PROFINET IO user's manual

Bus controller

Version: **1.45 (August 2019)**
Model no.: **MAPROFINET-ENG**

Translation of the original manual

1 General information

This bus controller makes it possible to connect X2X Link I/O nodes to PROFINET. PROFINET uses TCP/IP and is capable of using Ethernet in real time. PROFINET IO was developed for real-time (RT) and isochronous real-time (IRT) communication with the decentralized periphery. The designations RT and IRT merely describe the real-time properties for communication taking place within PROFINET IO.

1.1 Brief overview of properties

The following list includes some of the main properties of B&R PROFINET bus controllers.

- PROFINET RT - Conformance Class B
- Possible to fully configure X2X I/O modules via the fieldbus
- Firmware updates via integrated website
- Integrated switch for wiring multiple slaves
- Up to 1440 bytes of I/O data possible
- 100 Mbit/s full-duplex mode
- Bus controller and I/O module diagnostics at runtime via master environment or website

2 X20 technical description

2.1 Order data

Model number	Short description	Figure
	Bus controllers	
X20BC00E3	X20 bus controller, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately!	
X20cBC00E3	X20 bus controller, coated, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately!	
	Required accessories	
	System modules for bus controllers	
X20BB80	X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/ X20AC0SR1 included	
X20PS9400	X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply	
X20PS9402	X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated	
X20cBB80	X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included	
X20cPS9400	X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20BC00E3, X20cBC00E3 - Order data

2.2 Technical data

Model number	X20BC00E3	X20cBC00E3
Short description		
Bus controller	PROFINET IO slave	
General information		
B&R ID code	0xBB7D	0xE4E0
Status indicators	Module status, bus function	
Diagnostics		
Module status	Yes, using status LED and software	
Bus function	Yes, using status LED and software	
Power consumption		
Bus	2.5 W	
Additional power dissipation caused by actuators (resistive) [W]	-	
Certifications		
CE	Yes	
EAC	Yes	
UL	cULus E115267 Industrial control equipment	
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5	
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X	
Interfaces		
Fieldbus	PROFINET IO slave	
Variant	2x shielded RJ45 (switch)	
Line length	Max. 100 m between 2 stations (segment length)	
Transfer rate	100 Mbit/s	
Transfer		
Physical layer	100BASE-TX	
Half-duplex	Yes	
Full-duplex	Yes	
Autonegotiation	Yes	
Auto-MDI / MDIX	Yes	
Min. cycle time [1]		
Fieldbus	1 ms	
X2X Link	250 µs	
Synchronization between bus systems possible	Yes	
Electrical properties		
Electrical isolation	PROFINET isolated from bus and I/O	
Operating conditions		
Mounting orientation		
Horizontal	Yes	
Vertical	Yes	
Installation elevation above sea level		
0 to 2000 m	No limitations	
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m	
Degree of protection per EN 60529	IP20	
Ambient conditions		
Temperature		
Operation		
Horizontal mounting orientation	-25 to 60°C	
Vertical mounting orientation	-25 to 50°C	
Derating	-	
Storage	-40 to 85°C	
Transport	-40 to 85°C	
Relative humidity		
Operation	5 to 95%, non-condensing	Up to 100%, condensing
Storage	5 to 95%, non-condensing	
Transport	5 to 95%, non-condensing	
Mechanical properties		
Note	Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB80 bus base separately	Order 1x X20TB12 terminal block separately Order 1x X20cPS9400 pow- er supply module separately Order 1x X20cBB80 bus base separately
Spacing [2]	37.5 $^{+0.2}$ mm	

Table 2: X20BC00E3, X20cBC00E3 - Technical data

1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
2) Spacing is based on the width of the X20BB80 bus base. In addition, an X20PS9400 or X20PS9402 supply module is always required for the bus controller.

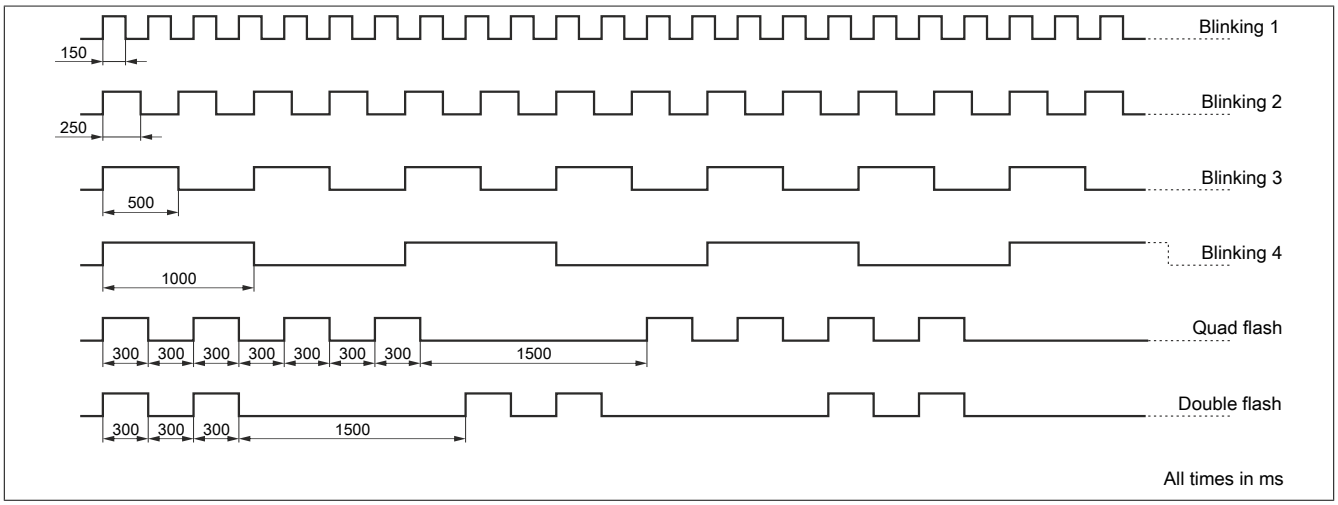
2.3 LED status indicators

The following table lists the LED status indicators available on the bus controller. Exact blink times are specified in the timing diagram in the next section.

Figure	LED	Color	Status	Description
	MS[1]	Green	Off	The PROFINET master is in "Stop" mode.
			Quad flash	The bus controller does not have a valid IP address (0.0.0.0). It will wait in this state until it is assigned an IP address from the PROFINET master or from an external source. This state can also occur if the bus controller is being operated in DHCP mode.
			Double flash	An unacknowledged alarm is pending on the bus controller.
			Blinking 1	The bus controller is in the initialization phase. This boot phase is where all connected I/O modules are initialized.
			Blinking 3	The bus controller is configuring the connected I/O modules. The configuration is transferred to the bus controller via the PROFINET master.
			On	A connection to a PROFINET master has been established. The master and slave are both in OPERATIONAL mode and data is being exchanged between them. This mode also indicates that the master itself is in RUN mode.
		Red	Blinking 4	The bus controller has detected an error. However, it can still be corrected in the master environment during runtime.
			Blinking 1	The bus controller has detected an error. This error cannot be corrected during runtime; a restart is required.
	BF[1]	Green	Blinking 2	Device identification ("blink" function in step 7 when searching for existing Ethernet stations).
			On	A connection to a PROFINET master has been established.
		Red	On	Not connected to a PROFINET Master
	L/A IFx	Green	Off	Indicates that no physical Ethernet connection exists
			Blinking	Ethernet activity taking place on the RJ45 interface (IF1, IF2) indicated by the respective LED
			On	Indicates an established connection (link), but no communication is taking place

1) The "MS" and "BF" LEDs are green/red dual LEDs.

LED status indicators - Blinking patterns

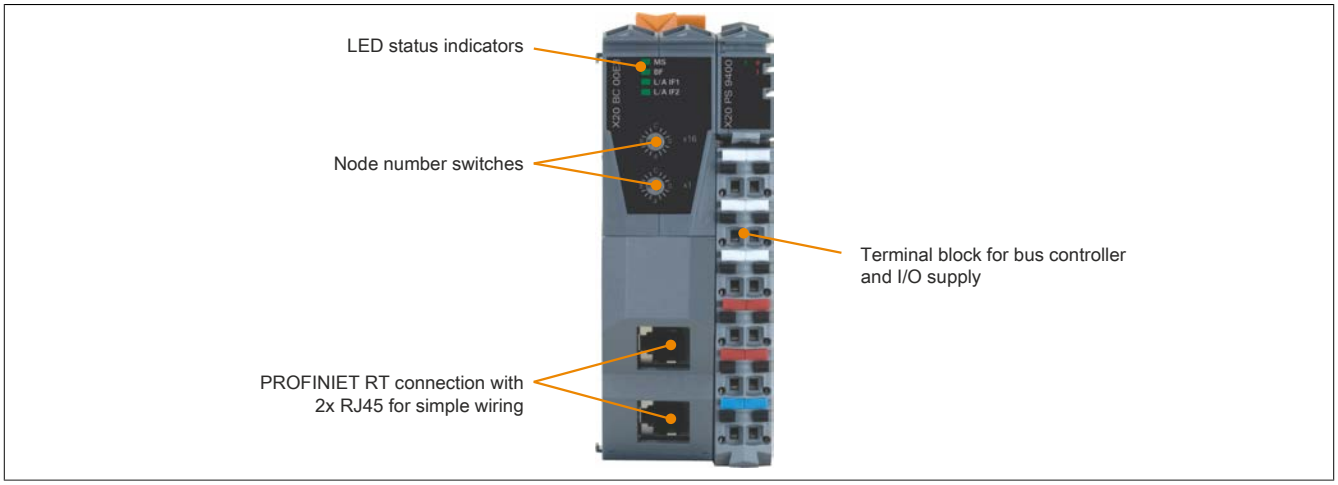


2.3.1 Error display

When the bus controller determines that a configured I/O module is not physically connected, or that an incorrect module is connected, this error is indicated via the MS LED. If the bus controller is set to "Warning", then it blinks green; otherwise, it blinks red once per second (Blinking 4).

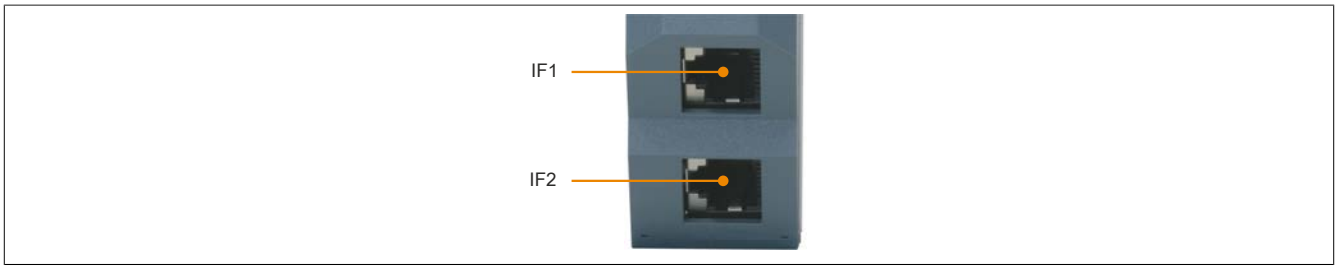
Information regarding the status of the bus controller can be read directly in the master environment. For a list of corresponding alarm codes with textual descriptions, see section "Diagnostics system and alarm status codes" on page 27.

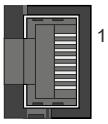
2.4 Operating and connection elements



2.5 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see section "Mechanical and electrical configuration - Wiring guidelines for X20 modules with Ethernet cables" of the X20 user's manual.



Interface	Pinout		
	Pin	Ethernet	
 1 RJ45 shielded	1	RXD	Receive data
	2	RXD\	Receive data\
	3	TXD	Transmit data
	4	Termination	
	5	Termination	
	6	TXD\	Transmit data\
	7	Termination	
	8	Termination	

2.6 Node number switches

The bus controller has 2 node number switches. The bus controller can be set to different operating modes using certain, pre-defined switch positions. They can also be used to configure various additional parameters (PROFINET device name, DHCP mode, etc.).

Switch position	Description
0x00	All parameters are loaded from flash memory: Default PROFINET initialization via the DCP protocol (factory state)
0x01 - 0xEF	These switch positions generate a valid PROFINET device name. This name is composed as follows: "brpnXXX". XXX refers to the decimal value of the node number switch position. The system automatically adds any necessary leading 0s. **Example** The node number switch must be set to 12. The name must consist of "brpn + node number" (three-digit node number). The resulting name is "brpn012".
0xF0	Clears flash (see "Erasing flash memory" on page 19)
0xF1 - 0xFD	Reserved, switch position not permitted
0xFE	IP address via DHCP server
0xFF	All parameters set to default: PME mode

Parameters	Value
IP address	0.0.0.0
Subnet mask	0.0.0.0
Gateway	0.0.0.0
PROFINET device name	"" → no factory default name

Parameters cannot be changed by the master in node switch position 0xFF.

Parameters	Value
IP address	192.168.100.1
Subnet mask	255.255.255.0
Gateway	192168100254
PROFINET device name	x20bc00e3

3 X67 technical description

3.1 Order data

Model number	Short description	Figure
	Bus controller modules	
X67BCE321.L12	X67 bus controller, 1 PROFINET interface, X2X Link power supply 15 W, 16 digital channels configurable as inputs or outputs, 24 VDC, 0.5 A, configurable input filter, 2 event counters 50 kHz, M12 connectors, high-density module	

Table 3: X67BCE321.L12 - Order data

Required accessories
See "Required cables and connectors" on page 16. For a general overview, see section "Accessories - General overview" of the X67 system user's manual.

3.2 Technical data

Model number	X67BCE321.L12
Short description	
Bus controller	PROFINET IO slave
General information	
Inputs/Outputs	16 digital channels, configurable as inputs or outputs using software, inputs with additional functions
Isolation voltage between channel and bus	500 V_{eff}
Nominal voltage	24 VDC
B&R ID code	
Bus controller	0xC5E8
Internal I/O module	0xD9CB
Sensor/Actuator power supply	0.5 A summation current
Status indicators	I/O function per channel, supply voltage, bus function
Diagnostics	
Outputs	Yes, using LED status indicator and software
I/O power supply	Yes, using LED status indicator and software
Connection type	
Fieldbus	M12, D-coded
X2X Link	M12, B-coded
Inputs/Outputs	8x M12, A-coded
I/O power supply	M8, 4-pin
Power output	15 W X2X Link power supply for I/O modules
Power consumption	
Fieldbus	4.2 W
Internal I/O	2.5 W
X2X Link power supply	24.3 W at maximum power output for connected I/O modules
Certifications	
CE	Yes
EAC	Yes
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
ATEX	Zone 2, II 3G Ex nA IIA T5 Gc IP67, Ta = 0 - Max. 60°C TÜV 05 ATEX 7201X
Interfaces	
Fieldbus	PROFINET IO slave
Variant	2x M12 interface (switch), 2x female connector on the module
Line length	Max. 100 m between 2 stations (segment length)
Transfer rate	100 Mbit/s
Transfer	
Physical layer	100BASE-TX
Half-duplex	Yes
Full-duplex	Yes
Autonegotiation	Yes
Auto-MDI / MDIX	Yes
Min. cycle time [1]	
Fieldbus	1 ms
X2X Link	250 µs
Synchronization between bus systems possible	Yes
I/O power supply	
Nominal voltage	24 VDC
Voltage range	18 to 30 VDC
Integrated protection	Reverse polarity protection
Power consumption	
Sensor/Actuator power supply	Max. 12 W [2]
Sensor/Actuator power supply	
Voltage	I/O power supply minus voltage drop for short-circuit protection
Voltage drop for short-circuit protection at 0.5 A	Max. 2 VDC
Summation current	Max. 0.5 A
Short-circuit proof	Yes
Digital inputs	
Input voltage	18 to 30 VDC
Input current at 24 VDC	Typ. 4 mA
Input characteristics per EN 61131-2	Type 1
Input filter	
Hardware	≤10 µs (channels 1 to 4) / ≤70 µs (channels 5 to 16)
Software	Default 0 ms, configurable between 0 and 25 ms in 0.2 ms intervals
Input circuit	Sink
Additional functions	50 kHz event counting, gate measurement

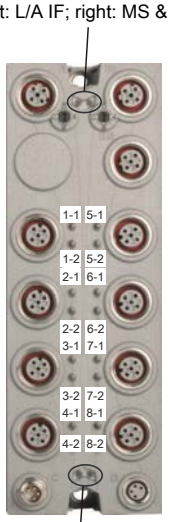
Table 4: X67BCE321.L12 - Technical data

Model number	X67BCE321.L12
Input resistance	Typ. 6 kΩ
Switching threshold	
Low	<5 VDC
High	>15 VDC
Event counter	
Quantity	2
Signal form	Square wave pulse
Evaluation	Each negative edge, cyclic counter
Input frequency	Max. 50 kHz
Counter 1	Input 1
Counter 2	Input 3
Counter frequency	Max. 50 kHz
Counter size	16-bit
Gate measurement	
Quantity	1
Signal form	Square wave pulse
Evaluation	Positive edge - Negative edge
Counter frequency	
Internal	48 MHz, 3 MHz, 187.5 kHz
Counter size	16-bit
Length of pause between pulses	≥100 µs
Pulse length	≥20 µs
Supported inputs	Input 2
Digital outputs	
Variant	FET positive switching
Switching voltage	I/O power supply minus residual voltage
Nominal output current	0.5 A
Total nominal current	8 A
Output circuit	Source
Output protection	Thermal shutdown in the event of overcurrent or short circuit, integrated protection for switching inductive loads, reverse polarity protection of the output power supply
Diagnostic status	Output monitoring with 10 ms delay
Leakage current when switched off	5 µA
Switching on after overload shutdown	Approx. 10 ms (depends on the module temperature)
Residual voltage	<0.3 V at 0.5 A nominal current
Peak short-circuit current	<12 A
Switching delay	
0 → 1	<400 µs
1 → 0	<400 µs
Switching frequency	
Resistive load	Max. 100 Hz
Inductive load	See section "Switching inductive loads".
Braking voltage when switching off inductive loads	50 VDC
Electrical properties	
Electrical isolation	Bus isolated from PROFINET and channel Channel not isolated from channel
Operating conditions	
Mounting orientation	
Any	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP67
Ambient conditions	
Temperature	
Operation	-25 to 60°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C
Mechanical properties	
Dimensions	
Width	53 mm
Height	155 mm
Depth	42 mm
Weight	350 g
Torque for connections	
M8	Max. 0.4 Nm
M12	Max. 0.6 Nm

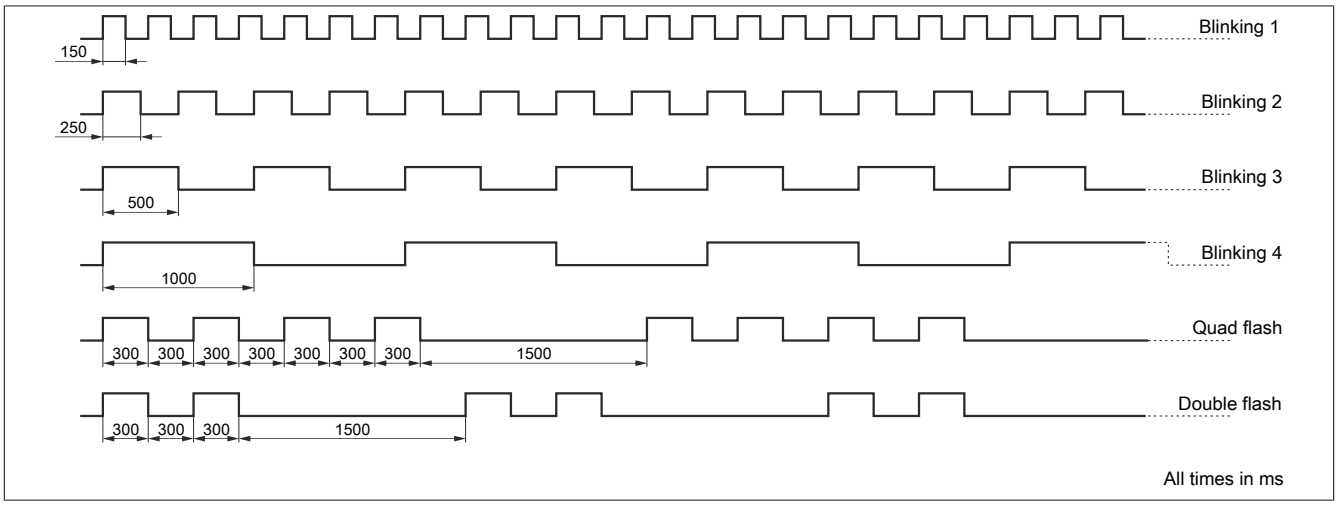
Table 4: X67BCE321.L12 - Technical data

1) The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.
2) The power consumption of the sensors and actuators connected to the module is not permitted to exceed 12 W.

3.3 LED status indicators

Figure	LED	Color	Status	Description
Status indicator 1: Left: L/A IF; right: MS & BF  Status indicator 2: Left: green, Right: red	**Status indicator 1**			
	MS and BF (combined)	Green	On	Connection has been established to a PROFINET master. The master and slave are both operational and data is being exchanged between them. This state also indicates that the master itself is in the RUN state.
			Blinking 1	The bus controller is in the initialization phase. This boot phase is where all connected I/O modules are initialized.
			Blinking 3	The bus controller is configuring the connected I/O modules. The configuration is transferred to the bus controller via the PROFINET master.
			Double flash	An unacknowledged alarm is pending on the bus controller.
		Red	On	Not connected to a PROFINET master
			Quad flash	The bus controller does not have a valid IP address (0.0.0.0). It will wait in this state until it is assigned an IP address from the PROFINET master or from an external source. This state can also occur if the bus controller is being operated in DHCP mode.
			Blinking 4	The bus controller has detected an error. However, it can still be corrected in the master environment during runtime.
			Blinking 1	The bus controller has detected an error. This error cannot be corrected during runtime; a restart is required.
			Off	The PROFINET master is in state "Stop" or the BC is not running (power supply, etc.)
	L/A IF1 & IF2 (combined)	Green	On	Indicates an established connection (link), but no communication is taking place
			Blinking	Ethernet activity taking place on the interface (IF1, IF2) indicated by the LED
		Red	Blinking 2	Device identification ("blink" function in step 7 when searching for existing Ethernet stations)
			Off	An active connection or link does not exist. No other device (PC, PROFINET master / slave) connected to any interface (IF1, IF2).
	I/O LEDs			
	1-1/2 to 8-1/2	Orange	-	Input/Output status of the corresponding channel
	Status indicator 2			
	Left	Green	Off	No power to module
			Single flash	No power to module
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	Right	Red	Off	No power to module or everything OK
			On	Error or reset status
			Single flash	Warning or error on an I/O channel. Level monitoring for digital outputs has been triggered.
			Double flash	Supply voltage not in the valid range

Status indicator 1 LED - Blink times



3.3.1 Error display

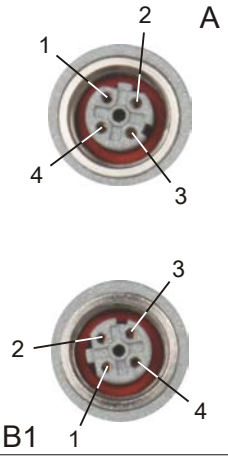
When the bus controller determines that a configured I/O module is not physically connected, or that an incorrect module is connected, this error is indicated via the MS LED. If the bus controller is set to "Warning", then it blinks green; otherwise, it blinks red once per second (Blinking 4).

Information regarding the status of the bus controller can be read directly in the master environment. For a list of corresponding alarm codes with textual descriptions, see section "Diagnostics system and alarm status codes" on page 27.

3.4 Operating and connection elements

3.5 PROFINET interfaces

The module is connected to a PROFINET network using pre-assembled cables. The connection is made using a circular connector (M12, 4-pin).

