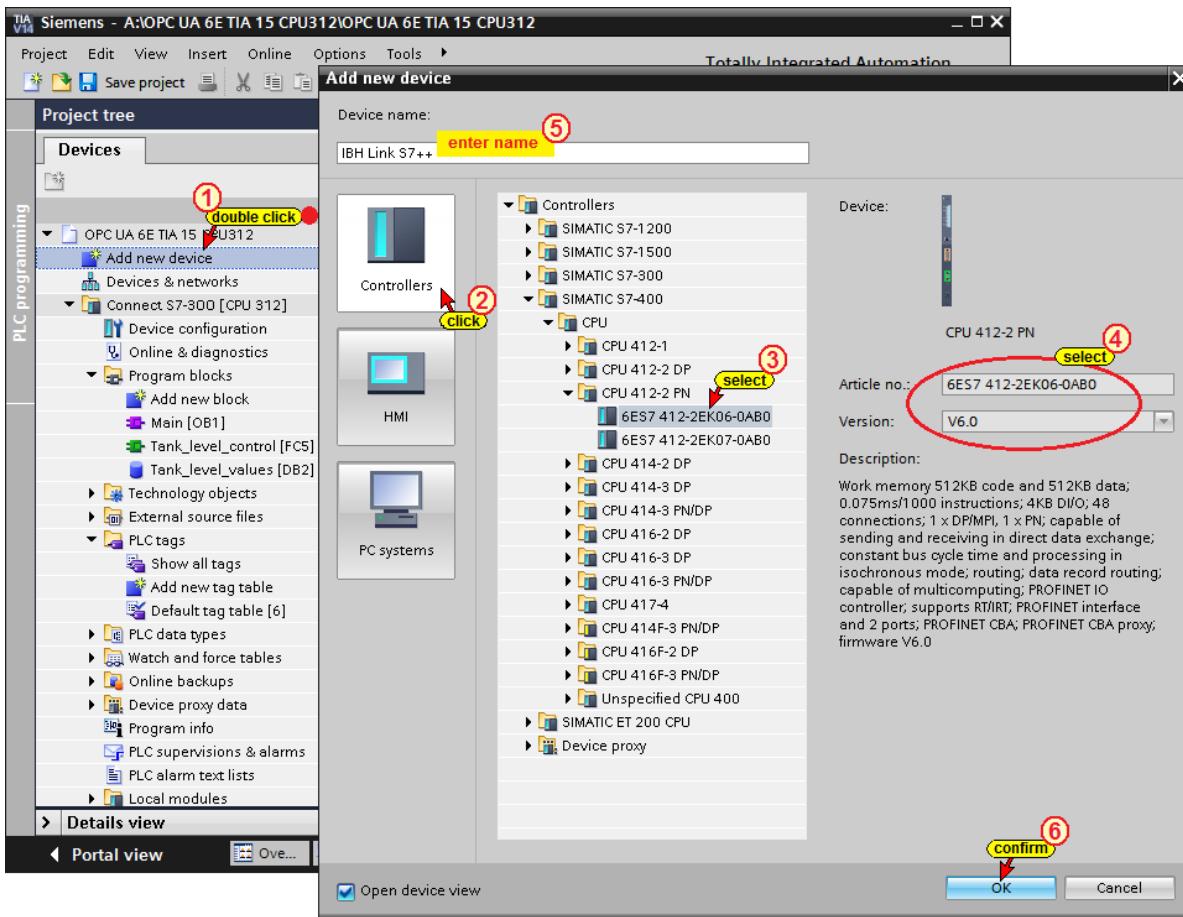
	Name	Data type	Offset	Start value	Monitor value	Comment
1	Static					
2	Min_value	Int	0.0	100	100	Tank filled less than 10%
3	Max_value	Int	2.0	10000	10000	Tank filled more than 90%
4	Dummy	Int	4.0	0	0	Dummy
5	Tank_level	Int	6.0	0	327	Tank level value

6.2 Inserting the IBH Link S7++ as CPU 412-2 PN into the project

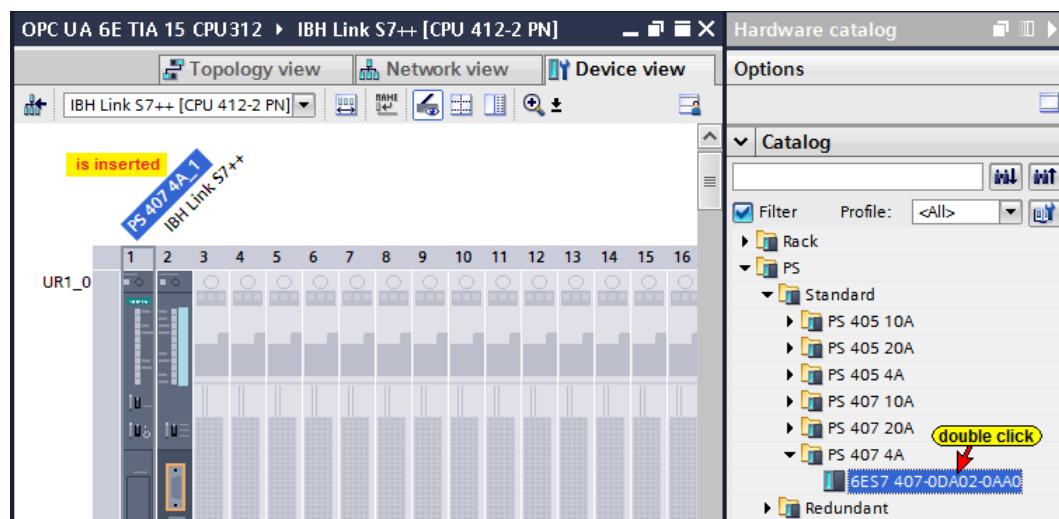
The IBH Link S7++ is created in the TIA Portal as an S7-400 station and connected to the corresponding bus system (MPI or PROFIBUS).

The following module must be used as a substitute for the IBH Link S7++:

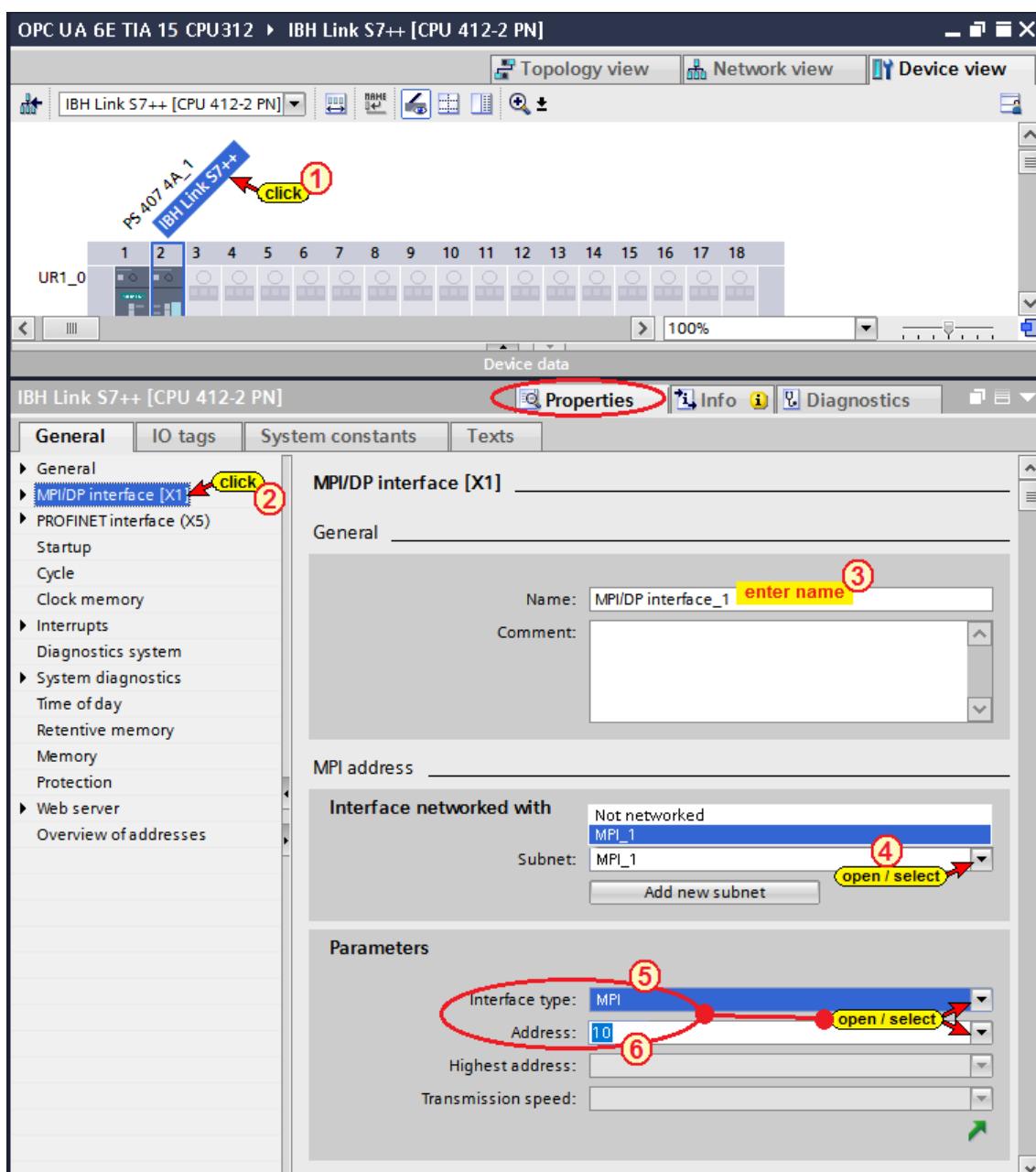
- MLFB: **6ES7 412-2EK06-0AB0 V6.0** in rack 0, slot 2



Insert the power supply in IBH Link S7++

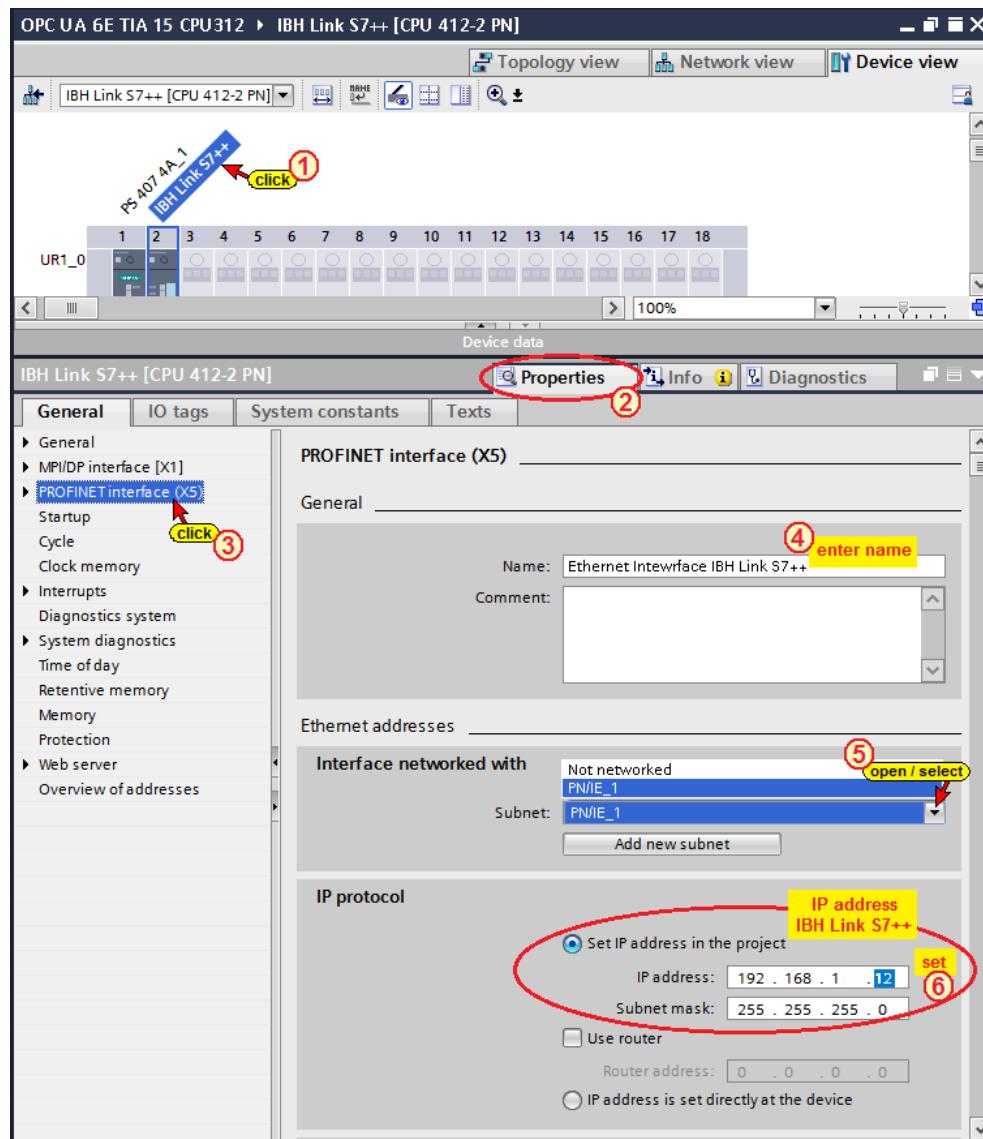


MPI interface of the CPU 412 (MPI interface IBH Link S7++)



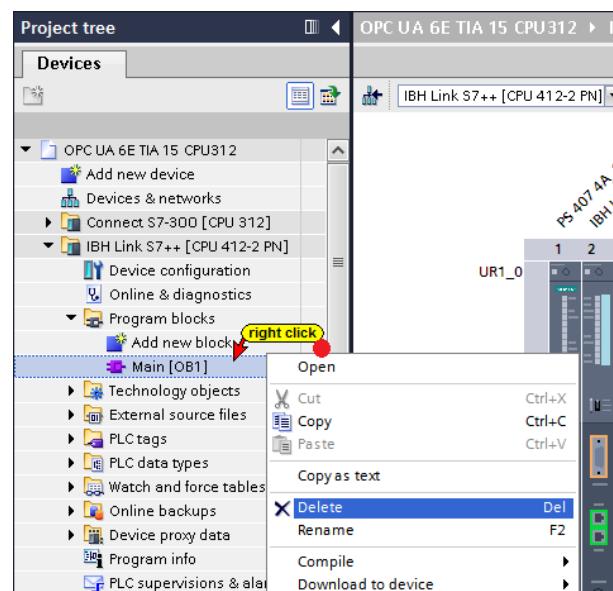
Ethernet interface of the CPU 412

Ethernet Interface IBH Link S7++ to IBH Link UA



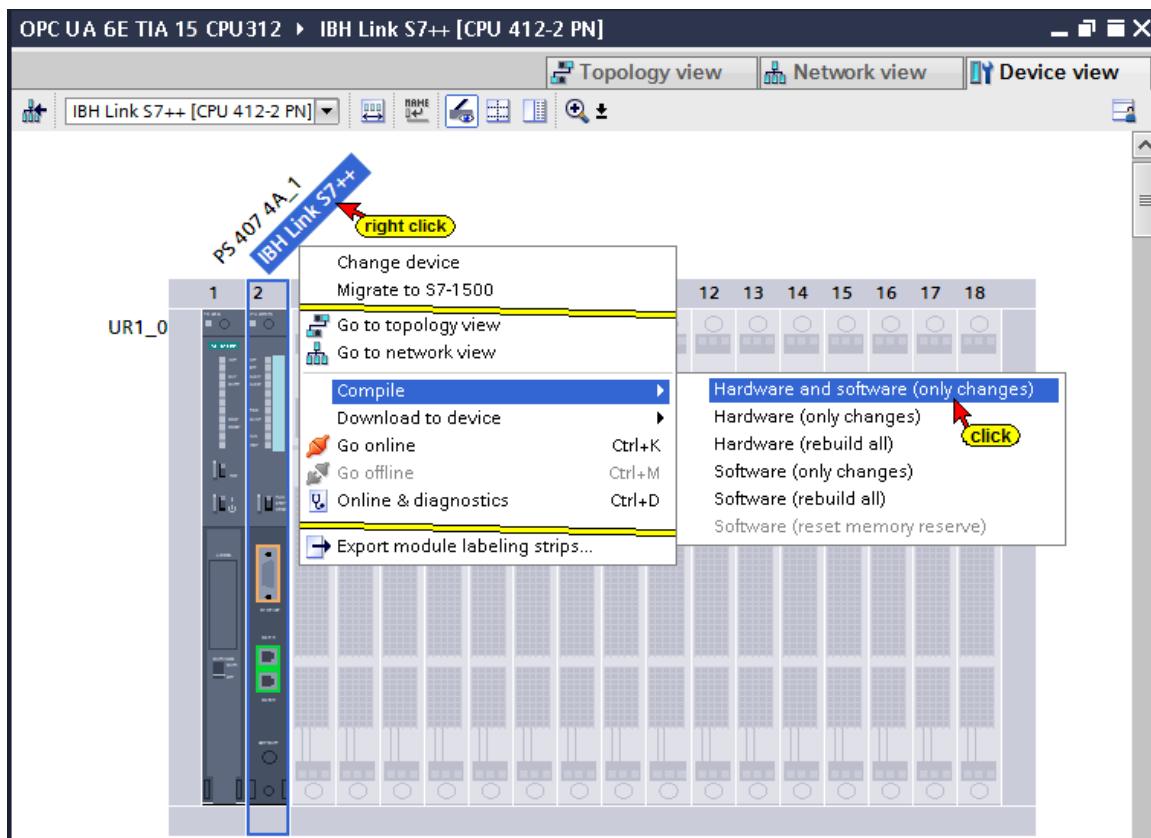
Deleting blocks (IBH Link S7++ / CPU 412)

No PLC blocks can be loaded into the IBH Link S7++. Therefore, in the offline mode all PLC blocks of the IBH Link S7++ / CPU412 must be deleted.

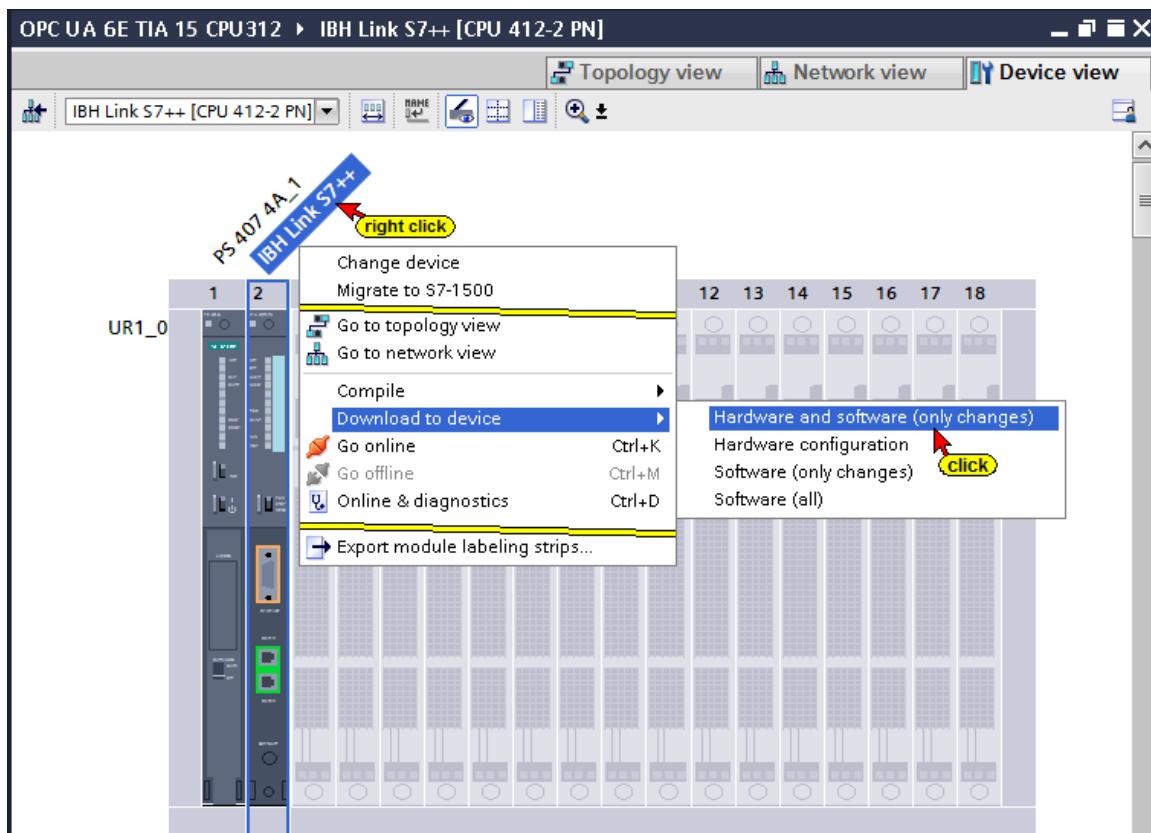


Hardware and software (IBH Link S7++ / CPU 412)

The hardware configuration and the software must be compiled prior loading into the device.

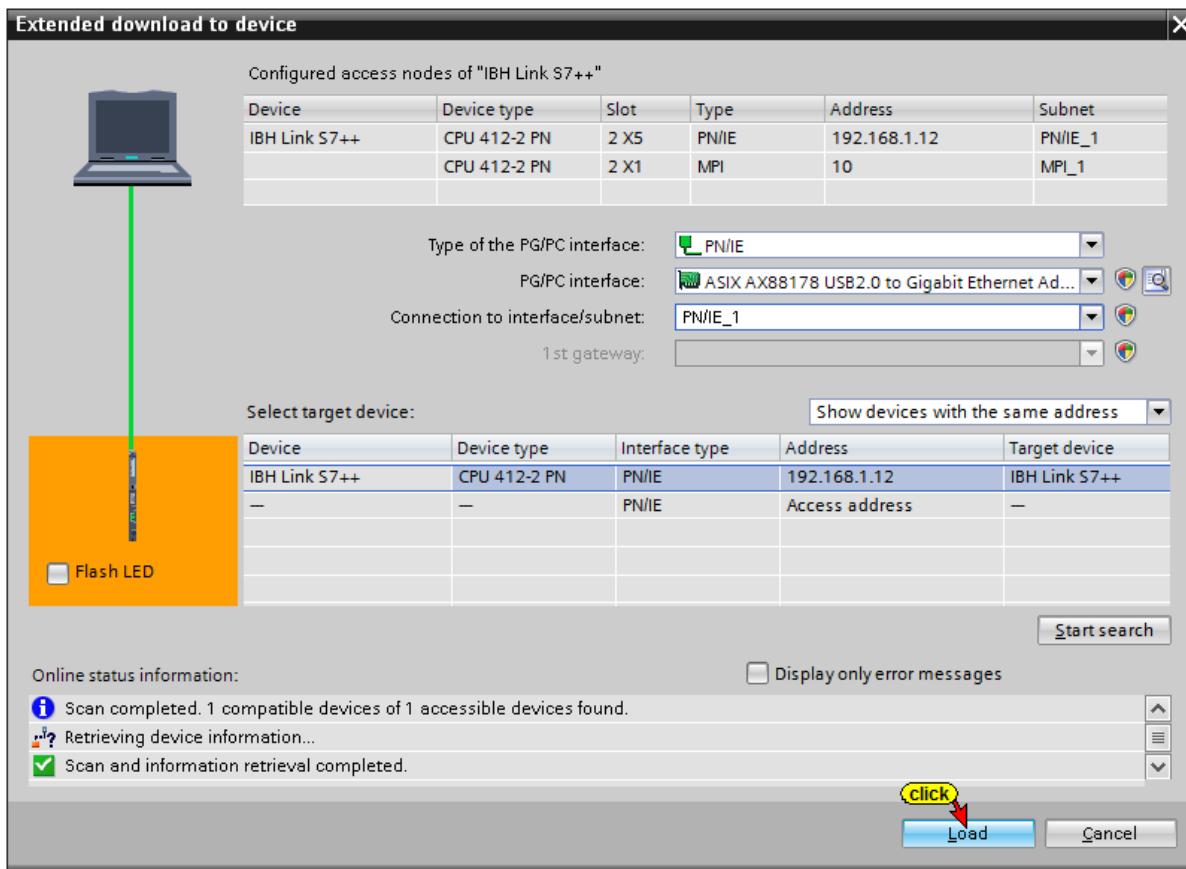
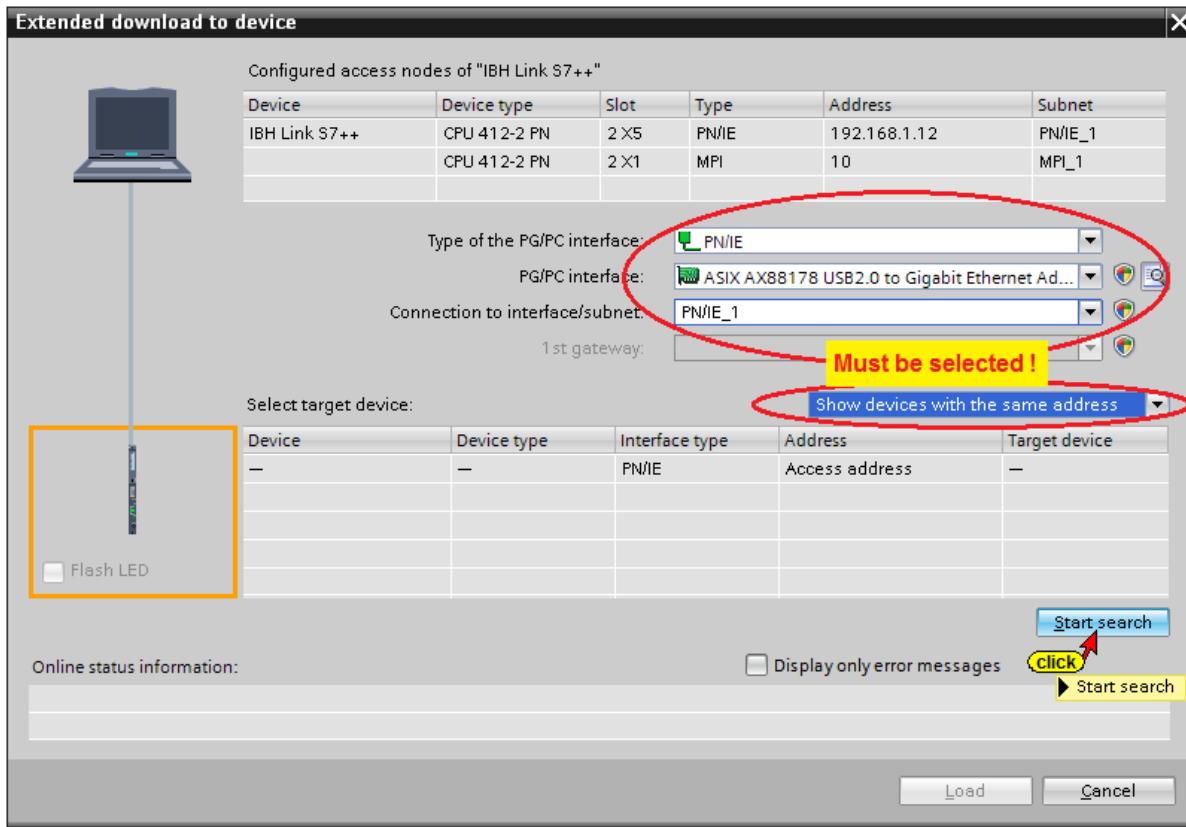


Download hardware to the device (IBH Link S7++ / CPU 412)

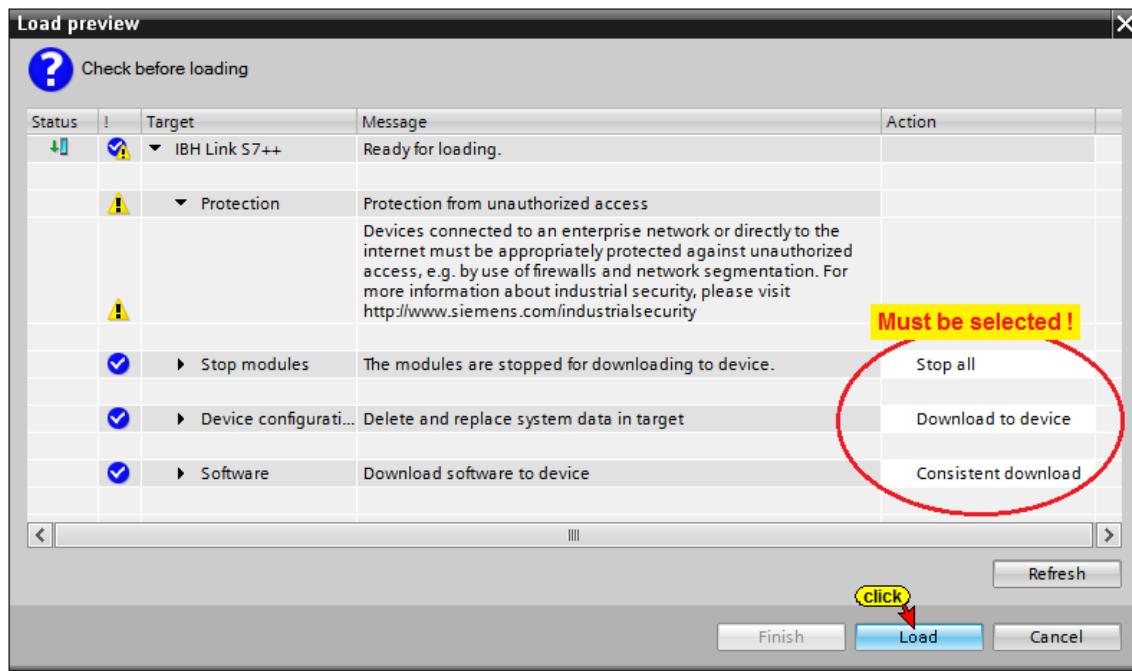


Loading the hardware configuration into the device (IBH Link S7++ / CPU 412)

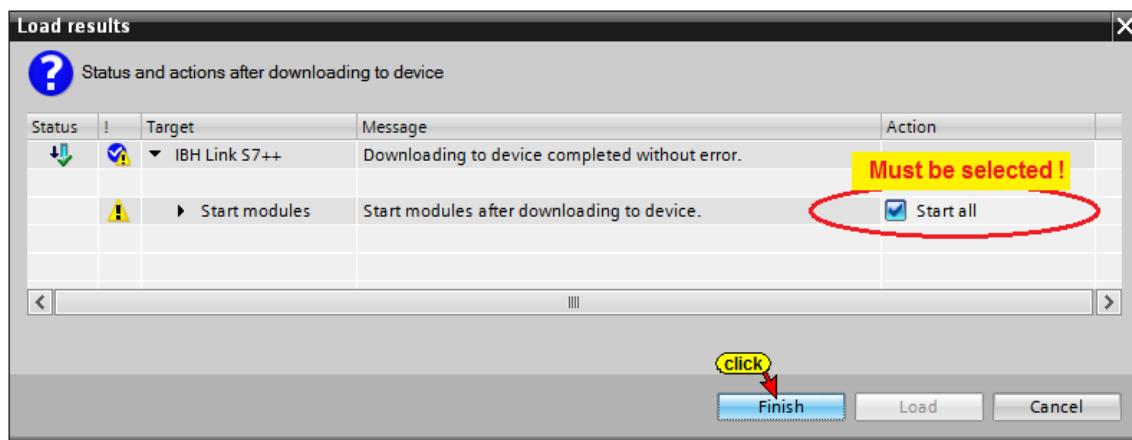
The settings are to be made in the dialog box according the screen shots



Several dialog boxes are opened to display the steps of loading.

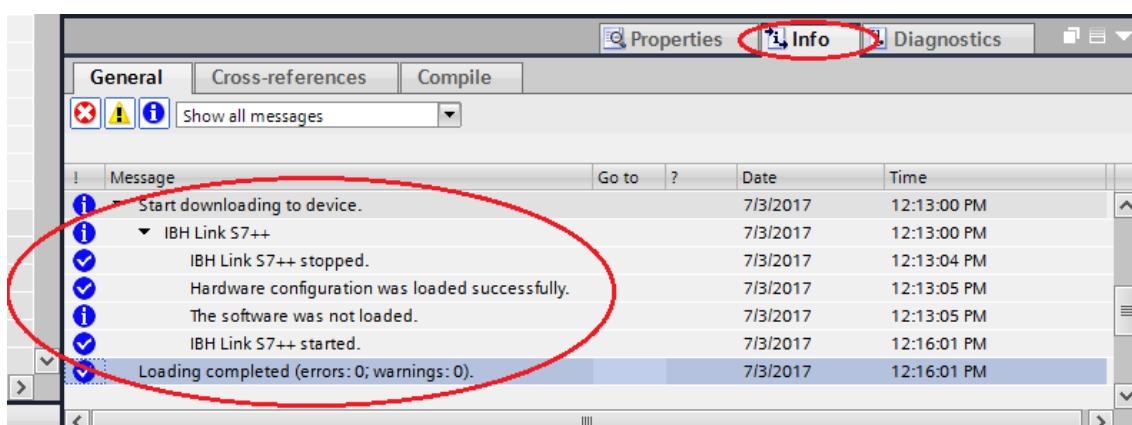


The loading of the hardware configuration is completed.



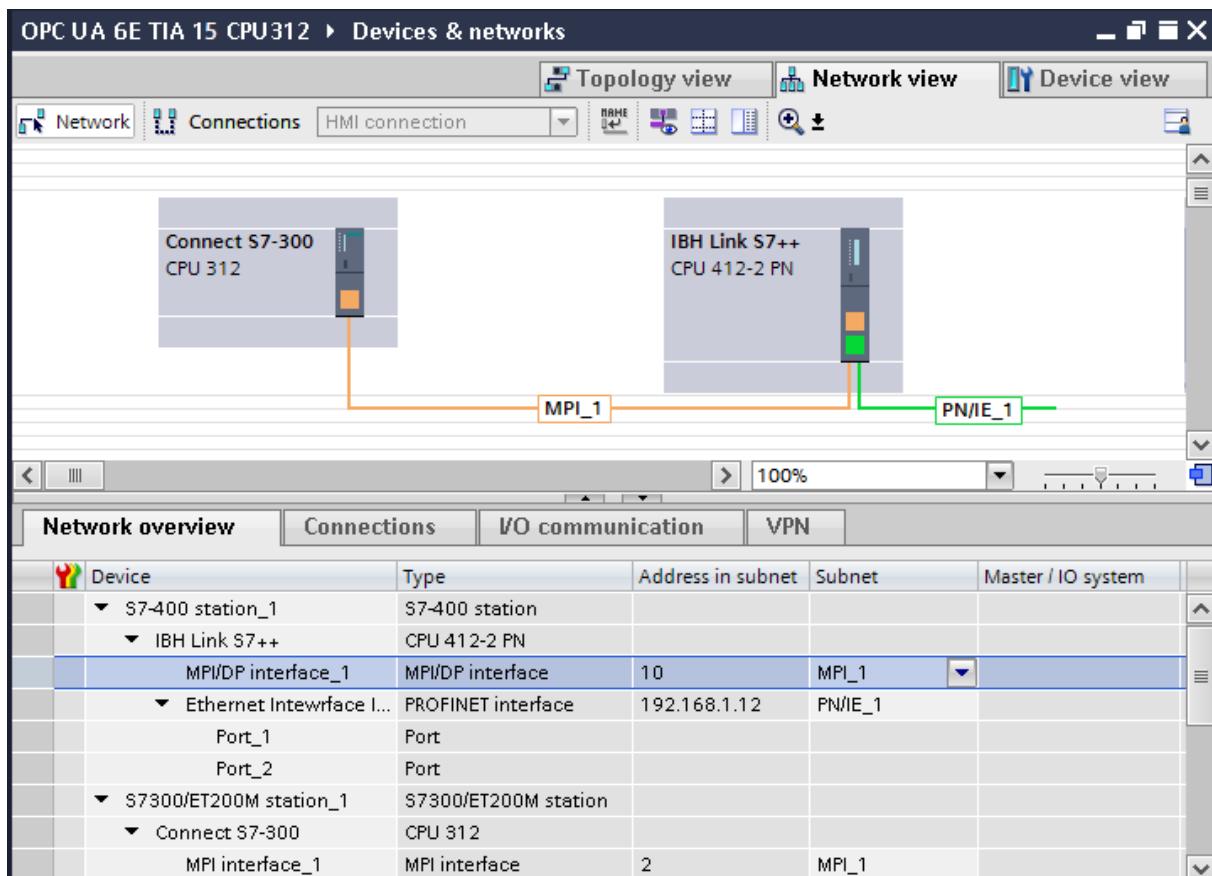
The stopped device (IBH Link S7++) is restarted after loading the hardware configuration.

Successful load of the hardware configuration into the IBH Link S7++ (CPU 412-2 PN) is displayed.



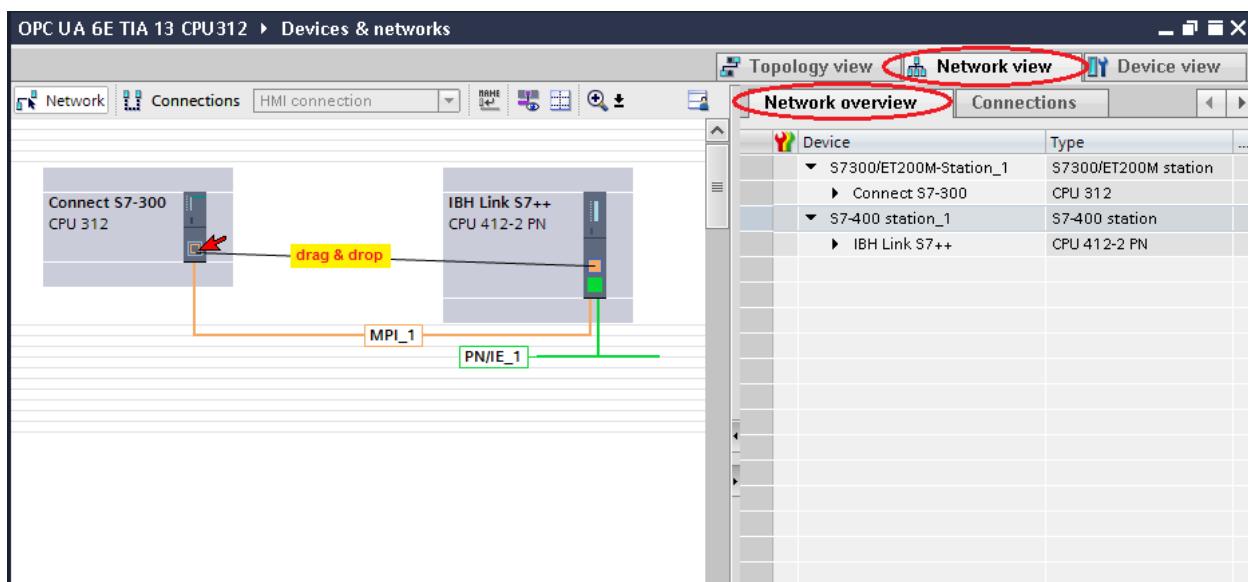
6.3 Creating an MPI connection between PC_1 (CPU 312) and IBH Link S7++ (CPU 412-2 PN)

The MPI connection is automatically created and displayed.



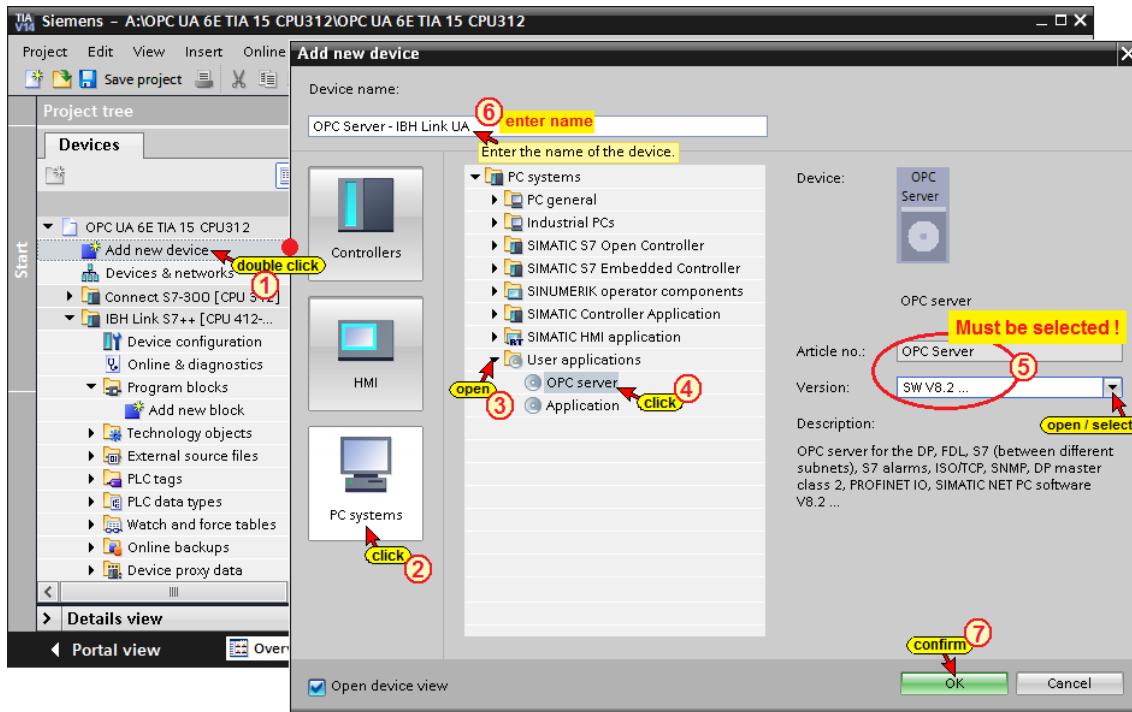
Note TIA V13

The MPI connection between PC_1 (CPU 312) and IBH Link S7++ (CPU 412-2 PN) In the TIA V13 portal must be created by using Drag&Drop.

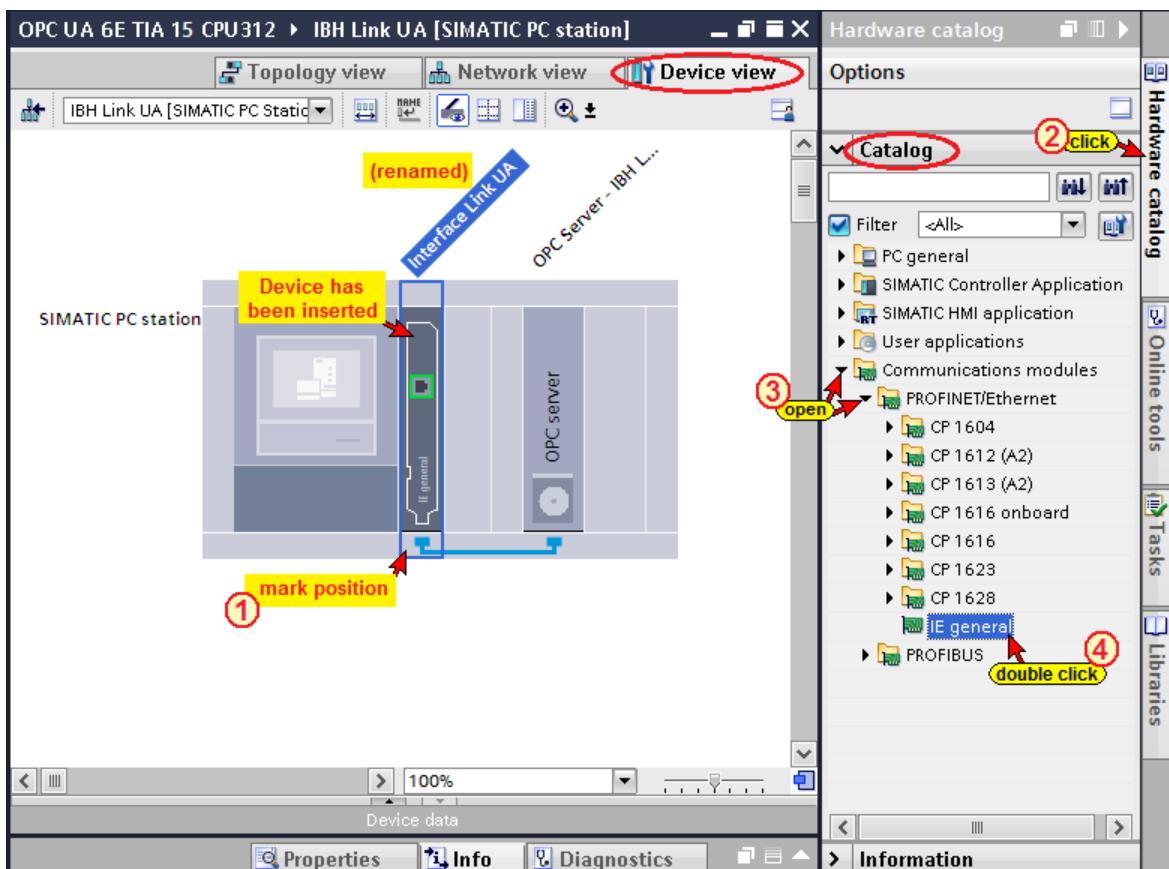


6.4 Inserting IBH Link UA as SIMATIC PC station

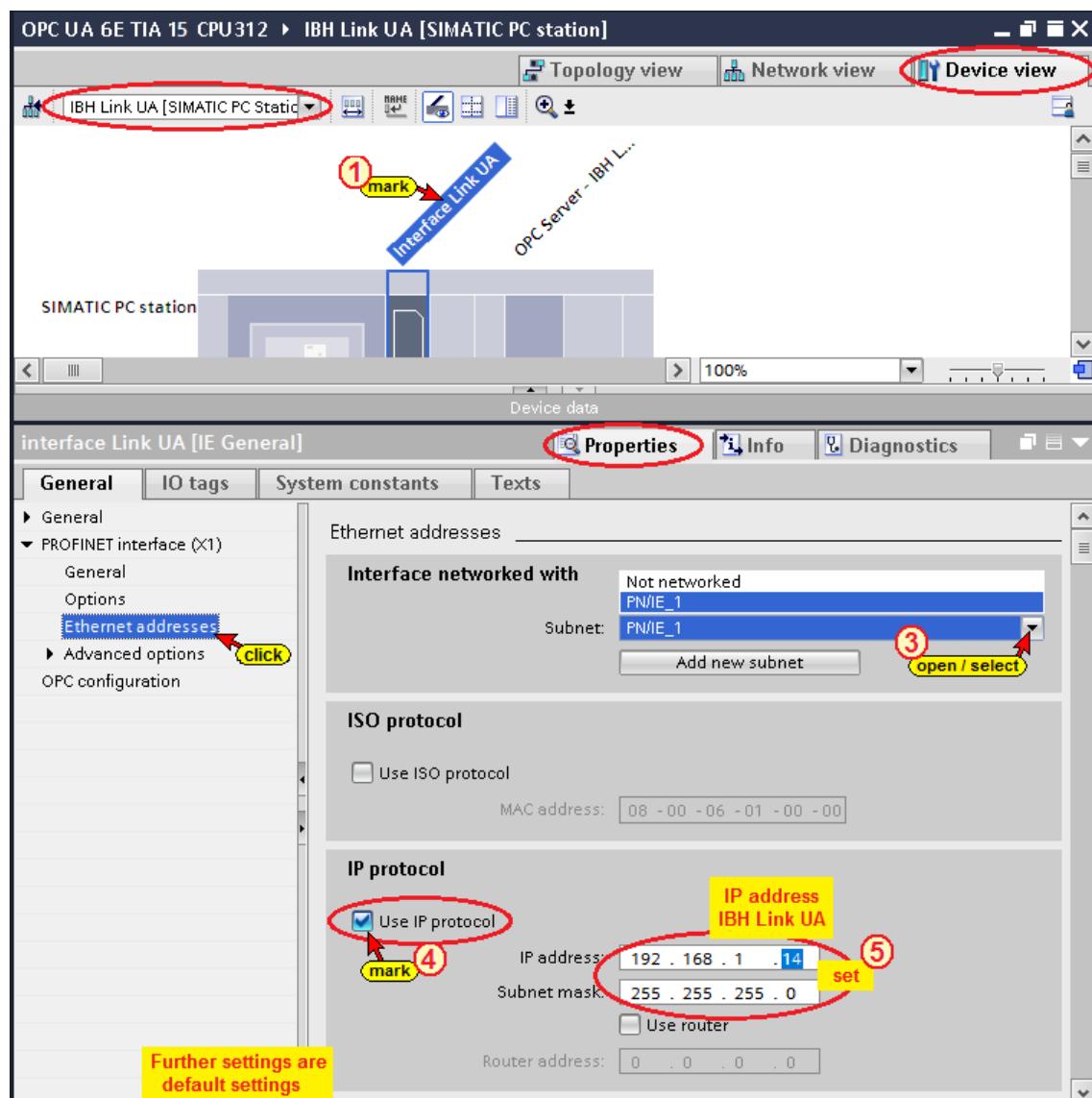
If an OPC server is inserted into the project, also a SIMATIC PC station is automatically inserted.



Inserting the communication module into the IBH Link UA

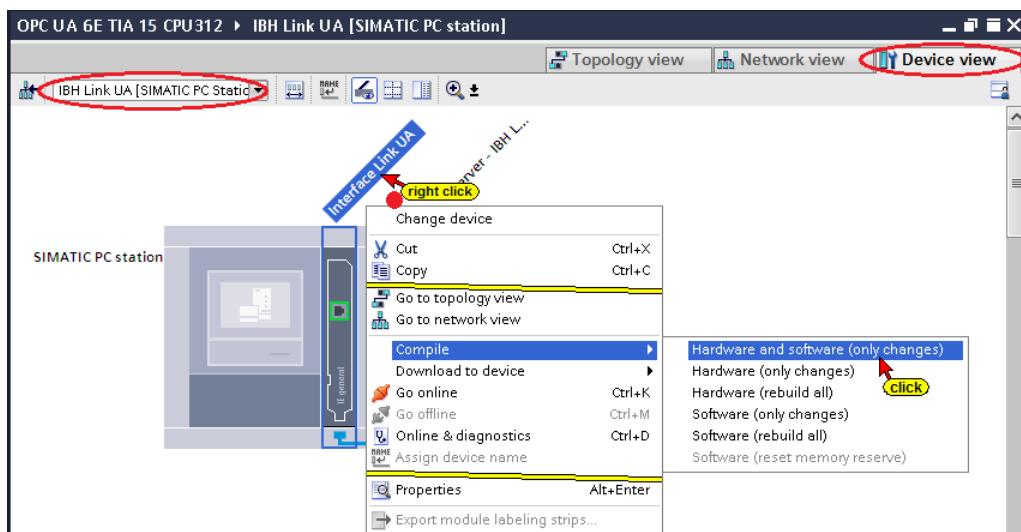


Setting properties of the Communication module

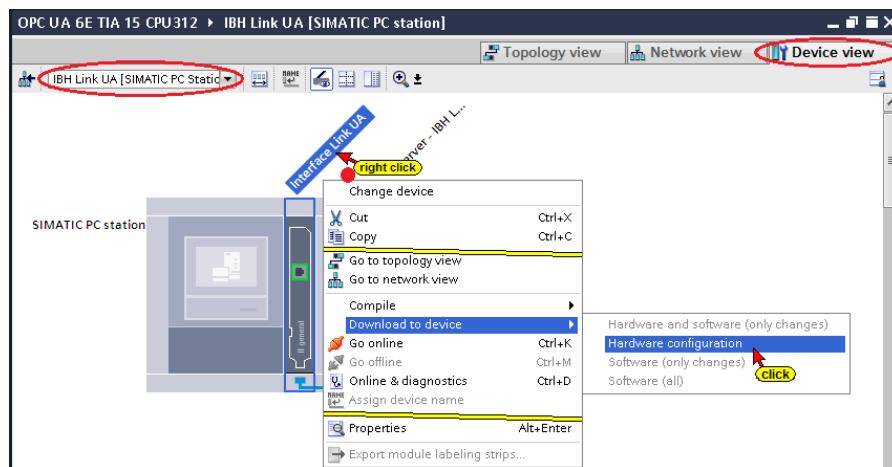


Loading the Hardware of the communication module into the IBH Link UA

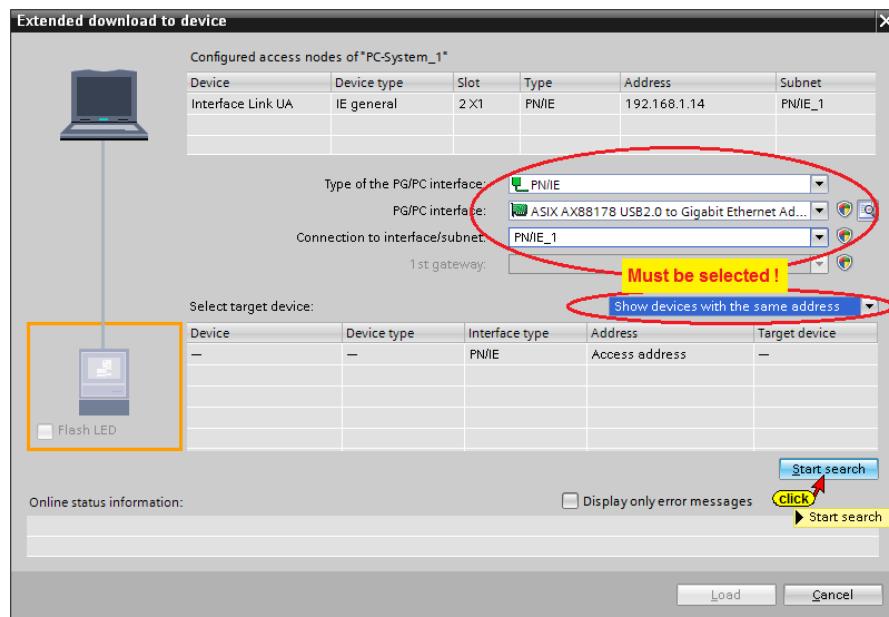
Prior loading into the IBH Link UA the Hardware must be compiled.



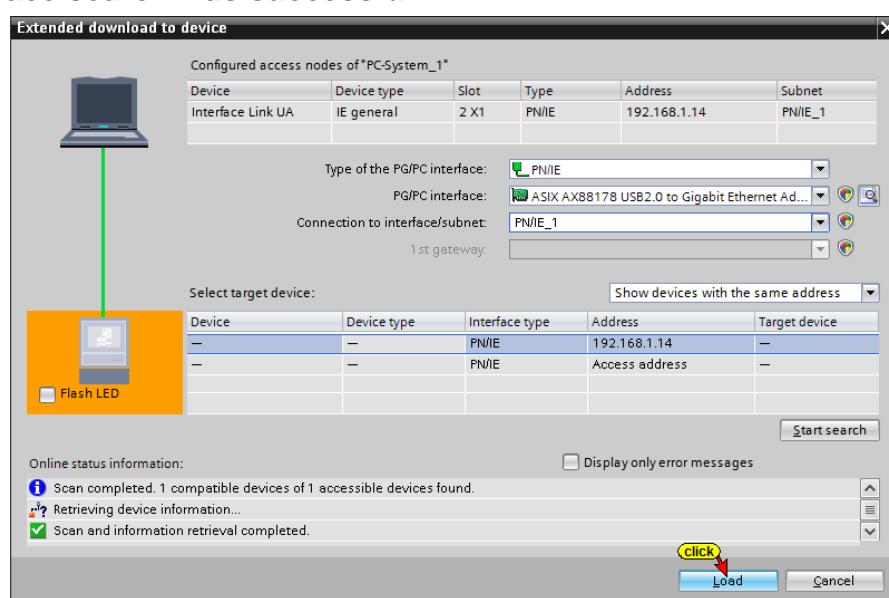
Load the hardware configuration into the device (IBH Link UA)



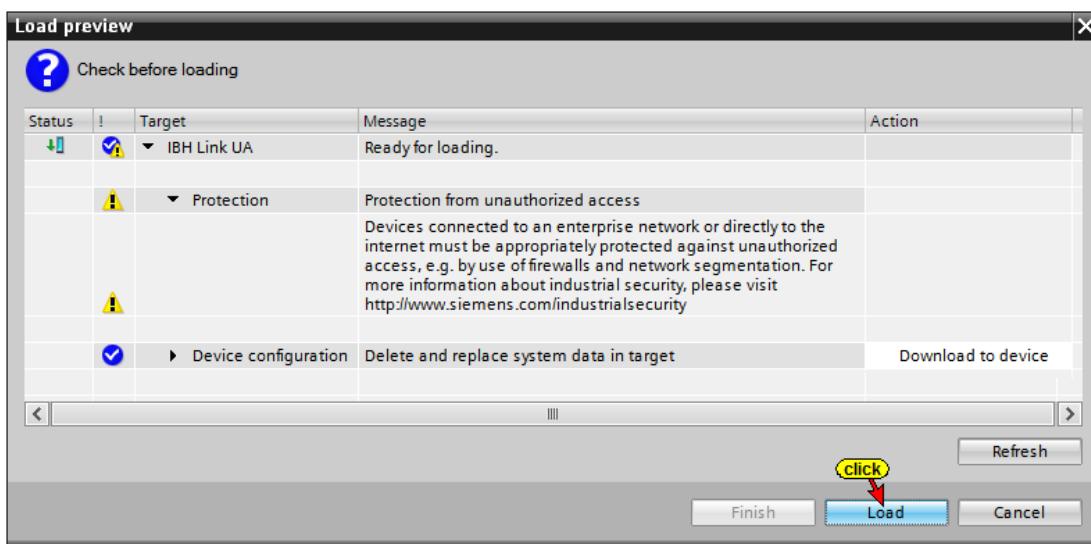
The settings are to be made according the screen shots in the **Extended download to device** dialog box.



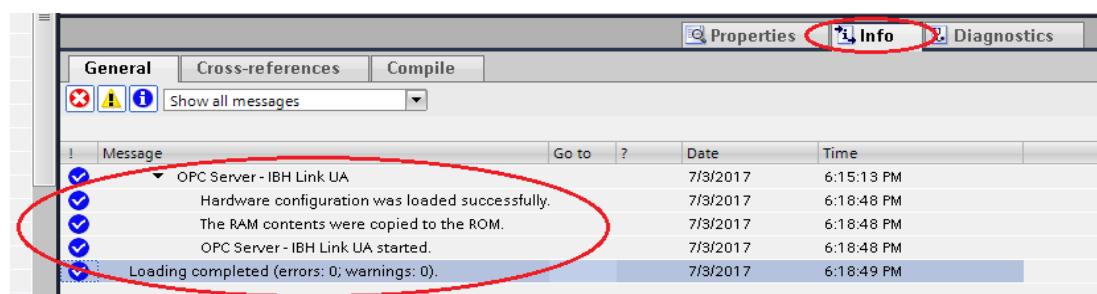
The interface search was successful.



A check is carried out prior loading.

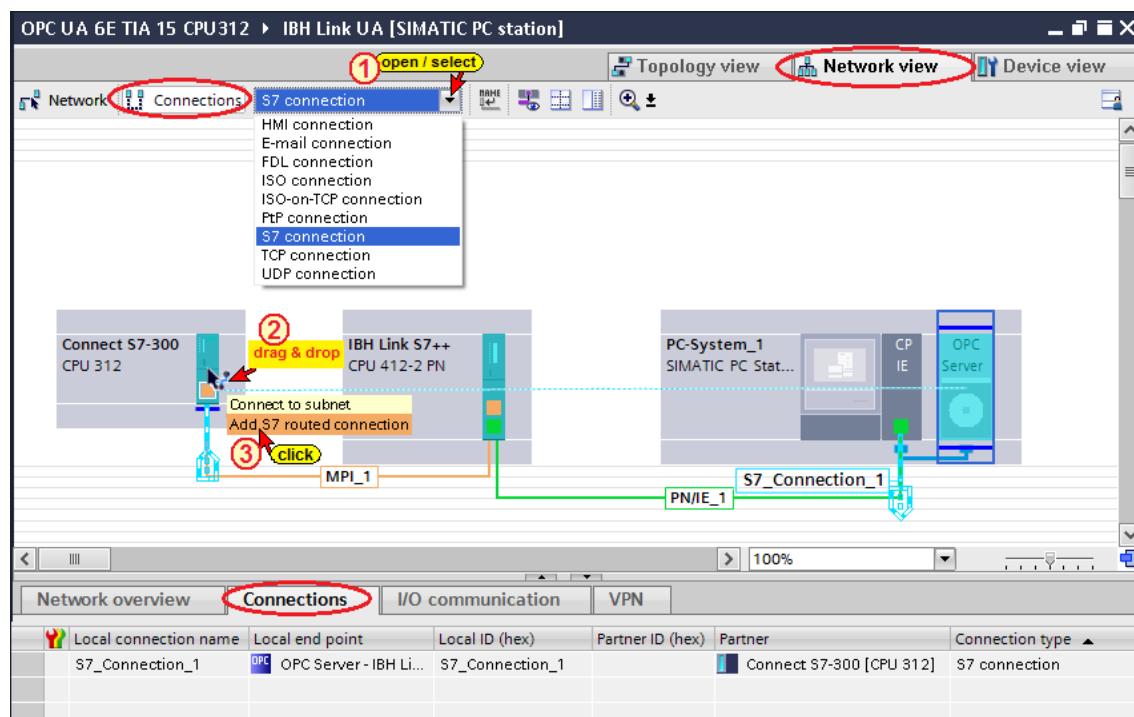


The successful loading of the hardware configuration into the IBH Link UA (Simatic PC station) is displayed.

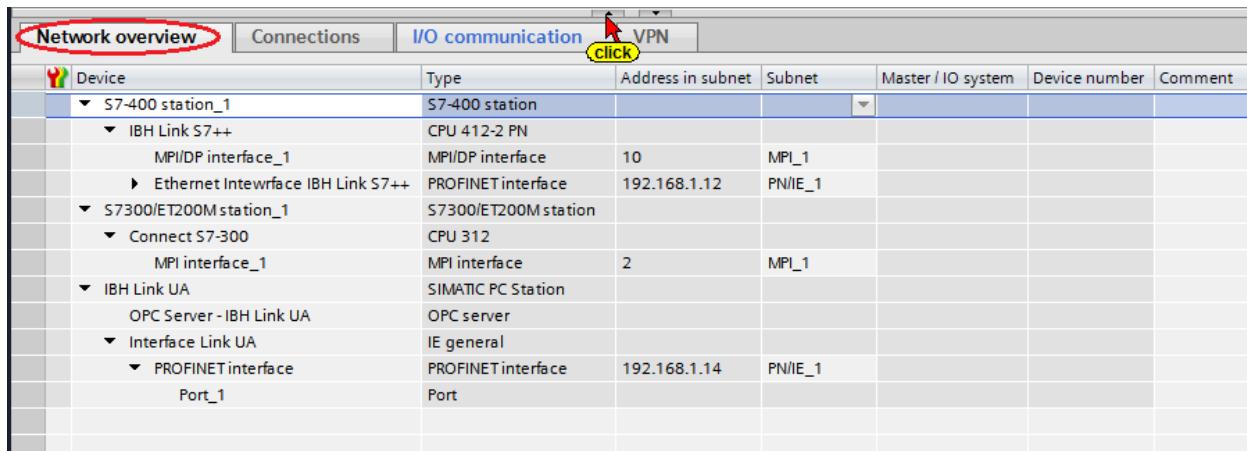


S7 connection from the OPC server to the CPU 312

Use **Drag&Drop** to pull the S7 connection from the OPC server to the CPU 312.



The created S7 connection is listed in the Network view window.

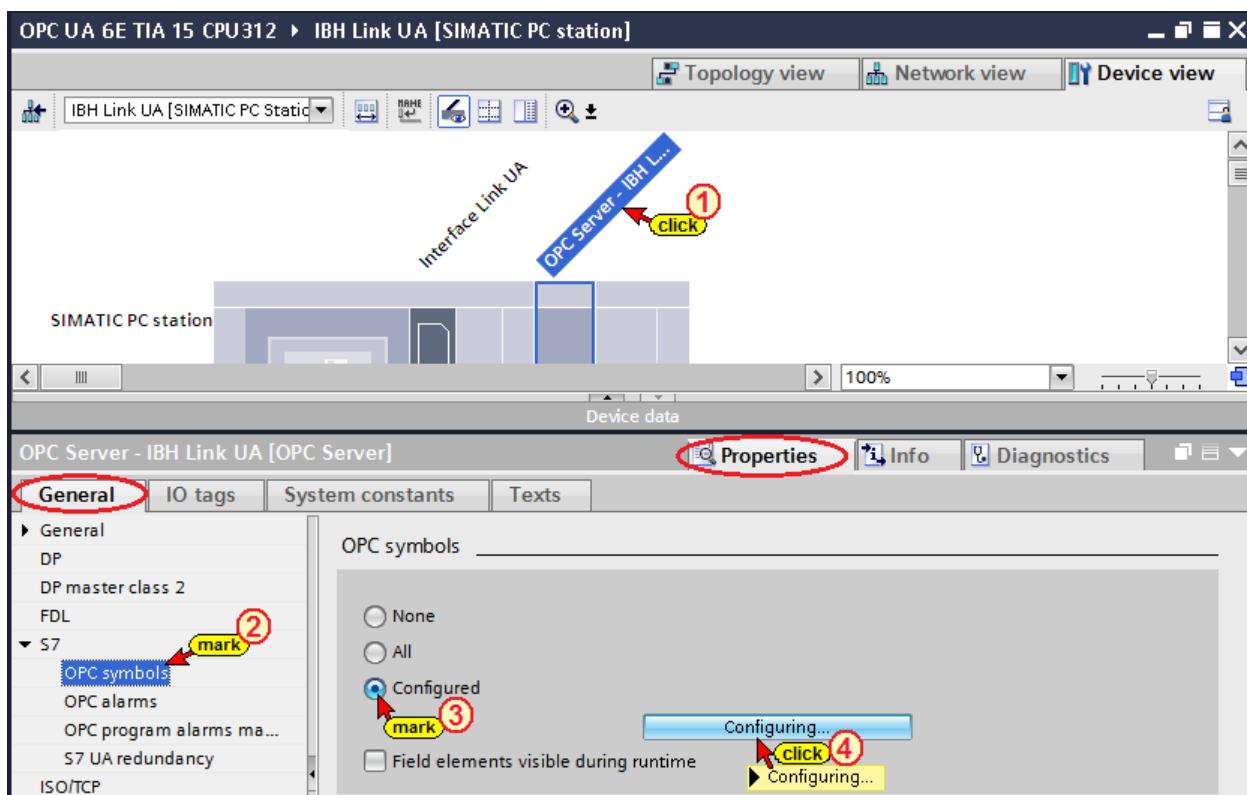


The screenshot shows the 'Network overview' tab selected in the TIA Portal interface. A red circle highlights the 'Network overview' tab. The table lists various network components and their details:

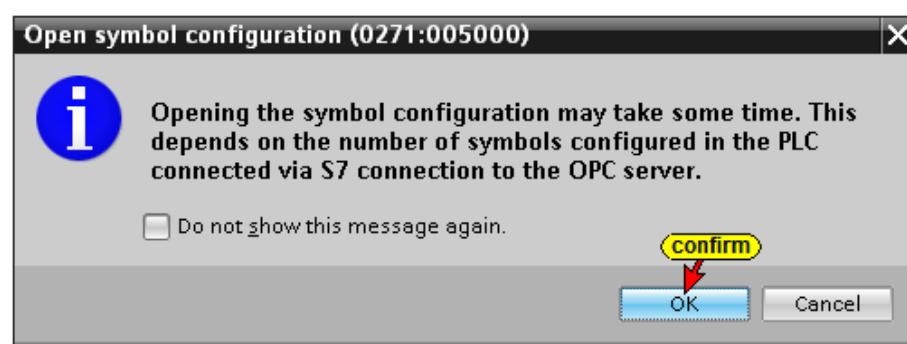
Device	Type	Address in subnet	Subnet	Master / IO system	Device number	Comment
S7-400 station_1	S7-400 station					
IBH Link S7++	CPU 412-2 PN					
MPI/DP interface_1	MPI/DP interface	10		MPL_1		
Ethernet Interface IBH Link S7++	PROFINET interface	192.168.1.12		PN/IE_1		
S7300/ET200M station_1	S7300/ET200M station					
Connect S7-300	CPU 312					
MPI interface_1	MPI interface	2		MPI_1		
IBH Link UA	SIMATIC PC Station					
OPC Server - IBH Link UA	OPC server					
Interface Link UA	IE general					
PROFINET interface	PROFINET interface	192.168.1.14		PN/IE_1		
Port_1	Port					

Select OPC tags (symbols) in the OPC configuration

Configure in the **OPC Server / Open Properties**.

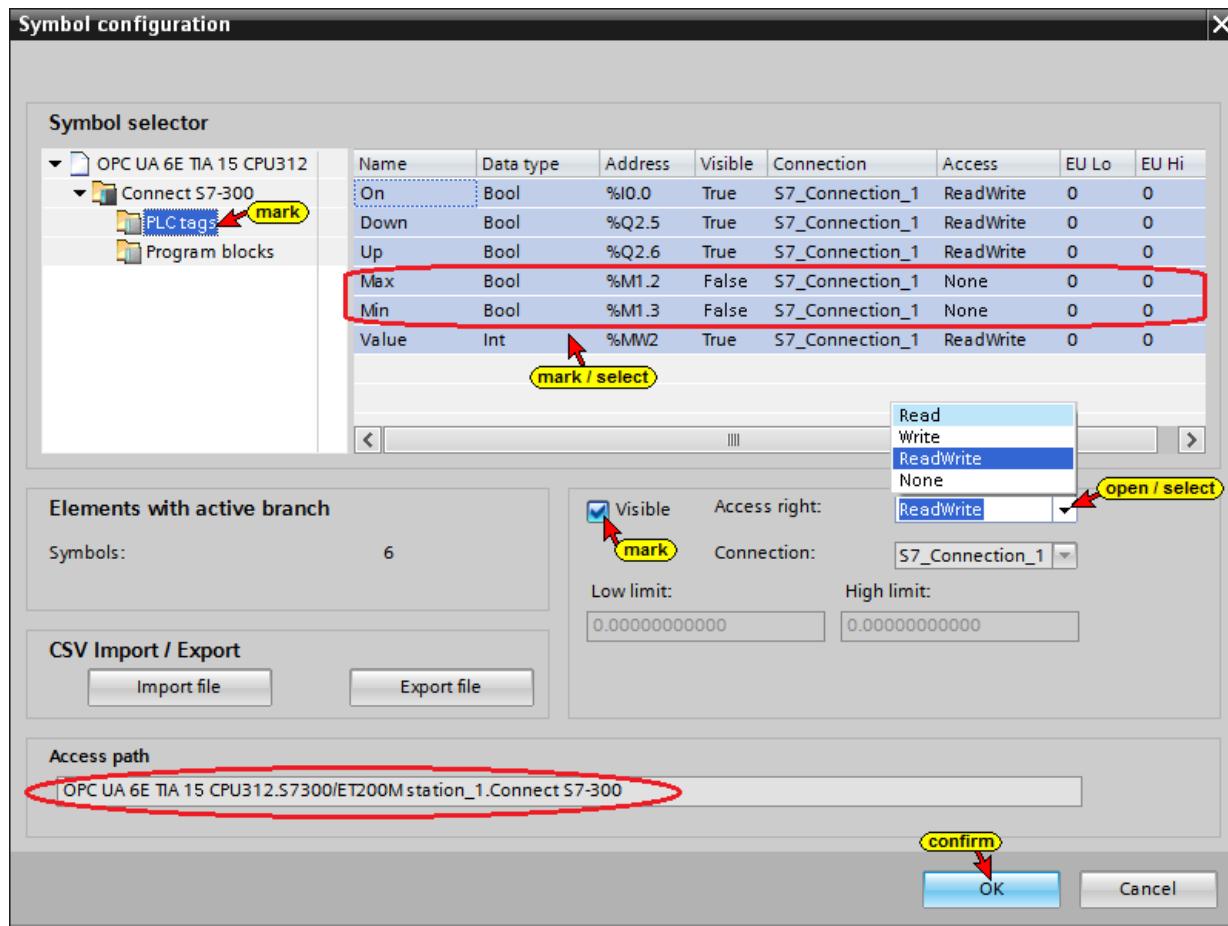


A note is issued by the TIA Portal because the information on the entire symbol table is accepted.



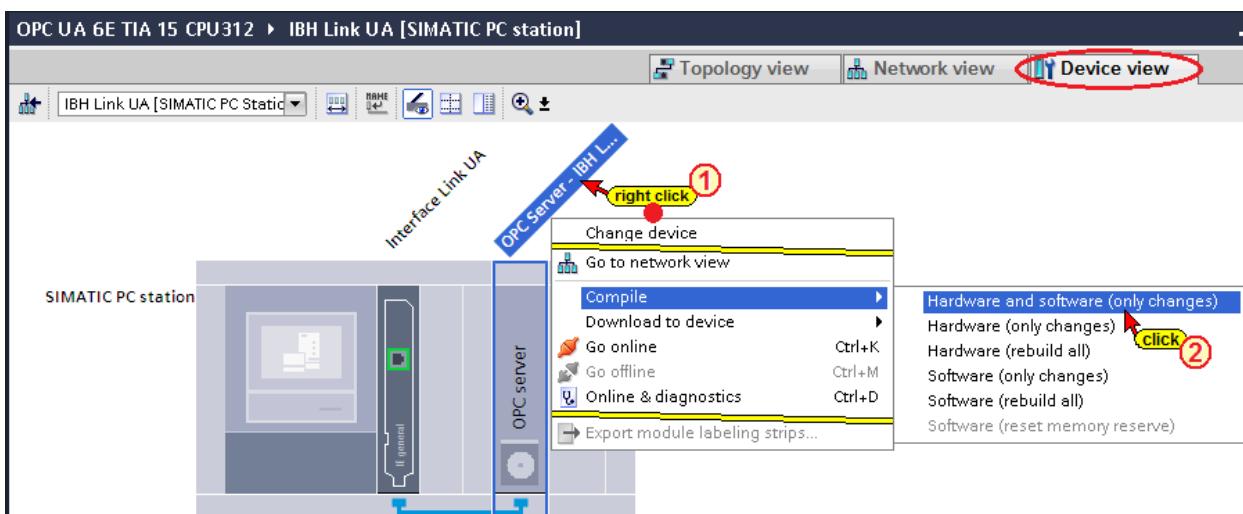
Clicking the Configure button opens the **Symbol Configuration** dialog box. The operands defined in the symbol table (PLC program CPU 312) are listed and may be selected as OPC tags.

The access rights **Read / Write etc.** can be assigned to the individual operands (OPC tags).



The access right of the OPC tags **Max** and **Min** are set to **None** and **Visible** are disabled (**False**).

