



## Quick Start Guide PN/MQTT Coupler

Order number: 700-162-3MQ02

Version  
**2** en

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# 1 Safety instructions

## Target audience



This description is only intended for trained personnel qualified in control and automation engineering who are familiar with the applicable national standards.

For installation, commissioning, and operation of the components, compliance with the instructions and explanations in this operating manual is essential. The specialist personnel is to ensure that the application or the use of the products described fulfills all safety requirements, including all applicable laws, regulations, provisions, and standards.

## Intended use



The device has a protection rating of IP 20 (open type) and must be installed in an electrical operating room or a control box/cabinet in order to protect it against environmental influences. To prevent unauthorized operation, the doors of control boxes/cabinets must be closed and possibly locked during operation.

The consequences of improper use may include personal injury to the user or third parties, as well as property damage to the control system, the product, or the environment. Use the device only as intended!.

## Operation



Successful and safe operation of the device requires proper transport, storage, setup, assembly, installation, commissioning, operation, and maintenance.

Operate the device only in flawless condition. The permissible operating conditions and performance limits (technical data) must be adhered to.

Retrofits, changes, or modifications to the device are strictly forbidden.

# 2 Introduction



This document explains the initial commissioning of the PN/MQTT Coupler. The latest version of the documentation can be found at [www.helmholz.de](http://www.helmholz.de) or scan the QR code directly.



### 3 Function of the PN/MQTT Coupler

The MQTT protocol has become established in recent years as a simple transmission protocol for messages in the IoT world. MQTT stands for "Message Queue Telemetry Transport Protocol" and is an OASIS standard. Information on the MQTT protocol can be found here: [mqtt.org](http://mqtt.org)

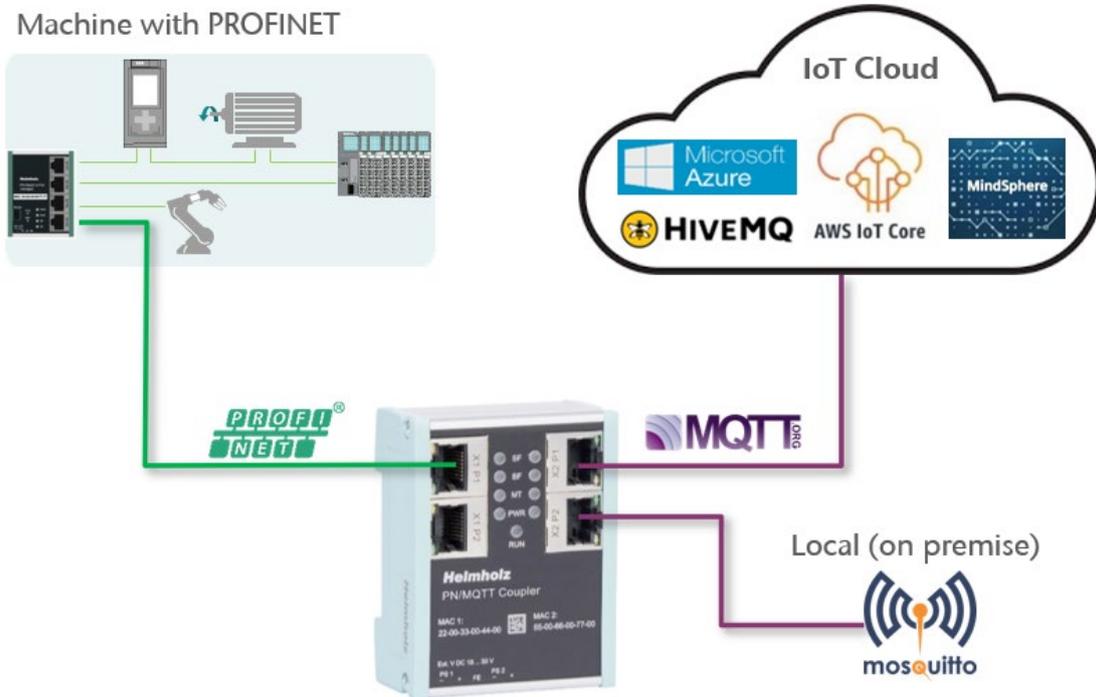
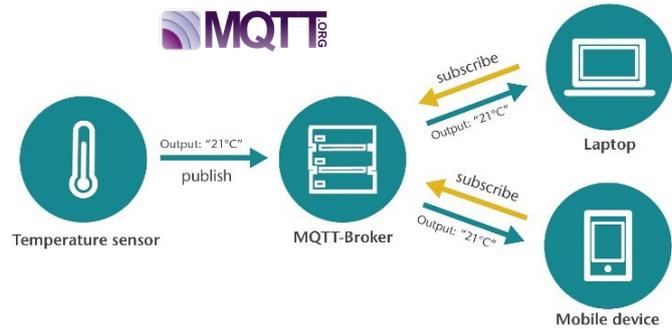
The MQTT protocol always uses a central broker for communication between devices, which receives messages from e.g. a sensor and forwards them to interested devices, e.g. a control unit.