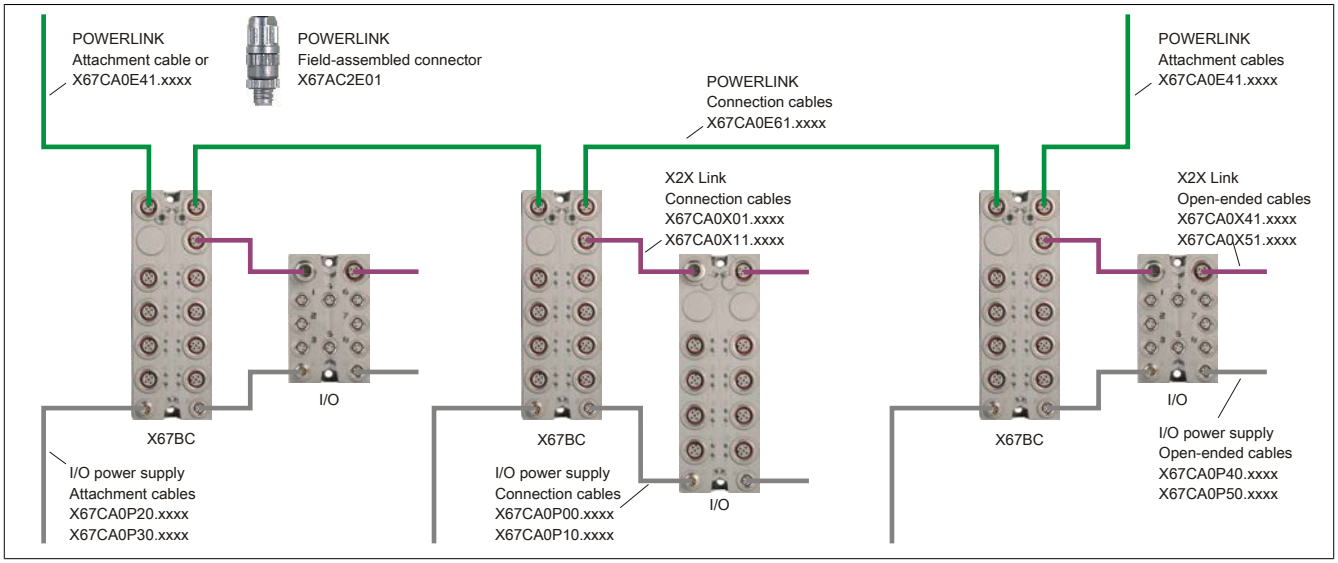
Connection	Pinout		
	Pin	PROFINET	
	1	TXD	Transmit data
	2	RXD	Receive data
	3	TXD\	Transmit data\
	4	RXD\	Receive data\
	A ... D-keyed female connector in module, PROFINET IN B1 ... D-keyed female connector in module, PROFINET OUT SHLD ... Shielding provided by threaded insert in the module		

Information:

The color of the wires used in field-assembled cables for connecting to the PROFINET interfaces may deviate from the standard.

Make sure to check proper pinout (see X67 system user's manual).

3.5.1 Required cables and connectors



3.6 Node number switches

The bus controller has 2 node number switches. The bus controller can be set to different operating modes using certain, pre-defined switch positions. They can also be used to configure various additional parameters (PROFINET device name, DHCP mode, etc.).

Switch position	Description
0x00	All parameters are loaded from flash memory: Default PROFINET initialization via the DCP protocol (factory state)
0x01 - 0xEF	These switch positions generate a valid PROFINET device name. This name is composed as follows: "brpnXXX". XXX refers to the decimal value of the node number switch position. The system automatically adds any necessary leading 0s. **Example** The node number switch must be set to 12. The name must consist of "brpn + node number" (three-digit node number). The resulting name is "brpn012".
0xF0	Clears flash (see "Erasing flash memory" on page 19)
0xF1 - 0xFD	Reserved, switch position not permitted
0xFE	IP address via DHCP server
0xFF	All parameters set to default: PME mode

Parameters	Value
IP address	0.0.0.0
Subnet mask	0.0.0.0
Gateway	0.0.0.0
PROFINET device name	"" → no factory default name

Parameters cannot be changed by the master in node switch position 0xFF.

Parameters	Value
IP address	192.168.100.1
Subnet mask	255.255.255.0
Gateway	192168100254
PROFINET device name	x67bce321.l12

3.7 Integrated mixed module

The full functionality of the X67DM1321.L12 mixed module is integrated in the X67BCE321.L12 bus controller module by default.

The following is a list of features provided by the mixed module.

- 16 digital mixed channels, can be configured as input or output
- Replacement of passive distributors
- Configurable digital input filters
- 2 additional channels with counter functions
- All outputs with single-channel diagnostics
- Extensive additional status information

Further information regarding configuration and technical data can be found in the X67DM1321.L12 module data sheet, available from the B&R website www.br-automation.com.

4 Basic information

4.1 General information

The B&R PROFINET bus controller enables the modular B&R I/O systems X20, X67 and XV to be integrated in PROFINET. Up to 253 I/O modules can be connected to a bus controller using the X2X system bus from B&R. This system bus is synchronized with the PROFINET fieldbus in order to achieve optimum performance.

Information regarding the configuration of B&R PROFINET bus controllers is provided to the master using GSDML files. These XML files contain all of the slave and master parameters needed to integrate them into a PROFINET master environment. These GSDML files can be downloaded from the B&R website www.br-automation.com in the respective bus controller's download section; they must then usually be imported into the applicable master environment.

When the bus controller is started, the I/O modules configured in the master environment are detected and their I/O data points are assigned.

4.2 Blink codes during startup

The boot loader indicates the following states on the "MS" module status LED:

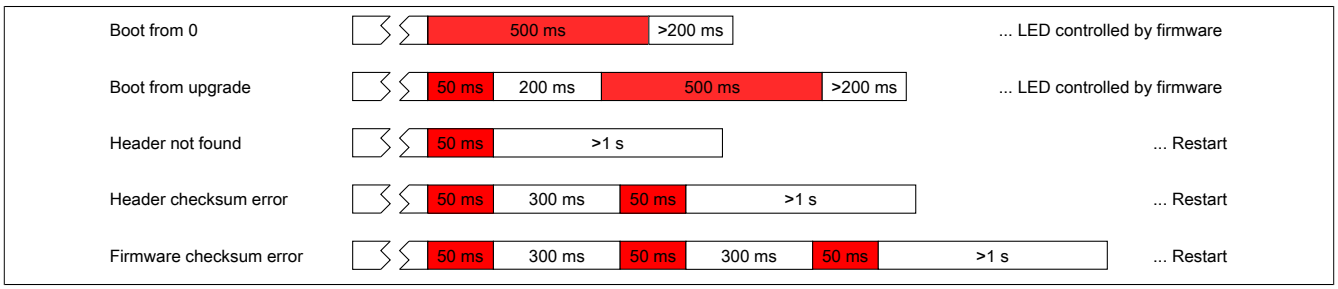


Figure 1: Blink codes during startup

If faulty firmware in the flash memory causes an error during booting, then the system will attempt to reboot using the factory default boot block.
In other words, if an error occurs in the firmware upgrade sector, then the module will automatically revert to the factory default sector (boot from 0).

4.3 Forcing a boot from the factory default sector

This is necessary if firmware has been stored in the upgrade sector, operates the watchdog correctly but doesn't allow the booting process to occur without errors. The boot loader simply starts the defective firmware and doesn't provide a way to carry out a subsequent update.

To force a boot from the factory default sector, one of the network address switches must be moved continuously during booting. This is detected by the boot loader, which causes the "MS" module status LED to begin flashing red quite very rapidly. After 1 second passes where the network address switch is no longer changed, the bus controller restarts using the factory default boot sector and the current network address switch.

4.4 Boot procedure

Switching on the power triggers the initialization phase. When the connection to the master is established, the bus controller receives information about the I/O module configuration and registers the modules configured on the X2X link. A mapping of the I/O data is also generated. If there is a problem during booting (e.g. module not inserted or wrong module inserted), then the bus controller will indicate the situation via the status LED's blink code (see "LED status indicators" on page 8).

A previously used configuration is stored in flash memory, but it is overwritten when the connection is established between the master and the slave. It is also possible for the user to delete the configuration stored in flash memory by setting the node number switches accordingly.

4.5 I/O configuration

With PROFINET bus controllers, each I/O module is uniformly configured by the master environment and its supplied GSDML file. Once the GSDML file has been imported into the master environment, it is possible to configure the module as needed. In addition, extra module-specific parameters are created for each module. The created configuration is transferred to the bus controller when it is loaded or when the connection is established between the PROFINET master and the slave.

4.6 XML description file

The supplied XML description file (GSDML file) contains all information about how the process data (I/O data) is structured as well as the configuration data for the bus controller and the I/O modules.

Most master environments, e.g. SIMATIC Step 7, allow this description file to be imported. The advantage of this method is that all I/O data points are already known (name, type) in the development environment without actually having to have a physical device present. In addition, the XML description file also specifies that configuration data should be sent to the bus controller during booting. In other words, the master always has access to the configuration automatically. Master systems configured in this way thus do not require a service technician to manually load the configuration to the bus controller during commissioning or when existing bus controllers are being replaced.

4.7 Erasing flash memory

Erasing flash memory using switch position 0xF0 returns the bus controller to its factory state.

Steps to be performed

1. Turn off the power supply to the bus controller.
2. Set the node number to 0xF0.
3. Turn on the power supply to the bus controller.
4. Wait until the "MS" LED flashes green for 5 s. The node number switch must be set to 0x00 and then back to 0xF0 within this time window of 5 seconds (rotate the top or left switch respectively).
5. Wait until the "MS" LED blinks with a red double-flash (flash has been cleared).
6. Turn off the power supply to the bus controller.
7. Set the desired node number (0x00 - 0xEF)
8. Turn on the power supply to the bus controller.
9. The bus controller boots with the configured node number.

5 Bus controller preconfiguration

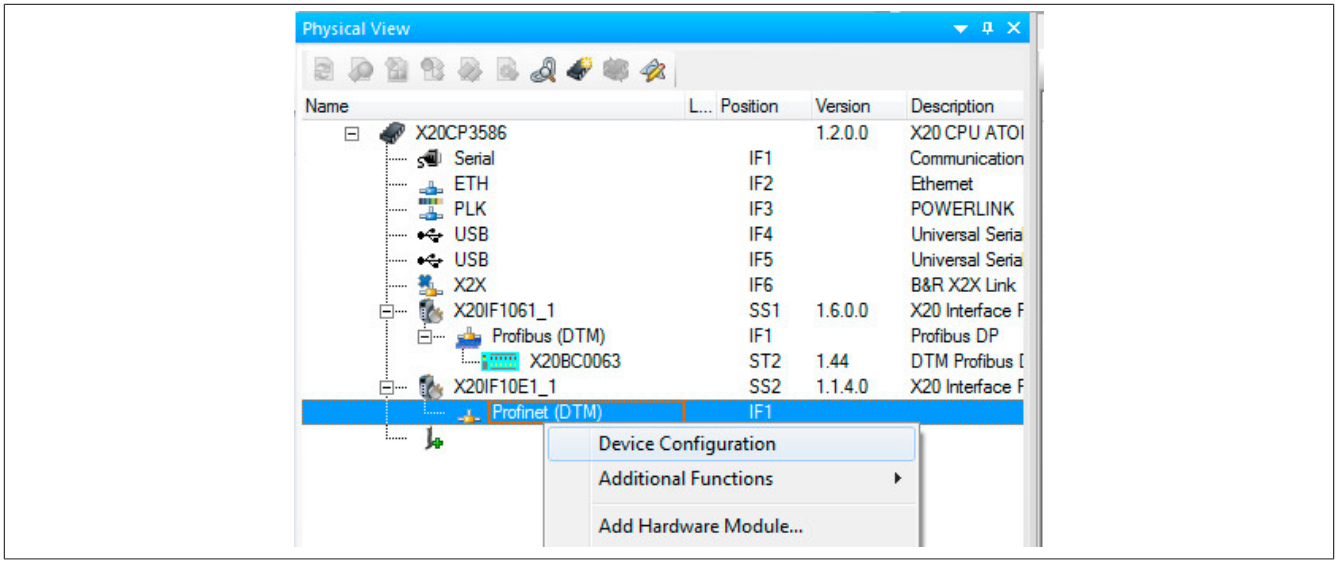
5.1 Changing PROFINET device names with Automation Studio

There are several ways of changing the name of a PROFINET device:

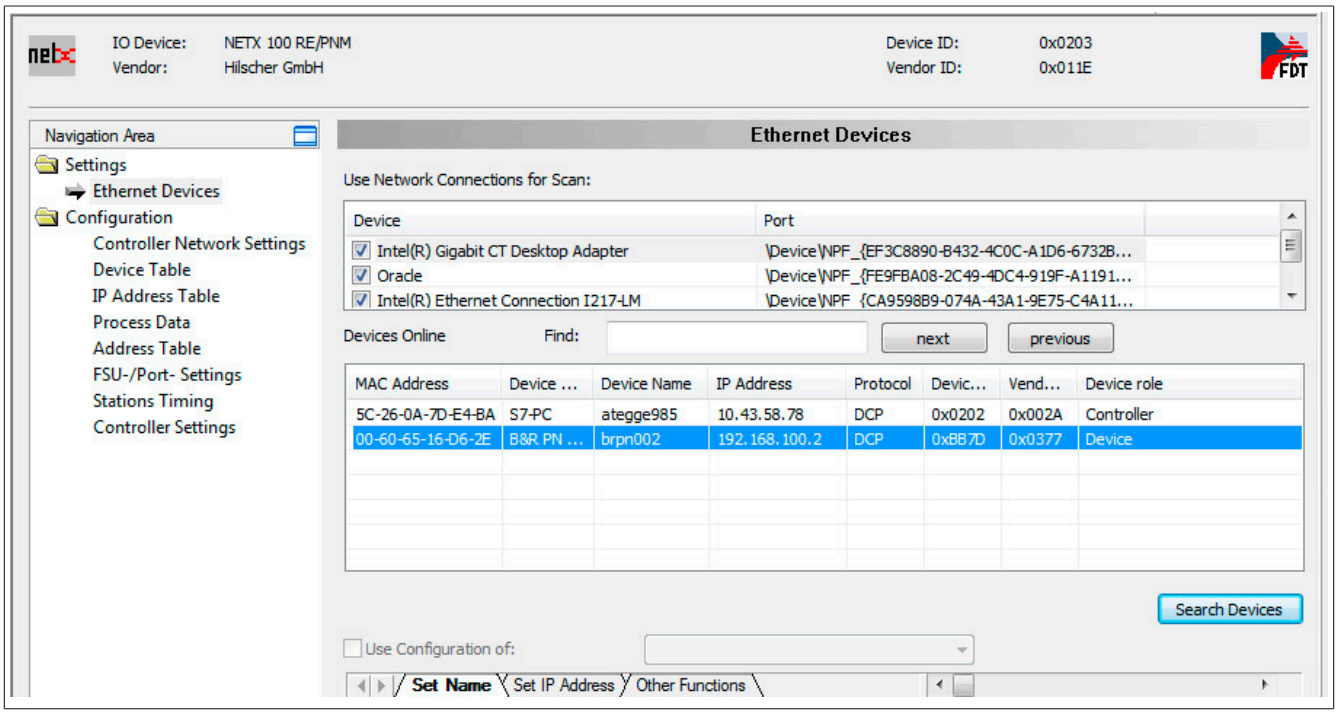
- Modifying with the node number switch
  In this case, the name of the device is automatically generated. (see section "X20 node number switches" on page 10 or "X67 node number switches" on page 16)
- Modifying with an external tool (e.g. Automation Studio)
  In this case, the PROFINET device can be assigned any name.

Assigning a PROFINET name using Automation Studio

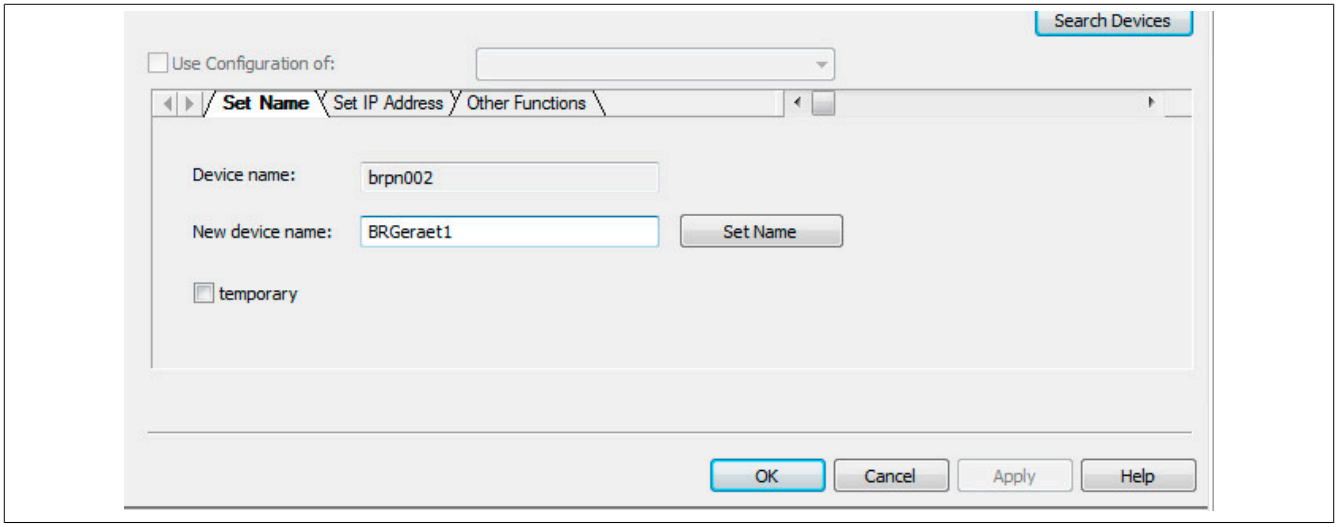
● To change the name of the PROFINET device, the **Device Configuration** item is selected in Automation Studio in the shortcut menu on the **PROFINET (DTM) interface** of the respective device.



● All devices connected to this interface can be searched for in the configuration dialog box via *Settings → Ethernet Devices* using **Search Devices**.



● After selecting the desired PROFINET device from the list, a random name can be entered in the **Set Name** tab. The new name is applied with the **Set Name** interface and the change is confirmed by clicking **OK**.



5.2 Configuration using Step 7 configuration tool

A successful PROFINET connection between a master and a slave can only be established if the bus controller has the same device name that is specified in the hardware configuration. If these device names do not match, valid PROFINET communication will never take place. With their Step 7 development environment, Siemens provides a tool to pre-configure PROFINET devices. It uses their unique MAC address to identify PROFINET devices. It is then possible to configure additional parameters such as the IP address or the PROFINET device name. In addition, this tool can be used to reset PROFINET devices to their factory state. Configured parameters are saved permanently to the device. B&R PROFINET bus controllers are delivered with the following settings.

The Step 7 configuration tool ignores capital letters when assigning device names. For example, if the name "X67BCE321.L12" is assigned, the bus controller is actually referred to as "x67bce321.l12" after configuration.

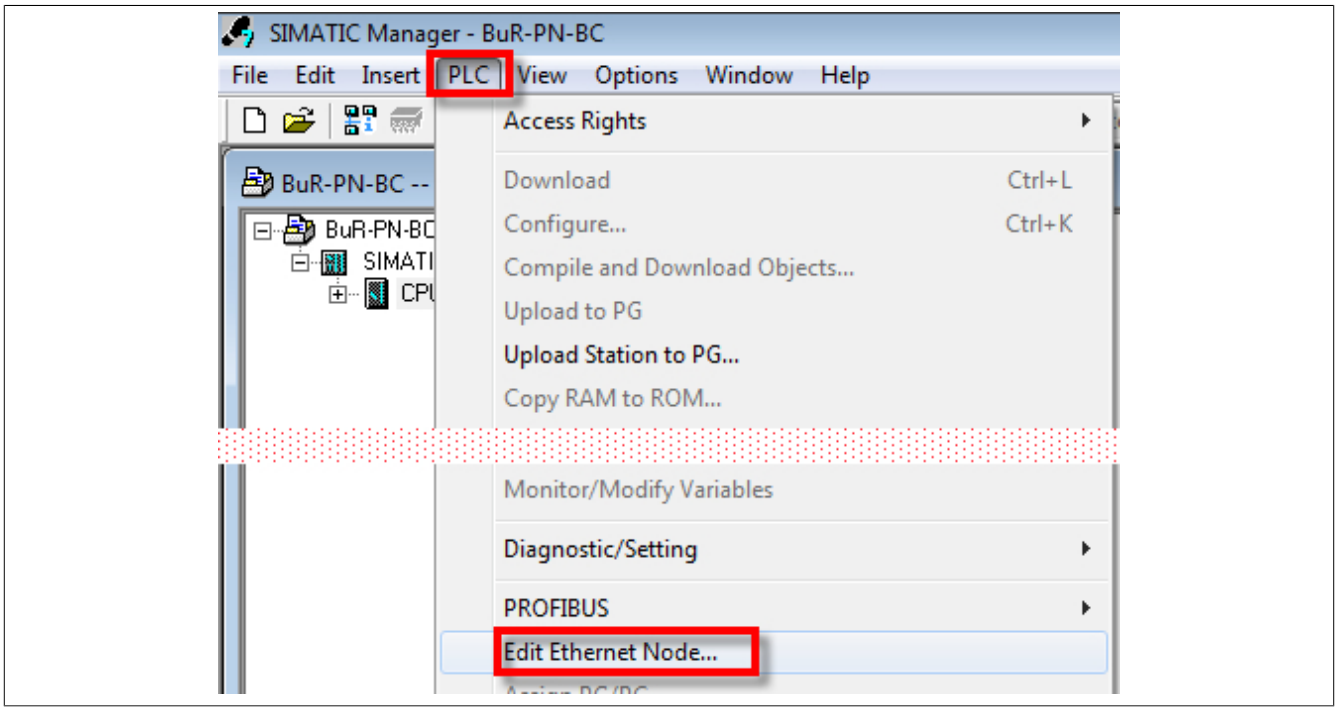
Bus controller factory settings:

PROFINET device name =	""
IP address =	0.0.0.0
Subnet mask =	0.0.0.0
Default gateway =	0.0.0.0

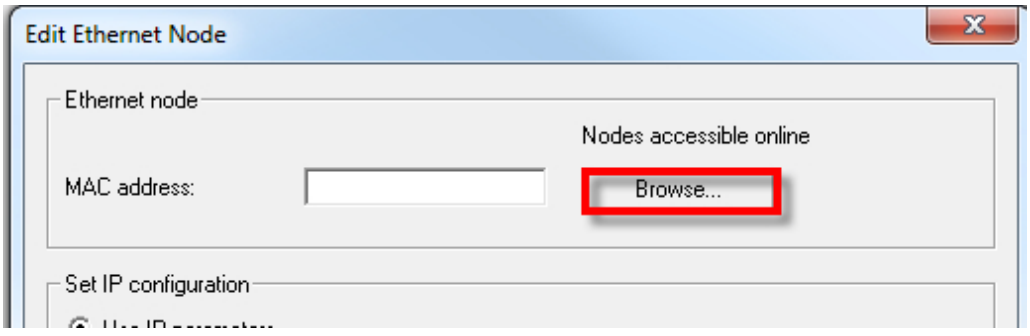
Example

Configuring the X67BCE321.L12 bus controller.

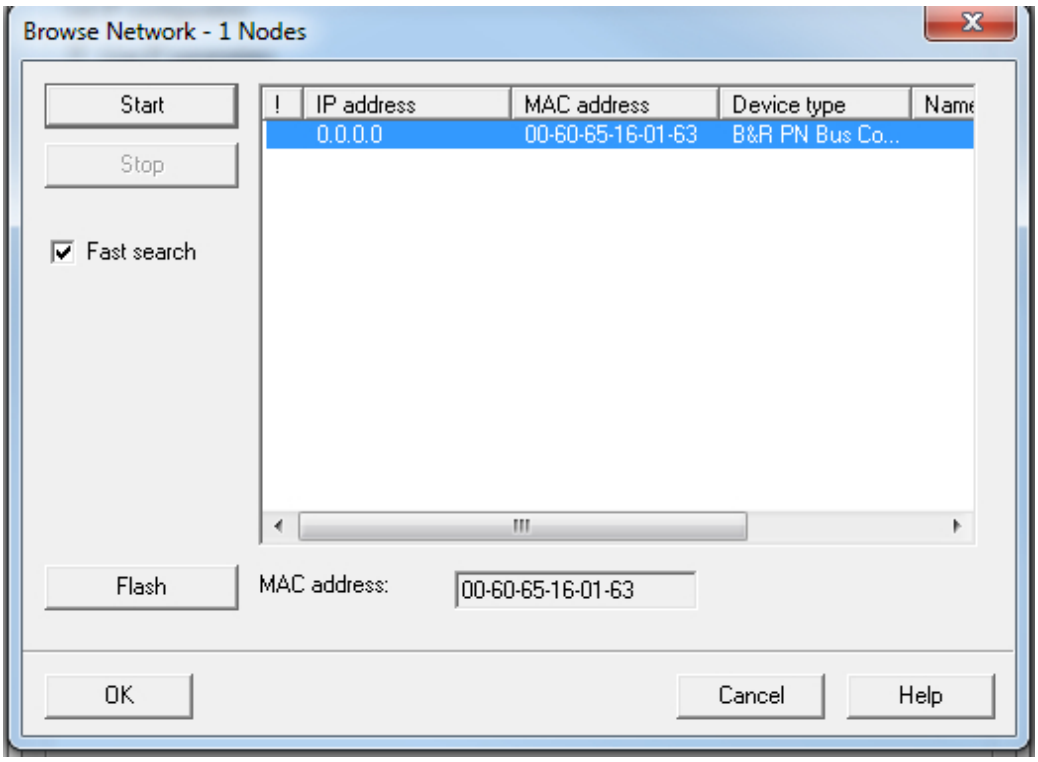
- In the SIMATIC Manager, select *PLC → Edit Ethernet Node* to open the configuration dialog box.