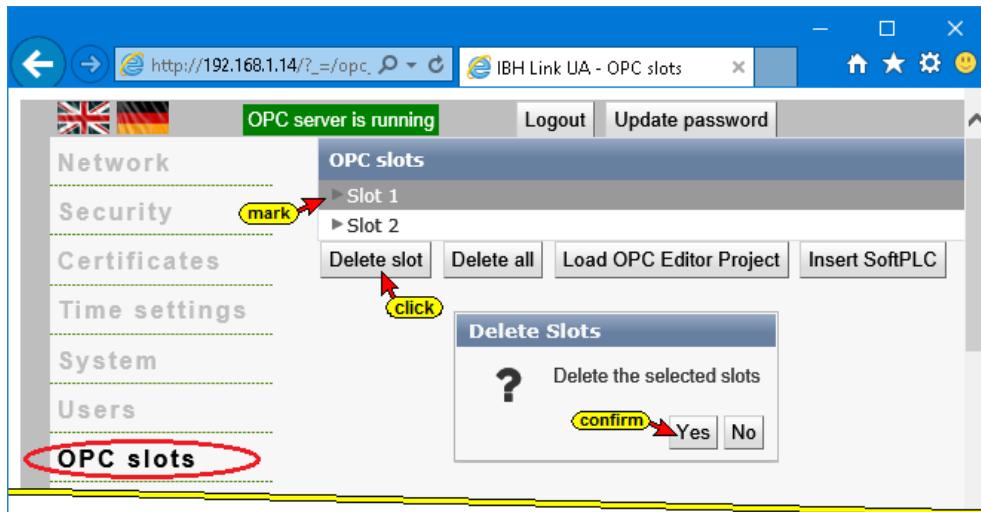
Compiling the IBH Link UA OPC server software and hardware



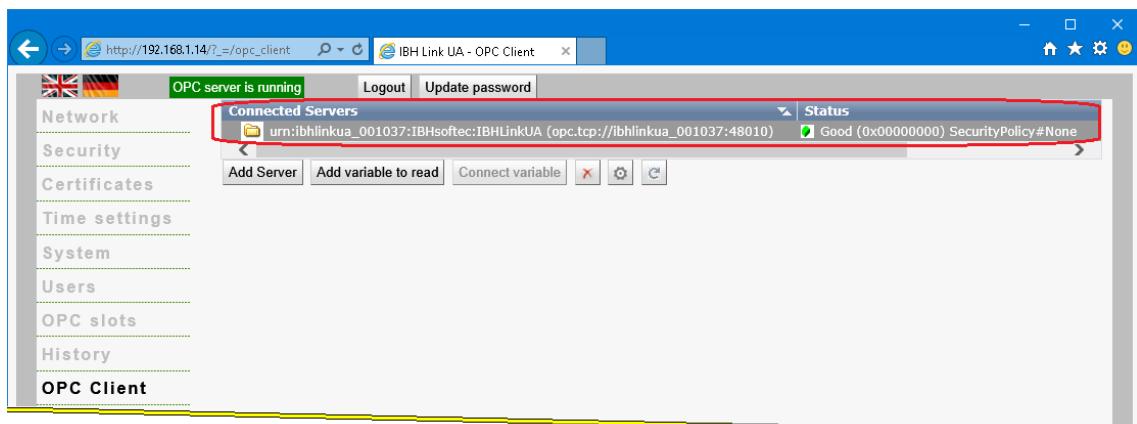
6.4.1 Setting the IBH Link UA

In the previous chapters different configurations have been loaded into the IBH Link UA OPC server. To ensure that only the configurations of this chapter exists in the OPC server it is wise to delete a previous setting.

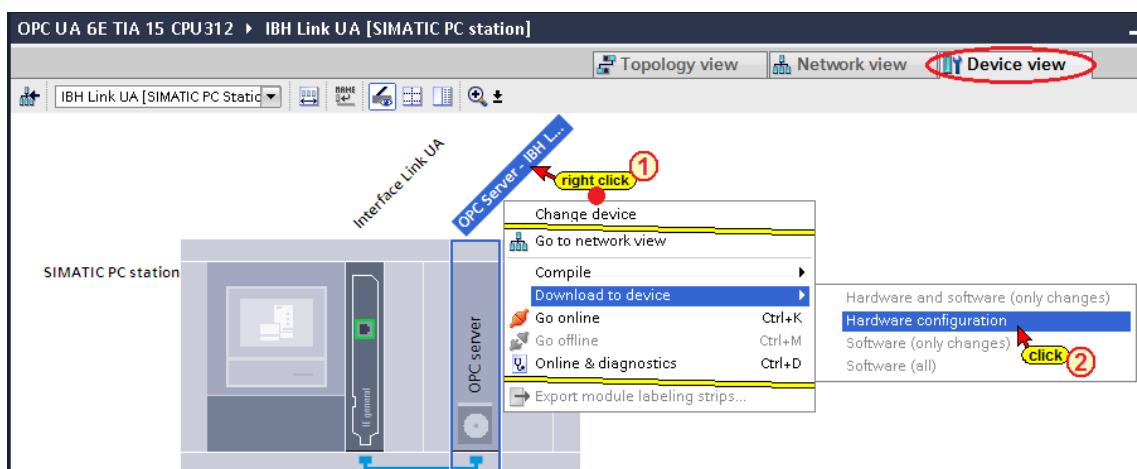
Delete all Slots except Slot 2



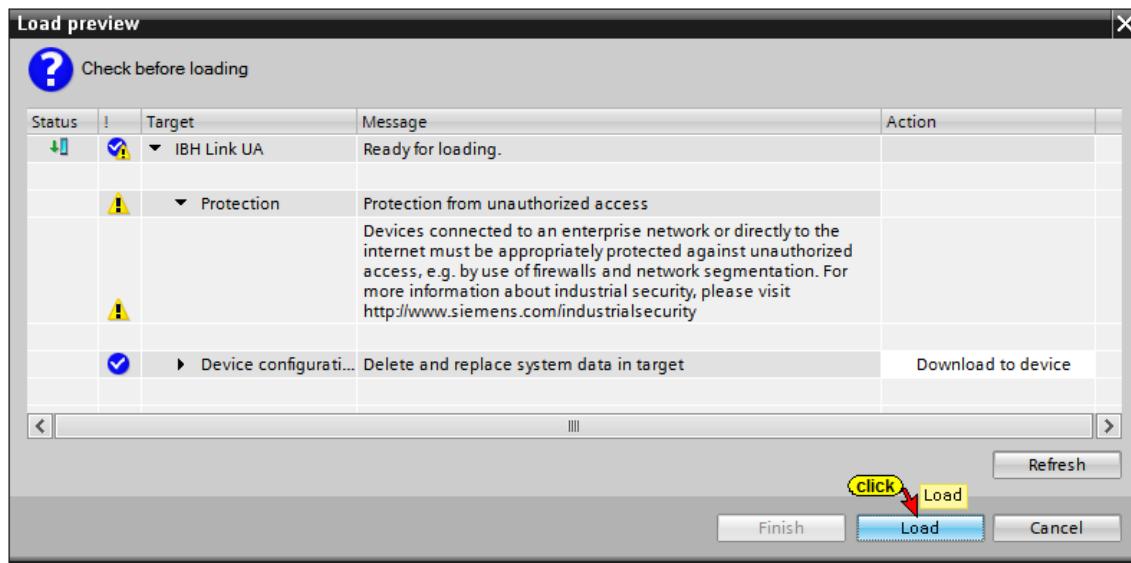
Make sure that the IBH Link UA as server and the status is **Good**.



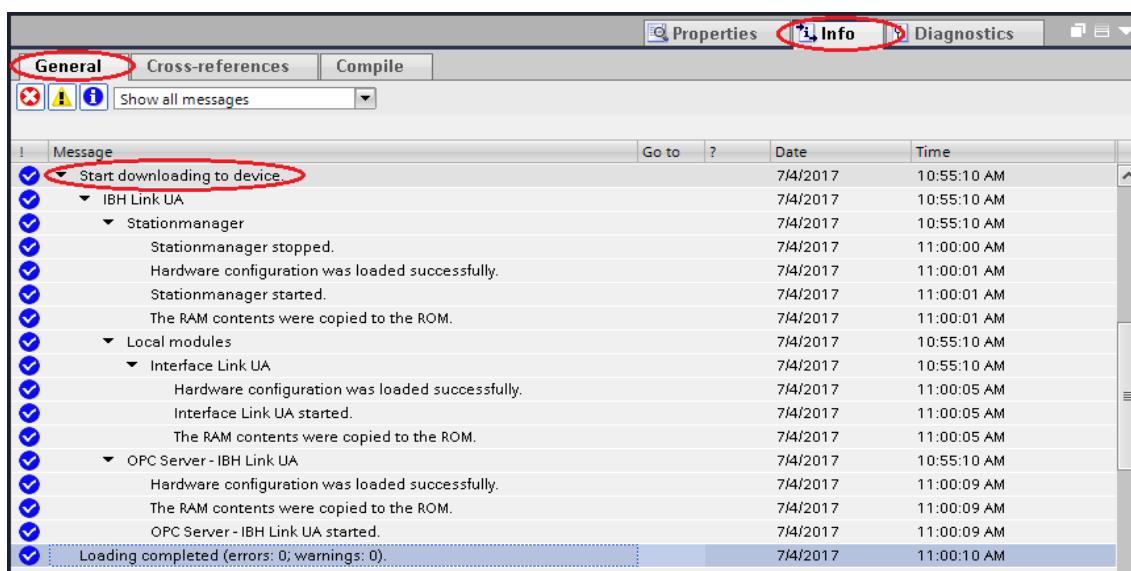
Loading the configuration of the OPC server into the IBH Link UA



A check is carried out prior loading.

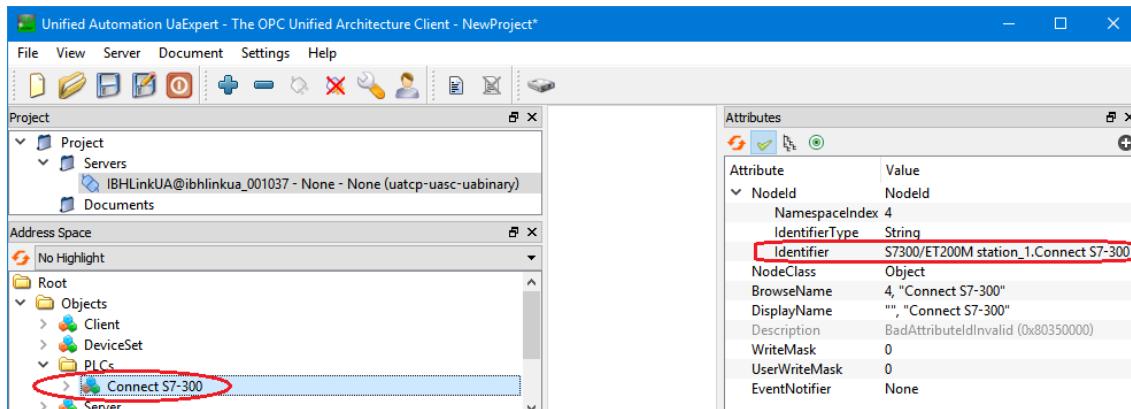


The steps of the successful loading process are displayed as info.

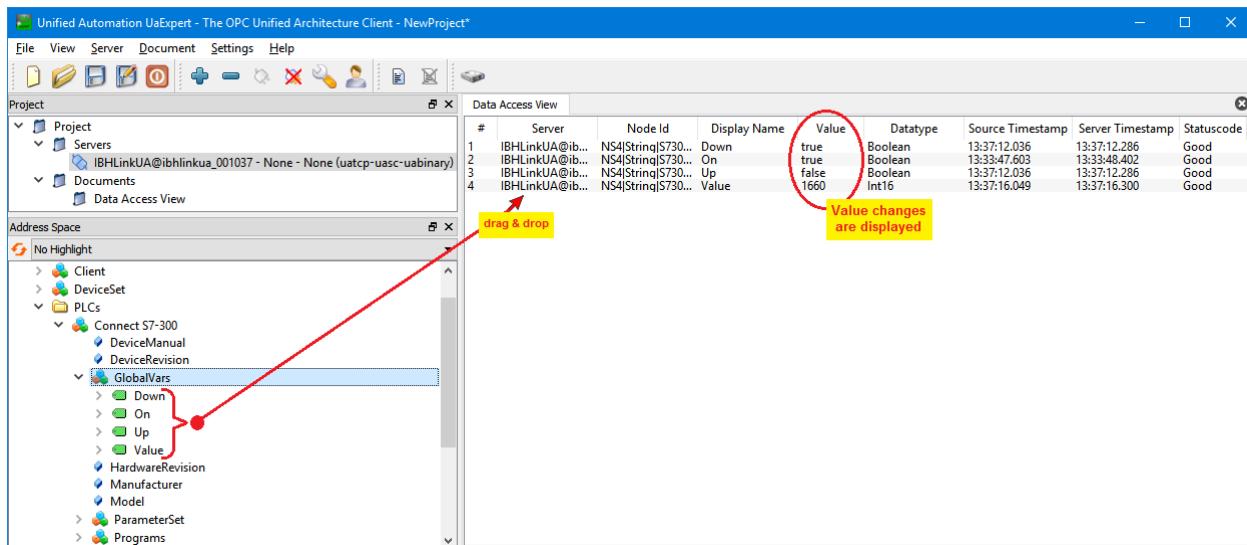


6.4.2 UaExpert - Program window

The PLC Program **Tank Control** is displayed in the UaExpert program window.



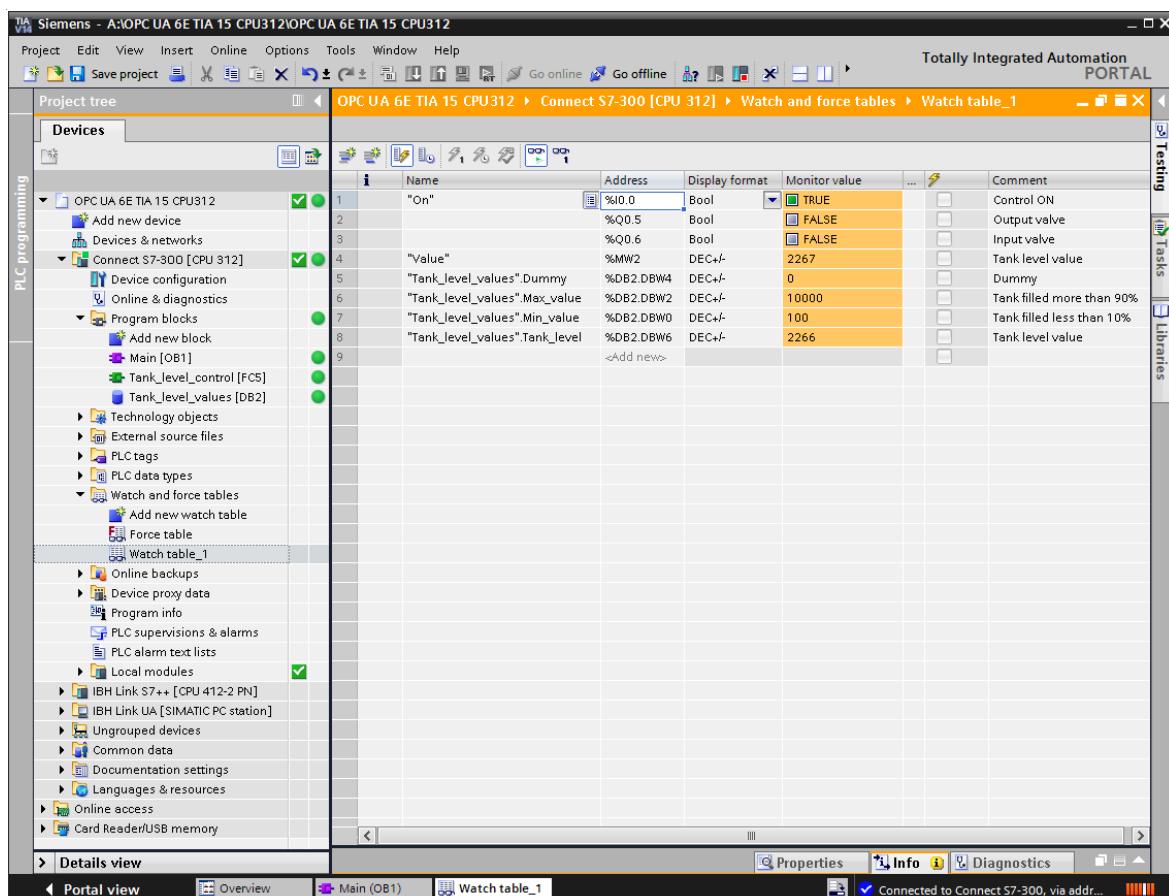
The operands of the symbol table, defined as OPC tags, are listed below **GlobalVars** in the **Address Space** area. Using Drag&Drop they can be pulled into the **Data Access View**.



If the PLC program tank level is processed, the changes of the variables are displayed.

To change the value of a variable, double-click its value in the **Data Access View** area.

The global variables (OPC tags) can also be displayed in the online status of PLC block OB1.

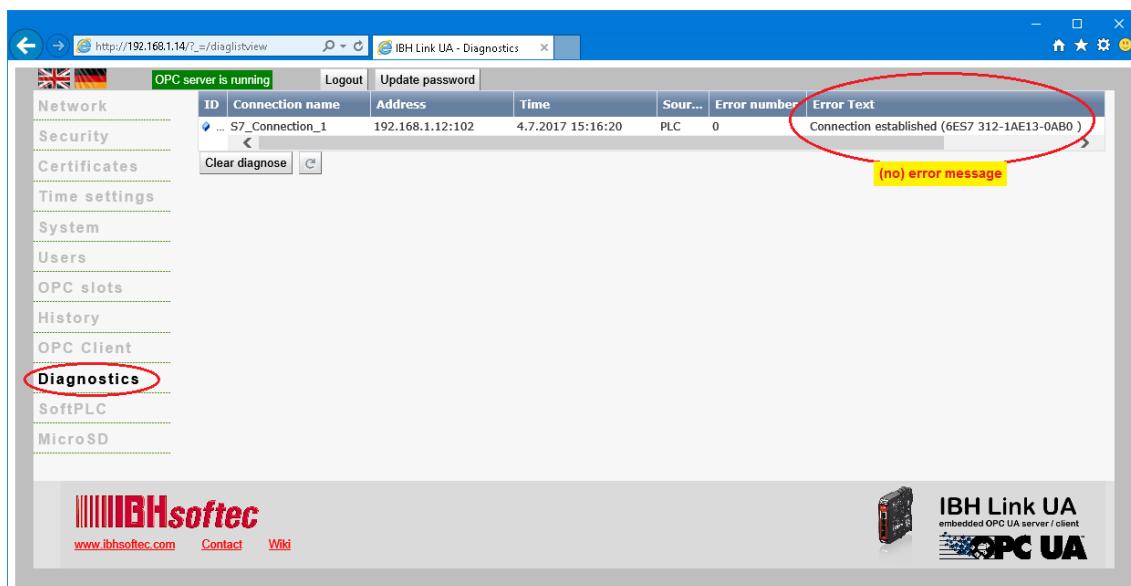


6.5 Diagnosis

The IBH Link UA and the IBH Link S7++ provide diagnostic possibilities.

6.6 IBH Link UA Diagnostics

If no values are displayed or error messages are displayed in the UaExpert **Data Access View** window, the **IBH Link UA Diagnostics window** informs you whether the connection to the PLC is established.



6.7 IBH Link S7++ Diagnostics

The IBH Link S7++ Web server provides further diagnostic options. The web server diagnostic page is opened by using the IBH Link S7++ IP address [example: http://192.168.1.12] within a web browser.



IBH Link S7++ Web Server Diagnostics page

The connected IBH Link S7++ stations are listed.

This screenshot shows the 'Diagnostics' section of the IBHLink S7++ web interface. A red arrow points to the 'Diagnostics' link in the top navigation bar. Below it, a table lists a single connected PROFIBUS device:

Address	Status	Type	Manufacturer
► 2	M	6EST 312-1AE13-0AB0	Original Siemens Equipment

At the bottom, there is a footer with the company information: IBHsoftec GmbH | Turmstr. 77 | 64743 Beerfelden | Tel.: +49 6068 3001 | Fax: +49 6068 3074 | info@ibhsoftec.com

This screenshot shows the 'Configuration' section of the IBHLink S7++ web interface. A red arrow points to the 'Configuration' link in the top navigation bar. Below it, a window titled 'Windows Security' is displayed, prompting for a user name and password. A red arrow points to the 'OK' button in the dialog box.

The Password can be changed

This screenshot shows the 'Change Password' page of the IBHLink S7++ web interface. It displays three input fields: 'Username' (admin), 'Password' (*****), and 'Repeat password' (*****). A red arrow points to the 'Save' button at the bottom right of the form.

IBH Link S7++ Web Server Configuration page

The screenshot shows the configuration interface for the IBHLink S7++ module. The top navigation bar includes links for Home, Configuration (circled in red), Diagnostics, and Change Password. A yellow 'click' button points to the Configuration link. The main area is a table with various configuration parameters:

Firmware version	NL50MPI V02.160 23.03.16 V1.55_release-25-g15512a6
Serial number / MAC Address	25208 00:02:A2:21:56:CB
Network name	S7_IBH_Link
IBHNet port (port 1099 is always active)	0
Configuration with NetPro	<input checked="" type="checkbox"/>
DHCP	<input type="checkbox"/>
IP address	192.168.1.12
Subnet mask	255.255.255.0
Default gateway	0.0.0.0
IPv6 (link-local)	[FE80::202:A2FF:FE21:56CB]
IPv6 (SLAAC)	[]
IPv6 (static)	[]
Baudrate	187,5 kBit/s
Own station address	10
Highest station address	31
Set default bus parameters	MPI PROFIBUS
Tslot_Init	415
Max. Tsdr	400
Min. Tsdr	20
Tset	12
Tqui	0
Gap factor	5
Retry limit	2
Ttr	9984
Activate Time-of-Day Synchronization	<input type="checkbox"/>
NTP update interval (10 - 86400 seconds)	60
NTP Server 1 (IP address)	0.0.0.0
NTP Server 2 (IP address)	0.0.0.0
NTP Server 3 (IP address)	0.0.0.0
NTP Server 4 (IP address)	0.0.0.0
MPI/DP update interval	

At the bottom right is a 'Save configuration' button.

IBHsoftec GmbH | Turmstr. 77 | 64743 Beerfelden | Tel.: +49 6068 3001 | Fax: +49 6068 3074 | info@ibhsoftec.com

7 IBH Link UA - Connection of an S5 CPU 103U

7.1 Example using the STEP 7 – Simatic Manager

The following example explains the creation of a project with the STEP 7 Simatic Manager with the connection of an S5 CPU 103U and the IBH Link UA via an Ethernet link via IBH Link S5++.



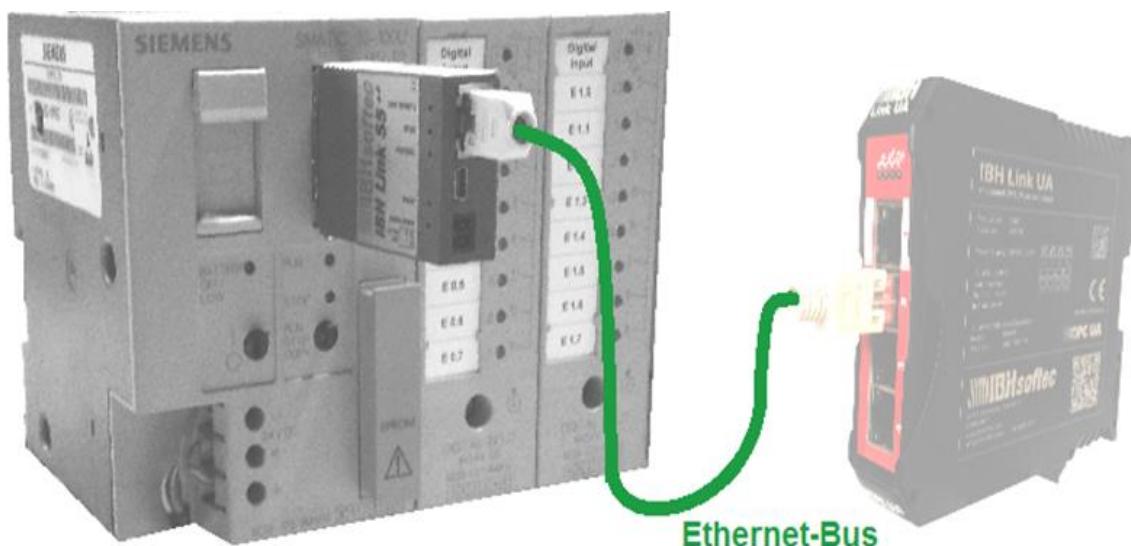
IBH Link S5++

The IBH Link S5++ is an Ethernet converter.

The protocol used is the usual standard TCP/IP. All the advantages of Ethernet are thus without any problems to the user.



The use of SimaticNet as well as the use of CP communication processors are neither necessary on the PC nor on the PLC side.



The prepared sample program, executed in the S5 CPU 103U, is identical to the PLC program **Tank Level** as described in the chapter 3.1.1. It simulates the filling and emptying of a tank.

The S5 program **TANK-PST.S5D** (or **Tank Level S5.S5P**) was loaded into the CPU S5 103U with the STEP 5 programming system **S5 for Windows** by IBHsoftec.

The SIEMENS PLC programming system SIMATIC Manager STEP 7 V5.5 is used to create the network configuration.

IBH Link UA configuration using the SIMATIC Manager STEP 7

S5 controllers do not have an Ethernet connection as standard.

If no communication processors with Ethernet interface are available, the IBH Link S5++ can be used to establish an Ethernet connection between the S5 CPU and the IBH Link UA.

Note:

The IM 151-8 PN/DP CPU V3.2 interface module provides a PROFINET interface with an integrated switch.

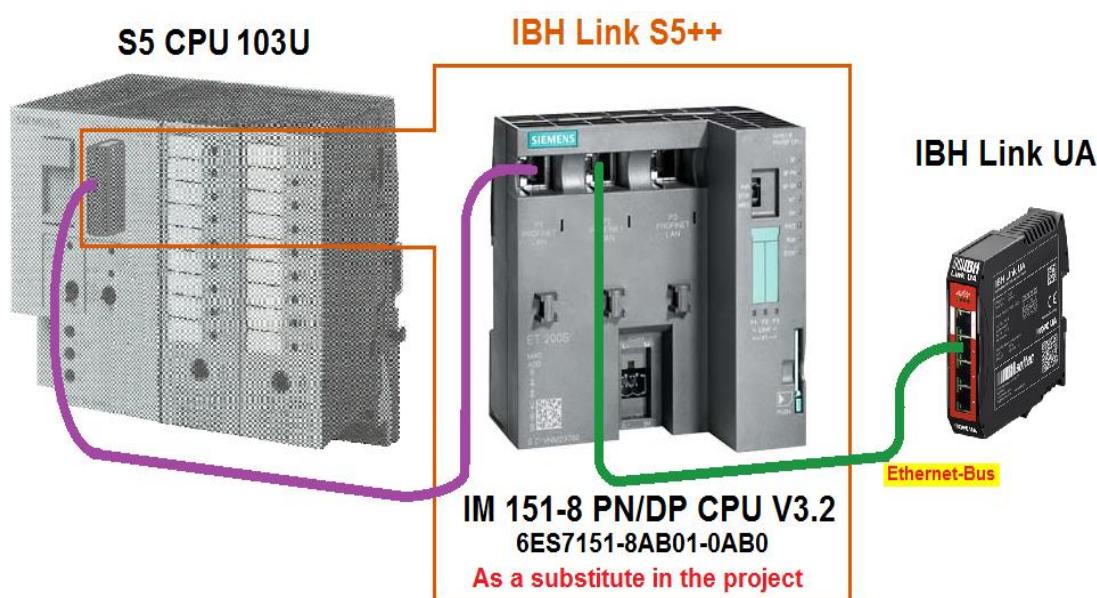
Via the PROFINET interface, PG communication and S7 communication are possible.

The IM 151-8 PN/DP CPU V3.2 interface module is available in the hardware catalog of the TIA Portal and STEP 7 (Simatic Manager).

The firmware of the IBH Link S5++ emulates the PROFINET interfaces of the IM 151-8 PN/DP CPU V3.2 (6ES7 151-8AB01-0AB0 V3.2) as far as this is required for the communication between the S5 CPU PG interface and the IBH Link UA Ethernet Port.

The following properties are available (compatible with the IM 151-8 PN/DP CPU V3.2):

Interface / Bus	Protocol
1x PROFINET (1 Port)	PG-Communication
1x PROFINET (1 Port)	ISO-on-TCP (RFC1006)



The symbol table for defining the OPC tags is available in the S5 CPU UA project. The hardware components necessary for the communication between the S5 CPU and the IBH Link UA are already specified.

S5 PLC Program: Tank Level S5

The PLC Program simulates the filling and emptying of a tank.

- The tank is equipped with a "level indicator". This tank value level (**Value**) is displayed.
- The tank level is controlled between a minimum (**Min**) and a maximum (**Max**).
- The control can be switched on (**On**).
- The valves (**Up – Input valve, Down – Output valve**) to control the tank level are displayed.

S5 Symbolic table (Tank Level S5)

The following operands are used in the S5 program. They are defined in the symbol table of the S5 program and should be available as OPC tags.

Symbol	Operand	Comment
On	I 0.1	Control ON
Max	F 1.2	Maximum reached
Min	F 1.3	Minimum reached
Value	FW 2	Tank level value
Cycle	OB 1	Cycle OB1
Down	Q 2.5	Output valve
Up	Q 2.6	Input valve
Tank_level_values	DB 2	Tank Values DB 2
Tank_level_control	FB 5	Tank level controll FB 5
Min_value	DW 0	Tank filled less than 10%
Max_value	DW 1	Tank filled more than 90%
Dummy	DW 2	Dummy
Tank_Level	DW 3	Tank level value Not possible using STEP 7

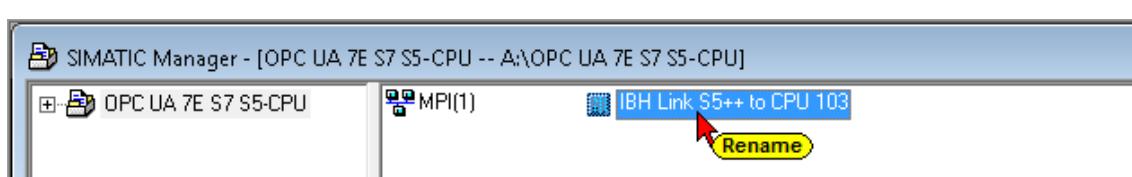
The operands are transferred to the **Default tag table** of the **IM 151-8 PN/DP CPU V3.2**.

These variables will be routed via the **IBH Link S5++** to the OPC-Server **IBH Link UA**

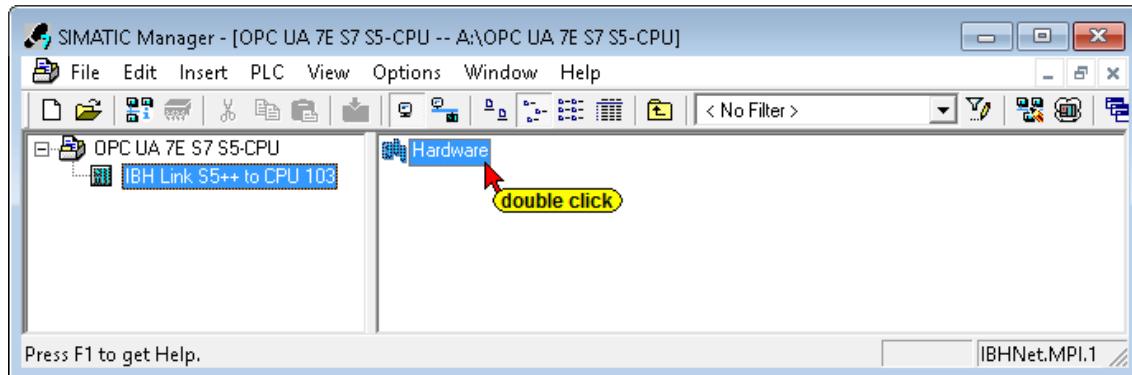
7.2 Creating the project in STEP 7 - Simatic Manager

Open the STEP 7 example project **OPC UA 7E S7 S5-CPU**.

Add a SIMATIC 300 station in the project, rename the station in **IBH Link S5++ to CPU 103** and save it.

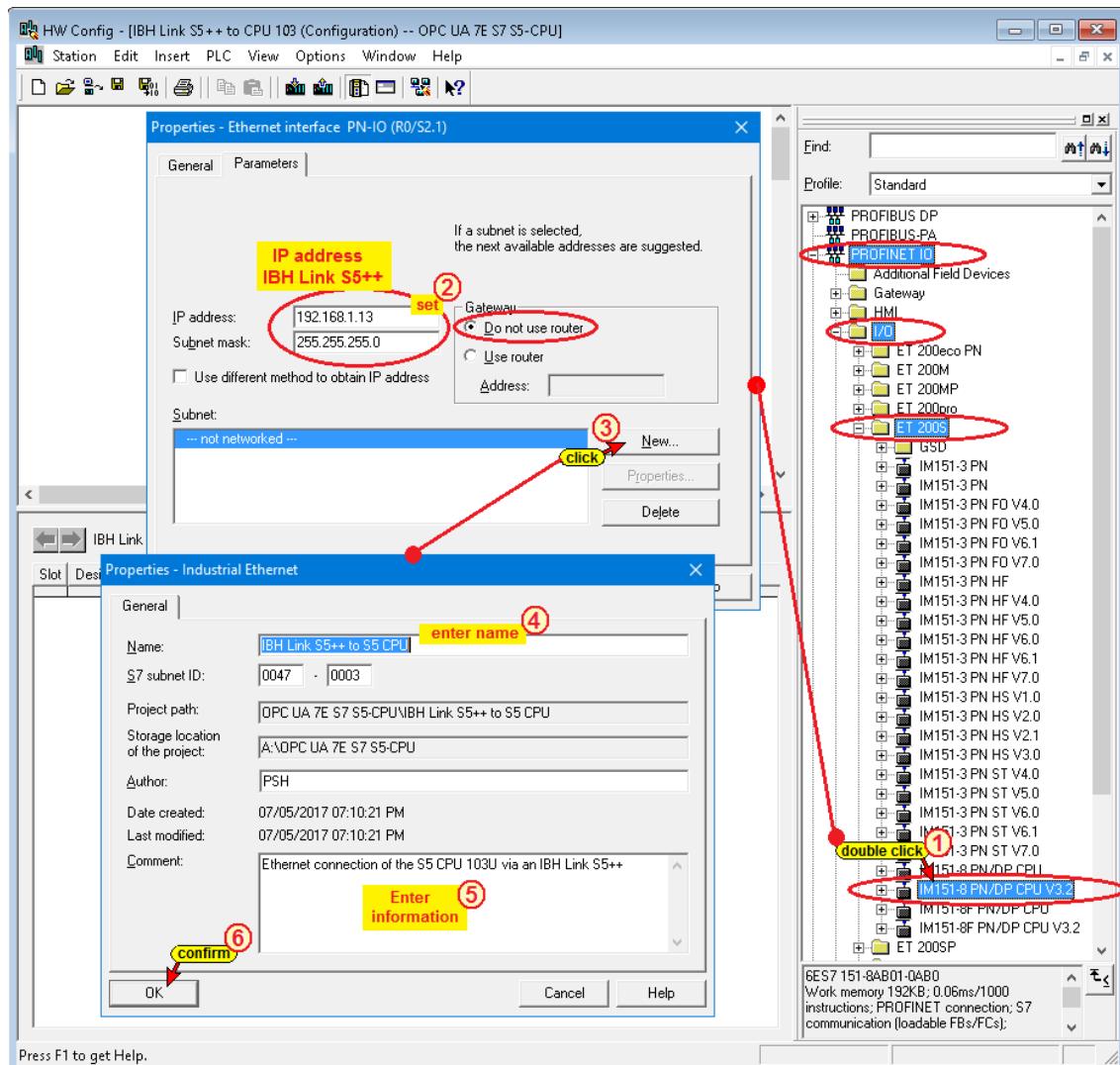


Double-click the icon **Hardware** to open the configuration window.

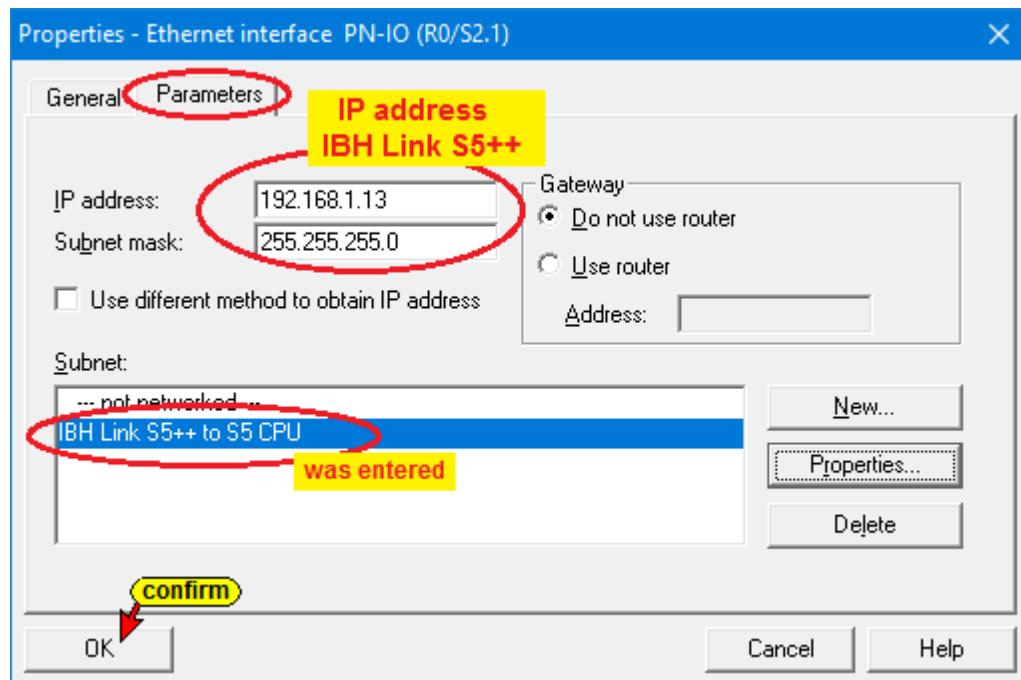


In the hardware configuration, double-click on **Profinet-I/O-ET 200S-IM115-8 PN / DB CPU V3.2**. The dialog box Properties - Ethernet Interface PN-IO (R0 / S2.1) will open.

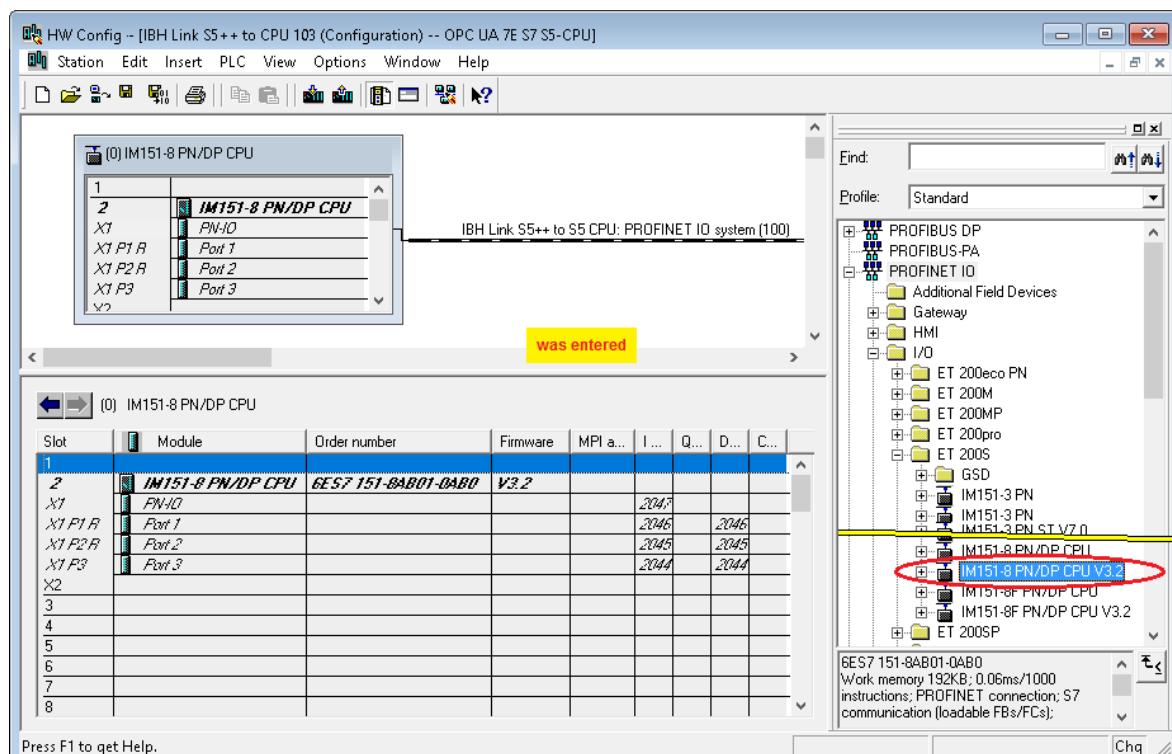
The IBH Link S5++ IP address and its sub net mask are entered in the desired fields. Clicking the New button to open the Properties – Industrial Ethernet dialog box. Confirming the open dialog boxes with OK will set the Ethernet connection. The interface is uniquely defined with additional entries.



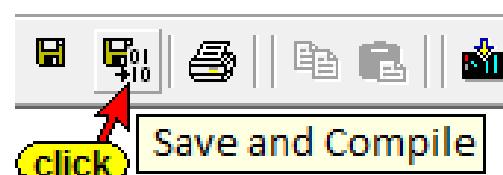
Clicking the button **OK** ⑥ in the **Properties - Ethernet interface PN-IO (R0 / S2.1)** dialog box confirms the Ethernet connection and transfers the settings to the hardware configurator.



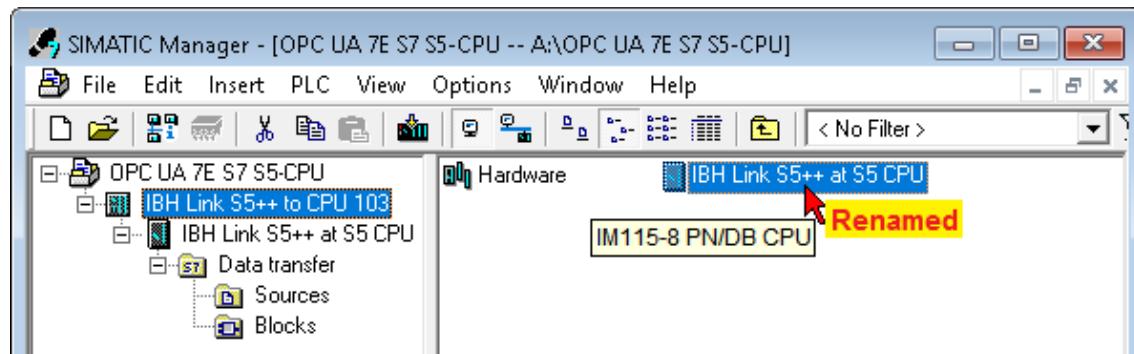
The specification of the Ethernet connection has been adopted in the hardware configurator.



The configuration of the Profinet I/O CPU - IM151-8PN/DP can now be translated and saved.

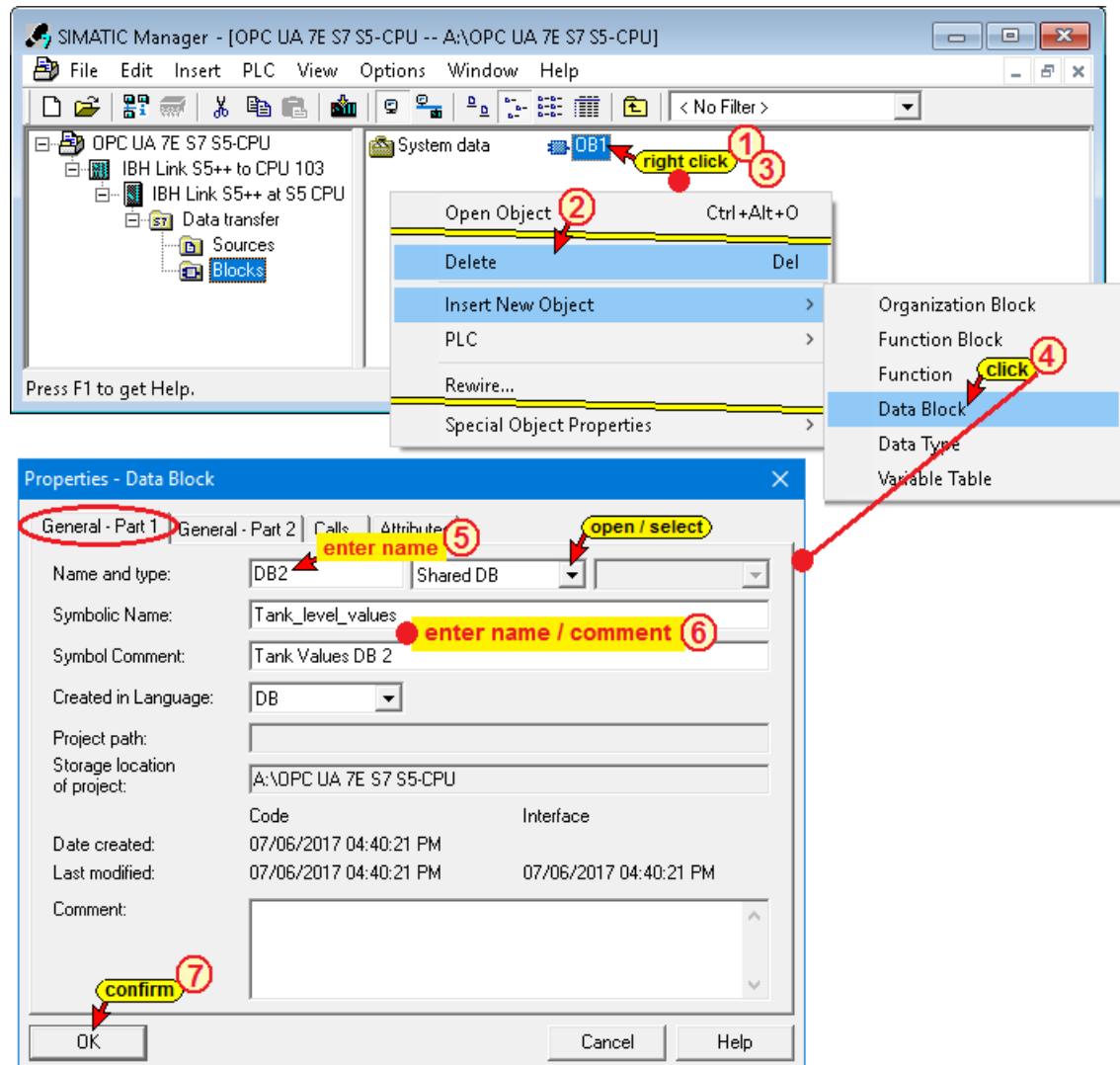


Renaming the *IM115-8 PN / DB CPU V3.2* to *IBH Link S5++ at S5 CPU*



Renaming the devices can increase the clarity.

Delete PLC Block OB1; Create PLC Block DB 2



DB 2 of the IBH Link S5++ at S5 CPU (IM115-8 PN/DB CPU V3.2)

The date block DB2 a symbolic name must be assigned to enable the possibility to use the variables defined in the DB2 to be OPC tags.

DB 2 of the IBH Link S5++ at S5 CPU

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Min_value	INT	100	Tank filled less than 10%
+2.0	Max_value	INT	10000	Tank filled more than 90%
+4.0	Dummy	INT	0	Dummy
+6.0	Tank_level	INT	0	Tank level value
=8.0		END_STRUCT		

Press F1 to get Help. | offline |

Insert S7 Symbolic Operand Names

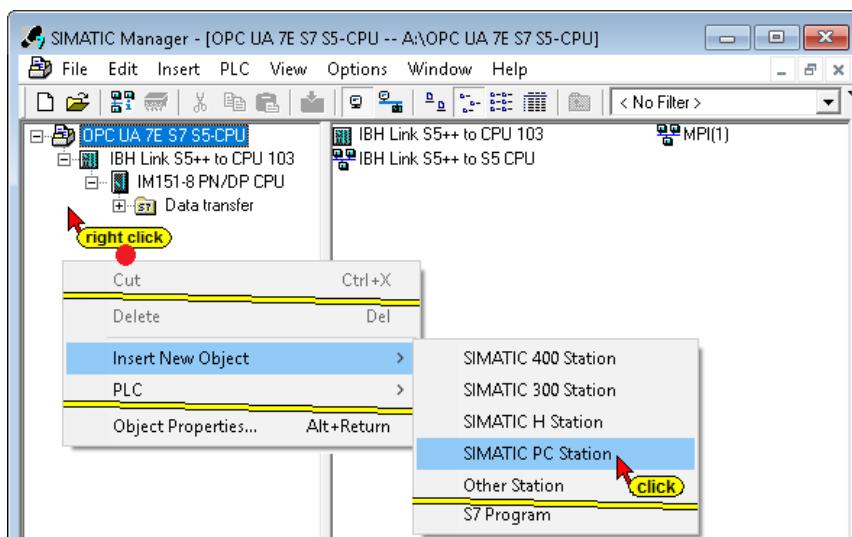
The symbol table (**Tank Level S5.SEQ**) was imported from the S5 program with the command **Table / Import**. These operands should be available as OPC tags.

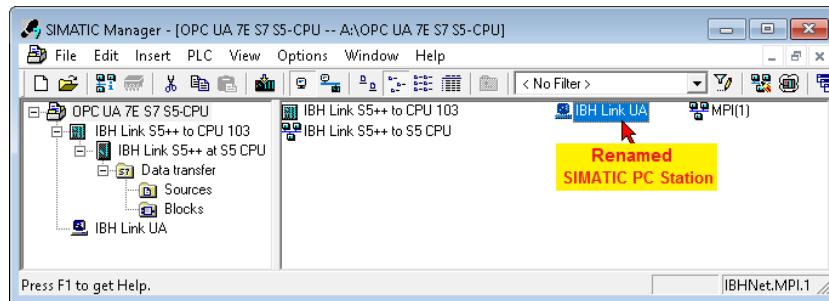
	Status	Symbol	Address	Data type	Comment
1		Min	M 1.3	BOOL	Minimum reached
2		Down	Q 2.5	BOOL	Output valve
3		On	I 0.1	BOOL	Control ON
4		Max	M 1.2	BOOL	Maximum reached
5		Up	Q 2.6	BOOL	Input valve
6		Tank_Level_values	DB 2	DB 2	Tank Values DB 2
7		Tank_Level_Control	FB 5	FB 5	Tank level control FB 5
8		Value	MW 2	INT	Tank level value
9		Cycle	OB 1	OB 1	Cycle OB1
10					

Press F1 to get Help.

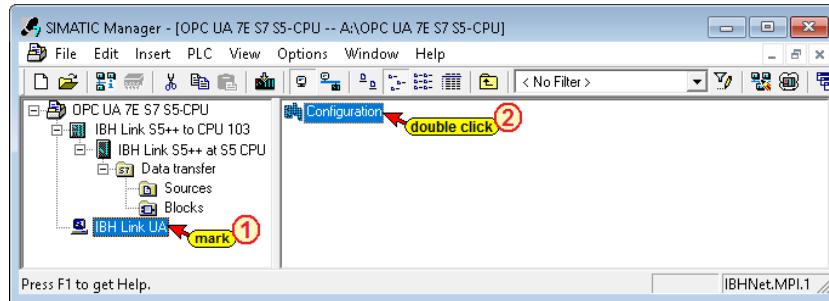
7.2.1 Insert the IBH Link UA as a SIMATIC PC station

With a right-click in the left window open the context menu and execute the command **Insert New Object / SIMATIC PC Station**.



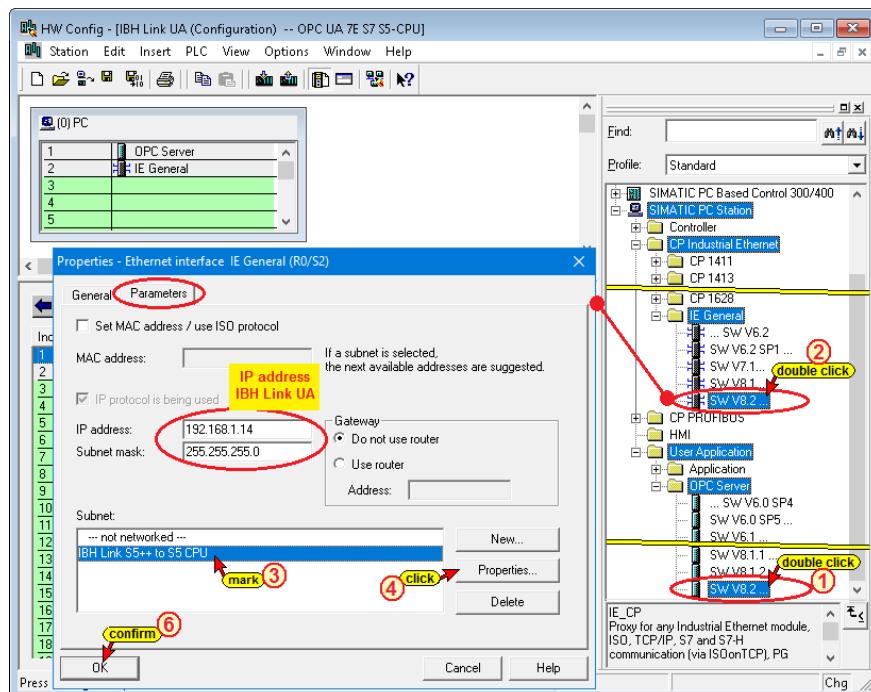


With a click in the left window on the renamed SIMATIC PC Station **IBH Link UA** and a double click in the right window on the configuration icon the hardware configurator is opened.



Configuration IBH Link UA (SIMATIC PC Station)

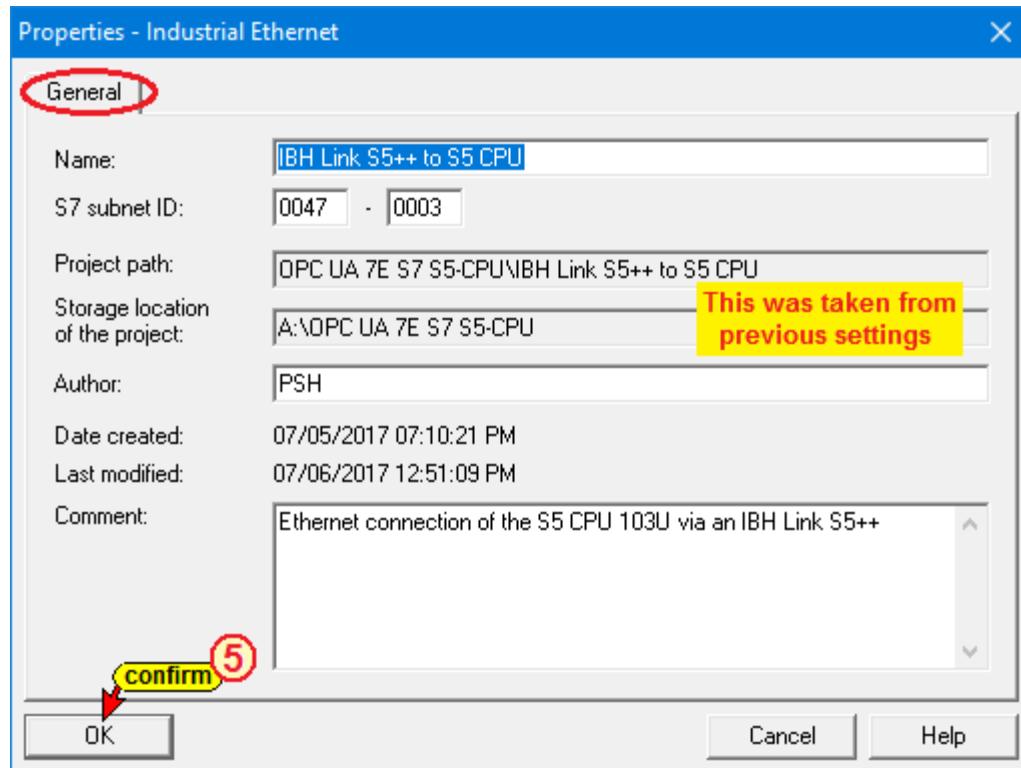
A double-click on <**SW V8.2 ...>** ① places the OPC server into the PC station. A further double click on <**IE General**> <**SW V8.2 ...>** ② opens the Properties dialog box - **Ethernet Interface IE General (R0/S2)**.



By clicking the steps ③ – ⑥ as shown in the screenshots the IP address and the subnet mask of the IBH Link UA, which were entered during configuration, are accepted.

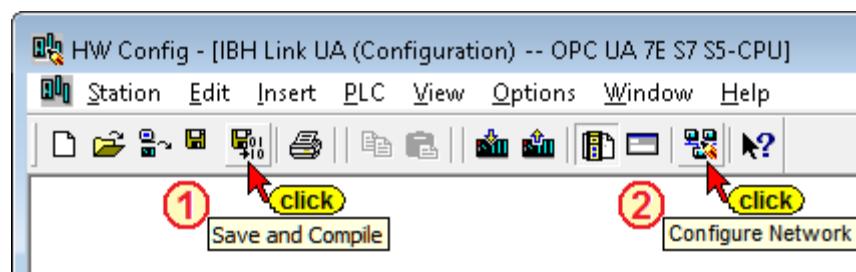
Properties – Industrial Ethernet dialog box

Clicking the button Properties in the Properties – Ethernet interface IE General (R0/S2) dialog box will show the previous made settings.



Save and compile the IBH Link UA configuration

Prior establishing the configuration between the IBH Link S5++ with the CPU 103 and the IBH Link UA the configuration must be compiled and saved.



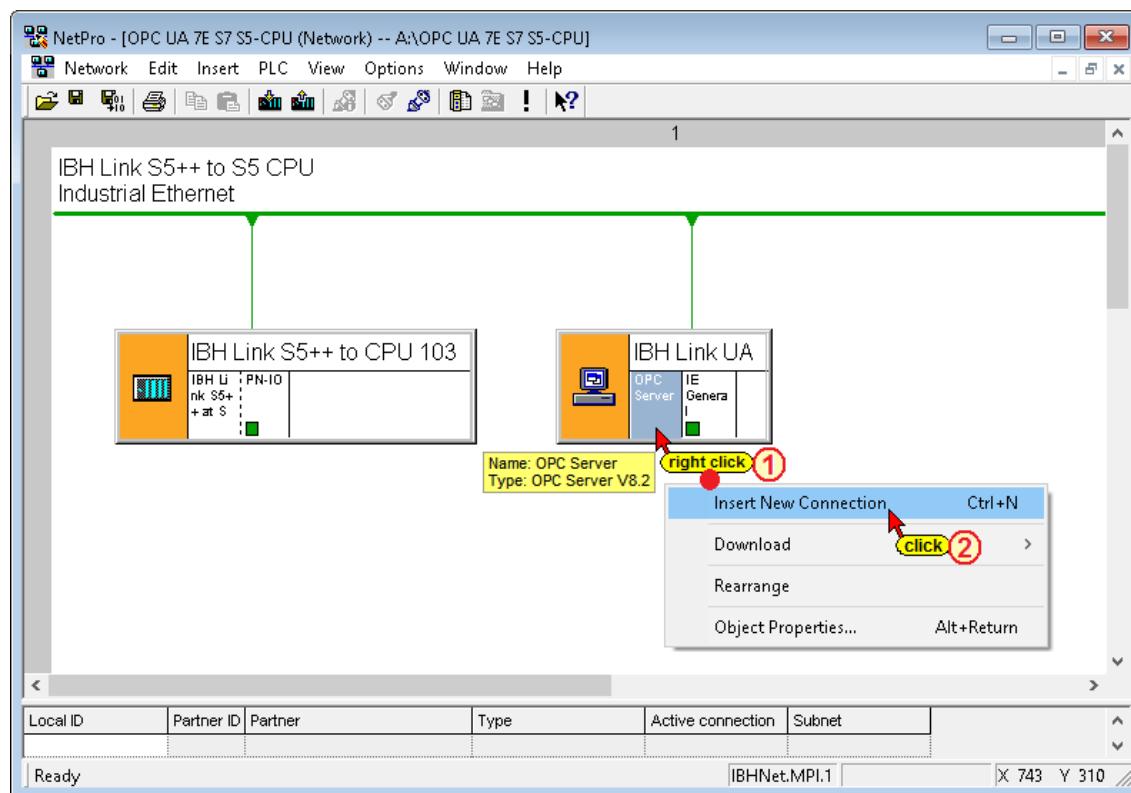
After saving and compiling, if no error is shown, click on the **Configure network** icon to open the NetPro window.



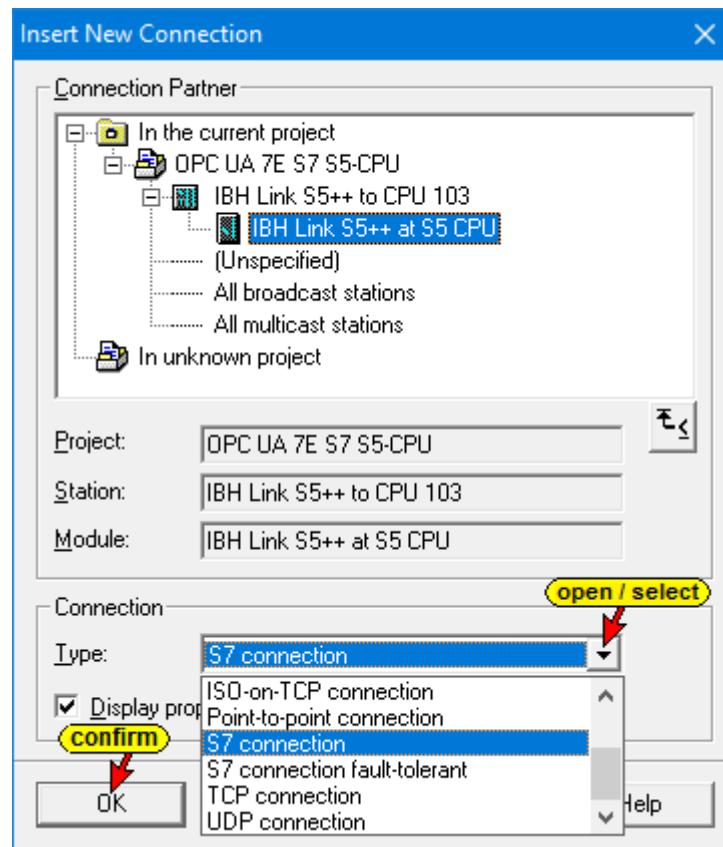
NetPro window – Insert new connection

If the saving and compilation was successful, the symbols of the network participants **IBH Link S5++ to CPU 103** and **IBH Link UA** displayed with an orange color background. A red background indicates an error and a white background stands for configuration not yet translated.

NetPro Window

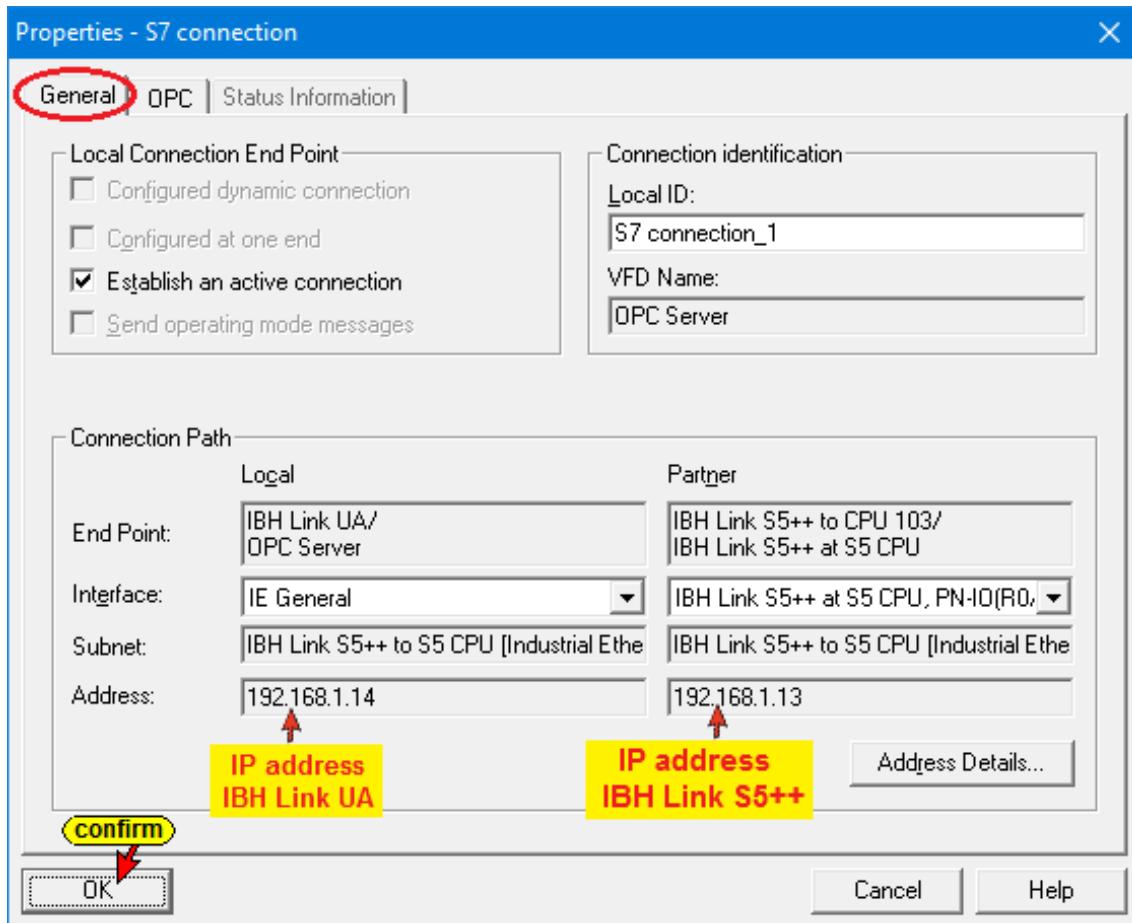


The **Insert New Connection** command opens the dialog box for specifying the S7 connection.



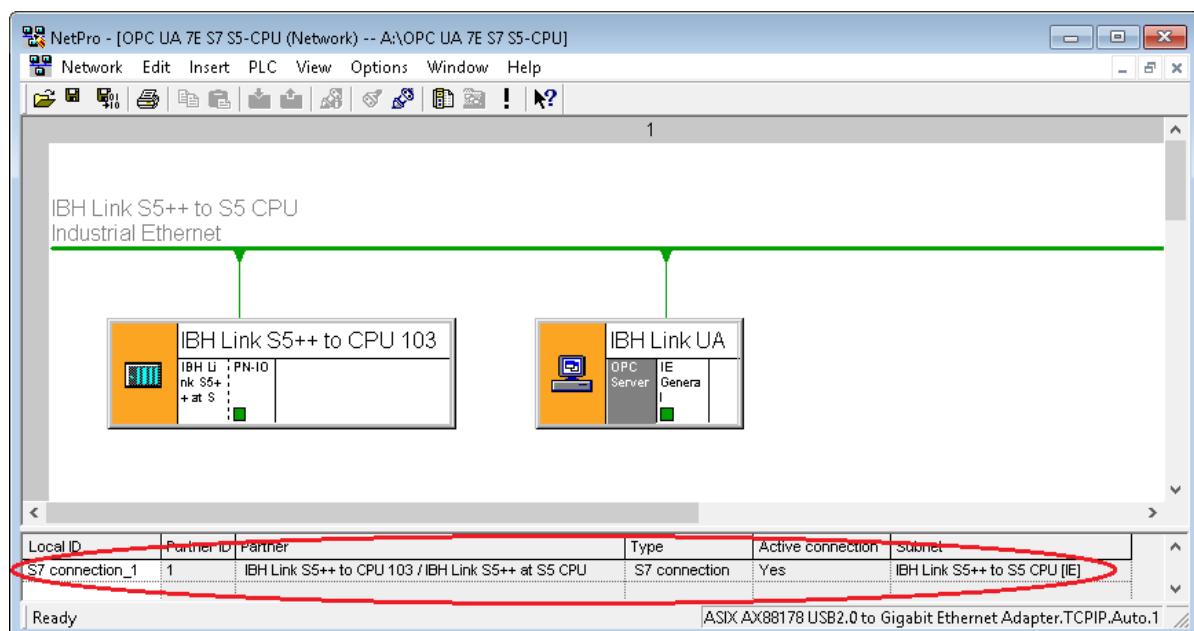
An S7 connection from the **IBH Link S5++ to CPU 103** to the **IBH Link S5++ at S5 CPU** (IM115-8 PN / DB CPU V3.2) must be defined.

In the open **Properties – S7 connection** dialog box lists the confirmed S7 connection.



Showing the S7 connection in the NetPro window

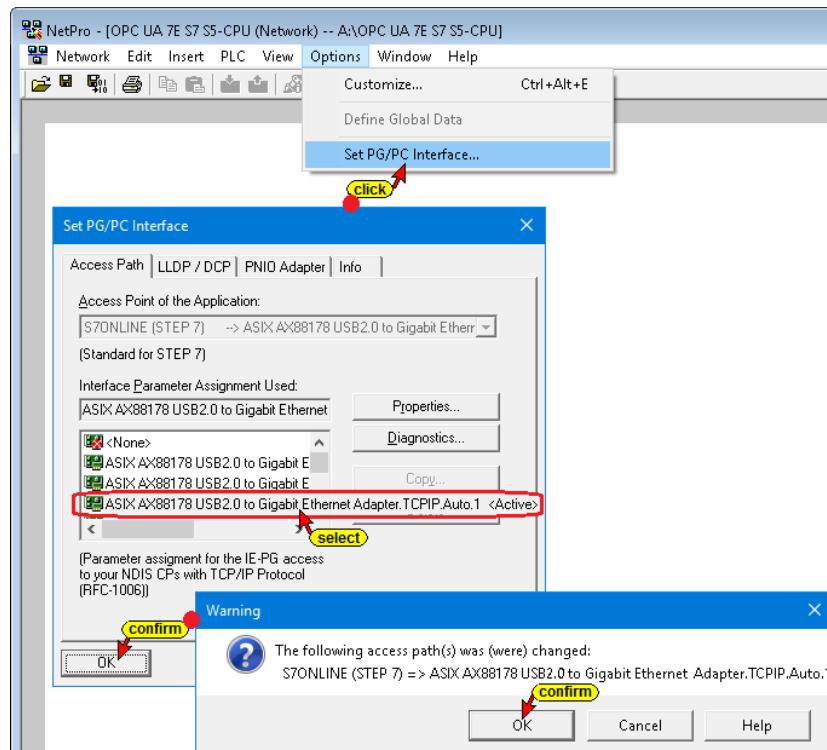
The S7 connection is displayed in the NetPro window.



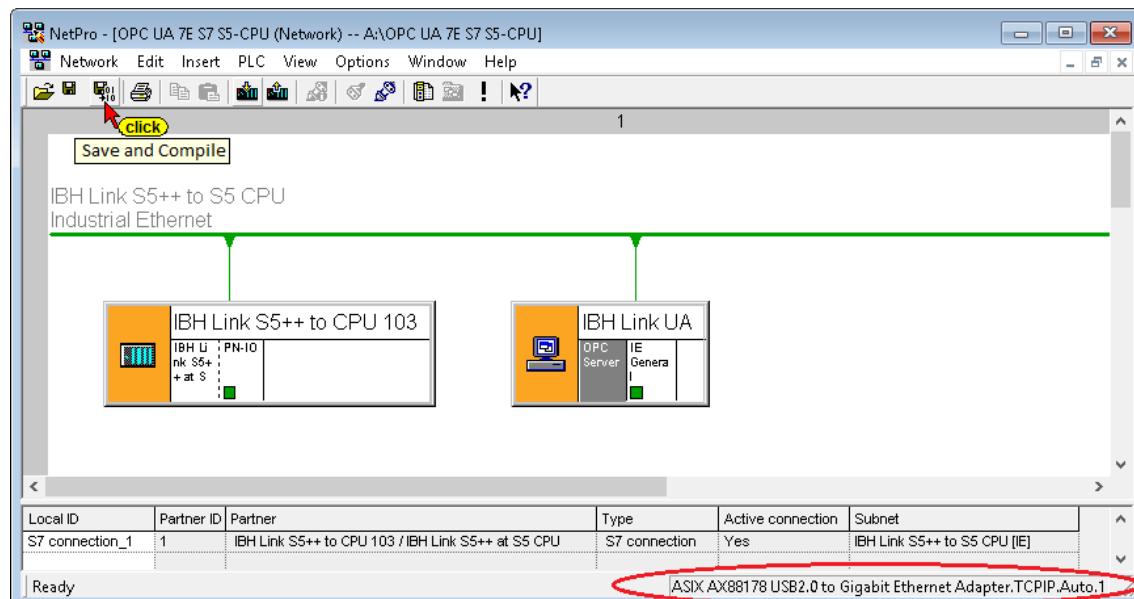
Prior loading the configuration into the modules, the interface to the modules must be set.

Set PG/PC interface as an Ethernet interface

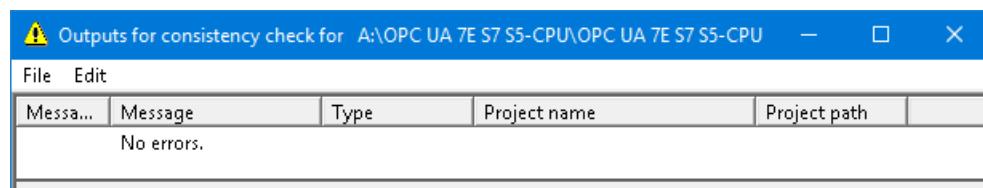
The name of the Ethernet connection may vary depending on the network card used in the PC.