When a sensor sends data to the broker, this is called "publish". If a device needs data, it must subscribe to the broker ("Subscribe"). The broker delivers the data to all subscribers when new data has arrived from the publisher.

Data is always transmitted under a freely definable identifier - the "Topic". The "Topic" is a descriptive text, e.g. "Temperature". In order to distinguish between different topics of the same type, groupings are used, e.g. "Living room/temperature". The groupings are divided by a hyphen ('/'). Thus the data can be mapped into more complex structures: "Upper floor/Living room/Temperature" or "Upper floor/Living room/Humidity".

The data delivered via MQTT can be transmitted in binary format, text format or structured in JSON format.

With the PN/MQTT Coupler a transfer of values between a PROFINET machine (PLC) and a MQTT broker is possible. It is possible to send values from the PLC via PROFINET to a broker ("Publish") as well as to subscribe values from a MQTT broker and receive them in the PLC via PROFINET ("Subscribe").



The integration into the PLC engineering tool is enabled by a GSDML file, an extra configuration software is not necessary. The configuration of the I/O data to be exchanged is done in the Siemens engineering tool. All settings for the MQTT connection can be done on the web page of the device.

MQTT brokers can be connected both locally ("On premise") and via the Internet ("Cloud"). A local broker can be operated, for example, with the open-source software "Mosquitto" in the company network on a PC/server or also on a small computer, such as a Raspberry PI. Such an application is described in this QuickStart Guide.



The PN/MQTT coupler can only establish a connection with one broker! If the data is also to be distributed to other brokers, the connection must be established between the brokers (Multi Broker).

In the cloud, IoT systems such as HiveMQ, Amazon IoT, Microsoft Azure or Siemens Mind-sphere (in preparation) can be connected directly. White papers on the specific configuration settings can be requested from Helmholtz Support.

## 4 Connection

### 4.1 Power supply

The PN/MQTT coupler must be supplied with DC 24 V at the wide-range input DC 18 ... 30 V via the supplied connector plug. The power supply is redundant, at least one supply path PS 1 or PS 2 must be connected.



*The housing of the PN/MQTT Coupler is not grounded. Please connect the functional earth terminal (FE) of the PN/MQTT Coupler properly to the reference gantry.*

### 4.2 Network

The left RJ45 sockets "X1 P1" and "X1 P2" are used to connect the PROFINET network, the right RJ45 sockets "X2 P1" and "X2 P2" are used to connect the Ethernet network in which the MQTT broker is accessible. The ports X1 P1 and X1 P2, as well as X2 P1 and X2 P2 are each internally connected to a switch.

The interfaces X1 and X2 are logically separate networks and not physically connected. Thus a clear separation between the machine data (PROFINET) and the MQTT data connection is possible. A network penetration with other functions by the PN/MQTT coupler is not possible.

The configured values are exchanged in the PN/MQTT coupler only as IO data between both network sides.

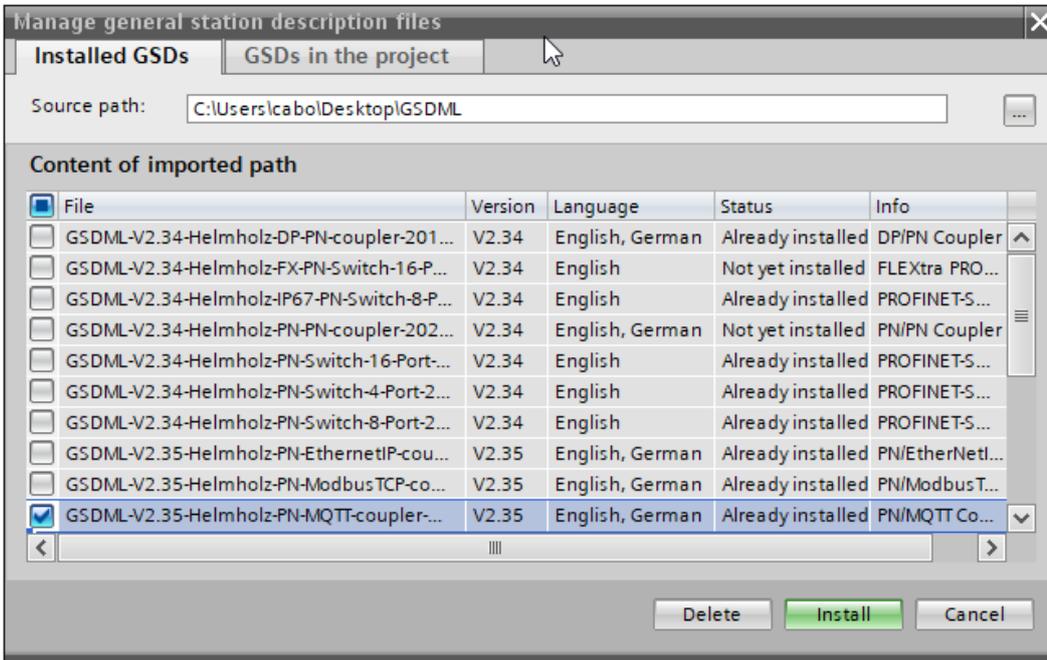
X1: PROFINET-Stack	Internal Memory	X2: MQTT Client
Outputs	→	Publish
Inputs	←	Subscribe



