PN/CAN Gateway, PROFINET/CANopen Slave

Manual

Version 3 | 9.11.2023 | for firmware V3.00 and above

Order number: 700-672-PNC01

Link to newest version of manual

Notes

To download the latest version of this manual, please visit our website at www.helmholz.de.

We welcome all ideas and suggestions.

Revision Record:

Version	Date	Change
1	12/4/2020	First version
2	1/26/2021	Corrections of content
3	9.11.2023	New HW version: USB, LEDs Corrections to technical data

Contents

1   General

This operating manual applies only to devices, assemblies, software, and services of Helmholz GmbH & Co. KG.

1.1   Target audience for this manual

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.

WARNING

Configuration, execution, and operating errors can interfere with the proper operation of the PN/CAN Gateways and result in personal injury, as well as material or environmental damage. Only suitably qualified personnel may operate the devices!

Qualified personnel must ensure that the application and use of the products described meet all the safety requirements, including all relevant laws, regulations, provisions, and standards.

1.2   Safety instructions

The safety instructions must be observed in order to prevent harm to living creatures, material goods, and the environment. The safety notes indicate possible hazards and provide information about how hazardous situations can be prevented.

1.3 Note symbols and signal words

HAZARD

If the hazard warning is ignored, there is an imminent danger to life and health of people from electrical voltage.

WARNING

If the warning is ignored, there is a probable danger to life and health of people.

CAUTION

If the caution note is ignored, people can be injured or harmed.

ATTENTION

Draws attention to sources of error that can damage equipment or the environment.

NOTE

Gives an indication for better understanding or preventing errors.

1.4   Intended use

The "PN/CAN Gateway CANopen Slave" enables the connection of a PROFINET network with a CANopen network. The PN/CAN Gateway is a CANopen slave according to CiA standard DSP301 V4.2.

All components are supplied with a factory hardware and software configuration. The user must carry out the hardware and software configuration for the conditions of use. Modifications to hardware or software configurations which are beyond the documented options are not permitted and nullify the liability of Helmholz GmbH & Co. KG.

The PN/CAN Gateway may not be used as the only means for preventing hazardous situations on machinery and systems.

Problem-free and safe operation of the PN/CAN Gateway presumes proper transport, storage, setup, assembly, installation, commissioning, operation, and maintenance.

The ambient conditions provided in the technical specifications must be adhered to.

The PN/CAN Gateway has a protection rating of IP20 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 access, the doors of control boxes/cabinets must be closed and possibly locked during operation.

1.5   Improper use

> ⚠ **WARNING**
>
> The consequences of improper use may include personal injuries of the user or third parties as well as property damage to the control system, the product, or the environment. Use the PN/CAN Gateway only as intended!

1.6 Liability

The contents of this manual are subject to technical changes resulting from the continuous development of products of Helmholz GmbH & Co. KG. In the event that this manual contains technical or clerical errors, we reserve the right to make changes at any time without notice.

No claims for modification of delivered products can be asserted based on the information, illustrations, and descriptions in this documentation. Beyond the instructions contained in the operating manual, the applicable national and international standards and regulations must also be observed in any case.

1.6.1 Disclaimer of liability

Helmholz GmbH &Co. KG is not liable for damages if these were caused by use or application of products that was improper or not as intended.

Helmholz GmbH & Co. KG assumes no responsibility for any printing errors or other inaccuracies that may appear in the operating manual unless there are serious errors about which Helmholz GmbH & Co. KG was already demonstrably aware.

Beyond the instructions contained in the operating manual, the applicable national and international standards and regulations must also be observed in any case.

Helmholz GmbH & CO. KG is not liable for damage caused by software that is running on the user's equipment which compromises, damages, or infects additional equipment or processes through the remote maintenance connection and which triggers or permits unwanted data transfer.

1.6.2 Warranty

Report any defects to the manufacturer immediately after discovery of the defect.

The warranty is not valid in case of:

- Failure to observe these operating instructions
- Use of the device that is not as intended
- Improper work on and with the device
- Operating errors
- Unauthorized modifications to the device

The agreements met upon contract conclusion under "General Terms and Conditions of Helmholz GmbH & Co. KG" apply.