- In the *Edit Ethernet Node* dialog box, all PROFINET devices in the network are shown by clicking **Browse** .



● In the *Browse Network* dialog box, select the desired PROFINET device and confirm by clicking **OK**.

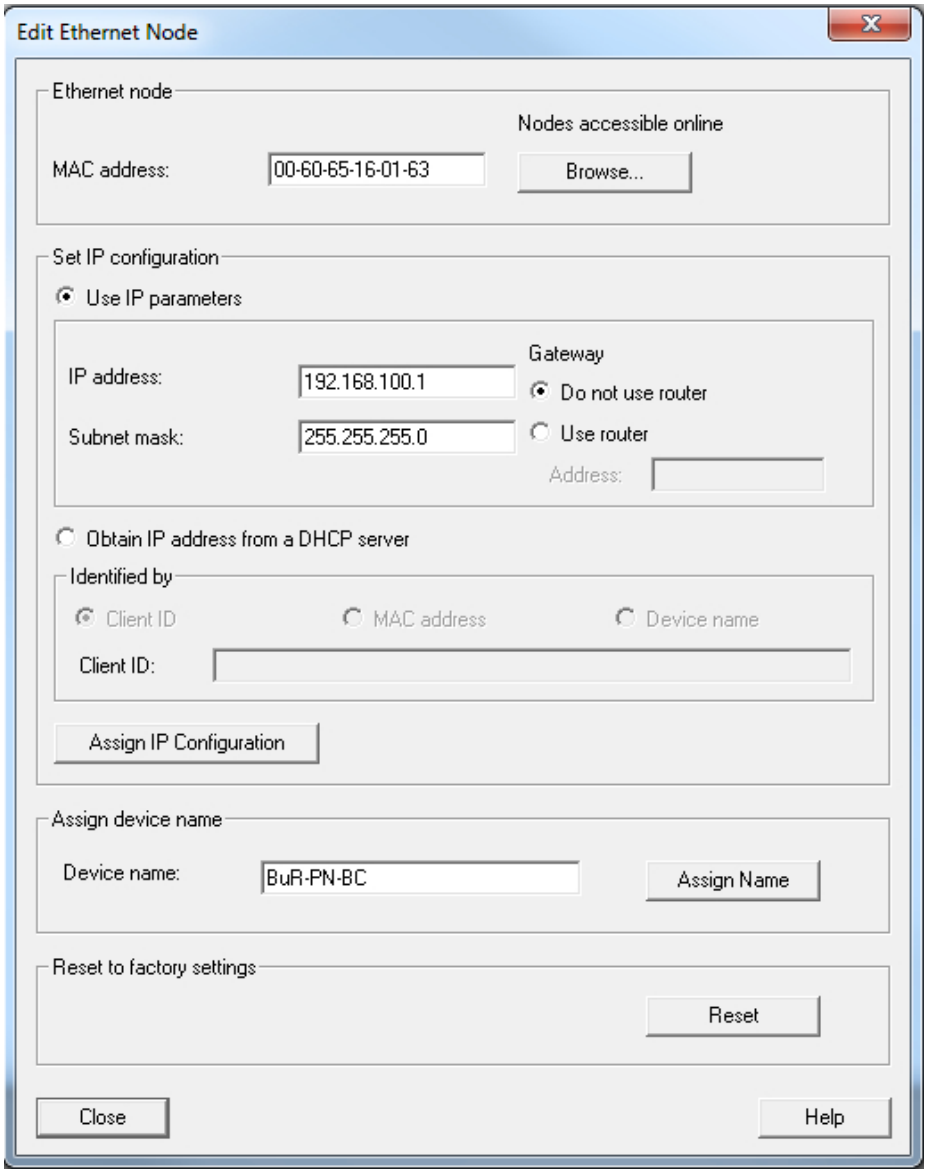


● The IP address and device name can now by entered in the *Edit Ethernet Node* dialog box.

The IP address and subnet mask can be manually entered in the **Use IP parameters** section and specified using **Assign IP Configuration**. This IP address is used for things such as calling up the device's web server.

The desired device name can be entered in the **Device name** edit field. This name is used to address the device in PROFINET. Click on **Assign Name** to set the name.

Reset resets all settings to the factory defaults.



6 GSDML description

6.1 The GSDML description file

The GSDML description file, available for download from the B&R website, is used to configure the bus controller and supported I/O modules. GSDML files are based on XML as well as a standard developed by the PNO user organization. Using this file, the bus controller is defined as an interface and can thus be configured in a master environment as a PROFINET device. The data points to be registered as well as the configuration registers are noted by the defined I/O modules. When a configuration is created and downloaded, the master is able to identify and register the bus controller. In addition, the bus controller uses the data present in the GSDML file to identify the configured I/O modules and register them on the X2X Link. If needed, each module can then be configured separately (and differently) in the master environment. When the configuration data is modified, the new configuration is downloaded again and transferred to the bus controller and then on to the respective I/O module.

6.2 Bus controller configuration

When configuring B&R PROFINET bus controllers, it is possible to set certain parameters such as the X2X cycle time. These parameters are then applied when the configuration is downloaded. Configurable parameters are noted in the GSDML file and interpreted accordingly by the bus controller.

6.2.1 Configuring the X2X cycle time

X2X cycle time is the result of 2 decisive factors. First, the PROFINET cycle time is taken into account when calculating the X2X cycle time. Second, the user can use an X2X reduction factor to further configure the desired X2X cycle time. The basic rule of thumb is that the X2X cycle time can never exceed the PROFINET cycle time. The following table provides an overview of possible configurations.

PROFINET cycle time [ms]	X2X reduction factor							
	1	2	4	8	16	32	64	128
1	**1000**	**500**	**250**	250	250	250	250	250
2	**2000**	**1000**	**500**	**250**	250	250	250	250
4	**4000**	**2000**	**1000**	**500**	**250**	250	250	250
8	4000	**4000**	**2000**	**1000**	**500**	**250**	250	250
16	4000	4000	**4000**	**2000**	**1000**	**500**	**250**	250
32	4000	4000	4000	**4000**	**2000**	**1000**	**500**	**250**
64	4000	4000	4000	4000	**4000**	**2000**	**1000**	**500**
128	4000	4000	4000	4000	4000	**4000**	**2000**	**1000**
256	4000	4000	4000	4000	4000	4000	**4000**	**2000**
512	4000	4000	4000	4000	4000	4000	4000	**4000**

6.2.2 X2X module initialization delay

This parameter allows the user to tell the bus controller how long the boot phase should last if a module is missing. If the bus controller determines that a configured module is not physically present during booting, it will wait this predefined time before ultimately switching to the RUN state and returning the corresponding error message. If all configured modules are physically present and correctly inserted during booting, the bus controller will still switch to the "operational" state immediately without waiting for the initialization delay to elapse. This parameter can be set to between 3 to 60 seconds and can be configured by the user in milliseconds. This parameter is configured in the master environment.

6.2.3 I/O Endian format

In certain circumstances, different PROFINET master systems also operate with a different I/O Endian format. Therefore the bus controller contains a configuration parameter for changing between Big and Little Endian format. This ensures that the stored I/O data will be displayed properly regardless of the master environment.

6.2.4 Event IOM_MISSING

An alarm is triggered by default when the event IOM_MISSING occurs (at startup, the bus controller detects that a configured I/O module is missing). However, this alarm can also be suppressed for application scenarios where it is not desired. The user can set whether this I/O module event should be interpreted as an alarm or just as a warning. The basic difference is that a warning only emits a green warning code instead of a red blink code.

6.2.5 Event IOM_FAILED

An alarm is triggered by default when the event IOM_FAILED occurs (during operation, the bus controller detects that a module which was present during startup is no longer providing a valid status). A red alarm blink code is used to notify the user. This alarm may not be desired in all situations. Therefore, the user can configure whether the IOM_FAILED event should be interpreted as an error or just as a warning. The basic difference is that an error triggers a red blink code. If the event is interpreted as a just warning, then only a green warning code is output.

6.3 Special module entries

6.3.1 ModuleOK

The ModuleOK data point specifies the status of the X2X module.

The return value **0xF5** indicates that there is no error and is composed as follows:

Bit	Description
0	I/O bus supply, 1 = OK
1	Reserved
2	I/O bus, 1 = OK
3	DataValid, 0 = OK, 1 = Old data
4 - 7	Always 1

This results in the following values:

Description	Value (decimal)	Value (hex)
X2X Link station inactive (e.g. no X2X Link power supply)	0	0x00
Everything OK (I/O data valid)	245	0xF5
No communication with the electronics module (bits 7 to 3 invalid)	249	0xF9
I/O data invalid, communication between X2X ASIC and electronics module OK (ASIC carried out a valid "Sync in" transfer with the electronics module in the previous X2X Link cycle)	253	0xFD

Information:

Any value unequal to 245 (0xF5) means that the I/O data of the corresponding module is invalid. This circumstance is usually taken into account or processed accordingly in the application.

6.3.2 "Special modules" module group

These modules had the status bytes removed in the GSDML (e.g. output status and ModuleOK). This is why only output and input data is used. The master receives the module status of these modules via Channel Diagnosis. (See "Structure of the diagnostics system" on page 27.)

Information:

This module group is only available in the GSDML description file starting in version 1.19.

These modules can only be used starting in firmware version 1.10.

A firmware update can be requested from International Support.

7 Diagnostics system and alarm status codes

A PROFINET network is diagnosed using a detailed alarm system. Predefined alarms are generated in the slave and transmitted to the master via the real-time channel. At runtime, these alarm texts are evaluated in the master development environment and handled accordingly. A textual description of each alarm number is also included in the GSDML description file. Since the GSDML file is integrated in the master environment, each defined alarm number can be assigned a defined textual description using the GSDML file. Alarms are basically divided into 3 categories:

- Bus controller-specific alarms. These only affect the bus controller itself.
- I/O module alarms that are triggered, for example, by a missing I/O module
- Channel Diagnosis alarms for the individual I/O modules, in which the status registers of the individual X2X modules are evaluated

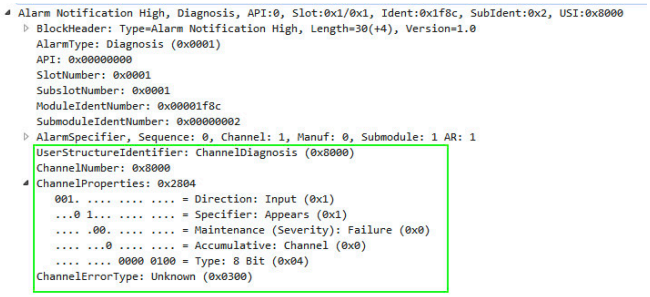
In addition to the PROFINET alarms that are issued, the bus controller also indicates an error with corresponding LED states.

7.1 Structure of the diagnostics system

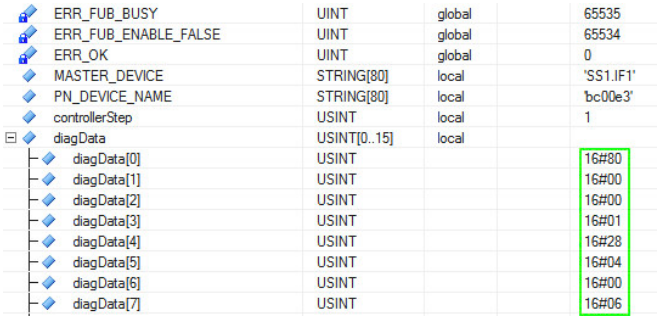
Diagnostic information can be easily displayed by network analysis programs such as Wireshark. When using a B&R PROFINET controller, the diagnostic information can be displayed in the Automation Studio Watch window using library "AsNxPnM".

Example of a display

Display in Wireshark



Display in Automation Studio



All diagnostic information and alarms are transmitted as 4 word or 8 USINT values. The values are defined as follows:

	Word 1		Word 2		Word 3		Word 4	
Wireshark / Automation Studio	USINT 1	USINT 2	USINT 3	USINT 4	USINT 5	USINT 6	USINT 7	USINT 8
	Identification number		Channel number		Channel properties		Error type	

Identification number (UserStructureIdentifier)

Always 0x8000: Only UserStructureIdentifier 0x8000 (Channel Diagnosis) is implemented in the B&R bus controller.

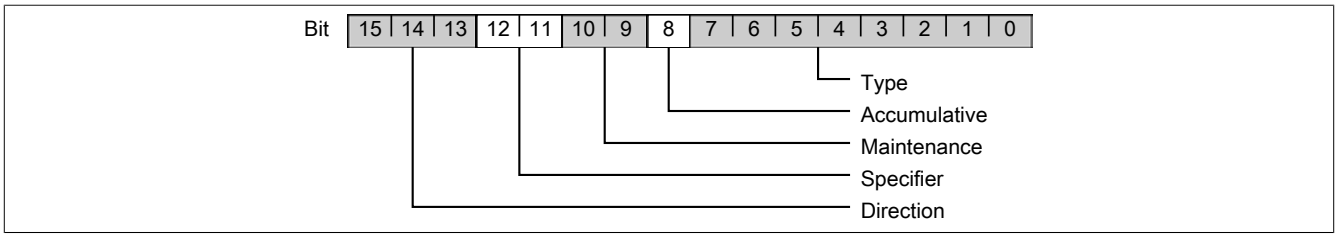
Channel number (ChannelNumber)

The channel number indicates whether the error is an error at the channel level, i.e. a physically existing channel of module 0x0000 to 0x7x7FFF, or at a higher level (submodule, module 0x8000).

Value	Explanation
0x0000 - 0x7FFF	Manufacturer-specific
0x8000	Submodules; Only one encoding for channel properties.
0x8001 - 0xFFFF	Reserved

Channel properties (ChannelProperties)

Channel properties contain detailed information about the channel(s) affected by the alarm or error message.



Bit	Value	Text	Explanation
ChannelProperties.Type			
0 to 7	0x00	-	Other data format or channel number is 0x8000
	0x01	1-bit	1-bit data length of the channel
	0x02	2-bit	2-bit data length of the channel
	0x03	4-bit	4-bit data length of the channel
	0x04	8-bit	8-bit data length of the channel
	0x05	16-bit	16-bit data length of the channel
	0x06	32-bit	32-bit data length of the channel
	0x07	64-bit	64-bit data length of the channel
	0x08 to 0xFF	-	Reserved
ChannelProperties.Accumulative			
8	0x00	Single	Diagnostics for displayed channel only
	0x01	Accumulative	Diagnostics for multiple channels
ChannelProperties.Maintenance			
9 to 10	0x00		Fault
	0x01		Maintenance required
	0x02		Maintenance absolutely necessary
	0x03		For detailed information, see field "QualifiedChannelQualifier".
ChannelProperties.Specifier			
11 to 12	0x00	All subsequent disappears	No more alarm events for the channel
	0x01	Appears	Alarm event for channel occurred
	0x02	Disappears	Alarm event for channel disappeared
	0x03	Disappears but others remain	Alarm event for channel disappeared, but additional events for channel are available
ChannelProperties.Direction			
13 to 15	0x00	Manufacturer-specific	Manufacturer-specific
	0x01	Input	Input channel
	0x02	Output	Output channel
	0x03	Input/Output	Input/Output channel
	0x04 to 0xFF		Reserved

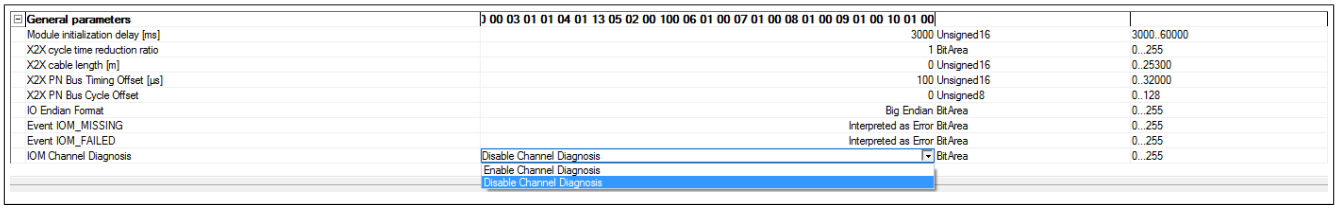
Error value (ChannelErrorType)

The error type contains the actual alarm or error message. Depending on the error number, they can be divided into different categories:

- 0x0000 to 0x001F: See table "General alarms" on page 29.
- 0x0020 to 0x00FF: See table "Safety-related alarms" on page 30.
- 0x0200 to 0x041F: See tables "Manufacturer-defined alarms" on page 30.
- 0x8000 to 0xFFFF: See table "Network-related alarms" on page 32.

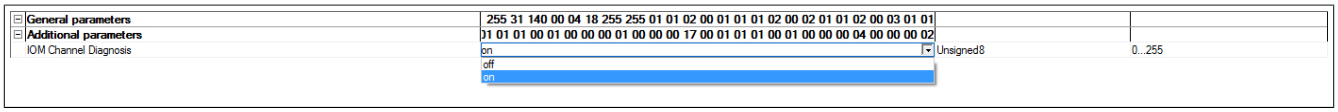
7.1.1 Disabling/Enabling Channel Diagnosis

Channel Diagnosis is disabled on the bus controller by default. It can be enabled by setting parameter "IOM Channel Diagnosis" to "Enable Channel Diagnosis" on the bus controller.



Channel Diagnosis can also be individually enabled or disabled for each separate module. This is done using menu option "IOM Channel Diagnosis" in the configuration menu of the respective module.

On	Channel Diagnosis for the module enabled
Off	Channel Diagnosis for the module disabled



7.2 Alarm table

The following tables contain information about bytes 7 and 8 (error type) of the diagnostic information. For more information, see "Structure of the diagnostics system" on page 27.

7.2.1 General alarms

The alarms of the "ChannelErrorType-1" include general error messages.

Alarm/ Error number	Error message	Alarm description
0x0000	Reserved	Unknown error
0x0001	Short circuit	Short circuit
0x0002	Undervoltage	Undervoltage
0x0003	Overvoltage	Overvoltage
0x0004	Overload	Overloading
0x0005	Overtemperature	Overtemperature
0x0006	Line break	Open circuit
0x0007	Upper limit value exceeded	Upper limit value overshot
0x0008	Lower limit value exceeded	Lower limit value undershot
0x0009	Error	Error
0x000A	Simulation active	Simulation active
0x000B - 0x000E	Reserved	Unknown error
0x000F	Default for "Parameter missing"[1)]	The channel requires an additional parameter. No or too few parameters written
0x0010	Default for "Parameterization fault"[1)]	Parameter error. Incorrect or too many parameters written
0x0011	Default for "Power supply fault"[1)]	Power supply fault
0x0012	Default for "Fuse blown/open"[1)]	Fuse defective
0x0013	Default for "Communication fault"[1)]	Communication fault. Incorrect sequence or sequence number
0x0014	Default for "Ground fault"[1)]	Ground fault
0x0015	Default for "Reference point lost"[1)]	Reference point lost
0x0016	Default for "Process event lost / Sampling error"[1)]	Process event lost / Sampling error
0x0017	Default for "Threshold warning"[1)]	Threshold warning
0x0018	[1)]Default for "Output disabled"	Output disabled
0x0019	Default for "FunctionalSafety event"[1)]	Functional safety event
0x001A	Default for "External fault"[1)]	External fault
0x001B - 0x001E	Manufacturer-specific	Manufacturer-specific
0x001F	Default for "Temporary fault"	Temporary fault

1) For older devices "Manufacturer-specific"

7.2.2 Safety-related alarms

The alarms of "ChannelErrorType-2" comprise alarms that are triggered in connection with safety functions.

Alarm/ Error number	Error message	Alarm description
0x0020 - 0x003F	Reserved for common profiles	Reserved
0x0040	Functional safety 0	Safety target addresses do not match
0x0041	Functional safety 1	Safety target address invalid
0x0042	Functional safety 2	Safety source address invalid or does not match
0x0043	Functional safety 3	Safety watchdog time is set to 0 ms
0x0044	Functional safety 4	Parameter "F_SIL" exceeds SIL of the device application
0x0045	Functional safety 5	Parameter "F_CRC_Length" does not match the generated value
0x0046	Functional safety 6	Version of the F-Parameter invalid
0x0047	Functional safety 7	Data in received FParameter block is inconsistent (CRC1 error)
0x0048	Functional safety 8	Device-specific or undefined diagnostic information, see data sheet
0x0049	Functional safety 9	Store iParameter: Watchdog time exceeded
0x004A	Functional safety 10	Restore iParameter: Watchdog time exceeded
0x004B	Functional safety 11	Inconsistent iParameters (iParCRC error)
0x004C	Functional safety 12	F_Block_ID not supported
0x004D	Functional safety 13	Transfer error: Inconsistent data (CRC2 error)
0x004E	Functional safety 14	Transfer error: Timeout
0x004F	Functional safety 15	Acknowledge needed to enable the channel(s)
0x0050 - 0x005F	Functional safety 16 to functional safety 31	Reserved
0x0060 - 0x00FF	Reserved for common profiles	Reserved

7.2.3 Manufacturer-defined alarms

The manufacturer-defined alarms of "ChannelErrorType-3" can be divided into 3 groups:

- Bus controller alarms
- I/O module alarms
- Channel Diagnosis alarms

The alarms and alarm texts listed in the following tables are defined in the GSDML file. Each GDSML file also contains a complete list of the errors for each X2X module.

These are the alarm texts that will be displayed in the PROFINET master environment.

Bus controller alarms

A bus controller alarm is triggered if the bus controller detects an internal error. These alarms have nothing to do with the current I/O module configuration; instead, there are problems with the IP address, the firmware or resources are insufficient, for example.

Alarm/ Error number	Alarm text "PN_BC_STATUS"[1)]	Error message	Alarm description
0x200	**xx**_FLASH_FAILED	Flash resource error	A general flash resource error has occurred.
0x201	**xx**_INVAL_BC_CFG_DATA	Faulty BC configuration data	Faulty bus controller configuration data exists. If faulty I/O module configuration data is detected, a warning alarm is issued (PN_BC_STATUS_IOM_BASED).
0x202	**xx**_IOM_NUM_EXCEEDED	Maximum number of modules exceeded	The number of permissible I/O modules has been exceeded for the current X2X configuration.
0x203	**xx**_IORT_DAT_EXCEEDED	I/O sync data length exceeded	The maximum I/O sync data length has been exceeded for the current X2X configuration.
0x204	**xx**_NO_IP_ADDRESS	Invalid IP address	This alarm can only be triggered if DHCP mode is enabled and an error occurs when assigning the IP address.
0x205	**xx**_DUPLICATE_IP_ADD	IP address exists multiple time	The bus controller has detected several identical IP addresses on the network.
0x206	**xx**_OUT_OF_RESOURCES	Hardware resource problem	The bus controller has insufficient resources to carry out its expected operations (hardware, RAM, etc.).
0x207	**xx**_INVALID_FIRMWARE	Invalid firmware	The bus controller detected faulty firmware during booting or a firmware download.
0x208	**xx**_FATAL_ERROR	General error	Unspecified fatal error

1) **xx** in the alarms indicates "PN_BC_STATUS", e.g. **xx**_FLASH_FAILED → PN_BC_STATUS_FLASH_FAILED

I/O module alarms

The bus controller constantly monitors the configured I/O modules during the startup phase as well as in state "Operational". If a module is removed during runtime, for example, the bus controller reports this to the master immediately by triggering the appropriate alarm. The bus controller responds to missing or incorrect modules, for example, but it will also issue an appropriate alarm when it evaluates faulty configuration data or incorrect module states.

Alarm/ Error number	Alarm text "PN_IOM_STATUS"[1)]	Error message	Alarm description
0x300	**xx**_MISSING	Missing I/O module	Missing I/O module detected during the boot phase. This alarm is interpreted as a warning only, not as an error.
0x301	**xx**_MISMATCH	Incorrect I/O module	An incorrect I/O module (module different than the one configured) was detected in the boot phase.
0x302	**xx**_UNSUPPORTED	Unsupported I/O module	Unsupported I/O module detected during the boot phase.
0x303	**xx**_FAILED	Faulty I/O module	Faulty or missing I/O module detected during operation.
0x304	**xx**_INVALID_CFG_DATA	Faulty I/O module configuration	The configuration data for an existing configured module is faulty.
0x305	**xx**_REGACC_ERROR	Register access not possible	Obsolete firmware is being used.