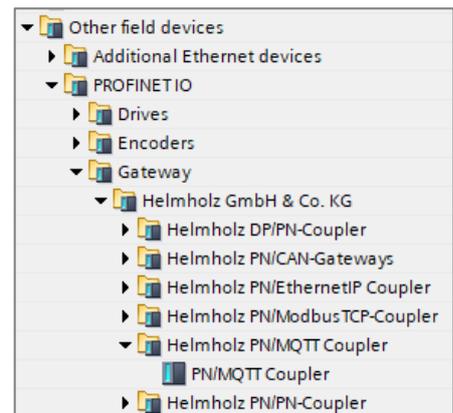
*If the MQTT broker should be placed in the same network (subnet) as the PROFINET PLC, the network X2 can be configured in the same subnet as the network X1. The interface X2 then needs its own IP address and must be connected to the network X1 with an Ethernet cable.*

## 5 Install GSDML file

Please download the GSDML file ("GSDML-V2.35-Helmholz-PN-MQTT-coupler-\_\_\_\_.xml") at [www.helmholz.de](http://www.helmholz.de) or scan the QR code. Install the GSDML file in the "Tools" / "Manage device description file (GSD)" menu in the TIA Portal.

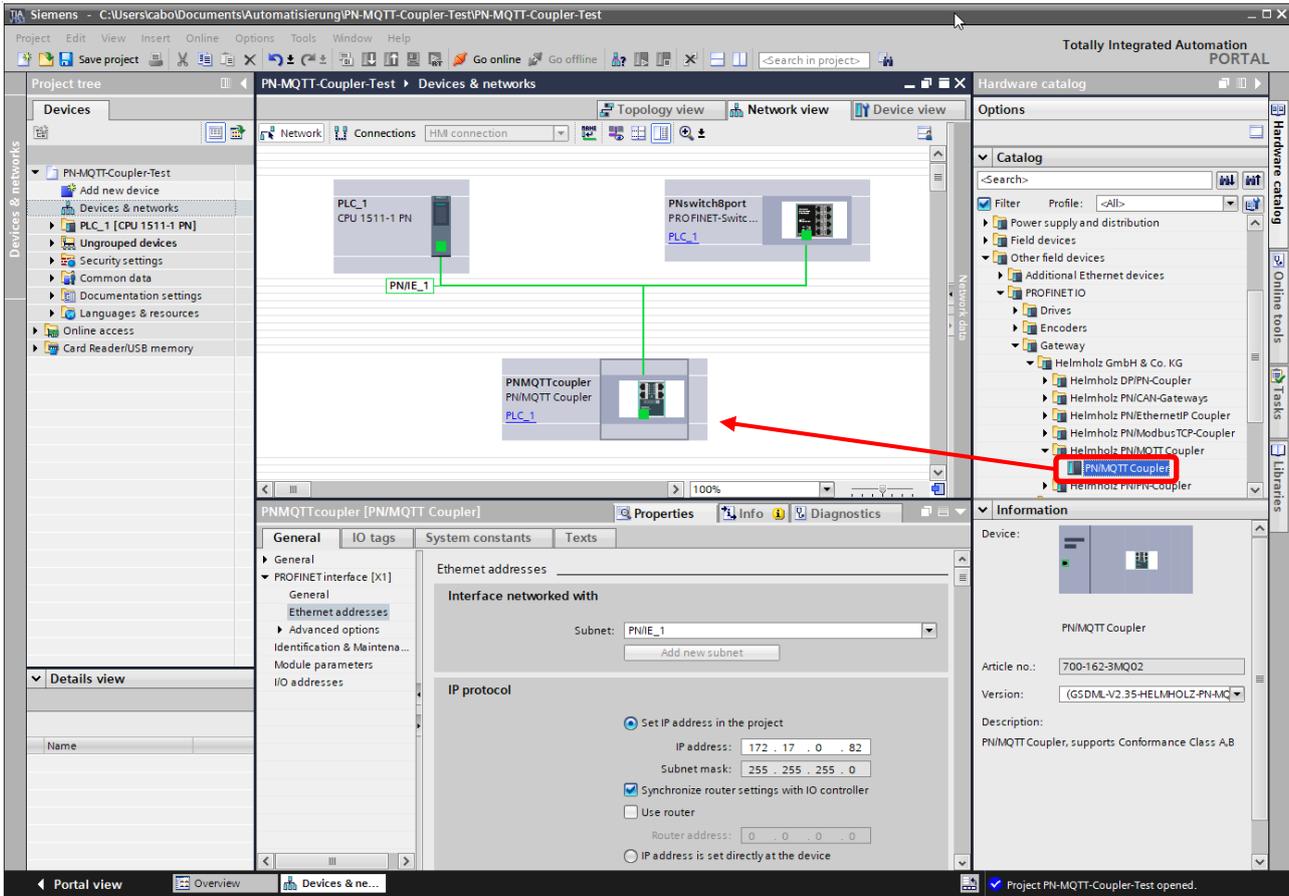


The PN/MQTT Coupler can be found in the hardware catalog at "Other field devices / PROFINET IO / Gateway / Helmholz GmbH & Co. KG".



## 6 Configuration in TIA Portal

Add the PN/MQTT coupler to the project and connect the coupler to the PROFINET network.



Assign a device name and check the Ethernet address for the device.

### 6.1 Parameterization of the PN/MQTT coupler

The parameterization of the PN/MQTT coupler is performed via the PROFINET hardware configurator (e.g. TIA Portal). The PROFINET parameters and the I/O data to be transmitted via MQTT are defined here. The configuration of the MQTT network connection (connection to the MQTT broker) is set via the web page of the device.

**Module parameters**

**Settings**

MQTT IP-address mode (X2):	Static IP
Static IP address:	192.168.128.82
Static IP subnet mask:	255.255.0.0
Static IP gateway:	192.168.2.250
Hostname mode:	From PROFINET configuration
DHCP hostname:	PNMQTTcoupler
Webpage:	on both network sides active
	<input type="checkbox"/> Diagnostic at PS1 failure
