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Quick Start Guide
PN/ModbusTCP Coupler

Order number: 700-159-3MB01

For firmware V1.00 and above

Content

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.

Security

The device is a network infrastructure component and therefore an important element in the security consideration of a plant. When using the device, therefore, observe the relevant recommendations to prevent unauthorized access to installations and systems. Further information on this can be found in the device manual.

2 Introduction

This document explains the initial commissioning of the PN/ModbusTCP Coupler. The latest version of the document and a detailed manual can be found at www.helmholz.de or scan the QR code directly.
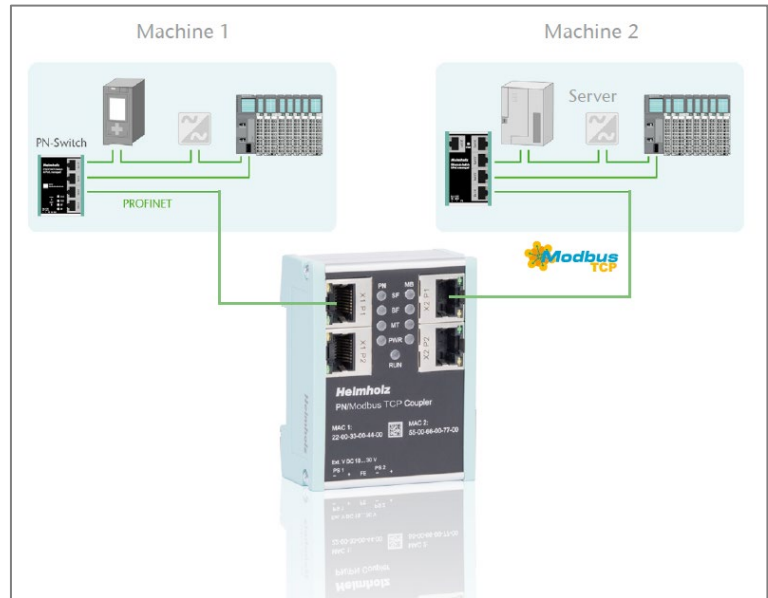
3 Function of the PN/ModbusTCP Coupler

With the PN/ModbusTCP Coupler a simple and uncomplicated connection of a PROFINET network with a ModbusTCP network is possible. The PN/ModbusTCP Coupler allows the data transfer between a PROFINET controller and ModbusTCP stations.

Received input data on one of the network sides is made available as output data to the other network side. The IO data transfer takes place live and as quickly as possible without additional handling blocks.

The maximum size of the transmitted data is 1024 bytes of input/output data. Up to 300 slots for IO modules are available.

The integration into the PLC engineering tool is made possible by a GSDML file; special configuration software isn't necessary.


In addition to the PROFINET / ModbusTCP communication, the PN/ModbusTCP Coupler also makes an MQTT Publisher available on both network sides. In this way, the values exchanged via the gateway can also be distributed via MQTT to visualization or operating data recording systems.

4 Connection

4.1 Power supply

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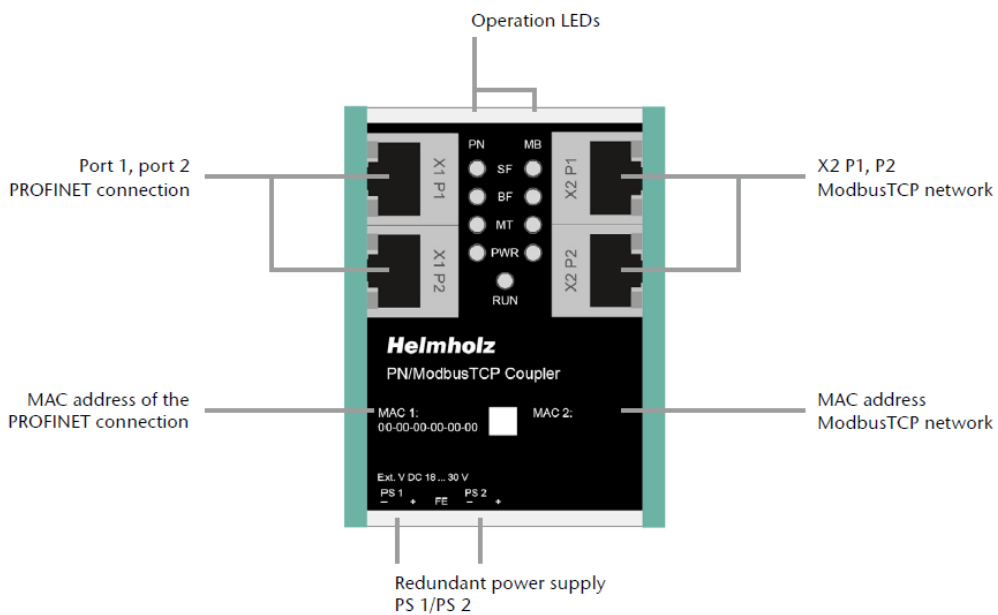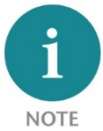
The housing of the PN/ModbusTCP Coupler is not grounded. Please connect the functional earth terminal (FE) of the PN/ModbusTCP Coupler properly to the reference potential.