1) **xx** on the alarms indicates "PN_IOM_STATUS", e.g. **xx**_MISSING → PN_IOM_STATUS_MISSING

Channel Diagnosis alarms

The status registers of the I/O modules are evaluated during Channel Diagnosis. In the event of Channel Diagnosis errors, the bus controller sends an alarm and makes an entry in the diagnostics buffer. This entry contains the error and slot number.

The diagnostics are acyclically queried by the PROFINET master. For possible causes and error corrections, see the data sheet of the respective I/O module.

Information:

This function is available starting with bus controller firmware version 1.6. A firmware update can be requested from International Support.

Alarm/ Error number	Alarm texts "PN_IOM_CHANNEL_STATUS"[1)]	Error message	Alarm description[2)]
0x0400	**xx**_UNDERFLOW	Underflow	Underflow
0x0401	**xx**_OVERFLOW	Overflow	Overflow
0x0402	**xx**_CONVERSIONERROR	Conversion error	Converter error
0x0403	**xx**_SUMERROR	Sum error	Composite error
0x0404	**xx**_SENSORERROR	Sensor error	Sensor error
0x0405	**xx**_VOLTAGEERROR	Voltage error	Voltage error
0x0406	**xx**_CURRENTERROR	Current error	Current error
0x0407	**xx**_STALLERROR	Stall error	Stall error
0x0408	**xx**_PHASESHIFTCURRENTERROR	Phase shift current error	Phase shift current error
0x0409	**xx**_PHASESHIFTVOLTAGEERROR	Phase shift voltage error	Phase shift voltage error
0x040A	**xx**_CHECKSUMERROR	Checksum error	Checksum error
0x040B	**xx**_ENCODERSUPPLYVOLTAGEERROR	Encoder supply voltage error	Encoder supply voltage error
0x040C	**xx**_SINCOSERROR	Sin/Cos error	Sine/Cosine error
0x040D	**xx**_POSITIONERROR	Position error	Position error
0x040E	**xx**_COMMUNICATIONERROR	Communication error	Communication error
0x040F	**xx**_COLLISIONDETECTION	Collision detection	Collision detection
0x0410	**xx**_PWMERROR	PWM error	PWM error
0x0411	**xx**_STARTBITERROR	StartBit error	StartBit error
0x0412	**xx**_STOPBITERROR	StopBit error	StopBit error
0x0413	**xx**_PARITYERROR	Parity error	Parity error
0x0414	**xx**_RXOVERRUN	RX overrun	RX overrun
0x0415	**xx**_IOLINK_PARASERVERLOCKED	IO-Link parameter server locked	IO-Link parameter server locked
0x0416	**xx**_IOLINK_PARASERVEREMPTY	IO-Link parameter server empty	IO-Link parameter server empty
0x0417	**xx**_IOLINK_NEWSERIALNO	IO-Link new serial number detected	IO-Link new serial number detected
0x0418	**xx**_IOLINK_INVALIDDATA	IO-Link invalid data from parameter server	IO-Link invalid data from parameter server
0x0419	**xx**_IOLINK_INVALIDID	IO-Link invalid device or vendor ID	IO-Link invalid device or vendor ID
0x041A	**xx**_IOLINK_INVALIDSERIALNO	IO-Link invalid serial number	IO-Link invalid serial number
0x041B	**xx**_IOLINK_TIMESTAMPERROR	IO-Link timestamp error	IO-Link timestamp error
0x041C	**xx**_IOLINK_PARASERVERERROR	IO-Link general parameter server error	IO-Link general parameter server error
0x041D	**xx**_CANWARNING	CAN warning	CAN warning
0x041E	**xx**_CANPASSIVE	CAN passive	CAN passive
0x041F	**xx**_CANBUSOFF	CAN bus offset	CAN bus offset

1) **xx** on the alarms indicates "PN_IOM_CHANNEL_STATUS", e.g. **xx**_UNDERFLOW → PN_IOM_CHANNEL_STATUS_UNDERFLOW
2) For more detailed information, see the documentation of the respective I/O module

7.2.4 Network-related alarms

The alarms of "ChannelErrorType-4" include general network error messages.

Alarm/ Error number	Meaning	Alarm description
0x8000	Data transmission impossible	Data transmission impossible
0x8001	Remote mismatch	Remote mismatch
0x8002	Media redundancy mismatch	Media redundancy mismatch
0x8003	Sync. mismatch	Sync. mismatch
0x8004	IsochronousMode mismatch	IsochronousMode mismatch
0x8005	Multicast CR mismatch	Multicast CR mismatch
0x8006	Reserved	Reserved
0x8007	Fiber optic mismatch	Fiber optic mismatch
0x8008	Network component function mismatch	Network component function mismatch
0x8009	Time mismatch	Time master does not exist or problem with accuracy occurred
0x800A	Dynamic frame packing function mismatch	Dynamic frame packing function mismatch
0x800B	Media redundancy with planned duplication mismatch	Media redundancy with planned duplication mismatch
0x800C	Reserved	Reserved
0x800D	Multiple interface mismatch	Information about multiple interface problems
0x800E - 0xFFFF	Reserved	Unknown error

8 Acyclic communication

Values that are not available as cyclic data points on the PROFINET bus can be queried using the acyclic read and write functions.

- When using bus controller X20BC00E3 in combination with PROFINET controller X20IF10E1-1, the acyclic communication function blocks of Automation Studio library "AsNxPnM" can be used.
- When using bus controller X20BC00E3 with a Siemens PROFINET controller, acyclic communication function blocks RDREC/SFB52 and WRREC/SFB53 of the Siemens STEP 7 and TIA portals can be used.

This makes it possible configure I/O modules at a later point and to query things such as status values that are not automatically transferred. The record read and write mechanisms can be used to read and write I/O module registers. This is always a synchronous process (i.e. each read or write action only provides a result once the bus controller has internally completed the asynchronous read or write action for the respective register). This ensures that multiple acyclic processes cannot influence one another, and that the registers are accessed serially instead.

Only the index addresses 0x7000, 0x7001 and 0x7002 from the vendor-specific pool are used for the read and write processes. Little-endian format is used for all record read and write procedures!

Information:

This function is available beginning with firmware Version 1.6. A firmware update can be requested from International Support.

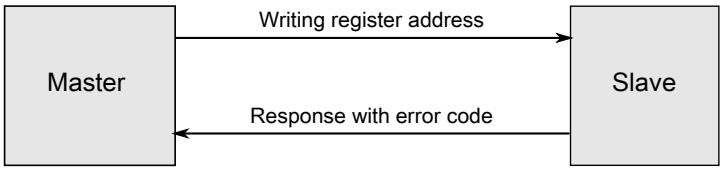
8.1 I/O module register functions

A register read access always requires 2 actions:

1) The desired register address must be defined with a "Record write".
2) The value of the previously defined I/O module register can now be read out with a "Record read".

8.1.1 Reading I/O module register

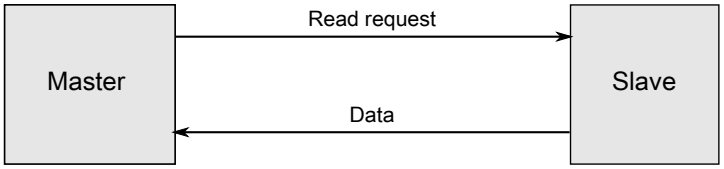
Writing I/O module register address

Index	**0x7000**
Data length	2 byte output = 2 byte register address
Return value	OK (see spec: IEC 61158-6) Error class: 11 Access — Error number: 1 "write length error"  **Structure of the register address:** Slot, subslot, index 0x7000

Reading I/O module register value

Index	0x7001
Return value	4 byte register value, INT32 (little-endian)

Error class		Error number	
10	Application	9	"Feature not supported"
10	Application	2	"Module failed"
11	Access	2	"Invalid slot/subslot"
12	Resource	2	"Resource busy"
12	Resource	3	"Resource unavailable"

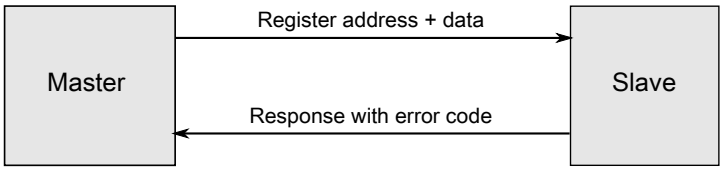


Structure of the read query: Slot, subslot, index 0x7001

8.1.2 Writing I/O module register

Index	0x7002
Data length	6 byte output = 2 byte register address + 4 byte data
Return value	OK (see spec: IEC 61158-6)

Error class		Error number	
10 =	Application	9 =	"Feature not supported"
11 =	Access	1 =	"write length error"
11 =	Access	2 =	"Invalid slot/subslot"
12 =	Resource	2 =	"Resource busy"
12 =	Resource	3 =	"Resource unavailable"



Structure of the register address: Slot, subslot, index 0x7002

8.2 Slot assignments

X20BC00E3

Slot 0 is always the PROFINET bus controller. Slot 1 is the supply module on the X20BC00E3. (X20PS9400 or X20PS9402). The slots are then assigned to the X2X modules in order.

Subslot 1 should be used for reading and writing acyclic data.

X67BCE321.L12

The X67BCE321.L12 module uses 2 slots. Slot 0 is the bus controller and slot 1 is the I/O module integrated in the bus controller. The following modules begin from slot number 2.

Subslot 1 should be used for reading and writing acyclic data.

9 Integrated website

The integrated website gives the user an overview of the bus controller's network parameters, the configured I/O modules and the switch configuration. The starting page includes information regarding specific bus controller settings such as IP address, hostname and the PROFINET device name. In addition, the website provides information about the current firmware version. Information concerning module diagnostics is incorporated into a tree structure. Expanding and collapsing the individual module nodes provides an overview of the configured I/O modules. In addition, various package counters are read from the integrated switch. This makes diagnosing errors on the network quick and easy.

Network parameters concerning the bus controller itself can be read, but they cannot be modified. The bus controller's IP configuration is handled during booting or by the PROFINET master when a connection is established.

Each page of the website contains help information that describes the functions and parameters displayed on that page. The link to this information can be found in the upper right corner of the page in the form of a question mark.

A connection to the website is established by entering the **current IP address** or the unique **hostname** in a Web browser. Some functions require authentication.

The hostname is composed of a predefined text and a unique MAC address. For example, if the bus controller has the MAC address 00:60:65:11:22:33, this will result in the following hostname: **br006065112233.**

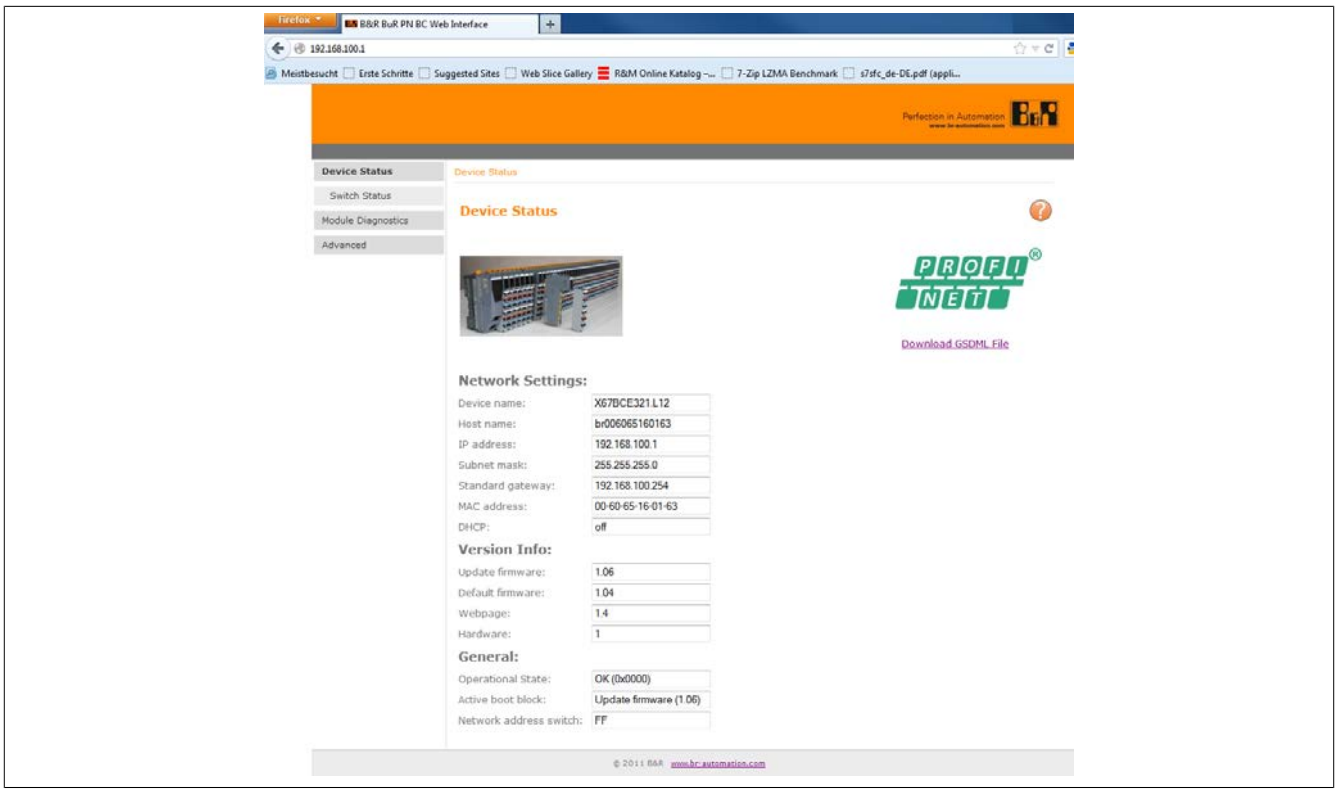
Default parameters available for the integrated website

IP address:	192.168.100.1
Username:	admin
Password:	B&R

Information:

Take note of the node number switch position.

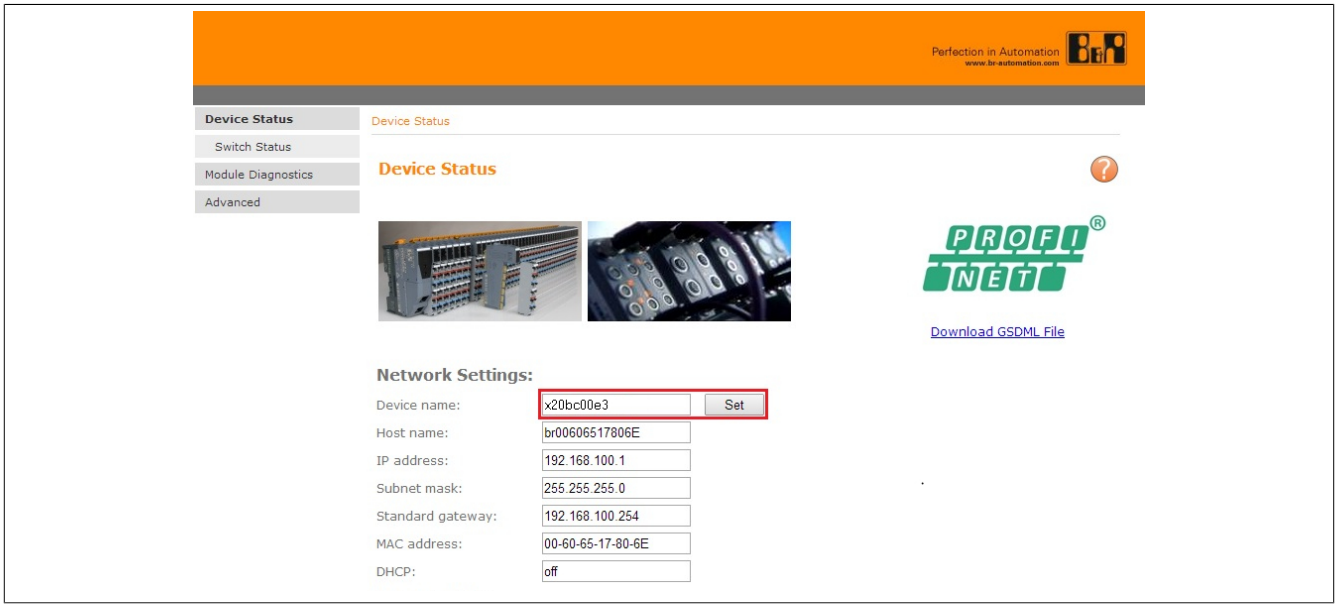
Please note that authentication parameters are case-sensitive.



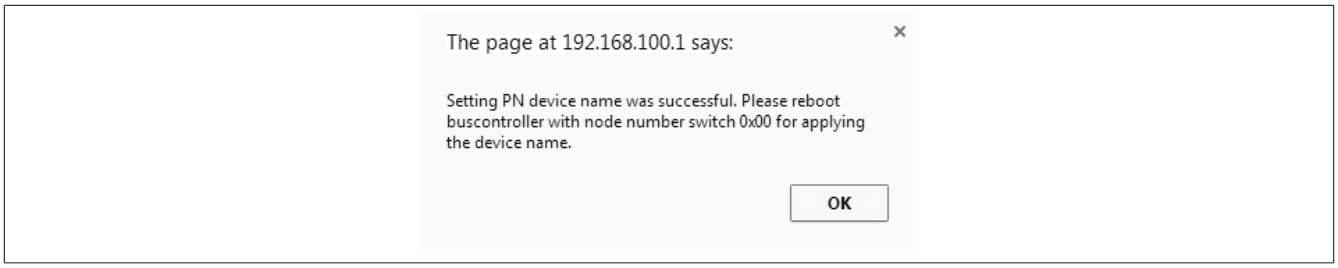
9.1 Changing the device name

In order to change the device name, set the node number switch to 0xFF and restart the bus controller. By doing so, the bus controller starts up with default parameters (see "Node number switches" on page 10).

● Subsequently, connect to the IP address 192.168.100.1 using an Internet browser. Enter in the desired name for the **Device name** parameter under **Network settings** on the start page of the integrated website. Confirm this by selecting the **Set** button.



● If the name has been saved to flash memory, then a message appears.



Information:

If you confirm this message by clicking OK, the current device name is shown again for the "Device name" parameter. The name which has been newly set only becomes effective after restarting the bus controller.

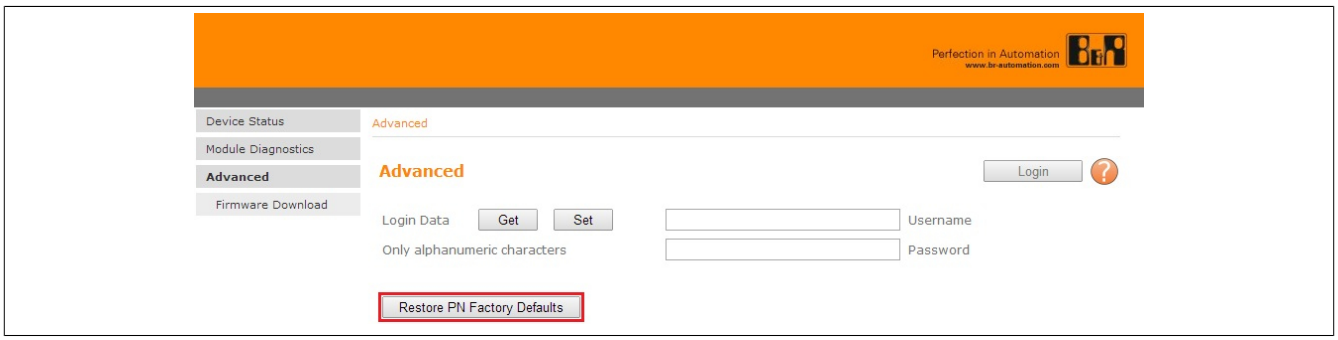
This function is available beginning with firmware Version 2.0.

Now the bus controller with the 0x00 node number switch position and the configured drive name can be restarted.

9.2 Reset bus controller to its factory settings

It's possible to reset the bus controller to its factory settings using the integrated website.

To do this, click on the **Advanced** button on the left of the website. After doing this, a window appears which allows the login data to be read or changed.



In addition, the button **Restore PN Factory Defaults** appears. This deletes the bus controller's flash memory and restores it to its factory settings. It behaves in the same as the node number position 0xF0.

In principle, all node switch positions with which you can access the website are permitted.

You have to be logged into your account for all activities in the **Advanced** area. (See "Integrated website" on page 35.)

Information:

This function is available beginning with firmware Version 2.0.

10 Firmware update

New functions and improved versions of the bus controller can be implemented by updating the firmware update. Firmware files are provided by the B&R support team.

Firmware is updated via the website integrated in the bus controller itself.

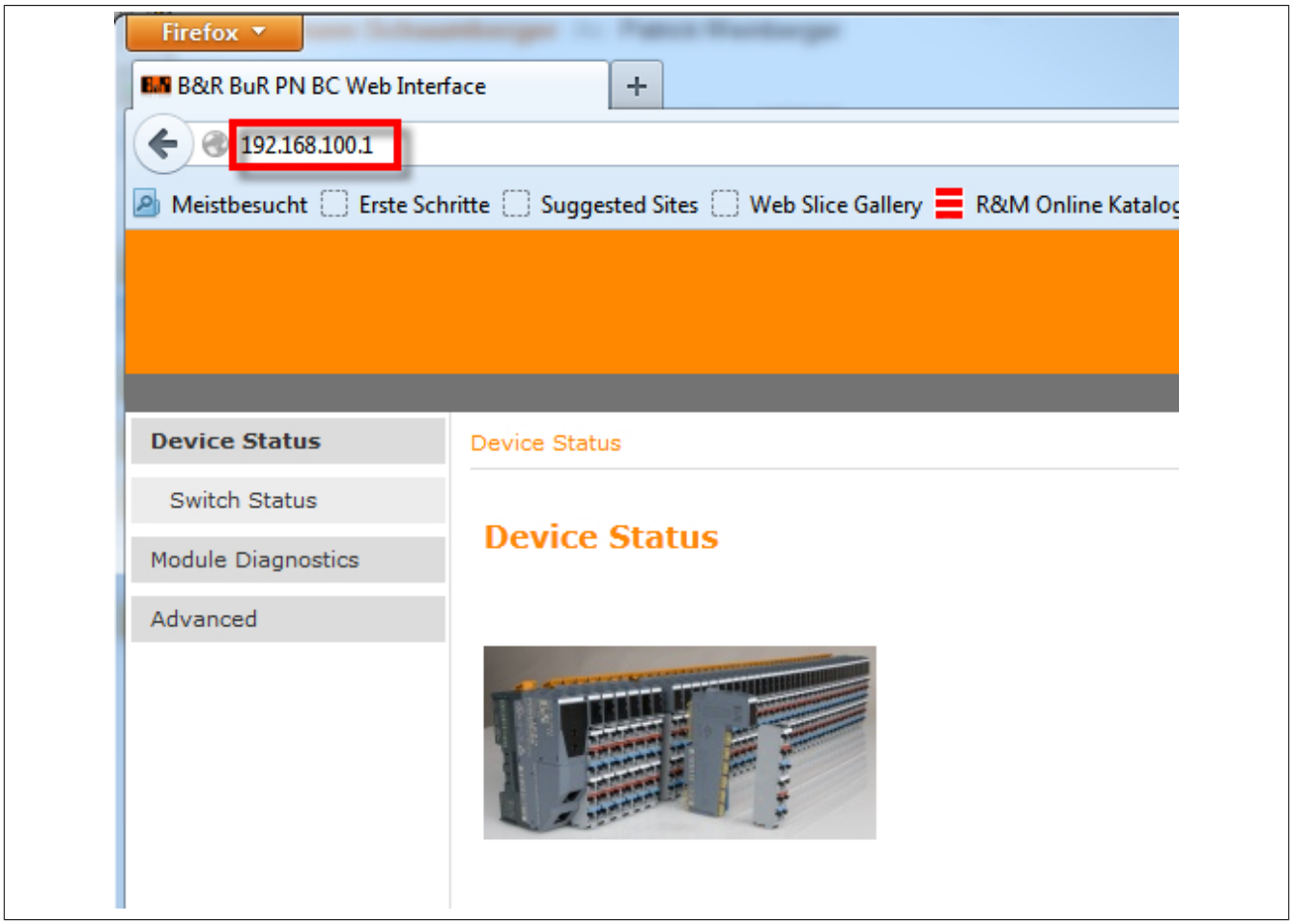
It's also possible to perform module firmware updates of X2X modules that are connected to the bus controller. The procedure for this is identical for the firmware update of the bus controller

Information:

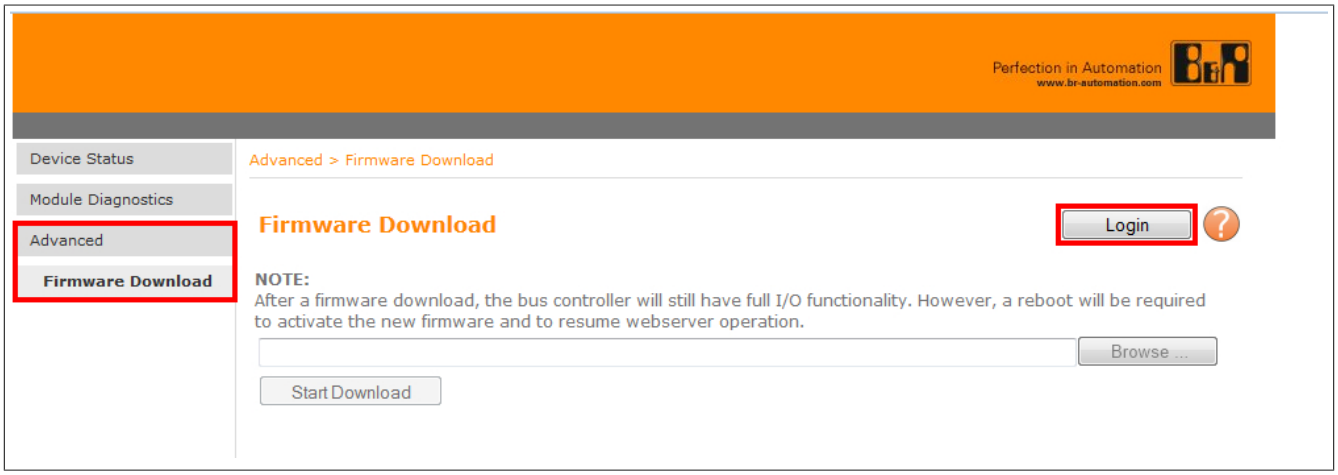
This function is available beginning with firmware Version 2.0.