	<input type="checkbox"/> Diagnostic at PS2 failure

**MQTT IP-address mode (X2):** Setting the IP address for the X2 network. Possible options: "DHCP", "Static IP" or "use IP from web page setting".

**Static IP address:** If the address mode is set to "Static IP", the static IP address of the X2 network can be specified here.

**Static IP subnet mask:** If the address mode has been set to "Static IP", the subnet mask of the X2 network can be specified here.

**Static IP gateway:** If the address mode has been set to "Static IP", the gateway of the X2 network can be specified here.

**Hostname mode:** "From PROFINET configuration" or "From webpage".

**DHCP hostname:** Name of the device

**Webpage:** On which network interfaces should the web page be displayed.

## 6.2 Operating principle of the PN/MQTT coupler

The data exchange between the PLC and the MQTT broker is organized via individual values. A value can be 1, 2 or 4 bytes in size and is in the I/O area of the PROFINET controller. Depending on the data direction, the value is writable to outputs (MQTT Publish) or readable from inputs (MQTT Subscribe).



Up to 100 different values can be exchanged between the PROFINET controller and the MQTT broker (100 slots). The values can be plugged as modules into the slots of the coupler as required.

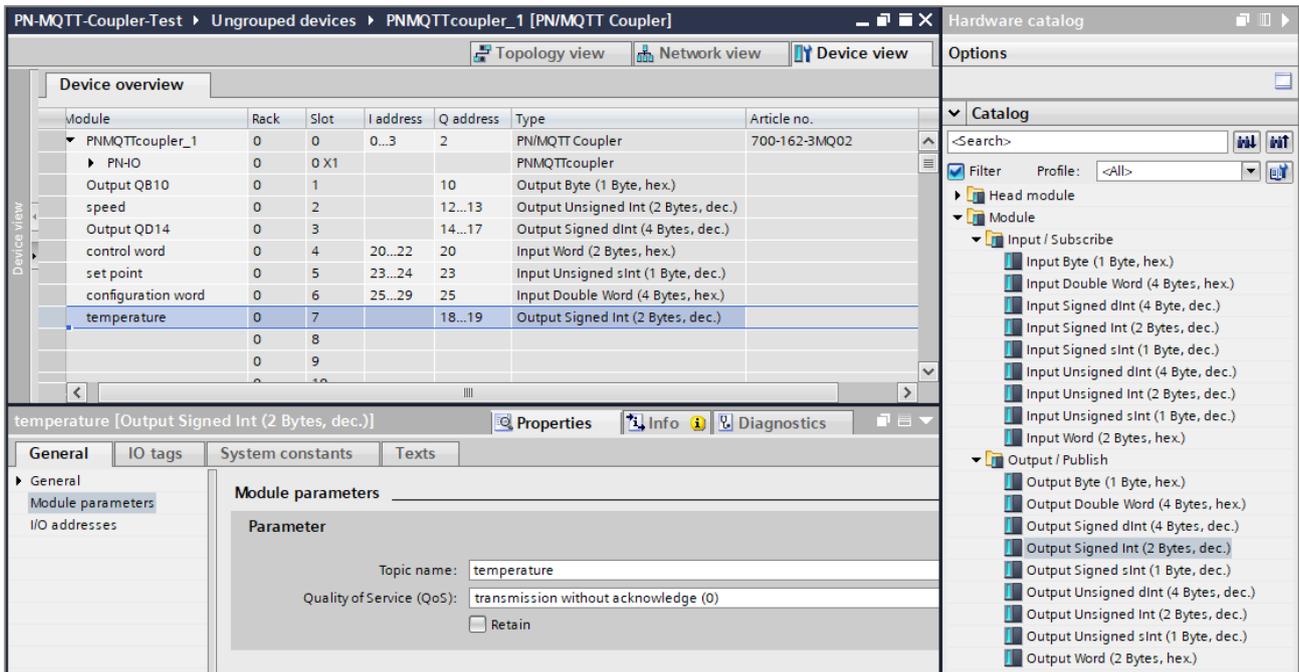
A module always represents exactly one value, which is exchanged with the broker via an MQTT topic name. A value is usually sent via MQTT in a readable form (direct text or JSON formatted). For this reason, there are different representation forms for each value size (1, 2, 4 bytes): hexadecimal, unsigned decimal, signed decimal.