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 ModbusTCP network. 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, there is a clear separation between the PROFINET network and the ModbusTCP network. A network penetration with other functions by the PN/MQTT coupler is not possible. The configured values are exchanged in the PN/ModbusTCP Coupler only as IO data between both network sides.

5   Install GSDML file

Please download the GSDML file ("GSDML-V2.34-Helmholz-PN-ModbusTCP-coupler-____.xml") at 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.
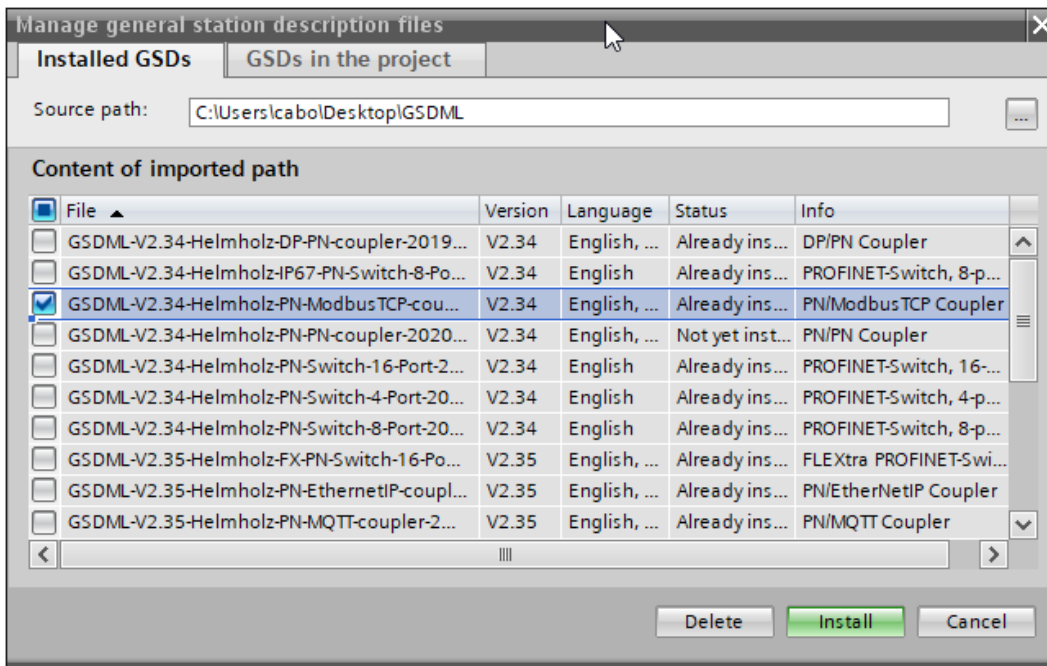
The PN/MQTT Coupler can be found in the hardware catalog at "Other field devices / PROFINET IO / Gateway / Helmholz GmbH & Co. KG".
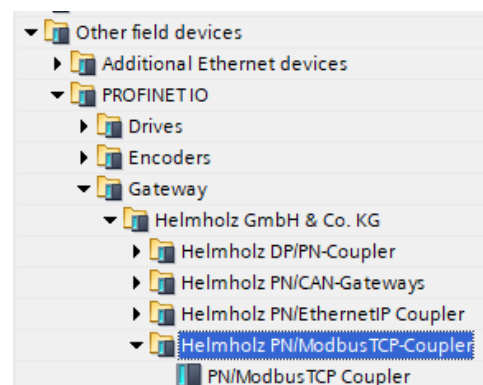
6   Data exchange concept

The PN/ModbusTCP Coupler is a ModbusTCP server. It receives data via ModbusTCP, which is transferred to the IO image of the PROFINET PLC (inputs in the PLC) and provides data, which it receives from the PROFINET PLC (outputs in the PLC).