10.1 Firmware update via website

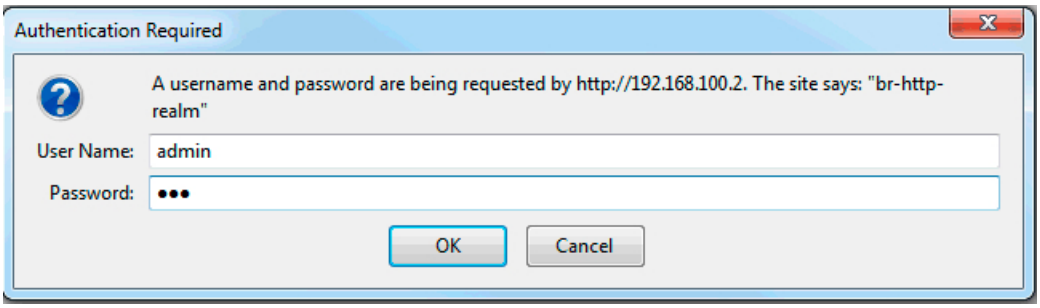
● To update the firmware, there must first be an active web connection to the bus controller using a web browser (e.g. Firefox, Internet Explorer, Chrome, etc.). This connection can be established by entering the current IP address of the bus controller in the web browser. If the bus controller is booted with its default parameters (see "Node number switches" on page 10), then the default IP address is **192.168.100.1**.



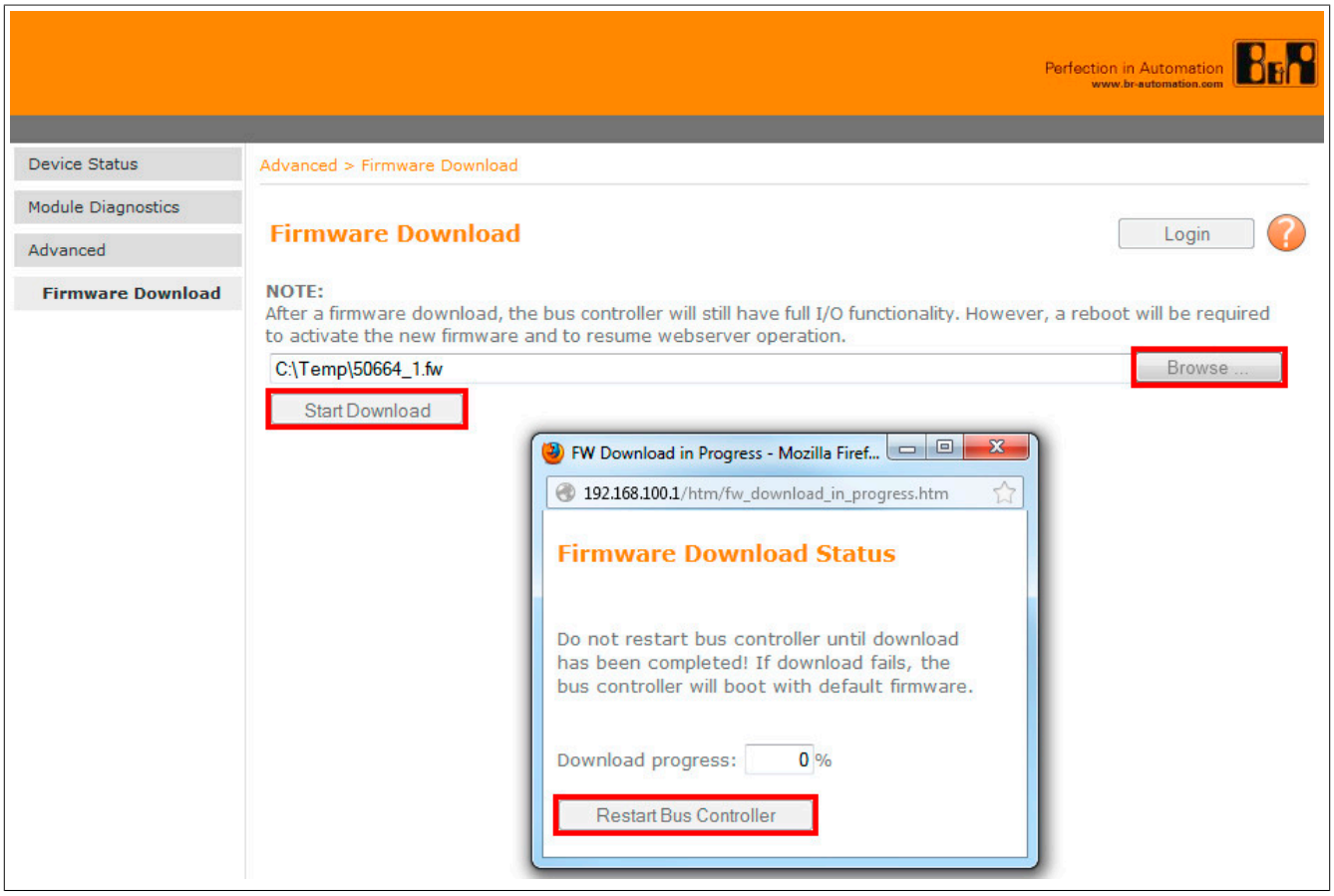
● Once this connection to the bus controller has been established, the user can navigate to the **Firmware download** menu option in the tree to the left. This option is located under the **Advanced** heading. Up on the right you can find the **Login** button.



● After pressing the **Login** button, an input field appears where the user can enter the configured username and password. The username **admin** and password **B&R** are set by default.



● Click on **Browse** to select the desired firmware file. The firmware download is then started by clicking **Start Download**. A pop-up window appears indicating the download progress. Once the firmware is finished downloading, the **Restart bus controller** button in the window is enabled and the bus controller can be restarted. New firmware only becomes active after the bus controller is restarted.



11 Commissioning with Step 7

Much of the following information can also be found in the "SIMATIC, Configure Hardware and Connection with STEP 7" manual for the SIMATIC Step 7 software from Siemens. This can be downloaded free of charge in the documentation area of the http://www.automation.siemens.com website.

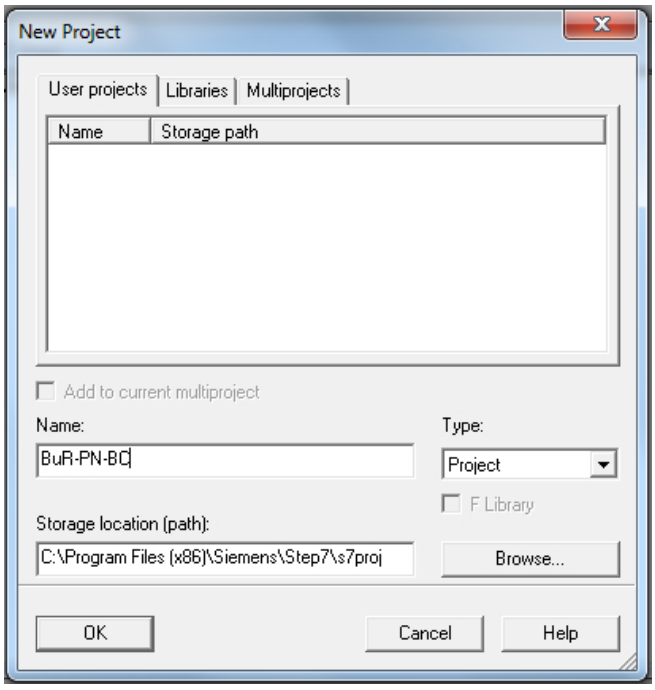
All screenshots depicted here were generated using the Step 7 version indicated below. Nevertheless, B&R PROFINET bus controllers can also be used with older software versions without any problems. While there may be differences in how the user interface is arranged, the menu structure generally remains the same.
The bus controller X67BCE321.L12 was used for this example. The use of the X20 variant is identical. There shouldn't be any difficulties integrating the bus controllers when using this document as a reference.

Software/Hardware used:

- B&R PROFINET bus controller
- GSDML file from the B&R website
- CPU315-2 PN / DP Siemens CPU as the PROFINET master
- SIMATIC Step 7 V5.5

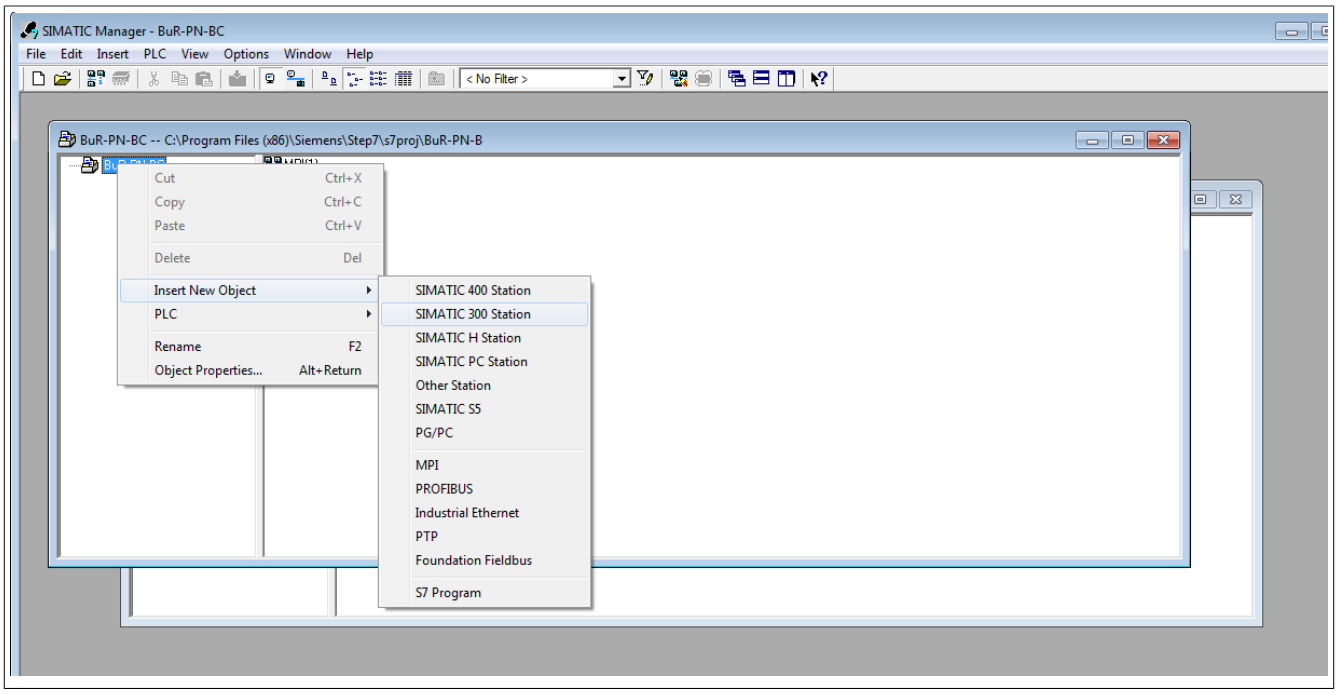
11.1 Creating a new project

● The first thing to do after opening the SIMATIC development environment is to create a new project. This can be done by selecting *File → New*. The project name must be entered in the selection dialog box. The project is then created by clicking **OK**.



11.2 Inserting a SIMATIC 300 station

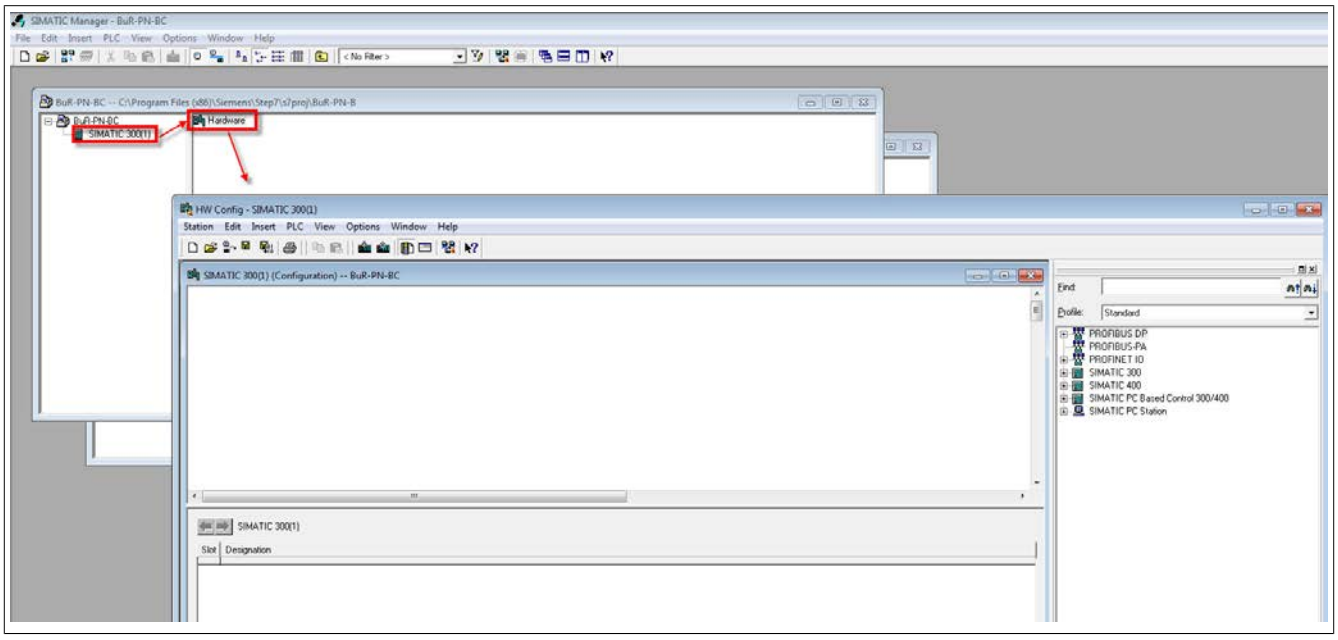
● The next thing to do is add a SIMATIC 300 station to the new project. This is done by **right-clicking** on the project name, selecting →*"Insert new object" and then choosing* → *"SIMATIC 300-Station"*. This specific station is inserted since the PROFINET master being used (CPU 315-2PN/DP) is part of the SIMATIC 300 product family.



11.3 Open hardware configuration

● Double-clicking on **Hardware** in the SIMATIC 300 station opens the hardware configuration. A new window is opened for this.

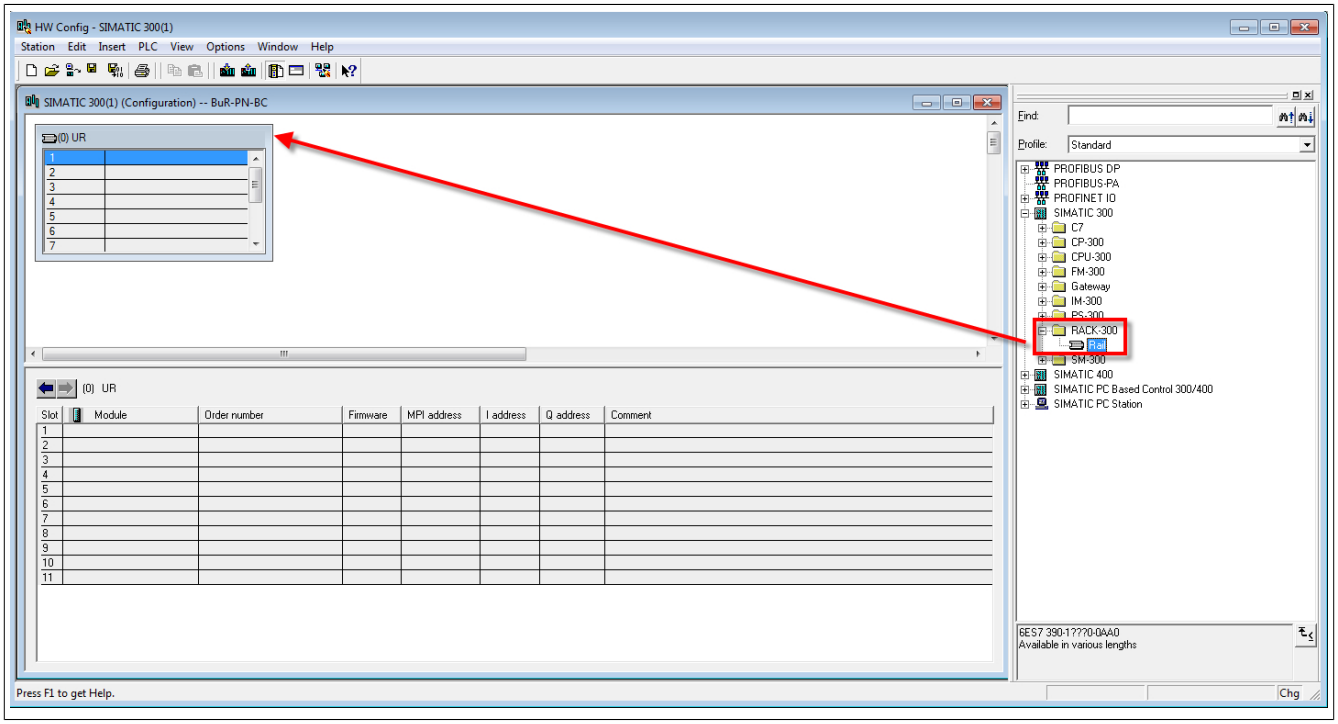
The hardware configuration serves as the basis for the entire PROFINET configuration. This is where the GSDML files will be imported and the PROFINET master and slave configured as needed.



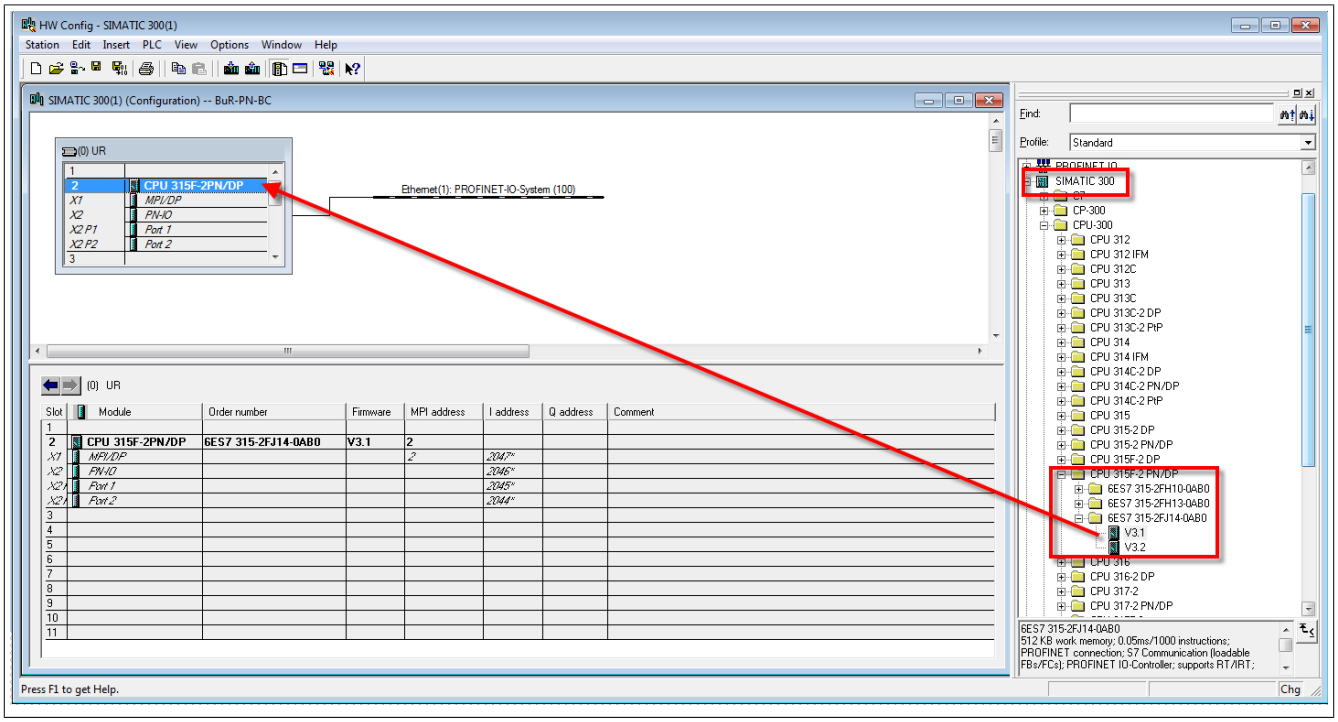
11.4 Configuring the PROFINET master

● The PROFINET master is configured in the newly created hardware configuration. However, a RACK-300 component must be inserted into the development environment.

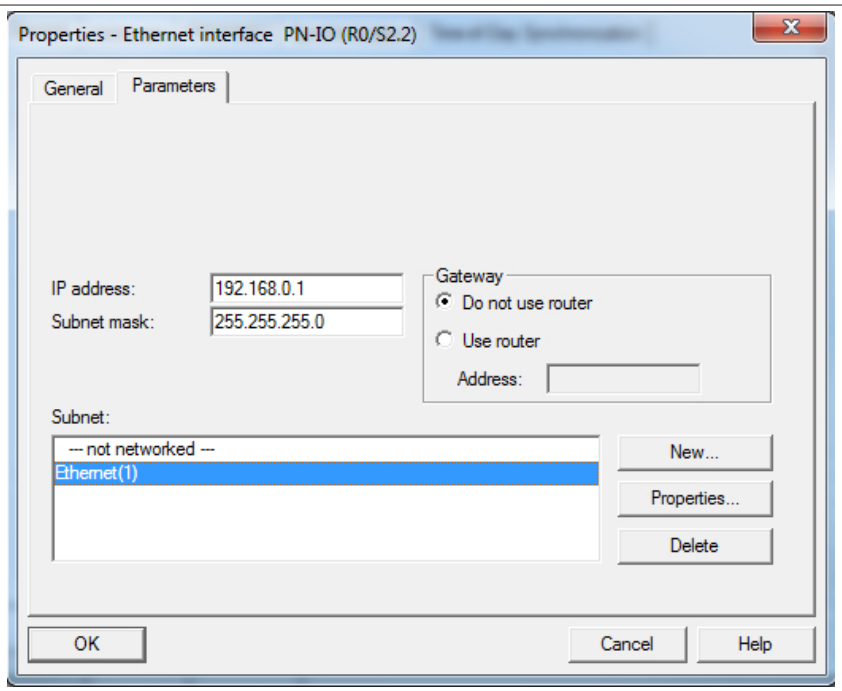
Components from the Hardware Catalog are added to the current hardware configuration using drag-and-drop.



● This is where the CPU315-2PN/DP will be inserted.