*Configuration example:*

Slot	Modul	EA	Type	Direction	Topic name (Example)	Value (Example)
1	Output Byte (1 Byte, hex.)	1 Byte Output	Byte	Publish →	"Output QB10"	"0x12"
2	Output Unsigned Int (2 Bytes, dez.)	2 Bytes Outputs	Unsigned Integer	Publish →	"Speed"	"65534"
3	Output Signed dInt (4 Bytes, dez.)	4 Bytes Outputs	Signed double Integer	Publish →	"Output QD14"	"-12345678"
4	Input Word (2 Bytes, hex.)	2 Bytes Inputs	Word	← Subscribe	„Control word “	„0xFFEE“
5	Input Unsigned sInt (1 Bytes, dez.)	1 Byte Inputs	Unsigned short Int	← Subscribe	„Set point “	„255“
6	Input Double Word ( 4 Byte, hex.)	4 Bytes Inputs	Double Word	← Subscribe	„Configuration “	„0x11223344“
7	Output Signed Int (2 Byte, dez.)	2 Bytes Outputs	Signed Integer	Publish →	„Temperature“	„25“
...						

Output modules are sent to the broker once after restarting the coupler and then after each change of the PLC value. If PLC values are sent that change very quickly, it is possible to specify a publish interval on the configuration web page to reduce a communication overload.

The value of the input modules is initialized with 0 after restarting the coupler and is permanently taken over into the input area when a new value is received via MQTT. A bit additionally indicates the reception of a value in the PLC.



For each module, the **Topic name** must be defined unambiguously in the module parameters. The name can be chosen suitable to the symbolic name of the PLC value. Up to 40 characters are available.

As another parameter, the method of **Quality of Service (QoS)** of the topic can be specified.

*Transmission without acknowledge (0):* The topic is sent without an acknowledgement from the broker („fire-and-forget“)

*Transmission with acknowledge (1):* The topic is sent, and an acknowledgement ("PUBACK") is expected from the broker. If no acknowledgement is received, the topic is sent again.

*Transmission with acknowledge and confirmation (2):* Provides the guarantee that a message has been "delivered exactly once". In order to be able to keep this guarantee, MQTT uses a two-stage acknowledgement of receipt.

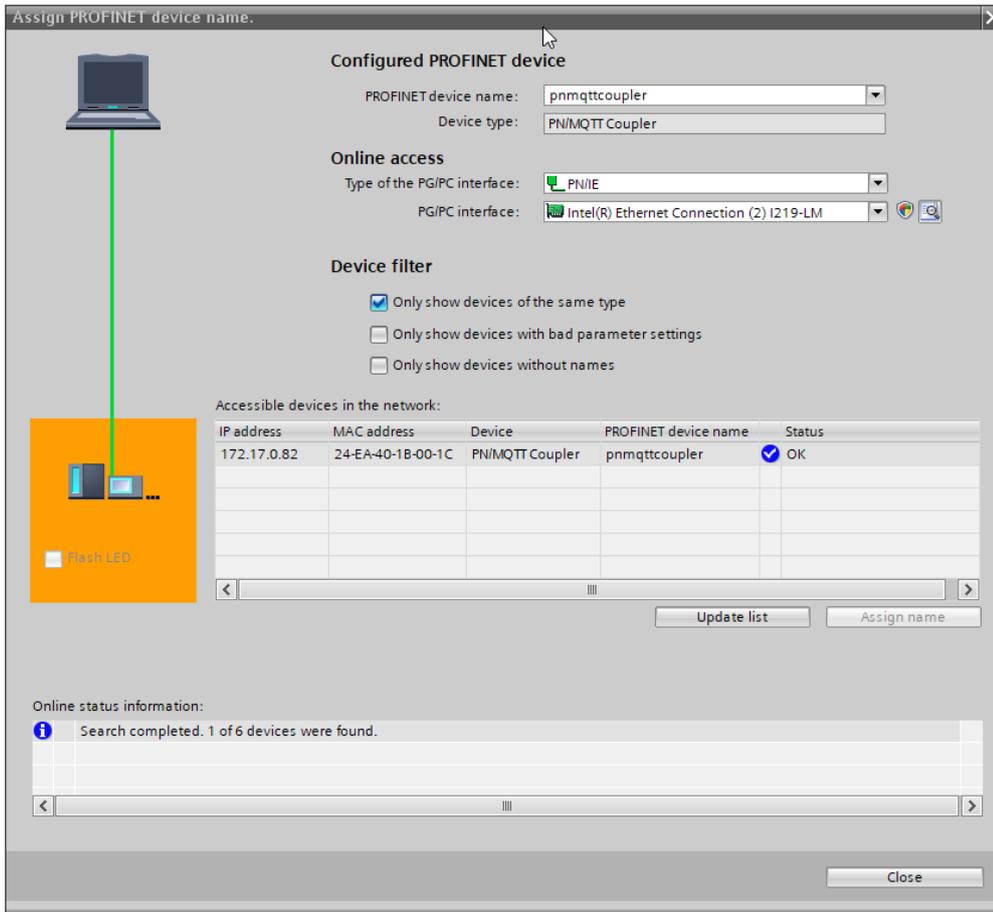
**Retain:** This option tells the broker to save the last message or value in the broker even if the connection to the MQTT client fails.