ModbusTCP distinguishes 4 different data types:

Discrete Inputs: Input bits; written by the PROFINET PLC

Coils: Output bits or internal data bits, are read by the PROFINET PLC, but can also be written

Input Register: Input word; written by the PROFINET PLC

Holding Register: Output word or internal data word; are read by the PROFINET PLC but can also be written

All data types are numbered from 0-65535. All data types have their own memory area in the PN/ModbusTCP coupler:
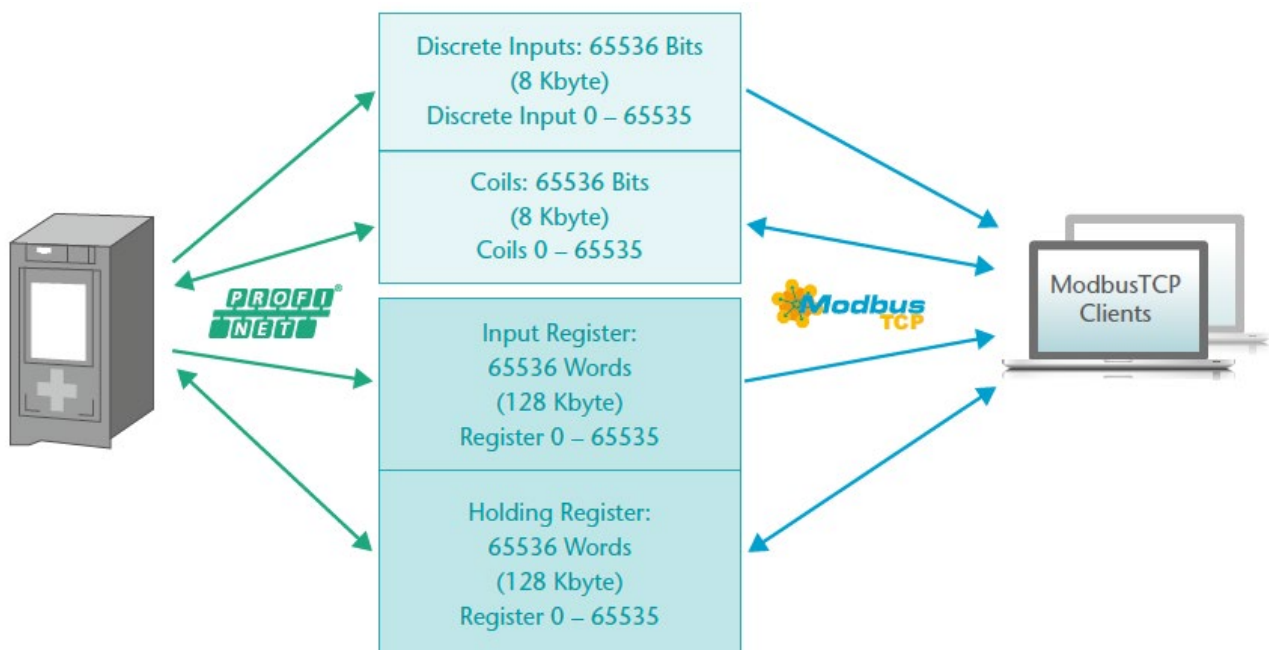
From the point of view of ModbusTCP communication, all coils, inputs and registers are always available in the PN/ModbusTCP coupler. So it is always possible to access all data types from address 0-65535.

Via the PROFINET configuration the ModbusTCP data can be assigned to the PLC I/O image in the slots, which are required in the PLC program. Up to 300 slots are available in the PN/ModbusTCP coupler for such assignments.

The following modules are available to access the ModbusTCP memory:

Discrete Inputs (PLC writes only):

- Write Discrete Inputs 1 – 32 Bytes (8 – 256 Bits)

Coils (read/write):