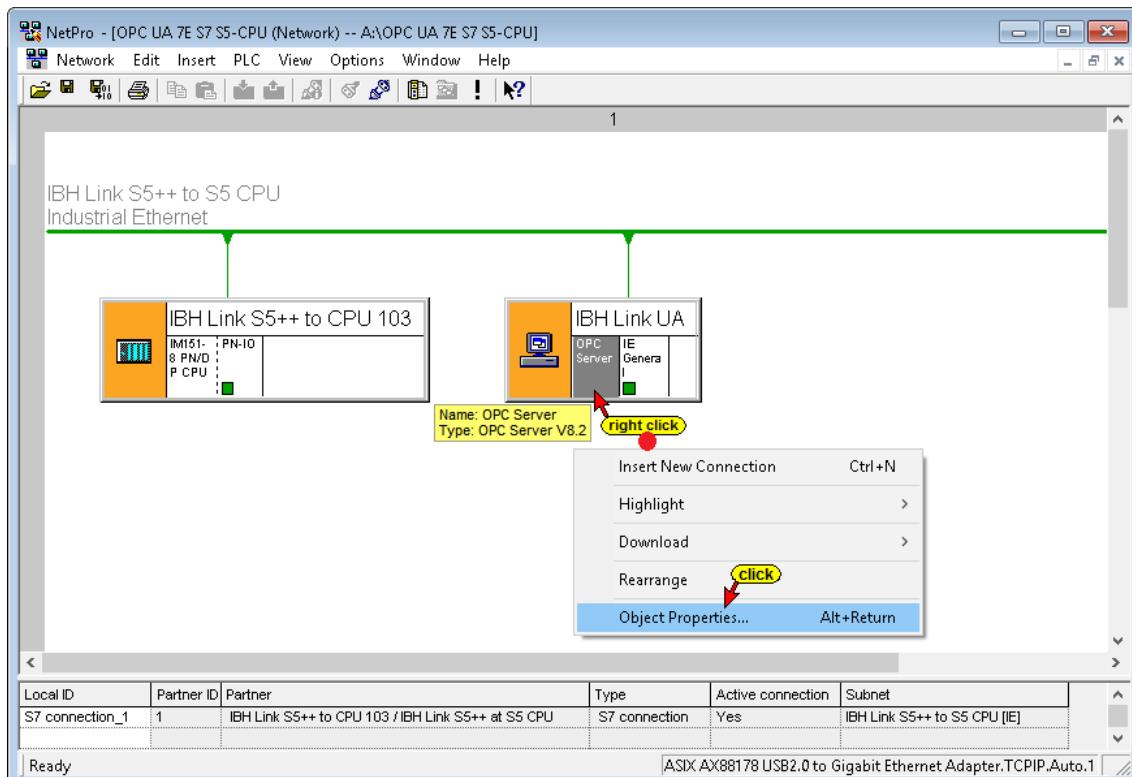
Save and translate the configuration, and load it into the IBH Link UA



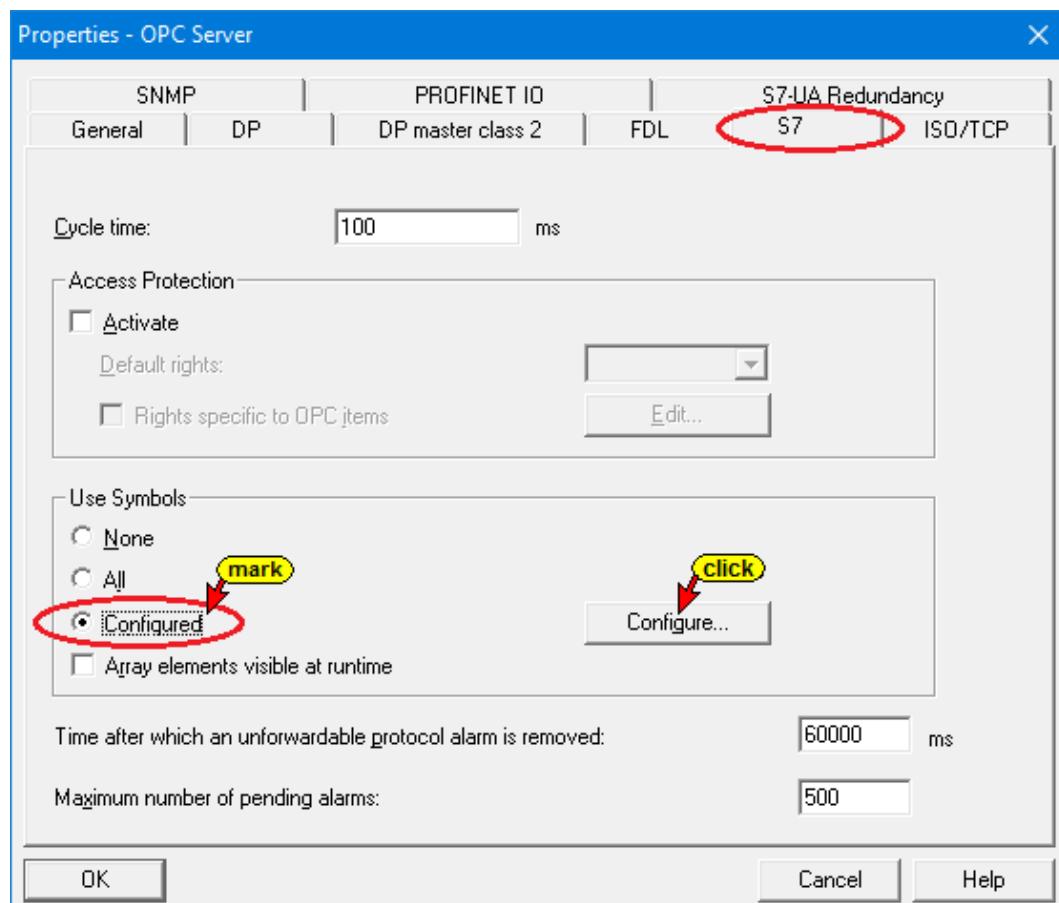
The successful compiling is displayed.



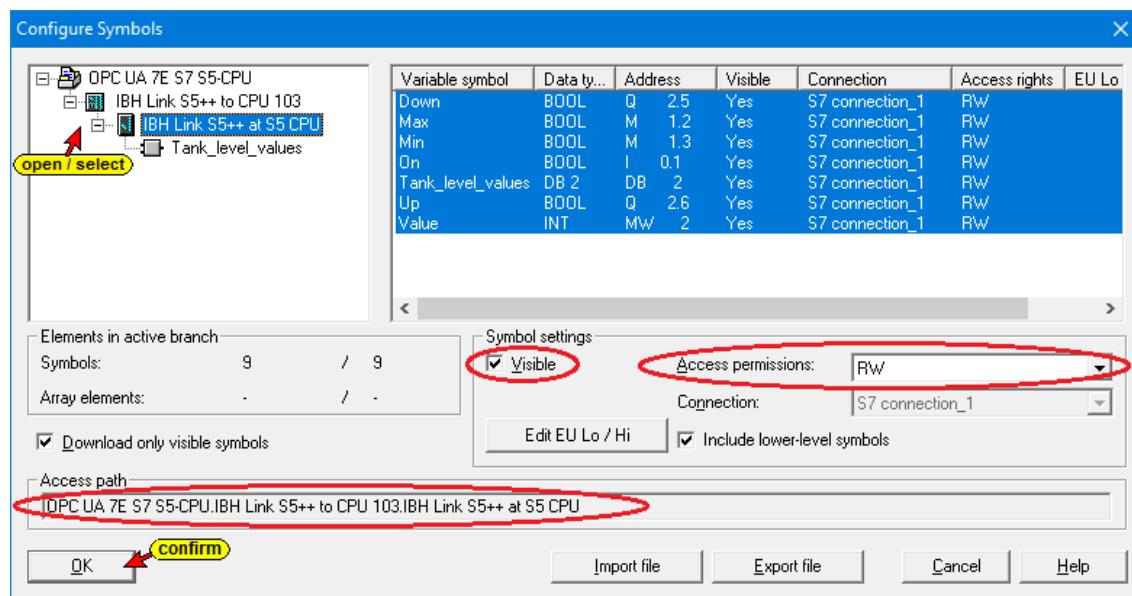
Select the symbols to be used (OPC tags)



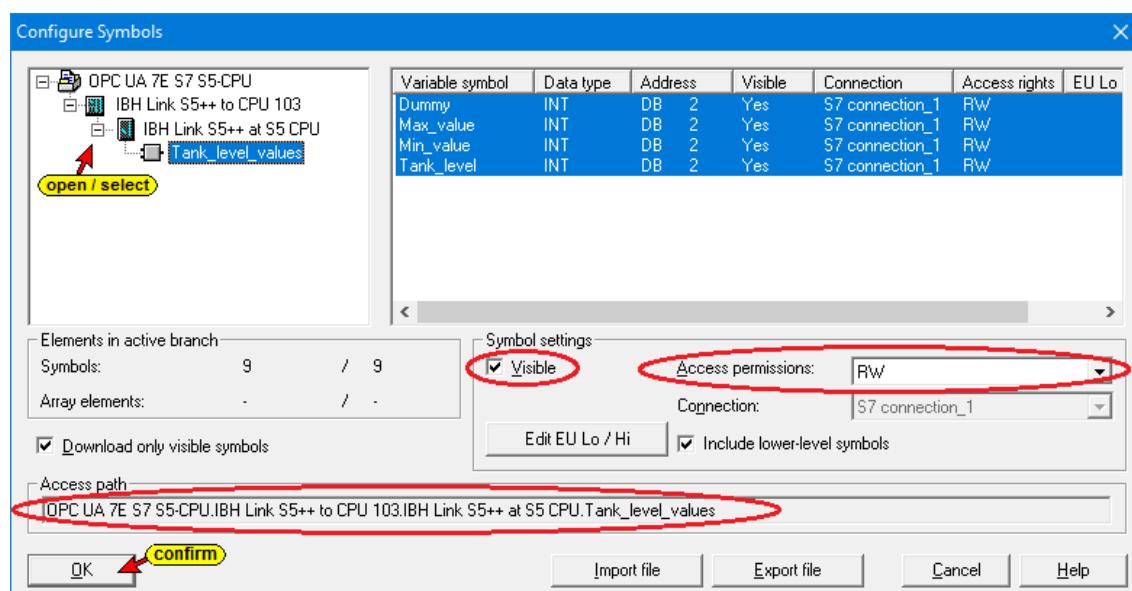
Clicking the **Object Properties** command starts the opening of several dialog boxes to define the symbols to be used for the S7 connection.



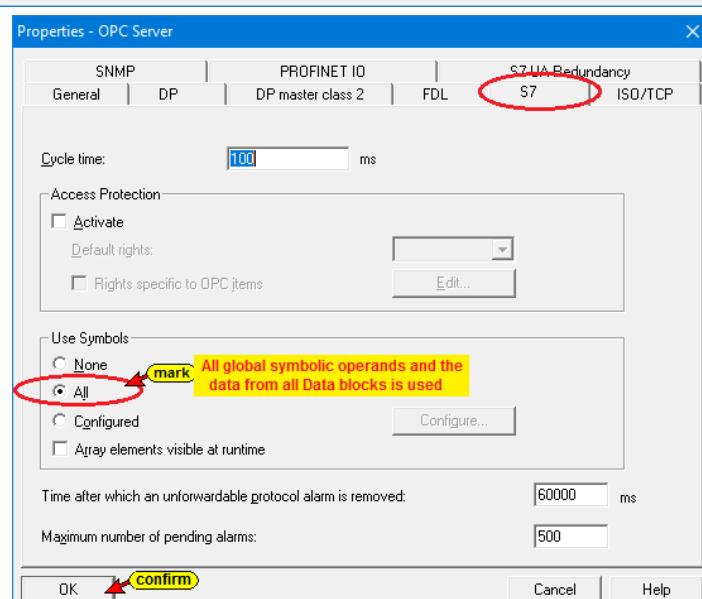
Configurable global symbolic named operands



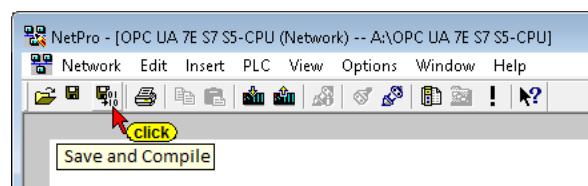
Data from data block DB 2 Tank_level_values



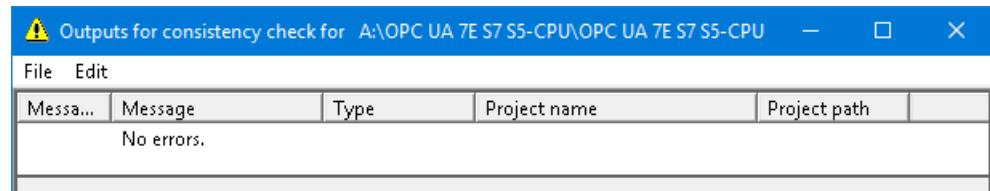
If all global symbolic operands and the data from all Data Blocks should be used as OPC Tags mark **All** in the **Properties – OPC Server** dialog box.



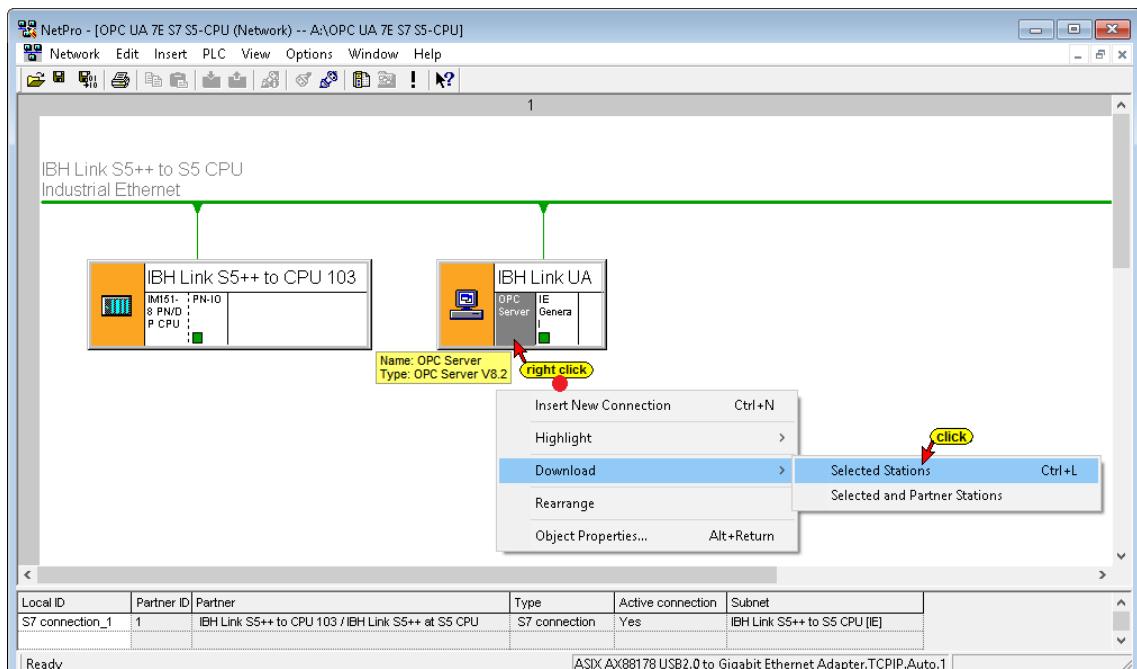
Save and Compile the configuration



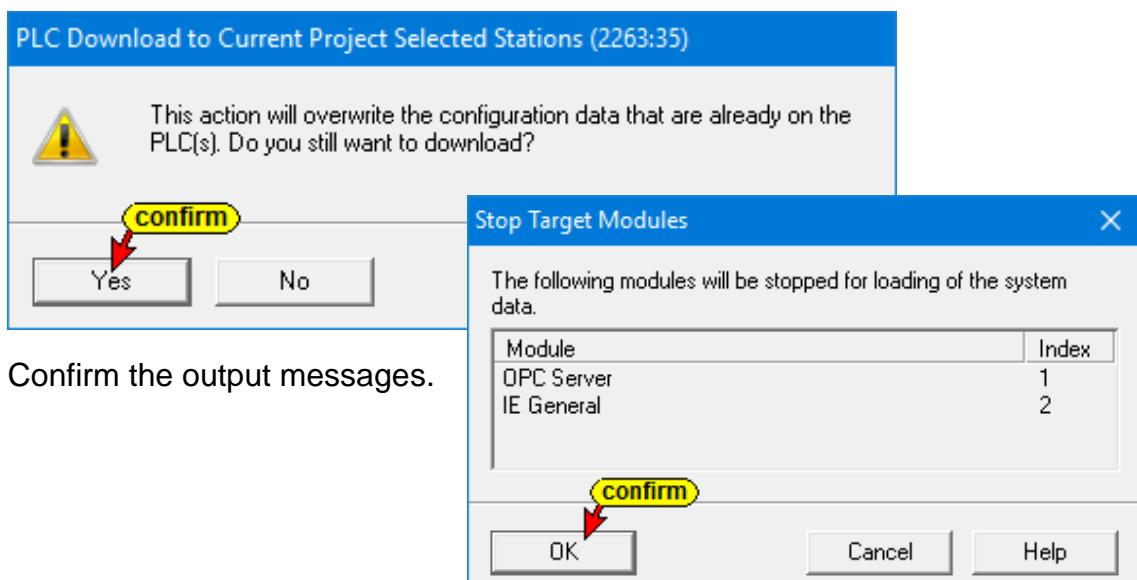
The successful compiling and saving is displayed.



Load the configuration into the IBH Link UA

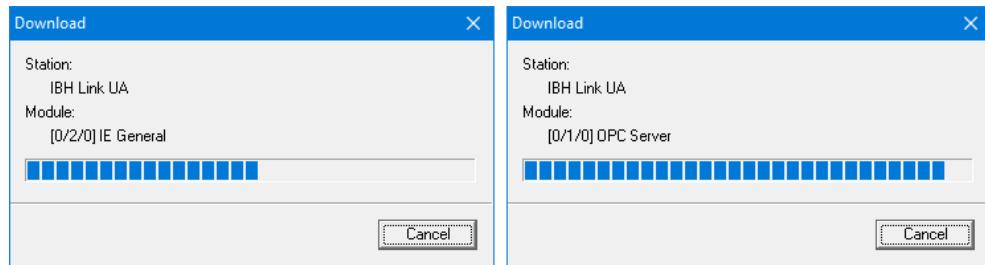


Loading the configuration into the IBH Link UA



Confirm the output messages.

The progress downloading the configuration into the IE General- and the OPC Server -module are shown.



OPC tags in the UaExpert window

#	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Statuscode
1	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Down	true	Boolean	19:10:51.971	19:10:52.472	Good
2	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Max	false	Boolean	19:10:39.791	19:10:40.440	Good
3	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Min	false	Boolean	19:10:41.839	19:10:42.445	Good
4	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	On	true	Boolean	19:10:44.279	19:10:45.452	Good
5	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Up	false	Boolean	19:10:51.971	19:10:52.472	Good
6	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[Int16]BH...	Value	1023	Int16	19:11:27.312	19:11:27.814	Good
7	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Dummy	0	Int16	19:10:39.355	19:10:51.469	Good
8	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Max_value	10000	Int16	19:10:54.923	19:10:55.720	Good
9	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[String]BH...	Min_value	100	Int16	19:10:57.000	19:10:57.735	Good
10	IBHLinkUA@ibhlinkua_001037 - None - None (uatcp-uasc-uabinary)	NS4[Int16]BH...	Tank_level	1087	Int16	19:11:27.312	19:11:27.814	Good

Online, the changes of the values in the S5 program are shown.

Operand	Contents	Modify value
-On	KM 1	Control ON
-Up	KM 0	Input value
-Down	KM 1	Output value
-Value	KF +4639	Tank level value
-Tank_level_values	---	Tank Values DB 2
-Min_value	KH 0064	Tank filled less than 10%
-Max_value	KH 2710	Tank filled more than 90%
-Dummy	KH 0000	Dummy
-Tank_Level	KF +4640	Tank level value

7.3 Project S5 CPU to OPC UA in the TIA portal

The following example explains the creation of a project with the TIA 14 / TIA 15 portal with the connection of an S5 CPU 103U and the IBH Link UA via an Ethernet link via IBH Link S5++.

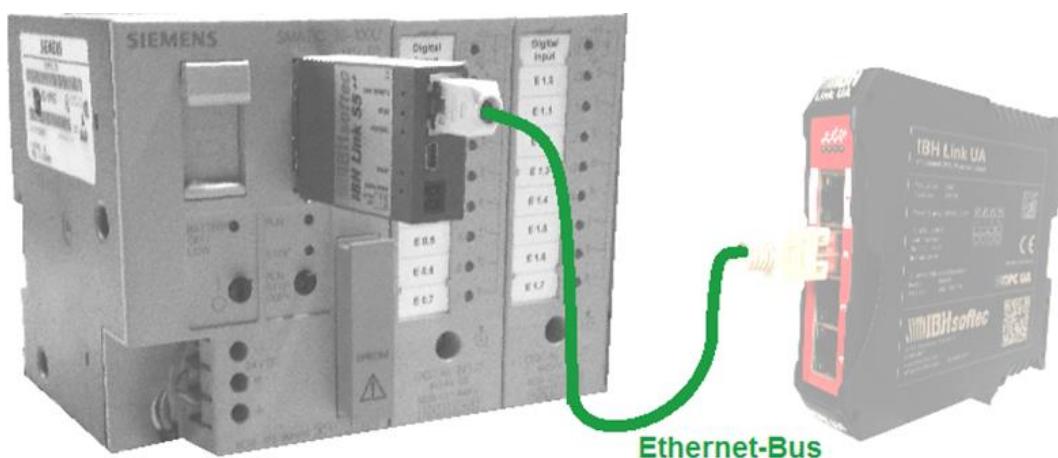


IBH Link S5++

The IBH Link S5++ is an Ethernet converter. The protocol used is the usual standard TCP/IP. All the advantages of Ethernet are thus without any problems to the user.



The use of SimaticNet as well as the use of CP communication processors are neither necessary on the PC nor on the PLC side.



The prepared sample program, executed in the S5 CPU 103U, is identical to the PLC program **Tank Level S5** as described in the chapter 3.1.1. It simulates the filling and emptying of a tank.

The S5 program **TANK-PST.S5D** (or tank level **S5.S5P**) was loaded into the CPU S5 103U with the STEP 5 programming system **S5 for Windows** by IBHsoftec.

The SIEMENS PLC programming system SIMATIC Manager STEP 7 V5.5 is used to create the network configuration.

IBH Link UA configuration using the TIA 15 portal

S5 controllers do not have an Ethernet connection as standard.

If no communication processors with Ethernet interface are available, the IBH Link S5++ can be used to establish an Ethernet connection between the S5 CPU and the IBH Link UA.

Note:

The IM 151-8 PN / DP CPU V3.2 interface module provides a PROFINET interface with an integrated switch.

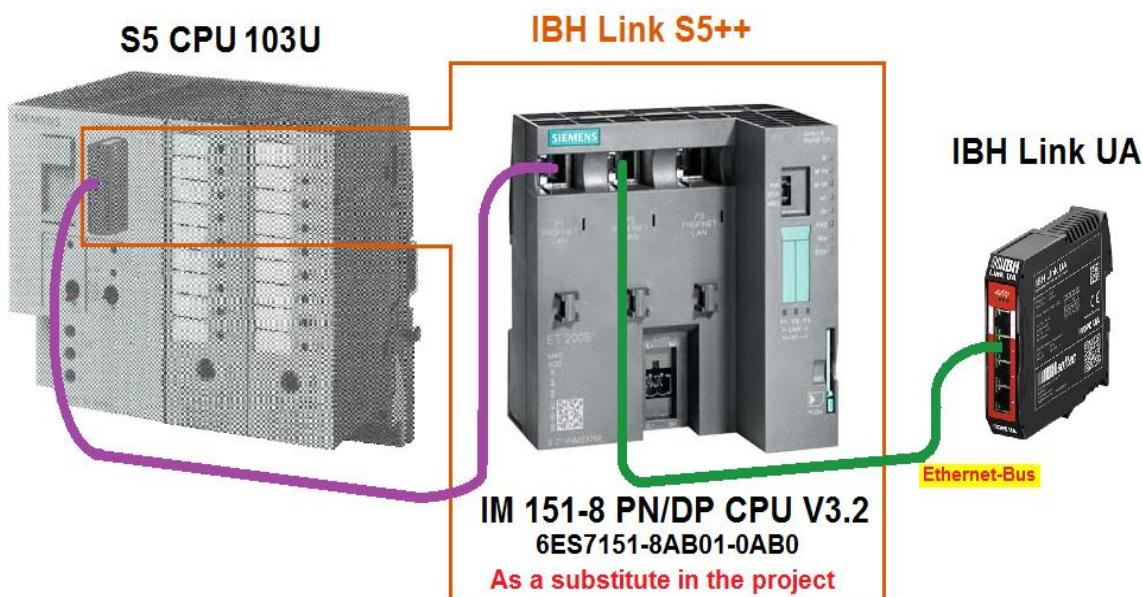
Via the PROFINET interface, PG communication and S7 communication are possible.

The IM 151-8 PN / DP CPU V3.2 interface module is available in the hardware catalog of the TIA Portal and STEP 7 (Simatic Manager).

The firmware of the IBH Link S5++ emulates the PROFINET interfaces of the IM 151-8 PN / DP CPU V3.2 (6ES7 151-8AB01-0AB0 V3.2) as far as this is required for the communication between the S5 CPU PG interface and the IBH Link UA Ethernet Port.

The following properties are available (compatible with the IM 151-8 PN / DP CPU V3.2):

Interface / Bus	Protocol
1x PROFINET (1 Port)	PG-Communication
1x PROFINET (1 Port)	ISO-on-TCP (RFC1006)



The symbol table for defining the OPC tags is available in the S5 CPU UA project. The hardware components necessary for the communication between the S5 CPU and the IBH Link UA are already specified.

S5 PLC Program: Tank level S5

The PLC Program simulates the filling and emptying of a tank.

- The tank is equipped with a "level indicator". This tank value level (**Value**) is displayed.

- The tank level is controlled between a minimum (**Min**) and a maximum (**Max**).
- The control can be switched on (**On**).
- The valves (**Up – Input valve, Down – Output valve**) to control the tank level are displayed.

S5 Symbolic table (Tank level S5)

The following operands are used in the S5 program. They are defined in the symbol table of the S5 program and should be available as OPC tags.

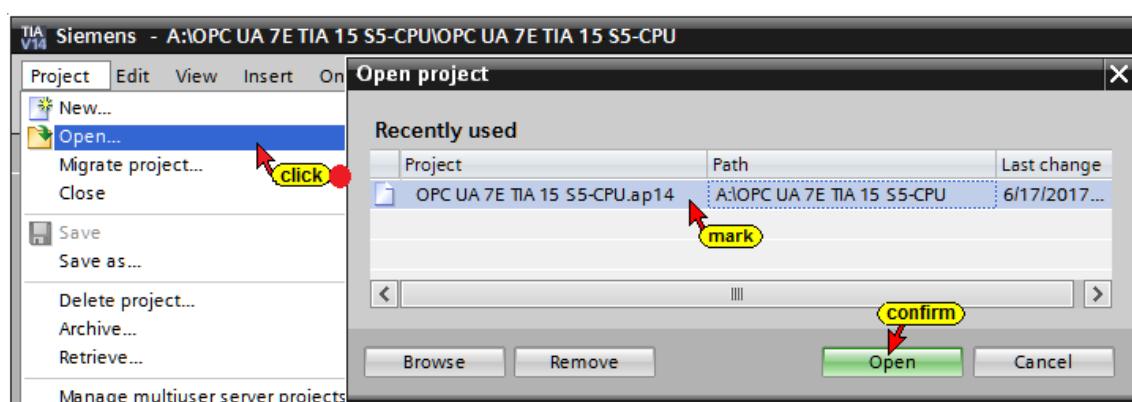
Symbol	Operand	Comment
On	I 0.1	Control ON
Max	F 1.2	Maximum reached
Min	F 1.3	Minimum reached
Value	FW 2	Tank level value
Cycle	OB 1	Cycle OB1
Down	Q 2.5	Output valve
Up	Q 2.6	Input valve
Tank_level_values	DB 2	Tank Values DB 2
Tank_level_control	FB 5	Tank level control FB 5
Min_value	DW 0	Tank filled less than 10%
Max_value	DW 1	Tank filled more than 90%
Dummy	DW 2	Dummy
Tank_Level	DW 3	Tank level value Not possible in the TIA 14 Portal

The operands are transferred to the **Default tag table_1** of the **IM 151-8 PN/DP CPU V3.2**.

These variables will be routed via the **IBH Link S5++** to the OPC-Server **IBH Link UA**

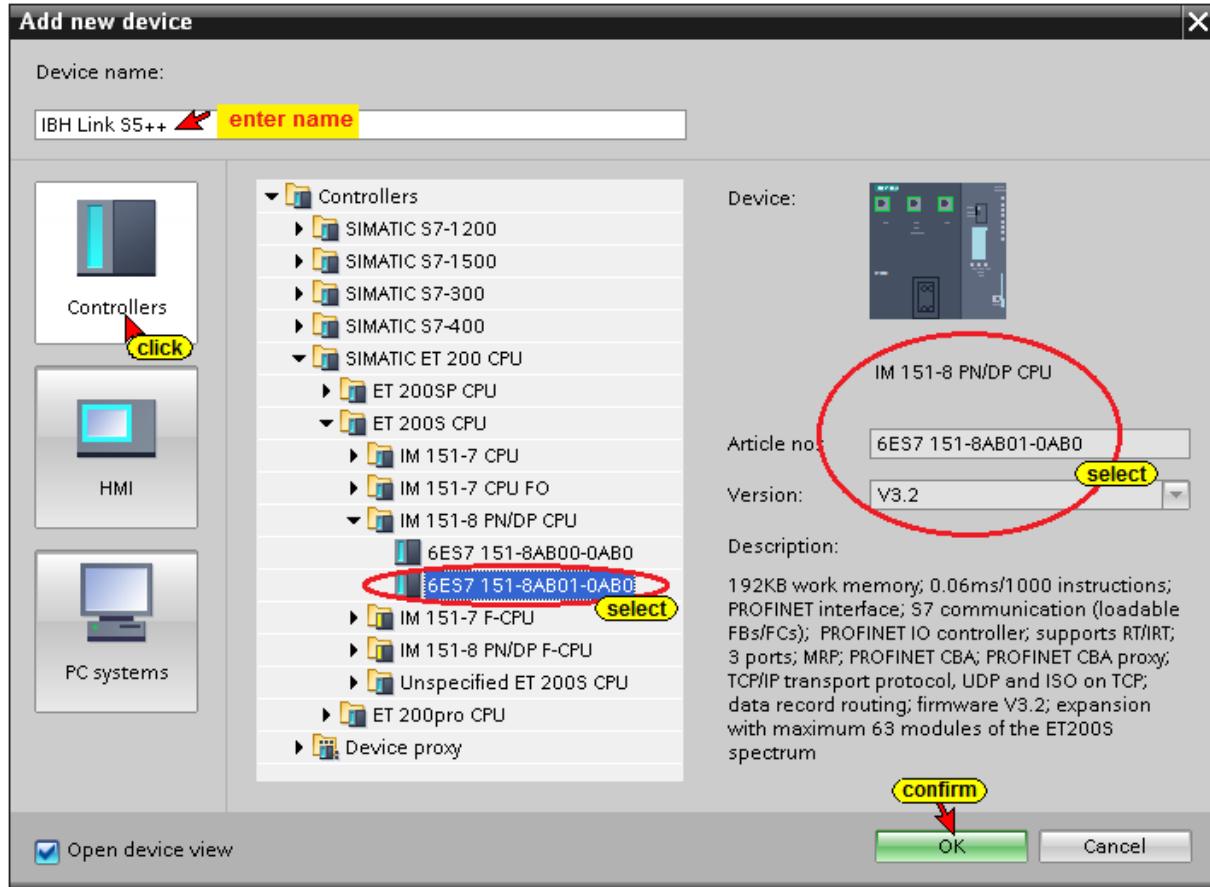
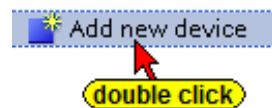
7.4 Creating the project in the TIA 15 Portal

Open the TIA 14 Portal example project **OPC UA 7E TIA 15 S5-CPU TIA 15** or create a new project with this name.



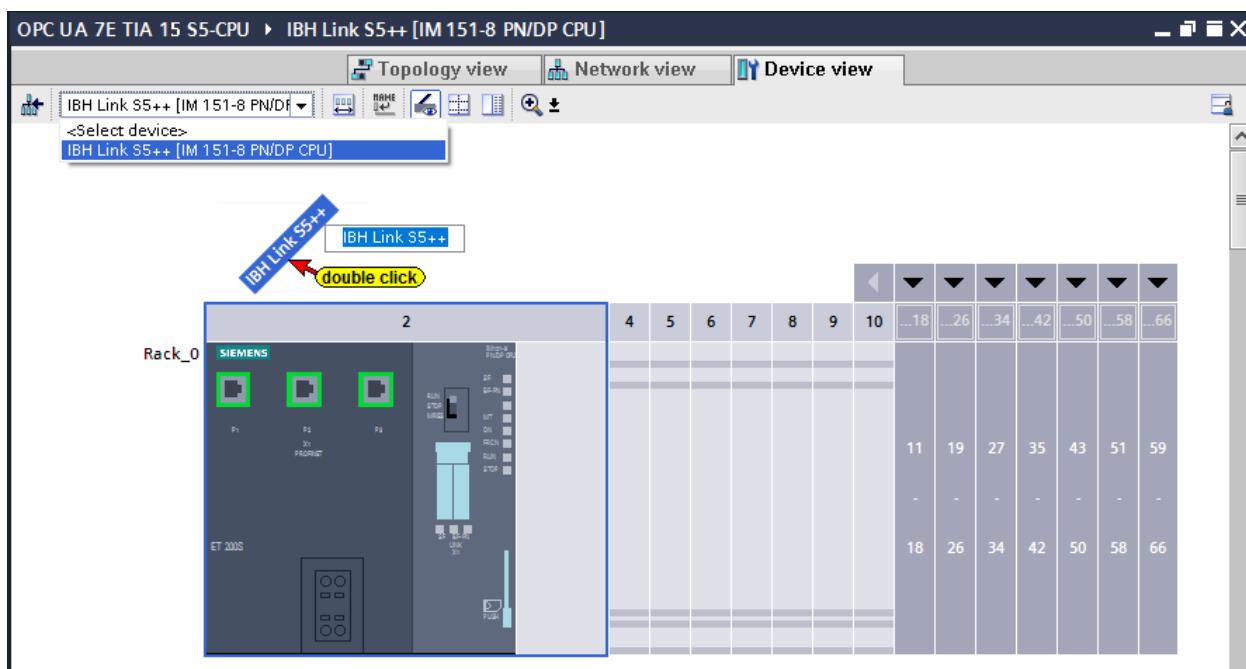
Insert the IM115-8 PN / DB CPU V3.2 device into the project

Double-click **Add New Device** to open the dialog box for selecting the modules.

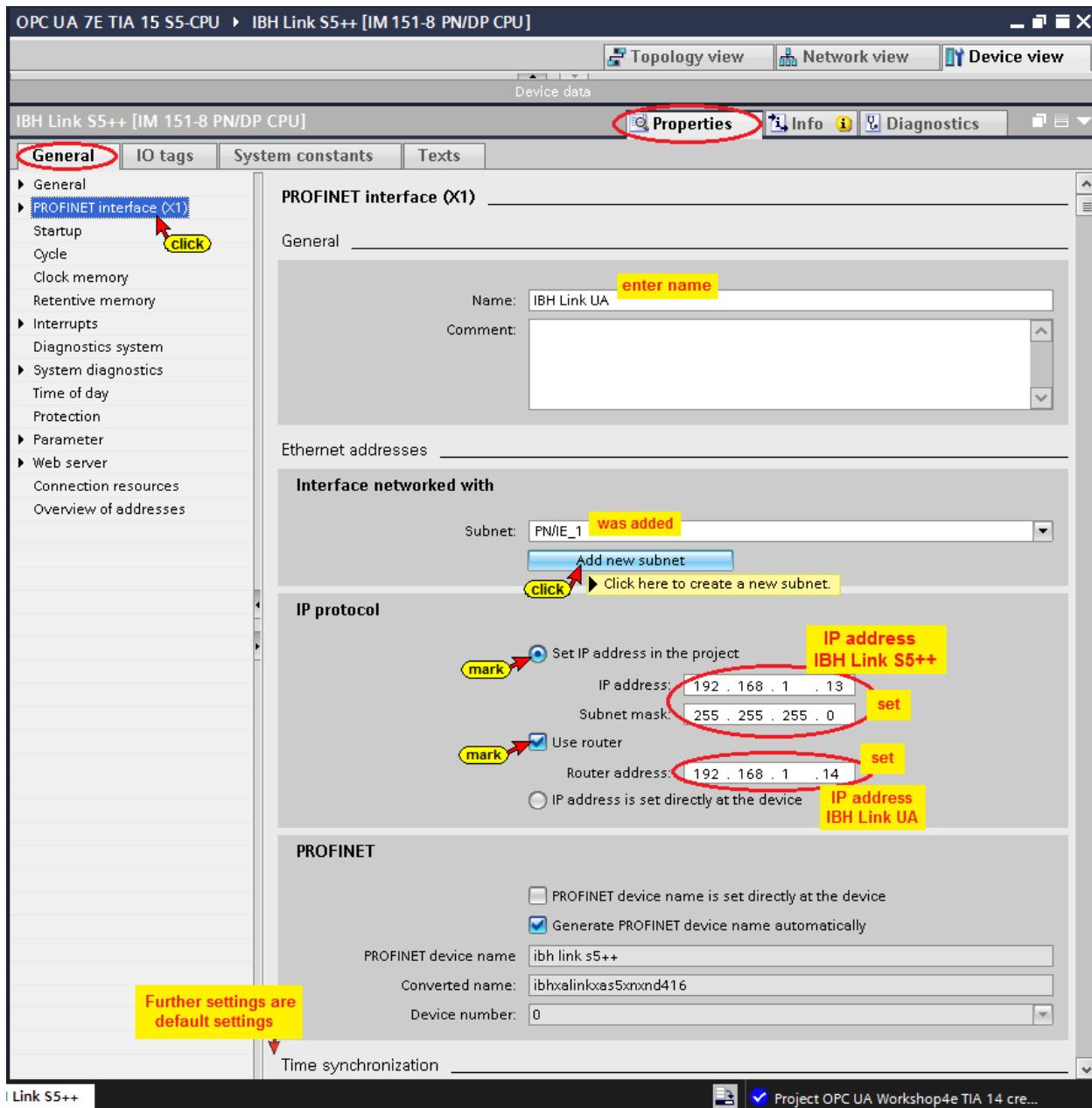


IBH Link S5++ (IM 115-8 PN/DP CPU) property configuration

The IBH Link S5++ (renamed IM 115-8 PN/DP CPU) is displayed in the **Device view**.



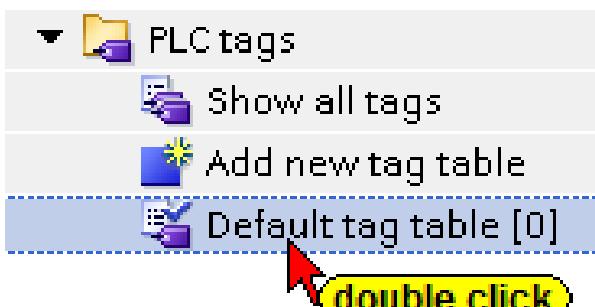
The Properties dialog box opens.



Set OPC tags (symbols) in the Default tag table

Double-clicking the command **Default tag table** opens the variable table. In this table, operands defined in the **symbol table of the S5 program** (Tank Level S5.SEQ) must be entered to allow them to be as OPC tags (OPC symbols) to be used by the OPC server.

A direct import of the S5 program symbol table (Tank Level S5.SEQ) as in STEP 7 is not possible in the TIA portal.



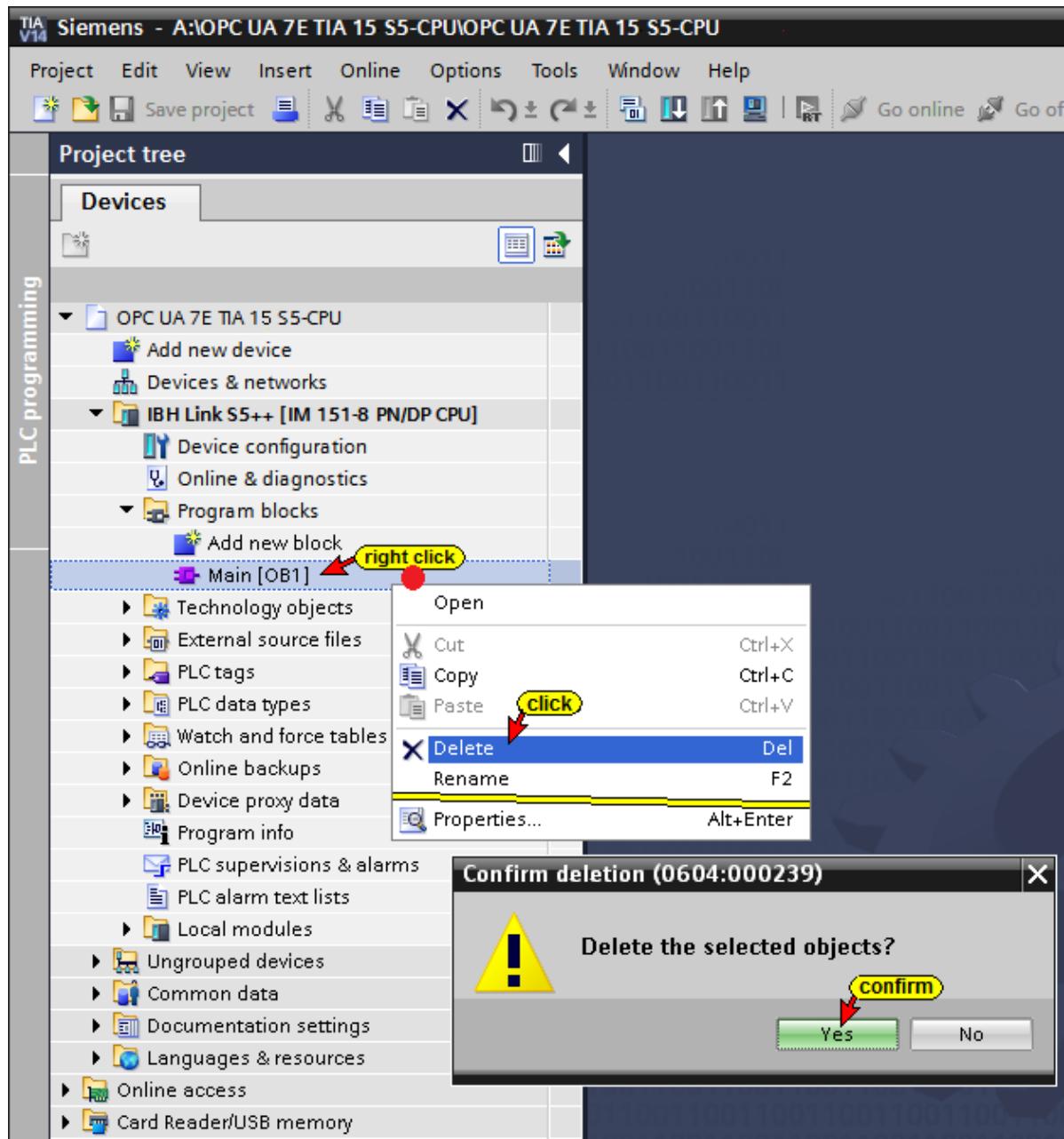
Default tag table

OPC UA 7E TIA 15 S5-CPU > IBH Link S5++ [IM 151-8 PN/DP CPU] > PLC tags > Default tag table [6]

	Name	Data type	Address	Comment
1	On	Bool	%IO.1	Tank level control ON
2	Down	Bool	%Q2.5	Count down to pre set value Tank empty
3	Up	Bool	%Q2.6	Count up to re set value Tank full
4	Max	Bool	%M1.2	Maximum reached
5	Min	Bool	%M1.3	Minimum reached
6	Value	Int	%MW2	Analog value (simulation)

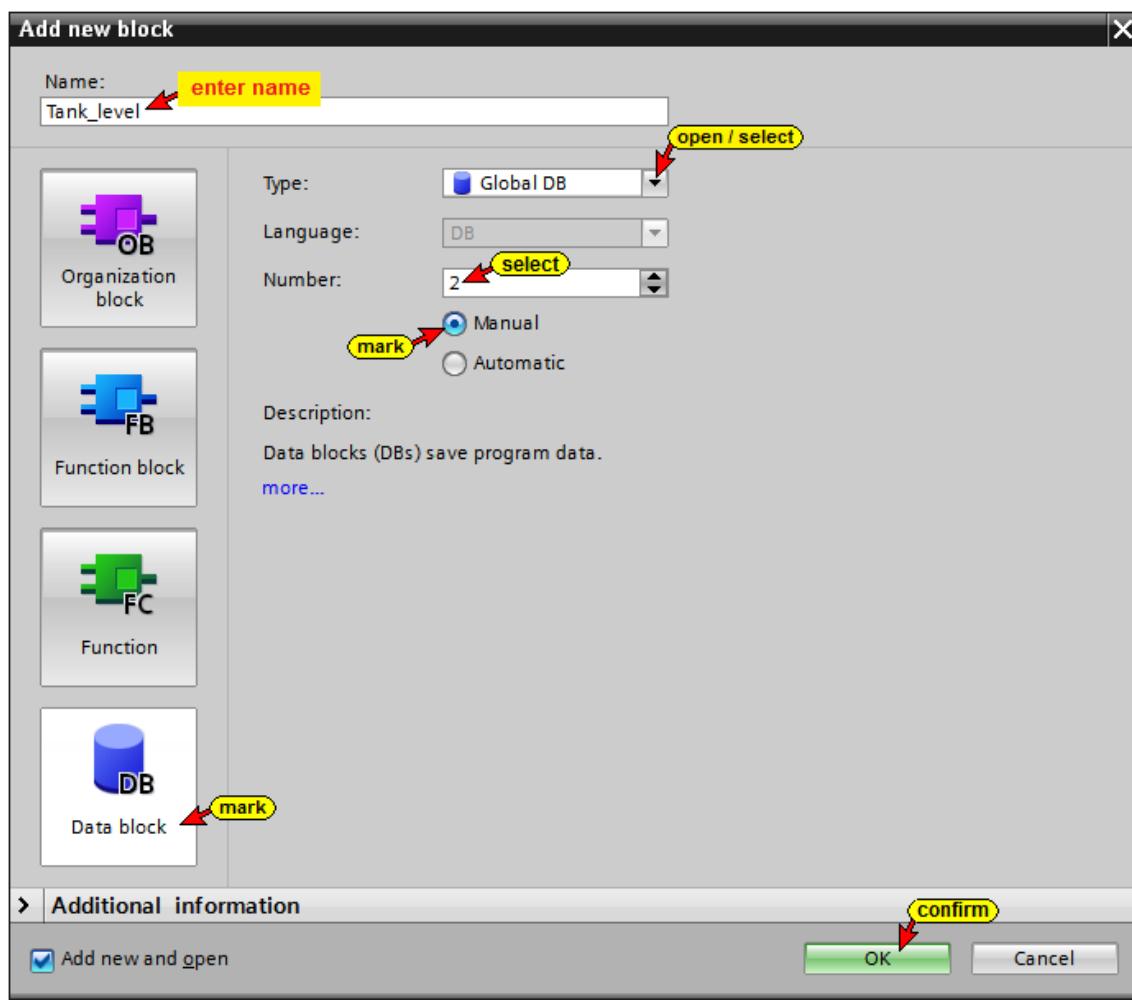
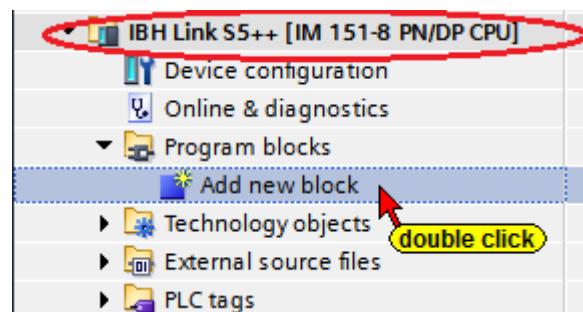
Delete PLC Block OB1

Only data can be transferred using the IBH Link S5++. All PLC program blocks, except data blocks, must therefore be deleted in the Profinet I/O CPU.



Creating Data Block DB 2

Double-click the command **Add new block** to open the dialog box for creating the desired block (DB 2). A symbolic name must be assigned to the data block. This is required to allow the data to be defined as OPC tags (OPC symbols) for the use of the OPC server.

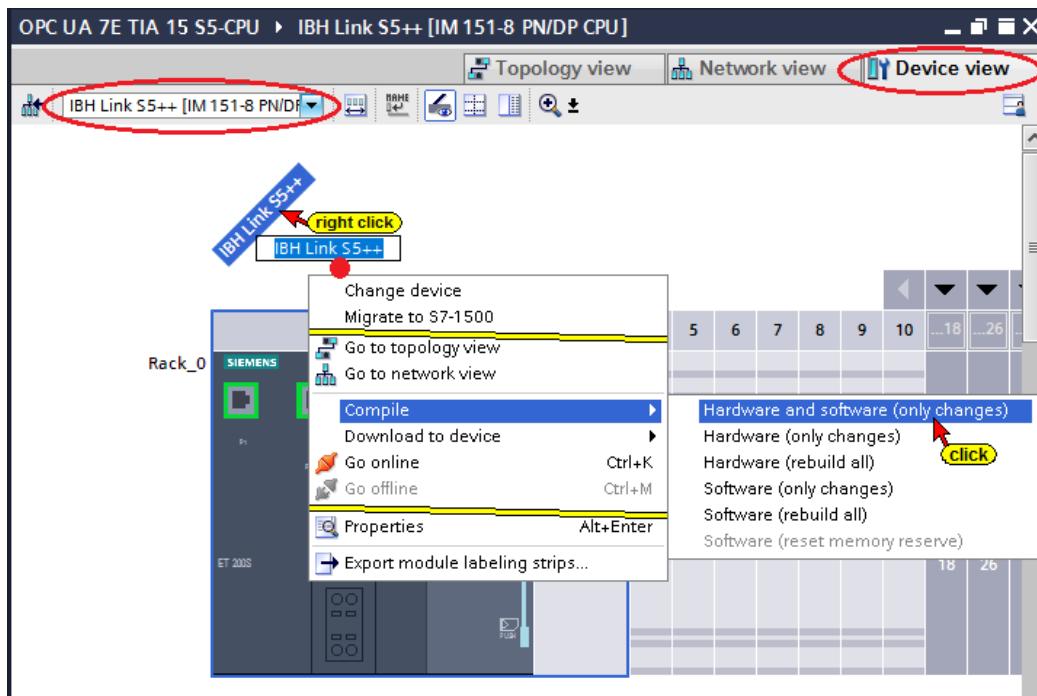


Data block DB2

OPC UA 7E TIA 15 S5-CPU > IBH Link S5++ [IM 151-8 PN/DP CPU] > Program blocks > Tank_level [DB2]			
Keep actual values Snapshot Copy snapshots to start values			
Tank_level			
Name	Data type	Start value	Comment
1 ▾ Static			
2 ▾ Min_value	Int	100	Tank filled less than 10%
3 ▾ Max_value	Int	10000	Tank filled more than 90%
4 ▾ Dummy	Int	0	Dummy
5 ▾ Tank_level	Int	0	Tank level value
6 ▾ <Add new>			

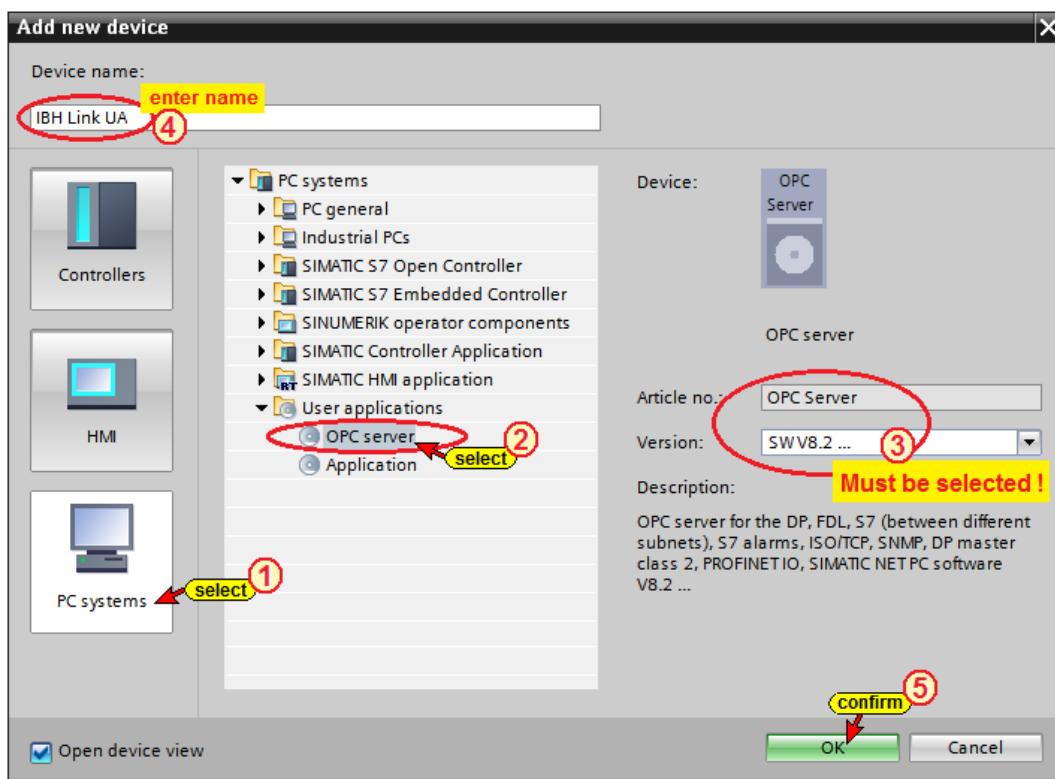
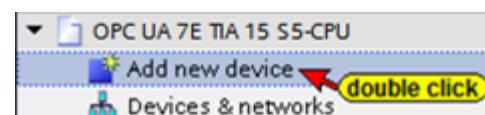
Hardware (IBH Link S5++) compilation

To detect errors the hardware configuration (**IM115-8 PN/DB CPU**) should be compiled. It is not possible to load PLC blocks in the device (**IBH Link S5++**).



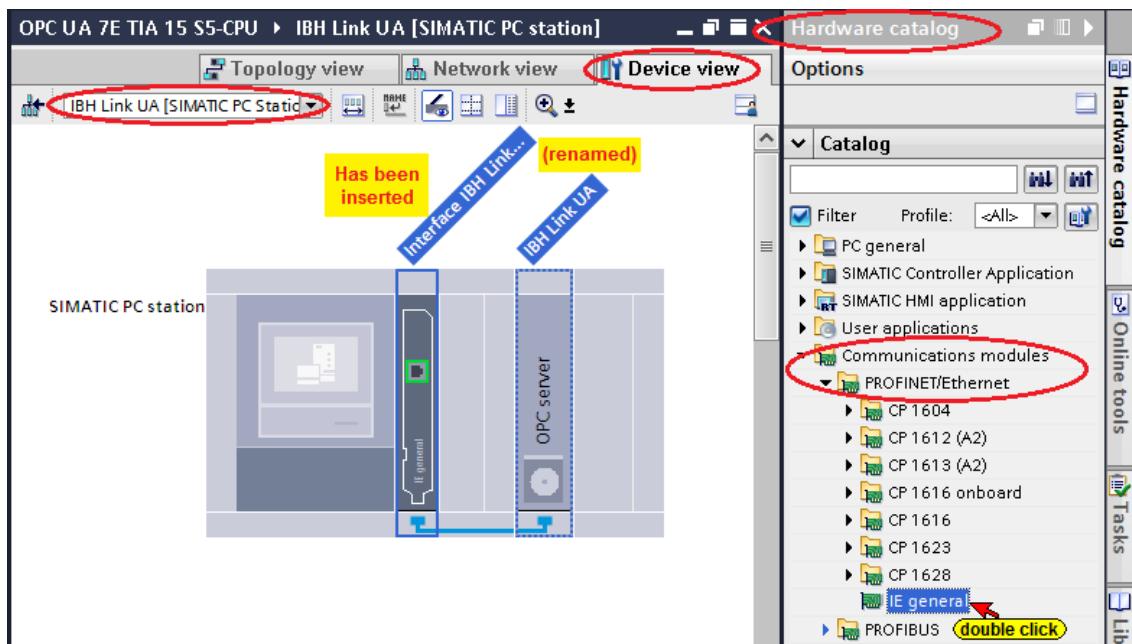
Insert the IBH Link UA as SIMATIC PC station

Double-click Add New Device to open the dialog box for selecting the modules.

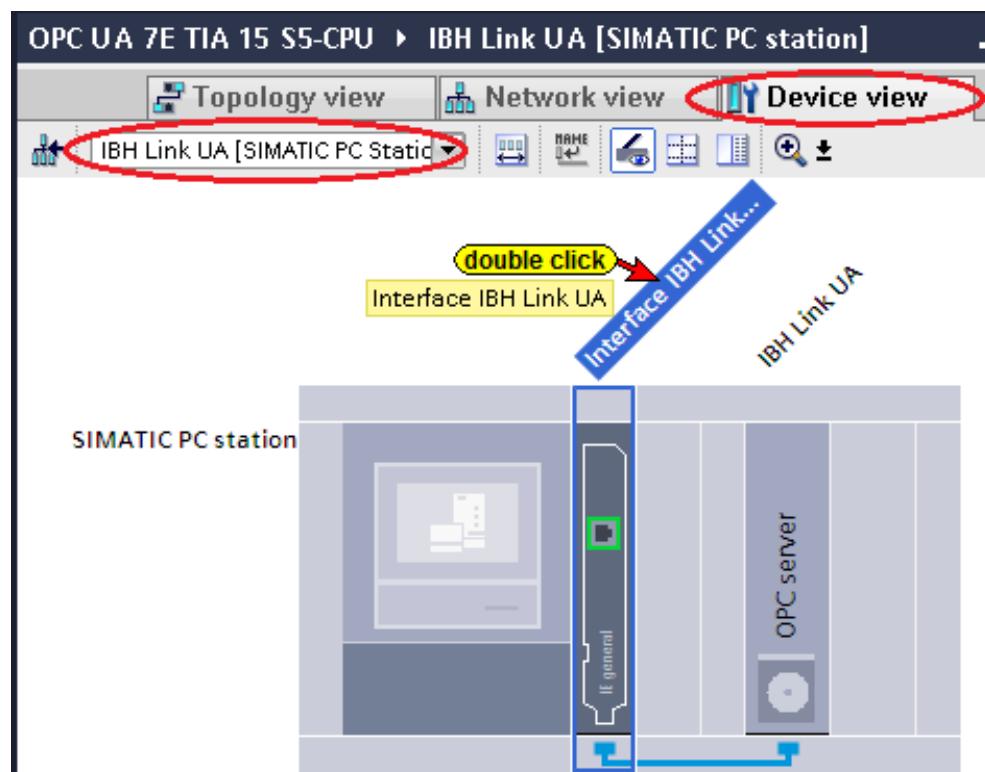


Insert the communication module into the IBH Link UA

Open the hardware catalog and define the communication module **IE general**.



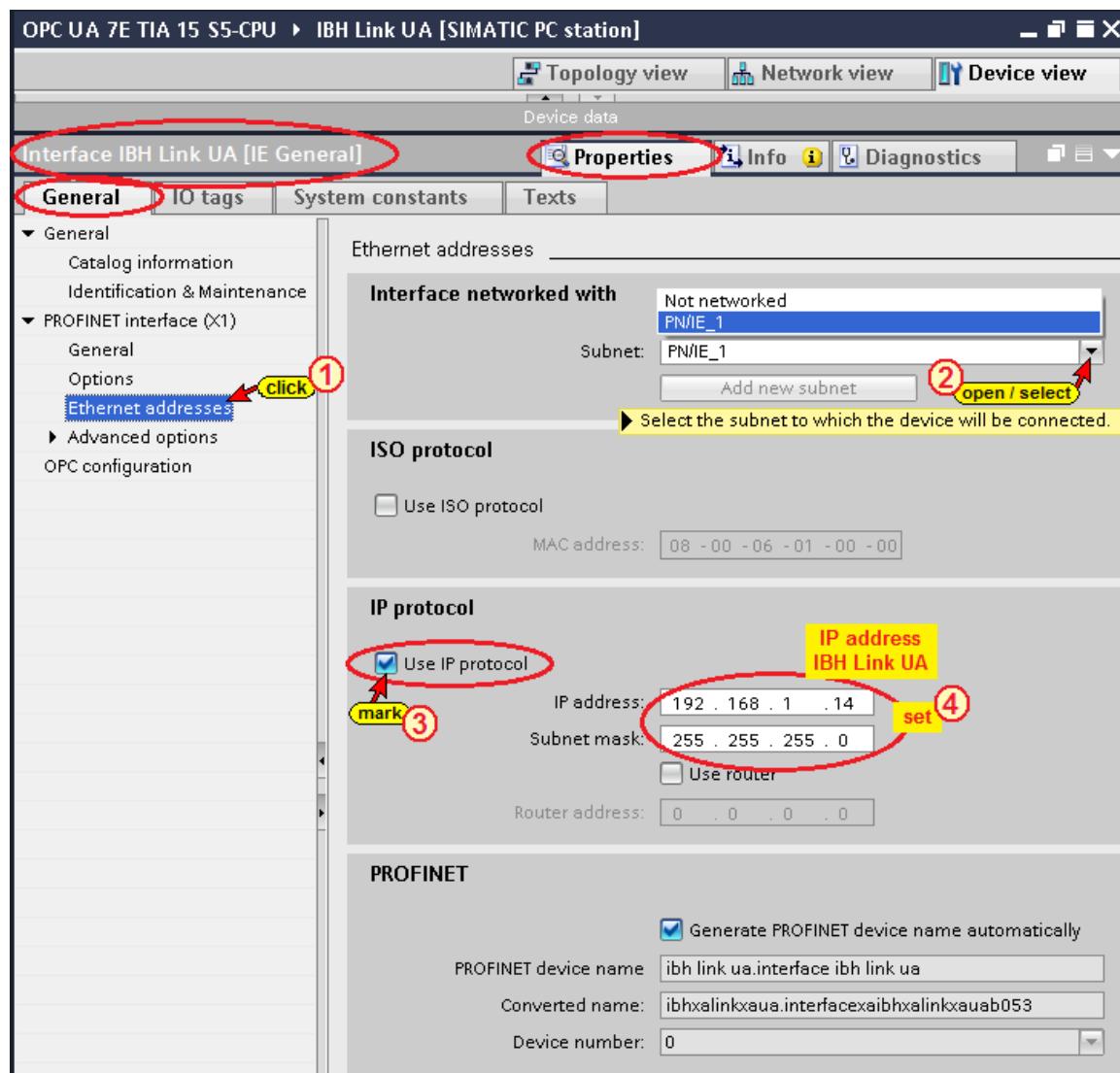
Set the Communication module properties



Clicking on **Interface IBH Link UA** in the **IBH Link UA [SIMATIC PC Station]** device screen opens the Properties dialog box of the **Interface IBH Link UA [IE General]**.

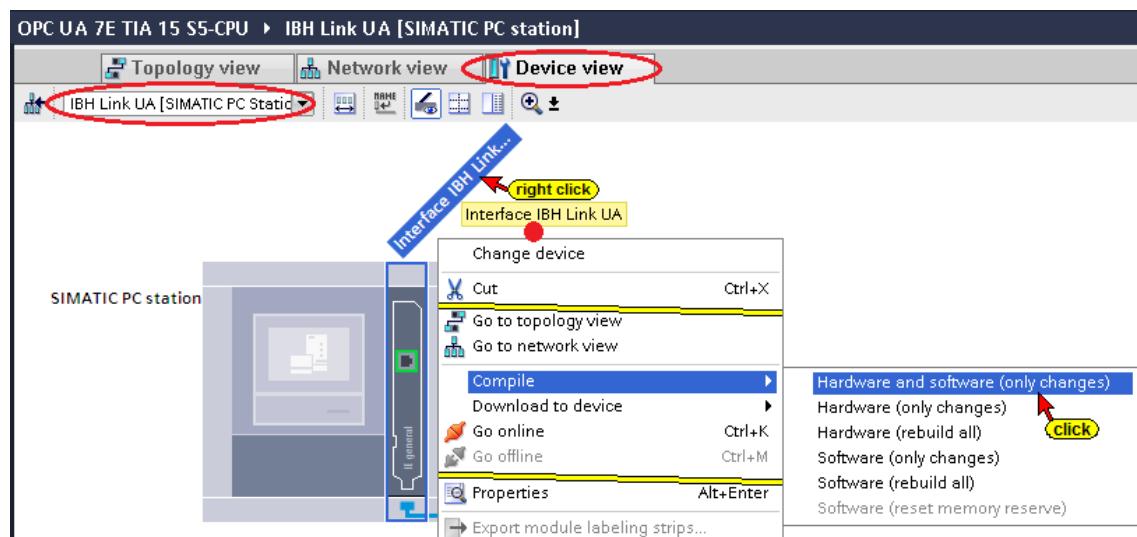
The Ethernet address of the IBH Link UA must be entered. In addition, the networking must be defined.

Features Communication module



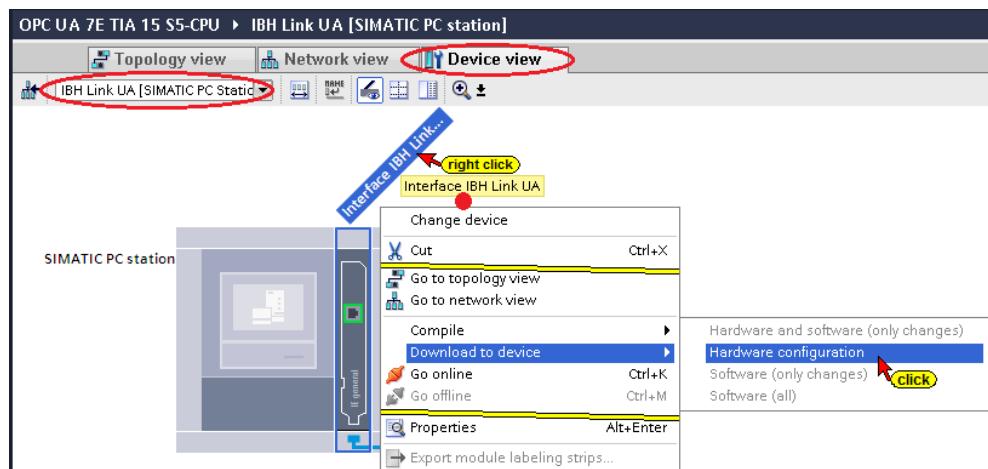
Loading the hardware configuration of the communication module in IBH Link UA

Prior loading, the hardware configuration must be compiled.

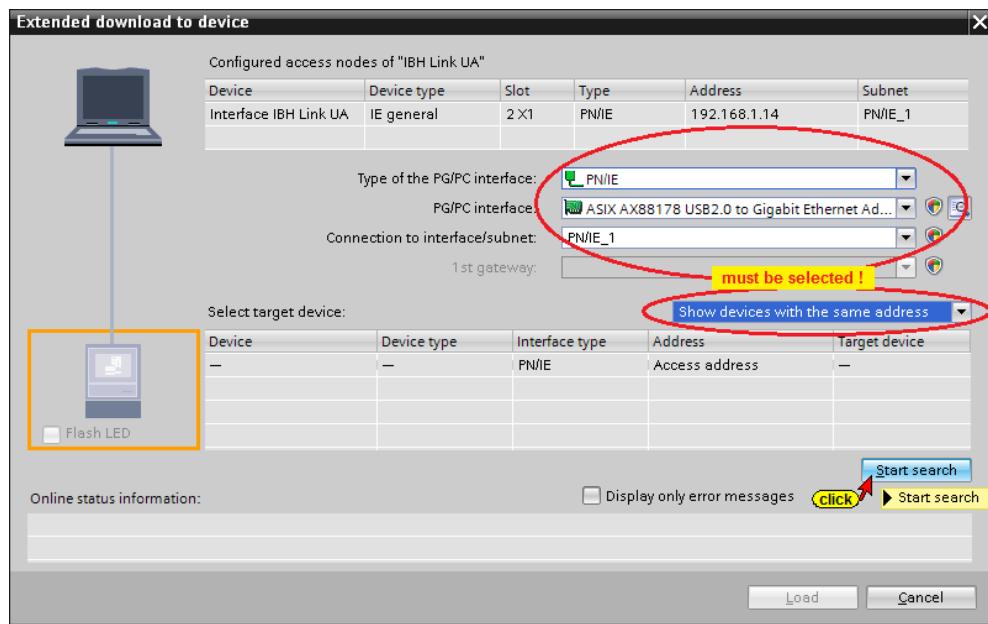


If no error occurs, the configuration shall be loaded into the module.

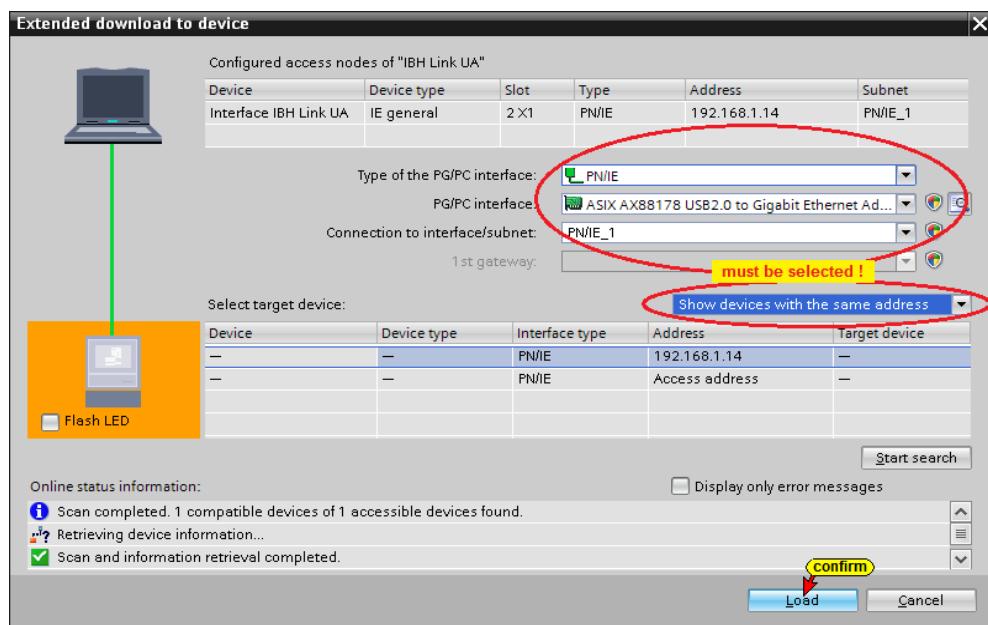
Loading the hardware configuration into the IBH Link UA



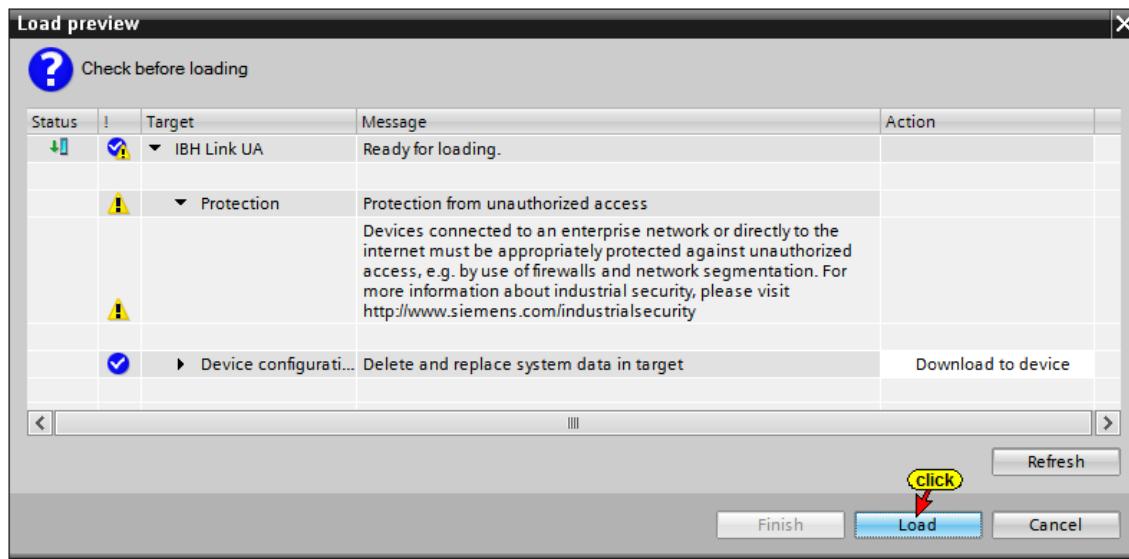
In the dialog box make the settings according to the screenshots.



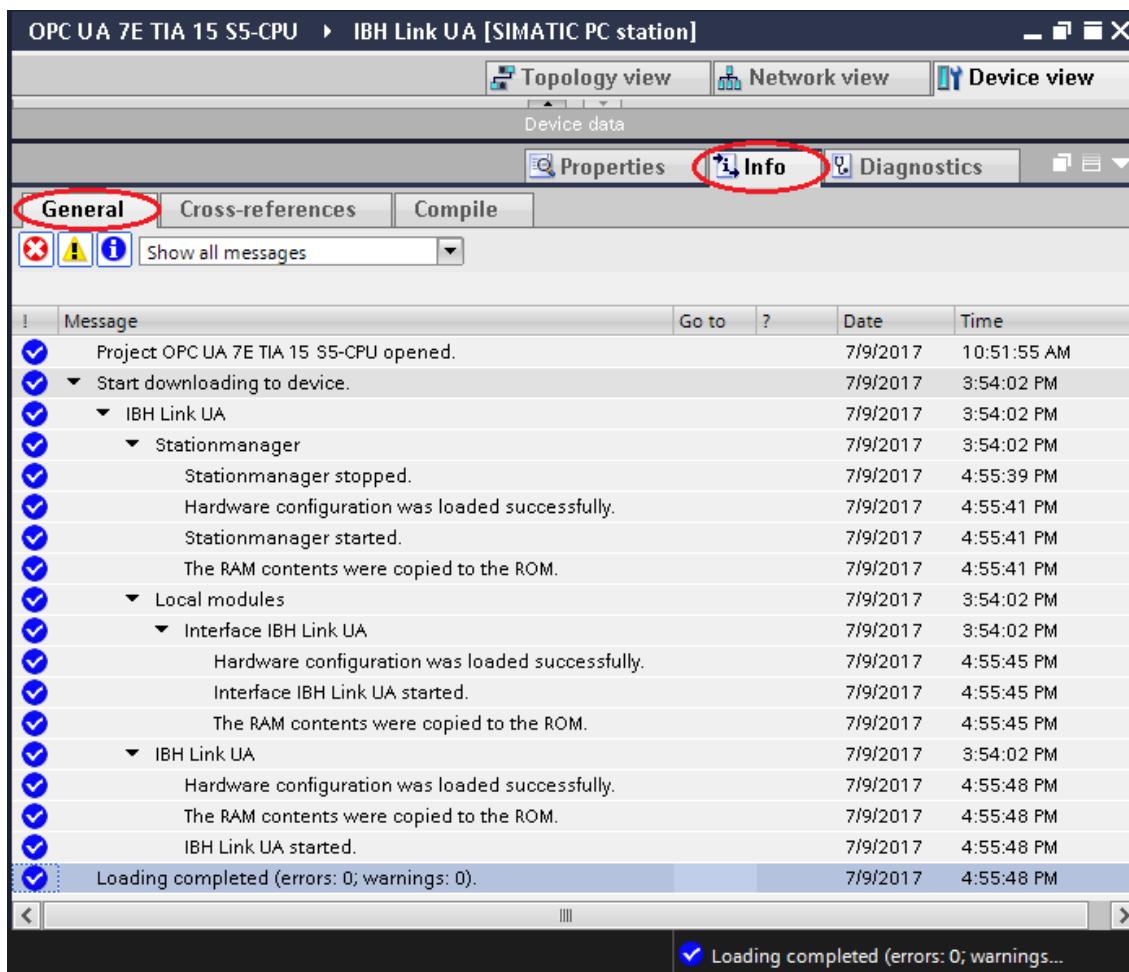
The interface search was successful.



Prior loading a check is carried out.



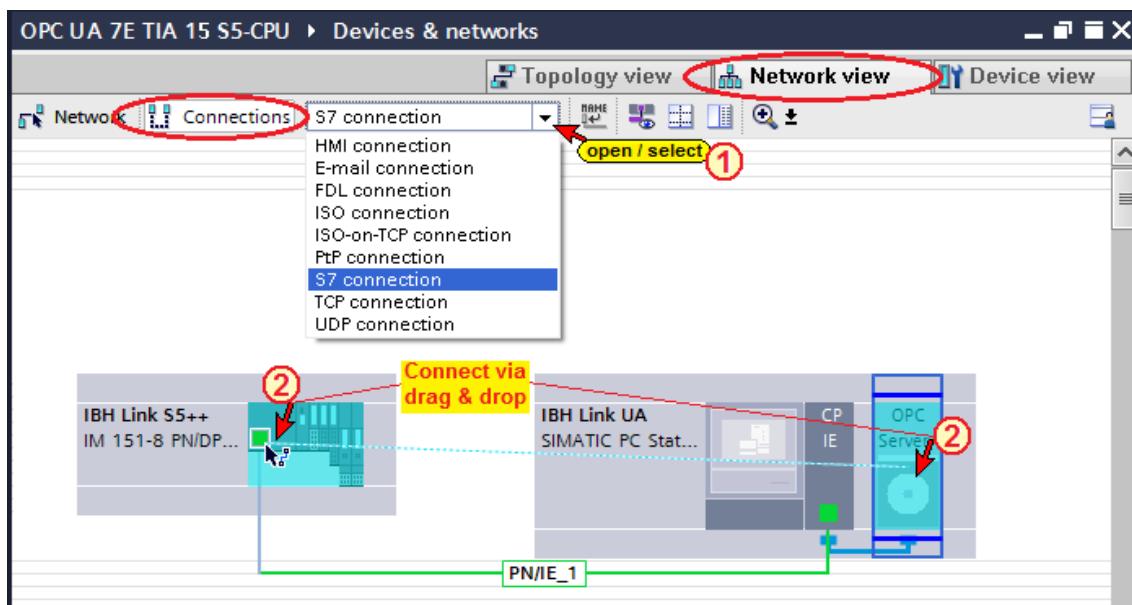
The successful loading of the hardware configuration into the IBH Link UA (Simatic PC station) is displayed.