### 6.3 Assign a name to the PN/MQTT coupler

When the configuration of the PN/MQTT coupler is completed in the hardware configurator of the engineering tool, it can be imported into the PLC.

To enable the PN/MQTT Coupler to be found by the PROFINET controller, the PROFINET device name must be assigned to the PN/MQTT Coupler. To do this, use the "Assign device name" function, which you can access with the right mouse button or in the Online menu if the PN/MQTT Coupler is selected.

Use the "Update list" button to search the network for PROFINET stations. With "Assign name" the PROFINET device name can be assigned to the device.



The unique identification of the PN/MQTT coupler is guaranteed here by the MAC address of the device. The PROFINET MAC address can be read on the front of the PN/MQTT Coupler on the left-hand side at X1 ("MAC 1").

If the PN/MQTT coupler has received the correct PROFINET name, it is recognized and configured by the PLC. If the configuration is correct, the PROFINET "BF" LED should be off.

To set the PROFINET name, the Helmholz IPSet Tool can also be used, which can be downloaded free of charge from the Helmholz website.

Scan the following QR code to download the IPSet Tool:



## 7 Configuration of MQTT connection

### 7.1 Access to the web page

As soon as the PN/MQTT coupler has been configured via the PROFINET PLC, the web page of the device is accessible via the PROFINET network. If the IP address is also available on the MQTT network page (static IP, DHCP successful), the web page is also accessible via the MQTT network. When accessing the device for the first time, a password must be assigned for the user "admin".

The screenshot displays the web interface for a Helmholz PN/MQTT Coupler. The page title is "PN/MQTT COUPLER" and the Helmholz logo is in the top right corner with the tagline "COMPATIBLE WITH YOU". The navigation menu includes: Overview, Module config, MQTT, MQTT TLS, Account, TLS certificates, Firmware upgrade, and Factory reset. The "Overview" section is active and shows two configuration panels: "PN Configuration X1 (left)" and "MQTT Configuration X2 (right)".

PN Configuration X1 (left)	
Device name	pnmqttcoupler
Operating mode	Connected
LEDs	SF: ● BF: ● MT: ● PWR: ●
MAC address	24:ea:40:1b:00:1c
IP address	172.17.0.82
Port 1 status	Link up, 100 MB/FD
Port 2 status	Link down, -/-

MQTT Configuration X2 (right)	
Mode	MQTT client
Operating mode	Connected
LEDs	SF: ● BF: ● MT: ● PWR: ●
MAC address	24:ea:40:1b:00:1f
IP address	192.168.128.82
Port 1 status	Link up, 100 MB/FD
Port 2 status	Link down, -/-

**Time**

Uptime	28:21:01
SNTP state	Server unreachable
System time	05:21:00
System date	02.01.2000

www.helmholz.com



NOTE

*If the web page of the device is not available, please check the "Web page" parameter in the PROFINET configuration. (see chap. 6.1).*

## 7.2 MQTT Configuration

The configuration to connect the MQTT broker can be done in the "MQTT" menu.

In the "IP Address" section, the IP address of the right network port "X2" of the PN/MQTT Coupler is displayed and can be set if it has not been specified via the PROFINET configuration.

The MQTT broker is addressed via interface X2. If the MQTT broker is located in the same network as the PROFINET PLC, see note in chapter 4.2.

The necessary settings for connecting to a local MQTT broker can be made on in the "MQTT Client Settings" area.

**MQTT version:** The PN/MQTT Coupler supports the MQTT standard "3.1.1" and the new standard "V5". Since the two standards are not compatible, the MQTT version must be set to match the broker.