- Write Coils 1 - 16 Bytes (8 – 128 Bits)
- Read Coils 1 – 16 Bytes (8 – 128 Bits)
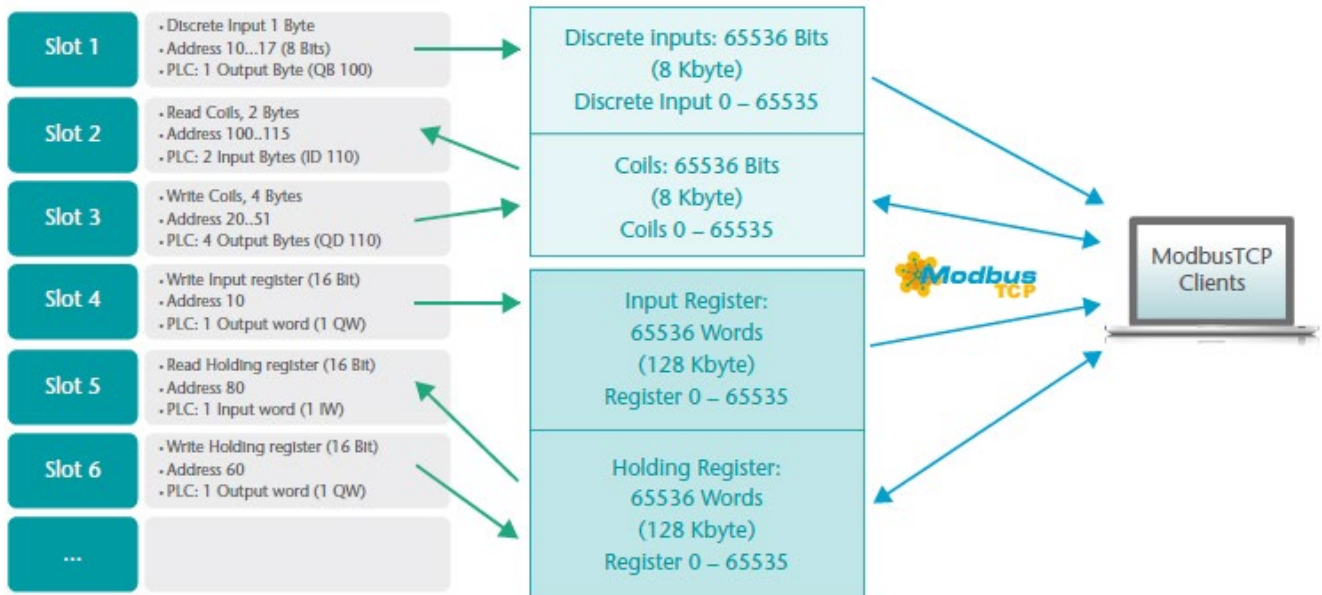
Input Register (PLC writes only):

- Write Input Register (16 Bit)

Holding Registers (read/write):

- Write Holding Register (16 Bit)

- Read Holding Register (16 Bit)

All modules have as **parameter** the register number (Input Register, Holding Register) or the first bit address (Discrete Inputs, Coils).

6.1 Example of a configuration

6.2 Supported ModbusTCP function codes

The PN/ModbusTCP Coupler supports the following function codes:

Data size	Data range	Function	Function code decimal	Function code hex
Bit access	Input bits	Read discrete inputs	2	0x02
	Output bits or internal bits	Read coils	1	0x01
		Write single coil	5	0x05
		Write multiple coils	15	0x0F
16 bit access	Input data	Read input register	4	0x04
	Output data or internal information	Read holding register	3	0x03
		Write single holding register	6	0x06
		Write multiple Register	16	0x10
		Read/write multiple holding registers	23	0x17
		Mask write holding register	22	0x16

7 Configuration in the TIA-Portal

Add the PN/ModbusTCP coupler to the project and connect the coupler to the PROFINET network.
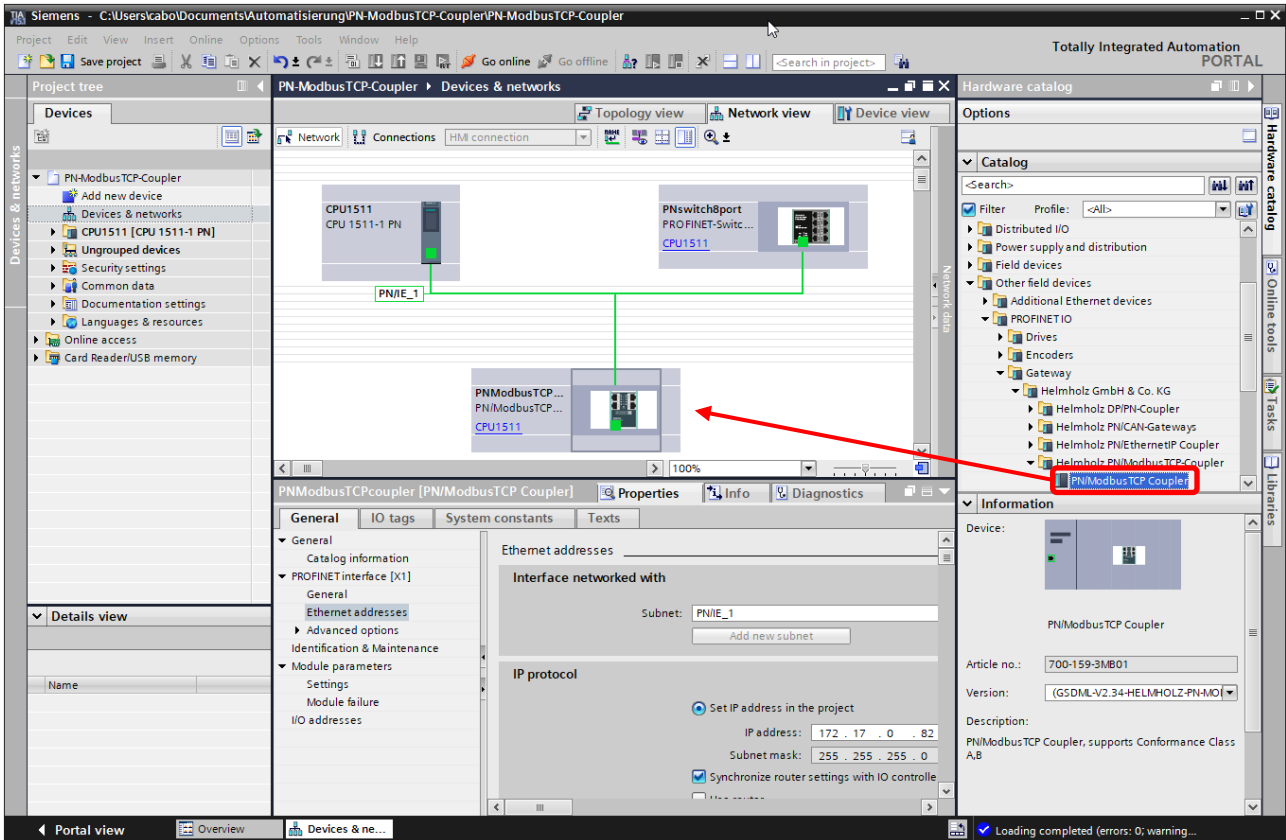
Assign a device name and check the IP address on the PROFINET network (X1) for the device.