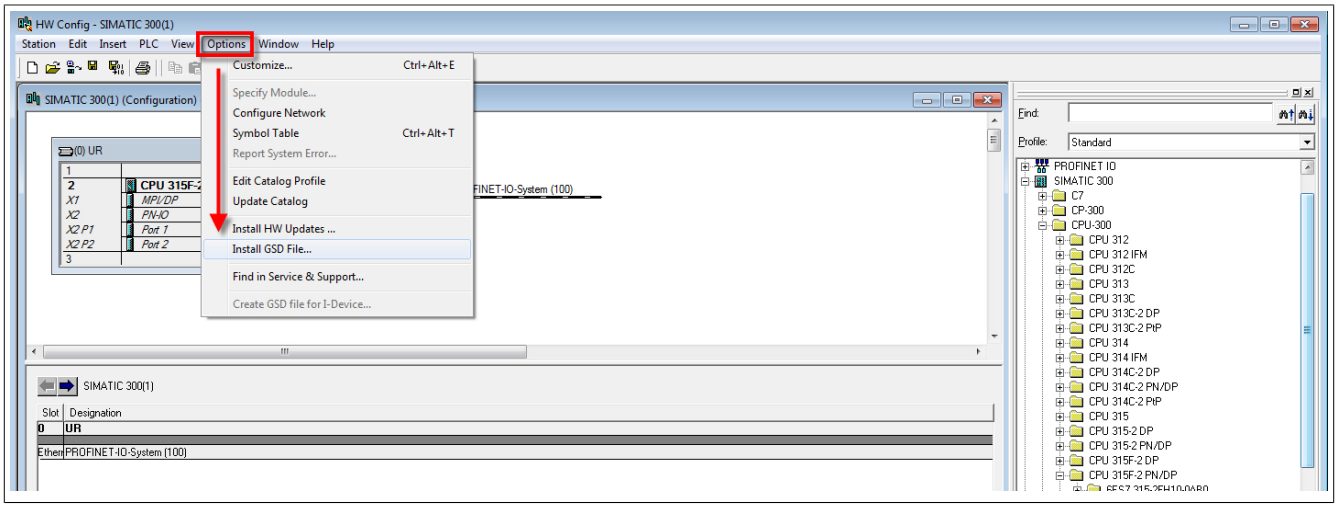


● When this CPU is added, the software asks the user if a new PROFINET network should be created. The network is then added to the project by selecting **New...**

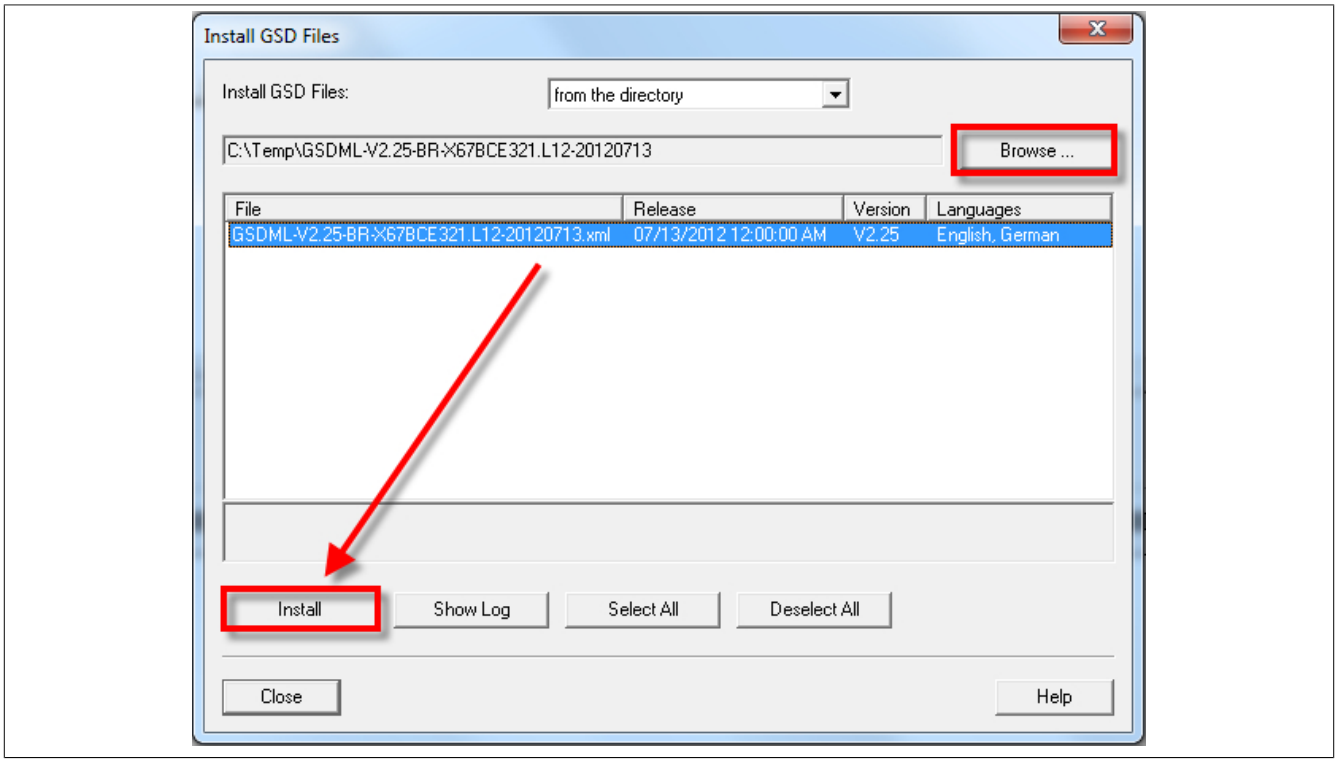


11.5 Importing the GSDML file

● To configure the bus controller in the hardware configuration, its GSDML file must be imported into the SIMATIC development environment. This is done using the *Options → Install GSD file menu option*.

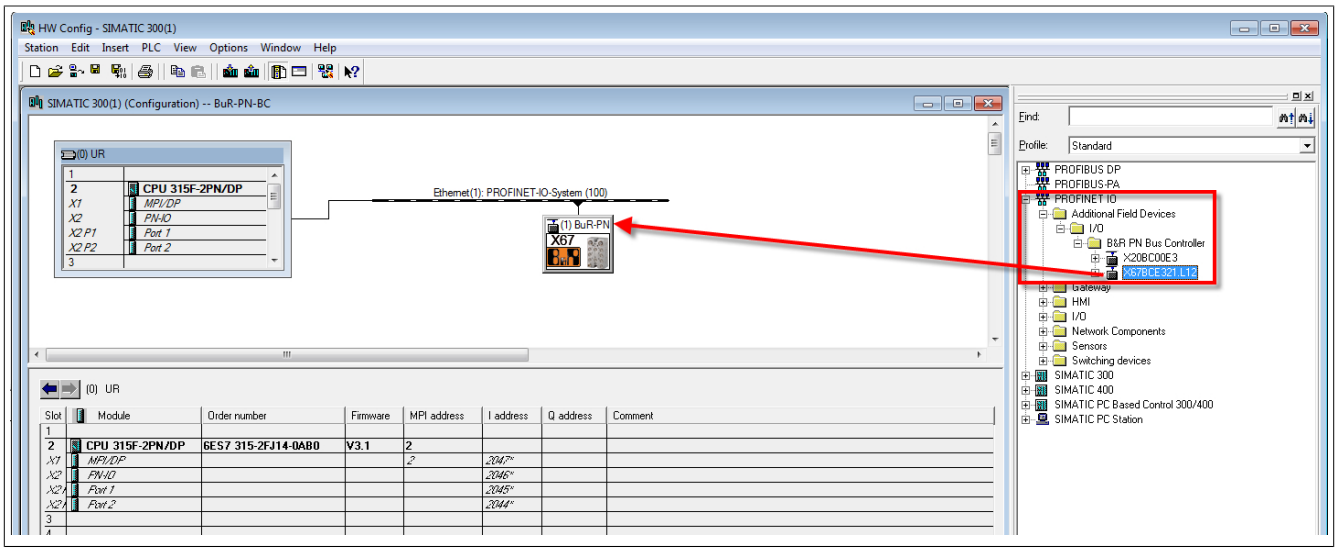


● The path to the stored GSDML file is then specified in the dialog box, and the PROFINET device is imported by selecting **Install**.

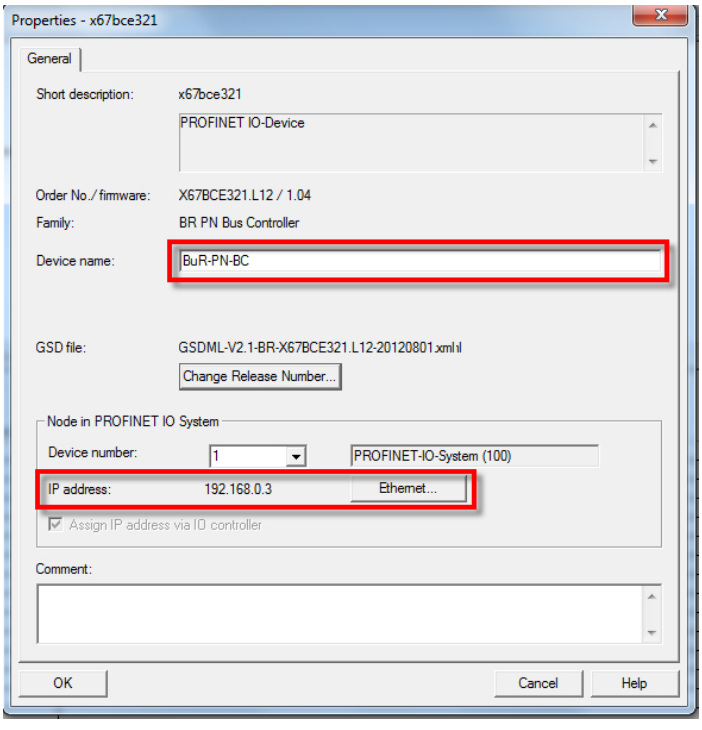


11.6 Configuring the PROFINET bus controller

● Once the GSDML file has been imported, the bus controller is available in the updated Hardware Catalog. A folder called "B&R PN Bus Controller" is created under the heading "PROFINET IO / *Additional field devices → I/O*. The bus controller can then be added to the new PROFINET network with drag-and-drop.



Double-clicking on the bus controller opens its properties window where the device name and IP address can be set. The PROFINET master can only establish a connection to the bus controller if the configured device name matches the actual name of the bus controller. By default, bus controllers are delivered without an assigned device name. They must first be preconfigured with the necessary name using the configuration tool integrated in Step 7 (see "Configuration using Step 7 configuration tool" on page 22). Another option is to assign the PROFINET device name of the bus controller using the node number switches (see "Node number switches" on page 10).

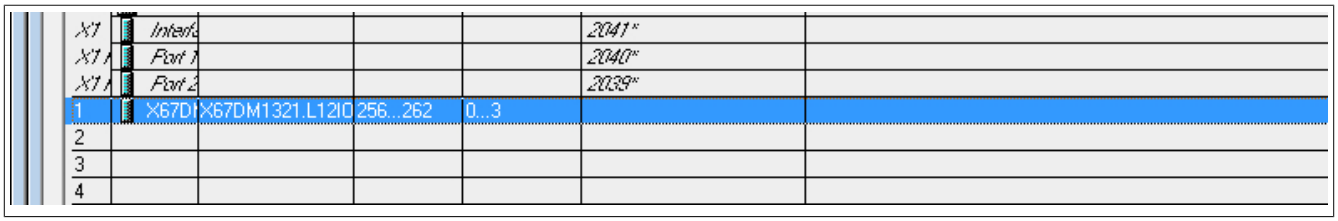


11.7 Modifying the default configuration

Information:

This section should only be applied when using the X67 bus controller.

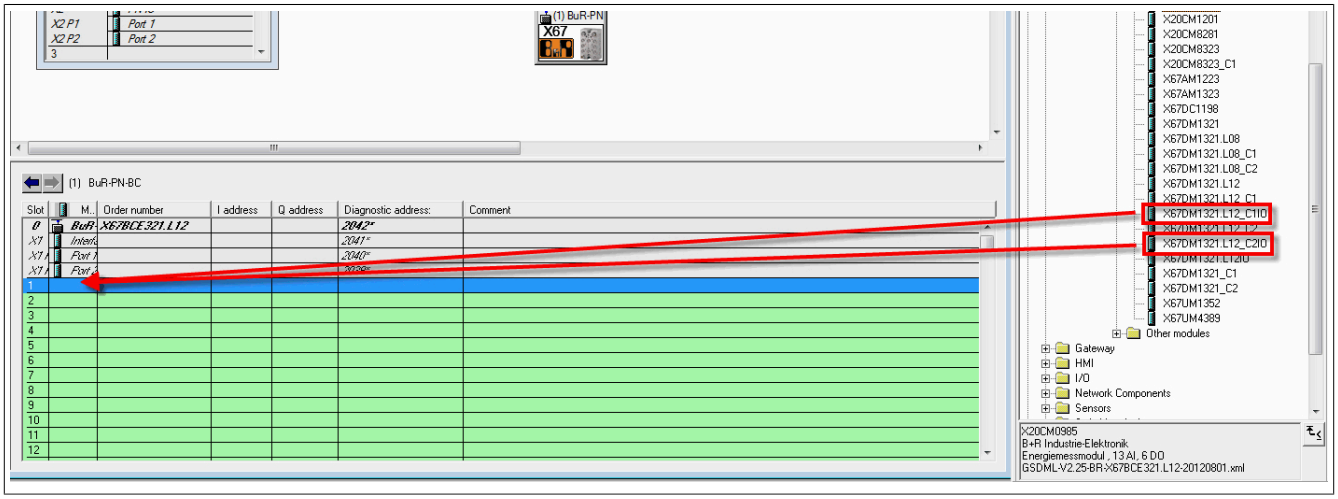
When adding the bus controller, the module X67DM1321.L12IO (16 channel I/O) is also automatically added to slot 1.



However, the default module must be deleted and replaced by another in order to use other functions from the integrated I/O module.

Example

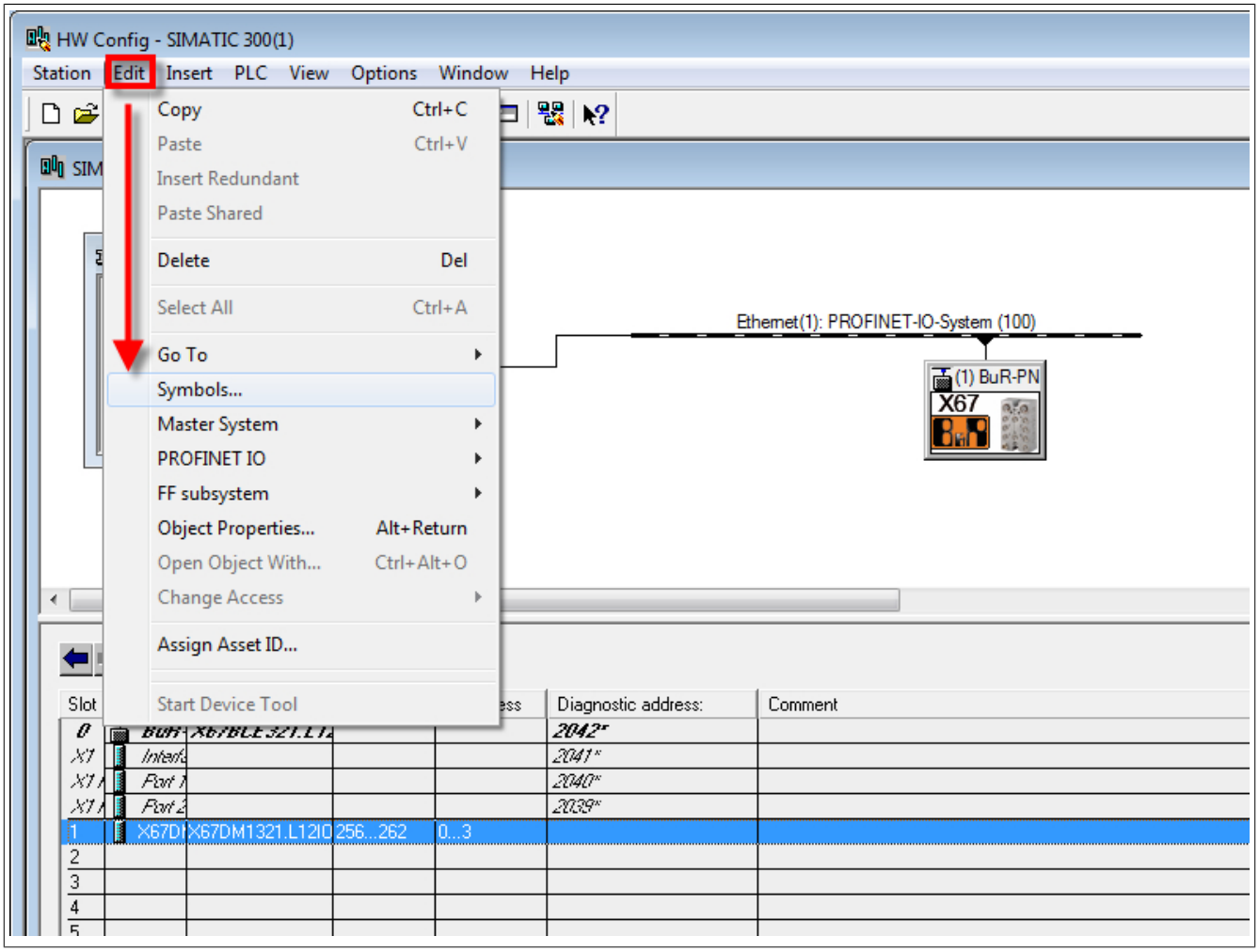
In order to use the counter function, the first module must be replaced by the module X67DM1321.L12_C1IO or the module X67DM1321.L12_C2IO (for gate measurement).



11.8 Add symbol names for created data points

Once the bus controller has been configured, all of the I/O modules in the project can be used in the project.

When an I/O module is dragged to the respective grid bellow the bus controller, the I/O data points needed for the module are automatically created. A symbolic data point name is entered in the GSDML description file for each of these data points. These symbolic names can later be imported to the Step7 master environment to provide better orientation.



All of the symbol names from the GDSML can be automatically added by clicking on **Add to Symbols** and applied to the project by selecting **OK** or **Apply**.

Blank symbol table

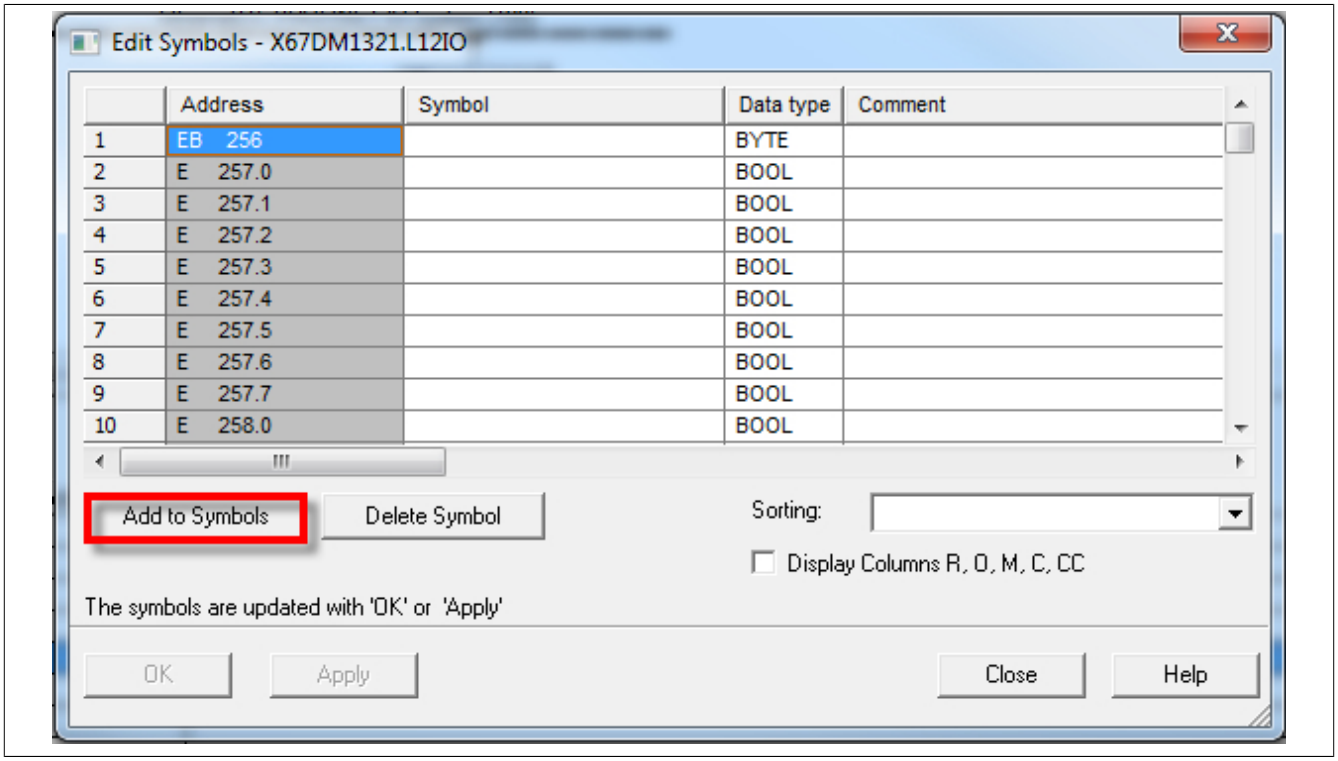


Figure 2: Blank symbol table

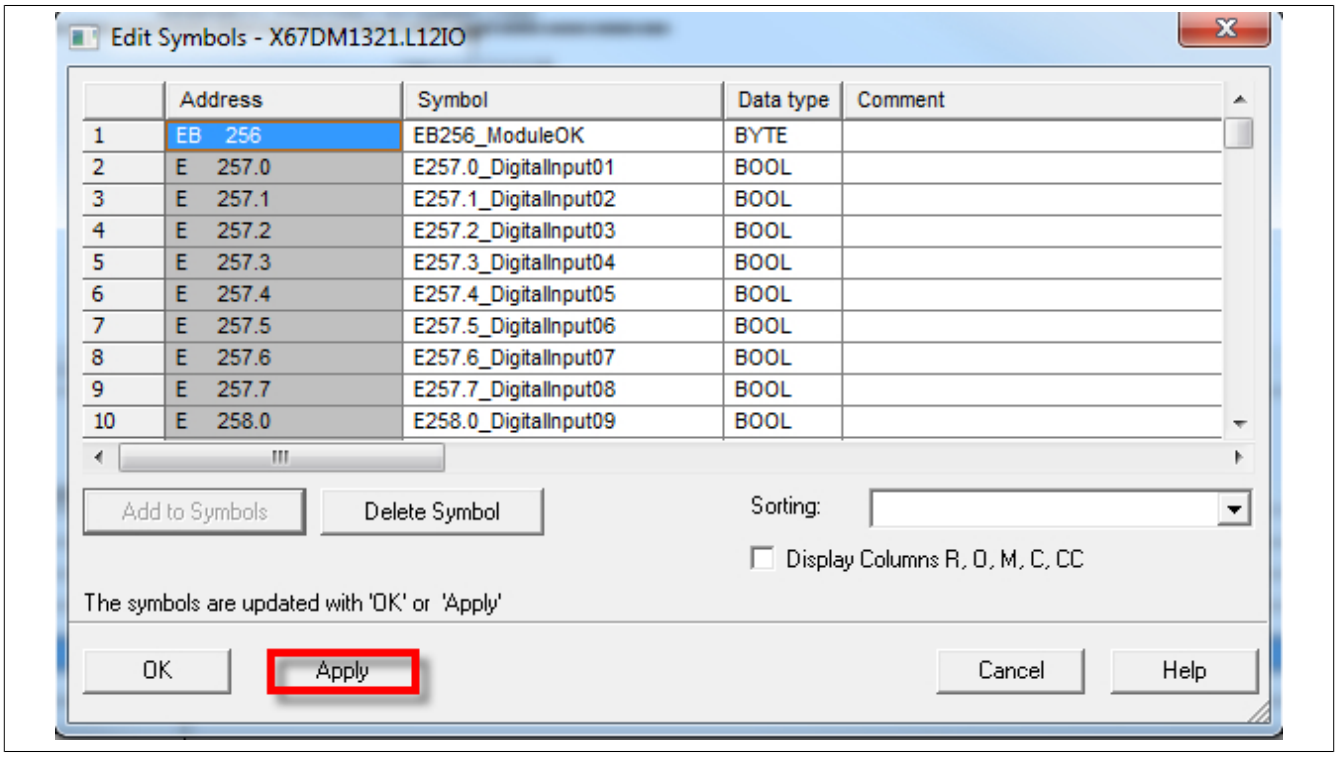


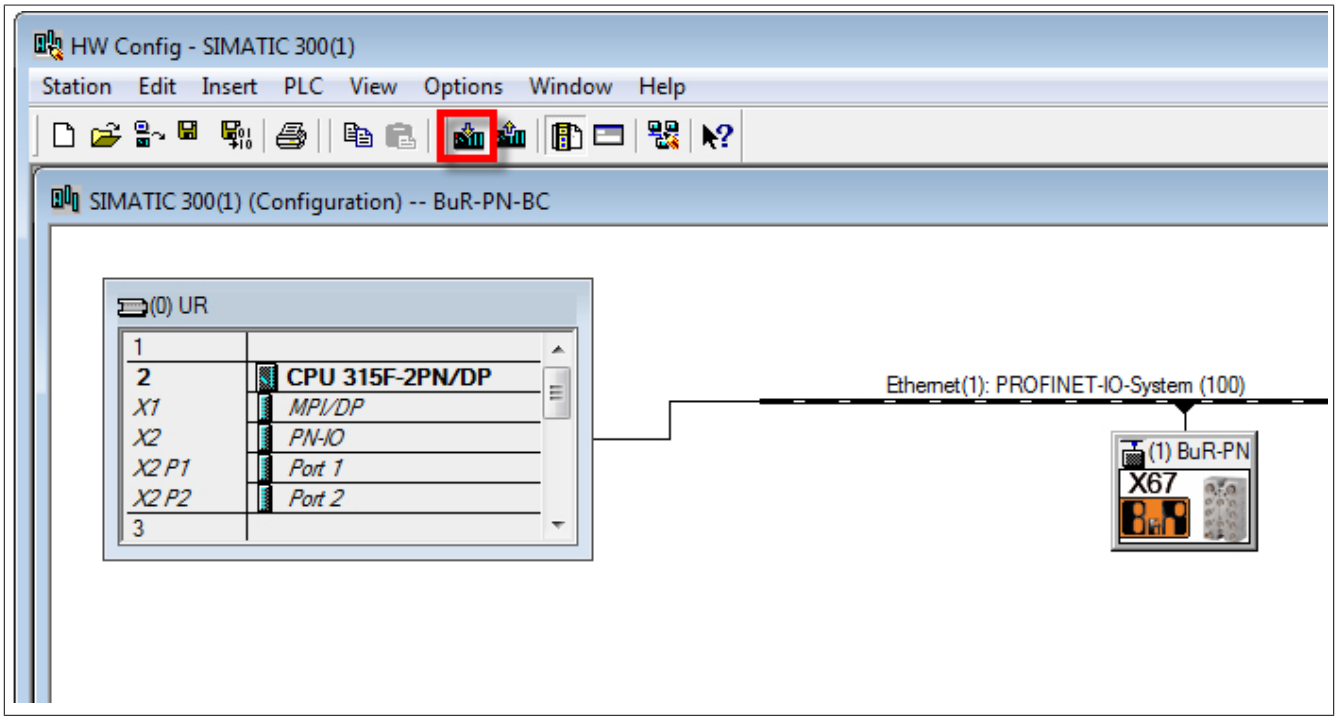
Figure 3: Updated symbol table with data point names from the GSDML description file

11.9 Configuration download

When adding the bus controller, the following I/O module is also automatically added to Slot 1:

- for X67BCE321.xxx: X67DM1321.L12 (Digital I/O module)
- for X20BC00E3: X20PS9400 (power supply)

Due to automatic insertion of the I/O modules on Slot 1, a valid configuration is already available that can be downloaded at any time. Other modules can be added later by dragging and dropping. When a configuration is loaded, the previous hardware configuration is automatically saved and compiled beforehand.