**ClientID:** Name of the MQTT client when logging on to a broker

**Username/Password:** Authentication at the broker

**Broker address:** IP address of the broker. The broker must be in the same subnet as the IP address of the coupler's X2 network.

**Broker TCP Port:** Port for the MQTT connection to the broker

**Keep alive:** Time grid for the cyclic life message of the coupler to the broker. If this message is missing, the broker assumes a failure of the coupler.

**Clean session:** Information to the broker when establishing the connection whether old messages should be deleted or saved.

**Transport Layer Security (TLS):** The transmission between the client and the broker can be encrypted.

*Disabled:* unencrypted data exchange between client and broker

*Enabled – without certificates:*

Enables encryption without authentication. This option does not require CA nor client certificate.

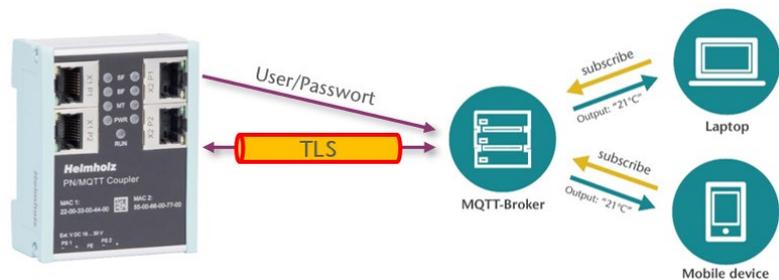
*Enabled – broker certificate:* enables encryption with broker authentication done by the client. This option requires CA to be uploaded for broker verification, see menu "MQTT TLS".

*Enabled – mutual TLS:* enables encryption with mutual broker and client authentication. With this option CA and client certificate is required. On top of broker verification done by client, broker can also verify client, because it sends its certificate during TLS handshake. Upload TLS-files in menu "MQTT TLS".

**Verify broker certificate (SNTP must be active):** It is checked whether the broker certificate has expired.

IP Address	
Mode	<input type="radio"/> DHCP <input checked="" type="radio"/> Static
DHCP - Hostname	PNMQTTcoupler
Current IP address	192.168.128.82
Current netmask	255.255.0.0
Current gateway	192.168.2.250
Current DNS server address	192.168.1.8

MQTT Client Settings	
MQTT version	3.1.1
ClientID	PNMQTTcoupler
Username	Username
Password	Password
Broker address	192.168.128.4
Broker TCP port	1883
Keep alive [Seconds]	60
Clean session	<input checked="" type="checkbox"/>
Transport Layer Security (TLS)	Disabled
Verify broker certificate (SNTP must be active)	<input type="checkbox"/>
MQTT Payload Data Format	Text
Publish interval [0.1s] (0 = as fast as possible)	0



**MQTT payload data format:** The value of a topic is always sent in simple text form.

Example:        -12345

Some MQTT applications expect a structured form in JSON format.

Example:        {  
                  "value": "-12345"  
                  }

**Publish interval:** An MQTT message is sent automatically when the output value in the PLC changes. If PLC values are sent that change very fast it is possible to limit the send interval. '0' tells the coupler to send as fast as possible and a number greater than zero tells it not to send faster than  $x * 0.1$  seconds.

### 7.3 Modul-Status

On the web page "Module status" the configured module configuration and the current IO data are displayed. If there is a configuration error, the error is displayed in the "Diagnostic message" column.

Module Configuration				
	Module Type	PN Configuration X1 (left)	MQTT Configuration X2 (right)	Diagnostic message
Slot#: 0	PN/MQTT Coupler	IN 4 Bytes (0xB3 01 00 00) / OUT 1 Byte (0x00)	Control Bits (0x00) / Status Register (0xB3 01 00 00)	
Slot#: 1	Output Byte	OUT 1 Byte (0x00)	PUBLISH: "Output_Byte_QB101" (0x00), QoS=0, Retain=False	
Slot#: 2	Output Unsigned short Int	OUT 1 Byte (0x00)	PUBLISH: "Output_Unsigned_sInt_QB102" (0x00), QoS=0, Retain=False	
Slot#: 3	Output Signed short Int	OUT 1 Byte (0x00)	PUBLISH: "Output_Signed_sInt_QB103" (0x00), QoS=0, Retain=False	
Slot#: 4	Output Word	OUT 2 Bytes (0x00 00)	PUBLISH: "Output_Word_QW110" (0x00 00), QoS=0, Retain=False	
Slot#: 5	Output Unsigned Int	OUT 2 Bytes (0x00 00)	PUBLISH: "Output_UnsignedInt_QW112" (0x00 00), QoS=0, Retain=False	
Slot#: 6	Output Signed Int	OUT 2 Bytes (0x00 00)	PUBLISH: "Output_SignedInt_QW114" (0x00 00), QoS=0, Retain=False	
Slot#: 7	Output double Word	OUT 4 Bytes (0x00 00 00 00)	PUBLISH: "Output_DoubleWord_QD120" (0x00 00 00 00), QoS=0, Retain=False	
Slot#: 8	Output Unsigned double Int	OUT 4 Bytes (0x00 00 00 00)	PUBLISH: "Output_Unsigned_dInt_QD124" (0x00 00 00 00), QoS=0, Retain=False	