7.1 Parameters of the PN/ModbusTCP Coupler

The parameterization of the PN/ModbusTCP Coupler can be done completely via the PROFINET hardware configurator. However, some parameters for the ModbusTCP network (X2) can optionally also be set via the web page, e.g. the IP address of the ModbusTCP server or the DHCP host name.

ModbusTCP IP-address mode: Setting the IP address for the ModbusTCP network. Selectable are "DHCP", "Static IP", "use IP from the web page setting".

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

Static IP subnet mask: If the address mode is set to "Static IP", the subnet mask can be specified here.

DHCP hostname mode: The host name of the device can be set in the PROFINET configuration or on the web page.

DHCP hostname: DHCP name of the device

ModbusTCP port: Port on which the ModbusTCP driver listens. Port 502 is always active, even if another port is set here.

Connection watchdog time (ms): Time in which a ModbusTCP connection is closed when there is no more communication over that connection. Range: 1 - 65535 ms

Maximum ModbusTCP connections: Maximum number of nodes that can establish simultaneous connections with the PN/ModbusTCP coupler.

Register for PROFINET-Status: Number of the register from which the status of the PN/ModbusTCP coupler can be read out via ModbusTCP. Range 0-65535

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

MQTT Publisher Option: On which network interfaces should the MQTT Publisher be activated (see Chap. 10).

Diagnostic at PS1/PS2 failure: In case of power supply failure at PS1/PS2 a diagnosis is sent to the PLC.

7.2 Configure ModbusTCP modules

For the data exchange between the ModbusTCP memory in the coupler and the PLC EA memory up to 300 modules can be plugged in the PROFINET configuration of the coupler. Now insert the desired modules for Discrete Inputs, Coils, Input Registers or Holding Registers into the slots.

All modules have as **parameter** the **register number** (Input Register, Holding Register) or the first **bit address** (Discrete Inputs, Coils). For the Input Bits and Coils from 8 bits (1 byte) up to 256 bits (32 bytes) can be addressed together in one slot.

Addressing of single bits is not possible via the PROFINET PLC, the smallest amount is a byte (8 Bits). However, the bit address can start at any position in the address space of the coils or discrete inputs, so it does not have to be divisible by 8.

> **i** **NOTE**
>
> Access to the same memory area by two modules is not permitted. There must be no gap in the configuration of the slots.

7.3 Assign a PROFINET device name to the PN/ModbusTCP Coupler

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

In order that the PN/ModbusTCP Coupler can be found by the PROFINET controller, the PROFINET device name must be assigned to the PN/ModbusTCP Coupler. For this use the function "Assign device name" which you can reach with the right mouse button or in the menu Online if the PN/ModbusTCP Coupler is selected.