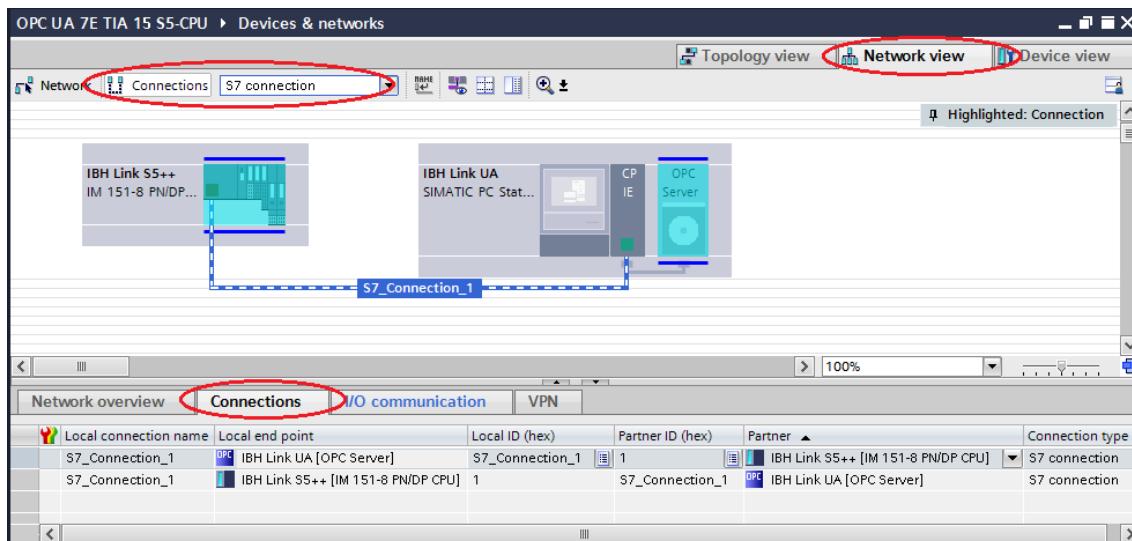
S7 connection from the OPC server to the IBH Link S5++ (IM115-8 PN / DB CPU)

The S7 connection is created by drag and drop, from the OPC server to the IBH Link S5++ (IM115-8 PN / DB CPU).

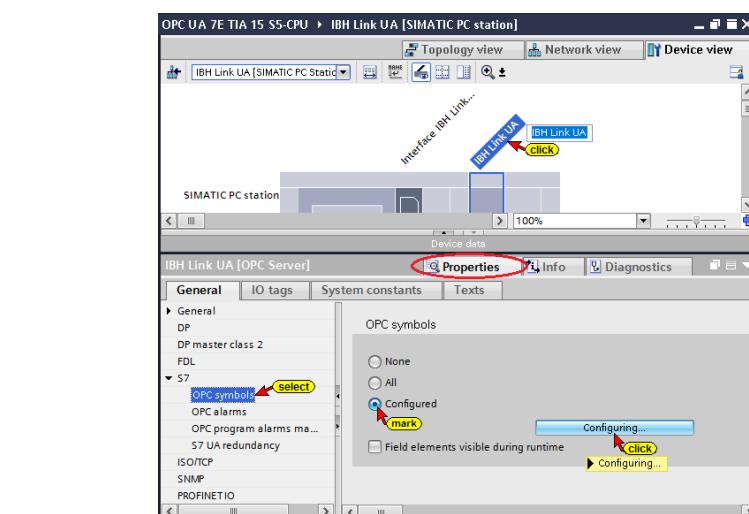
S7 connection



The S7 connection from the OPC server to the IBH Link S5++ (IM115-8 PN / DB CPU) is displayed.



Select OPC symbols (tags) in the OPC configuration

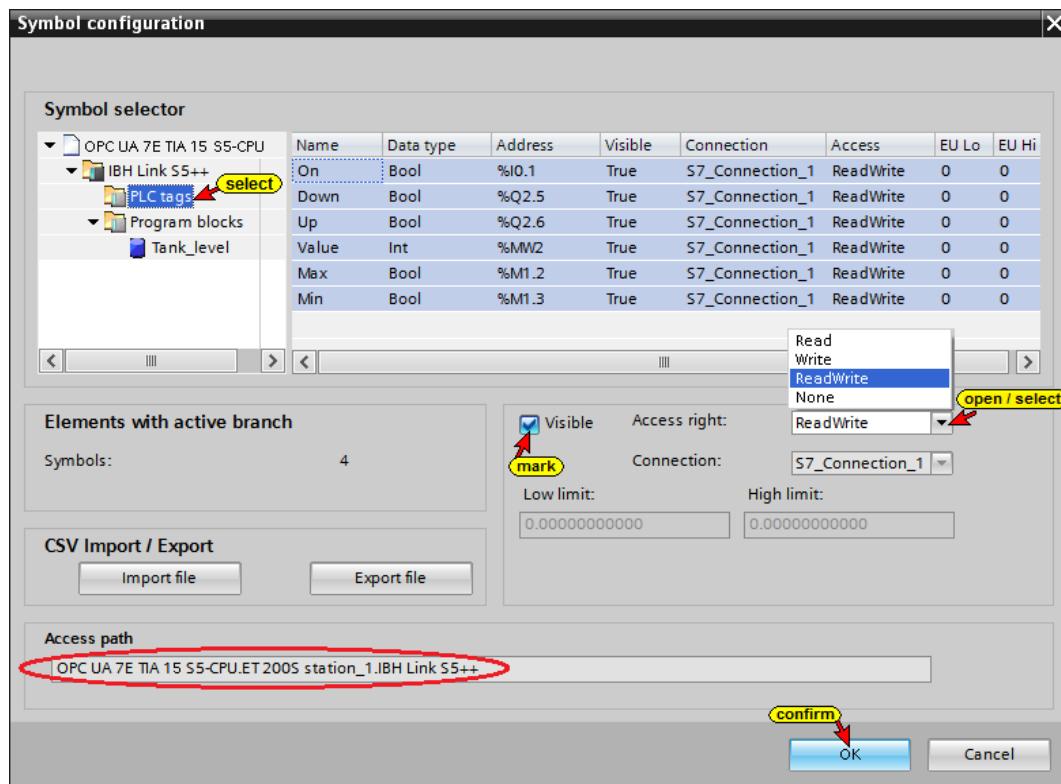


The **Configuring** button opens the **Symbol configuration** dialog box.

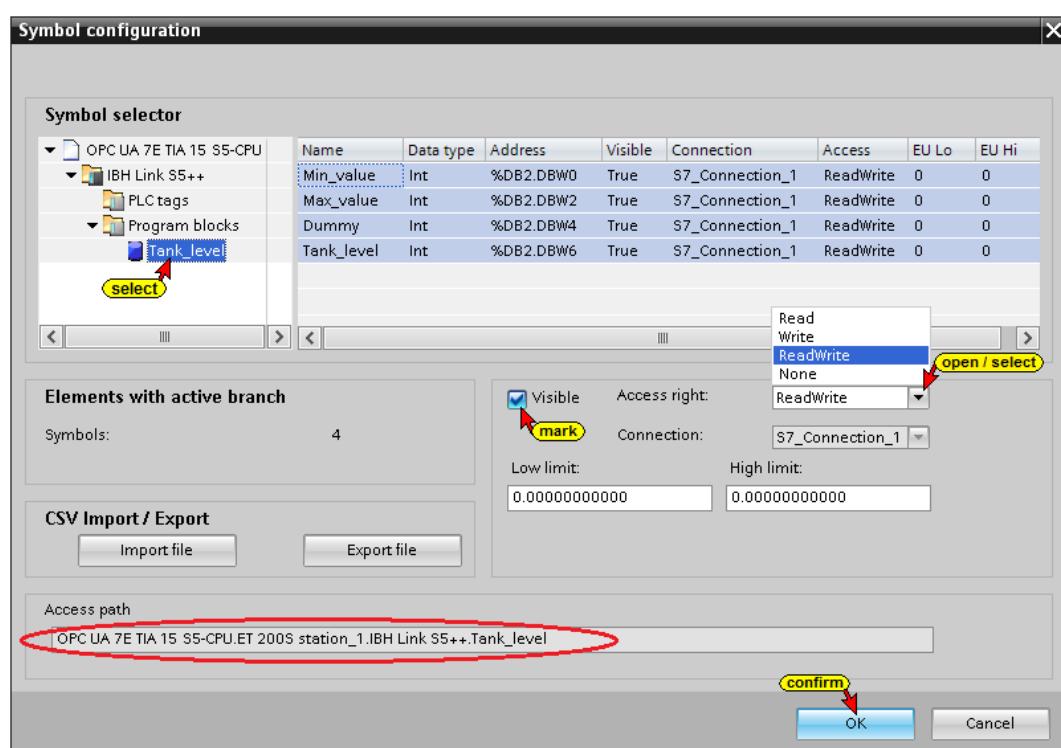
In the **Symbol Configuration** dialog box, the operands defined in the **Default tag table** (IBH Link S5++ - IM115-8 PN/DP CPU) and the data of the data blocks (DB 2) can be selected as OPC tags.

The access rights Read / Write etc. can be assigned to the individual operands (OPC tags).

OPC tags *Default tag table*

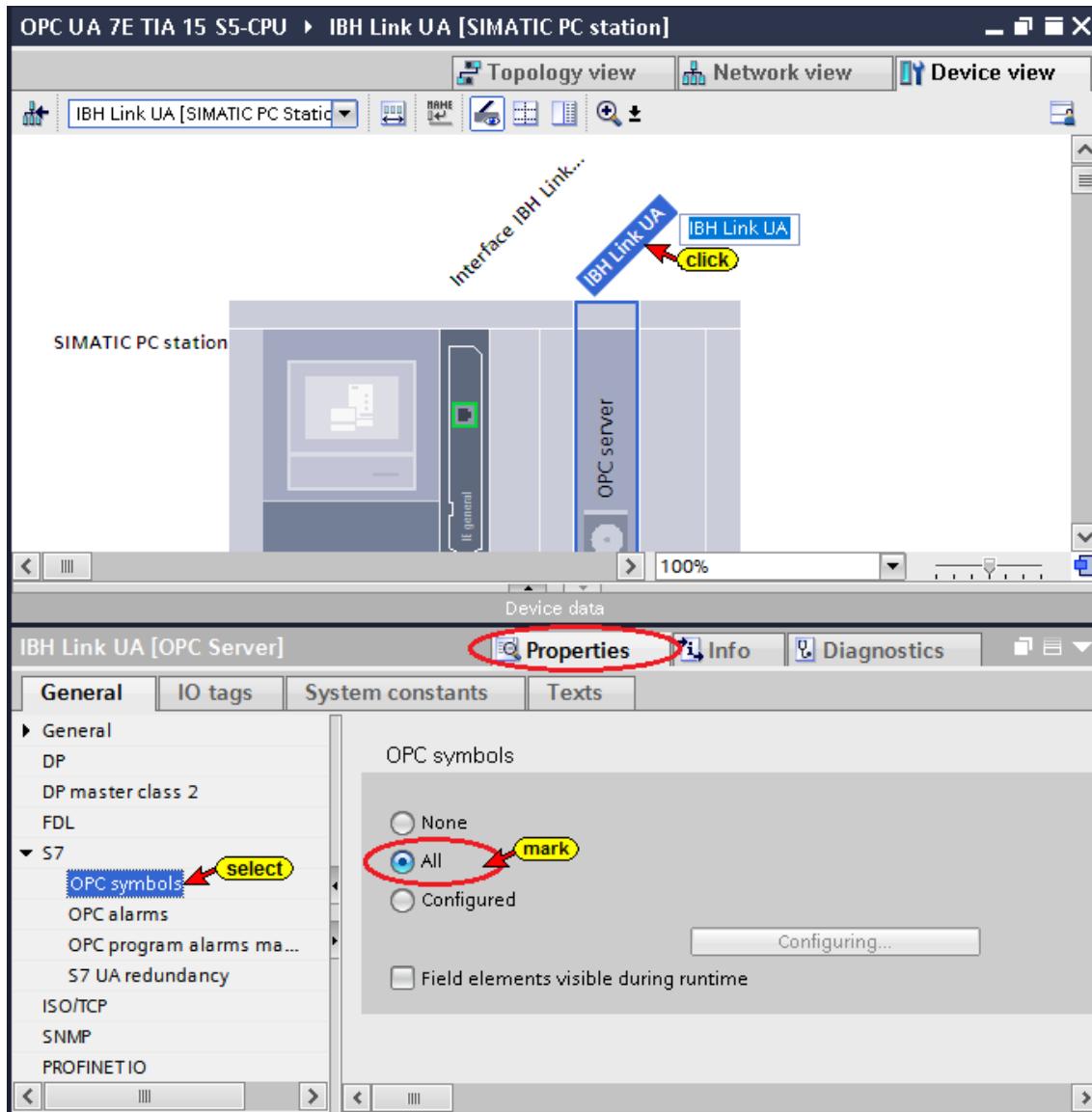


OPC tags Data Block DB2 (*Tank_level*)

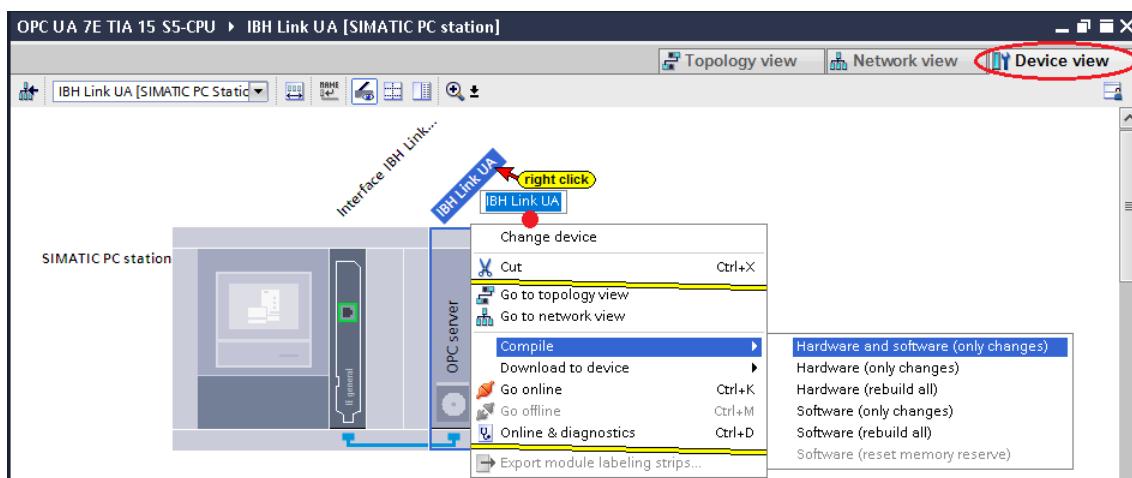


Define all OPC tags

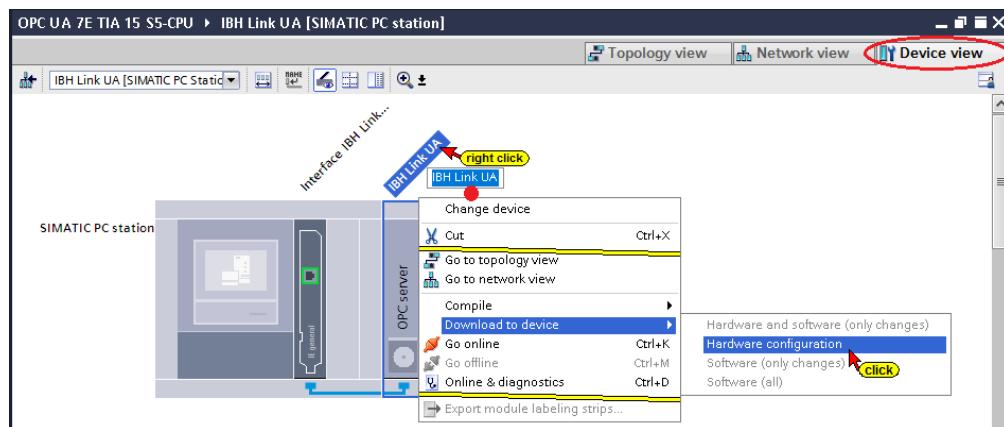
If **All** is marked, the operands defined in the **Default tag table** (IBH Link S5++ - IM115-8 PN/DP CPU) and all the data of the data blocks are selected as OPC tags.



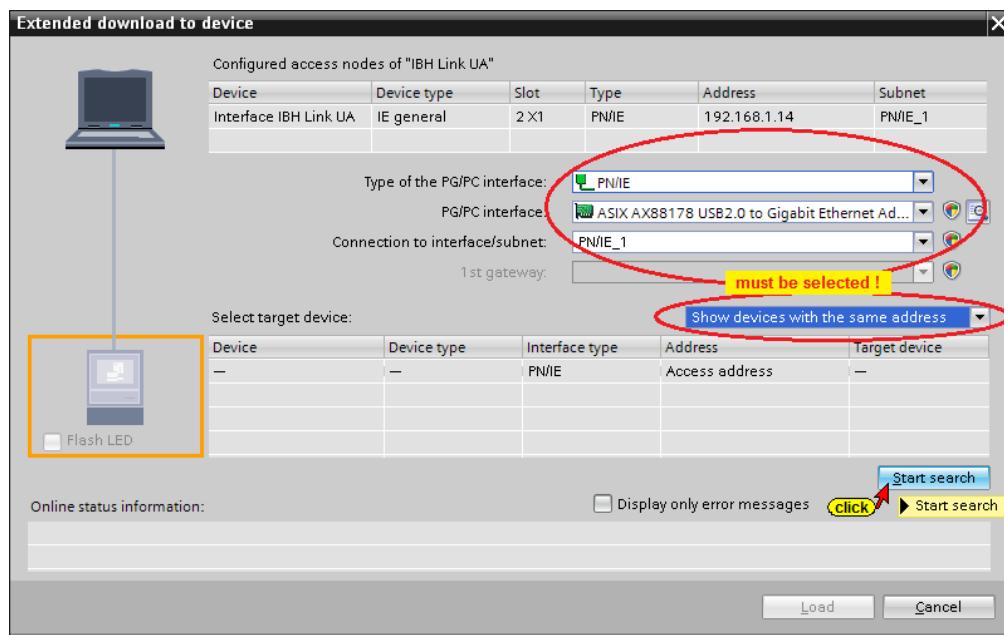
Compiling the configuration of the OPC server



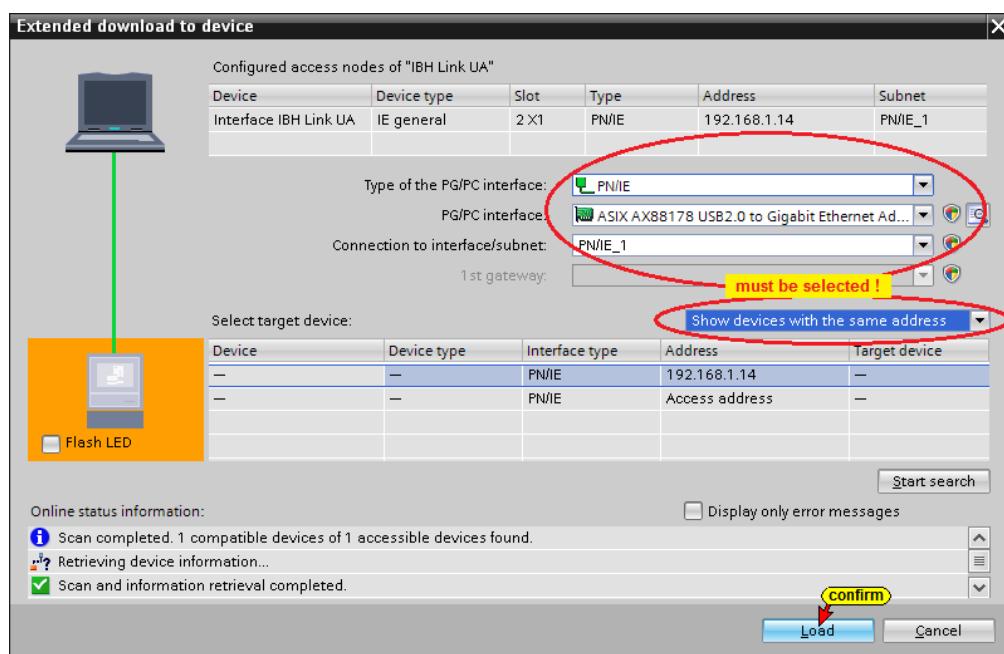
Load the configuration of the OPC server in IBH Link UA



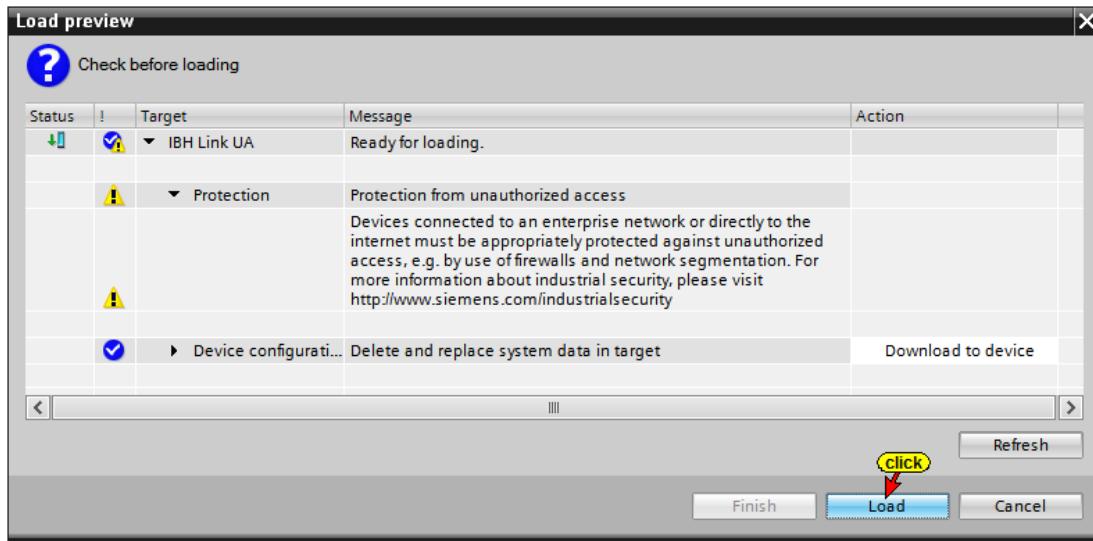
Make the settings in the dialog box according to the screenshots.



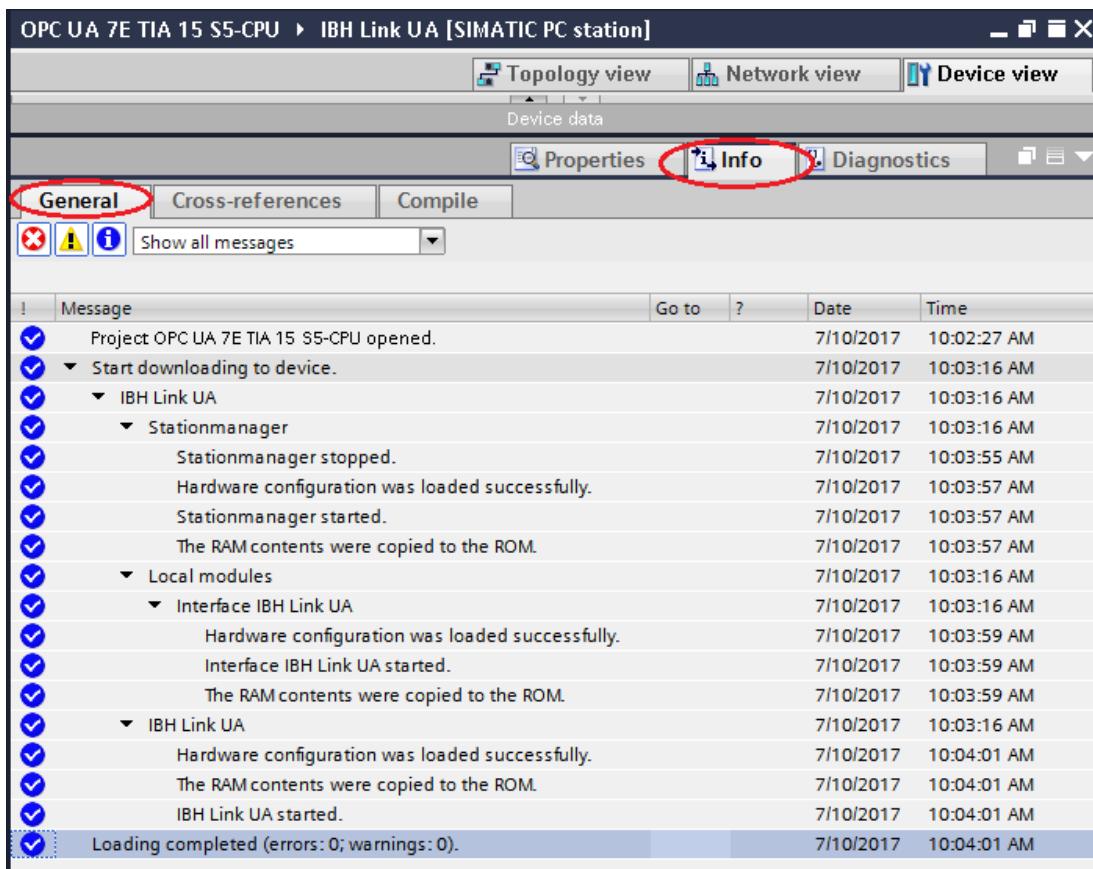
The interface search was successful.



Prior loading a check is carried out.



The successful loading of the hardware configuration into the IBH Link UA (Simatic PC station) is displayed.



UaExpert - Program Window

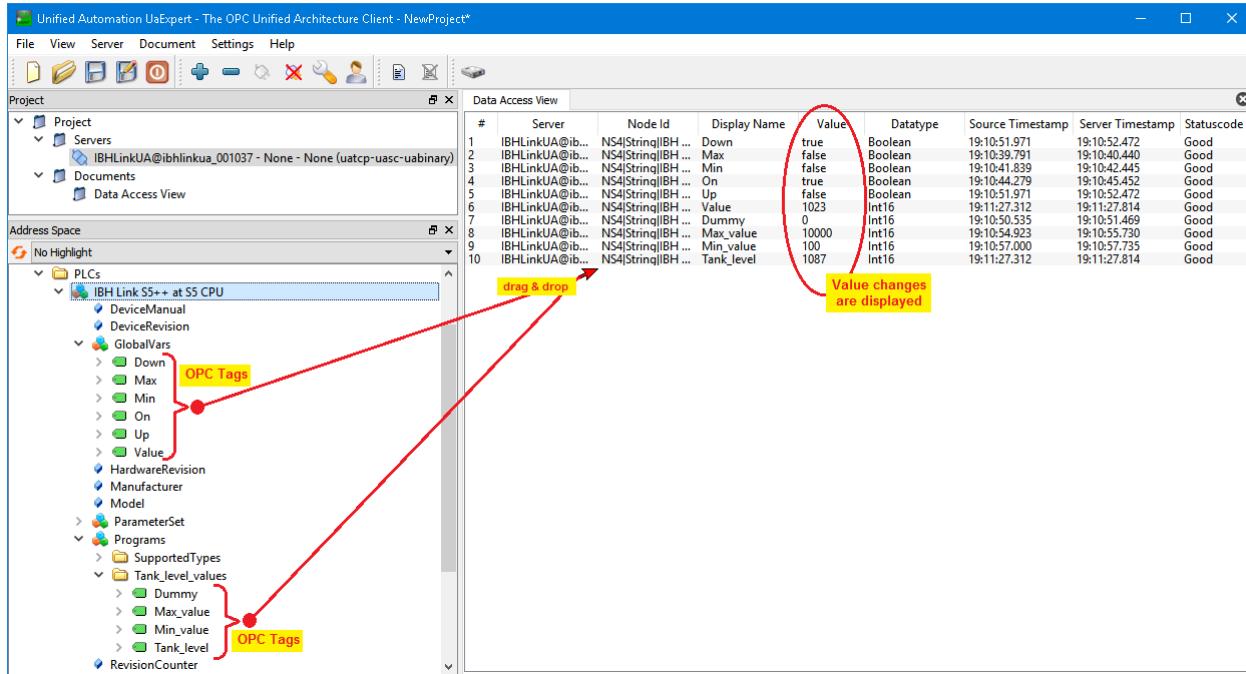
The PLC Data Block (DB2) **Tank_control** is displayed in the UaExpert program window.



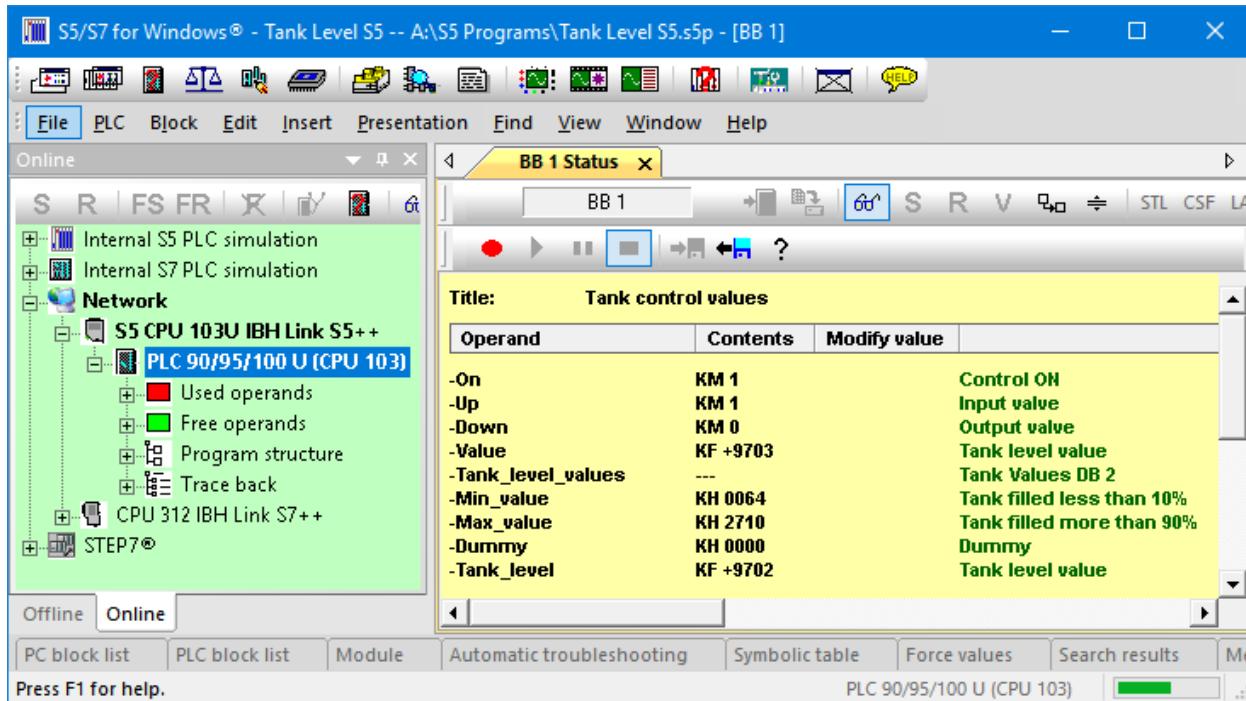
The operands defined in the symbol table, which have been declared as OPC tags, are listed under **GlobalVars**. These can be dragged into the Data Access View.

In addition, the variables of the data block **Tank-Level** (DB 2) are displayed under Programs.

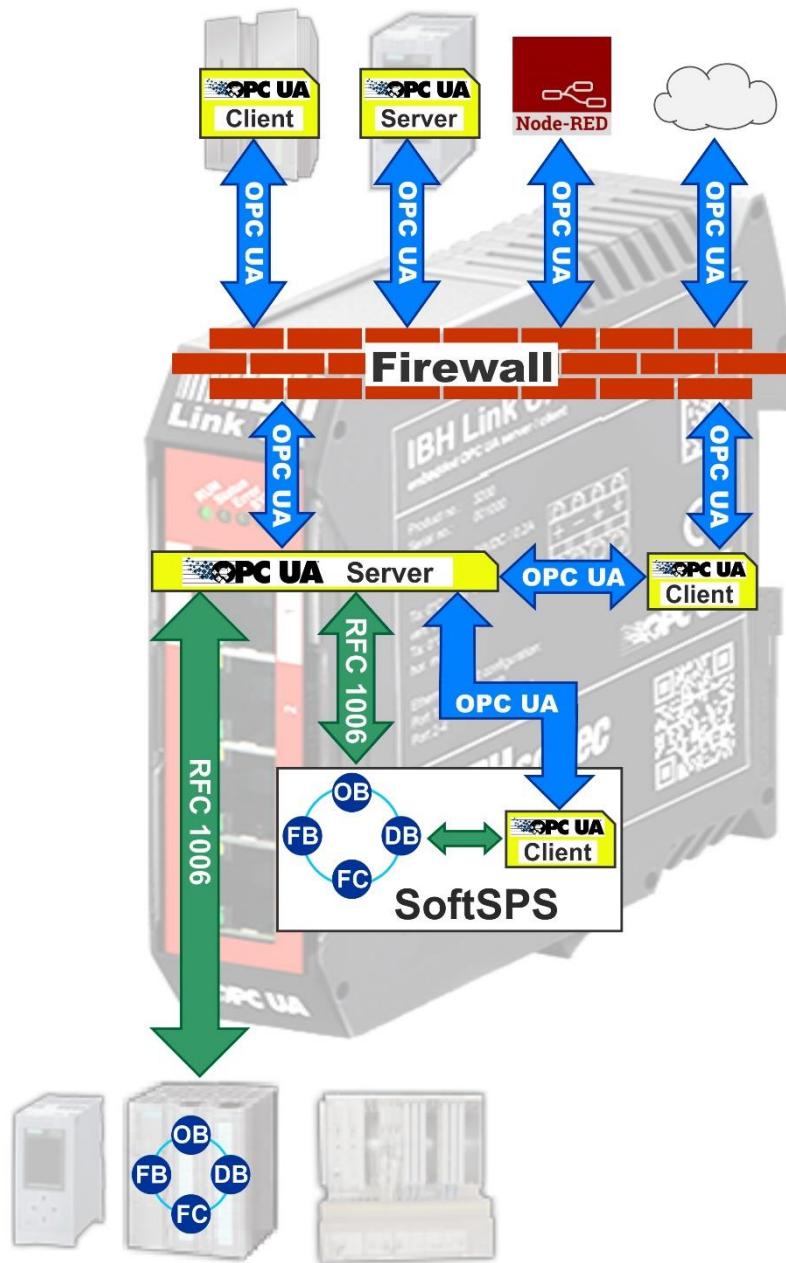
Programs
 > SupportedTypes
 > Tank_level



On-line the changes of the values in the S5 program are visible.



8 IBH Link UA – Integrated SoftPLC



The IBH Link UA contains a SoftPLC. The SoftPLC can read and write variables from the OPC UA server.

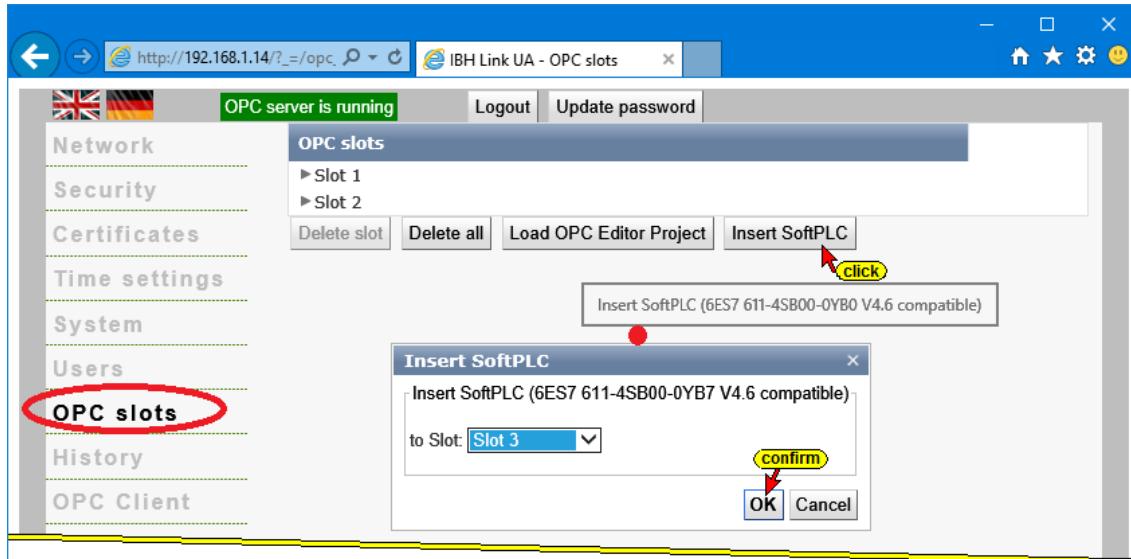
The integrated SoftPLC is used for data preprocessing and is programmed with STEP® 7 in LAD, FBD, STL, SCL or S7-GRAF.

The access (status, program transmission) to the integrated SoftPLC can be done out via STEP® 7 (SIMATIC Manager) or the TIA portal (TIA 13; TIA 14).

The IBH Link UA - SoftPLC is compatible with **SIMATIC WinAC RTX** Software PLC (**6ES7 611-4SB00-0YB7 V4.6**).

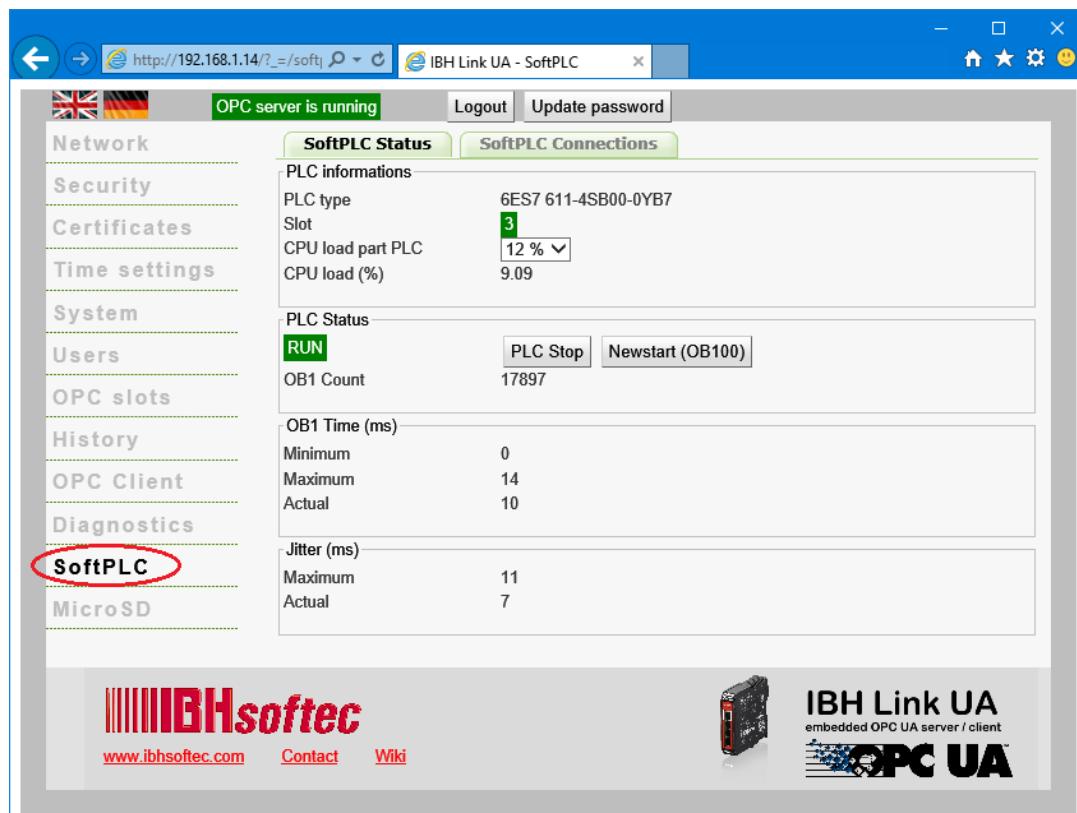
8.1 Activating the integrated SoftPLC

First, the SoftPLC must be activated via the WEB interface of the IBH Link UA.



8.2 SoftPLC Status and Settings

The SoftPLC status is displayed on the WEB interface of the Configurator.



The performance of the SoftPLC can be adjusted as follows:

CPU share PLC	Computing time 1000 mixed instructions
50%	about 360 µs
33%	about 550 µs
25%	about 720 µs
20%	about 900 µs
12%	about 1800 µs

8.3 Configuring SoftPLC with STEP® 7 (SIMATIC Manager)

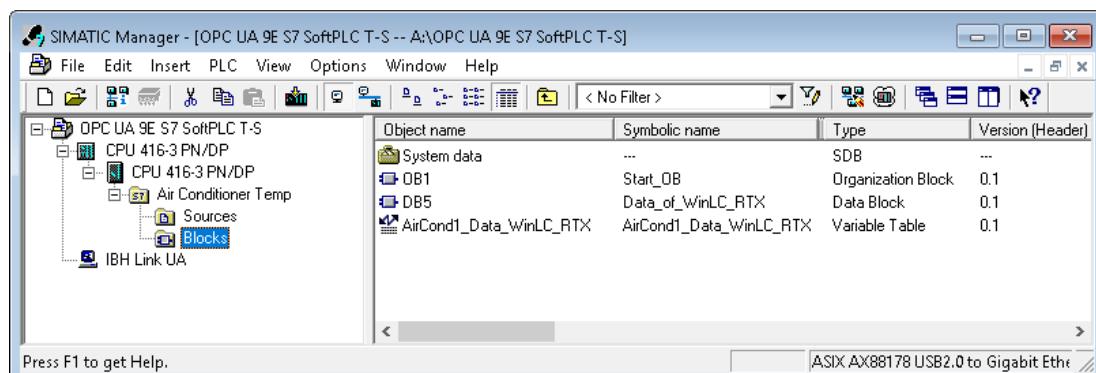
An OPC variable consists of the **Value**, the corresponding **TimeStamp** and the **Status**. The TimeStamp and status can be used to check the veracity of the transferred value.

In the following example project **OPC UA 9E S7 SoftPLC T-S**, data from an external server (**Temperature**, **Temp_SetPoint**) with the corresponding **TimeStamp** and **Status** are passed to the SoftPLC integrated in the IBH Link UA.

The temperature values and the TimeStamps are converted (° Fahrenheit in ° Celsius; Date and Time in Daytime). After conversion, the status data are sent to the PLC CPU 416 (IBHsofttec SoftPLC) for display (VAT1 – **AirCond1_Data_WinLC_RTX**).

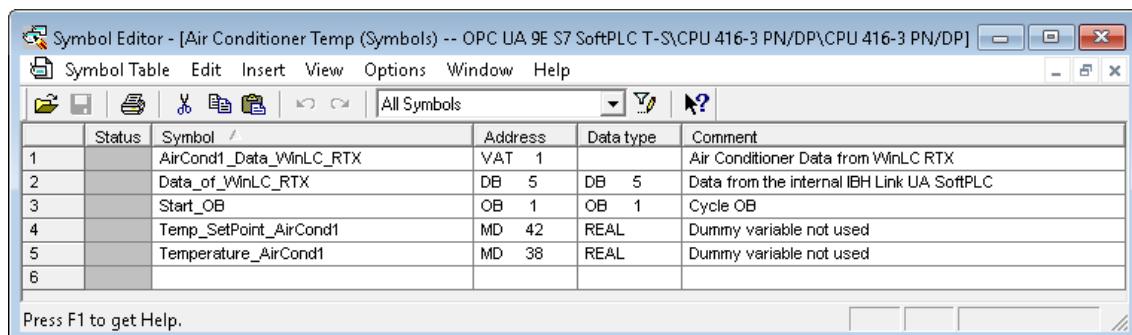
8.3.1 PLC CPU 416 Program (IBHsofttec SoftPLC)

The data from the IBH Link UA SoftPLC is transferred into the DB5 (**Data_of_WinLC_RTX**) of the CPU 416. VAT1 – **AirCond1_Data_WinLC_RTX** is used to display this data. OB 1 has no function.



The configuration of the PLC CPU 416 (IBHsofttec SoftPLC) is described in Chapter 3.1 Software PLC CPU 416-3 PN/DP.

Symbol Table Air Conditioner Temp



The screenshot shows the 'Symbol Editor - [Air Conditioner Temp (Symbols) -- OPC UA 9E S7 SoftPLC T-S\CPU 416-3 PN/DP\CPU 416-3 PN/DP]' window. The menu bar includes File, Edit, Insert, View, Options, Window, and Help. The toolbar has icons for New, Open, Save, Print, and Symbol Table. The main area is a table titled 'All Symbols' with columns: Status, Symbol, Address, Data type, and Comment.

	Status	Symbol	Address	Data type	Comment
1		AirCond1_Data_WinLC_RTX	VAT 1		Air Conditioner Data from WinLC RTX
2		Data_of_WinLC_RTX	DB 5	DB 5	Data from the internal IBH Link UA SoftPLC
3		Start_OB	OB 1	OB 1	Cycle OB
4		Temp_SetPoint_AirCond1	MD 42	REAL	Dummy variable not used
5		Temperature_AirCond1	MD 38	REAL	Dummy variable not used
6					

Press F1 to get Help.

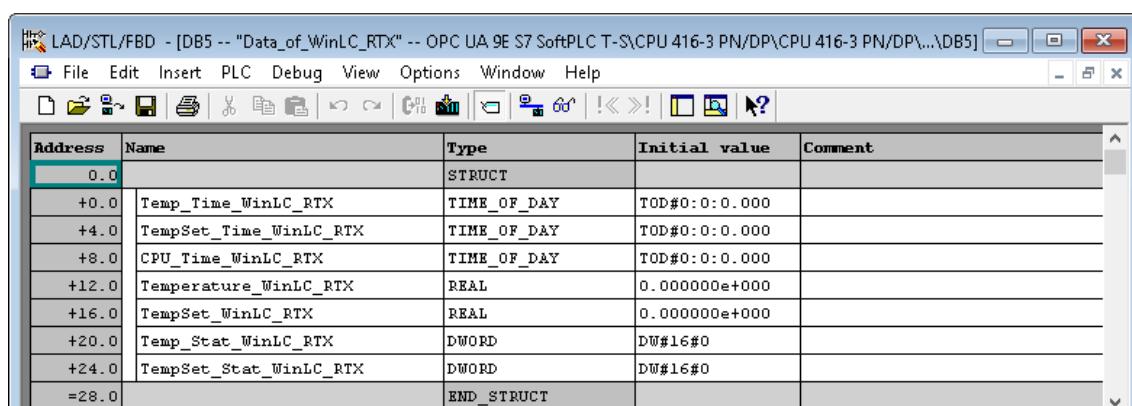
Note:

The variables **Temperatuer_AirCond1** and **Temp_SetPoint_AirCond1** are only required for the definition of the OPC variables.

The variables (MD 38, MD 42) have no further function.

Data Block DB5 – *Data_of_WinLC_RTX* –

The variables defined by the SoftPLC in the IBH Link UA to the PLC CPU 416 (IBHsoftec SoftPLC) are defined here.



The screenshot shows the 'LAD/STL/FBD - [DB5 -- "Data_of_WinLC_RTX" -- OPC UA 9E S7 SoftPLC T-S\CPU 416-3 PN/DP\CPU 416-3 PN/DP...DB5]' window. The menu bar includes File, Edit, Insert, PLC, Debug, View, Options, Window, and Help. The toolbar has icons for New, Open, Save, Print, and LAD/STL/FBD. The main area is a table titled 'Address' with columns: Address, Name, Type, Initial value, and Comment.

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Temp_Time_WinLC_RTX	TIME_OF_DAY	TOD#0:0:0.000	
+4.0	TempSet_Time_WinLC_RTX	TIME_OF_DAY	TOD#0:0:0.000	
+8.0	CPU_Time_WinLC_RTX	TIME_OF_DAY	TOD#0:0:0.000	
+12.0	Temperature_WinLC_RTX	REAL	0.000000e+000	
+16.0	TempSet_WinLC_RTX	REAL	0.000000e+000	
+20.0	Temp_Stat_WinLC_RTX	DWORD	DW#16#0	
+24.0	TempSet_Stat_WinLC_RTX	DWORD	DW#16#0	
=28.0		END_STRUCT		

8.3.2 Transferring the program (Air Conditioner Temp) into the PLC

The connection from the PC to the CPU 416-3 PN/DP is made via the Ethernet interface of the PC. The PG / PC interface must be selected accordingly in SIMATIC Manager. The name of the Ethernet connection may vary depending on the network card used in the PC.

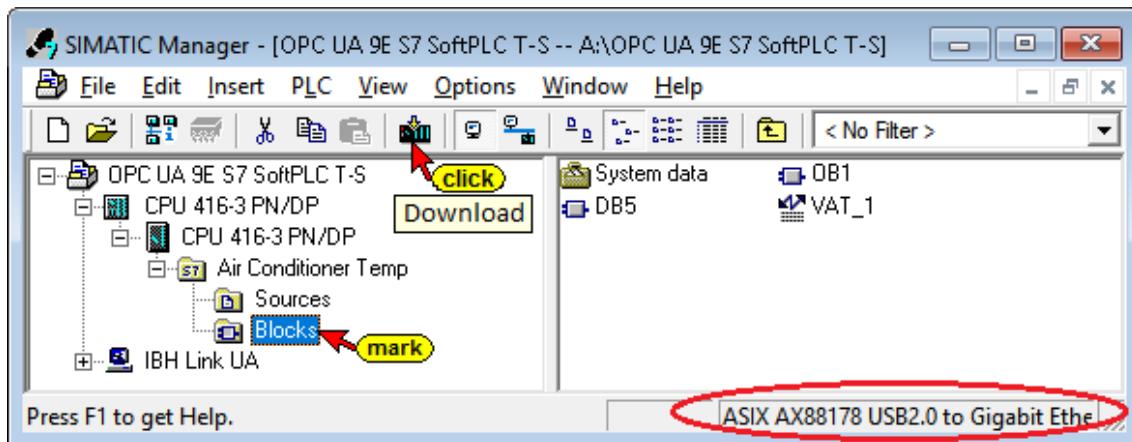
Note:

The connection to be selected depends on the Ethernet interface present in the PC. The name is made up as follows:

PC Ethernet interface.TCPIP.Auto.1 <Active>

 ASIX AX88178 USB2.0 to Gigabit Ethernet Adapter.TCPIP.Auto.1 <Active>

Transfer of PLC Blocks and Configuration

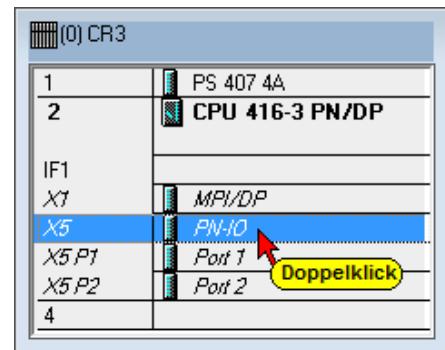


Configuration of the CPU 416-3 PN/DP Setting / Checking

Clicking on **CPU 416-3 PN/DP** in the left window and double-clicking on **Hardware** in the right window opens the hardware configurator.

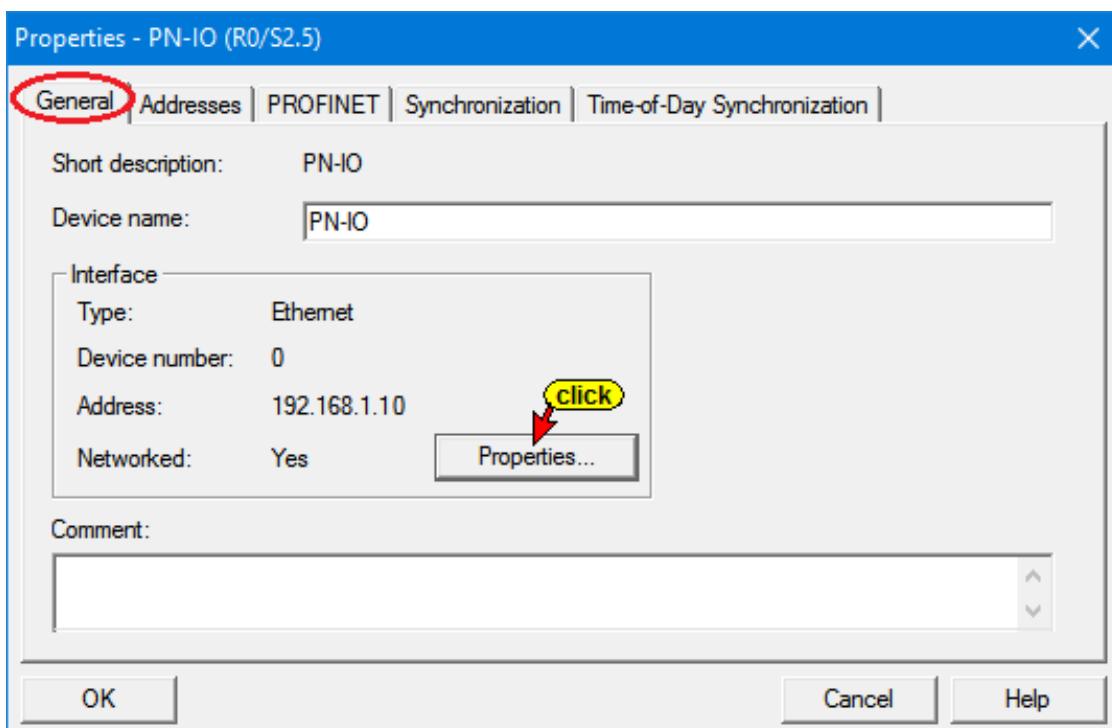


The hardware is identical to the configuration shown in chapter 3, page 5 and 6, Project **OPC UA 3E S7 Tank Level** – Hardware Configuration.

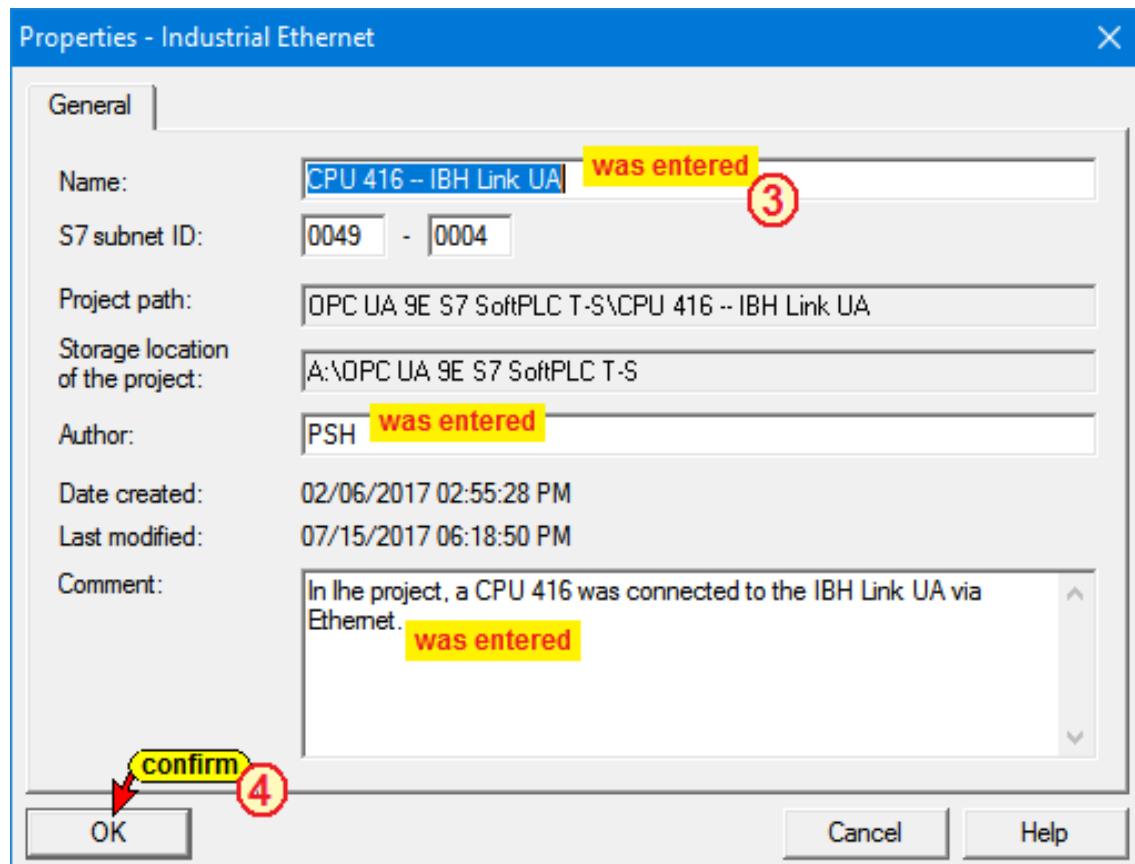
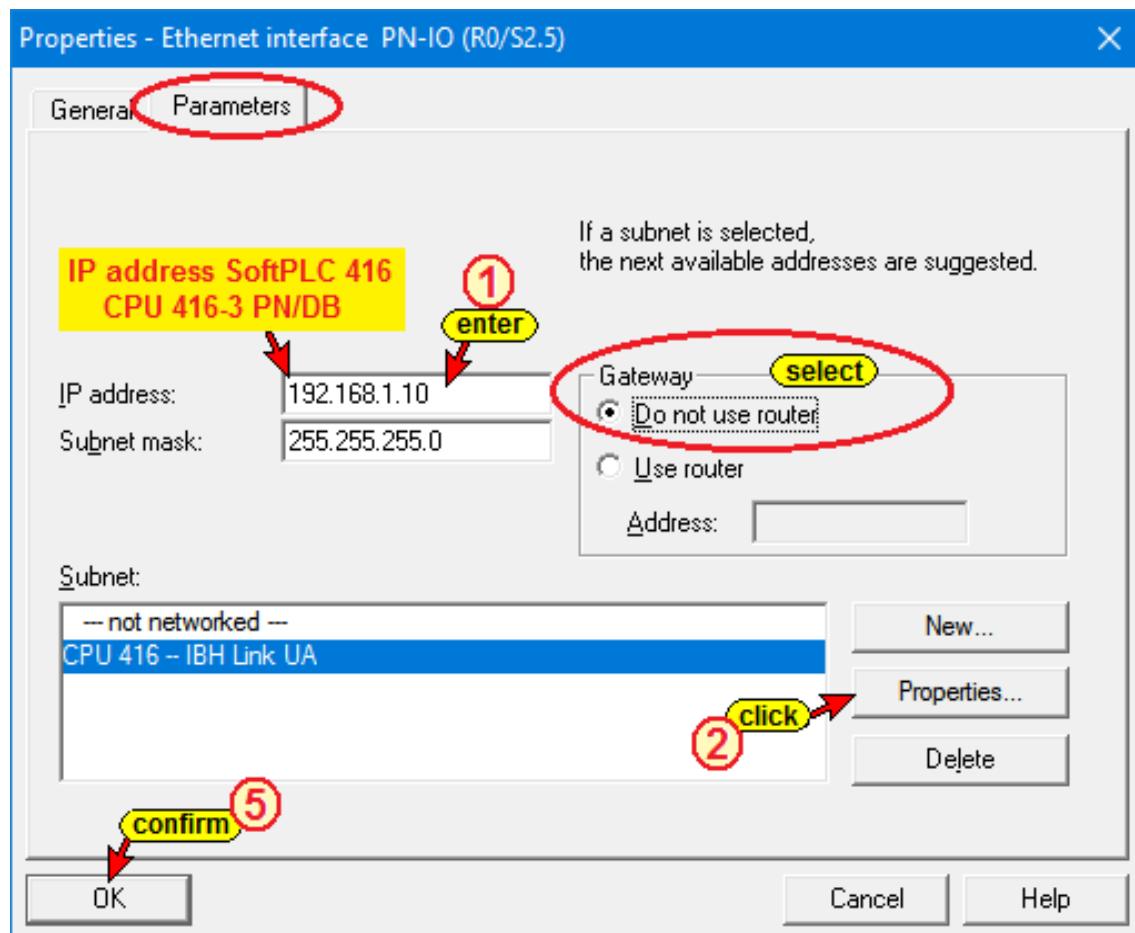


Double-clicking the line X5 PN-IO opens the Properties PN-IO (R0/S2.5) dialog box.

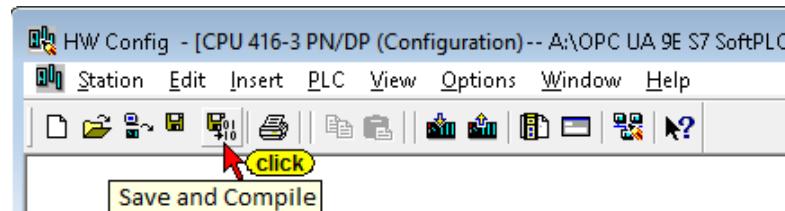
In the open dialog box **Properties – PN-IO (R0/S2.5)**, click the button **Properties**.



The dialog box **Properties - Ethernet interface PN-IO (R0/S2.5) / Parameters** opens.

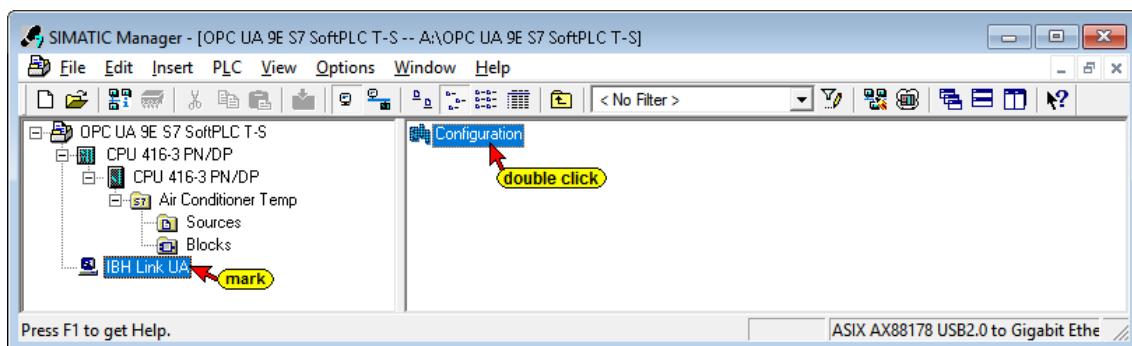


Click the **Save and Compile** icon to save the configuration of the Modules.



8.3.3 Configuration of the IBH Link UA as SIMATIC PC station

Double-click the renamed SIMATIC PC Station **IBH Link UA** in the left window and a double click on **Configuration** in the right window opens the hardware configurator.

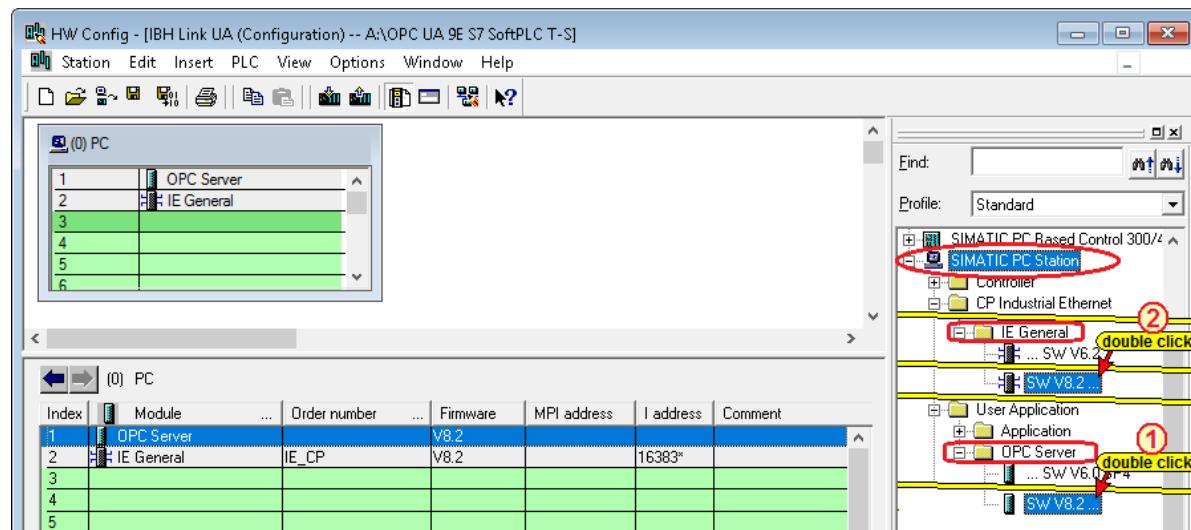


Configuration IBH Link UA (SIMATIC PC Station)

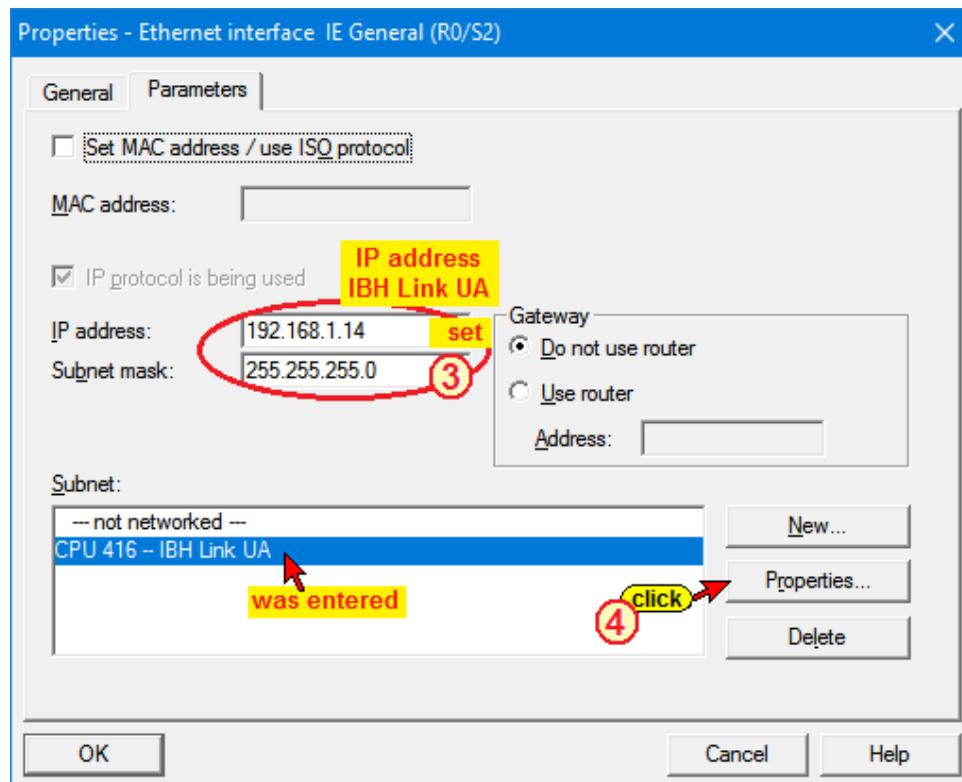
Note:

The Siemens **OPC Server SW V8.2...** and the CP Industrial Ethernet interface **IE General SW V8.2...** are available in the hardware catalogs of **STEP7 SIMATIC Manager, TIA V13, TIA V14** and **TIA V15**.

Double-clicking on <SW V8.2...> ① takes the OPC server into the PC station.

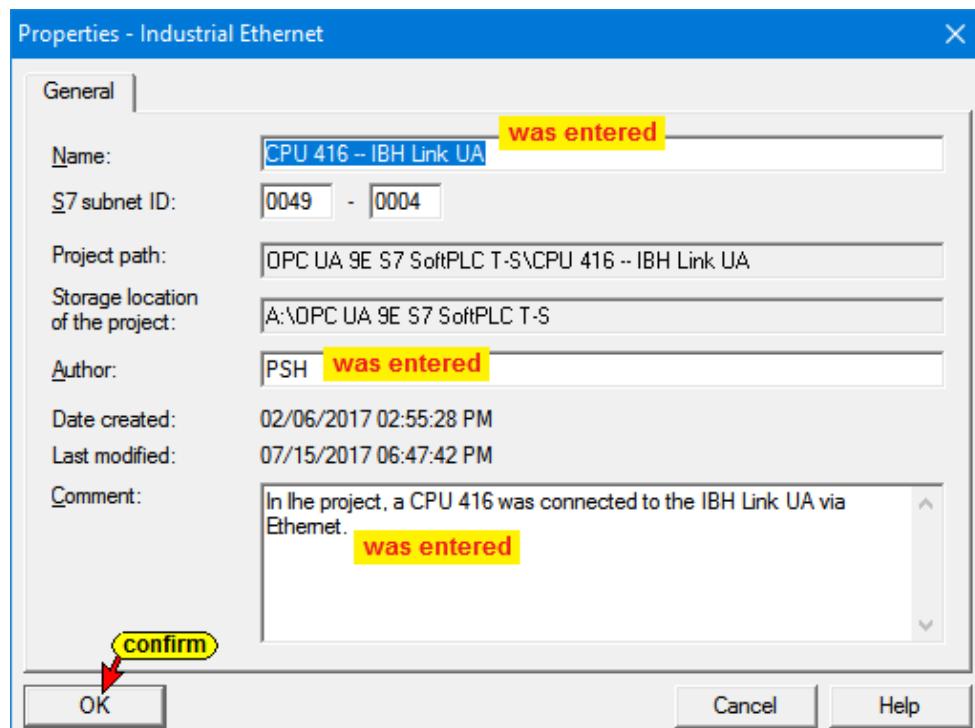


A double click on <IE General> <SW V8.2...> ② opens the dialog box **Properties - Ethernet Interface IE General (R0/S2)**.



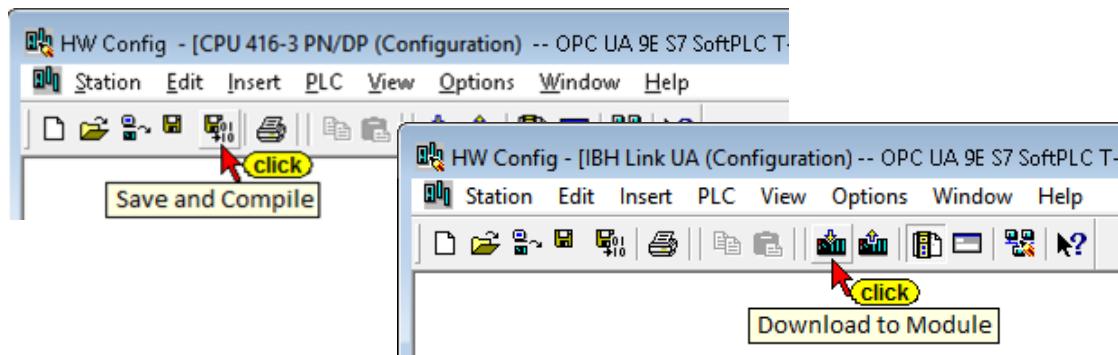
In the open dialog box **Properties – IE General**, set the IBH Link UA IP address. Click the button **Properties** ④ to open the dialog box **Properties – Industrial Ethernet**.

The information shown have been entered during the CPU 416 configuration.

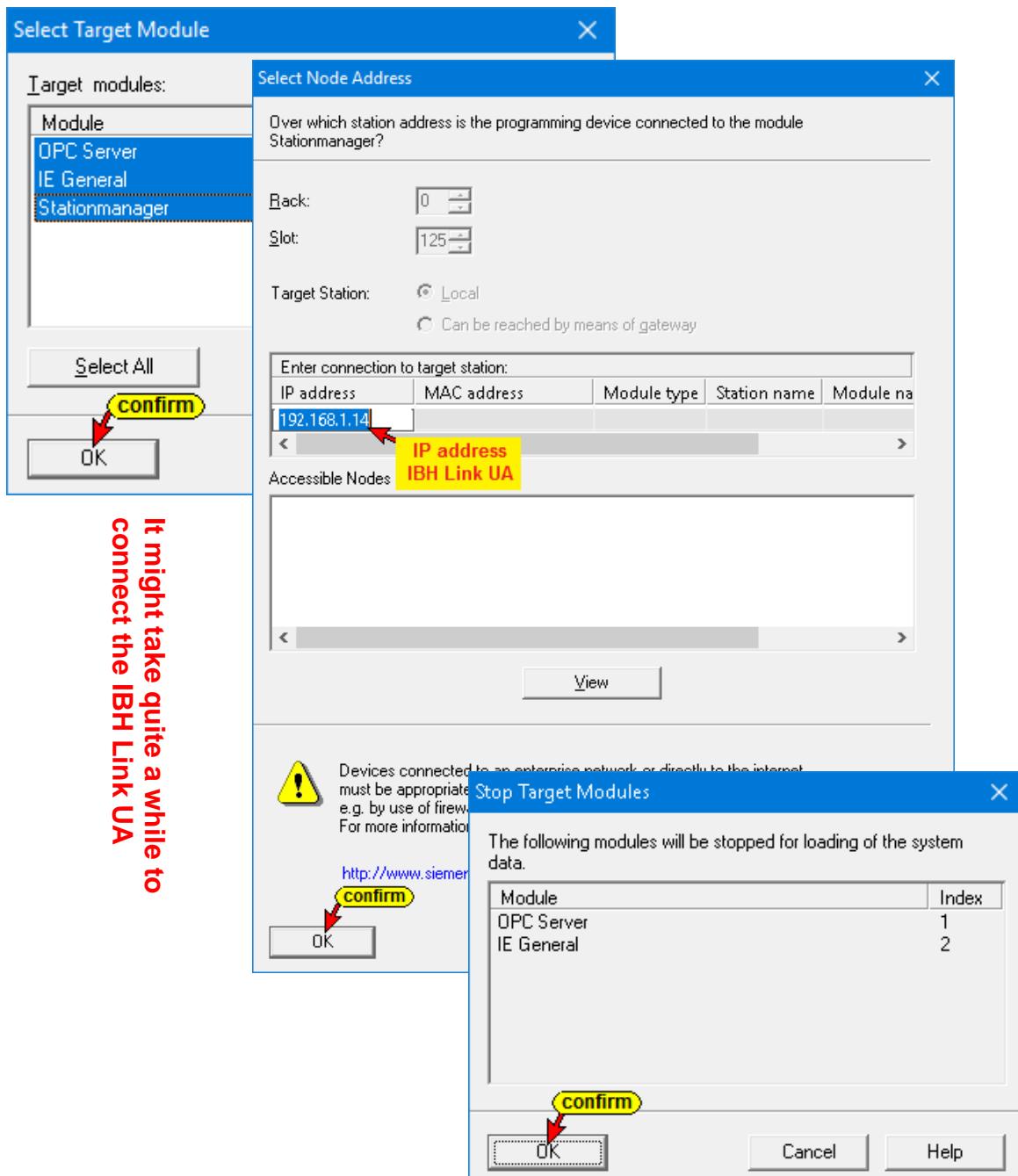


Loading the configuration into the IBH Link UA.