1.7 Recycling / WEEE

The company Helmholz GmbH & Co. KG is registered as a manufacturer with the HELMHOLZ brand and the device type "Small devices of information and telecommunications technology for exclusive use in households other than private households" as well as the following registration data:

Helmholz GmbH & Co. KG,
Location / Headquarters: 91091 Großenseebach,
Address: Hannberger Weg 2,
Name of authorized representative: Carsten Bokholt,

Registration number: DE 44315750.

The electrical devices described in this document are to be recycled. According to Directive 2012/19 / EU on waste electrical and electronic equipment (WEEE), they must not be disposed of by municipal waste disposal companies.

2 System overview

2.1 General/area of application

The "PN/CAN Gateway, PROFINET/CANopen Slave" enables the coupling of machines with CANopen bus to machines with PROFINET network. The PN/CAN Gateway represents a freely configurable, fully-fledged CANopen device on the CAN bus and extended the PLC – system / machine to a CANopen device.

On the PROFINET network, the PN/CAN Gateway is a PROFINET I/O device. The data of the CANopen SDOs are transparently and freely configurable inserted into the PROFINET network and can thus be read or written directly in the PLC.

The PN/CAN Gateway is integrated into the hardware configurator of the PROFINET controller with a GSDML file, and all values of the PN/CAN-Gateways are available as IO information. Special handling blocks are not necessary. An EDS or DCF file is used to permanently load a manufacturer-specific CANopen device configuration into the device.

2.2 Properties of PN/CAN-Gateways CANopen

The PN/CAN Gateway, PROFINET/CANopen Master has the following properties:

- PROFINET IO device as defined in IEC 61158-6-10

- Integrated two-port Ethernet switch

- Full-duplex transmission rate of 100 Mbps

- PROFINET Conformance Class C

- Media redundancy (MRP client)

- CANopen device as of CANopen protocol DSP 301

- Up to 1 Mbps CAN bit rate

- Up to 16 TPDOs / 16 RPDOs

- Up to 1440 bytes input and 1440 bytes output data on PROFINET

- Supports NMT, Heartbeat, node guarding, Sync and emergency messages

- Configuration using GSDML file

- No handling blocks necessary

- 24 V DC power supply

- 3 LEDs, bi-color

- USB device interface to load the configuration and for online diagnosis and firmware update
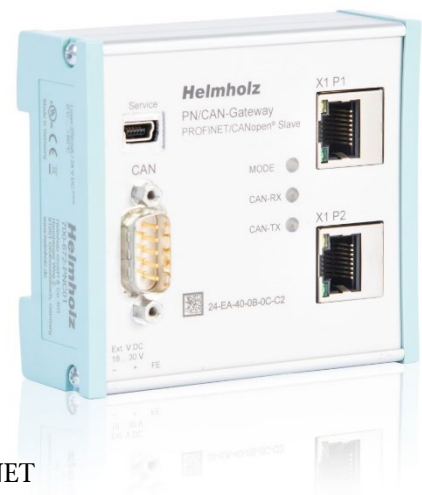
3 Installation

3.1 Access restriction

The modules are open operating equipment and must only be installed in electrical equipment rooms, cabinets, or housings.

Access to the electrical equipment rooms, cabinets, or housings must only be possible using a tool or key, and access should only be granted to trained or authorized personnel.

3.2 Electrical installation

Observe the regional safety regulations.

3.3 Protection against electrostatic discharges

To prevent damage through electrostatic discharges, the following safety measures are to be followed during assembly and service work:

- Never place components and modules directly on plastic items (such as polystyrene, PE film) or in their vicinity.
- Before starting work, touch the grounded housing to discharge static electricity.
- Only work with discharged tools.
- Do not touch components and assemblies on contacts.

3.4 Overcurrent protection

Overcurrent protection is not necessary as the PN/CAN Gateway transports no load current. The power supply of the PN/CAN Gateway electronics is to be secured externally with a fuse of maximum 1 A (slow-blowing).

3.4.1 Operation

Operate the PN/CAN Gateway only in flawless condition. The permissible operating conditions and performance limits must be adhered to.

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

The PN/CAN Gateway is a piece of operating equipment intended for use in industrial plants. During operation, all covers on the unit and the installation must be closed in order to ensure protection against contact.