With the "Update list…" button, the network can be browsed for PROFINET participants. The PROFINET device name can be assigned to the device with "Assign name".
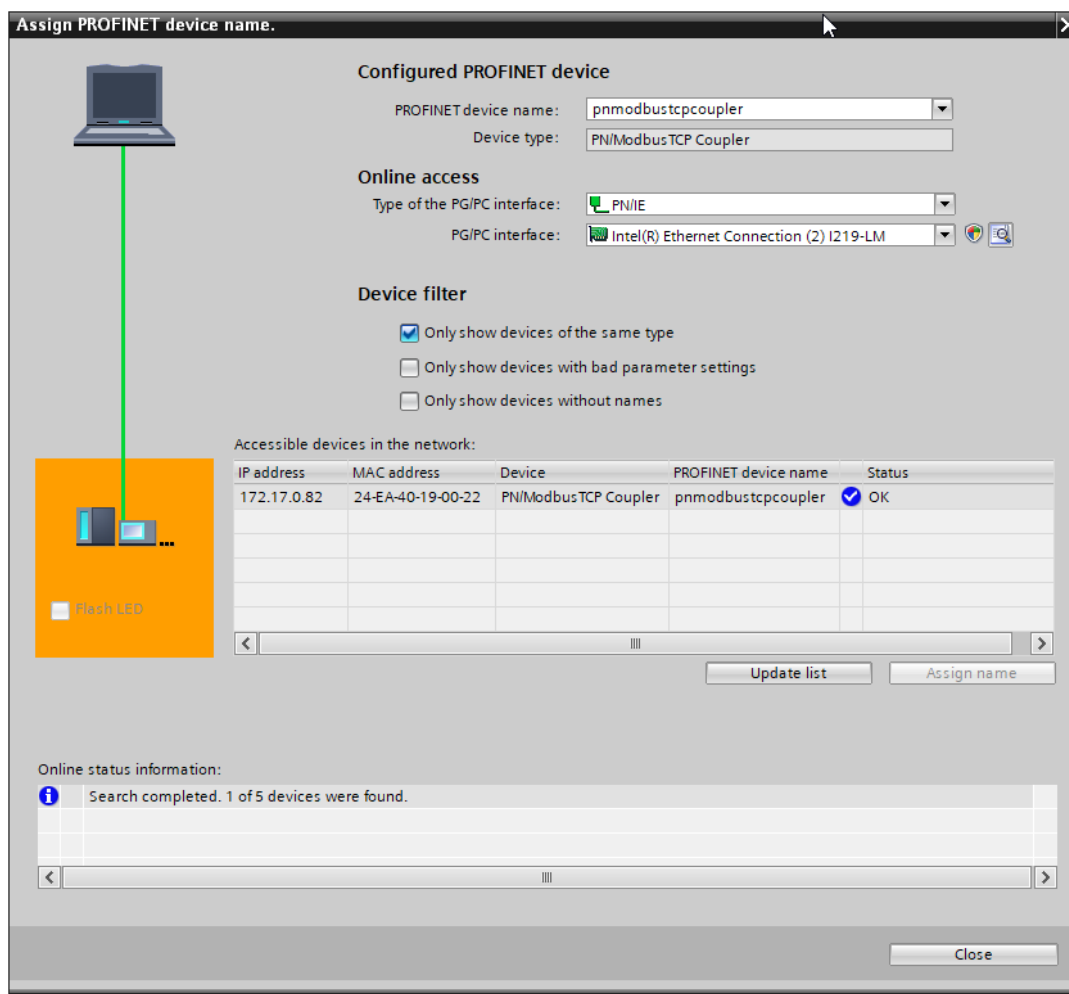
The unique identification of the PN/ModbusTCP Coupler in the PROFINET network is guaranteed by the MAC address of the device. The PROFINET MAC address can be read on the front panel of the PN/ModbusTCP coupler on the left side at X1 ("MAC 1").

If the PN/ModbusTCP Coupler has received the correct PROFINET name, then 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, you can also use the Helmholz IPSet tool, which can be downloaded free of charge from the Helmholz website. Scan the following QR code to download the IPSet tool:

8 Status and control via PLC program

The PN/ModbusTCP Coupler provides a status and a control byte via the PROFINET input image.

Status Byte 1: Status-Bits

7	6	5	4	3	2	1	0
PROFINET configuration completed. Device is ready to operate.	-	Power supply detected on PS 1 (left)	Power supply detected on PS 2 (left)	MQTT connection on network X1active	MQTT connection on network X1active	ModbusTCP network has an active IP address (static or obtained via DHCP)	Network cable detected

Status byte 2: Number of active connections

Control byte 1: Control Bits

7	6	5	4	3	2	1	0
-	-	-	-	-	-	ModbusTCP memory reset (coils, inputs, and registers)	Disconnect all ModbusTCP connections and prevent connection establishment

The PN/ModbusTCP coupler starts after successful PROFINET configuration and is immediately in operation after PLC RUN. A further release via PLC program is not necessary. If the automatic start is not desired, the PN/ModbusTCP coupler can be prevented from starting independently by setting bit 0 to 1 in the control byte during PLC startup. If the bit is later set to 0 in the PLC, the PN/ModbusTCP coupler is immediately ready for operation.