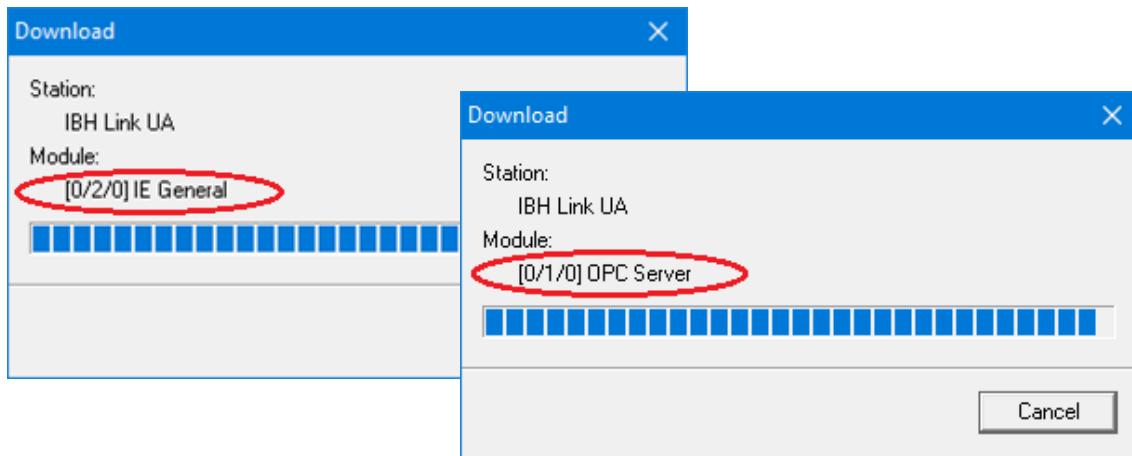
After **Save and Compile** the configuration can be loaded into the IBH Link UA.



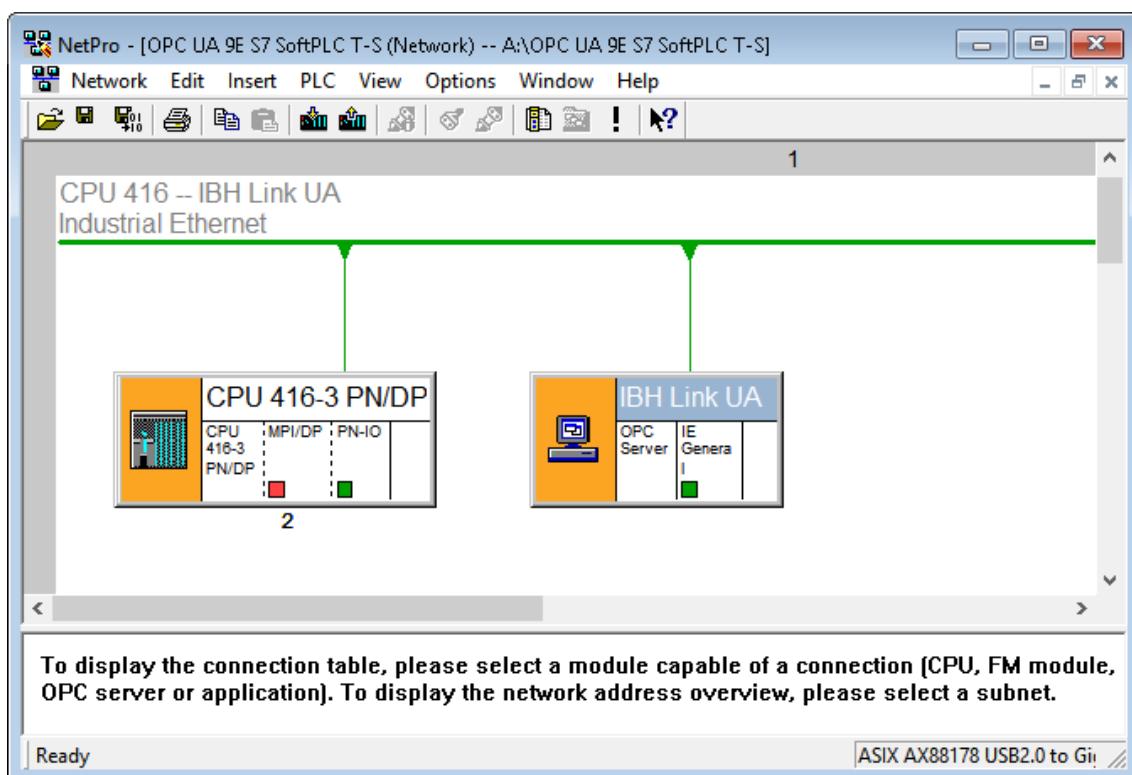
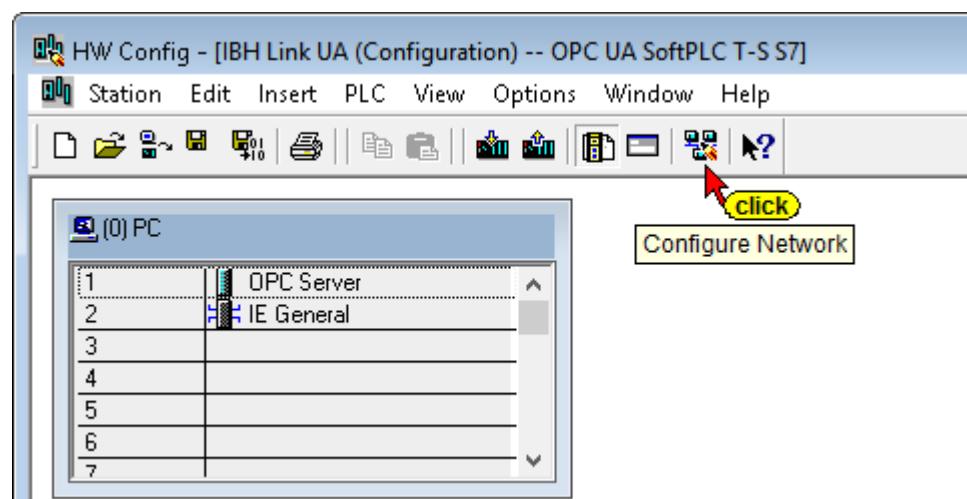
Loading into the IBH Link UA requires several steps.



The progress of loading into the IBH Link UA is displayed.

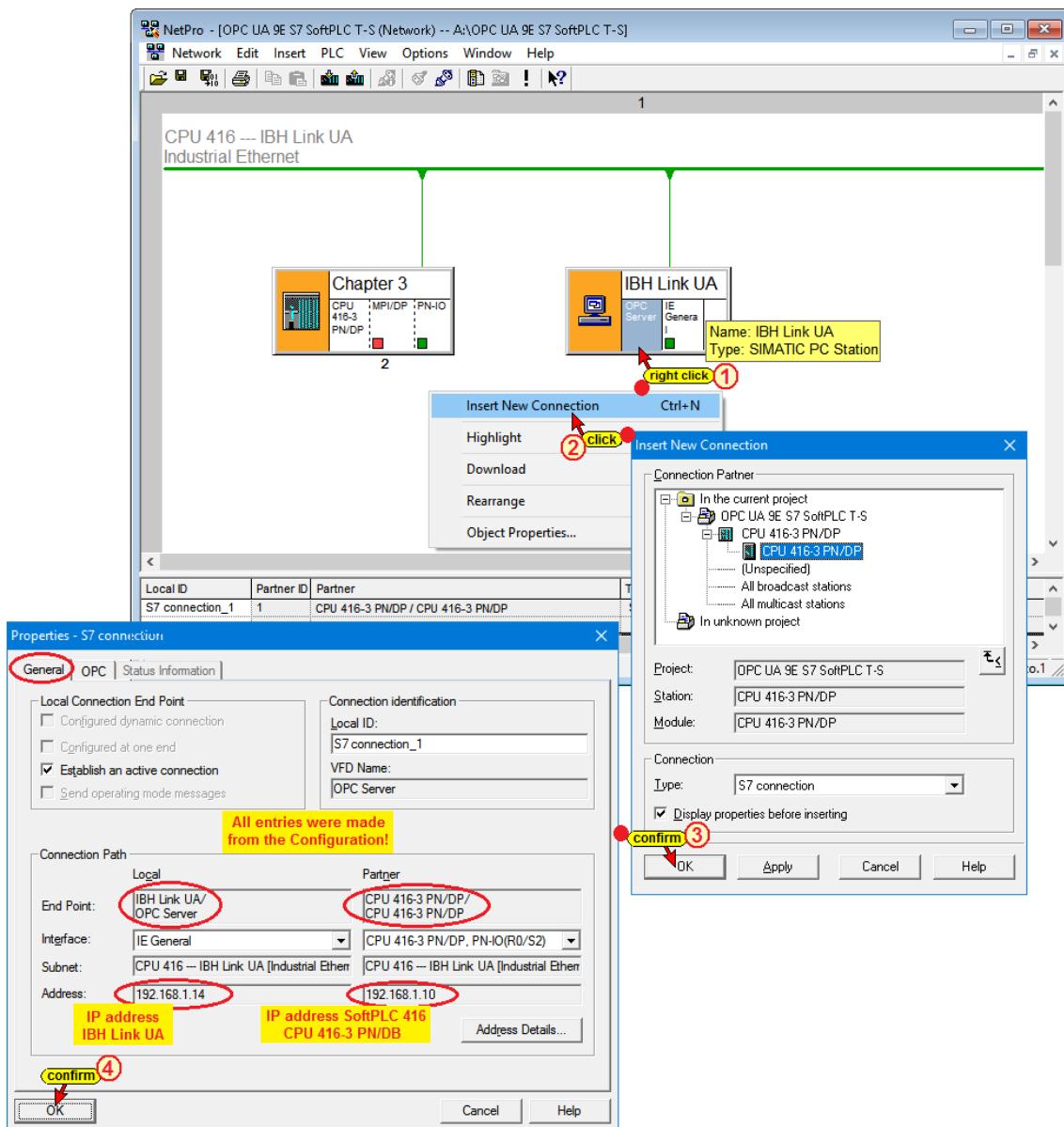


Clicking on the **Configure network** icon displays the CPU-416 and IBH Link UA link graphically.

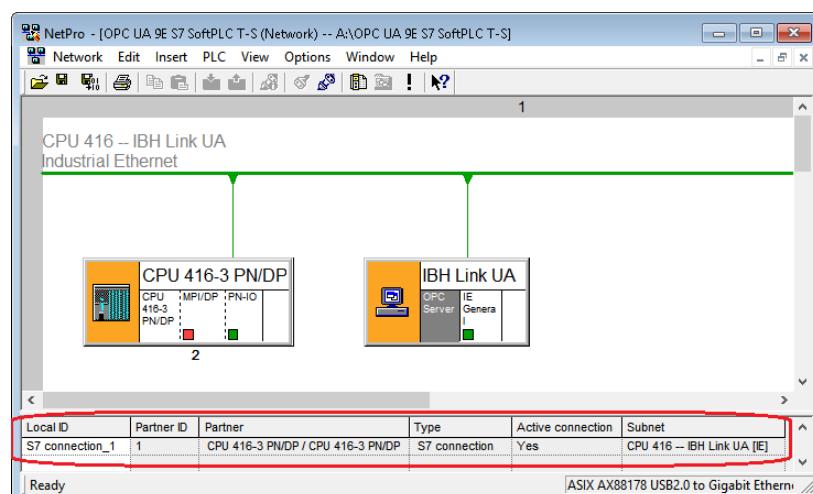


Connecting the CPU-416 with the IBH Link UA

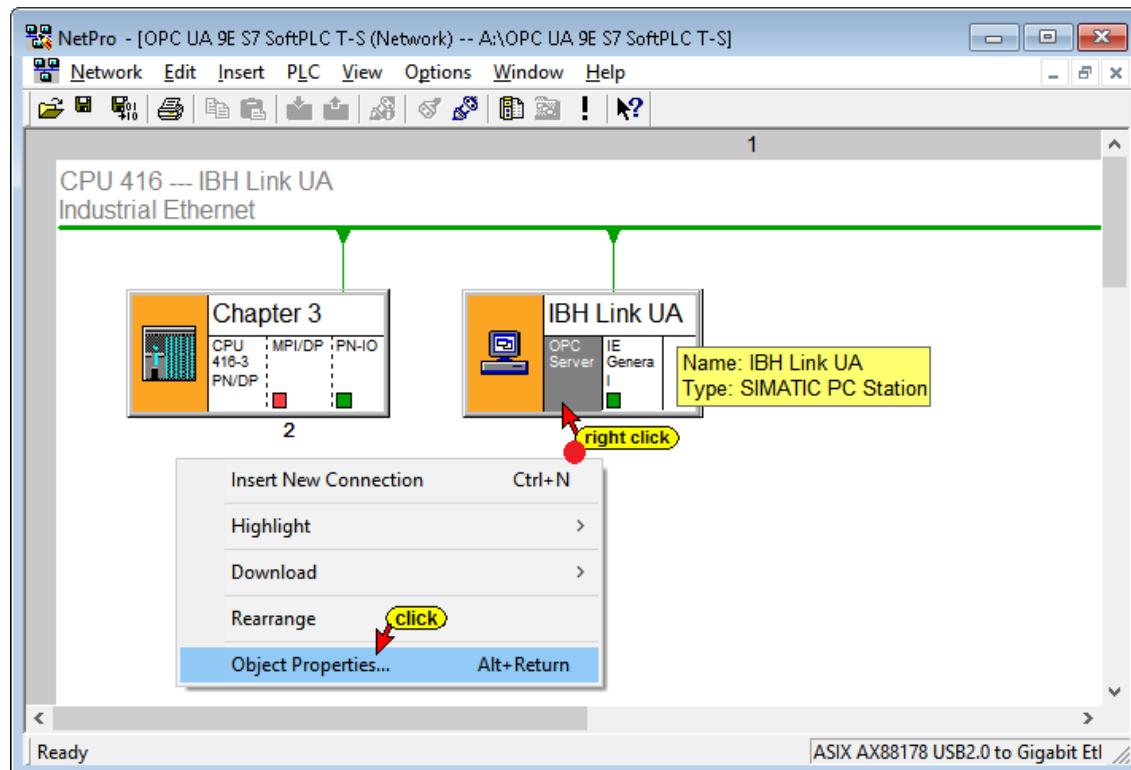
Using the following steps, an **S7 connection** is established between the CPU-416-3 PN/DP and the IBH Link UA.



The S7 Connection is listed.



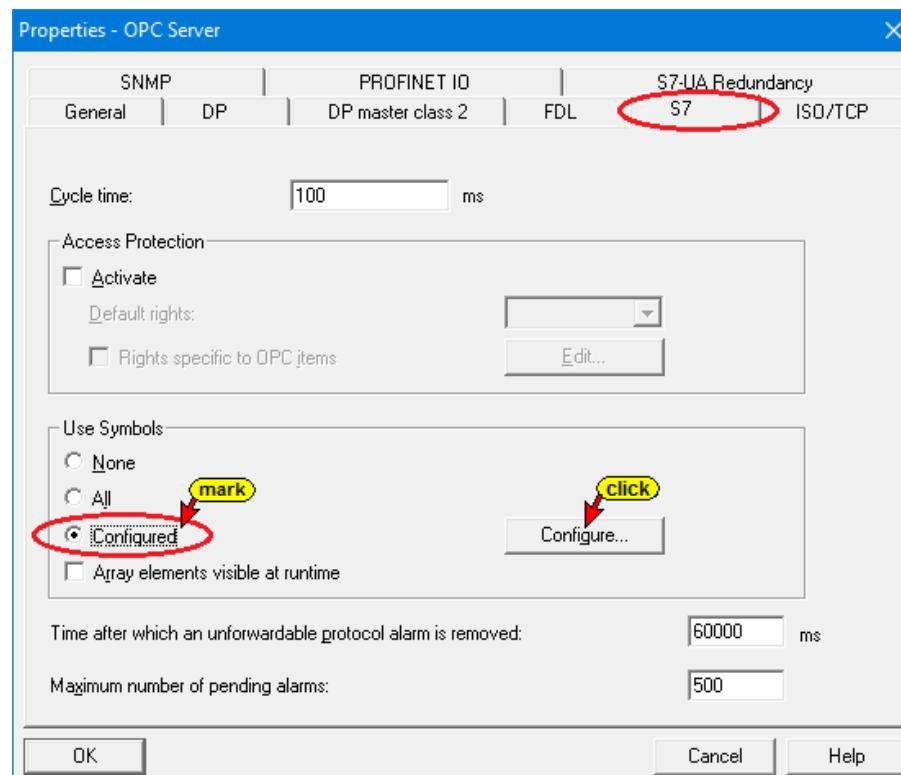
8.3.4 Select the symbols to be used (OPC tags)



Clicking the ***Object Properties*** command starts the opening of several dialog boxes to define the symbols to be used for the S7 connection.

Properties - OPC Server

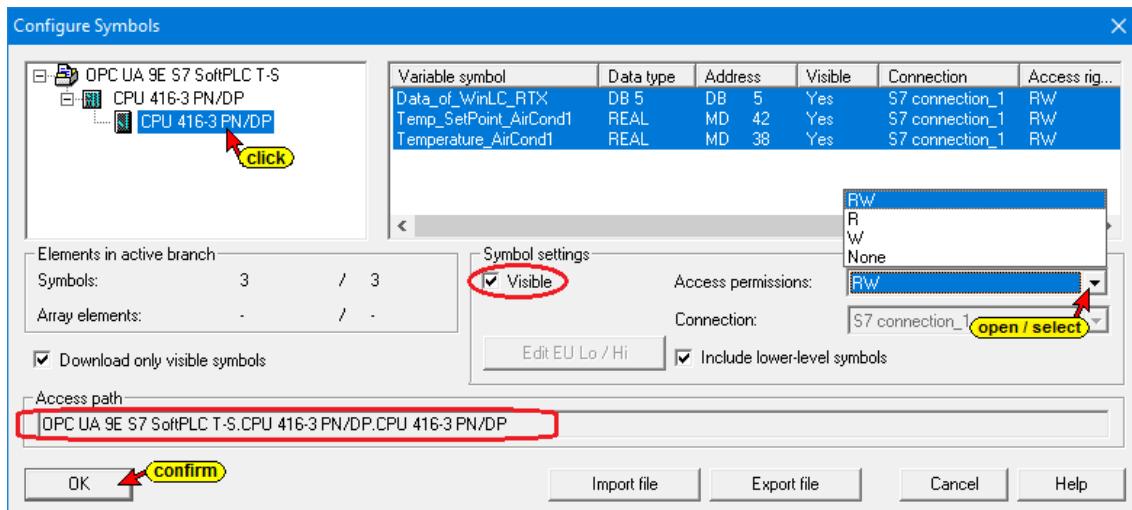
The tab S7 defines whether symbols should be used.



The **Configure** button opens a dialog box listing the operands defined in the symbol table. These operands must be selected as OPC tags.

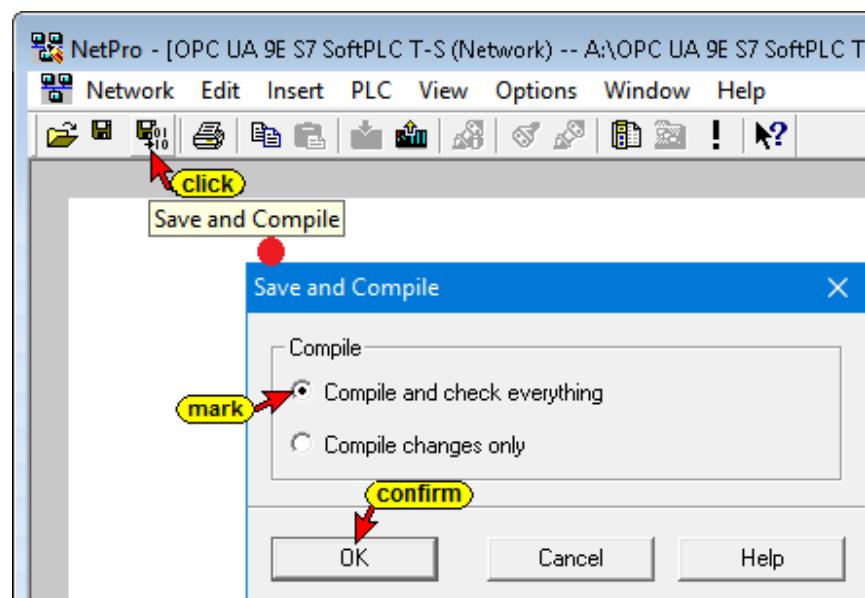
Due to the previously configured S7 connection the PLC knows the variables.

Configurable global symbolic named operands

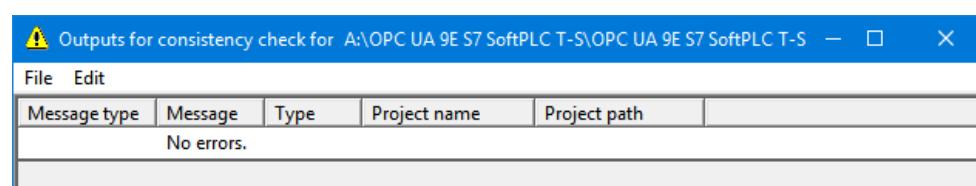


Confirm the OPC Tag selection by clicking OK in the Configure Symbols and in the Properties - OPC Server dialog box.

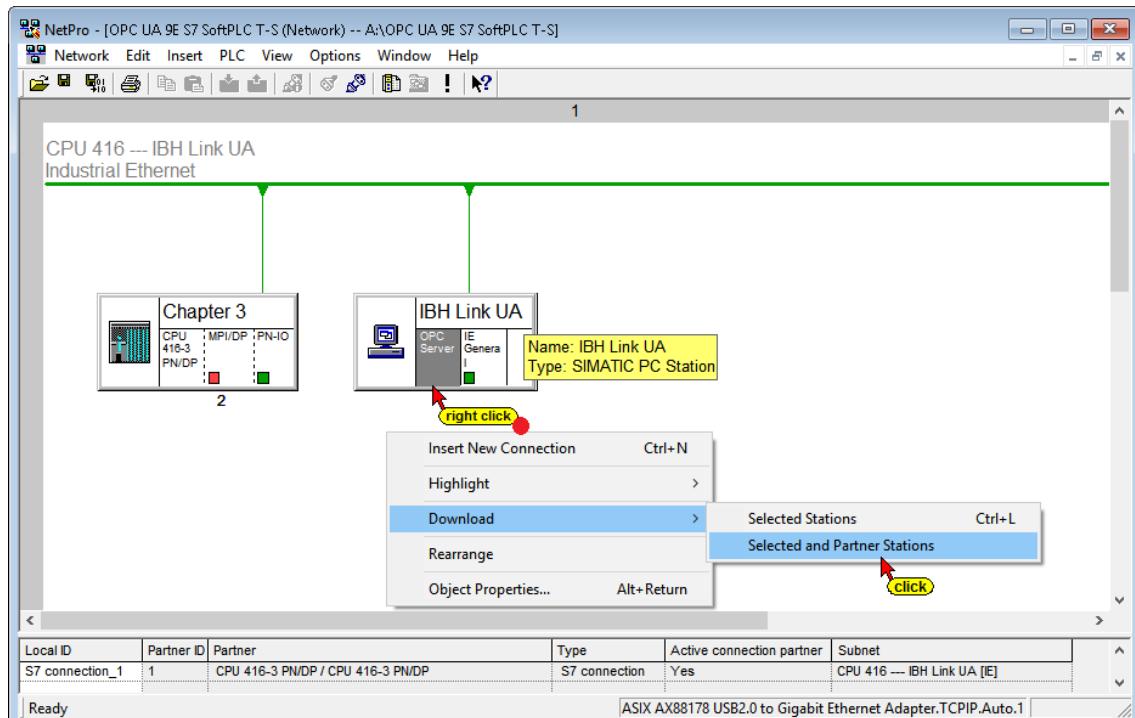
Save and Compile the configuration changes



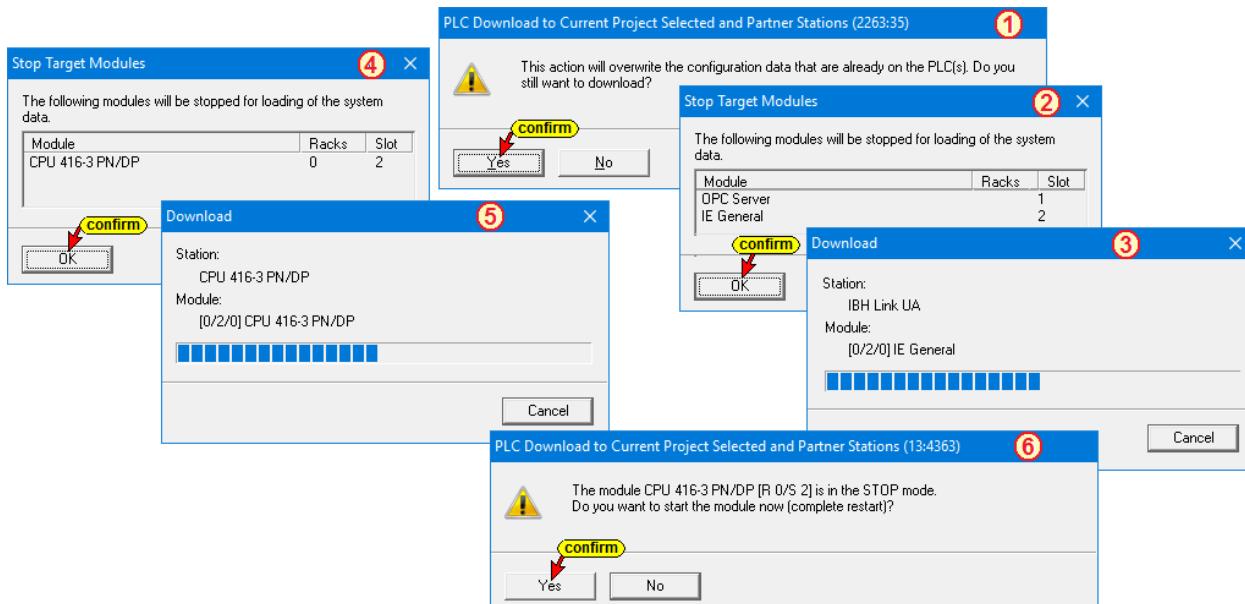
If no error has been determined with **Save and Compile**, the following confirmation is displayed



Now the configuration can be loaded into the IBH Link UA and the CPU-416.



Loading into the PLC 416 and the IBH Link UA requires several steps.



- The configuration of the Modules CPU 416-3 PN/DP, OPC Server and IE General are overwritten, identified and stopped
- After loading the configuration into the CPU 416-3 PN/DP the CPU must restarted.
- The loading into the IBH Link UA (OPC Server / IE General) is started.

Add a Server

Set up the IBH Link UA server. To do so enter the previously copied endpoint URL ***opc.tcp://192.168.1.14: 48010*** into the field opened in the IBH Link UA Web browser window / OPC Client for an ***external OPC UA server***.

The ***Security Policy None*** and the ***Security Mode None*** have been selected for data transmission.

Set up the ***External OPC UA Server*** is defined. To do so the endpoint URL ***opc.tcp://192.168.1.10: 48011*** of the external ***OPC UA Server*** is enter the field opened in the IBH Link UA Web browser window / OPC Client.

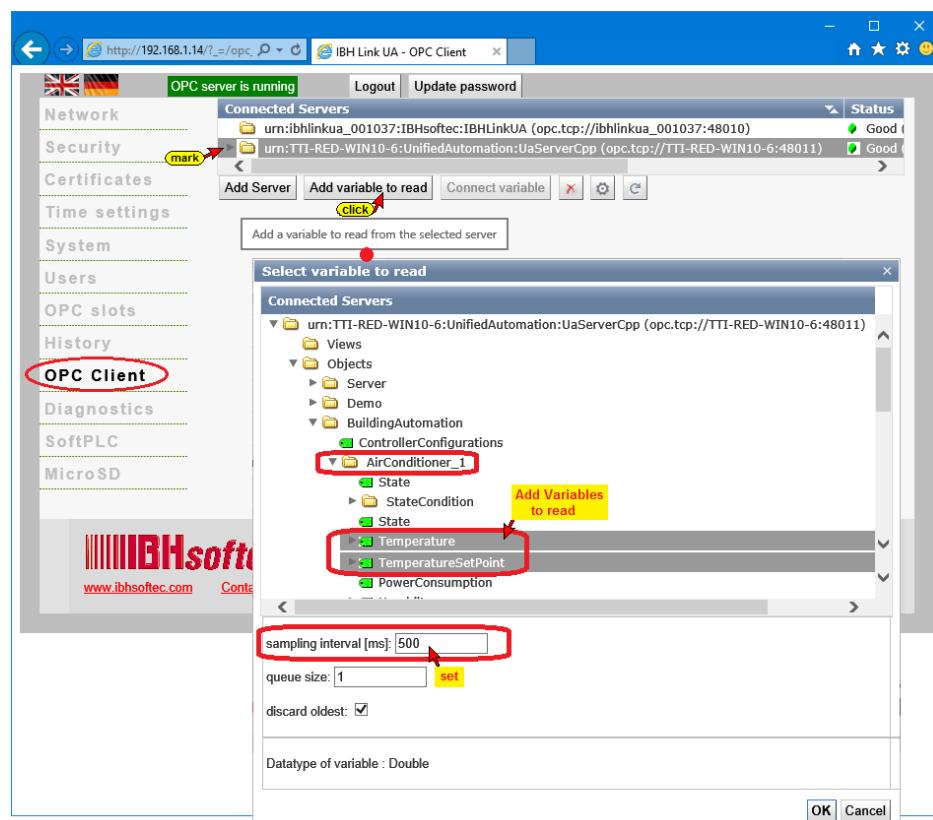
The absolute endpoint URL must be used because there is no ***NameServer*** available.

For data transmission, the ***Security Policy None*** and the ***Security Mode None*** have been selected.

For detailed information see chapter 5-12 – ***Starting the external OPC UA server***.

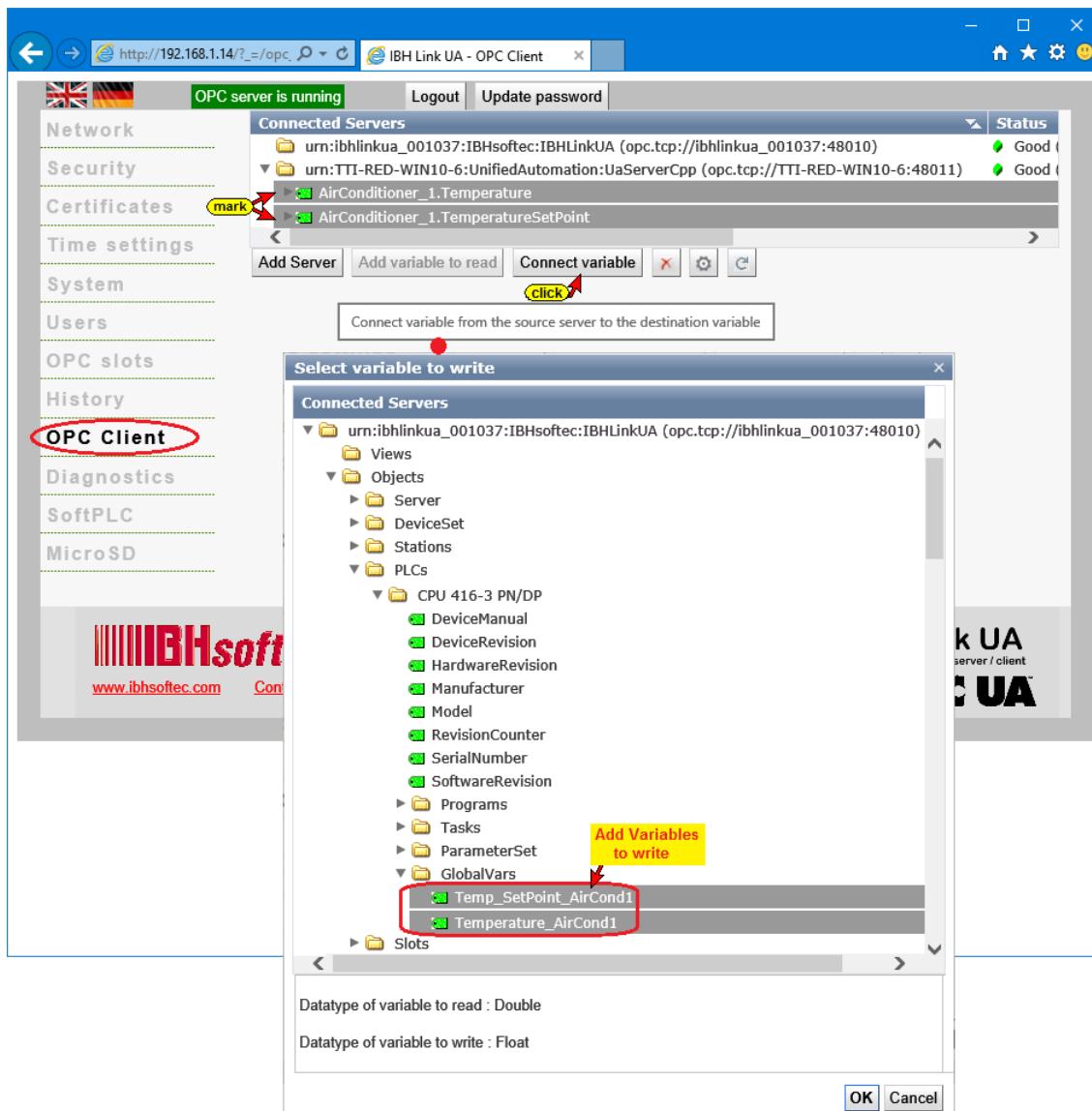
Add Read Variable

The two variables ***Temperature*** and ***TemperatureSetPoint*** from the external OPC UA Server are declared to be read variables. They are passed to the PLC program in the CPU-416 via the IBH Link UA OPC Server.

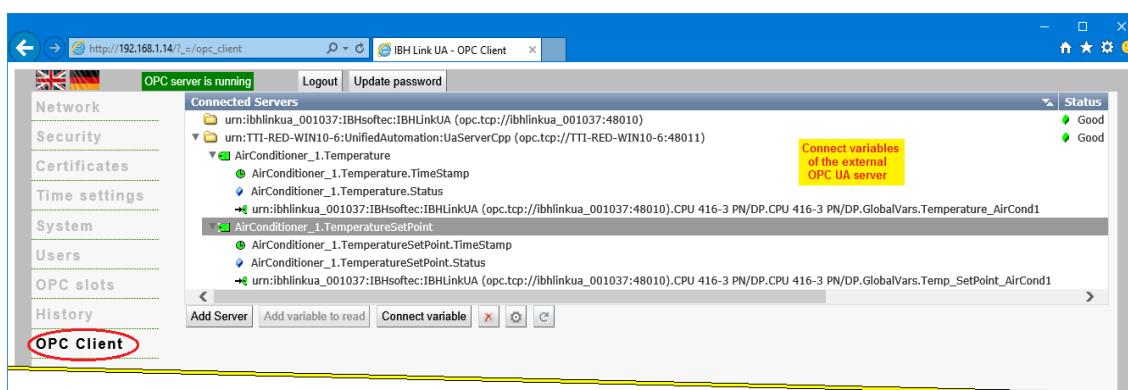


Connect to Variables

The two as read variables declared **Temperature** and **TemperatureSetPoint** are connected to the IBH Link UA OPC Server, which then feeds them to the PLC program in the CPU 416.

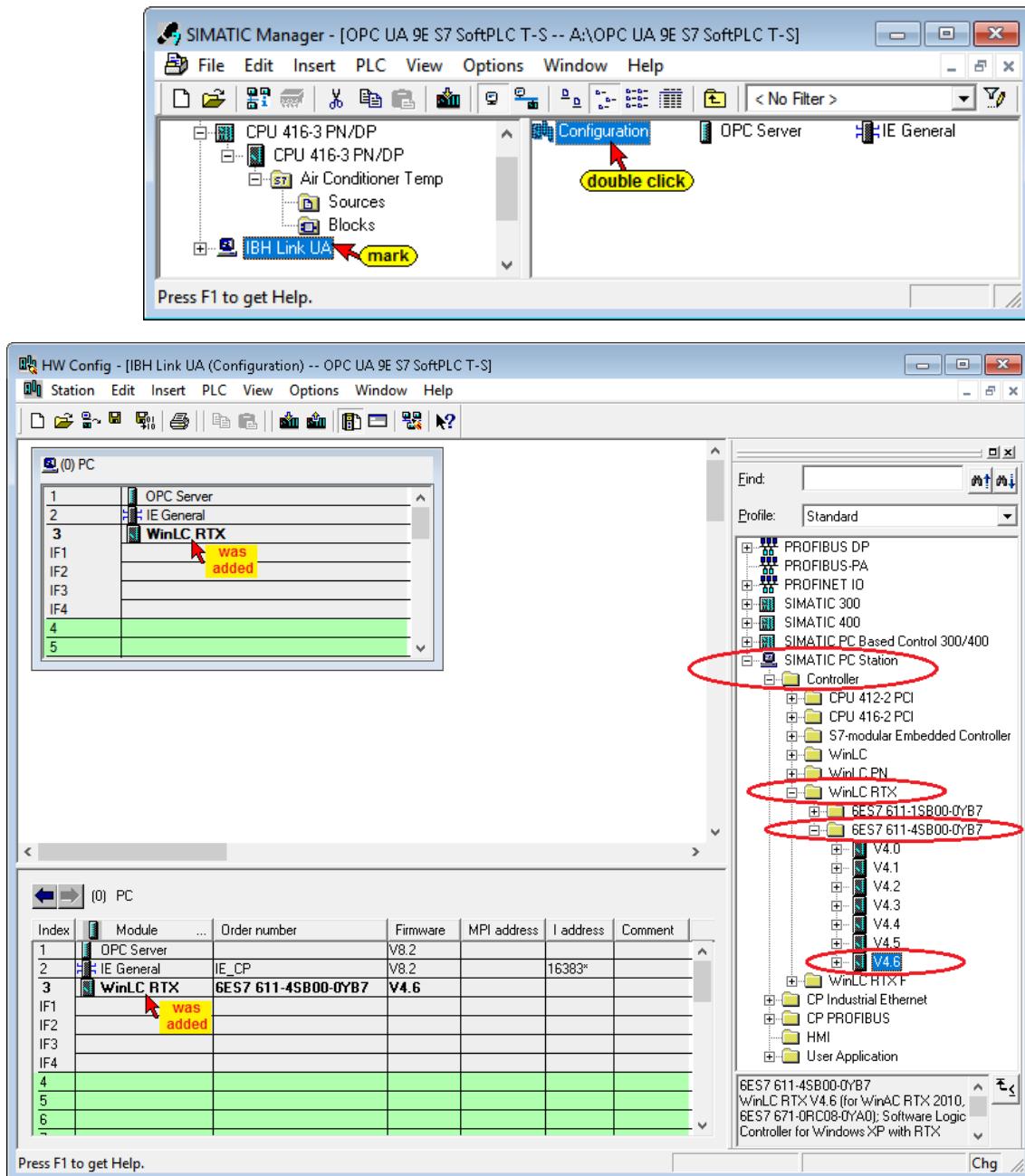


AirConditioner_1 → CPU 416-3 PN/DP – GlobalVars

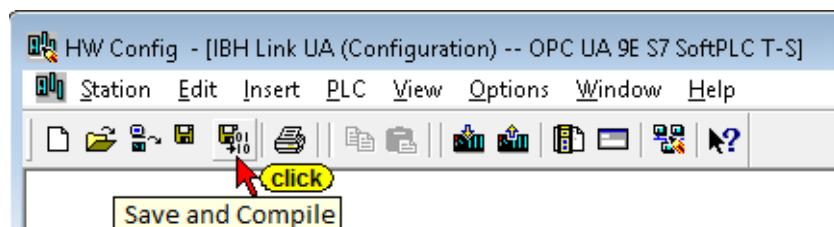


8.3.5 Inserting a SoftPLC as SIMATIC WinAC RTX in the SIMATIC PC Station (IBH Link UA)

The hardware configurator is opened by clicking on the renamed SIMATIC PC station IBH Link UA in the left window and double-clicking on Configuration in the right window.

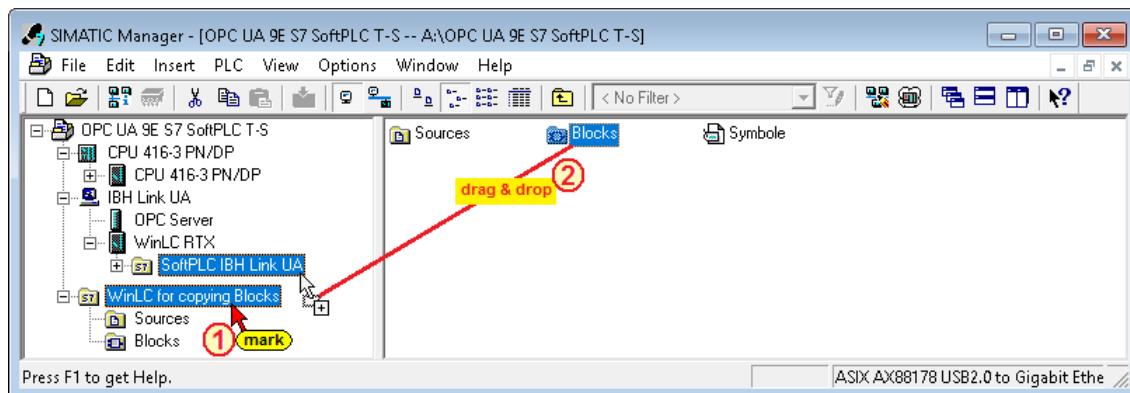


Click the **Save and Compile** icon to save the configuration of the Modules.

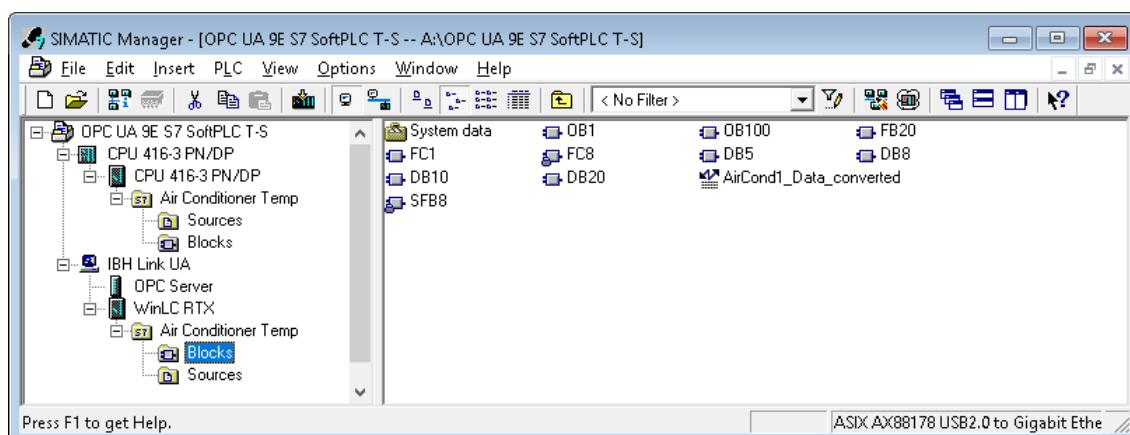


8.3.6 Creating the S7 program for SoftSPS WinLC RTX

Copying **Blocks** and **Symbols** from the S7 program **WinLC for copying Blocks** to the S7 program of the WinLC RTX (renamed to **SoftPLC IBH Link UA**) using drag and drop.



The S7 program **WinLC for copying Blocks** can then be deleted.



8.3.7 The PLC program for the SoftPLC of the IBH Link UA

The SFB 8 (USEND) block located in the Siemens libraries is used to transmit an OPC variable made from the actual value, the associated time stamp (TimeStamp) and the status (Quality Code).

With these data, the PLC program can evaluate not only the value of a variable, but also its quality and age.

If the variable "**CurrentTime**" existing on each OPC UA server is also placed in a data area of the PLC, the status of the connection to the OPC UA server can also be evaluated. The SFB 8 (USEND) block has the necessary parameters for simple logging of OPC variables.

With the special function code 65400 (Hex FF78) the SFB 8 (USEND) can only be used to transfer OPC variables.

The 4 ANY pointers and the parameter R_ID of the block are used to transfer the variables using the call command.

The SoftPLC can read or write the OPC variables cyclically.

The configuration is performed by calling the SFB 8 (USEND) in the restart Organization Block (OB100 Call).

Note:

The SFB 8 (USEND) PLC block can only be used in the **SoftPLC** of the **IBH Link UA** with the **Special Function Code 65400 (Hex FF78)**.

Due to the only once transferring parameters by calling the block SFB 8 (USEND), the SoftPLC is enabled to read or write OPC variables cyclically.

No instance data block is required for the transfer of the parameters. An instance data block must exist when USEND is called due to the syntax of a system function block call.

If the SFB 8 (USEND) block is called in another CPU with the special function code 65400 (Hex FF78), an error message is displayed.

Parameters of the Block SFB 8 (USEND) - ID = 65400 (hex FF78)

REQ	:= TRUE	// Not evaluated
ID	:= W#16#FF78	// Fixed value: 65400
R_ID	:= DW#16#1F40002	// Modus: // Low Word; 2: Read(PLC Variable) // High Word: Sampling in milliseconds // 500 milliseconds
DONE	:=	// is not set
ERROR	:=	// No ERROR=0; ERROR=1
STATUS	:=	// 0x0000 on success, 0x8090 on error
SD_1	:=	// Pointer to the OPC Variable.
SD_2	:=	// Pointer to the OPC Variable for the // Value of the OPC Variable.
SD_3	:=	// Pointer to the PLC Variable for the // Status of the Variable.
SD_4	:=	// Pointer to the PLC Variable for the // Time Stamp .

Client Function of SFB 8 (USEND)

Cyclic reading and writing. The SoftPLC can read or write the OPC variables cyclically.

The configuration will be done within the SFB 8 (USEND) and called during the warm start (OB100).

Parameter	Declaration	Data type	Storage area	Description
REQ	INPUT	BOOL	E, A, M, D, L	Not evaluated
ID	INPUT	WORD	M, D, Const.	Fixed value: 65400
				Mode Low Byte: 0: Read (Variable as XML String) 1: Write (Variable as XML String) 2: Read (PLC Variable) 3: Write (PLC Variable) 4: Read (Special Variable) 5: Write (Special Variable) 6: Read (Server Variable) 7: Write (Server Variable)
R_ID	INPUT	DWORD	E, A, M, D, L, Const.	Flag 14: While writing the Any Pointer points to DATE_AND_TIME Flag 15: While writing the Any Pointer points to a STRING High Word: Sampling in milliseconds
DONE	OUTPUT	BOOL	E, A, M, D, L	is not set ERROR=0: The parameters were passed correctly
ERROR	OUTPUT	BOOL	E, A, M, D, L	ERROR=1: The parameters were passed not correctly
STATUS	OUTPUT	WORD	E, A, M, D, L	0x0000 on success, 0x8090 on error.
SD_1	IN_OUT	ANY	D	Pointer to the OPC Variable. Pointer to the OPC Variable for the value of the OPC Variable. Allowed is Data Type BOOL, BYTE, CHAR, WORD, INT, DWORD, DINT, REAL, DATE, DATE_AND_TIME.
SD_2	IN_OUT	ANY	E, A, M, D	Note: If the ANY pointer points to a DB, the DB must always be specified (f.i.: P# DB10.DBX5.0 Byte 0). Pointer to the PLC Variable for the status of the OPC Variable. Allowed is Data Type DWORD
SD_3	IN_OUT	ANY	E, A, M, D	Note: If the ANY pointer points to a DB, the DB must always be specified (f.i.: P# DB10.DBX5.0 Byte 10). Pointer to the PLC Variable for the Time Stamp of the OPC Variable. Allowed is Data Type DATE_AND_TIME.
SD_4	IN_OUT	ANY	D	Note: If the ANY pointer points to a DB, the DB must always be specified (f.i.: P# DB10.DBX5.0 Byte 10).

OPC Variable Definitions

To uniquely identify the OPC variables, they are assigned a number (namespace), next to the actual name.

The OPC Variables are defined as follows:

Mode 0 and 1: 'ns=<Namespace>;s=<Identifier>'

or: **ns=<Namespace>;i=<Numeric Identifier>'**

All OPC Variables can be read using this mode.

The IBH Link UA knows the following Namespaces:

Namespace	Area
0	General OPC Server Variables
1, 2, 3, 5	No evaluable variables
4	All PLC specific OPC variables
6	IBH Link UA Special Variables

Mode 2 and 3: '<Identifier>'

The identifier is formed as follows:

**<Station name>.<PLC Name>.<GlobalVars>.<Variable name
from Variables table>**

or:

**<Station name>.<PLC Name>.<Programs>.<Variable name>
<Data Block name>**

Mode 4 and 5: <Numeric Identifier>

Number of the Special Variable from Namespace 6.

Modus 6 and 7: <Numeric Identifier>

Number of the Server Variable from Namespace 0.

Variables used in the example:

(WinLC RTX – Static Variables FB20/DB 20 Air Conditioner Temp)

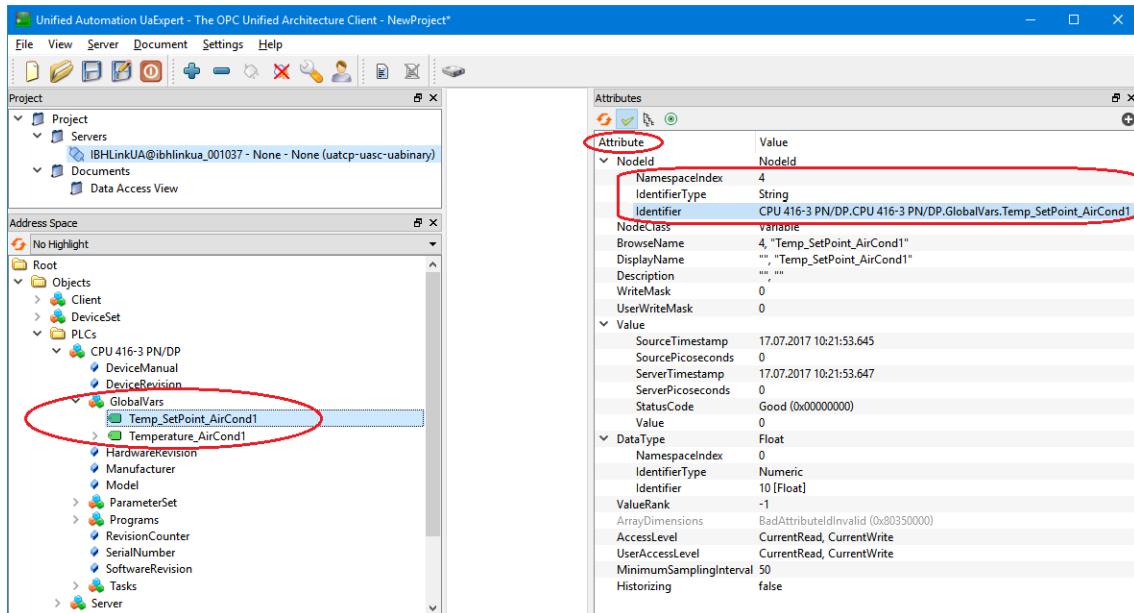
The **Identifiers Temp_SetPoint_AirCond1** and
Temperature_AirCond1 have the **Namespaceindex 4**.

The **Identifiers** are:

**CPU 416-3 PN/DP.CPU 416-3 PN/DP.GlobalVars.
Temp_SetPoint_AirCond1**

**CPU 416-3 PN/DP.CPU 416-3 PN/DP.GlobalVars.
Temperature_AirCond1**

Identifiers in the Attributes window



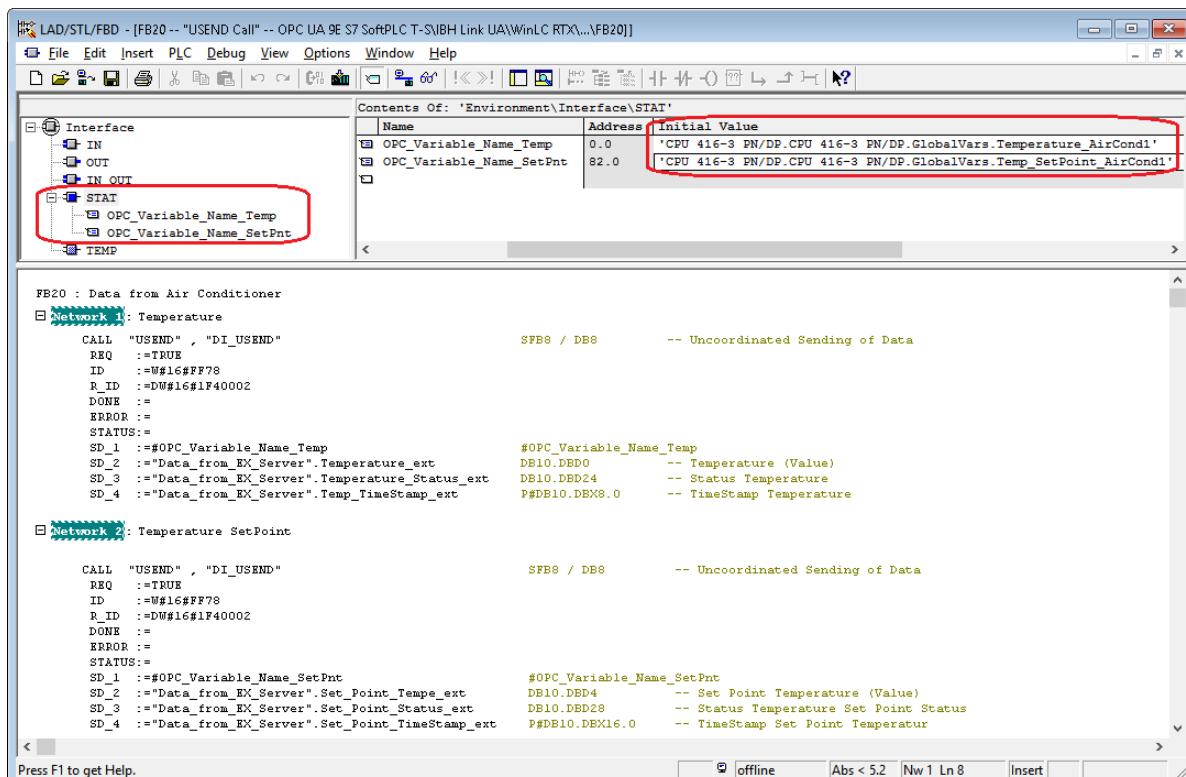
Note:

If the **Identifier** is marked in the **Attributes** window, it can be copied to the Windows clipboard (**Ctrl + C**) for further use.

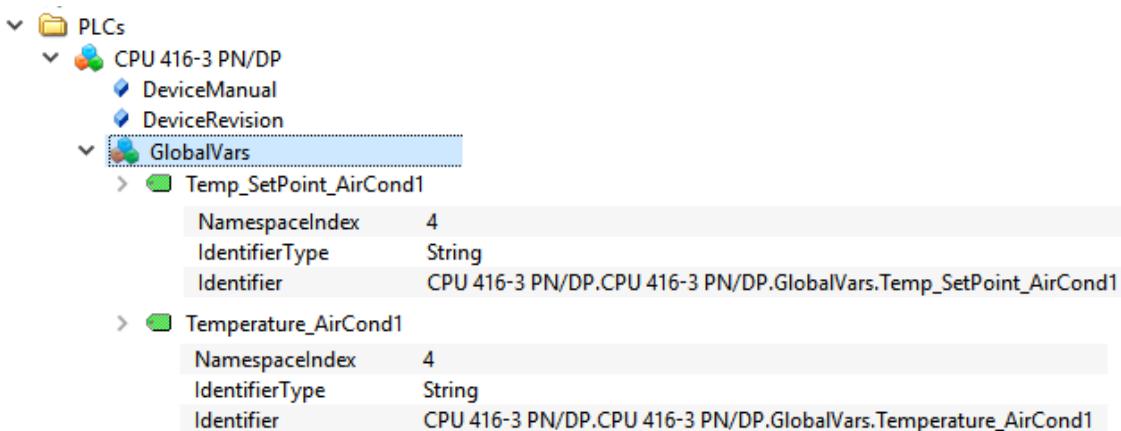
The copied identifiers must be pasted as the initial values of the static variables

Temperature_AirCond1 and **Temp_SetPoint_AirCond1**
into the PLC block (S7 Program – Air Conditioner Temp) **FB20**.

Function block FB 20 – USEND Call



The identifiers were copied from the ***UaExpert Attributes*** window and pasted as initial values of the STAT variables of FB20.



These variables are used as pointers when calling USEND with parameter ***SD_1***.

The parameters REQ and ID have been defined according to the table on page 9-20.

The parameter R_ID is composed as follows:

- Low Word: Value 2 (hex 0002) – Read (PLC Variable).
- High Word: 500 milliseconds – hex 01F4 –

Parameter ***R_ID*** – double word: = 16#1F40002

The parameters ***DONE***, ***ERROR*** and ***STATUS*** are not used in the example.

- SD_1 := Pointer to the OPC variable.
- SD_2 := Pointer to PLC Variable for the value of the OPC variable.
- SD_3 := Pointer to the PLC Variable for the status of the OPC variable.
- SD_4 := Pointer to the PLC Variable for the Time Stamp of the OPC Variable.

Note:

The same instance data block (DB 8 - DI_USEND) is used for both calls of SFB 8 - USEND. This instance data block is only present to satisfy the syntax.

The block FB 20 is called once in the OB 100 when the PLC is started. It is only necessary to transfer the parameters to the PLC that has integrated the block (SFB 8 - USEND).

Only the SoftPLC in IBH Link UA uses USEND in this form !

Data block DB 10 – Data_from_EX_Server

The variables of the external OPC server (OPC variable of the air conditioner 1) are stored here.

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Temperature_ext	REAL	0.000000e+000	Temperature (Value)
+4.0	Set_Point_Tempext	REAL	0.000000e+000	Set Point Temperature (Value)
+8.0	Temp_TimeStamp_ext	DATE_AND_TIME	DT#90-1-1-0:0:0	TimeStamp Temperature
+16.0	Set_Point_TimeStamp_ext	DATE_AND_TIME	DT#90-1-1-0:0:0	TimeStamp Set Point Temperatur
+24.0	Temperature_Status_ext	DWORD	DW#16#0	Status Temperature
+28.0	Set_Point_Status_ext	DWORD	DW#16#0	Status Temperature Set Point Status
=32.0		END_STRUCT		

Functions FC 8 and FC 1 – Fahrenheit_to_Celsius

The function FC 8 (DT_TOD) converts the variables of the type DATE_AND_TIME into the type Daytime. The function FC 1 converts ° Fahrenheit in ° Celsius.

Data block DB 5 – Show_Time_Temperature_St

The data block DB 5 stores the converted variables of the data block DB 10. These variables can then be read as OPC variables from the CPU 416-3 PN/DP.

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Temperature_Time	TIME_OF_DAY	TOD#0:0:0.000	
+4.0	SetPoint_Time	TIME_OF_DAY	TOD#0:0:0.000	
+8.0	CPU_Time	TIME_OF_DAY	TOD#0:0:0.000	
+12.0	Temperature	REAL	0.000000e+000	
+16.0	Temp_SetPoint	REAL	0.000000e+000	
+20.0	Temperature_Status	DWORD	DW#16#0	
+24.0	SetPoint_Status	DWORD	DW#16#0	
=28.0		END_STRUCT		

Organization block OB 1 – Start_OB

OB1 calls the functions FC1 and FC3 to form the conversions.

Organization block OB 100 – COMPLETE RESTART

OB100 calls the Function Block FB 20 only once. FB 20 executes the System Function Blocks SFB 8 – USEND

Note:

If the FB 20 has been modified, the OB 100 must be reinitialized.

Note:

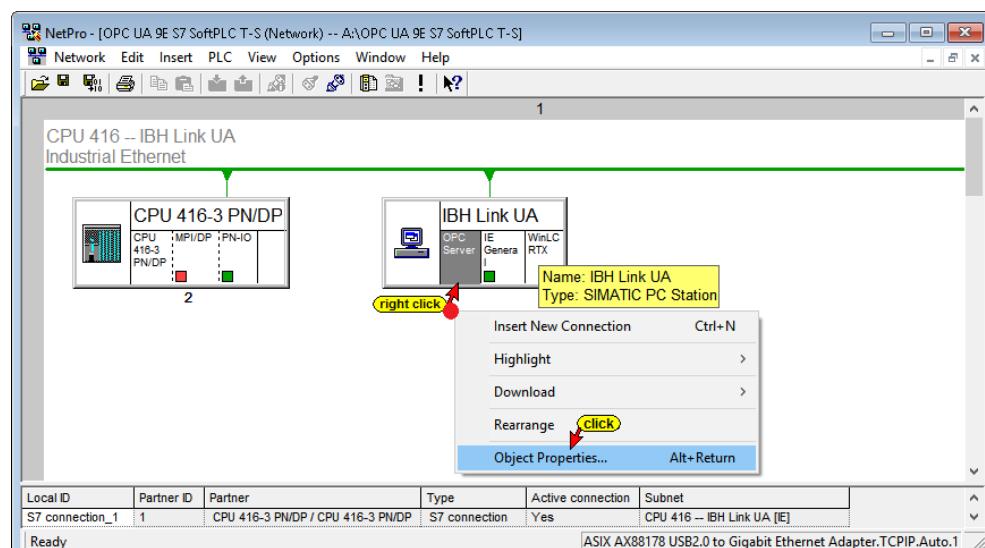
It is important that the block, executing the System Function Blocks SFB 8 – USEND, is called only once.

The System Function Block transfers the parameters to the SoftPLC.

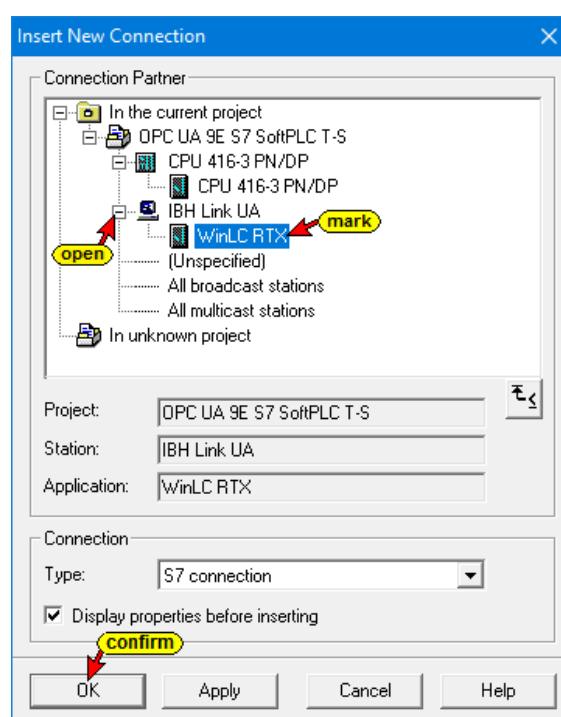
In the proper sense, the System Function Blocks SFB 8 – USEND, is not executed.

8.3.8 Insert the S7 Connection with NetPro

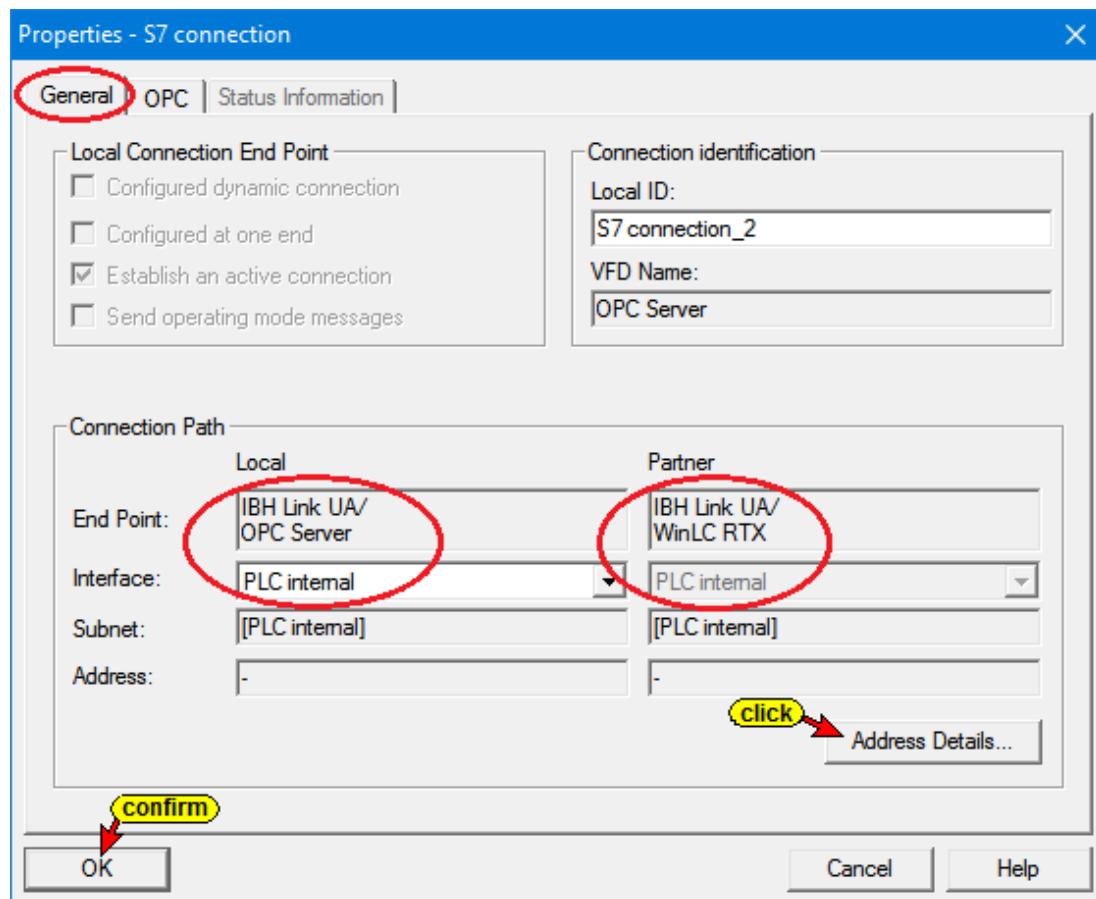
A connection must be added between the OPC server and the in the IBH Link UA integrated SoftPLC CPU (**WinAC RTX**).



Clicking the command **Insert New Connection** opens the dialog box.



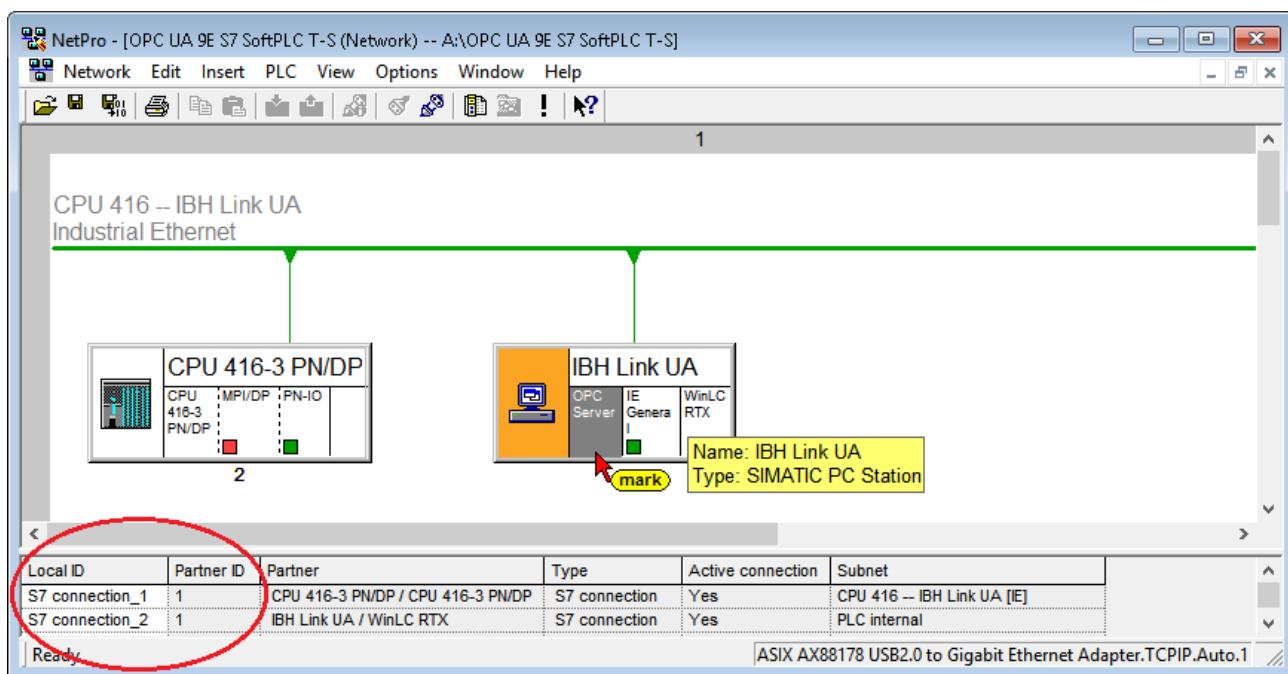
Click **OK** to open the **Properties – S7 Connection** dialog box – Tab **General**.



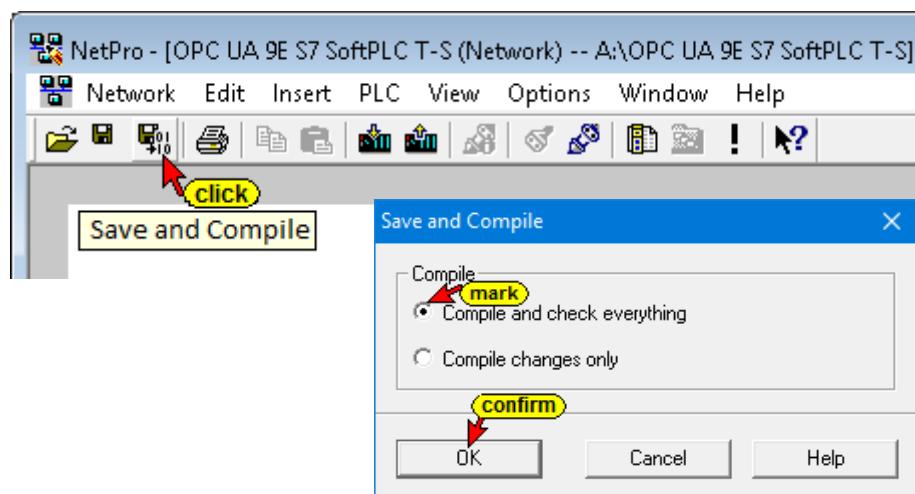
Click the **Address Details** button for more details of the connection.

Marking the OPC server displays its connections.

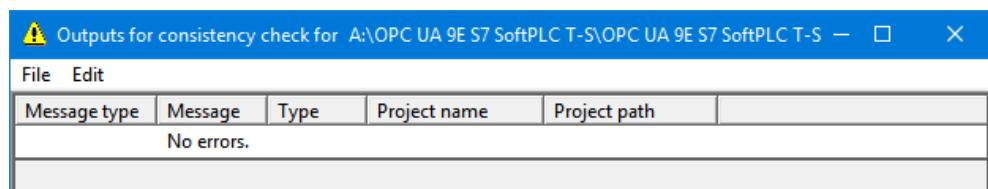
- S7 connection 1: CPU 416-3 PN/DP – IBH Link UA CPU [IE]
- S7 connection 2: IBH Link UA CPU – WinLC RTX



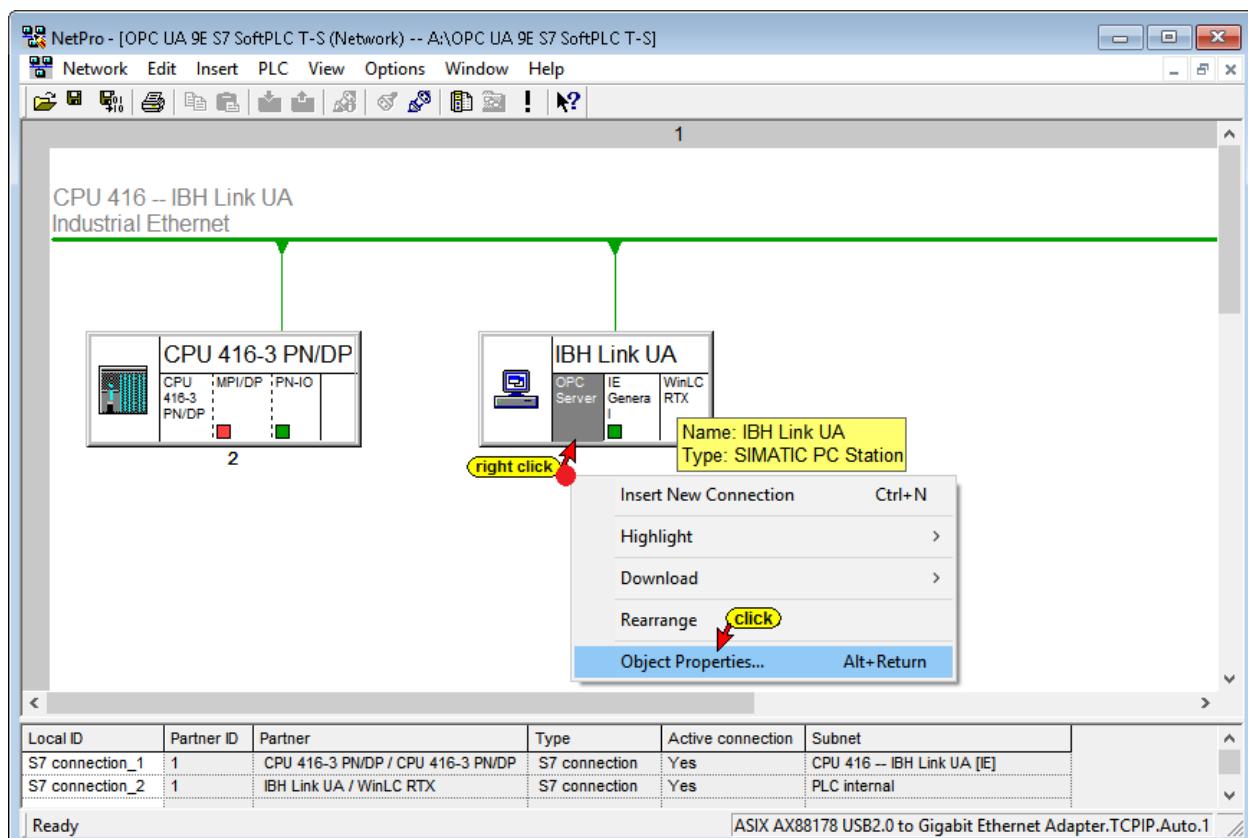
Save and Compile the configuration



The successful compiling and saving is displayed.