> **ⓘ ATTENTION**
>
> Bus connections are interrupted when the PN/CAN Gateway is switched off!
>
> Before commencing with any kind of work on the PN/CAN Gateway, ensure that no unpermitted
>
> disruptions of connected systems occur following interruption of the bus connections.

3.5 Installation position

The PN/CAN Gateway can be installed in any position. The front plate must be accessible in order to plug in bus lines.

3.6 Minimum clearance

It is recommended to adhere to the minimum clearances specified when installing devices. Adhering to these minimum clearances will ensure that:

- The modules can be installed and removed without having to remove any other system components

- There will be enough space to make connections to all existing terminals and contacts using standard accessories

- There will be enough space for cable management systems (if needed)

4 Setup and wiring

4.1 EMC/safety/shielding

The PN/CAN Gateway complies with EU Directive 2004/108/EC ("Electromagnetic Compatibility").

One effective way to protect against disturbances caused by electromagnetic interference is to shield electric cables, wires, and components.

> **!** **ATTENTION**
>
> When setting up the system and routing the required cables, make sure to fully comply with all standards, regulations, and rules regarding shielding. Precisely observe the corresponding texts of the PROFIBUS user organization for setting up PROFINET and the setup guidelines of CANopen. All work must be done professionally!
>
> Shielding faults can result in serious malfunctions, including the system's failure.

To ensure electromagnetic compatibility (EMC) in your control cabinets in electrically harsh environments, the following EMC rules are to be observed in the design:

- All metal parts of the cabinet are to be connected with each other over a large area with good conductivity (no paint on paint). Where necessary, use contact washers or serrated washers.

- The cabinet door must be connected to the ground straps (top, middle, bottom) over as short a distance as possible.

- Signal cables and power cables are to be laid separated spatially by a minimum distance of 20 cm from each in order to avoid coupling paths.

- Run signal lines only from one level into the cabinet if possible.

- Unshielded cables in the same circuit (outgoing and incoming conductors) must be twisted if possible.

- Contactors, relays, and solenoid valves in the closet, or in adjacent cabinets if applicable, must be provided with quenching combinations, e.g. with RC elements, varistors, diodes.

- Do not lay wires freely in the closet; instead, run them as closely as possible to the cabinet housing or mounting panels. This also applies to reserve cables. These must be grounded on at least one end, and it is better if they are grounded at both ends (additional shielding effect).

- Unnecessary line lengths should be avoided. Coupling capacitances and inductances are kept low this way.

- Analog signal lines and data lines must be shielded.

4.2 Wiring of the PN/CAN Gateway

4.2.1 Voltage supply

The PN/CAN Gateway is supplied with 24 V DC voltage via the 3-pin power supply plug.

4.2.2 CAN bus connection

Pin	CAN bus D-sub connector
1	-
2	CAN low
3	CAN GND
4	-
5	PE, Shield
6	-
7	CAN high
8	-
9	-

NOTE

PN/CAN Gateway contains no terminating resistor for the CAN bus!

4.2.3 PROFINET connection

Pin	Signal	RJ45 plug PROFINET	Color	Wire pair
1	TD+	Transmission data +	Yellow	1
2	TD-	Transmission data -	Orange	1
3	RD+	Receive data +	White	2
4	-	-	-	-
5	-	-	-	-
6	RD-	Receive data -	Blue	2
7	-	-	-	-
8	-	-	-	-

4.2.4 USB interface

The service USB interface is only required for the firmware update and for diagnoses in the event of support.

5 CAN bus

CAN bus (Control Area Network) is an international open fieldbus standard for building, manufacturing, and process automation applications. CAN bus communications are defined in standard ISO 11898-2.

5.1 Wiring a CAN Bus

A CAN bus cable requires at least three wires: CAN high, CAN low, and CAN ground. Only linear bus topologies are allowed, A terminating resistor of 120 ohms must be connected between CAN high and CAN low at both ends of the CAN bus cable. The PN/CAN Gateway has no installed bus terminating resistor.

The maximum cable lengths will depend mainly on the bit rate being used.

Bit rate	Bus length	Bit time
1 Mbps	30 m	1 µs
800 kbps	50 m	1.25 µs
500 kbps	100 m	2 µs
250 kbps	250 m	4 µs
125 kbps	500 m	8 µs
50 kbps	1500 m	20 µs

The cable lengths specified above should only be used as reference values. The maximum cable length will also depend on the number of connected participants, on the use and the number of repeaters and on the cable type.