9 Web interface of PN/ModbusTCP Coupler

The web interface of the PN/ModbusTCP coupler provides an overview of the status and the configuration of the device, as well as the possibility to perform a firmware update.

Furthermore, the ModbusTCP configuration can be set in the web interface, if this is not specified by the PROFINET configuration.

When accessing the web interface for the first time, a password must be set for the default user "admin". The password can be adjusted subsequently in the "Account" menu.

The "Overview" web page shows the current settings and status. In the upper line there is the menu for further web pages.

NOTE   Calling the website may influence the transmission performance of the PN/ModbusTCP Coupler.

The "Module config" page shows the IO modules defined by the PROFINET configuration. On the ModbusTCP page the data type and the address are also indicated. The current value is displayed in brackets.

On the web page "ModbusTCP server settings" the IP address and the DNS name of the ModbusTCP network interface can be set, as far as these were not fixed by the GSDML configuration.
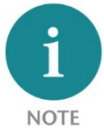
10 MQTT Publisher

The PN/ModbusTCP Coupler provides besides the PROFINET / ModbusTCP communication also a MQTT Publisher. MQTT is a widely used and simple protocol for distributing information in large networks.

For all IO modules defined in the PROFINET configuration, the current values can now be sent by the PN/ModbusTCP coupler via MQTT when the value changes.

The MQTT Publisher can be activated either on the PROFINET network side (X1) or on the ModbusTCP network side (X2), depending on which network side the data is required or where the MQTT Broker is installed. The MQTT Publisher cannot work on both network sides at the same time.

> **i NOTE** Since MQTT works slower than the priority PROFINET/Modbus TCP communication, it may be that not all value changes are transmitted via MQTT, but always only the last value state.

10.1 MQTT Publisher Settings

To be able to distribute data via MQTT in a network, an MQTT broker is always required. The broker can run anywhere in the network. The settings of the MQTT publishers can be specified separately for the two network sides on the website under "MQTT".

ClientID: The name of the MQTT publisher

Username / Password: Optional username and password to login to the MQTT broker

Broker IP address: IP address of the MQTT broker

Broker TCP port: MQTT port on the MQTT broker

Keep alive (seconds): MQTT connection monitoring during inactivity

> **i NOTE** The MQTT Publisher of the PN/ModbusTCP Coupler currently does not provide encryption!

10.2 MQTT data format

Each configured slot sends its own MQTT message. An MQTT message consists of the topic name and the actual data value (payload). Both are usually transmitted in plain text format. The data is transmitted as hexadecimal bytes for coils and discrete inputs or as a 16-bit decimal number for holding registers and input registers.

The topic name is formed depending on which network - PROFINET (X1) or ModbusTCP (X2) - the MQTT Publisher is activated on.

	PROFINET network:	ModbusTCP network:
Module	MQTT Topic Name	MQTT Topic Name
Write discrete inputs	PN-ClientID/Slot X/Output, Y bytes (1 to 32 bytes)	ModbusTCP-ClientID/Discrete Inputs/Address X, Y Bytes (1 to 32 bytes)
Read Coils	PN-ClientID/Slot X/Input, Y bytes (1 to 16 bytes)	ModbusTCP-ClientID/Coils /Address X, Y Bytes (1 to 16 bytes)
Write Coils	PN-ClientID/Slot X/Input, Y bytes (1 to 16 bytes)	ModbusTCP-ClientID/Coils /Address X, Y bytes (1 to 16 single bytes)
Read holding register	PN-ClientID/Slot X/Output (2 byte decimal value)	ModbusTCP-ClientID/Holding Register/Register X (2 byte decimal value)
Write holding register	PN-ClientID/Slot X/Output (2 byte decimal value)	ModbusTCP-ClientID/Holding Register/Register X (2 byte decimal value)
Write input register	PN-ClientID/Slot X/Output (2 byte decimal value)	ModbusTCP-ClientID/Input Register/Register X (2 byte decimal value)
Example	PN_MQTT/Slot 1/Input, 3 bytes | 0x12 0x23	MODBUS_MQTT/Coils/Address 49, 2 bytes | 0x12 0x34
	PN_MQTT/Slot 5/Output | 12345	MODBUS_MQTT/Holding Register/Register 10 | 12345

On both network interfaces the following MQTT topics can be read additionally:

"**ClientID/Modules List**": Contains the list of all topics provided by the PN/ModbusTCP coupler via the addressed interface.

"**ClientID/Status Register**": Contains the value of the two status bytes.