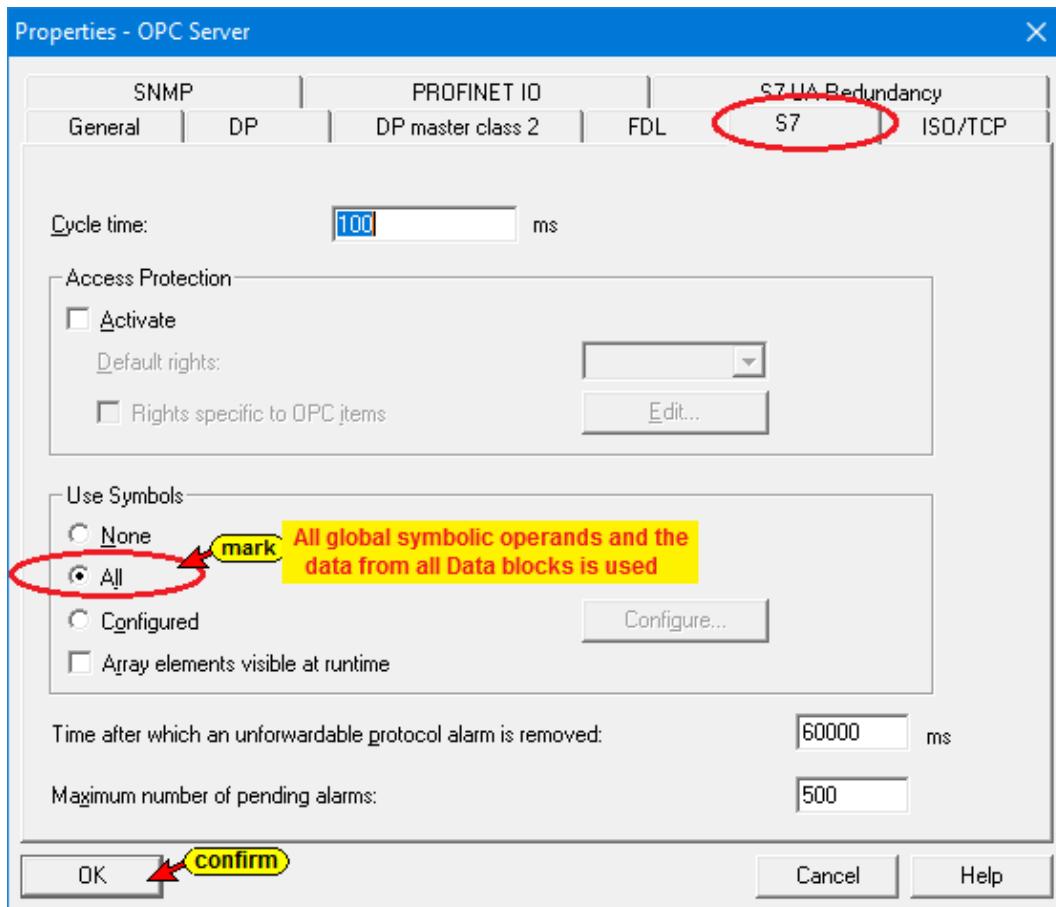


8.3.9 Select the OPC tags

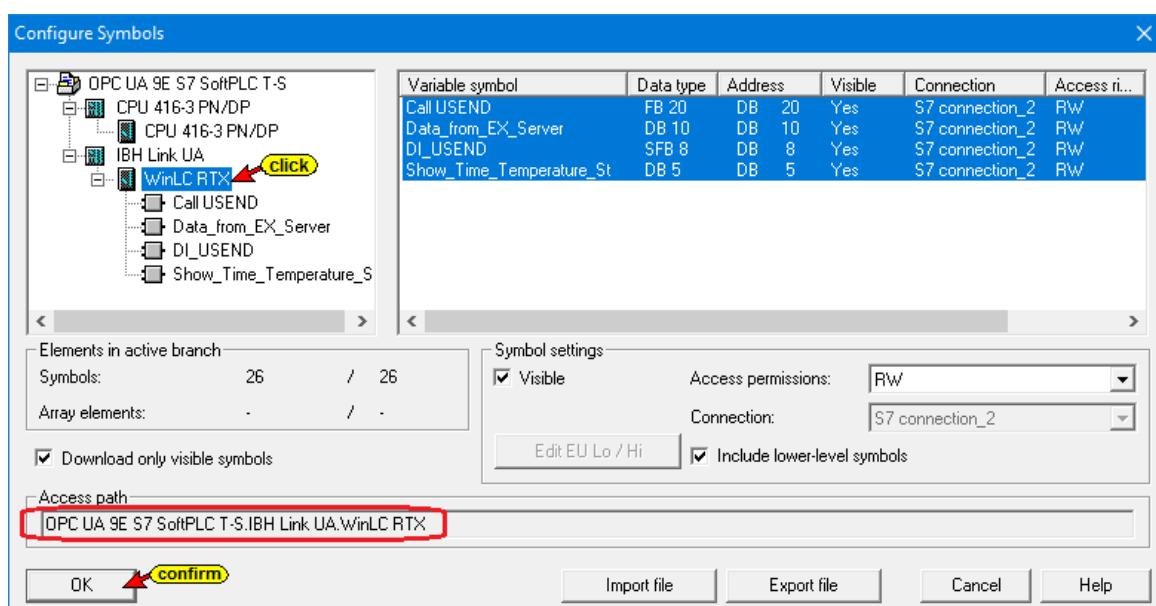


Clicking the **Object Properties** command starts the opening of several dialog boxes.

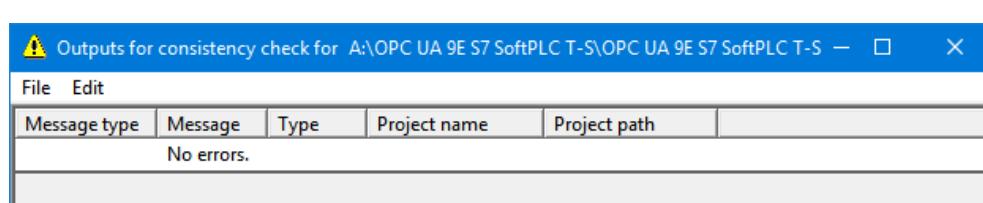
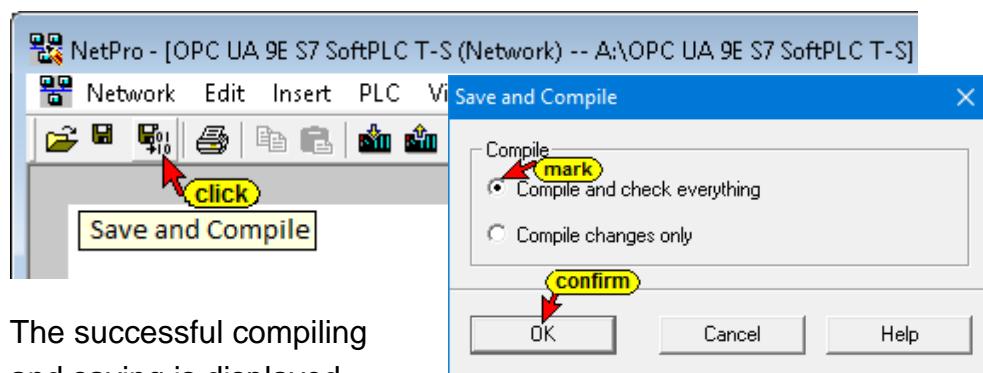
Because all global symbolic operands and the data from all Data blocks should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.



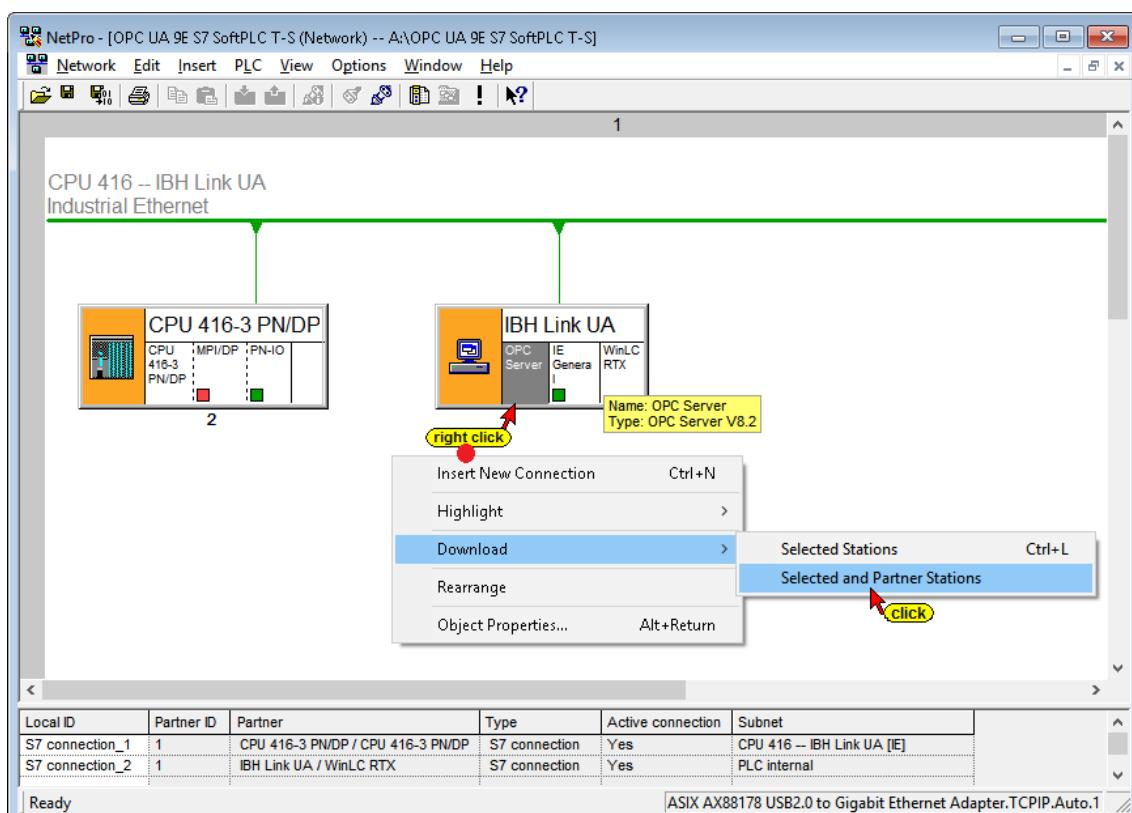
If Configured is marked, the Configure button opens the Configure Symbols dialog box. The data blocks and its data can be selected as OPC tags. The Tags are displayed due to the previously configured S7 connection.



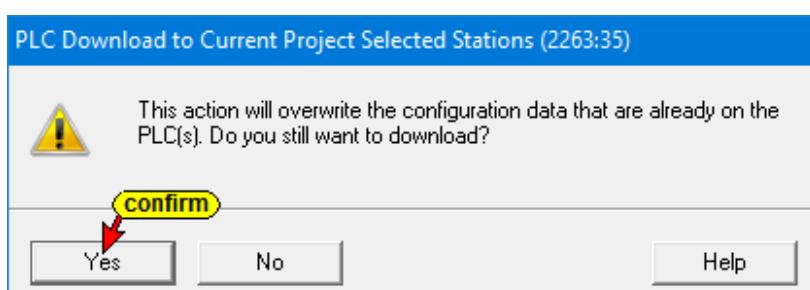
Save and Compile the configuration with the OPC Tags



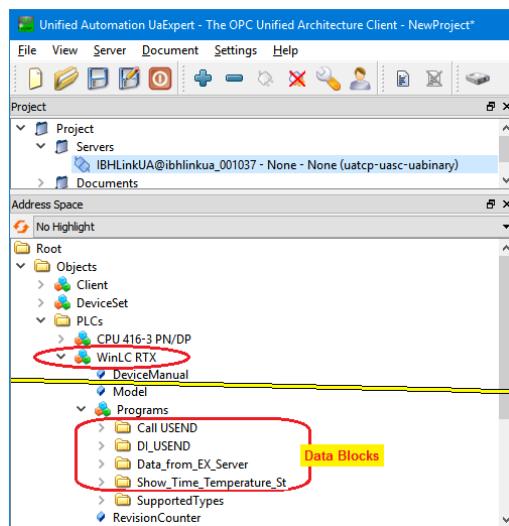
Load the configuration into the IBH Link UA



Loading the configuration into the IBH Link UA



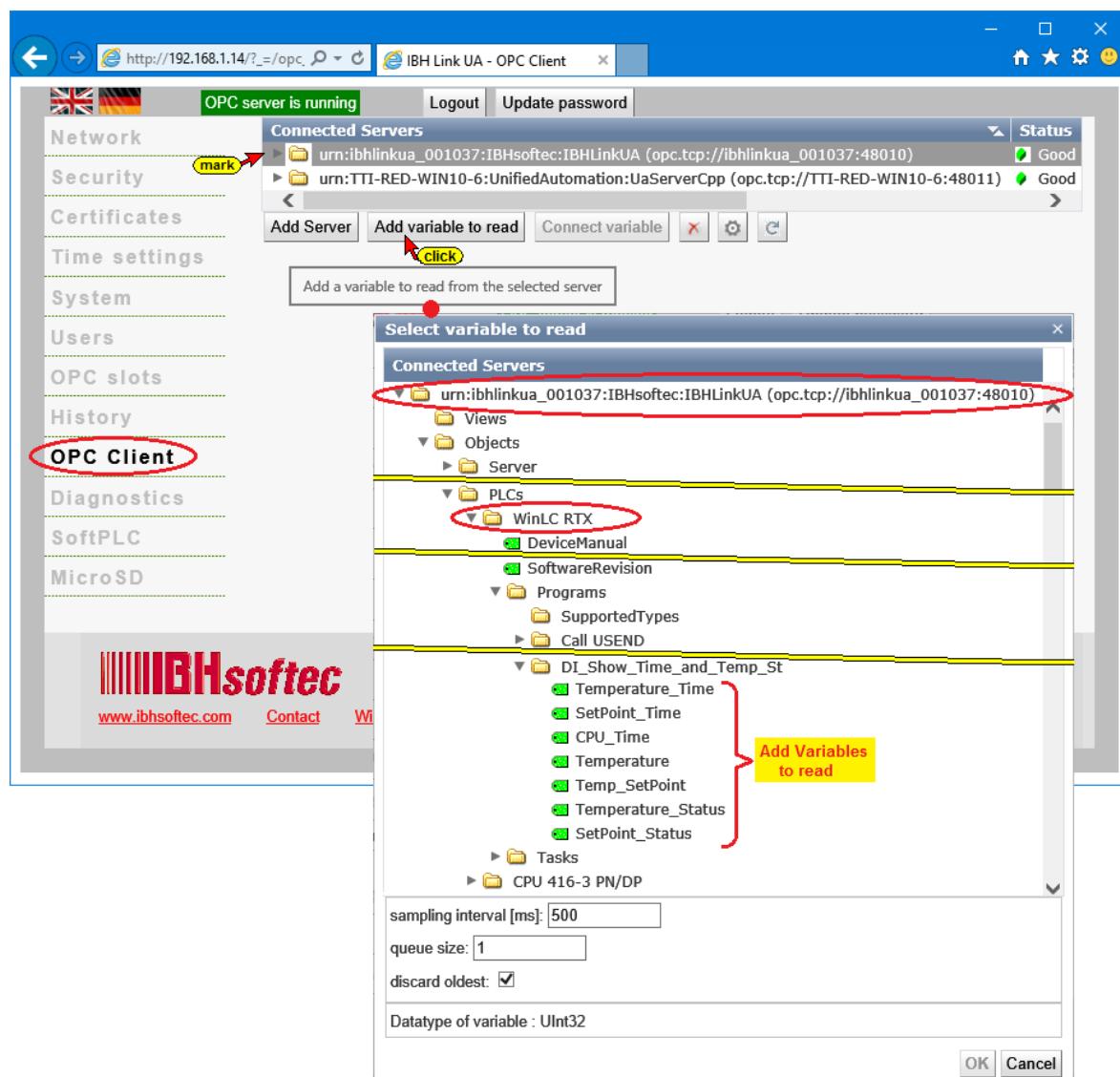
The SoftSPS (WinLC RTX) appears in the UA Expert Window



After loading, the SoftPLC with its Data Blocks is displayed in the UA Expert window.

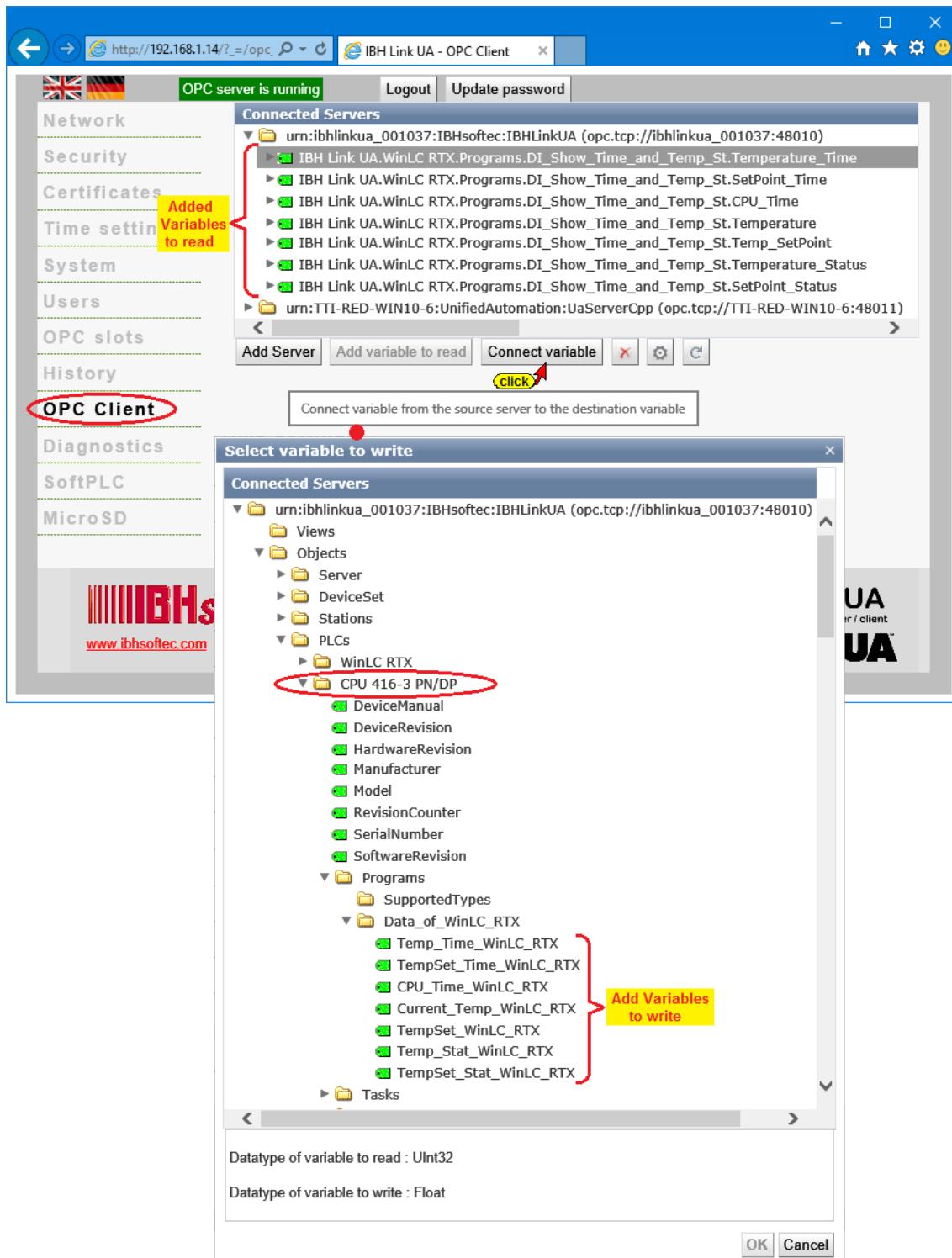
8.3.10 Read OPC Server variables from SoftSPS (WinLC RTX)

The OPC variables to be read by the SoftPLC (WinLC RTX) are selected via the OPC UA Client function.



Connect to Variables

The read Variables from the SoftSPS (WinLC RTX) must be connected to Variables of the CPU 416-3 PN/DP.



In the IBH Link UA web browser window **OPC Client** the connections are displayed.



8.3.11 Display of the transferred variables

Variable Table – **AirCond1_Data_WinLC_RTX (VAT 1)** – of the PLC **CPU 416-3 PN/DP** online.

	Address	Symbol	Display format	Status value	Modify value
1	MD_38	"Temperature_AirCond1"	FLOATING_POINT	71.9948	
2	MD_42	"Temp_SetPoint_AirCond1"	FLOATING_POINT	72.0	
3	DB5.DB0_0	"Data_of_WinLC_RTX".Temp_Time_WinLC_RTX	TIME_OF_DAY	TOD#10:27:09.249	
4	DB5.DB0_4	"Data_of_WinLC_RTX".TempSet_Time_WinLC_RTX	TIME_OF_DAY	TOD#10:27:09.249	
5	DB5.DB0_8	"Data_of_WinLC_RTX".CPU_Time_WinLC_RTX	TIME_OF_DAY	TOD#10:27:10.000	
6	DB5.DB0_12	"Data_of_WinLC_RTX".Temperature_WinLC_RTX	FLOATING_POINT	22.21354	
7	DB5.DB0_16	"Data_of_WinLC_RTX".TempSet_WinLC_RTX	FLOATING_POINT	22.22222	
8	DB5.DB0_20	"Data_of_WinLC_RTX".Temp_Stat_WinLC_RTX	HEX	DW#16#00000000	
9	DB5.DB0_24	"Data_of_WinLC_RTX".TempSet_Stat_WinLC_RTX	HEX	DW#16#00000000	

OPC UA 9E S7 SoftPLC T-S\CPU 416-3 PN/DP\...\Air Conditioner Temp

RUN Abs < 5.2

Variable Table – **AirCond1_Data_WinLC RTX (VAT 1)** – of the integrated IBH Link UA **SoftPLC WinLC RTX** online.

	Address	Symbol	Display format	Status value	Modify value
1	DB5.DB0_0	"Show_Time_Temperature_St".Temperature_Time	TIME_OF_DAY	TOD#10:30:19.364	
2	DB5.DB0_4	"Show_Time_Temperature_St".SetPoint_Time	TIME_OF_DAY	TOD#10:30:19.364	
3	DB5.DB0_8	"Show_Time_Temperature_St".CPU_Time	TIME_OF_DAY	TOD#10:30:19.931	
4	DB5.DB0_12	"Show_Time_Temperature_St".Temperature	FLOATING_POINT	22.22222	
5	DB5.DB0_16	"Show_Time_Temperature_St".Temp_SetPoint	FLOATING_POINT	22.22222	
6	DB5.DB0_20	"Show_Time_Temperature_St".Temperature_Status	HEX	DW#16#00000000	
7	DB5.DB0_24	"Show_Time_Temperature_St".SetPoint_Status	HEX	DW#16#00000000	
8	DB10.DB0_0	"Data_from_EX_Server".Temperature_ext	FLOATING_POINT	72.0	
9	DB10.DB0_4	"Data_from_EX_Server".Set_Point_TempExt	FLOATING_POINT	72.0	
10	DB10.DB0_24	"Data_from_EX_Server".Temperature_Status_ext	HEX	DW#16#00000000	
11	DB10.DB0_28	"Data_from_EX_Server".Set_Point_Status_ext	HEX	DW#16#00000000	

OPC UA 9E S7 SoftPLC T-S\IBH Link UA\...\SoftPLC IBH Link UA

RUN Abs < 5.2

The UAExpert program window **AddressSpace** displays information of the connected external OPC server.

Double-click **TemperatureSetPoint** to modify the value.

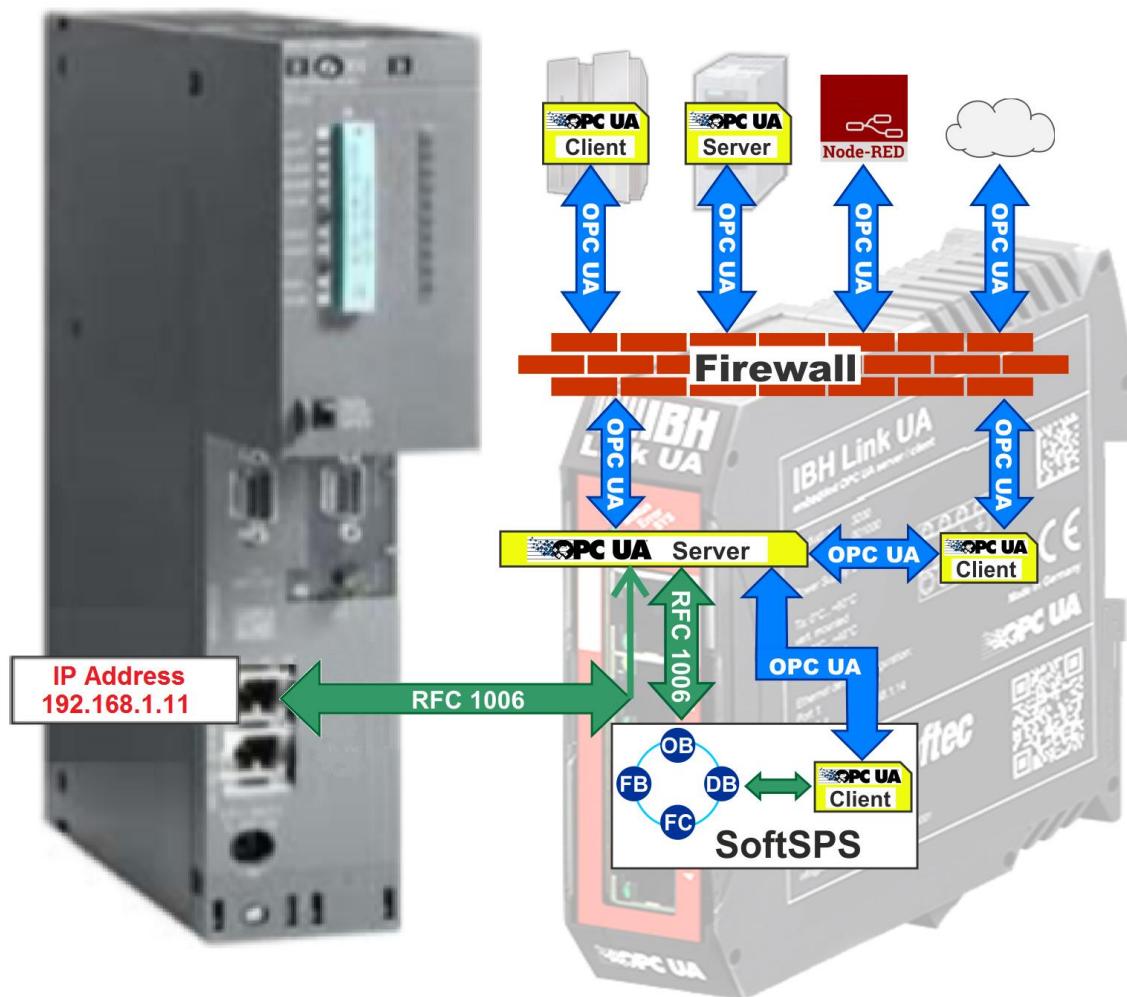
The screenshot shows the UAExpert interface with the following details:

- Address Space:** Shows a tree structure with nodes like BuildingAutomation\AirConditioner_1\Humidity, AirConditioner_1, AirConditioner_10, Demo, Server, and AlarmsNoNodes. Specific nodes like Temperature and TemperatureSetPoint are highlighted with red boxes and labeled with "drag & drop" arrows.
- Data Access View:** A table showing data access details for various nodes. The table includes columns: #, Server, Node Id, Display Name, Value, Datatype, Source Timestamp, Server Timestamp, and Status. A yellow box highlights the "double click to modify" action on the TemperatureSetPoint row.

8.4 Configuring the SoftPLC in the IBH Link UA with the TIA Portal

In the following example project – **OPC UA SoftPLC T-S TIA15**. The temperature values and the TimeStamps are converted (° Fahrenheit in ° Celsius; Date and Time in Daytime). After conversion, the status data are sent to the PLC CPU 416 (IBHsofttec SoftPLC) for display (VAT).

The temperature values and the TimeStamps are converted (° Fahrenheit in ° Celsius; Date and Time in Daytime). After conversion, the status data are sent to the PLC CPU 416 (IBHsofttec SoftPLC) for display (VAT).



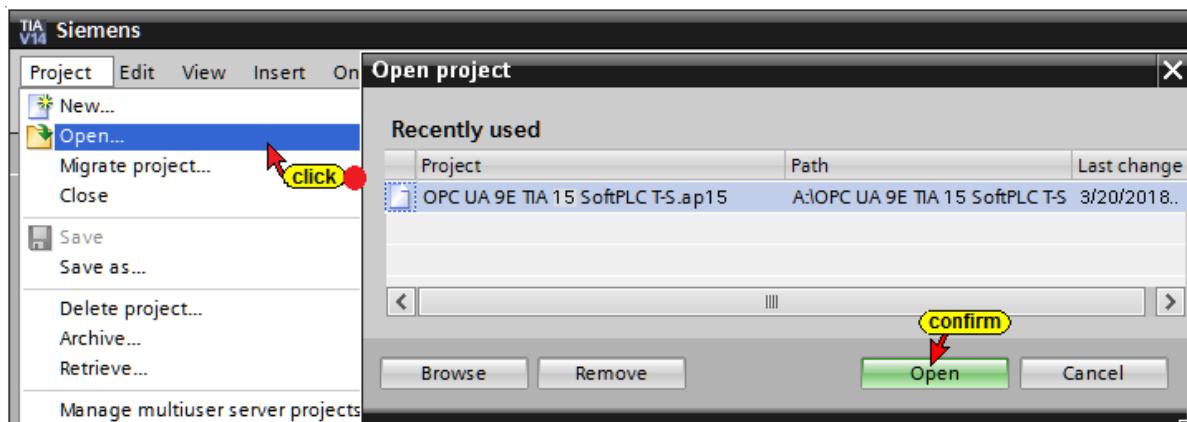
8.4.1 Activating the integrated SoftPLC

The SoftPLC must be activated via the WEB interface of the IBH Link UA. For more details, how to activate the integrated SoftPLC see page 9-2.

8.4.2 PLC program of the SoftPLC 416 [CPU 416-3 PN/DP]

The data from the IBH Link UA SoftPLC is transferred into the DB5 (*Data_of_WinLC_RTX*) of the CPU 416. VAT1 – *AirCond1_Data_WinLC_RTX* is used to display this data. OB 1 has no function.

Open the project OPC UA 9E TIA15 SoftPLC T-S



Data Block DB5 – *Data_of_WinLC_RTX* –

The variables defined by the SoftPLC in the IBH Link UA to the PLC CPU 416 (IBHsoftec SoftPLC) are defined here.

OPC UA 9E TIA 15 SoftPLC T-S > SoftPLC 416 [CPU 416-3 PN/DP] > Program blocks > Data_of_WinLC_RTX [DB5]				
Keep actual values Snapshot				
Data_of_WinLC_RTX				
	Name	Data type	Start value	Comment
1	Static			
2	Temp_Time_WinLC_RTX	Time_Of_Day	TOD#00:00:00	
3	TempSet_Time_WinLC_RTX	Time_Of_Day	TOD#00:00:00	
4	CPU_Time_WinLC_RTX	Time_Of_Day	TOD#00:00:00	
5	Current_Temp_WinLC_RTX	Real	0.0	
6	TempSet_WinLC_RTX	Real	0.0	
7	Temp_Stat_WinLC_RTX	DWord	16#0	
8	TempSet_Stat_WinLC_RTX	DWord	16#0	
9	<Add new>			

Watch Table_1

Watch Table_1 of the PLC **CPU 416-3 PN/DP** is used to display the data from the SoftPLC WinLC_RTX, integrated in the IBH Link UA.

OPC UA 9E TIA 15 SoftPLC T-S > SoftPLC 416 [CPU 416-3 PN/DP] > Watch and force tables > Watch table_1					
i	Name	Address	Display format	Monitor value	Modify value
1	"Data_of_WinLC_RTX".Temp_Time_WinLC_RTX	%DB5.DBDO	TIME_OF_DAY		
2	"Data_of_WinLC_RTX".TempSet_Time_WinLC_RTX	%DB5.DB4	TIME_OF_DAY		
3	"Data_of_WinLC_RTX".CPU_Time_WinLC_RTX	%DB5.DB8	TIME_OF_DAY		
4	"Data_of_WinLC_RTX".Current_Temp_WinLC_RTX	%DB5.DB12	Floating-point number		
5	"Data_of_WinLC_RTX".TempSet_WinLC_RTX	%DB5.DB16	Floating-point number		
6	"Data_of_WinLC_RTX".Temp_Stat_WinLC_RTX	%DB5.DB20	Hex		
7	"Data_of_WinLC_RTX".TempSet_Stat_WinLC_RTX	%DB5.DB24	Hex		
8	"Temperature_AirCond1"	%MD38	Floating-point number		
9	"Temp_SetPoint_AirCond1"	%MD42	Floating-point number		

Default Tag Table_1

	Name	Data type	Address	Comment
1	Temperature_AirCond1	Real	%MD38	Dummy variable not used
2	Temp_SetPoint_AirCond1	Real	%MD42	Dummy variable not used

Note:

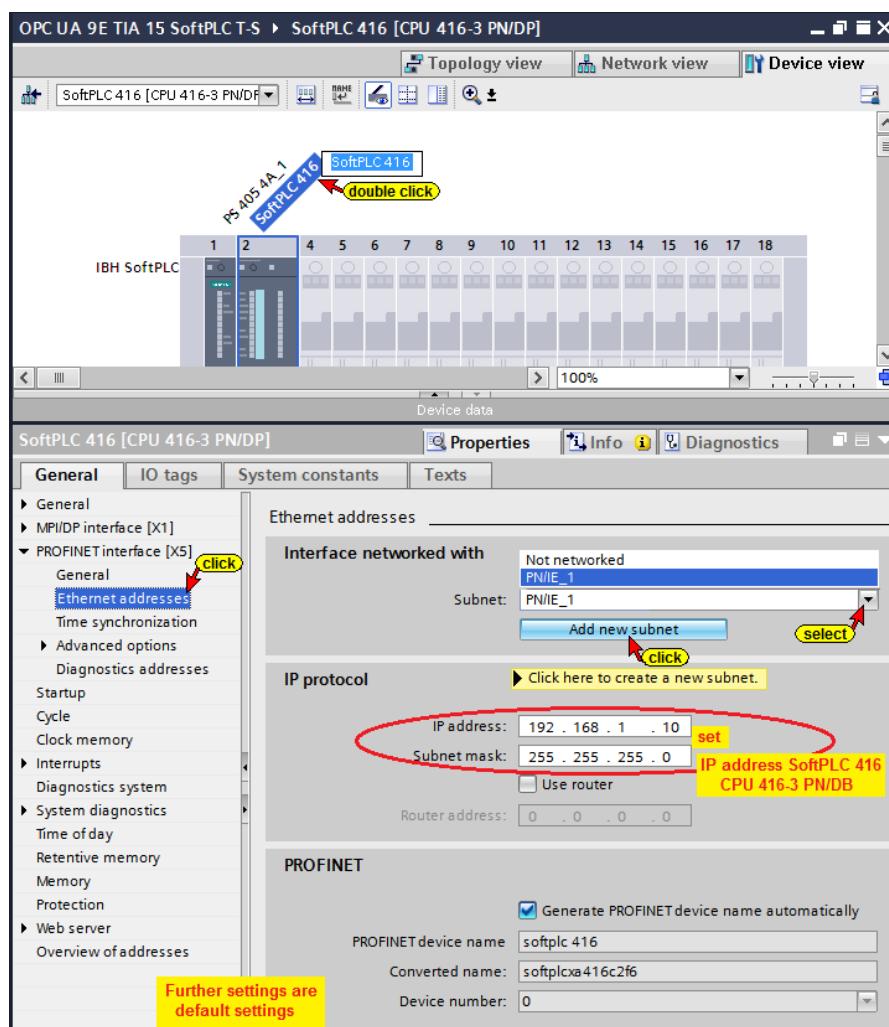
The variables **Temperatuer_AirCond1** and **Temp_SetPoint_AirCond1** are only required for the definition of the OPC variables.

The variables (MD 38, MD 42) have no further function.

The Organization Block **Main [OB 1]** has no function.

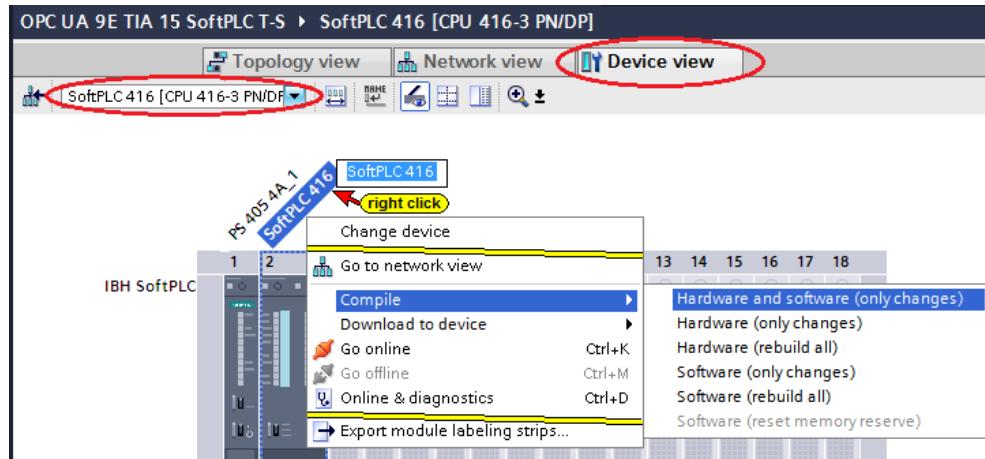
8.4.3 Hardware Configuration CPU 416-3 PN/DP

A double-click on CPU 416-3 PN/DP opens the dialog box to set the interface Ethernet address. The PC executing the IBHsoftec SoftPLC 416 has the Ethernet address 192.168.1.10.

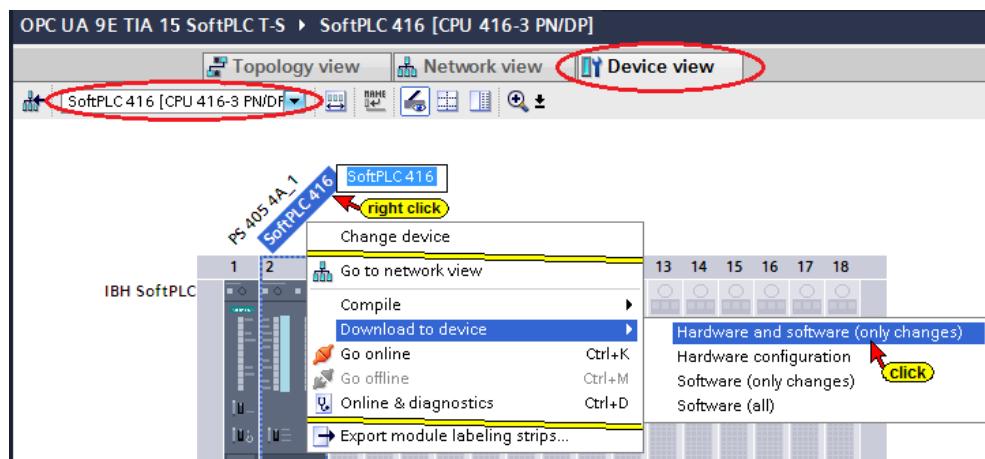


Loading the Hardware and Software into the CPU 416-3 PN/DP

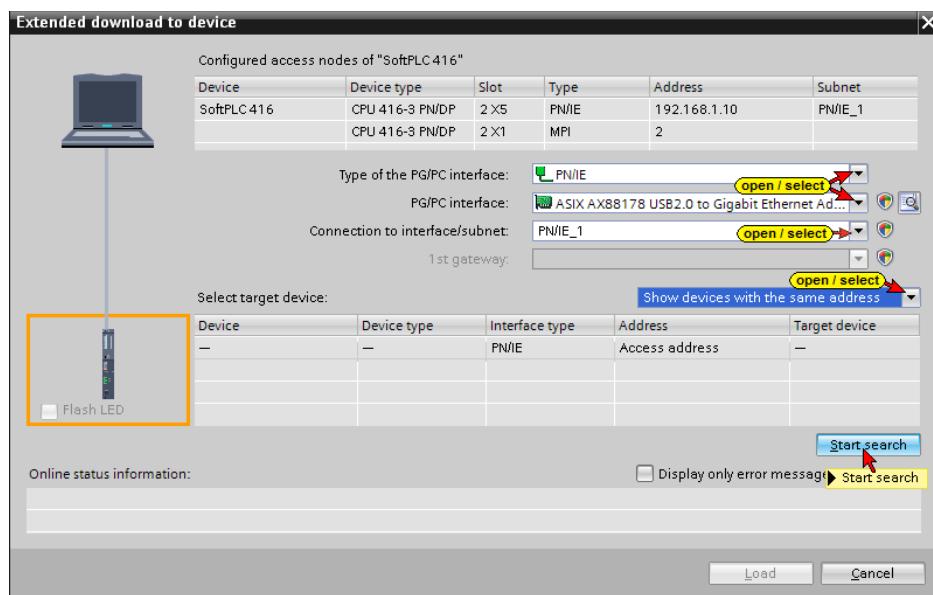
With the commands from the context menu, the software and the hardware of the device are compiled.



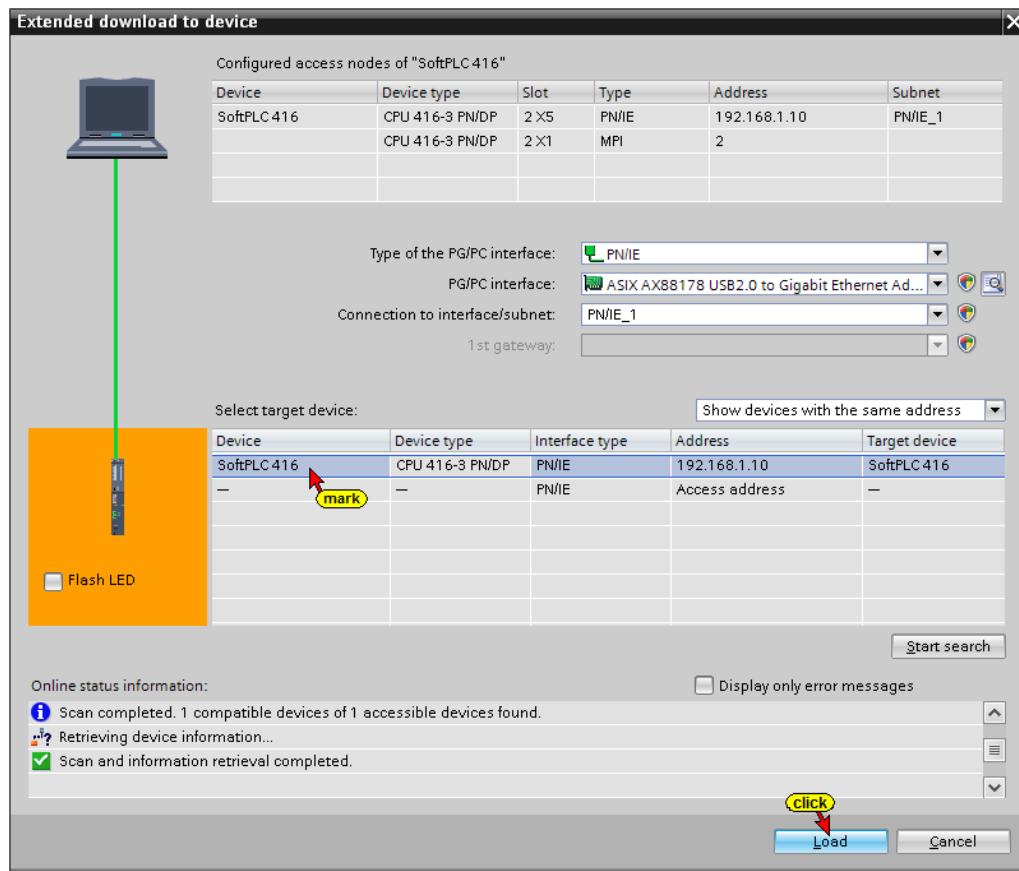
With the commands from the context menu, the software and the hardware configuration are load into the device



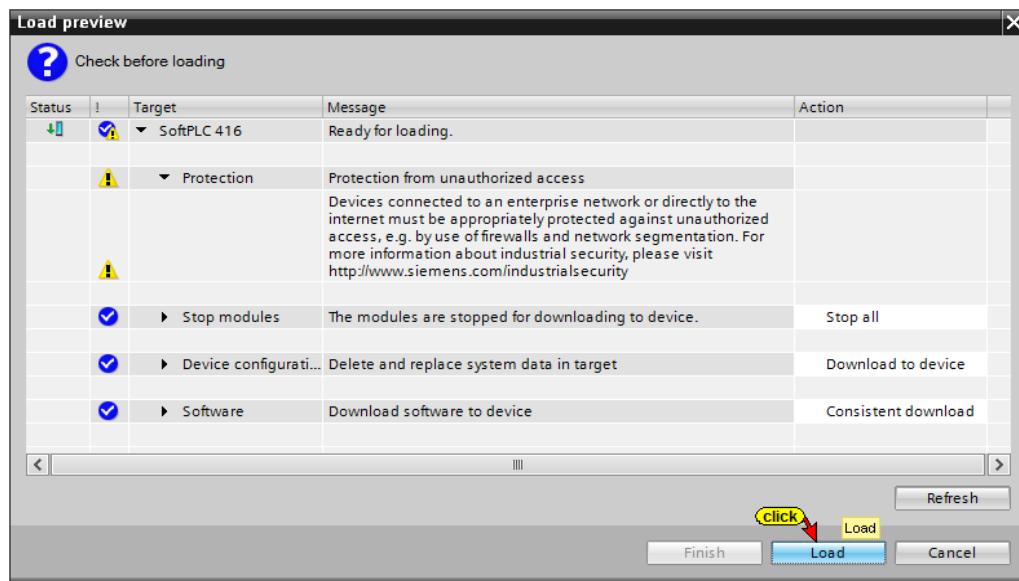
The load command of the hardware configuration opens the dialog box shown below.



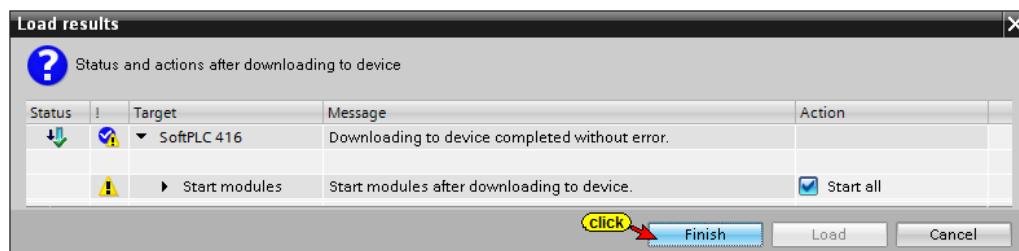
The successful search is displayed



A preview of the loading is displayed.

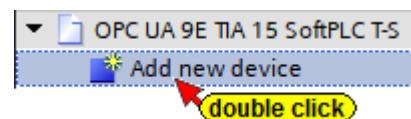


Finish loading

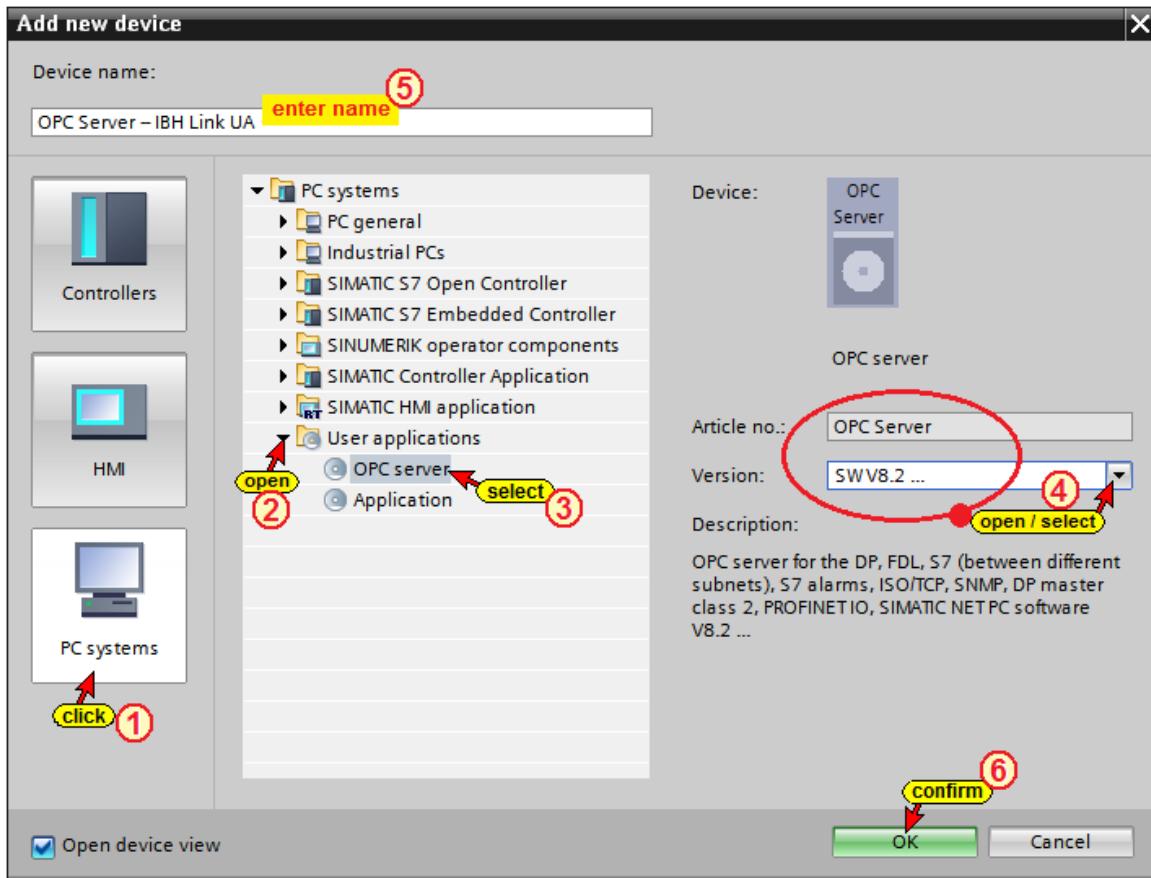


8.4.4 IBH Link UA as SIMATIC PC station

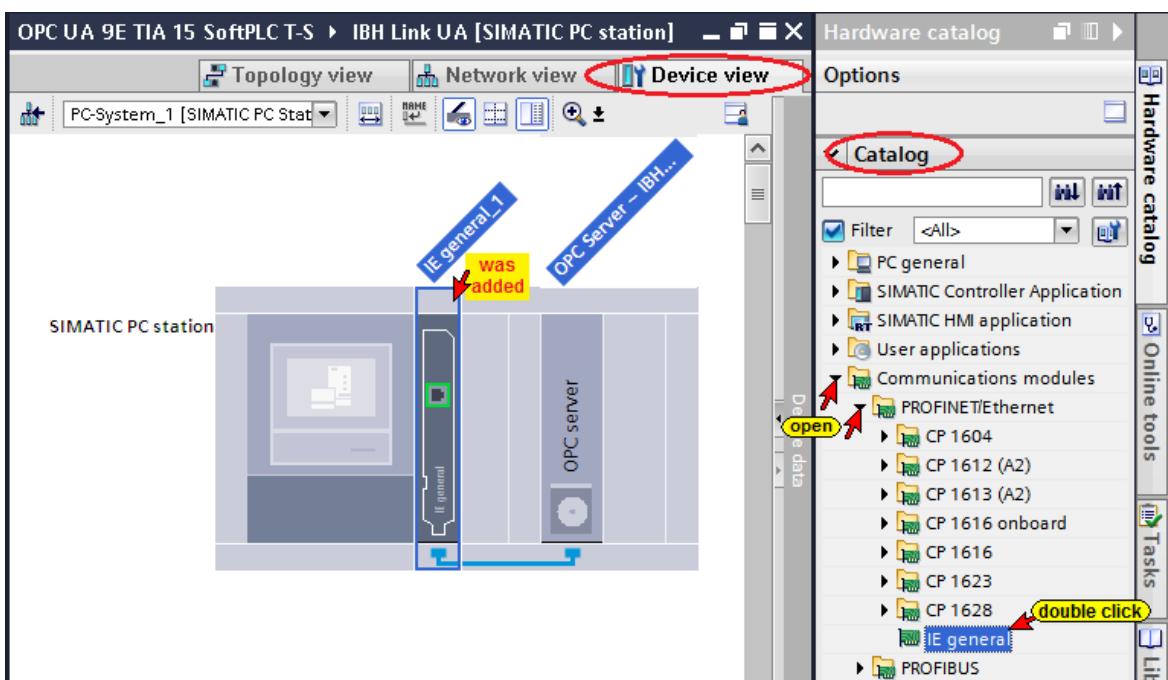
A double-click on **Add New Device**
opens the Device Selection dialog box.



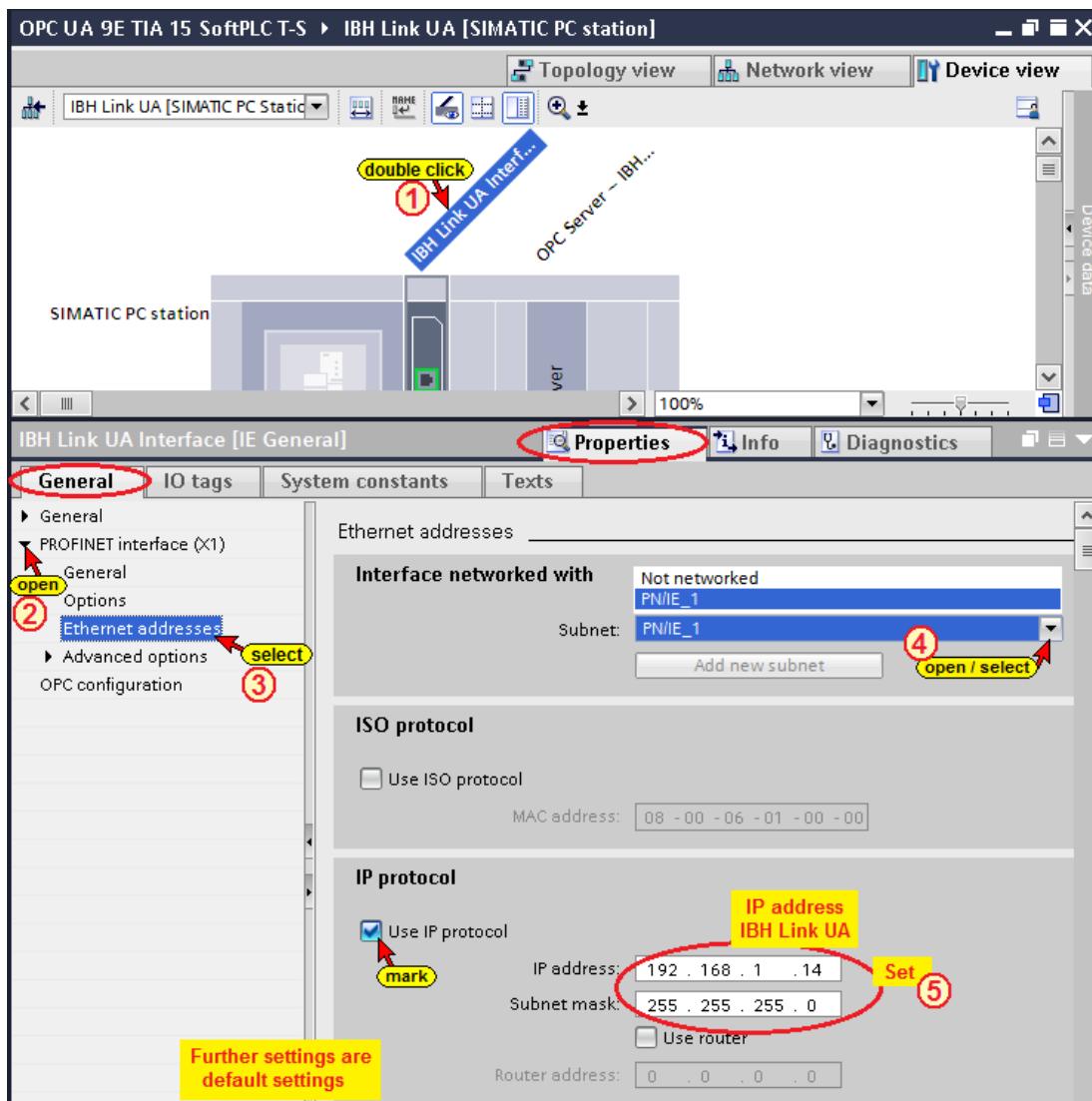
If an OPC server is inserted into the project, a SIMATIC PC station is automatically inserted.



Insert the communication module into the IBH Link UA

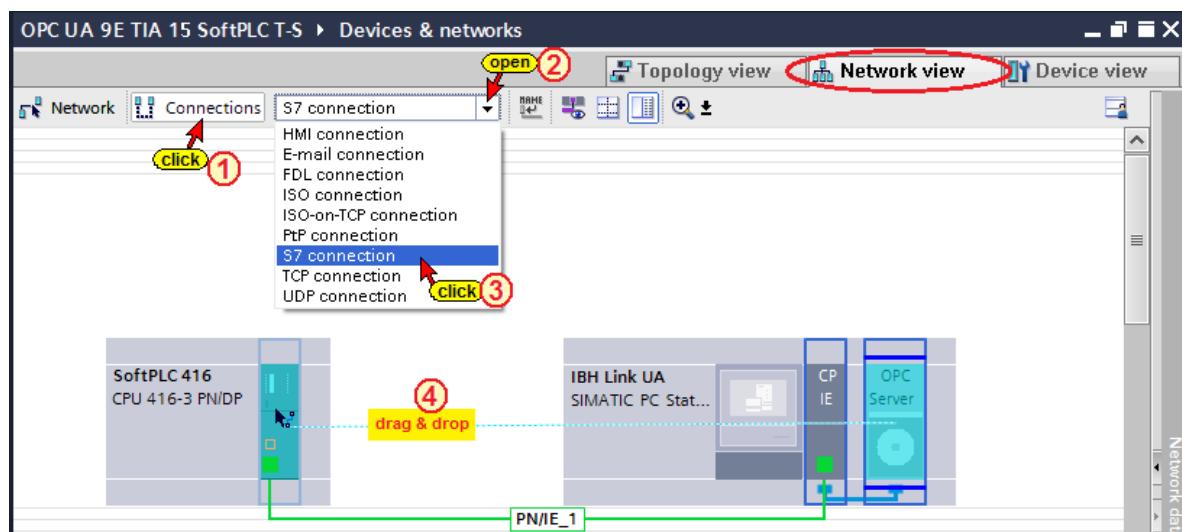


Setting the Properties of the Communication module

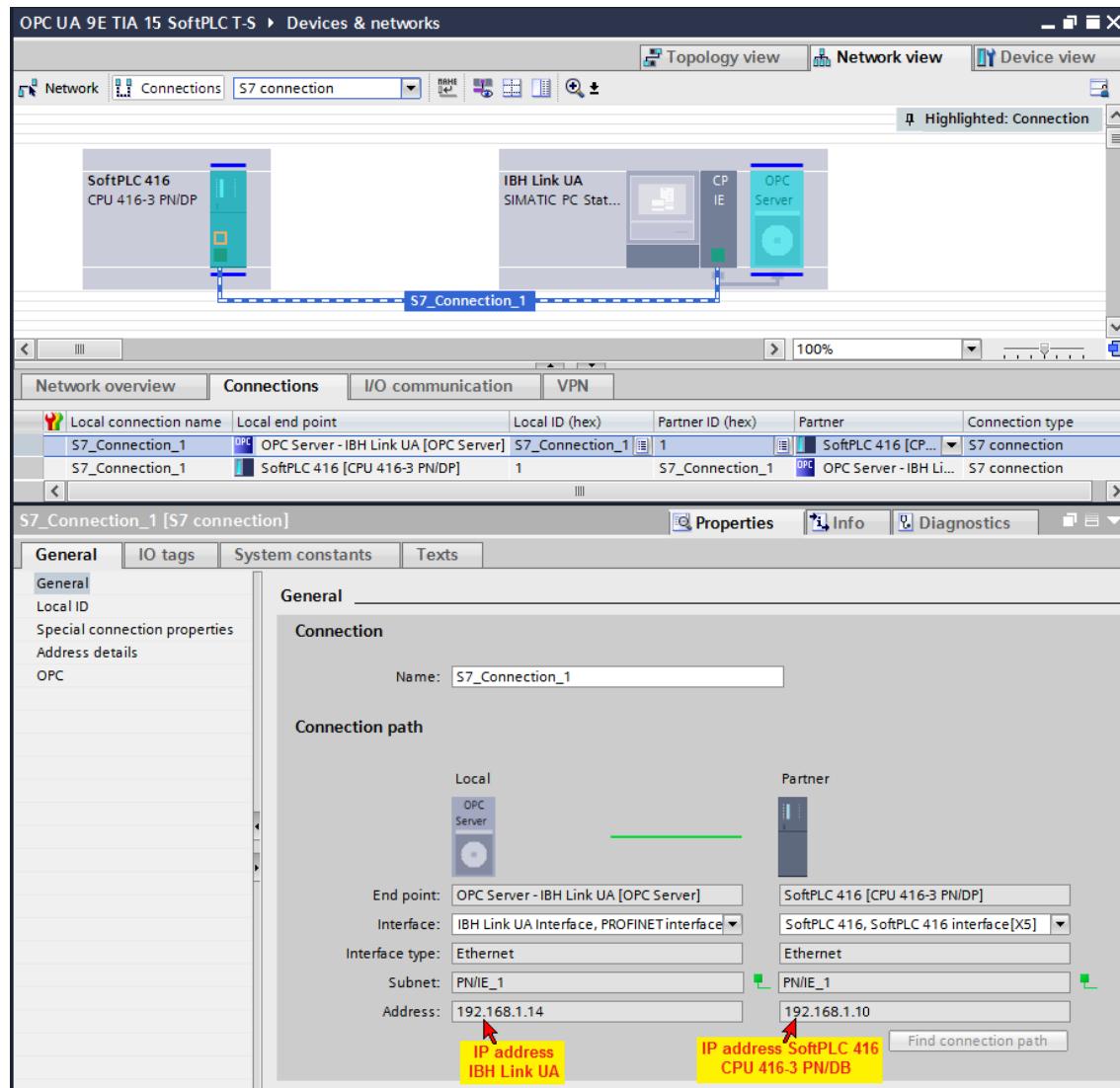


8.4.5 S7 Connection IBH Link UA OPC Server – SoftPLC 416

Use drag&drop to establish the S7 connection from the OPC Server to the PLC 416.

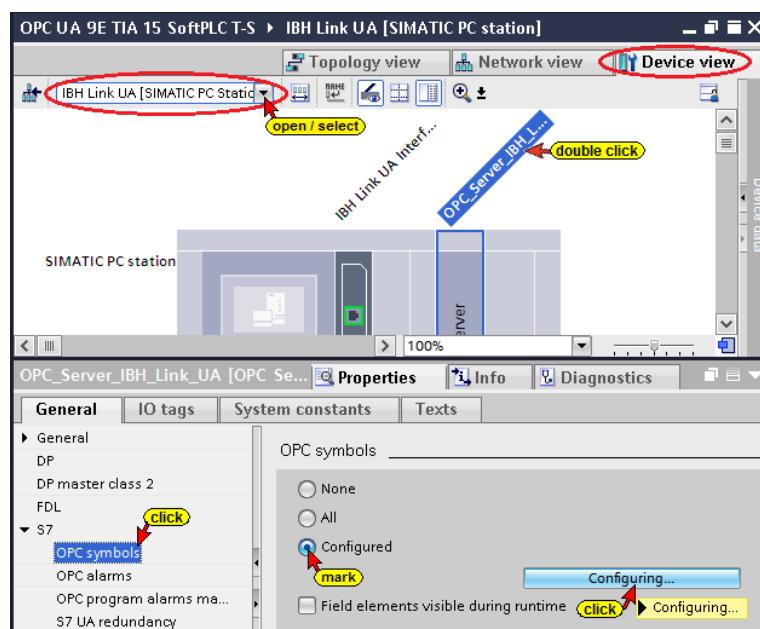


The established S7 connection is shown



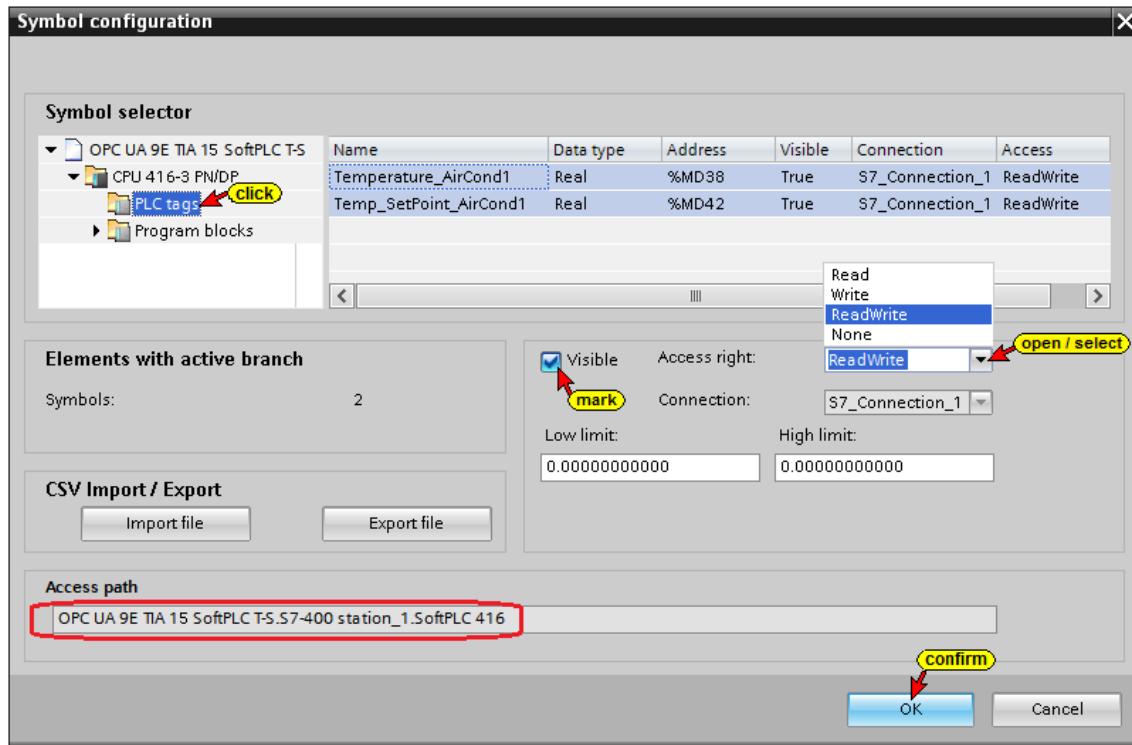
Select OPC tags (symbols) in the OPC configuration

Open the OPC Server / Property configuration.

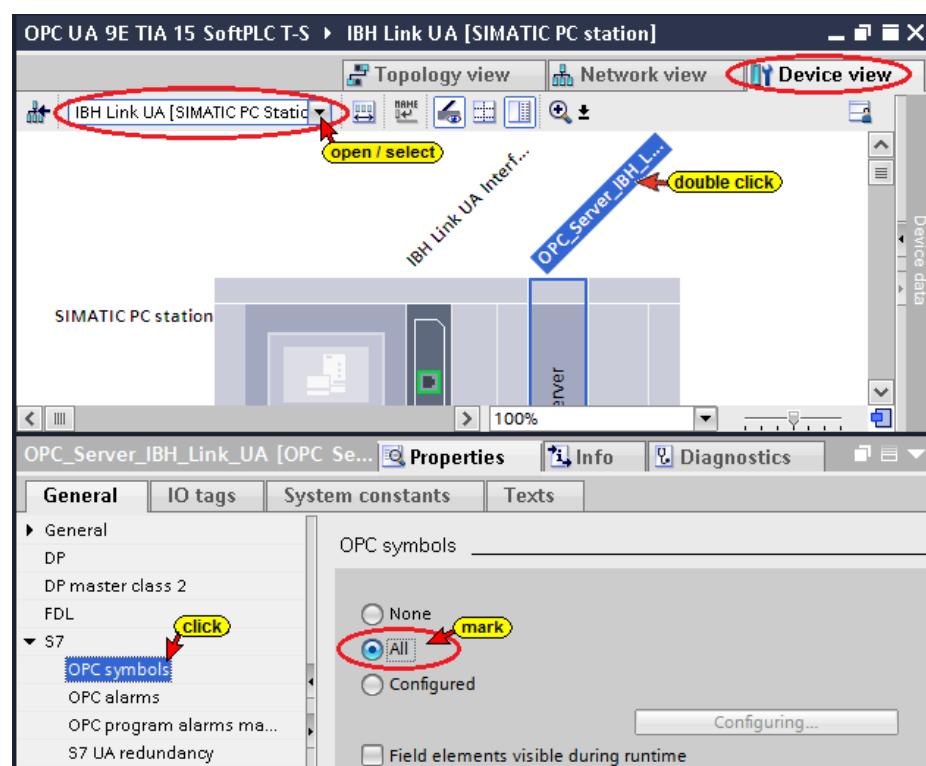


The **Configure** button opens a **Configuring...** dialog box listing the operands defined in the symbol table. These operands must be selected as OPC tags.

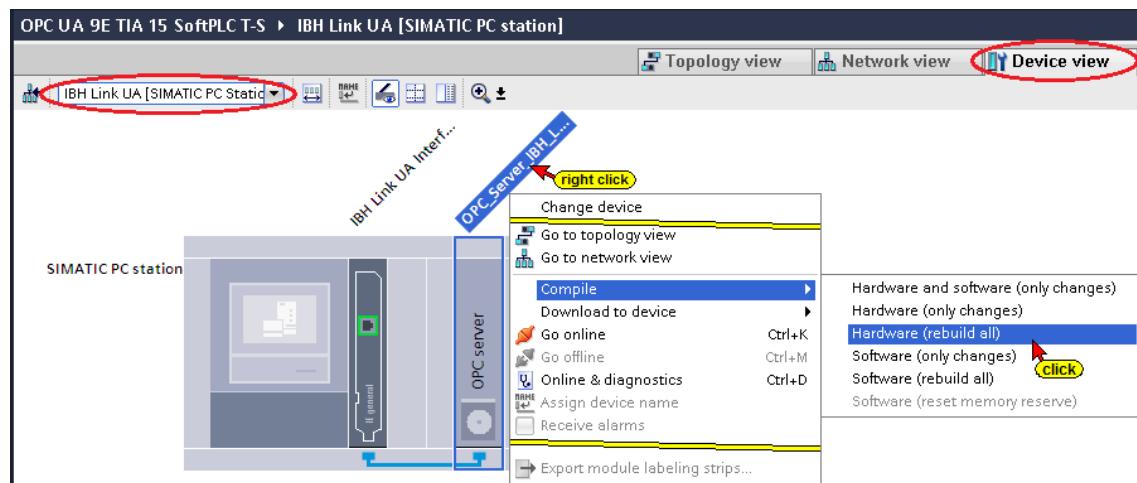
Due to the previously configured S7 connection the PLC knows the variables.



In the example, all global symbolic operands and the data from the Data block should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.

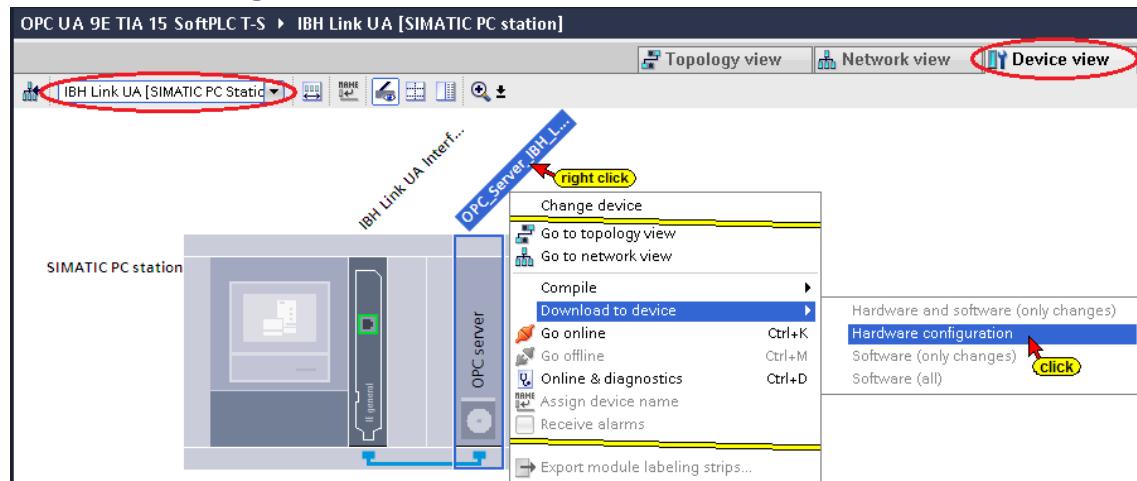


Compiling the OPC Server configuration

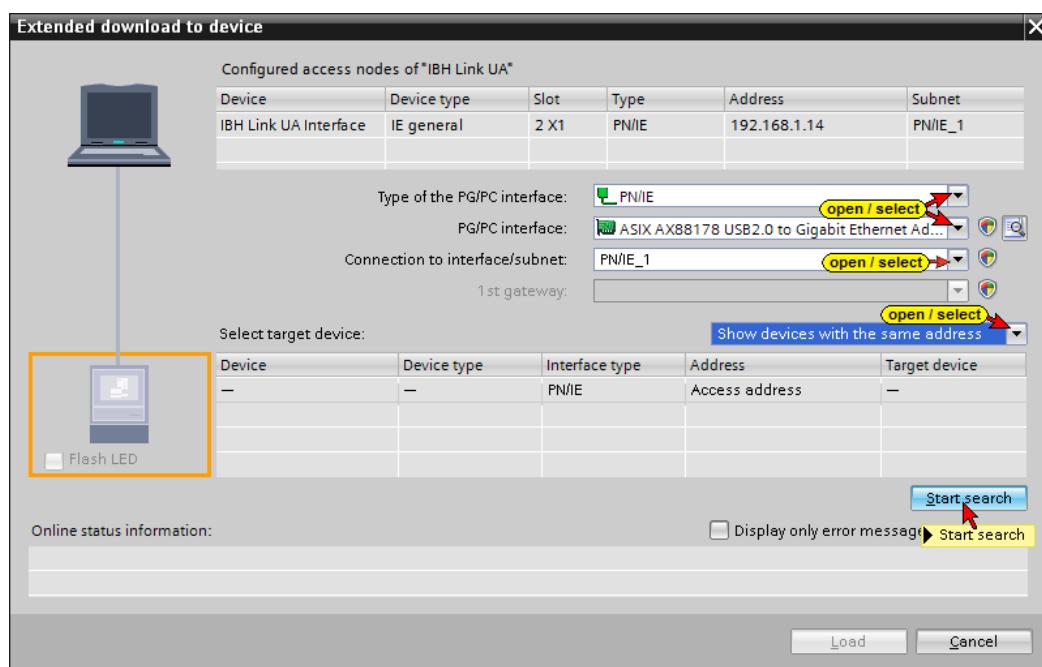


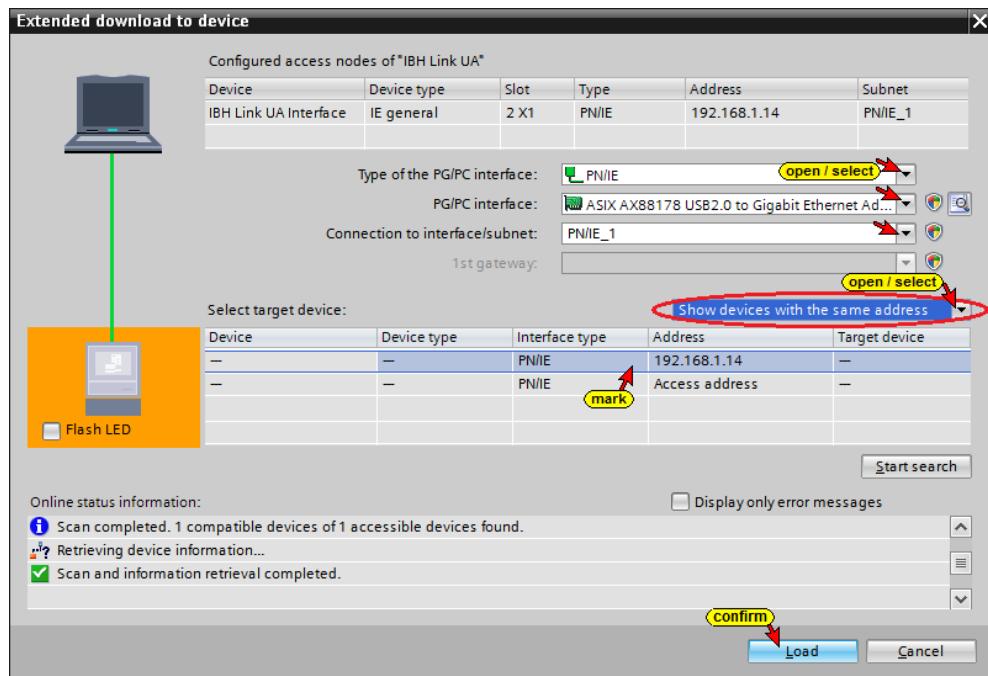
If no error occurs during the hardware compilation, the hardware can be loaded into the IBH Link UA OPC server.