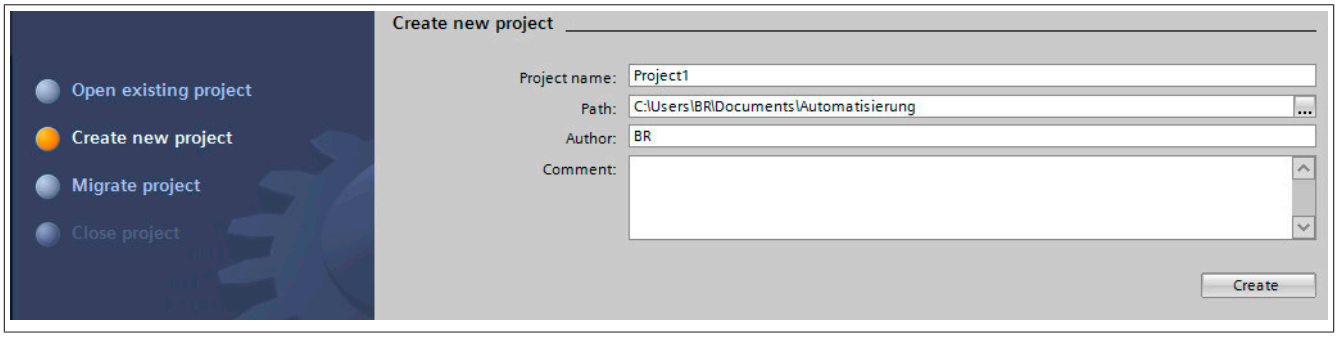
12 TIA portal

Software and hardware used for this example:

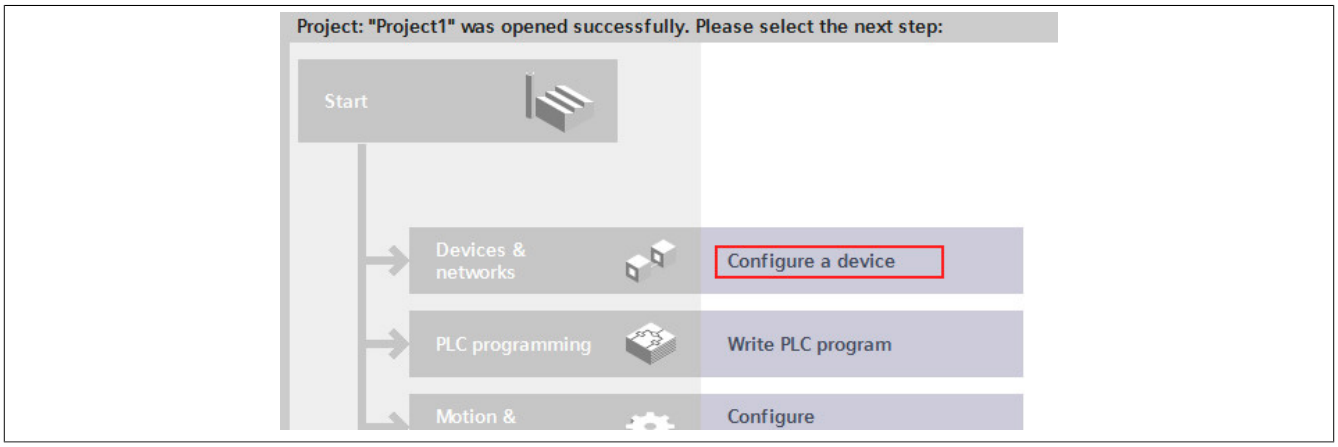
- X20BC00E3 B&R PROFINET bus controller
- GSDML file from the B&R website
- CPU315-2 PN / DP Siemens CPU as the PROFINET master
- TIA portal version 13 (test version)

12.1 Creating a new project

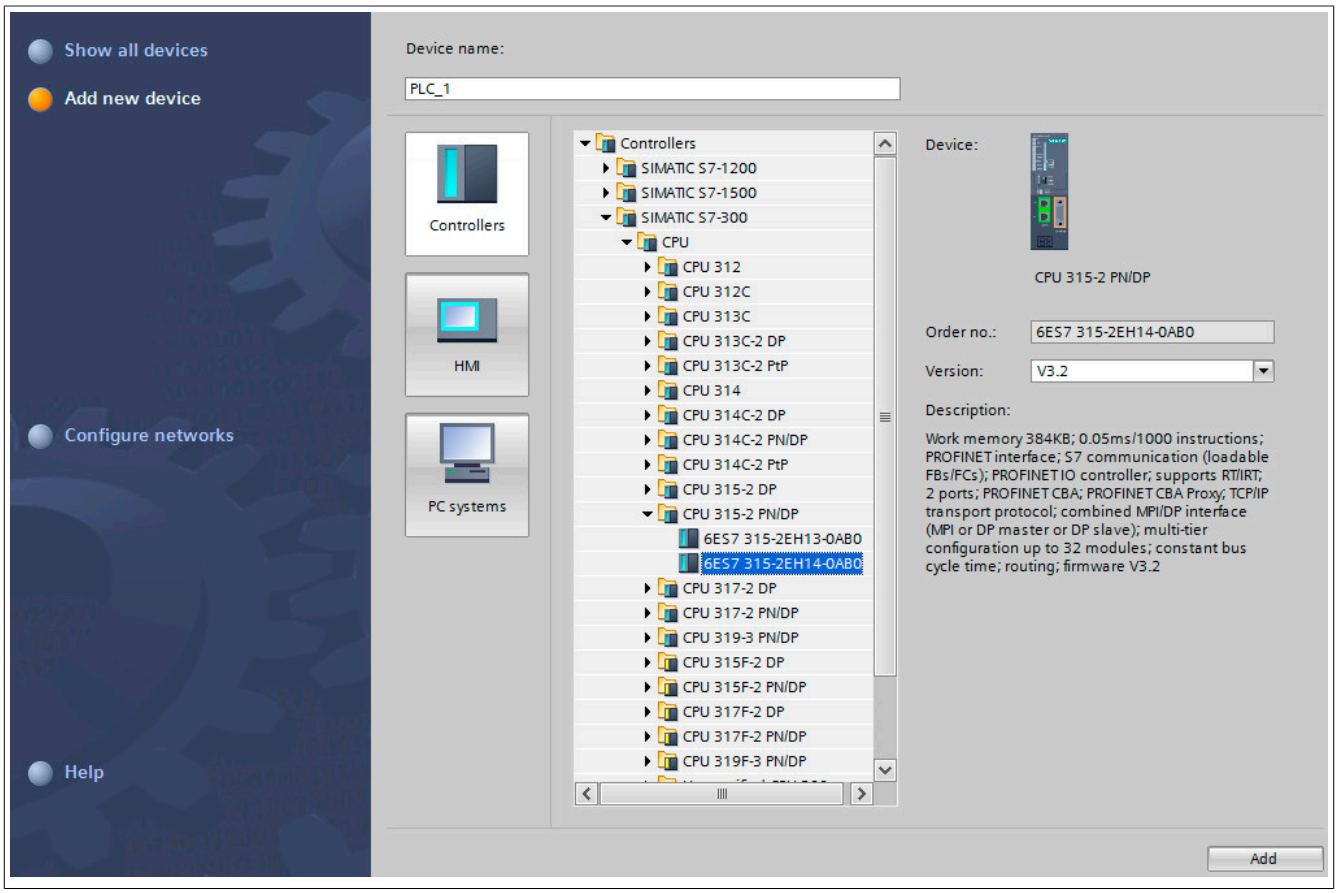
● After opening the TIA Portal development environment, a new project must first be created. To do this, select **Create new project** and specify the name and path of the new project. The new project is created with button **Create**.



● After the project is created, the necessary devices can be added and configured.
The first step is to select **Configure a device**.

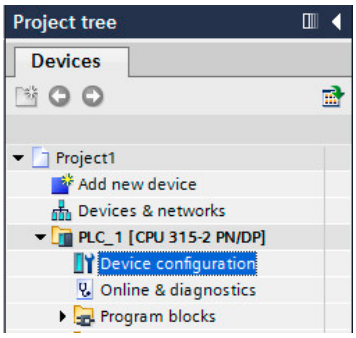


- The CPU used is selected using **Add new device** and added to the configuration with button **Add**.

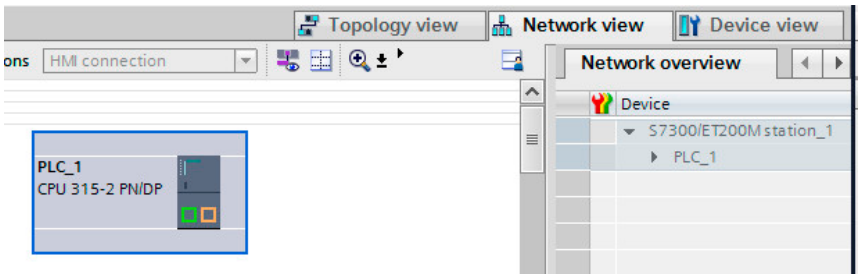


12.2 Adding PROFINET bus controllers

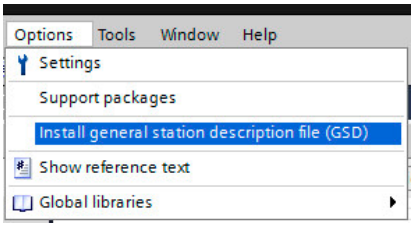
● To add a PROFINET bus controller, you must switch to the hardware view. To do this, select **Device configuration** by double-clicking in column **Project tree**.



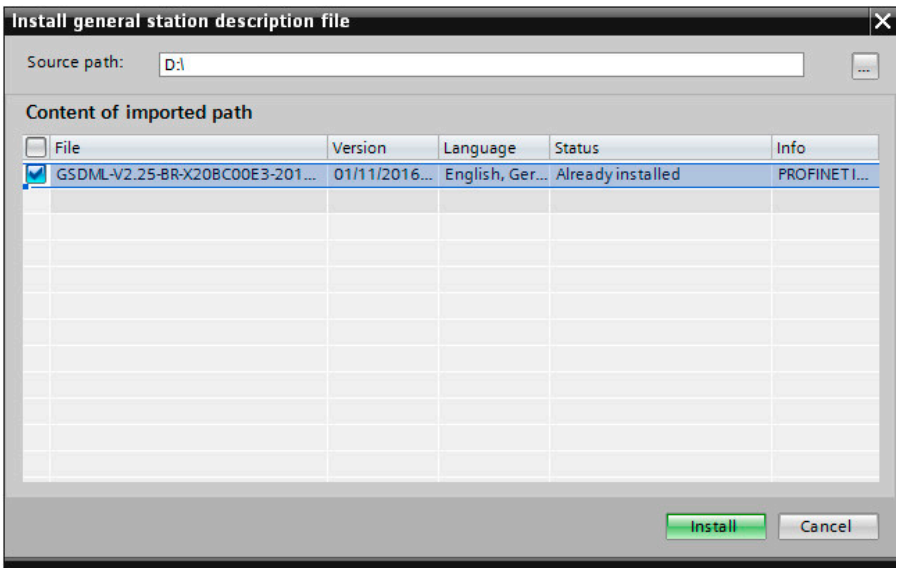
● The hardware structure can be checked or updated via tab **Network view**.



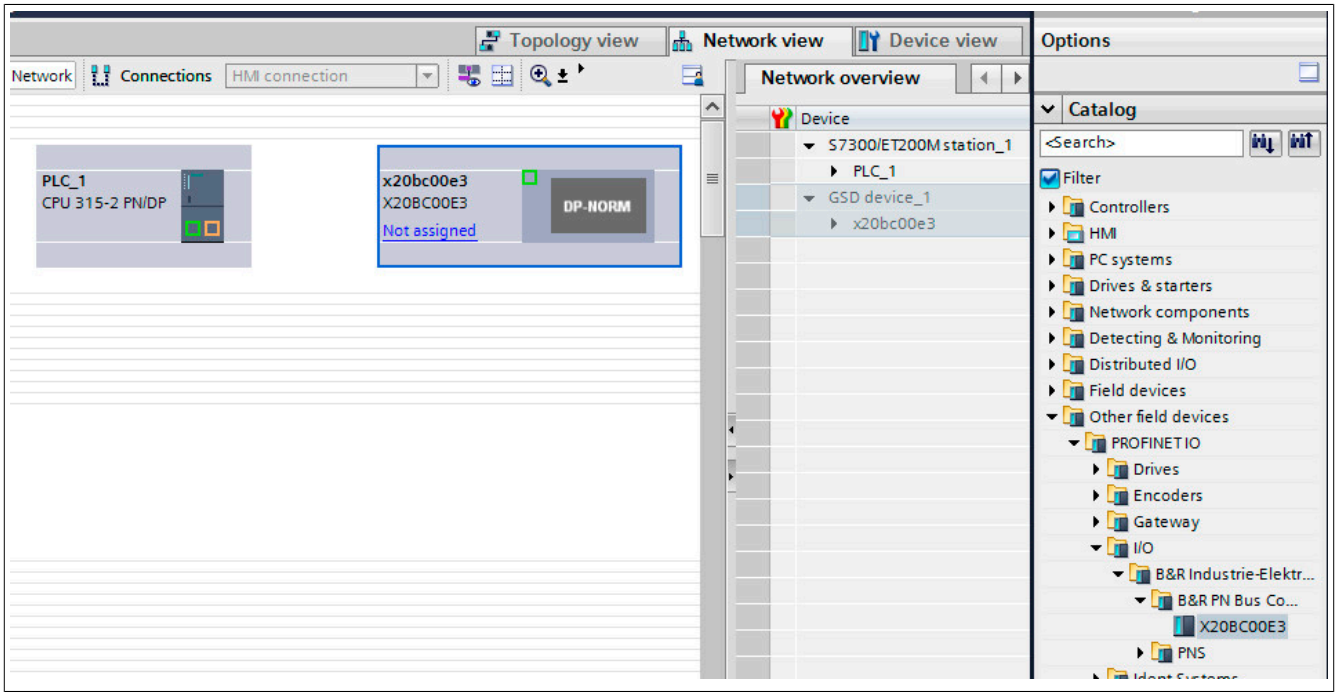
● In order to use the B&R bus controller, its description file must first be installed. The description file can be downloaded from the B&R website and installed via *Options → Install general station description file (GSD)*.



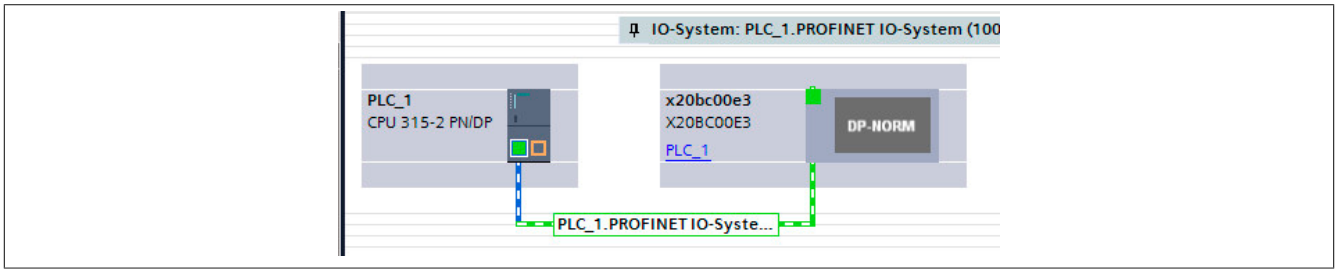
● The downloaded description file is selected in the dialog box and added to the project with button **Install**. This adds the bus controller to the Hardware Catalog of the TIA Portal.



● Now the installed B&R bus controller can be used in the project. This is done by selecting the bus controller in the Hardware Catalog and pulling it into the project using drag-and-drop.



● The installed CPU and the bus controller are connected via PROFINET. For this purpose, the PROFINET interface of the CPU is connected to the PROFINET interface of the bus controller via drag-and-drop.



● To establish communication between the PROFINET IO controller (master) and PROFINET IO device (slave), the PROFINET device name stored on the bus controller must match the name configured in the TIA Portal.

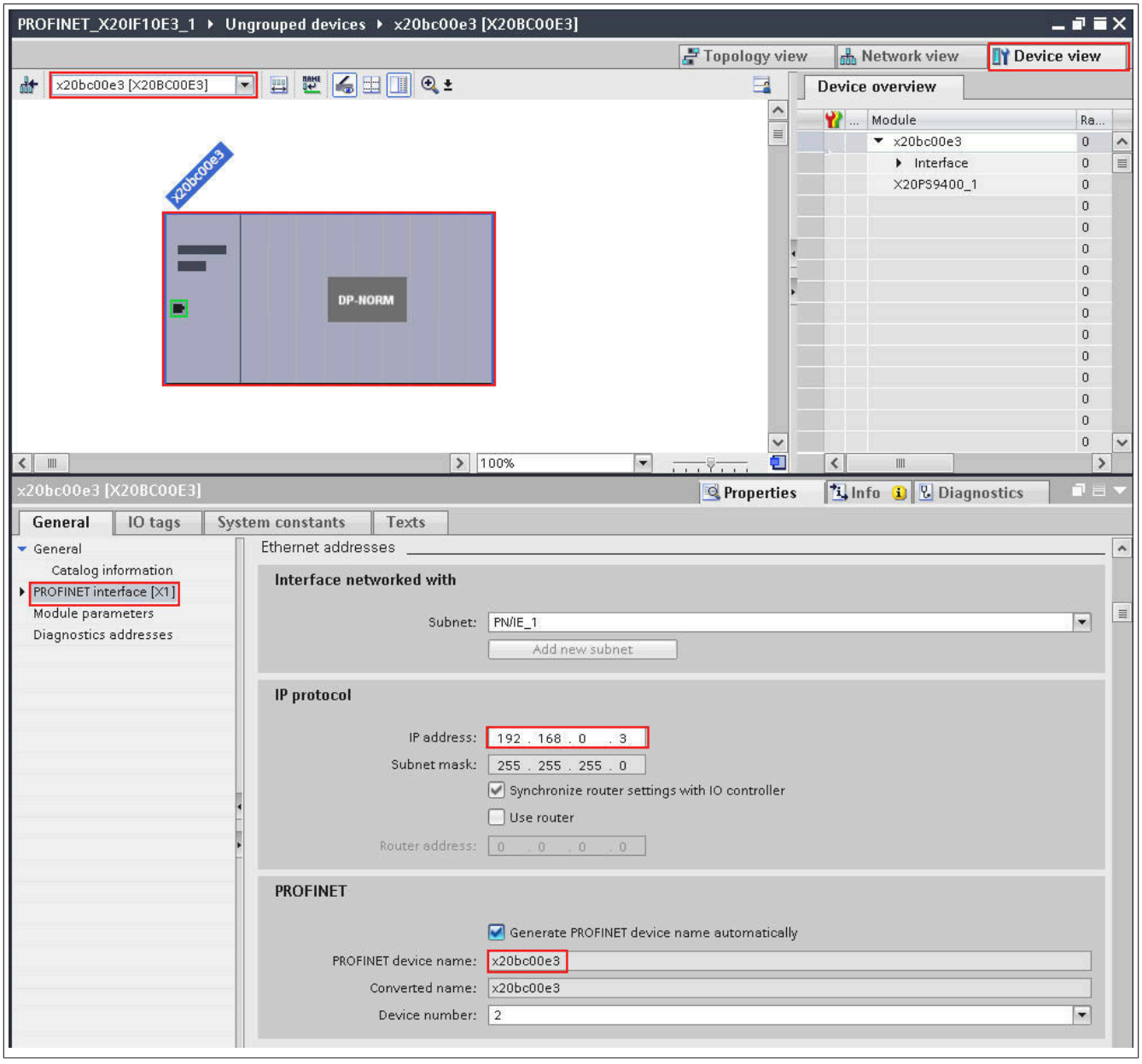
The PROFINET device name of the bus controller can be set as follows:

- Using the node number switches. See "Node number switches" on page 10.
- Using an external tool. See " Changing PROFINET device names with Automation Studio" on page 20.

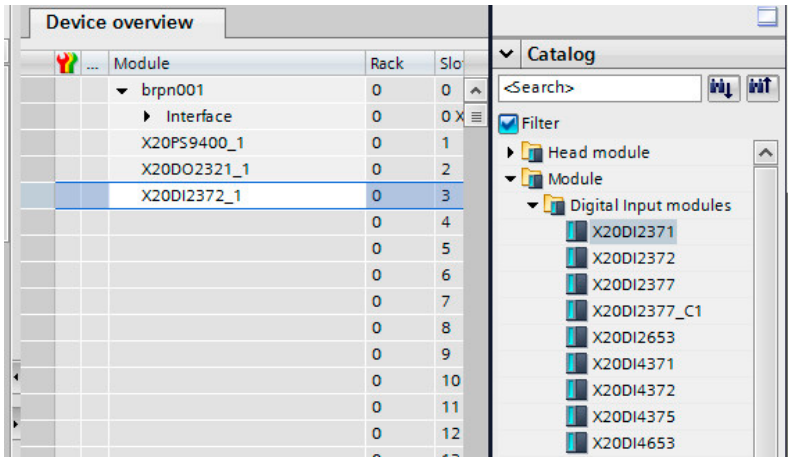
To set the PROFINET IO device name in the TIA Portal, select the PROFINET bus controller (X20BC00E3) from the drop-down list in the **Device overview**. By double-clicking on the image of the module, the setting options become visible below. The desired PROFINET IO device name must be set here.

If "Generate PROFINET device name automatically" is active, the default name stored in the PROFINET IO device is assigned automatically.