## 8 Status and control via the PLC

### 8.1 Status of PN/MQTT Coupler

The PN/MQTT Coupler provides a status (4 bytes) via the PROFINET input image:

Byte/Bit	7	6	5	4	3	2	1	0
<b>Input Byte 0</b>	PROFINET configuration OK	0	PS 1 Voltage available	PS 2 Voltage available	0	0	X2 network IP address available	X2 network cable detected
<b>Input Byte 1</b>	0	0	0	0	0	0	0	MQTT Broker connection active
<b>Input Byte 2</b>	Last MQTT error code (MQTT V5) or Connect Return/Reason-Code							
<b>Input Byte 3</b>	<i>Reserved</i>							

### 8.2 Control of PN/MQTT Coupler

The PN/MQTT coupler can be controlled via the following control bits (1 byte) in the PROFINET output image:

Byte/Bit	7	6	5	4	3	2	1	0
<b>Output Byte 0</b>	MQTT lock data exchange	MQTT Disconnect connection	-	-	-	-	-	Clear MQTT Error Code

### 8.3 Subscribe Module

In addition to the input data for the actual value, the subscriber modules additionally have a status byte and a control byte.

**Status bits of Subscribe Module:**

Byte/Bit	7	6	5	4	3	2	1	0
<b>Input Byte 0</b>	1 = new data received	Receive counter						

**Control bits of Subscribe Module:**

Byte/Bit	7	6	5	4	3	2	1	0
<b>Output Byte 0</b>	1 = Reset data receive bit	-	-	-	-	-	-	-

## 9 Technical data

Order no.	700-162-3MQ02
Article designation	PN/MQTT Coupler
PROFINET interface (X1)	
Connection	2x RJ45, integrated switch
Protocol	PROFINET IO Device as defined in IEC 61158-6-10
Transmission rate	100 Mbit/s full duplex
I/O image size	max. 1024 Byte of input/output data
Number of configurable slots	100
Features	PROFINET Conformance Class B ( <i>in preparation</i> ), media redundancy (MRP-Client), automatic addressing, Topology detection (LLDP, DCP), diagnosis alarms
MQTT interface (X2)	
Connection	2x RJ45, integrated switch
Protocol	
Transmission rate	10/100 Mbit/s, full-/half duplex
Status indicator	9 LEDs function status, 8 LEDs Ethernet-status
Voltage supply	DC 24 V (18 - 28 V DC)
Current draw	max. 210mA
Power dissipation	max. 5 W
Dimensions (D x W x H)	35 x 58 x 72 mm
Weight	approx. 135 g
Certifications	CE, PROFINET Conformance Class B ( <i>in preparation</i> )
Protection rating	IP 20
Relative humidity	95% non-condensing
Mounting position	any
Ambient temperature	0° C to 60° C
Transport and storage temperature	-20° C to 80° C

## 10 LED status information

	X1 PROFINET (left side)	X2 MQTT network (right side)
<b>SF (red)</b>		
Off	Configuration correct	Configuration correct
On	There is no configuration, the configuration is faulty or MQTT broker connection is not possible.	PROFINET side not configured or failed
Flashing	PROFINET function "LED flashing" for finding the device is executed	-
<b>BF (red)</b>		
Off	The device is configured	Network configuration is valid and MQTT broker connection is active
On	The device has no configuration, the PROFINET device name is incorrect, or there is no connection with the PROFINET controller	Network configuration is valid, but no MQTT broker connection exists
Flashing	PROFINET function "LED flashing" for finding the device is executed	No connection possible due to faulty or non-existent network configuration
<b>MT (yellow)</b>		
Flashing	A firmware update is being carried out	A firmware update is being carried out
Flashing with SF and BF	PROFINET function "LED flashing" for finding the device is being carried out	
<b>PWR (green)</b>		
On	PS1 Power supply present	PS1 Power supply present
<b>RUN (green)</b>		
Off	Firmware or device defective. Please contact Support	
On	The device is ready to operate	
<b>RJ45 LEDs</b>	X1 P1/P2 und X2 P1/P2	
Green (Link)	Connected	
Orange (Act)	Data transfer at the port active	



*The contents of this Quick Start Guide have been checked by us so as to ensure that they match the hardware and software described.*

*However, we assume no liability for any existing differences, as these cannot be fully ruled out. The information in this Quick Start Guide is, however, updated on a regular basis. When using your purchased products, please make sure to use the latest version of this Quick Start Guide, which can be viewed and downloaded on the Internet from [www.helmholz.de](http://www.helmholz.de).*

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