Load the configuration into the IBH Link UA OPC server

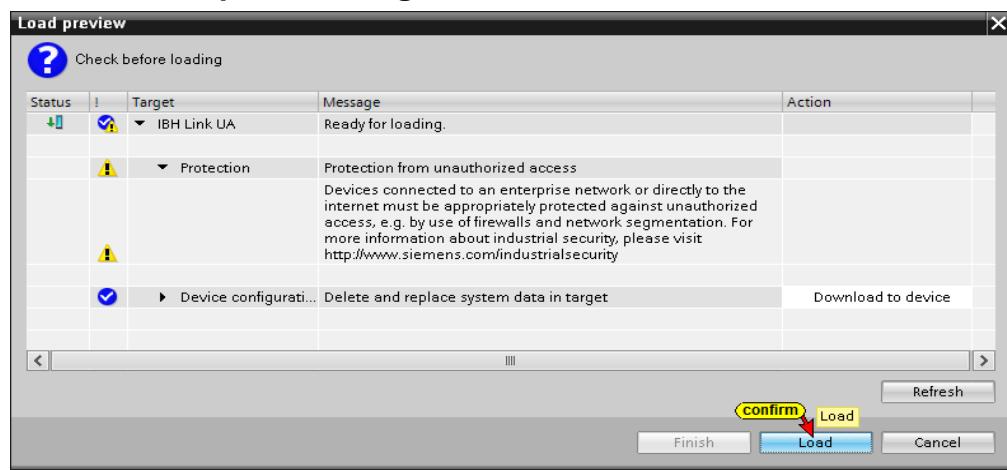


The selection of the interface is shown

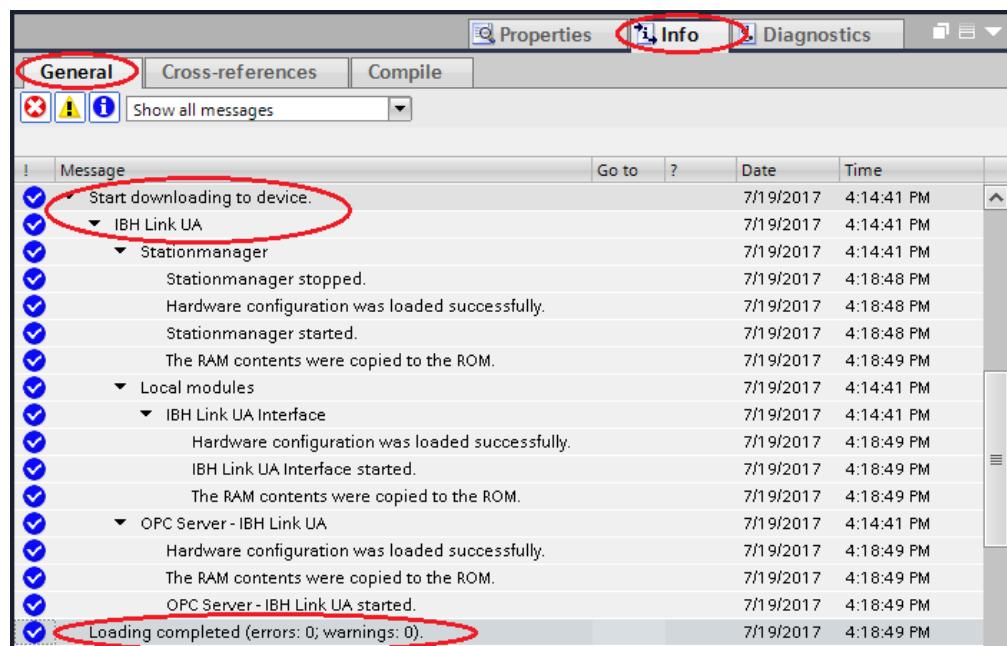




A check is carried out prior loading.



The progress of the loading process is displayed.



Add a Server

Set up the IBH Link UA server. To do so enter the previously copied endpoint URL `opc.tcp://192.168.1.14: 48010` into the field opened in the IBH Link UA Web browser window / OPC Client for an **external OPC UA server**.

The **Security Policy None** and the **Security Mode None** have been selected for data transmission.

Set up the **External OPC UA Server** is defined. To do so the endpoint URL `opc.tcp://192.168.1.10: 48011` of the external **OPC UA Server** is enter the field opened in the IBH Link UA Web browser window / OPC Client.

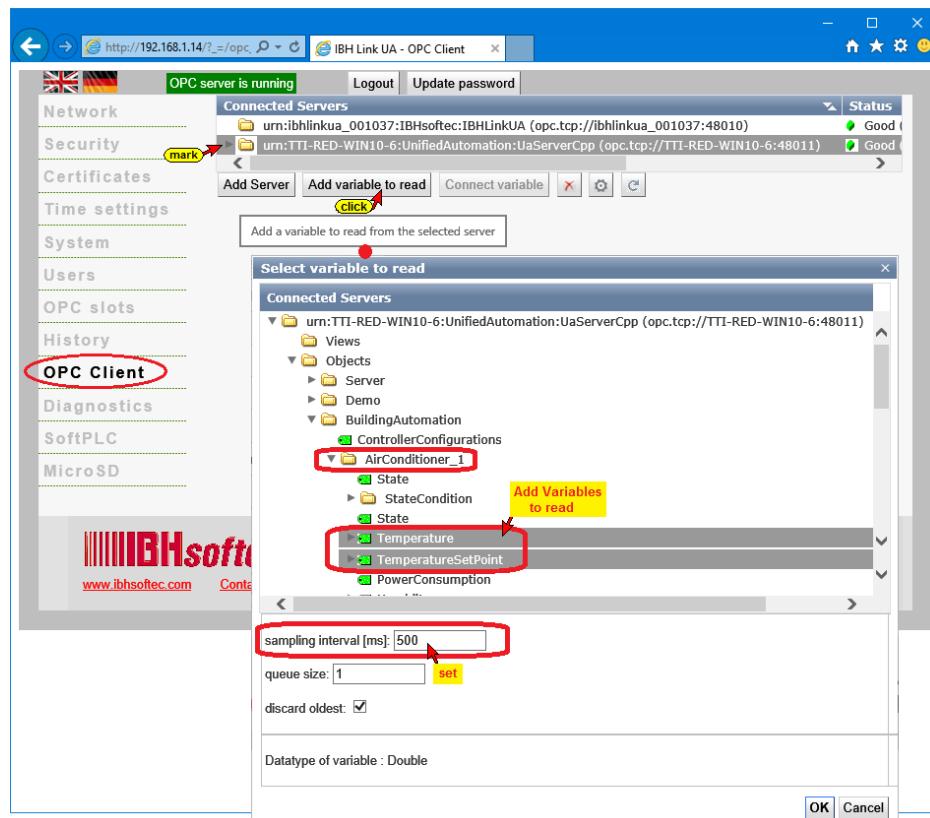
The absolute endpoint URL must be used because there is no **NameServer** available.

For data transmission, the **Security Policy None** and the **Security Mode None** have been selected.

For detailed information see chapter 5-12.

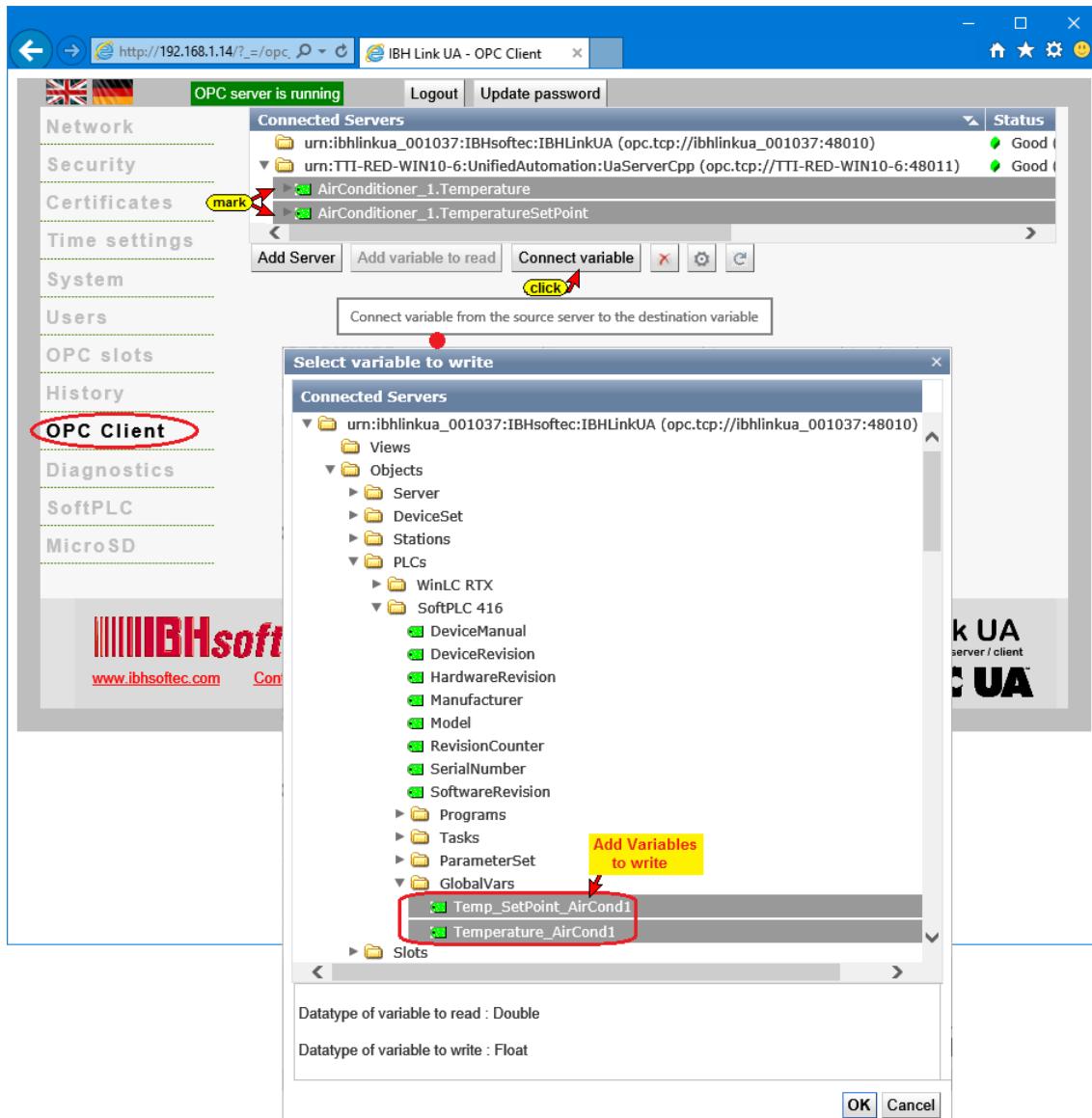
Add Read Variable

The two variables **Temperature** and **TemperatureSetPoint** from the external OPC UA Server are declared to be read variables. They are passed to the PLC program in the CPU-416 via the IBH Link UA OPC Server.



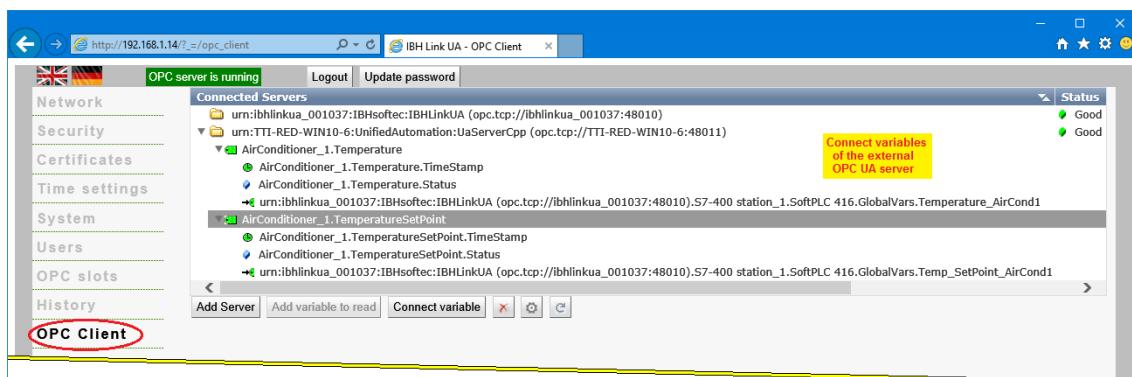
Connect to Variables

The two as read variables declared **Temperature** and **TemperatureSetPoint** are connected to the IBH Link UA OPC Server, which then feeds them to the PLC program in the CPU 416.



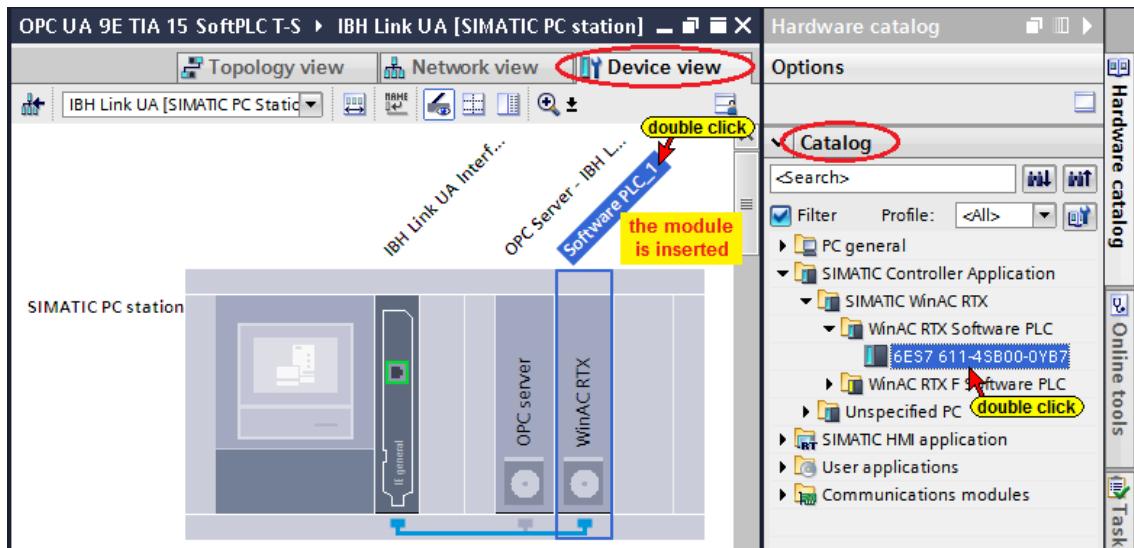
In the IBH Link UA web browser window **OPC Client** the established connections are displayed.

AirConditioner_1 → SoftPLC 416 – GlobalVars

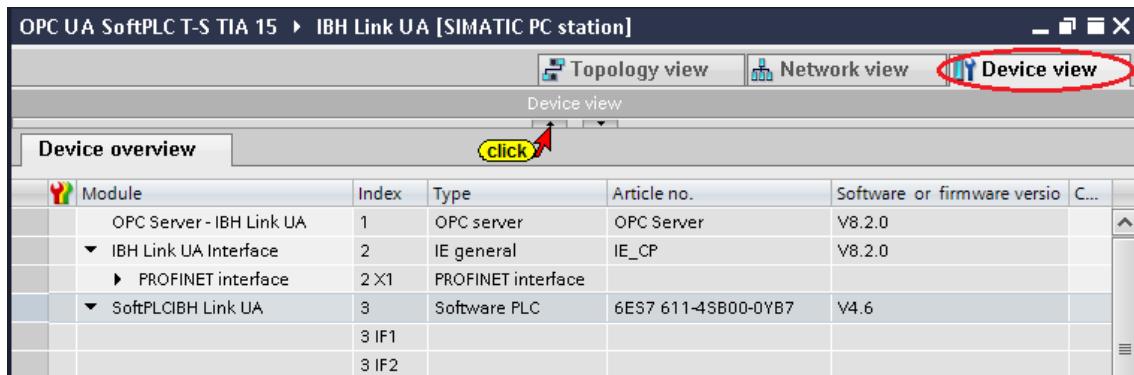


8.4.6 Inserting a SoftPLC as SIMATIC WinAC RTX in the SIMATIC PC Station (IBH Link UA)

A double-click on ***WinAC RTX Software PLC / 6ES7 611-4SB00-0YB7*** firmware version ***V4.6***. inserts the module in the SIMATIC PC Station (IBH Link UA).



To ensure that the modules are at the right position and have the required software version click on ***Device view*** to open the ***Device overview*** listing.



8.4.7 The PLC program for the SoftPLC of the IBH Link UA

The SFB 8 (USEND) block located in the Siemens libraries is used to transmit an OPC variable made from the actual value, the associated time stamp (TimeStamp) and the status (Quality Code).

The PLC program for the SoftPLC of the IBH Link UA

With these data, the PLC program can evaluate not only the value of a variable, but also its quality and age.

If the variable "***CurrentTime***" existing on each OPC UA server is also placed in a data area of the PLC, the status of the connection to

the OPC UA server can also be evaluated. The SFB 8 (USEND) block has the necessary parameters for simple logging of OPC variables.

With the special function code 65400 (Hex FF78) the SFB 8 (USEND) can only be used to transfer OPC variables.

The 4 ANY pointers and the parameter R_ID of the block are used to transfer the variables using the call command.

The SoftPLC can read or write the OPC variables cyclically.

The configuration is performed by calling the SFB 8 (USEND) in the restart Organization Block (OB100 Call).

Note:

The SFB 8 (USEND) PLC block can only be used in the **SoftPLC** of the **IBH Link UA** with the **Special Function Code 65400 (Hex FF78)**.

Due to the only once transferring parameters by calling the block SFB 8 (USEND), the SoftPLC is enabled to read or write OPC variables cyclically.

No instance data block is required for the transfer of the parameters. An instance data block must exist when USEND is called due to the syntax of a system function block call.

If the SFB 8 (USEND) block is called in another CPU with the special function code 65400 (Hex FF78), an error message is displayed.

Parameters of the Block SFB 8 (USEND) - ID = 65400 (hex FF78)

```
REQ    := TRUE           // Not evaluated
ID     := W#16#FF78       // Fixed value: 65400
R_ID   := DW#16#1F40002  // Modus:
                  // Low Word; 2: Read(PLC Variable)
                  // High Word: Sampling in milliseconds
                  // 500 milliseconds
DONE   :=
ERROR  :=
STATUS :=
SD_1   :=
SD_2   :=
SD_3   :=
SD_4   :=
```

// is not set
// No ERROR=0; ERROR=1
// 0x0000 on success, 0x8090 on error
// Pointer to the OPC Variable.
// Pointer to the OPC Variable for the
// Value of the OPC Variable.
// Pointer to the PLC Variable for the
// Status of the Variable.
// Pointer to the PLC Variable for the
// Time Stamp.

Client Function of SFB 8 (USEND)

Cyclic reading and writing. The SoftPLC can read or write the OPC variables cyclically. The configuration will be done within the SFB 8 (USEND) and called during the warm start (OB100).

Parameter	Declaration	Data type	Storage area	Description
REQ	INPUT	BOOL	E, A, M, D, L	Not evaluated
ID	INPUT	WORD	M, D, Const.	Fixed value: 65400 Mode Low Byte: 0: Read (Variable as XML String) 1: Write (Variable as XML String) 2: Read (PLC Variable) 3: Write (PLC Variable) 4: Read (Special Variable) 5: Write (Special Variable) 6: Read (Server Variable) 7: Write (Server Variable)
R_ID	INPUT	DWORD	E, A, M, D, L, Const.	Flag 14: While writing the Any Pointer points to DATE_AND_TIME Flag 15: While writing the Any Pointer points to a STRING High Word: Sampling in milliseconds
DONE	OUTPUT	BOOL	E, A, M, D, L	is not set ERROR=0: The parameters were passed correctly ERROR=1: The parameters were passed not correctly
ERROR	OUTPUT	BOOL	E, A, M, D, L	0x0000 on success, 0x8090 on error.
STATUS	OUTPUT	WORD	E, A, M, D, L	Pointer to the OPC Variable.
SD_1	IN_OUT	ANY	D	Pointer to the OPC Variable for the value of the OPC Variable. Allowed is Data Type BOOL, BYTE, CHAR, WORD, INT, DWORD, DINT, REAL, DATE, DATE_AND_TIME.
SD_2	IN_OUT	ANY	E, A, M, D	Note: If the ANY pointer points to a DB, the DB must always be specified (f.i.: P# DB10.DBX5.0 Byte 0). Pointer to the PLC Variable for the status of the OPC Variable. Allowed is Data Type DWORD
SD_3	IN_OUT	ANY	E, A, M, D	Note: If the ANY pointer points to a DB, the DB must always be specified (f.i.: P# DB10.DBX5.0 Byte 10). Pointer to the PLC Variable for the Time Stamp of the OPC Variable. Allowed is Data Type DATE_AND_TIME.
SD_4	IN_OUT	ANY	D	Note: If the ANY pointer points to a DB, the DB must always be specified (f.i.: P# DB10.DBX5.0 Byte 10).

OPC Variable Definitions

To uniquely identify the OPC variables, they are assigned a number (namespace), next to the actual name.

The OPC Variables are defined as follows:

Mode 0 and 1: 'ns=<Namespace>;s=<Identifier>'

or: **ns=<Namespace>;i=<Numeric Identifier>'**

All OPC Variables can be read using this mode.

The IBH Link UA knows the following Namespaces:

Namespace	Area
0	General OPC Server Variables
1, 2, 3, 5	No evaluable variables
4	All PLC specific OPC variables
6	IBH Link UA Special Variables

Mode 2 and 3: '<Identifier>'

The identifier is formed as follows:

**<Station name>.<PLC Name>.<GlobalVars>.<Variable name
from Variables table>**

or:

**<Station name>.<PLC Name>.<Programs>.<Variable name>.
<Data Block name>**

Mode 4 and 5: <Numeric Identifier>

Number of the Special Variable from Namespace 6.

Modus 6 and 7: <Numeric Identifier>

Number of the Server Variable from Namespace 0.

Variables used in the example:

(WinLC RTX – Static Variables FB20/DB 20 Air Conditioner Temp)

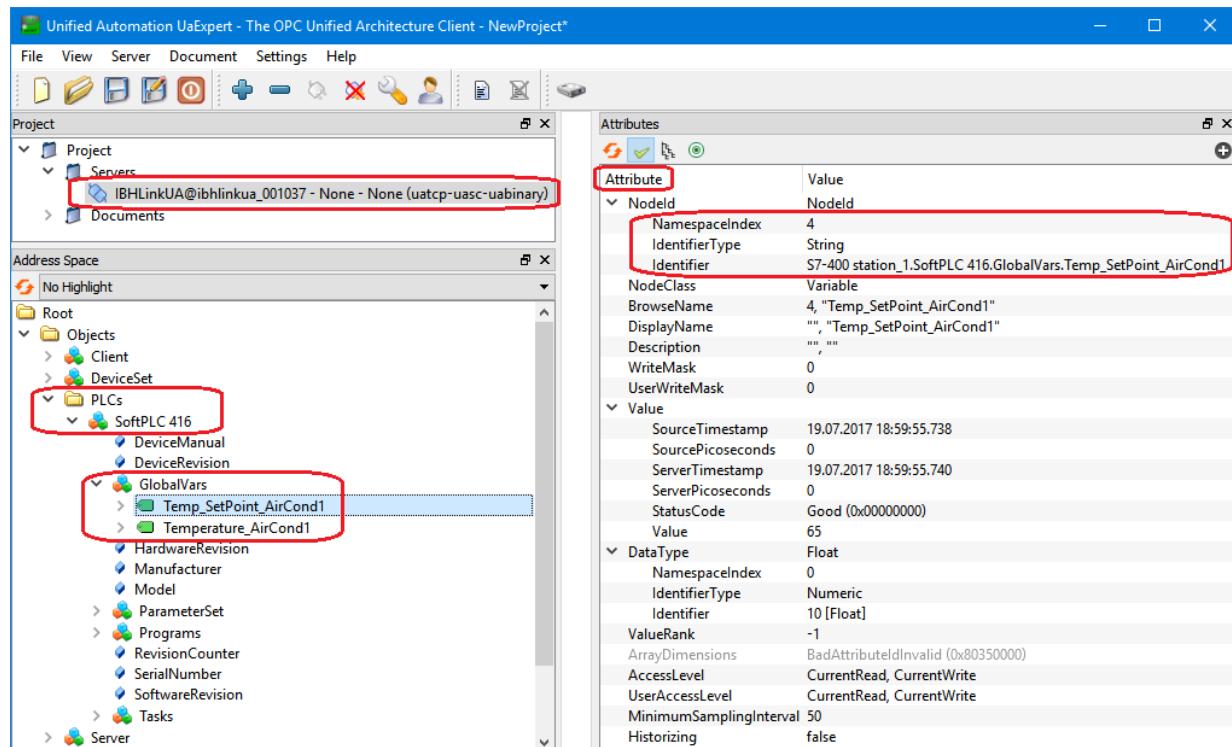
The **Identifiers Temp_SetPoint_AirCond1** and
Temperature_AirCond1 have the **Namespaceindex 4**.

The **Identifiers** are:

**S7-400 station_1.SoftPLC 416.GlobalVars.
Temp_SetPoint_AirCond1**

**S7-400 station_1.SoftPLC 416..GlobalVars.
Temperature_AirCond1**

Identifiers in the Attributes window



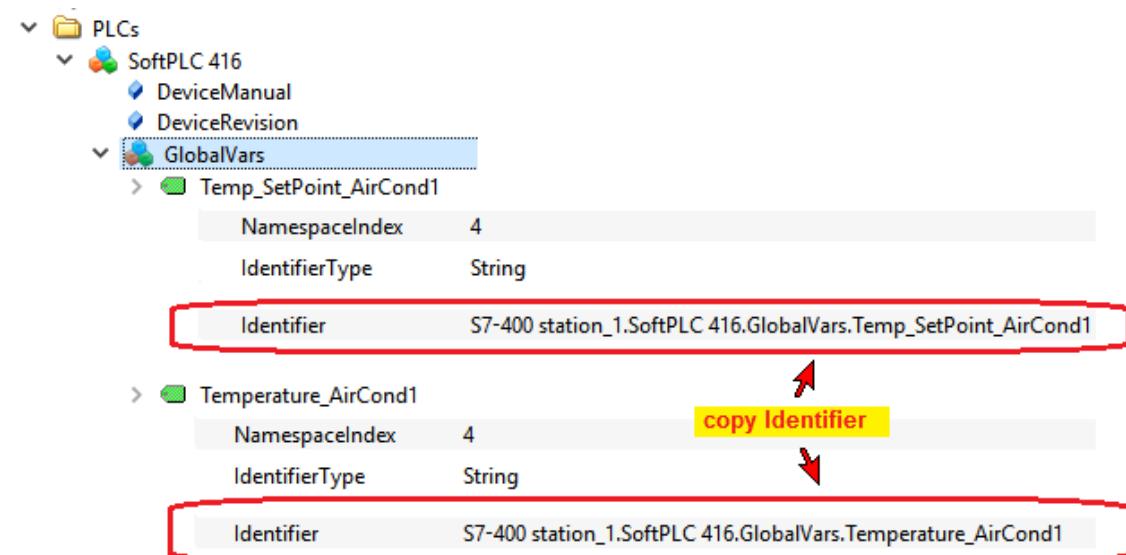
Note:

If the **Identifier** is marked in the **Attributes** window, it can be copied to the Windows clipboard (**Ctrl + C**) for further use.

The copied identifiers must be pasted as the initial values of the static variables

Temperature_AirCond1 and **Temp_SetPoint_AirCond1**

into the PLC block (S7 Program – Air Conditioner Temp) **FB20**.



Function block FB 20 – Calling_USEND

The screenshot shows the SIMATIC Manager interface with the project path: ...SoftPLC T-S > IBH Link UA [SIMATIC PC station] > SoftPLC IBH Link UA [WinAC RTX] > Program blocks > Calling_USEND [FB20]. The window title is "Calling_USEND".

Static Variables:

Name	Type	Offset	Default value	Comment
Pointer_OPCTemp	String[80]	...	'S7-400 station_1.SoftPLC 416.GlobalVars.Temperature_AirCond1'	
Pointer_OPCTempSetPoint	String[80]	...	'S7-400 station_1.SoftPLC 416.GlobalVars.Temp_SetPoint_AirCond1'	

Network 1: Temperature

Line	Instruction	Value	Comment
1	CALL USEND , "DI_USEND"	\$DB8	
2	Any		
3	REQ :=TRUE	TRUE	
4	ID :=W#16#FF78	W#16#FF78	
5	R_ID :=DW#16#1F40002	DW#16#1F40002	
6	DONE :=		
7	ERROR :=		
8	STATUS :=		
9	SD_1 :=#Pointer_OPCTemp	\$DB10.DBDO	Temperature (Value)
10	SD_2 :="Data_from_EX_Server".Temperature_ext	\$DB10.DB24	Status Temperature
11	SD_3 :="Data_from_EX_Server".Temperature_Status_ext	P#DB10.DBX8.0	TimeStamp Temperature
12	SD_4 :="Data_from_EX_Server".Temp_TimeStamp_ext		
13			

Network 2: Temperature Set Point

Line	Instruction	Value	Comment
1	CALL USEND , "DI_USEND"	\$DB8	
2	Any		
3	REQ :=TRUE	TRUE	
4	ID :=W#16#FF78	W#16#FF78	
5	R_ID :=DW#16#1F40002	DW#16#1F40002	
6	DONE :=		
7	ERROR :=		
8	STATUS :=		
9	SD_1 :=#Pointer_OPCTempSetPoint	\$DB10.DB4	Set Point Temperature (Value)
10	SD_2 :="Data_from_EX_Server".Set_Point_Tempe_ext	\$DB10.DB28	Status Temperature Set Point Status
11	SD_3 :="Data_from_EX_Server".SetPoint_Status_ext	P#DB10.DBX16.0	TimeStamp Set Point Temperatur
12	SD_4 :="Data_from_EX_Server".Set_Point_TimeStamp_ext		

The identifiers were copied from the **UaExpert Attributes** window and pasted as initial values of the STAT variables of FB20.

These variables are used as pointers when calling USEND with parameter **SD_1**.

The parameters REQ and ID have been defined according to the table on page 9-48.

The parameter R_ID is composed as follows:

- Low Word: Value 2 (hex 0002) – Read (PLC Variable).
- High Word: 500 milliseconds – hex 01F4 –

Parameter **R_ID** – double word: = 16#1F40002

The parameters **DONE**, **ERROR** and **STATUS** are not used in the example.

- SD_1 := Pointer to the OPC variable.
- SD_2 := Pointer to PLC Variable for the value of the OPC variable.
- SD_3 := Pointer to the PLC Variable for the status of the OPC variable.
- SD_4 := Pointer to the PLC Variable for the Time Stamp of the OPC Variable.

Note:

The same instance data block (DB 8 - DI_USEND) is used for both calls of SFB 8 - USEND. This instance data block is only present to satisfy the syntax.

The block FB 20 is called once in the OB 100 when the PLC is started. It is only necessary to transfer the parameters to the IBH Link UA integrated PLC that has the block (SFB 8 - USEND).

Only the SoftPLC in IBH Link UA uses USEND in this form !

DI_USEND – Instance Data Block DB 8

The same instance data block (DI_USEND – DB 8) is used for both calls of USEND - SFB 8. This instance data block is only available to satisfy the syntax.

Data_from_EX_Server – Data block DB 10

The variables of the external OPC server (OPC variable of the air conditioner 1) are stored here.

	Name	Data type	Offset	Start value	Comment
1	Temperature_ext	Real	0.0	0.0	Temperature (Value)
2	Set_Point_Tempe_ext	Real	4.0	0.0	Set Point Temperature (Value)
3	Temp_TimeStamp_ext	Date_And_Time	8.0	DT#1990-01-01-00:00:00	TimeStamp Temperature
4	Set_Point_TimeStamp_ext	Date_And_Time	16.0	DT#1990-01-01-00:00:00	TimeStamp Set Point Temperatur
5	Temperature_Status_ext	DWord	24.0	16#0	Status Temperature
6	SetPoint_Status_ext	DWord	28.0	16#0	Status Temperature Set Point Status

COMPLETE RESTART – Organization block OB100

CALL									
▼ Block title: "Complete Restart"									
Comment									
▼ Network 1: Calling USEND									
<table border="1"> <tr> <td>1</td> <td>CALL "Calling_USEND", "DI_Calling_USEND"</td> <td>%FB20, %DB20</td> </tr> <tr> <td>2</td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> </tr> </table>	1	CALL "Calling_USEND", "DI_Calling_USEND"	%FB20, %DB20	2			3		
1	CALL "Calling_USEND", "DI_Calling_USEND"	%FB20, %DB20							
2									
3									

Fahrenheit to Celsius – FC 1 and DT_TOD – FC 8 Functions

The function **DT_TOD** (FC 8) converts the variables of the type DATE_AND_TIME into the type Daytime. The function FC 1 converts ° Fahrenheit into ° Celsius.

Main – Organization block OB1

```

... ▶ IBH Link UA [SIMATIC PC station] ▶ SoftPLC IBH Link UA [WinAC RTX] ▶ Program blocks ▶ Main [OB1] □ X

▼ Block title: "Main Program Sweep (Cycle)"

▼ Network 1: Convert Date and Time in Time of Day (TimeStamp Temperature)
  1 | CALL T_CONV
  2 |   Date_And_Time TO Time_of_Day
  3 |   IN := "Data_from_EX_Server".Temp_TimeStamp_ext
  4 |   OUT := "Show_Time_Temperature_Status".Temperature_Time
          P#DB10.DBX8.0
          $DB5.DBDO

▼ Network 2: Convert Date and Time in Time of Day (CPU Time)
  1 | CALL T_CONV
  2 |   Date_And_Time TO Time_of_Day
  3 |   IN := "Data_from_EX_Server".Set_Point_TimeStamp_ext
  4 |   OUT := "Show_Time_Temperature_Status".SetPoint_Time
          P#DB10.DBX16.0
          $DB5.DB4

▼ Network 3: Convert Date and Time in Time of Day (CPU Time)
  1 | CALL T_CONV
  2 |   Date_And_Time TO Time_of_Day
  3 |   IN := #OB1_DATE_TIME
  4 |   OUT := "Show_Time_Temperature_Status".CPU_Time
          $DB5.DB8

▼ Network 4: Temperatures and Status
  1 | CALL "Fahrenheit_to_Celsius"
  2 |   Fahrenheit := "Data_from_EX_Server".Temperature_ext
  3 |   Celsius := "Show_Time_Temperature_Status".Temperature
          %FC1
          $DB10.DBDO
          $DB5.DB12
  4 |
  5 | CALL "Fahrenheit_to_Celsius"
  6 |   Fahrenheit := "Data_from_EX_Server".Set_Point_TempExt
  7 |   Celsius := "Show_Time_Temperature_Status".Temp_SetPoint
          %FC1
          $DB10.DB4
          $DB5.DB16
  8 |
  9 | L   "Data_from_EX_Server".Temperature_Status_ext
 10 | T   "Show_Time_Temperature_Status".Temperature_Status
          $DB10.DB24
          $DB5.DB20
 11 |
 12 | L   "Data_from_EX_Server".Set_Point_Status_ext
 13 | T   "Show_Time_Temperature_Status".SetPoint_Status
          $DB10.DB28
          $DB5.DB24
 14 |

```

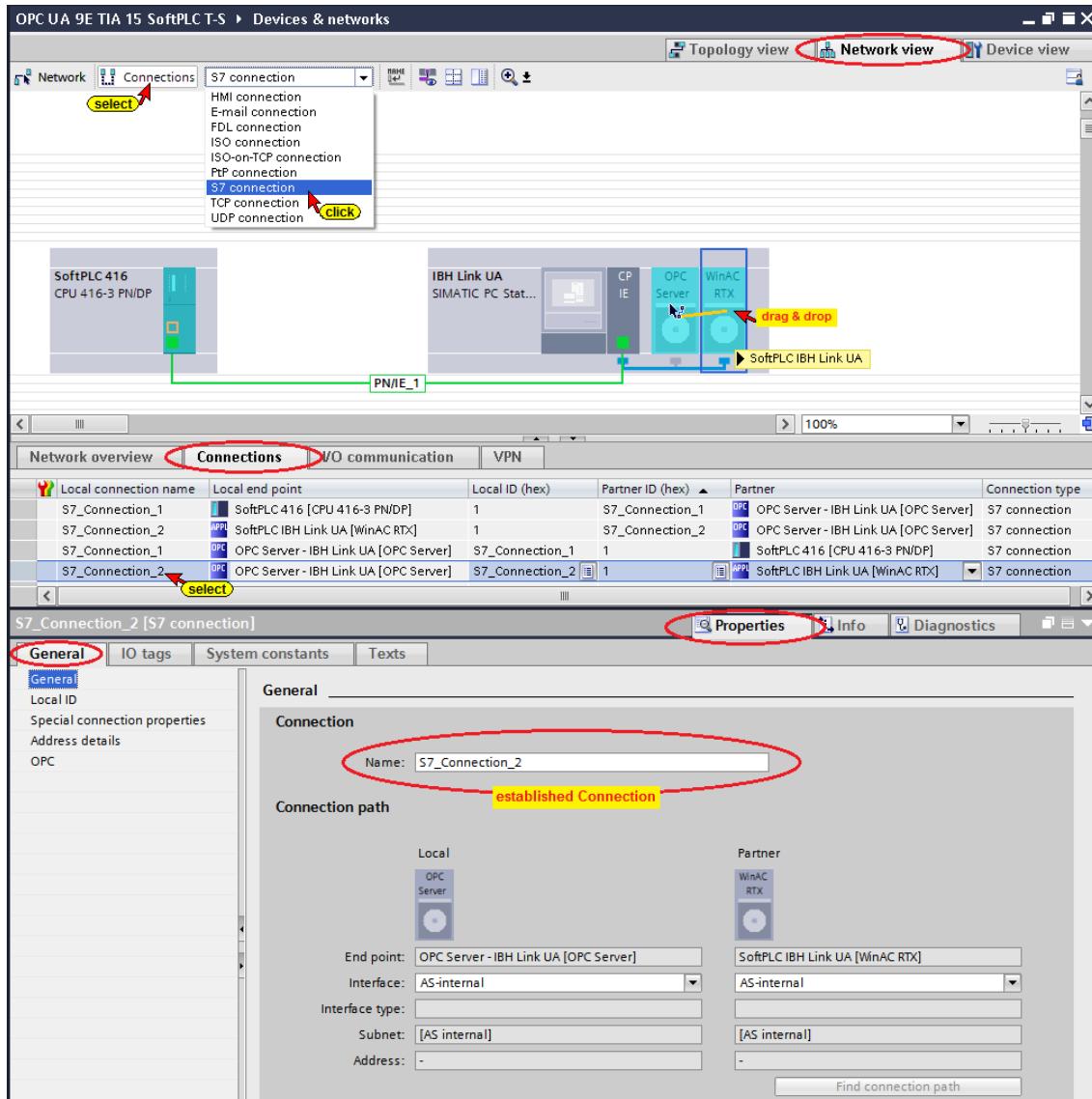
Show_Time_Temperature_Status Data block – DB 5

The converted variables of **Data_from_EX_Server** – (DB 10) are stored in this block. The SoftPLC 416 (CPU 416-3 PN/DP) reads these as OPC variables.

Name	Data type	Offset	Start value	Comment
1 Static				
2 Temperature_Time	TimeOfDay	0.0	TOD#00:00:00	
3 SetPoint_Time	TimeOfDay	4.0	TOD#00:00:00	
4 CPU_Time	TimeOfDay	8.0	TOD#00:00:00	
5 Temperature	Real	12.0	0.0	
6 Temp_SetPoint	Real	16.0	0.0	
7 Temperature_Status	DWord	20.0	16#0	
8 SetPoint_Status	DWord	24.0	16#0	

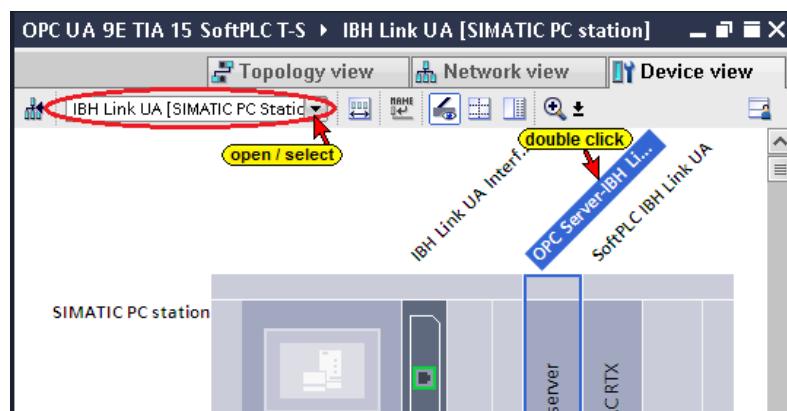
8.4.8 S7 Connection –OPC Server-IBH Link UA – SoftPLC IBH Link UA

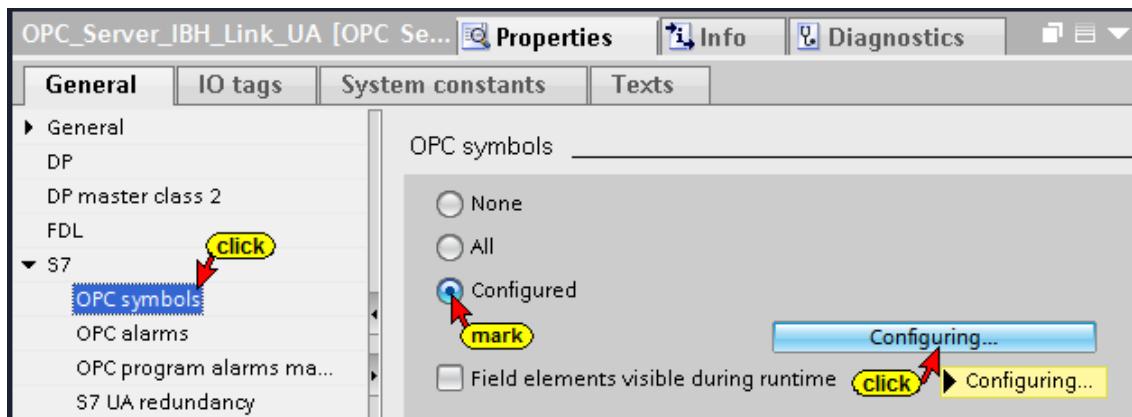
Use Drag&Drop to establish the S7 connection from the **OPC Server-IBH Link UA** to the **SoftPLC IBH Link UA [WinAC RTX]**.



Select OPC tags (symbols) in the OPC configuration

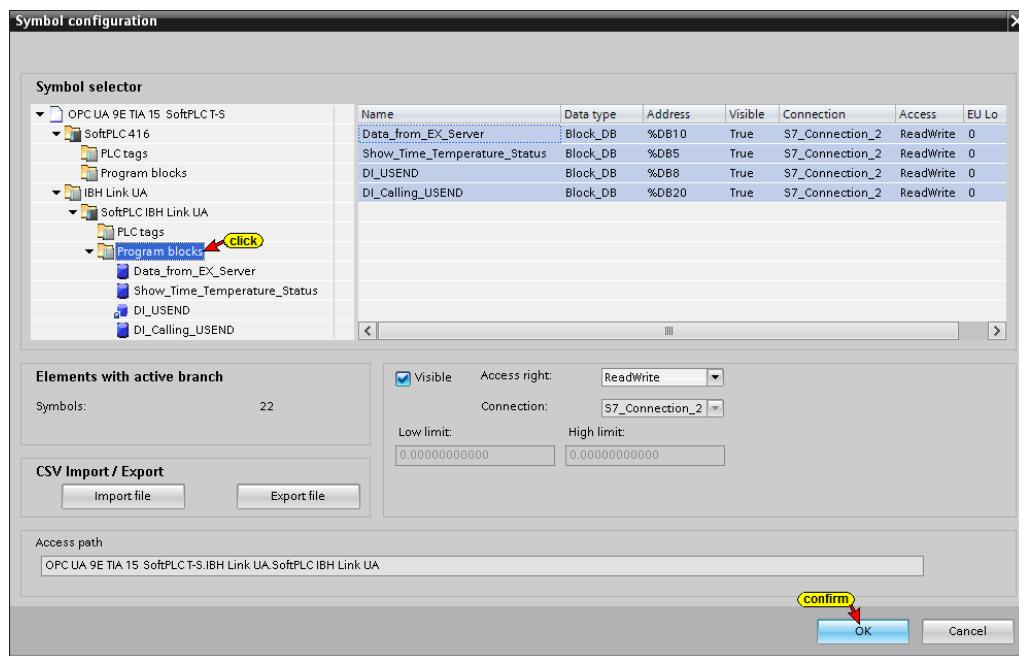
Open the OPC Server / Property configuration.



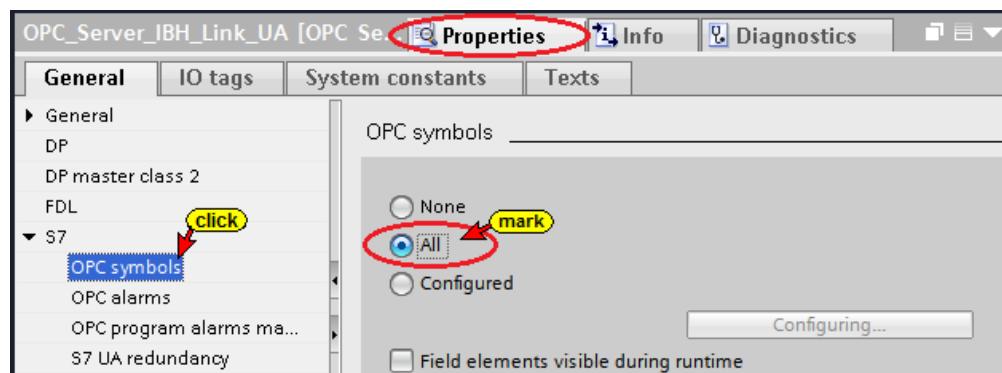


The **Configure** button opens a **Configuring...** dialog box listing the operands defined in the symbol table. These operands must be selected as OPC tags.

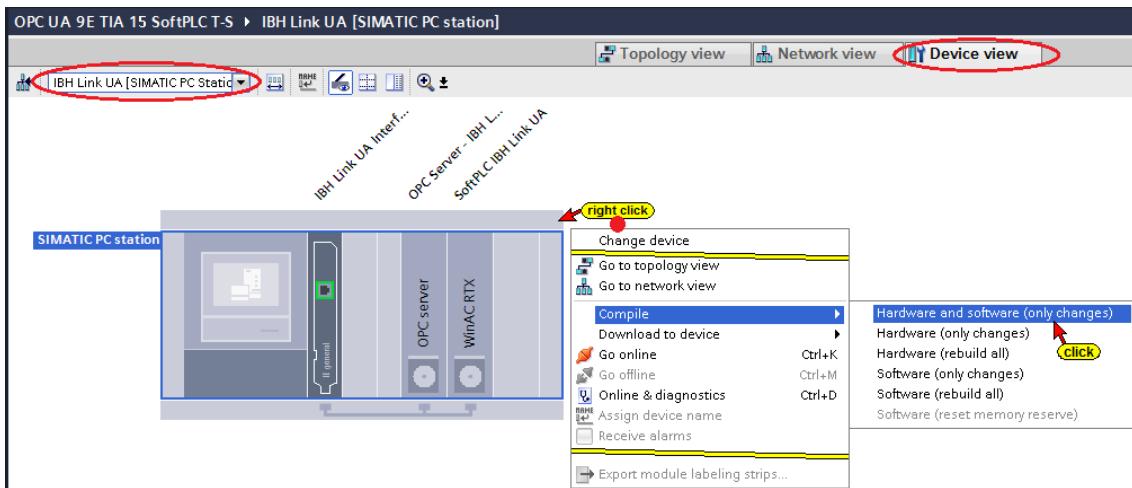
Due to the previously established S7 connection from the **OPC Server-IBH Link UA** to the **SoftPLC IBH Link UA [WinAC RTX]** the variables are known.



In the example, all global symbolic operands and the data from the Data block should be used as OPC Tags, mark **All** in the **Properties – OPC Server** dialog box.

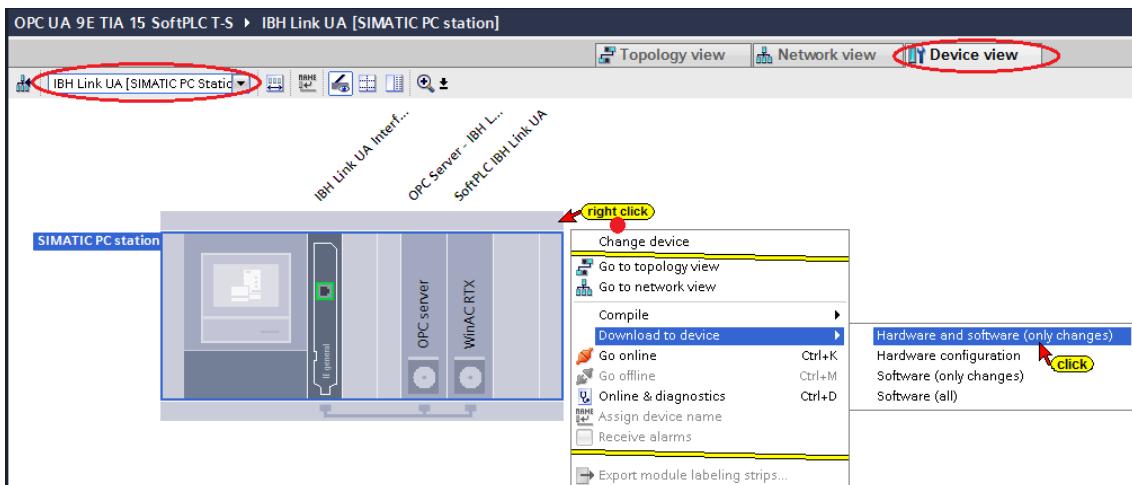


Compiling the IBH Link UA Hardware and Software

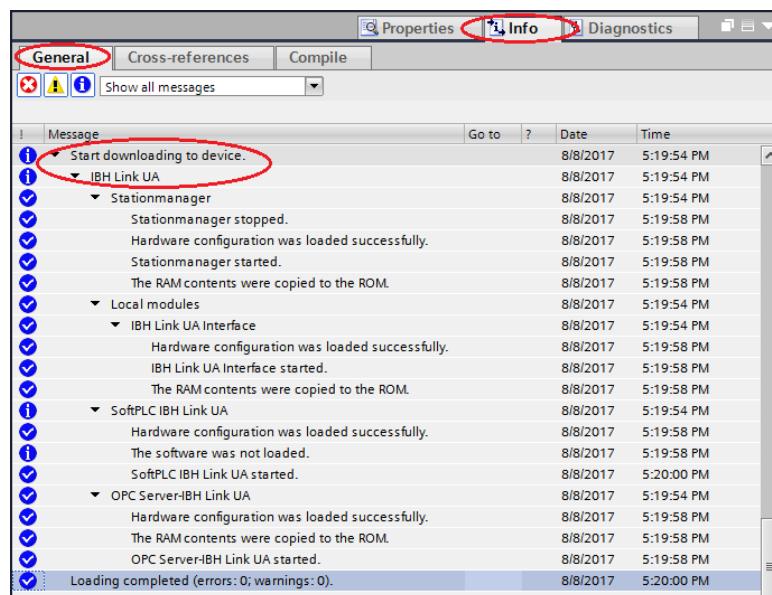


If no error occurs during the hardware and software compilation, they can be loaded into the IBH Link UA (OPC server, Interface and SoftPLC).

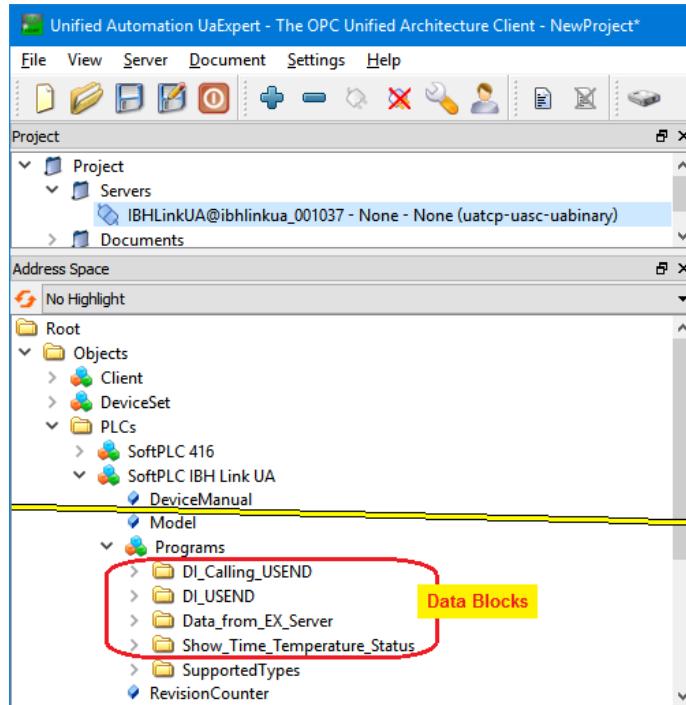
Load the Hardware and Software into the IBH Link UA



The progress of the loading process is displayed.

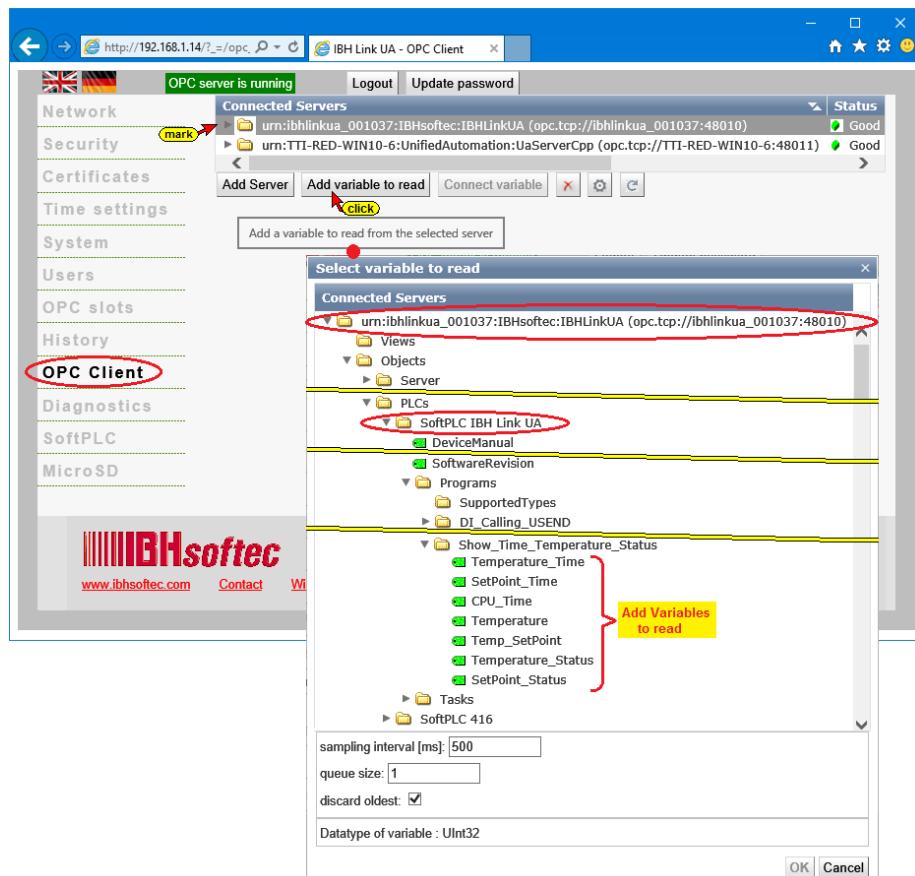


The SoftPLC IBH Link UA (WinLC RTX) with its data blocks appears in the UA Expert Window



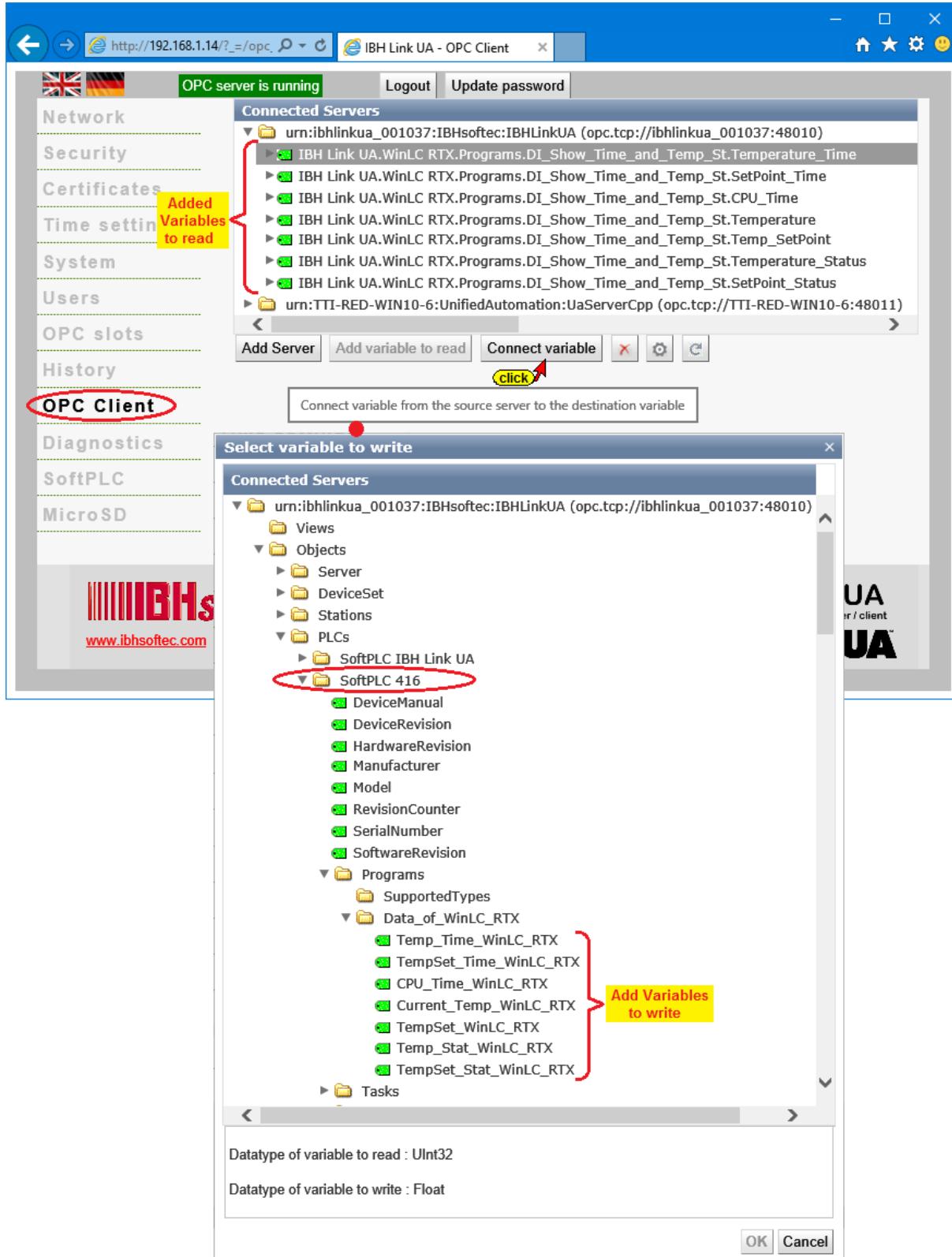
8.4.9 Read OPC Server variables from SoftSPS (WinLC RTX)

The OPC variables to be read by the **SoftPLC IBH Link UA [WinLC RTX]** are selected via the OPC UA Client function.



Connect to Variables

The read Variables from the **SoftPLC IBH Link UA [WinLC RTX]** must be connected to Variables of the **SoftPLC 416 [CPU 416-3 PN/DP]**.



In the IBH Link UA web browser window **OPC Client** the connections are displayed.

8.4.10 Display of the transferred variables [CPU 416-3 PN/DP]

Watch table_1 – **Data_of_WinLC_RTX** – of the **SoftPLC 416 [CPU 416-3 PN/DP]** online.

	Name	Address	Display format	Monitor value	Modify value
1	"Data_of_WinLC_RTX".Temp_Time_WinLC_RTX	%DB5.DBDO	TIME_OF_DAY	TOD#09:21:49.316	
2	"Data_of_WinLC_RTX".TempSet_Time_WinLC_RTX	%DB5.DBDO4	TIME_OF_DAY	TOD#09:21:49.316	
3	"Data_of_WinLC_RTX".CPU_Time_WinLC_RTX	%DB5.DBDO8	TIME_OF_DAY	TOD#09:21:50.054	
4	"Data_of_WinLC_RTX".Current_Temp_WinLC_RTX	%DB5.DBDO12	Floating-point number	25.57945	
5	"Data_of_WinLC_RTX".TempSet_WinLC_RTX	%DB5.DBDO16	Floating-point number	26.66667	
6	"Data_of_WinLC_RTX".Temp_Stat_WinLC_RTX	%DB5.DBDO20	Hex	16#0000_0000	
7	"Data_of_WinLC_RTX".TempSet_Stat_WinLC_RTX	%DB5.DBDO24	Hex	16#0000_0000	
8	"Temperature_AirCond1"	%MD38	Floating-point number	78.05341	
9	"Temp_SetPoint_AirCond1"	%MD42	Floating-point number	80.0	

8.4.11 Display of the transferred variables [WinLC RTX]

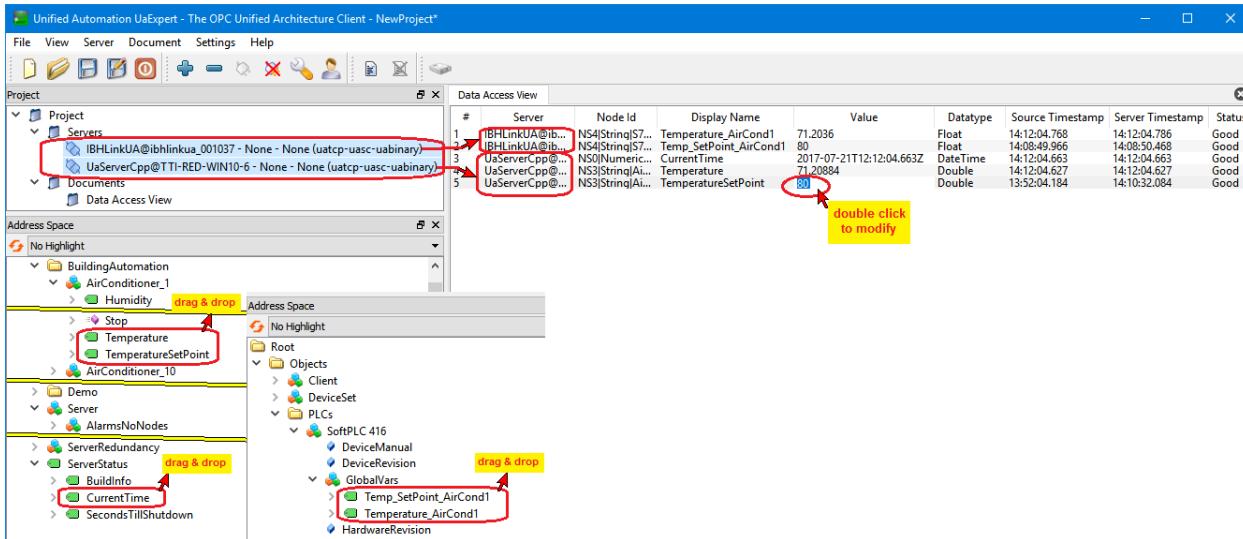
Watch table_1 – **data of data blocks** – of the **SoftPLC IBH Link UA [WinLC RTX]** online.

	Name	Address	Display format	Monitor value
1	"Data_from_EX_Server".Temp_TimeStamp_ext	P#DB10.DBX8.0	DATE_AND_TIME	DT#2017-08-09-09:17:30.022
2	"Data_from_EX_Server".Temp_TimeStamp_ext	P#DB10.DBX8.0	DATE_AND_TIME	DT#2017-08-09-09:17:30.022
3	"Data_from_EX_Server".Temperature_ext	%DB10.DBDO	Floating-point number	76.69491
4	"Data_from_EX_Server".Set_Point_Tempe_ext	%DB10.DBDO4	Floating-point number	80.0
5	"Data_from_EX_Server".Temperature_Status_ext	%DB10.DBDO24	Hex	16#0000_0000
6	"Data_from_EX_Server".SetPoint_Status_ext	%DB10.DBDO28	Hex	16#0000_0000
7	"Show_Time_Temperature_Status".Temperature_Time	%DB5.DBDO	TIME_OF_DAY	TOD#09:17:30.022
8	"Show_Time_Temperature_Status".SetPoint_Time	%DB5.DBDO4	TIME_OF_DAY	TOD#09:17:30.022
9	"Show_Time_Temperature_Status".CPU_Time	%DB5.DBDO8	TIME_OF_DAY	TOD#09:17:30.438
10	"Show_Time_Temperature_Status".Temperature	%DB5.DBDO12	Floating-point number	24.8305
11	"Show_Time_Temperature_Status".Temp_SetPoint	%DB5.DBDO16	Floating-point number	26.66667
12	"Show_Time_Temperature_Status".Temperature_Status	%DB5.DBDO20	Hex	16#0000_0000
13	"Show_Time_Temperature_Status".SetPoint_Status	%DB5.DBDO24	Hex	16#0000_0000

8.4.12 External OPC server Connection

the UAExpert program window **AddressSpace** displays information of the connected external OPC server.

Double-click **TemperatureSetPoint** to modify the value.



9 IBH Link UA – Alarms and Conditions

OPC UA has defined the interface between ***OPC Clients*** and ***OPC Servers*** in the specification ***Alarms and Conditions***.

Servers can report asynchronous alarms to clients registered with the server.

The alarms are triggered via the message blocks of the PLC controllers of the 300 and 400 series. These are the following blocks

Event		Description	
ALARM_8	SFB34	8 channels, acknowledgeable, no associated values	S7-400
ALARM_8P	SFB35	8 channels, acknowledgeable, up to 10 associated values	S7-400
NOTIFY	SFB36	1 channel, non- acknowledgeable, up to 10 associated values	S7-400
ALARM	SFB33	1 channel, acknowledgeable, up to 10 associated values	S7-400
ALARM_S	SFC18	1 channel, non- acknowledgeable, 1 associated value	S7-400 und S7-300
ALARM_SQ	SFC17	1 channel, acknowledgeable, 1 associated value	S7-400 und S7-300
NOTIFY_8P	SFB31	8 channels, non- acknowledgeable, up to 10 associated values	S7-400
ALARM_DQ	SFC107	1 channel, acknowledgeable, 1 associated value	S7-400 und S7-300
ALARM_D	SFC108	1 channel, non- acknowledgeable, 1 associated value	S7-400 und S7-300

(Source: Programming a Message System for OPC UA Alarms & Conditions with .NET C# for the SIMATIC NET OPC UA Server, Entry ID: 26548467, December 2011)

The programming and parameterization of the Alarms and Conditions is carried out with the Simatic Manager or the TIA portal. The two programming systems manage the message texts and transmit them to the IBH Link UA.

The SoftPLC integrated in the IBH Link UA also has the alarm-triggering blocks as it is compatible with the S7-400.

Control systems without Alarm system (SFB / SFC blocks) can also indirectly trigger ***Alarms and Conditions*** via the integrated SoftPLC.

The SoftPLC reads cyclically the values to be monitored from the connected PLC and triggers ***Alarms and Conditions*** depending on the programming of the SoftPLC.

Even an existing plant with e.g. an old S5 control system can be upgraded for ***Alarms and Conditions***.

Example – OPC UA 10E TIA 15 Tank Alarm

The prepared sample project

OPC UA 10E TIA 15 Tank Alarm contains a PLC

Program, executed on the device ***Tank level*** [CPU 416-3 PN/DP). This PLC Program is identical to the PLC Program with the identical name as described in chapter 3.3.2.



The level of the tank is displayed as ***Value*** (Int). The signal ***Down*** is present during the emptying of the tank. The signal ***Up*** indicates that the tank is filled. These informations are passed to the SoftSPS in the IBH Link UA to OPC UA Server / Client. This approach shows how CPUs, which do not have the blocks to propagate messages, can use this technique.

The SFC 108 "ALARM D" is used to send the information about the filling / emptying situation to the OPC server for further processing (e.g., visualization).

During the emptying of the tank the message ***Empty Tank, nnn liters in Tank*** is transferred until the level ***Min_value*** is reached.

During the filling of the tank the message: ***Fill Tank, nnn liters in Tank*** is transferred until the level ***Max_value*** is reached.

Activate the integrated SoftPLC

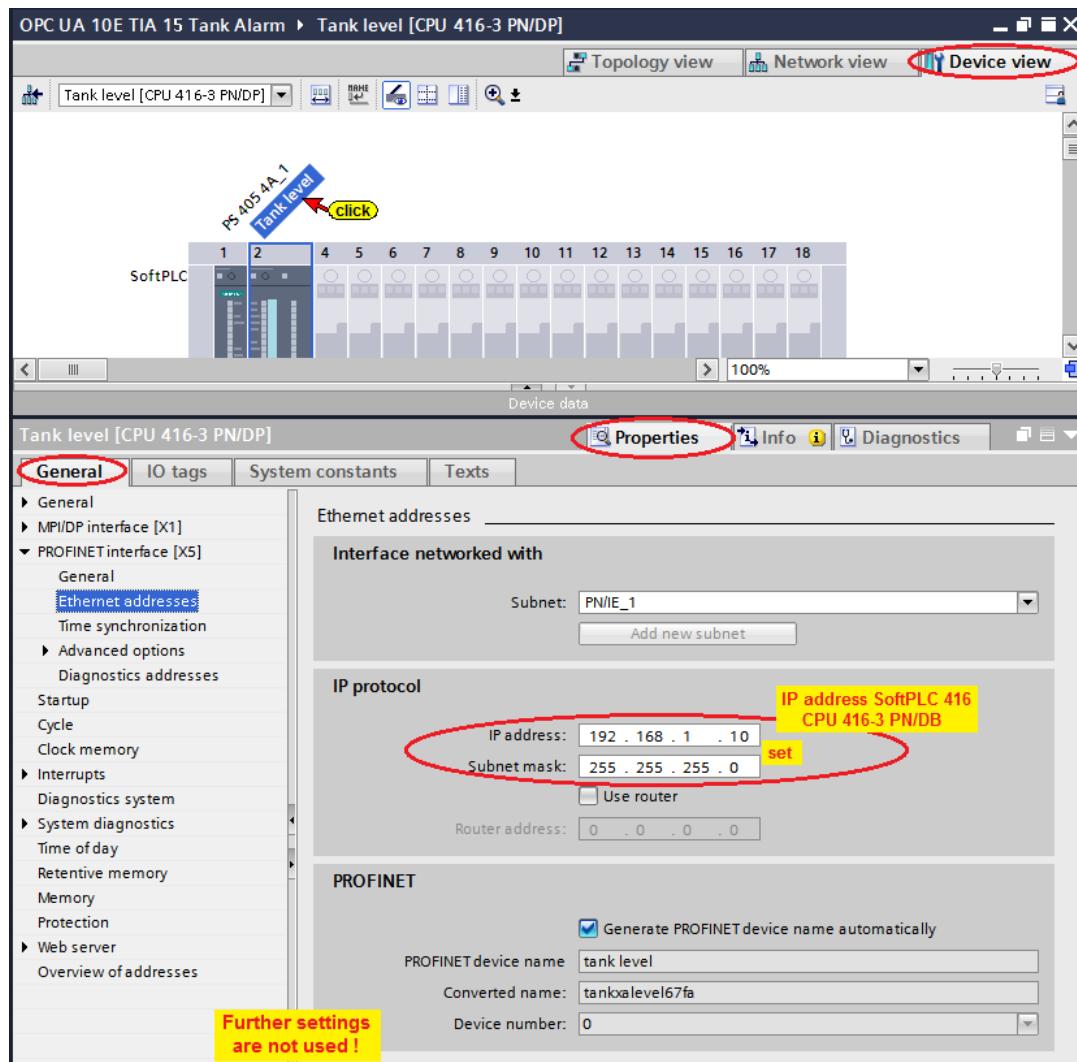
The SoftPLC must be activated via the WEB interface of the IBH Link UA.

The status of the SoftPLC can be observed on the WEB interface of the IBH Link UA configurator.

IBHsoftec SoftPLC 416 Program Tank level [CPU 416-3 PN/DP]

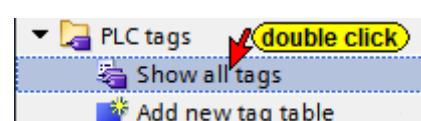
An S7 400 station with the CPU 416-3 PN/DP (6ES7 416-3ER05-0AB0) firmware version V5.1 and with a power supply PS 407 A4 was created as hardware.

The Ethernet address has been set in the **Properties/Tank level [CPU 416-3 PN/DP]/Ethernet addresses** dialog box.



The tags from the default tag table are used as OPC tags (variables).

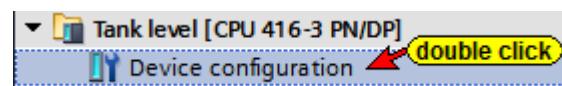
A double-click opens the tag table.



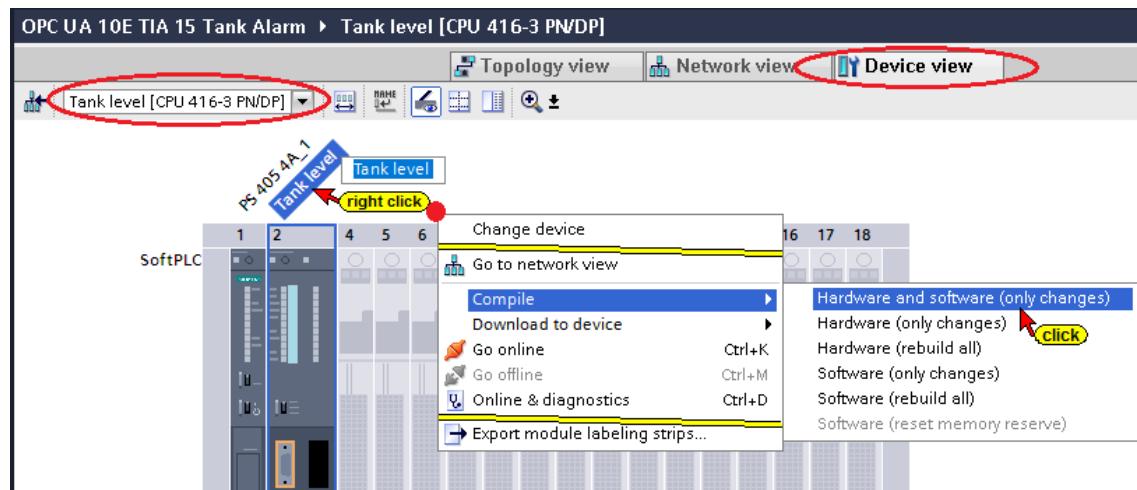
	Name	Tag table	Data type	Address	Comment
1	On	Default tag table	Bool	%IO.0	Control ON
2	Max	Default tag table	Bool	%M1.2	Maximum reached
3	Min	Default tag table	Bool	%M1.3	Minimum reached
4	Down	Default tag table	Bool	%Q2.5	Output valve
5	Up	Default tag table	Bool	%Q2.6	Input valve
6	Value	Default tag table	Int	%MW2	Tank level value

Configuring the hardware and software of the CPU 416-3 PN/DP

A Double-click opens the **Device Configuration**.