11 Firmware update

The firmware of the PN/ModbusTCP Coupler can be updated very easily via the website. You can get the firmware from the Helmholz website at www.helmholz.de.
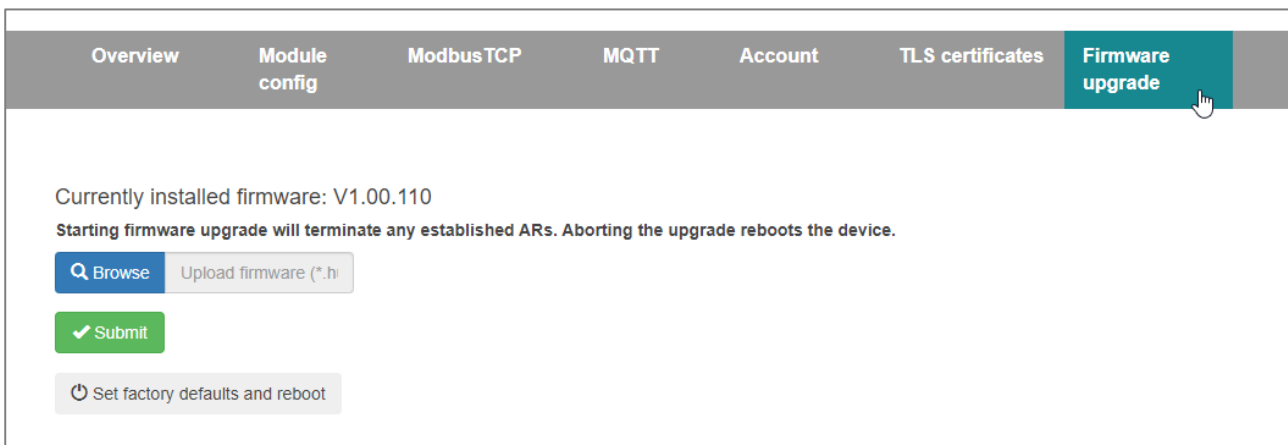
Link to the latest firmware:
http://www.helmholz.de/goto/700-159-3MB01#tab-software

The firmware file can be recognized by the file extension "HUF" (Helmholz Update File) and is encrypted to protect it from modification.

A firmware update can be performed via the web interface on the "Firmware upgrade" page.

With the button "Browse" the firmware can be selected. With the button "Submit" the firmware is transferred to the PN/ModbusTCP coupler and burned. Afterwards the PN/ModbusTCP coupler executes a reboot, and the new firmware is active.

> **!** **ACHTUNG**
>
> During the update process the operation of the PN/MQTT Coupler is interrupted. Do not switch off the device during the update process!

12 Resetting to factory settings

Resetting the PN/ModbusTCP Coupler to factory settings can be done via the web page or via the PROFINET function.

When resetting the PN/ModbusTCP coupler, the configuration is irretrievably deleted, and the settings are reset to the factory defaults. The firmware remains at the current status.

To reset via the website, use the button on the "Firmware upgrade" page: ⏻ Set factory defaults and reboot

To reset the PN/ModbusTCP Coupler, the Helmholz tool "IPSet" can also be used via the PROFINET network.

13 Technical data

Order no.	700-162-3MB01
Article designation	PN/ModbusTCP 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	Up to 1024 Byte of input and output data
Number of configurable slots	300
Features	PROFINET Conformance Class B, media redundancy (MRP-Client), automatic addressing, Topology detection (LLDP, DCP), diagnosis alarms
MQTT interface (X2)	
Connection	2x RJ45, integrated switch
Protocol	ModbusTCP Server
Transmission rate	10/100 Mbit/s, full-/half duplex
Storage size	65536 Coil Bits, 65536 Discrete Input Bits, 65536 Input Register, 65536 Holding Register
Supported function codes	1, 2, 3, 4, 5, 6, 15, 16, 22, 23
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
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

14 LED status information

	X1 PROFINET (left side)	X2 MQTT network (right side)
SF (red)		
Off	Configuration correct	Configuration correct
On	There is no configuration, the configuration does not agree with the configuration on the right side (X2), or a diagnosis exists.	PROFINET side not configured or failed
Flashing	PROFINET function "LED flashing" for finding the device is executed	-
BF (red)		
Off	The device is configured	The device is configured
On	The device has no configuration, the PROFINET device name is incorrect, or there is no connection with the PROFINET controller	No Ethernet cable plugged in or no Ethernet connection
Flashing	PROFINET function "LED flashing" for finding the device is executed	-
MT (yellow)		
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	-
PWR (green)		
On	PS1 Power supply present	PS2 Power supply present
RUN (green)		
Off	Firmware or device defective. Please contact Support	
On	The device is ready to operate	
RJ45 LEDs	X1 P1/P2 und X2 P1/P2	
Green (Link)	Connected	
Orange (Act)	Data transfer at the port active	