In addition, the IP address must be assigned. An IP address is assigned from the address range of the PROFINET IO controller by default. This IP address corresponds to the management IP address of the CPU. For more information, see "Establishing a connection to the hardware" on page 59.



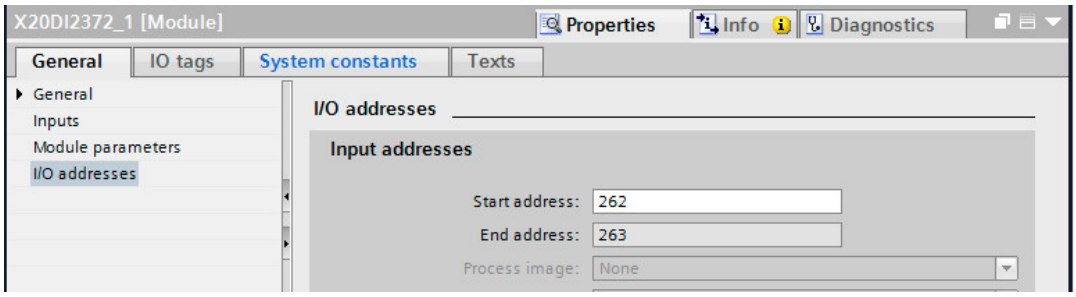
● In addition, further configurations can be carried out for the module.



● After modules are added, they can be easily configured by selecting them.

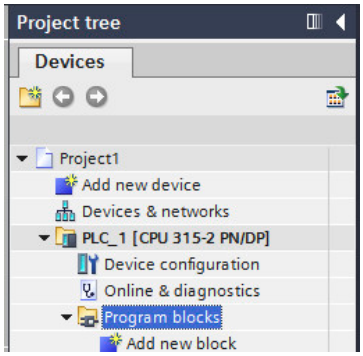
Example

The "End address" of a module is read out via *Properties* → *General* → *I/O addresses* in order to be able to link it with a variable created in the application.

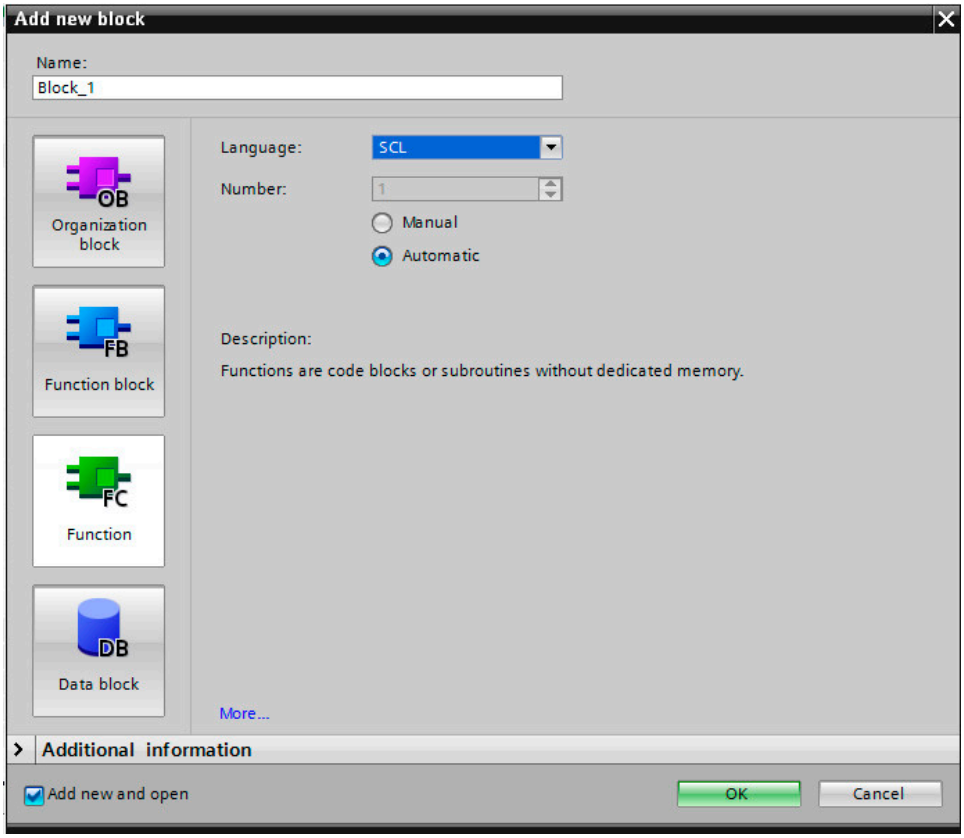


12.3 Creating the application

● An application can be added via *Project tree → Program blocks*.



● If a new program is created via **Add new block**, first the name of the block as well as the programming language are set and confirmed by clicking **OK**.
In this example it is **SCL** (Structured Text), although any programming language can be used.

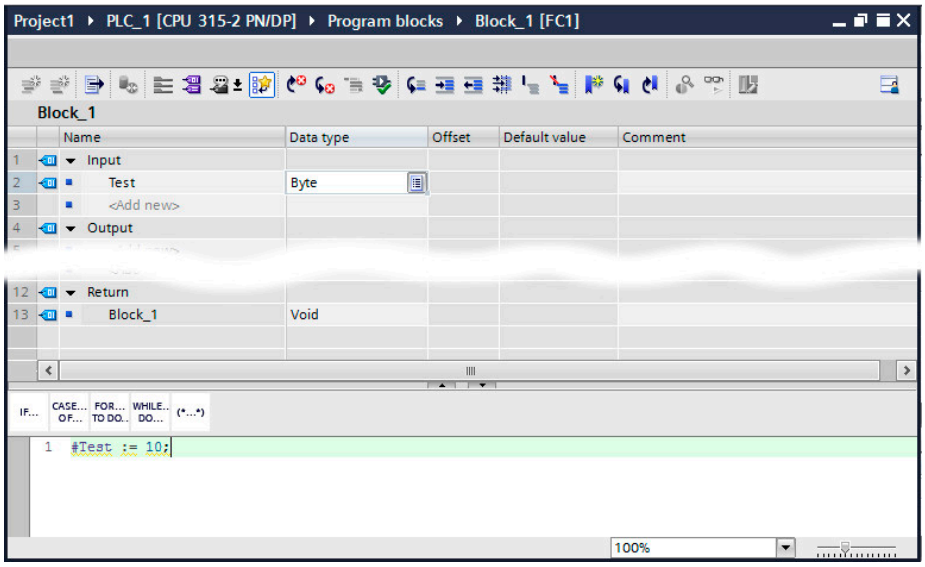


● The block is broken into two parts

- Variables can be created in the upper portion of the block.
- The application is programmed in the lower portion.

Example

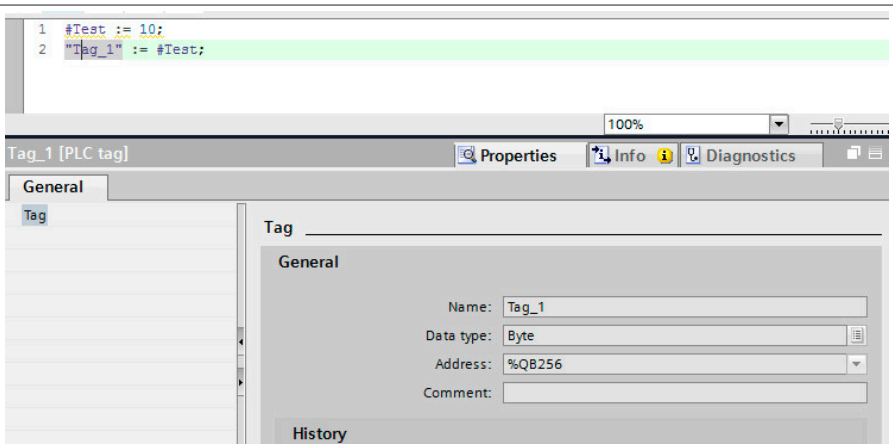
A variable named "Test" and with data type "BYTE" should be created and assigned using the application of the value 10.



● Now a **tag** can be created in the application so that the variable can be linked with an output via an address. This is created with "%QB + address" or "%IB + address":

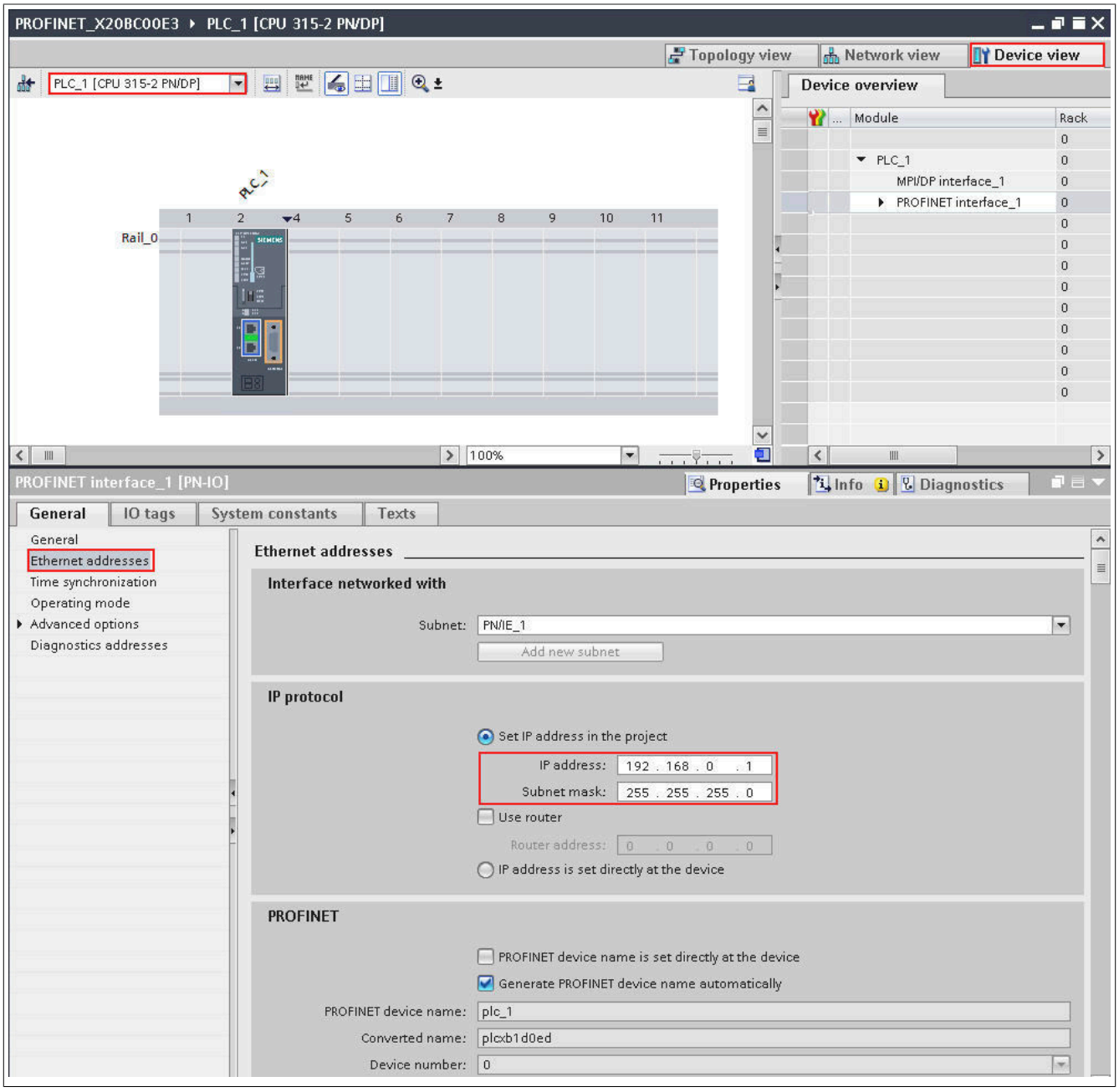
Example

The tag %QB256 is assigned to the "#Test" variables.

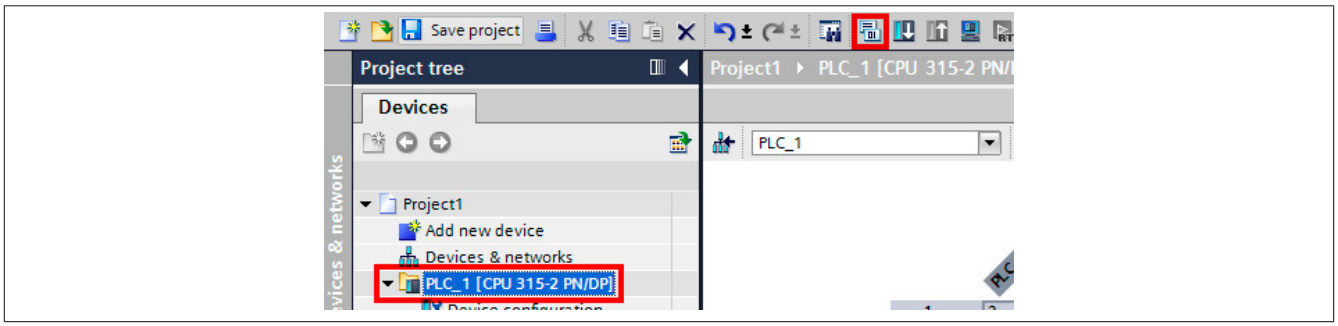


12.4 Establishing a connection to the hardware

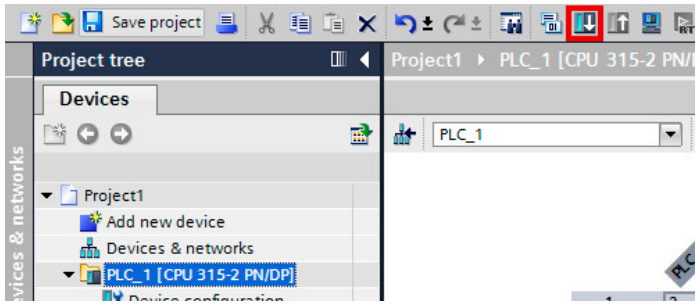
● To establish a connection from the TIA Portal to the CPU, the IP address and CPU subnet mask must be configured in the TIA Portal. To do this, select the CPU in the **Device view**. Clicking on the Ethernet interfaces with the mouse opens the corresponding window in menu "Properties". The IP address and subnet mask can be entered here. The management IP address of the CPU corresponds to the PROFINET IO controller IP address.



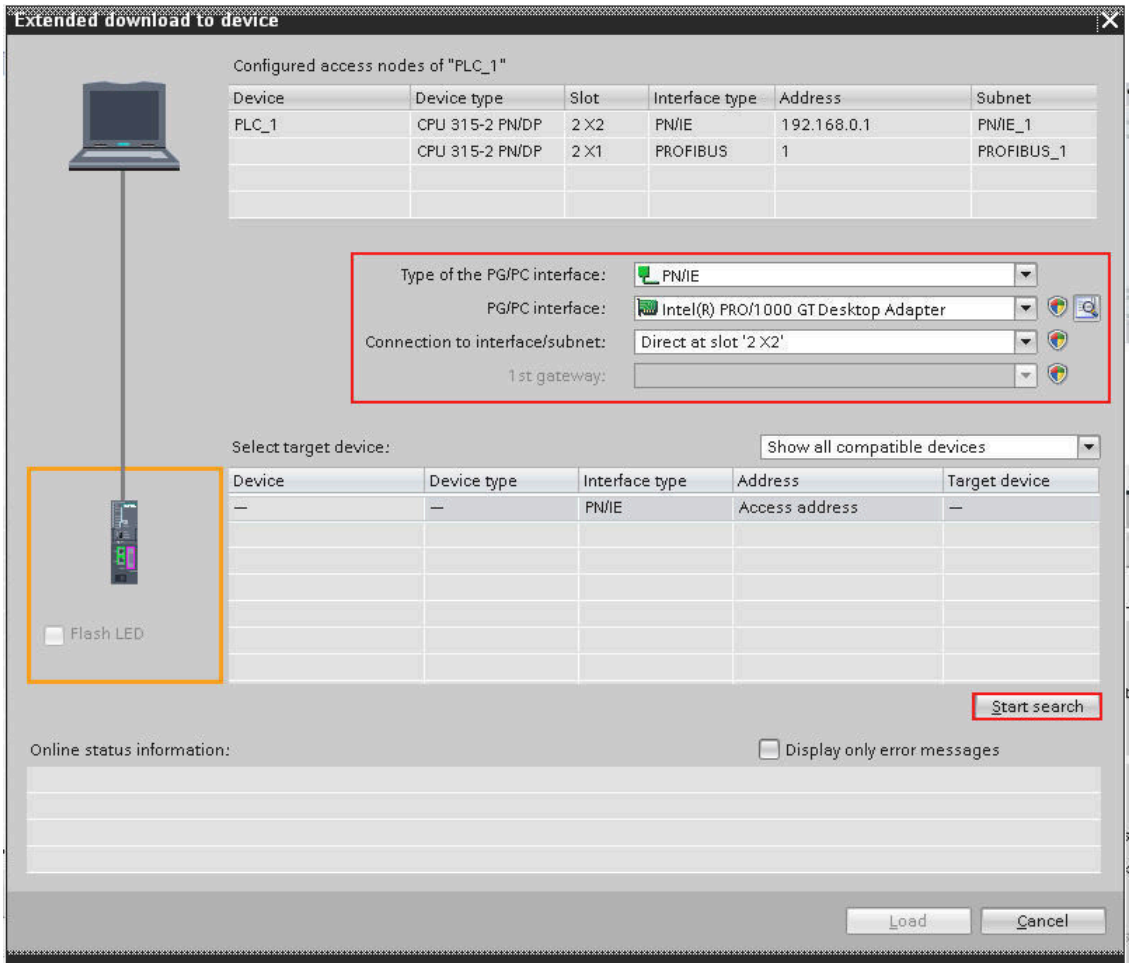
● Now the project can be translated. For this, the "PLC_1[CPU 315-2 PN/DP" CPU is selected from the **Project tree** view and the **Compile** button is selected in the toolbar.



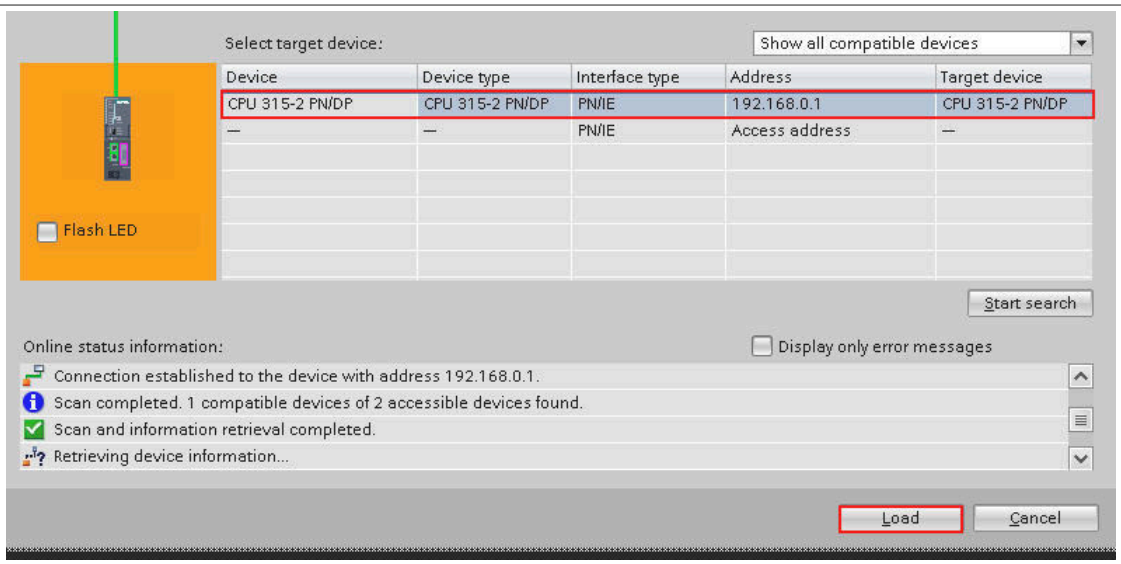
● After the project has been successfully translated, it can be loaded to the device. To do this, click on **Download to device** in the toolbar.



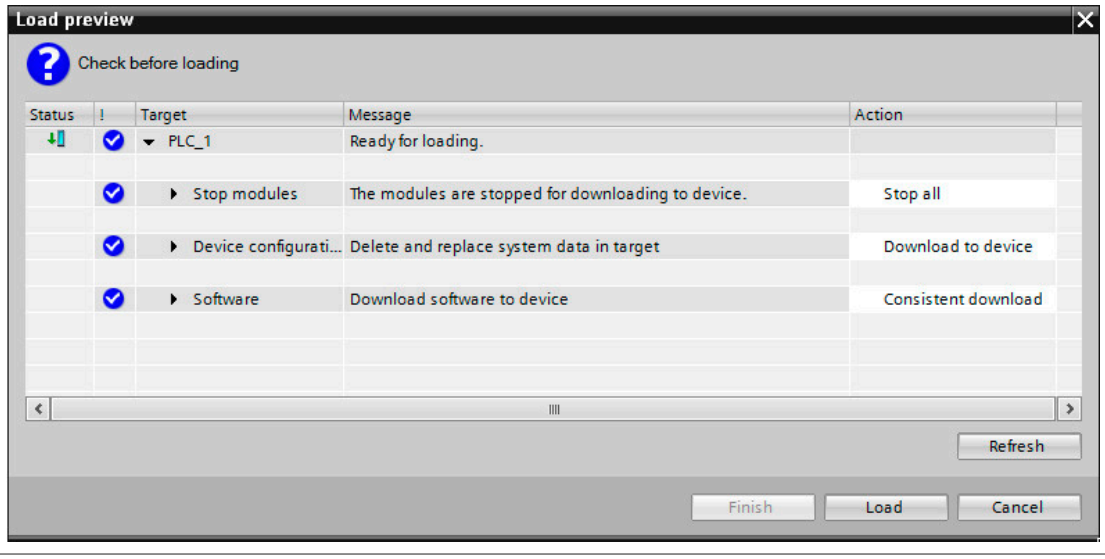
● A dialog box opens in which the interface configuration can be set.
Click on **Start search** to search through the network for devices. If no devices are found, this indicates that the IP address was set incorrectly in the CPU.



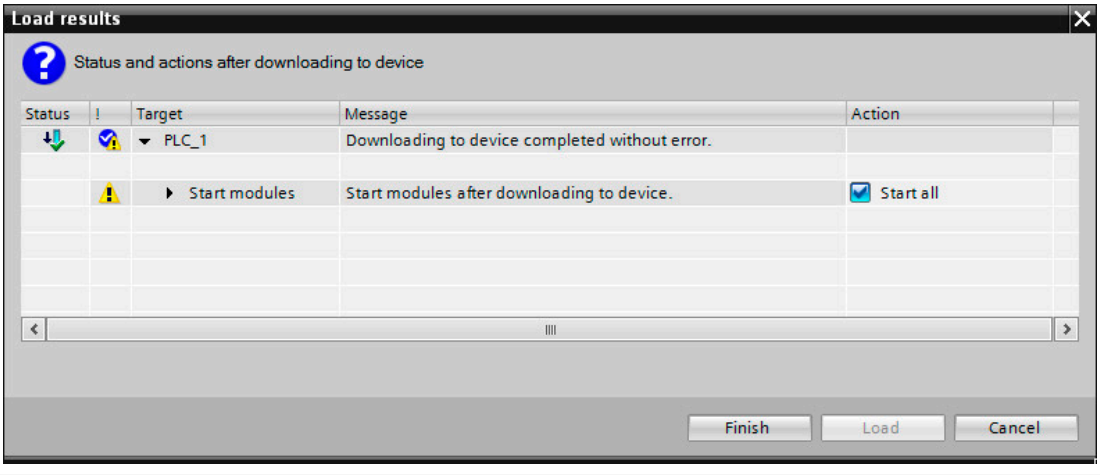
● The devices found are listed under **Compatible devices in target subnet** after a successful search. After selecting the CPU, the data can be loaded to the CPU by clicking on **Load**.



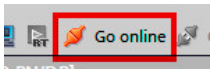
● Before loading, a notification window is opened that lists a preview of all loading cycles. This way you can check if the correct data is being transferred. After clicking on **Load**, the data is transferred.



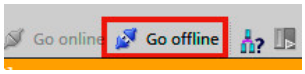
● The result of the loading cycle is listed and must be confirmed by selecting **Finish**.



● The **Go online** button is selected to establish a connection to the CPU. The connection is established and the slave is set to the run state if it is configured properly.
No change to the configuration and application can be carried out in the run state.



● The connection to the CPU can be disconnected by selecting **Go offline**.



● The application can be started and stopped by clicking on **Start CPU** and **Stop CPU** in the toolbar.