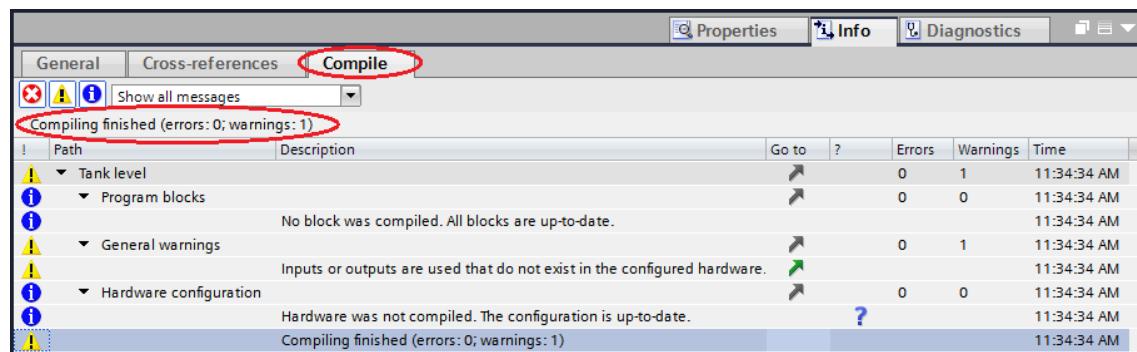


Use the command from the context menu to compile the software and the hardware.



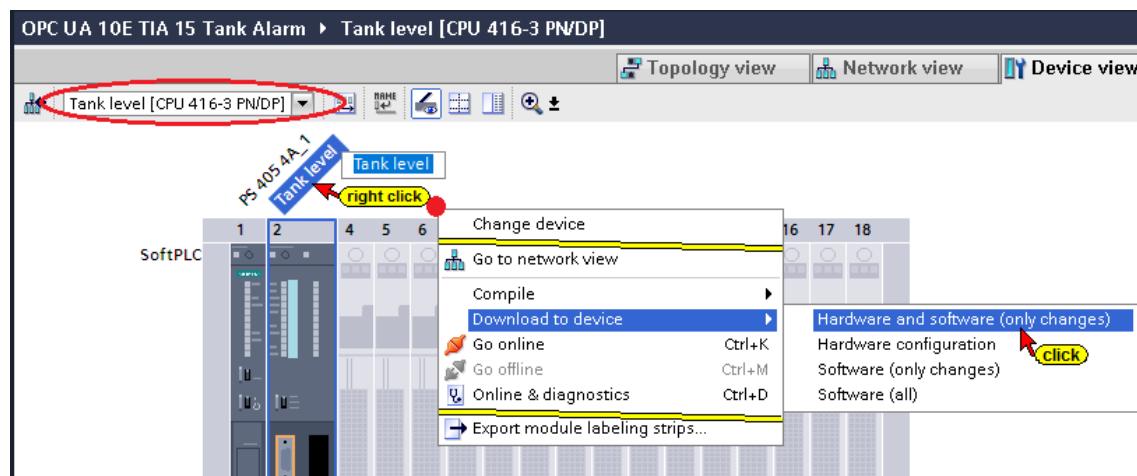
Hardware and software compilation with warnings

Ignore the warnings. The SoftPLC 416 requires no I/O modules.

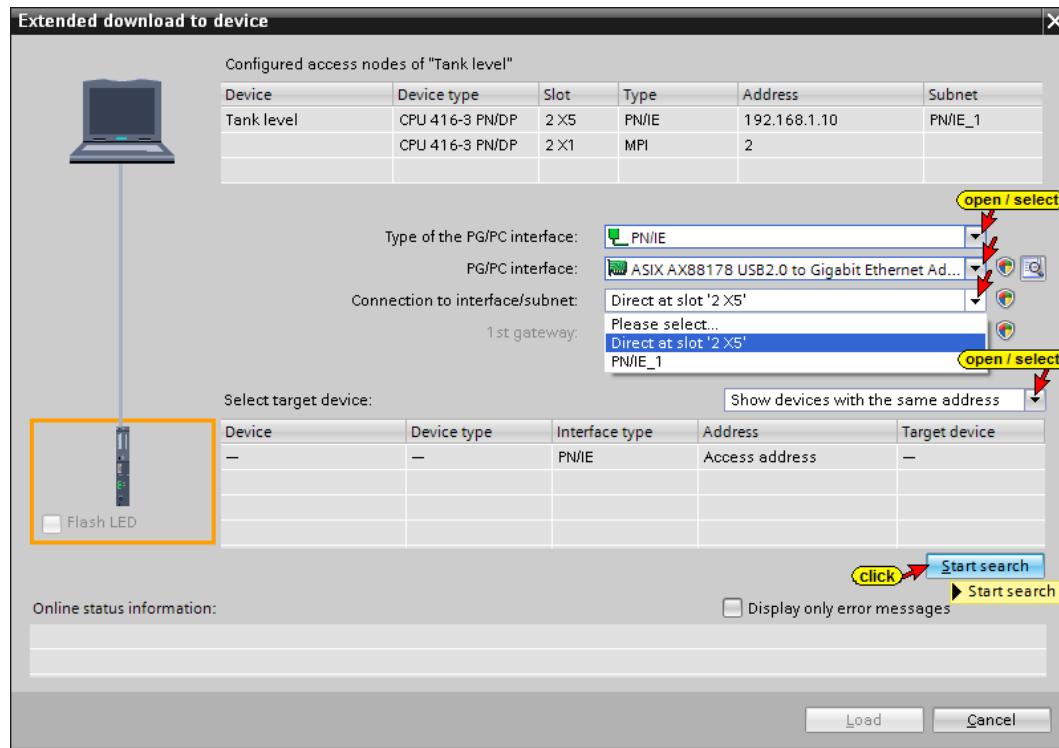


Download the hardware and software into the CPU

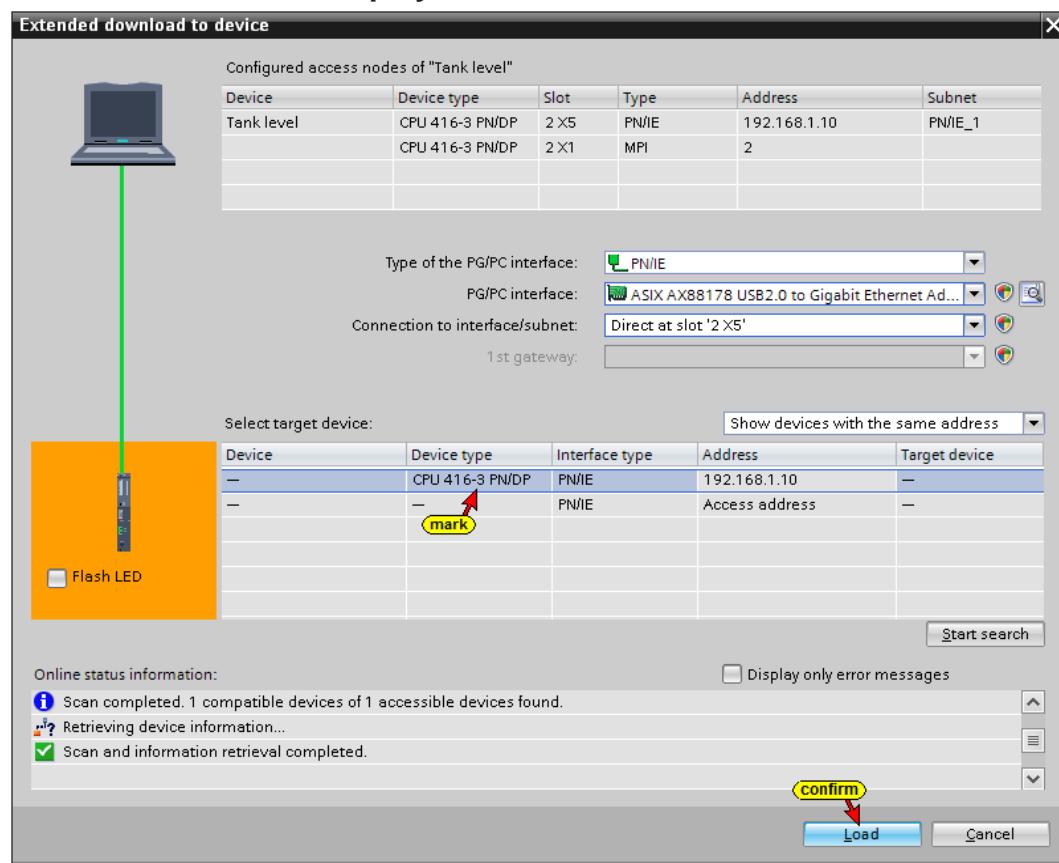
With the commands from the context menu, the software and the hardware configuration can now be loaded into the device.



The Download command opens the dialog box to set the interface for the device. Direct at slot '2 X5' must be selected because the Hardware configuration has not yet been downloaded into the CPU.



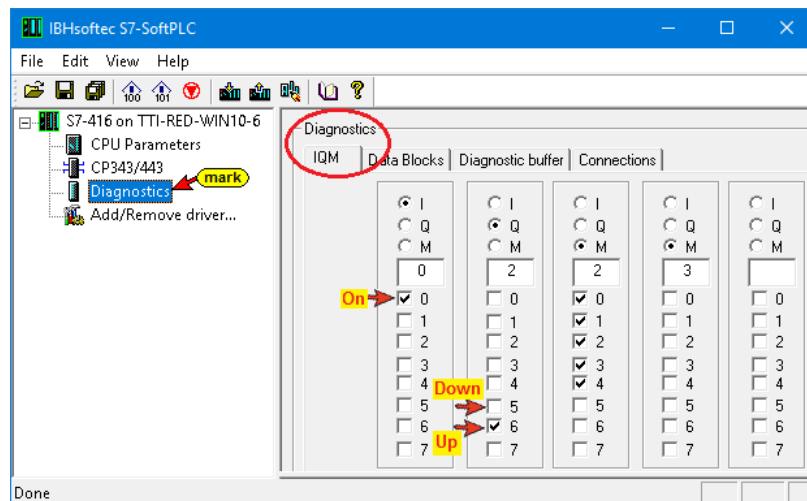
The successful search is displayed



The loading process requires several confirmations of messages and dialog boxes.

SoftPLC diagnostics CPU 416-3 PN/DP

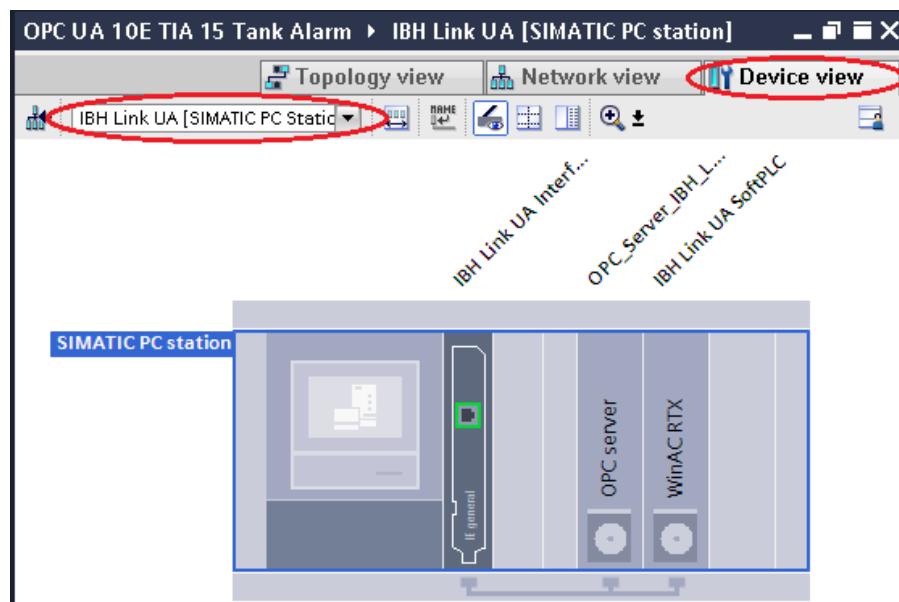
The Input I0.0 **ON** was set in the diagnostic window IQM of the SoftPLC 416. The Outputs Q2.5 or Q2.6 indicate "Down" and "Up". The "value" is represented by M2 and M3.



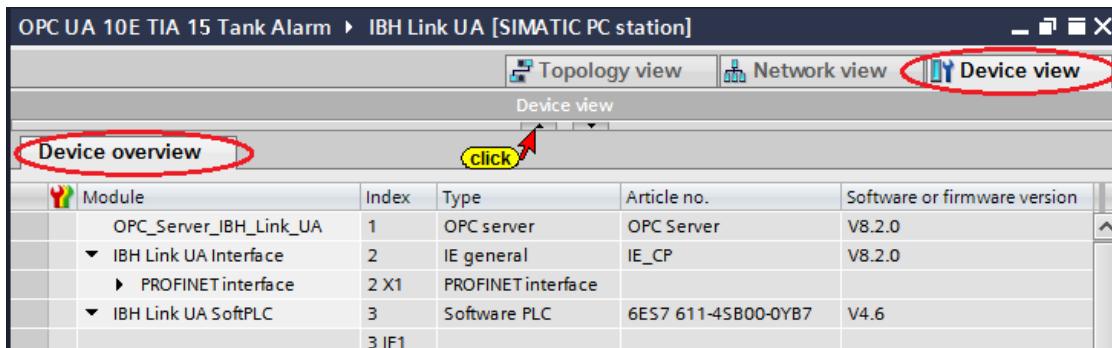
9.1 IBH Link UA Hardware Setup

The following components from the hardware catalog must be configurated for the **IBH Link UA [SIMATIC PC Station]**:

- OPC_Server_IBH_Link_UA – **OPC server V8.2.0** at Slot 1
- IBH Link UA Interface Communication module Profinet/Ethernet - **IE General IE_Cp V8.2.0** at Slot 2
- IBH Link UA SoftPLC – Simatic Controller Application Software PLC **WinAC RTX – 6ES7 611-4SB00-0YB7 V4.6** at Slot 3



IBH Link UA [SIMATIC PC Station]



9.1.1 IBH Link UA SoftPLC SPS Programm

Double-click to open the PLC block **Tank evaluation** [FB 10].

In this block, the block **ALARM D** (SFC 108) is called twice for transferring messages.

The signals **High** and **Low** are used to trigger the transfer of the messages.

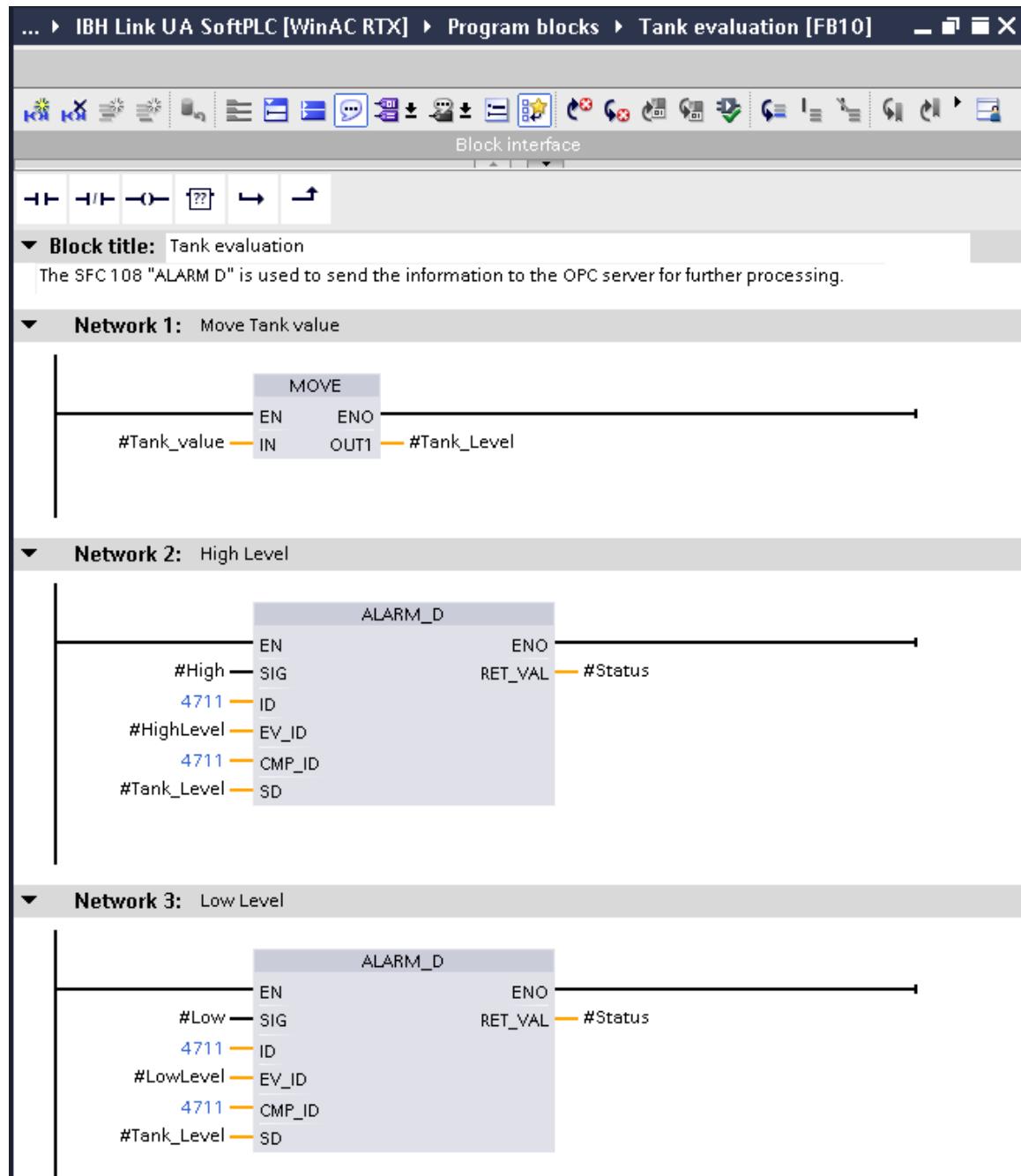
ALARM D (SFC 108) Parameters

The following table shows the parameters of the instruction "ALARM_D":

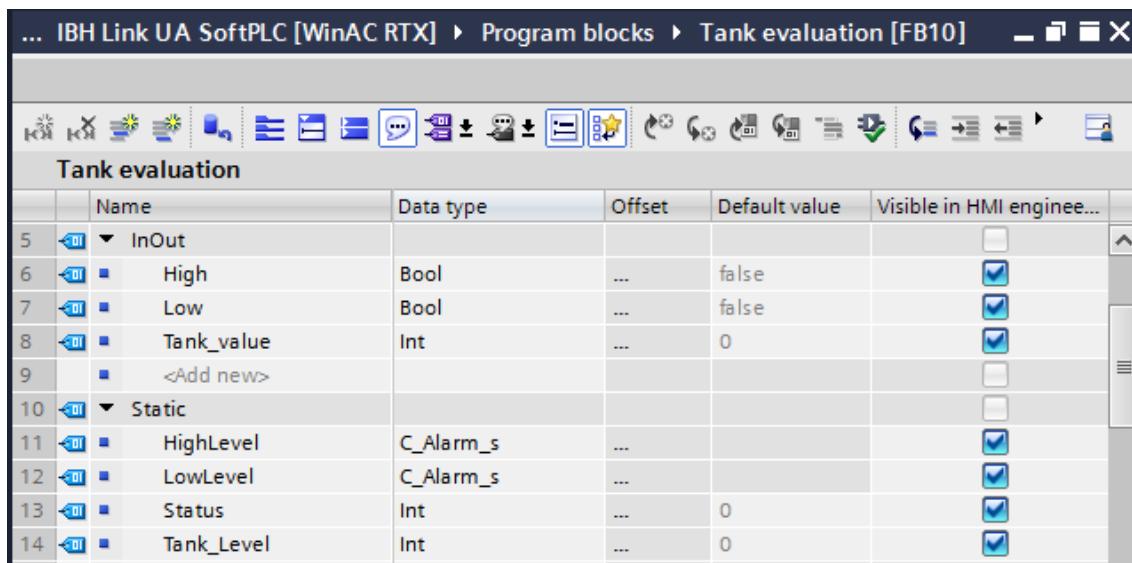
Parameter	Declaration	Data type	Memory area	Description
SIG	INPUT	BOOL	I, Q, M, D, L	The alarm triggering signal
ID	INPUT	WORD	I, Q, M, D, L or constant	Data channel for alarms: W#16#EEEE
EV_ID	INPUT	DWORD	I, Q, M, D, L	Alarm number (not allowed: 0)
CMP_ID	INPUT	DWORD	I, Q, M, D, L or constant	component identifier (not permitted: 0) ID for the subsystem to which the corresponding alarm is assigned Recommended values: <ul style="list-style-type: none"> • Low word: 1 to 65535 • High word: 0 You will not have any problems with the SIEMENS program package if you comply with these recommendations.

Parameter	Declaration	Data type	Memory area	Description
SD	INPUT	ANY	I, Q, M, D, T, C	Associated value Maximum length: 12 bytes Only the BOOL data types are permitted (not permitted: bit array), BYTE, CHAR, WORD, INT, DWORD, DINT, REAL, DATE, TOD, TIME, S5TIME, DATE AND TIME
RET VAL	OUTPUT	INT	I, Q, M, D, L	Error information

PLC block **Tank evaluation [FB 10]**



Variables table – PLC block *Tank evaluation* [FB 10]

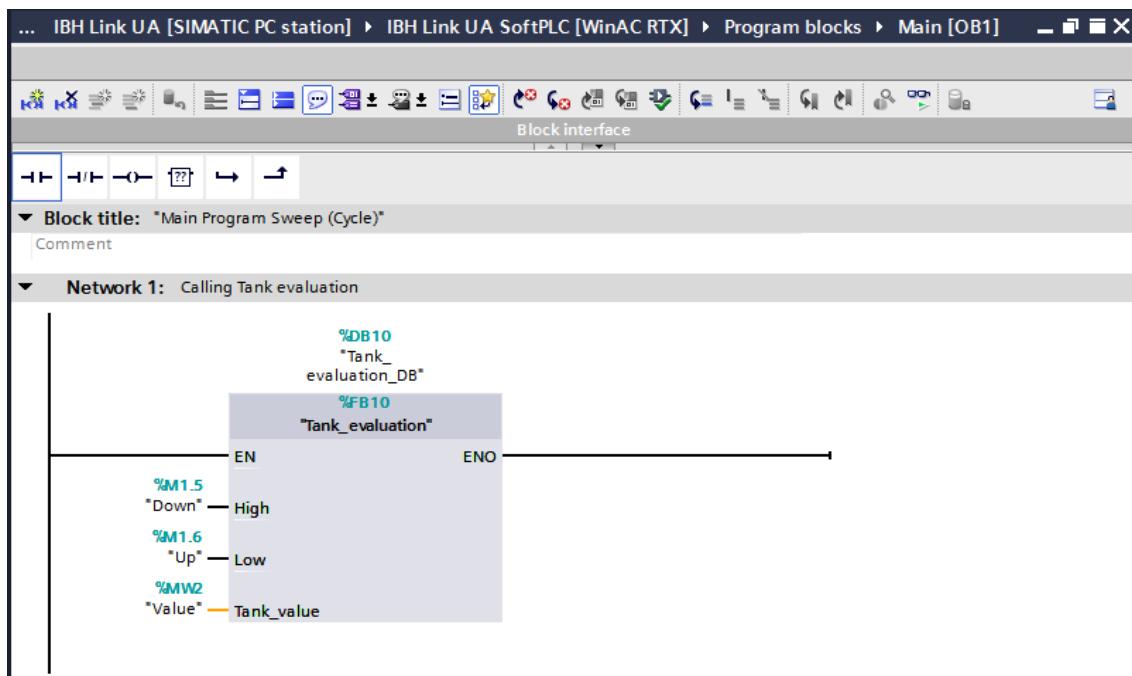


The screenshot shows the 'Variables table' for the 'Tank evaluation' block. The table has columns for Name, Data type, Offset, Default value, and Visible in HMI engine... (checkboxes). The data is as follows:

	Name	Data type	Offset	Default value	Visible in HMI engine...
5	InOut				<input type="checkbox"/>
6	High	Bool	...	false	<input checked="" type="checkbox"/>
7	Low	Bool	...	false	<input checked="" type="checkbox"/>
8	Tank_value	Int	...	0	<input checked="" type="checkbox"/>
9	<Add new>				<input type="checkbox"/>
10	Static				<input type="checkbox"/>
11	HighLevel	C_Alarm_s	...		<input checked="" type="checkbox"/>
12	LowLevel	C_Alarm_s	...		<input checked="" type="checkbox"/>
13	Status	Int	...	0	<input checked="" type="checkbox"/>
14	Tank_Level	Int	...	0	<input checked="" type="checkbox"/>

Organization Block Main [OB1]

The function module **Tank_evaluation** [FB 10] should be called now because the instance data block **Tank_evaluation_DB** must exist in order to define the values for the PLC messages of the **Data type C_Alarms_s**.



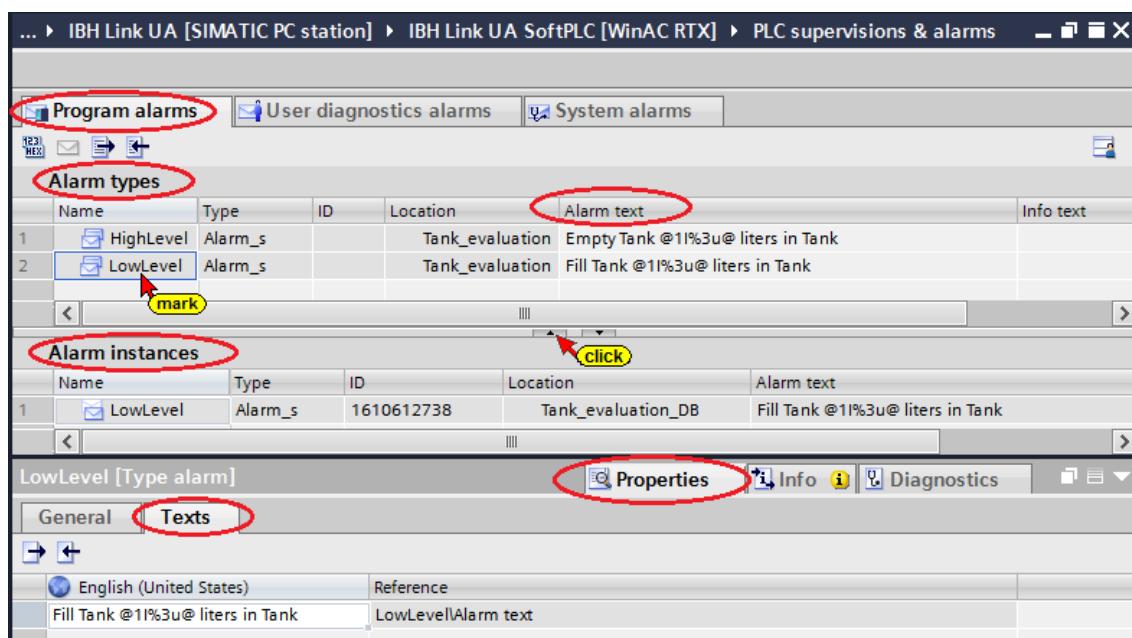
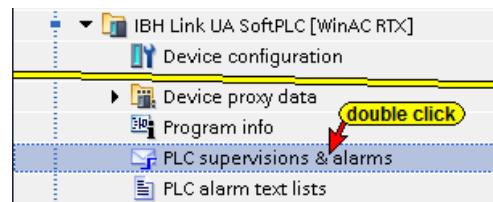
9.1.2 Configuring PLC messages

Values can be assigned to the messages being defined with the parameters SD. These values may have a maximum length of 12 bytes.

The accompanying value is a block beginning and ending with the character @.

Opening the Program alarms window

Double-click to open the Program alarms window to set the associated values.



Marking a line in the **Alarm types** field, lists the **ID** of the associated name in the **Alarm instances** field.

The **Alarm text** belonging to the individual names can be edited in the **Alarm types** list.

Structure of associated values in alarms

Format specification

The format starts with the character "%". The alarm texts have the following fixed formats:

Format	Description
%[i]X	Hexadecimal number with i digits
%[i]u	Decimal number without sign with i digits
%[i]d	Decimal number with sign with i digits
%[i]b	Binary number with i digits
%[i][y]f	Floating-point number with sign with y digits after the decimal point and total number of digits i
%[i]s	String (ANSI string) with i digits Characters are printed up to the first 0 Byte (00Hex).
%t#<Name of the text list>	Access to text list

- If the number of digits [i] is too small, the value is still output in full length.
- If the number of digits [i] is too large, an appropriate number of fill characters is output before the value.

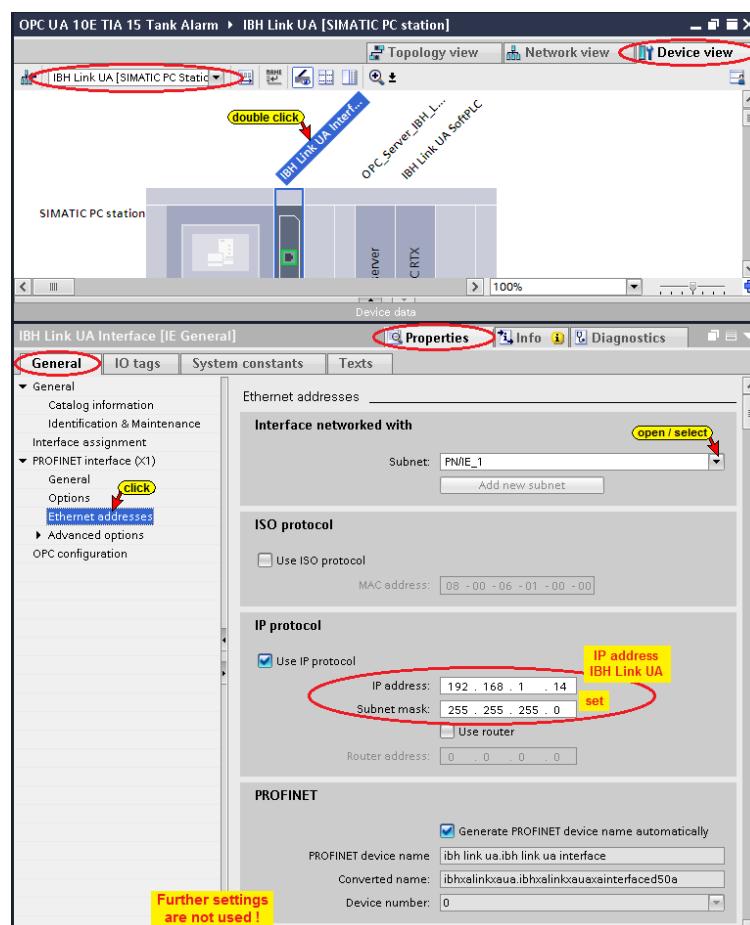
Element type

This uniquely configures the data type of the associated value:

Elements type	Data type
Y	BYTE
W	WORD
X	DWORD
I	Integer
D	DINT
B	BOOL
C	CHAR
R	REAL

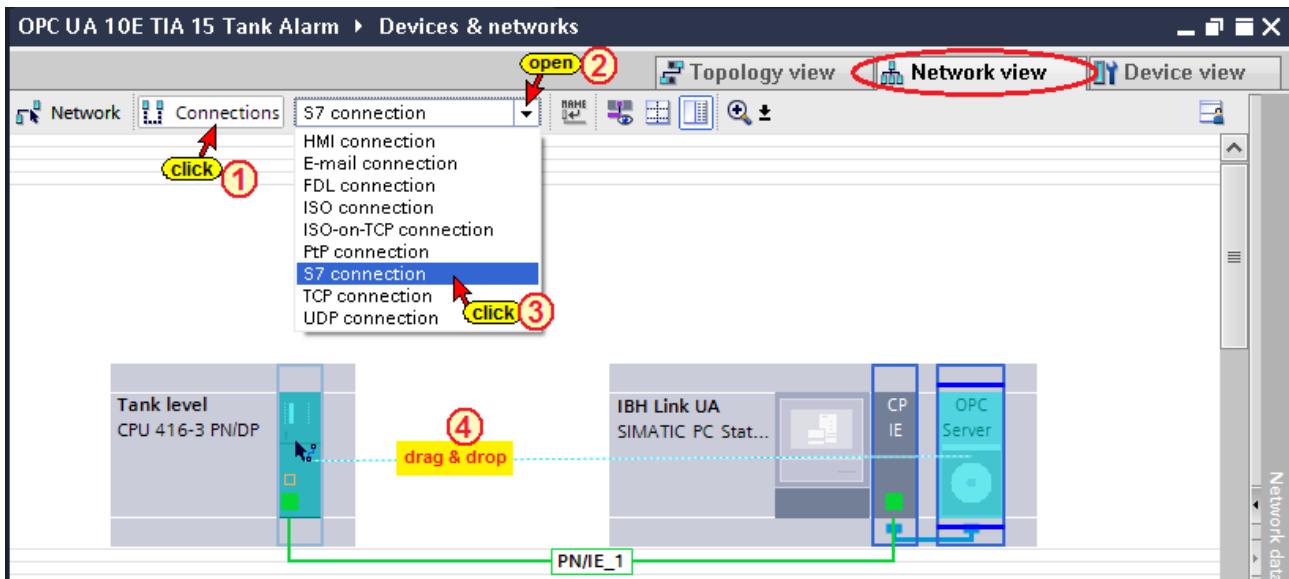
Example:

Alarm text:	Output on the display:
Empty Tank @1%3u@ liters in Tank	Empty Tank 8568 liters
Fill Tank @1%3u@ liters in Tank	Fill Tank 2844 liters

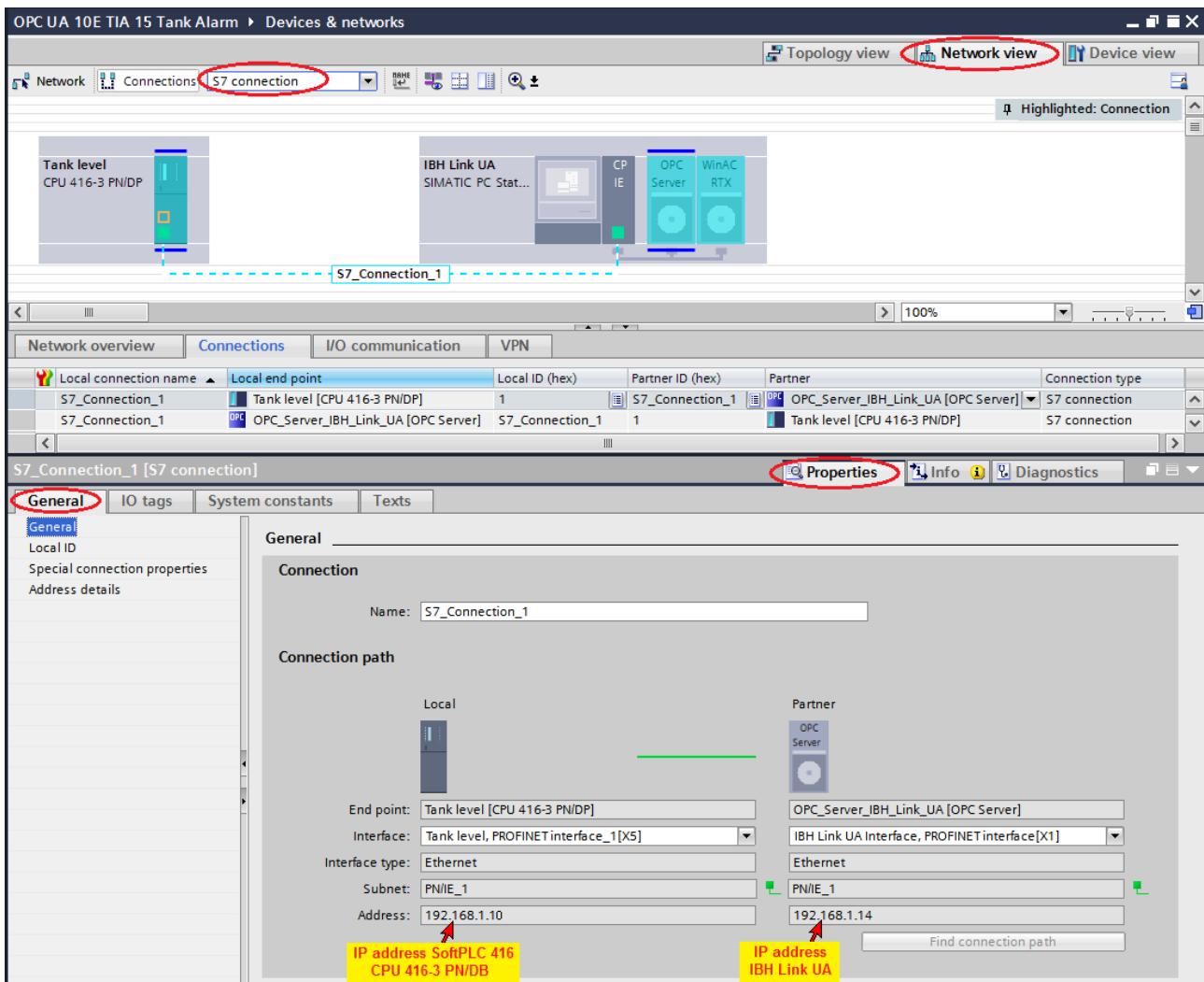


9.1.3 S7 Connection IBH Link UA OPC Server – SoftPLC 416

Use Drag&Drop to establish the S7 connection from the **IBH Link UA OPC Server** to the **SoftPLC 416 (Tank level CPU 416-3PN/DP)**.



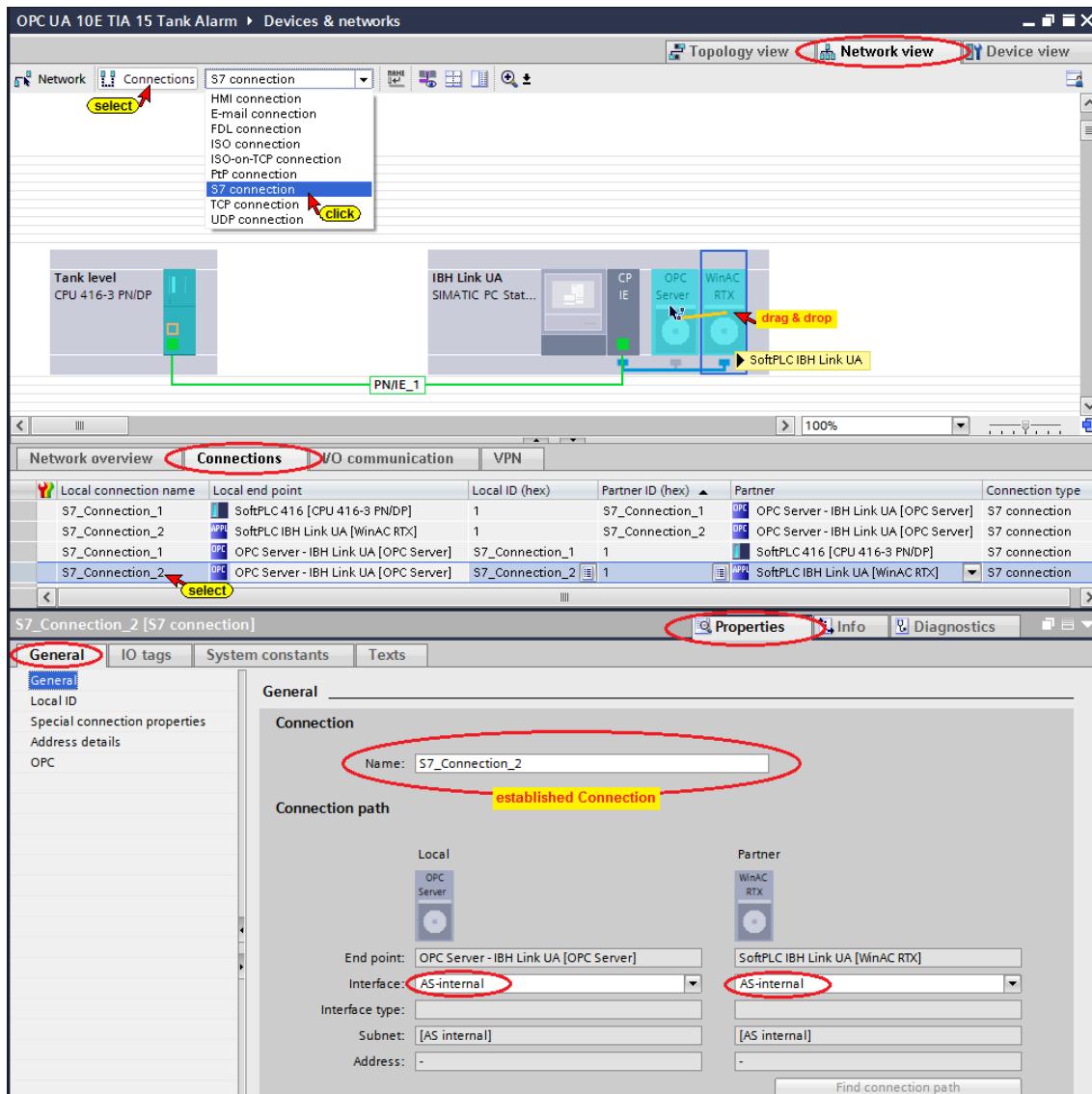
The established S7 connection is shown



9.1.4 S7 Connection –OPC Server-IBH Link UA – SoftPLC IBH Link UA

A second S7 connection is required between the OPC Server and the SoftPLC integrated in the IBH Link UA. The S7 connection is established internally in the IBH Link UA.

Use Drag&Drop to establish the S7 connection from the **OPC Server-IBH Link UA** to the **SoftPLC IBH Link UA [WinAC RTX]**.



Alarms and OPC connection establishment settings

Attention:

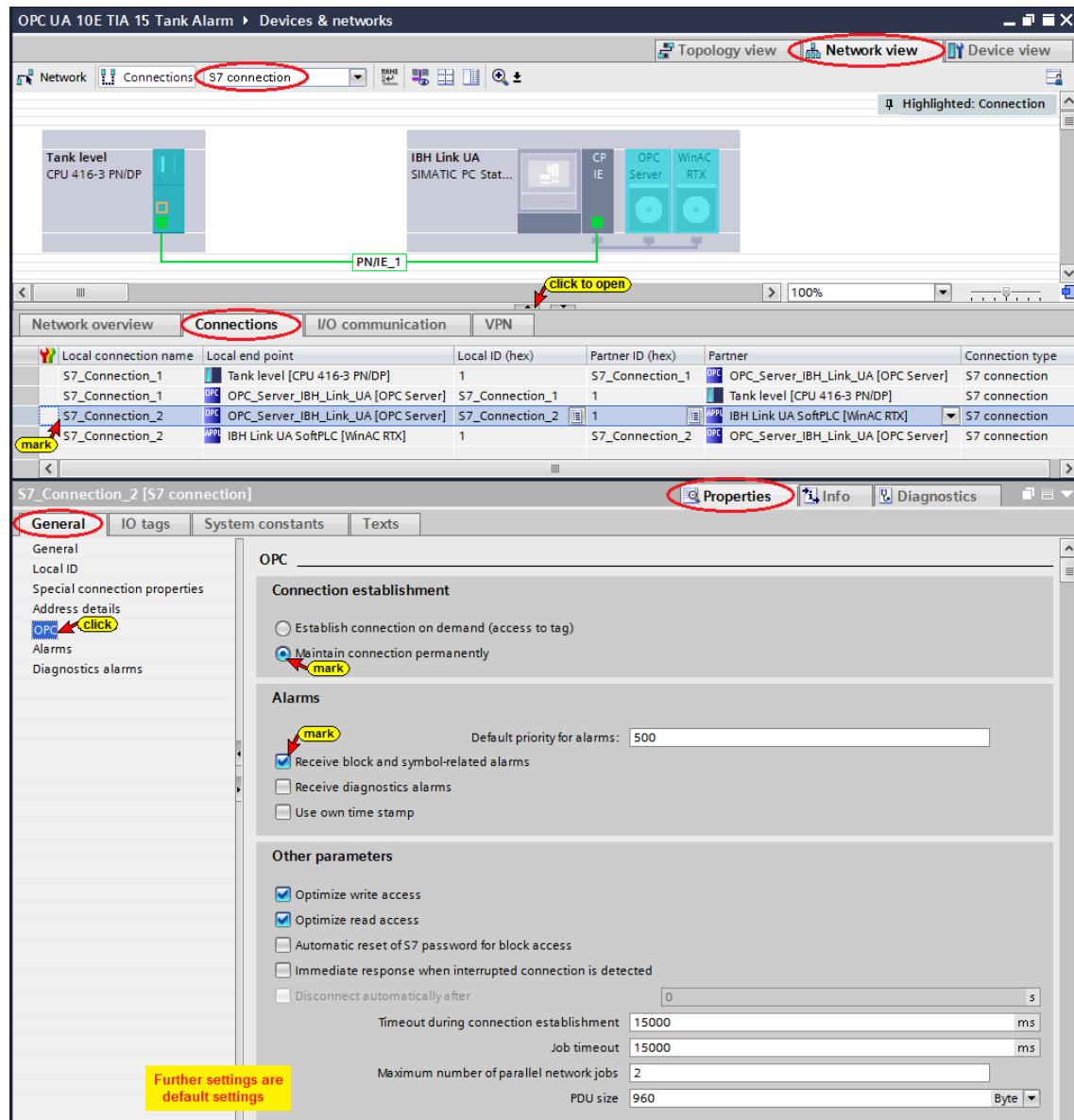
Click on the line **S7_Connections_2 – OPC Server - BH Link UA [OPC Server] (Local Endpoint); SoftPLC BH Link UA [WinAC RTX] (Partner)** and open the window Properties/General/OPC.

Set the options according the screenshot.

Alarms and OPC connection establishment settings

It should be stated that:

- Maintain the connection permanently.
- Receive block and symbol-related alarms.



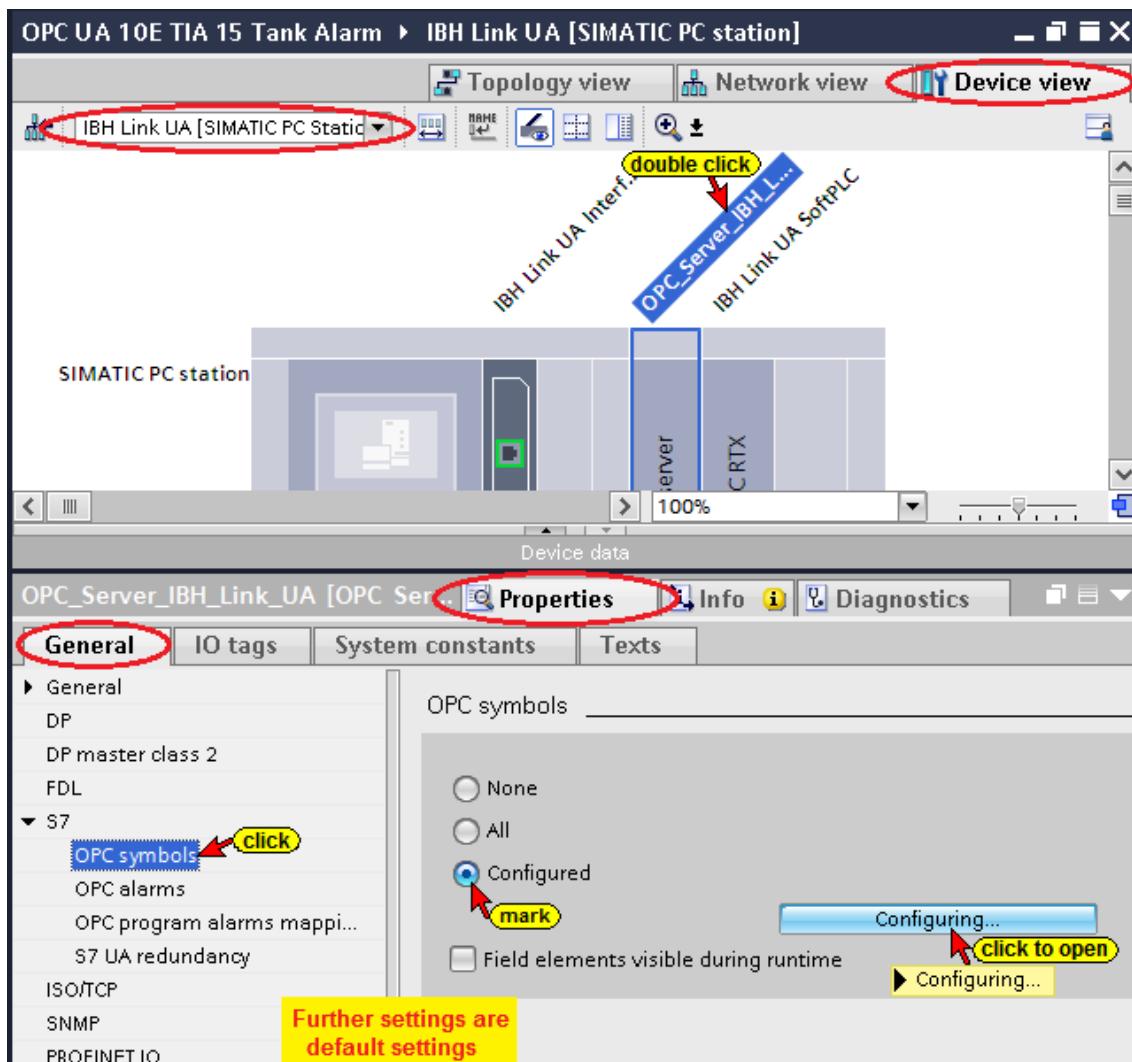
9.1.5 Select OPC tags (symbols) in the OPC configuration

Due to the two (2) previously establish S7 connection:

- **IBH Link UA OPC Server** to and from the **SoftPLC 416 (Tank level CPU 416-3PN/DP)**
- **SoftPLC IBH Link UA [WinAC RTX]** to and from the **IBH Link UA OPC Server**.

The programming system (TIA 14) the knows the tags to be used as OPC tags (tags defined in the tag table, data from the data blocks).

Select OPC tags



The following OPC tags are required in the example and must be selected Symbol configuration dialog box:

Tank level [CPU 416-3 PN/DP]		Name	Access	Visible
	PLC tags	Down Up Value	Read	True
	Data Blocks: Tank_level_value	All data	None	False
IBH Link UA SoftPLC [WinAC RTX]				
	PLC tags	Down Up Value	Read / Write	True
	Data Blocks: Tank_evaluation_DB	All data	Read / Write	True

PLC tags Tank level [CPU 416-3 PN/DP]

Symbol configuration

Name	Data type	Address	Visible	Connection	Access	EU Lo
On	Bool	%I0.0	False	S7_Connection_1	None	0
Max	Bool	%M1.2	False	S7_Connection_1	None	0
Min	Bool	%M1.3	False	S7_Connection_1	None	0
Down	Bool	%Q2.5	True	S7_Connection_1	Read	0
Up	Bool	%Q2.6	True	S7_Connection_1	Read	0
Value	Int	%MW2	True	S7_Connection_1	Read	0

Symbol selector:

- OPC UA 10E TIA 15 Tank Alarm
 - Tank level
 - PLC tags **Click to open**
 - Program blocks
 - Tank_level_values
- IBH Link UA
 - IBH Link UA SoftPLC
 - PLC tags
 - Program blocks
 - Tank_evaluation_DB

IBH Link UA SoftPLC [WinAC RTX]; Data Block Tank_evaluation_DB

Symbol configuration

Name	Data type	Address	Visible	Connection	Access	EU Lo
Tank_evaluation_DB	Block_DB	%DB10	True	S7_Connection_2	ReadWrite	0

Symbol selector:

- OPC UA 10E TIA 15 Tank Alarm
 - Tank level
 - PLC tags
 - Program blocks
 - Tank_level_values
- IBH Link UA
 - IBH Link UA SoftPLC
 - PLC tags
 - Program blocks **click to open**

IBH Link UA SoftPLC [WinAC RTX]; Data, Data Block Tank_evaluation_DB

Symbol configuration

Name	Data type	Address	Visible	Connection	Access	...
High	Bool	%DB10.DBX0.0	True	S7_Connection_2	ReadWrite	0
Low	Bool	%DB10.DBX0.1	True	S7_Connection_2	ReadWrite	0
Tank_value	Int	%DB10.DBW2	True	S7_Connection_2	ReadWrite	0
Status	Int	%DB10.DBW12	True	S7_Connection_2	ReadWrite	0
Tank_Level	Int	%DB10.DBW14	True	S7_Connection_2	ReadWrite	0

Symbol selector:

- OPC UA 10E TIA 15 Tank Alarm
 - Tank level
 - PLC tags
 - Program blocks
 - Tank_level_values
- IBH Link UA
 - IBH Link UA SoftPLC
 - PLC tags
 - Program blocks
 - Tank_evaluation_DB **click to open**

Elements with active branch:

Symbols: 5

CSV Import / Export:

Access path:

OPC UA 10E TIA 15 Tank Alarm.IBH Link UA.IBH Link UA SoftPLC.Tank_evaluation_DB

Buttons:

- Import file
- Export file
- OK
- Cancel

Context menu (ReadWrite):

- Read
- Write
- Select**
- ReadWrite
- None

Visible checkbox:

Visible checked

Access right dropdown:

ReadWrite

Connection dropdown:

S7_Connection_2

Low limit:

0.000000000000

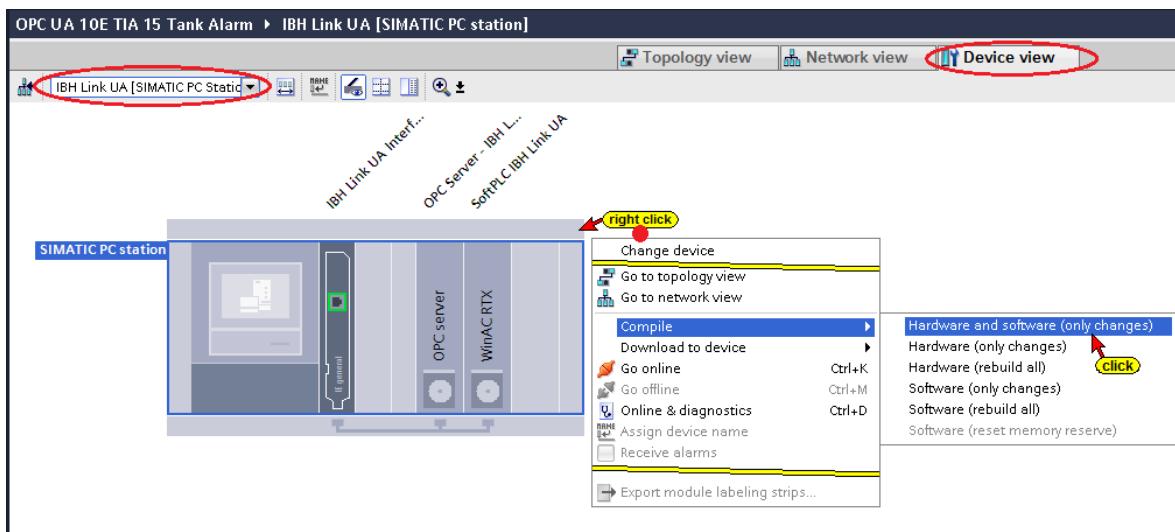
High limit:

0.000000000000

Confirm button:

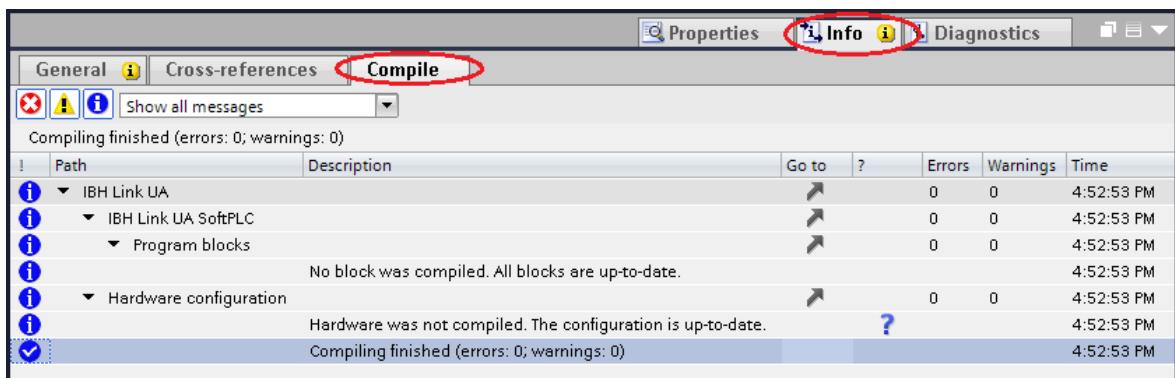
confirm

Compiling the IBH Link UA Hardware and Software



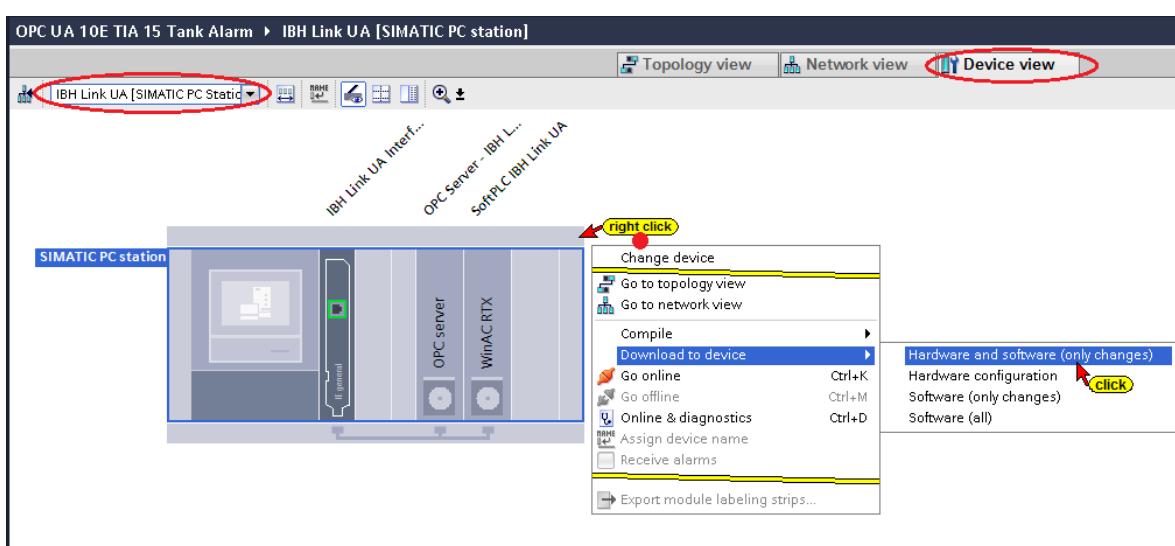
If no error occurs during the hardware and software compilation, they can be loaded into the IBH Link UA (OPC server, Interface and SoftPLC).

Hardware Software compilation without errors



Load the Hardware and Software into the IBH Link UA

With the commands from the context menu the software and the hardware configuration are load into the device.



Creating an OPC clients in the IBH Link UA

In the IBH Link UA Web browser window / OPC Client, an additional OPC Server must be added.

Add a Server

Click the Add Server button and paste the previously copied endpoint URL `opc.tcp://192.168.1.14:48010` into the field **Url of a computer with discovery service running.**

Click the Refresh button to open the Security Policy list.

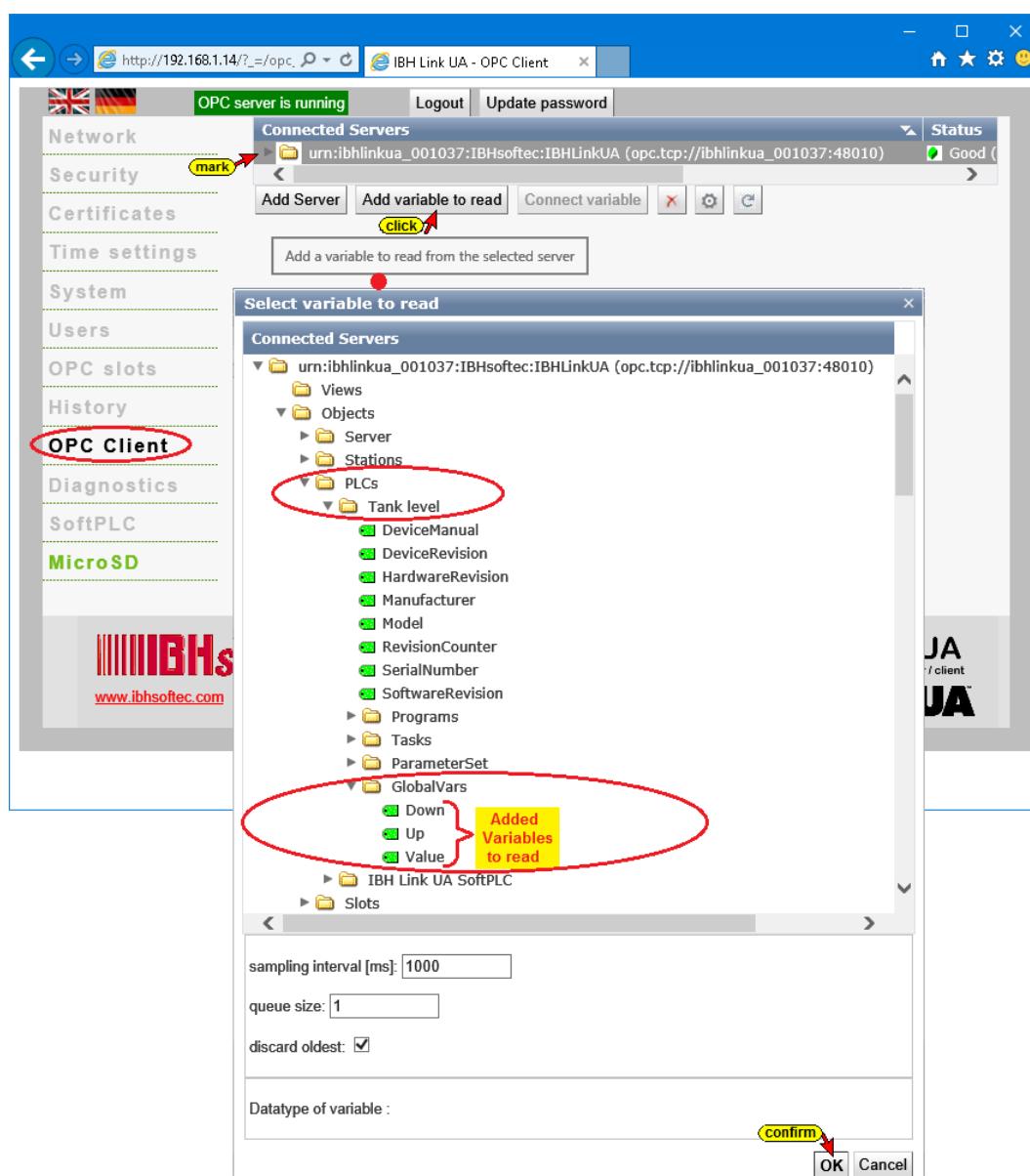
Select the **Security Policy None** and the **Security Mode None**.

Confirm the selection. For detailed information see chapter 5-12.



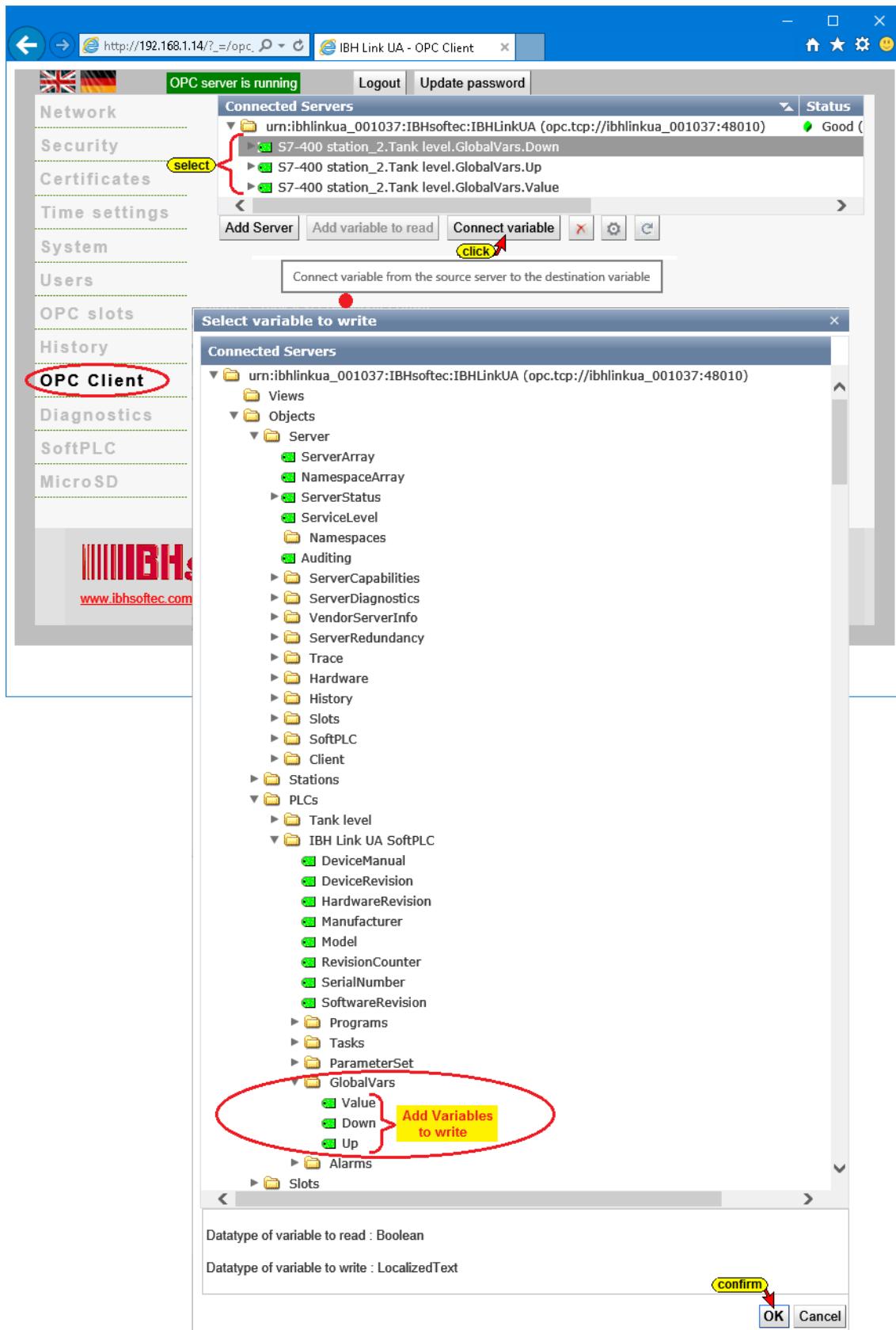
Add Variable to Read

Select the **GlobeVars** (tags) **Down**, **Up**, and **Value** from the PLC **Tank level** to be read variables.



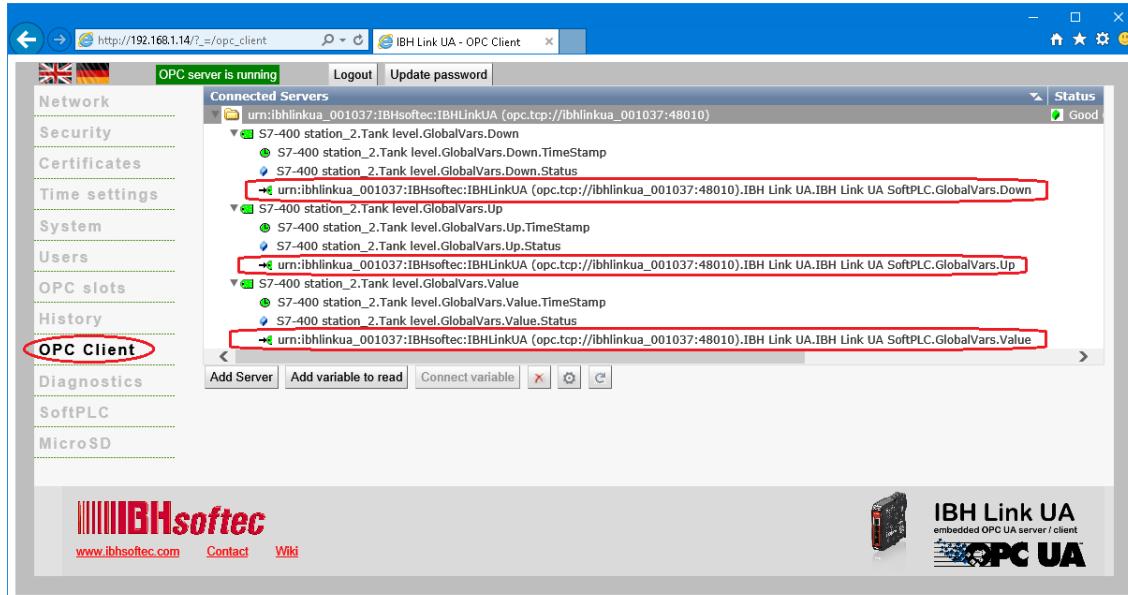
Connect Variables

The three variables from the **Tank level** (IBHsofttec SoftSPS CPU 416-3 PN/DP) Down, Up, and Value are declared as read variables, to be passed via the IBH Link UA OPC Server to the integrated **SoftPLC [WinAC RTX]** in the IBH Link UA.



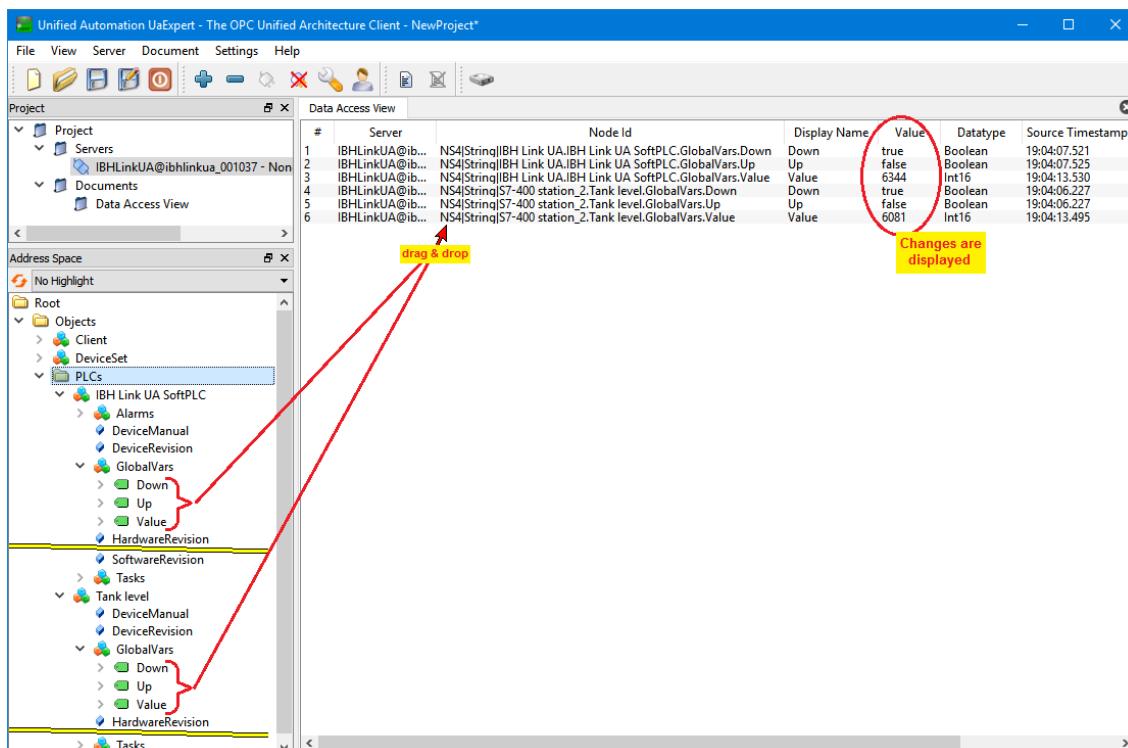
In the IBH Link UA web browser window **OPC Client** the established connections are displayed.

Tank level [CPU 416-3 PN/DP] → SoftPLC [WinAC RTX]



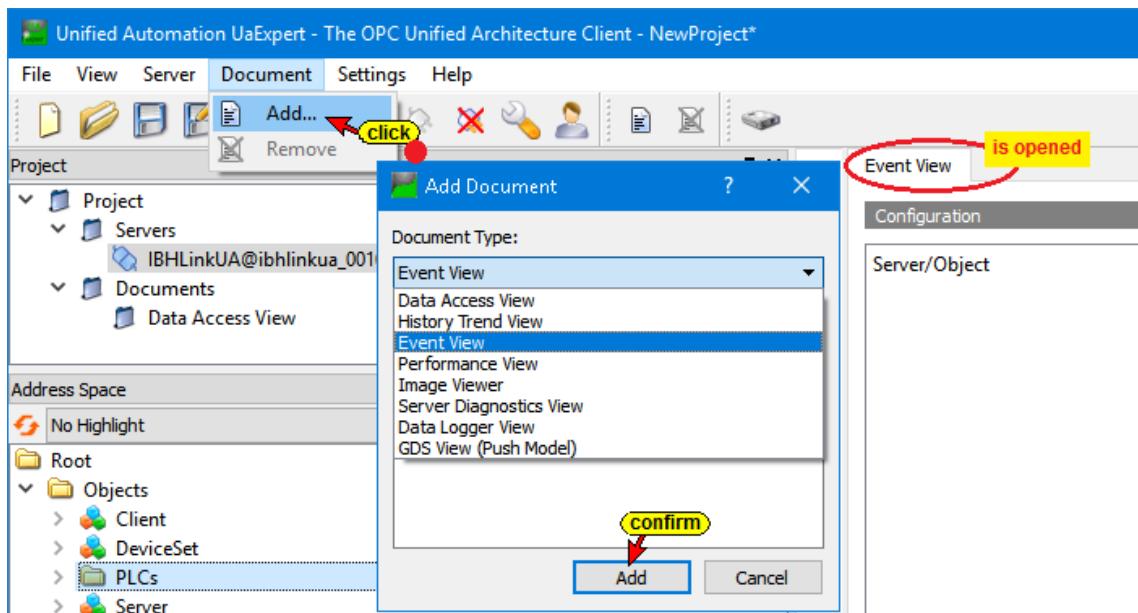
UaExpert Program window

The global variables from the PLC Program **Tank level [CPU 416-3 PN/DP]** and the PLC Program of the **IBH Link UA SoftPLC [WinAC RTX]** can be monitored in the *Data Access View* of the UaExpert Program window.



To display the messages from the calls of the **PLC Alarm blocks (SFC 108 "ALARM D")**, the **Event View** window must be opened.

Event View window



Use Drag&Drop to move the complete PLC – **IBH Link UA SoftPLC [WinAC RTX]** in the **EventView** window. All the alarms coming from the PLC are displayed. It is not possible to select individual alarms.

Messages transmitted by the calls of PLC alarm blocks are listed with their TimeStamp.