5.2 CAN bus plug

Helmholz offers a comprehensive range of CAN bus connectors that can be used with the PN/CAN Gateway. All Helmholz CAN bus connectors come with a terminating resistor that can be switched on and off.

5.3   The CANopen protocol

The CANopen® protocol is a layer 7 (application layer) protocol based on the CAN bus. CAN bus layers 1 and 2 (physical layer and data link layer) are used by the CAN bus unchanged.

The service elements provided by the application layer make it possible to implement applications that are distributed throughout the network. CANopen communication profiles and standards are administered by the CIA (CAN in Automation e.V.). The standard DS 301 "CANopen application layer and communication profile" is relevant for the PN/CAN Gateway. This is available at CAN in Automation's website (http://www.can-cia.org).

The CANopen standards assign a fixed definition to the 11-bit identifier and the 8 data bytes of a CAN bus frame. Each device in a CANopen network has a configurable node ID (module number, 1–127).

5.3.1   CANopen objects

Data exchange with a CANopen device takes place either via established service data objects (SDOs) or freely configurable process data objects (PDOs).

Every CANopen device has a fixed directory of SDOs (object directory) that are addressed with an index (16 bits) and a sub-index (8 bits).

Example: Index 0x1000 / sub-index 0 = "Device type", 32-bit unsigned

SDOs with a width of 8/16/32 bits can be read and written with one CANopen frame, Longer SDOs (e.g. strings) are transferred using multiple frames.

SDOs can be processed as soon as a CANopen device is ready for operation. The "SDO request" and "SDO response" functions are available for SDOs. The object number (index and sub-index), the access mode and type are stored in the first four bytes of the CAN frame. The last four bytes of the CAN frame then contain the value for the SDO.

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Command specifier	16 SDO index		8 bit SDO sub-index	1-4 bytes of parameter data			

PDOs contain the operating values of a CANopen device for cyclical process operations. Each CANopen device can manage multiple PDOs (according to the specification, the COB identifier for the first four transmission PDOs and four reception PDOs are defined).

Each of these PDOs will have its own COB-ID. Any information of the CANopen device can be mapped for reading and writing in the up to 8 data bytes. The values from the object dictionary (SDOs) are always the values mapped.

PDOs are automatically mapped at the startup by most CANopen device (default mapping). The assignment can generally be changed via defined SDOs when the device supports this.

5.3.2 CANopen functions

The CANopen functions are subdivided into the following basic types:

- SDO read and SDO write operations
- PDO send and PDO receive operations
- Network management
- Emergency messages

The function code is stored in the upper four bits of the CAN identifier, which, together with the node ID, forms the communication object identifier, or COB-ID. CANopen normally uses CAN bus frames with 11-bit identifiers (CAN 2.0A).

COB identifier (COB-ID):

10	9	8	7	6	5	4	3	2	1	0
Function				Node ID						

Broadcast functions:

Function	Function code (binary)	Resulting COB-ID
NMT	0000	0_{hex}
SYNC	0001	80_{hex}
TIME STAMP	0010	100_{hex}

Node functions:

| Function	Function code (binary)	Resulting COB-ID
EMERGENCY	0001	$81_{hex} - FF_{hex}$
TPDO1 (tx)	0011	$181_{hex} - 1FF_{hex}$
RPDO1 (rx)	0100	$201_{hex} - 27F_{hex}$
TPDO2 (tx)	0101	$281_{hex} - 2FF_{hex}$
RPDO2 (rx)	0110	$301_{hex} - 37F_{hex}$
TPDO3 (tx)	0111	$381_{hex} - 3FF_{hex}$
RPDO3 (rx)	1000	$401_{hex} - 47F_{hex}$
TPDO4 (tx)	1001	$481_{hex} - 4FF_{hex}$
RPDO4 (rx)	1010	$501_{hex} - 57F_{hex}$
SDO (tx)	1011	$581_{hex} - 5FF_{hex}$
SDO (rx)	1100	$601_{hex} - 67F_{hex}$
NMT error control	1110	$701_{hex} - 77F_{hex}$

"tx" = transmitted by the slave
"rx" = received by the slave

5.3.3 Network management

Network status (NMT states):

Each CANopen device can have various system states. After the device is switched on, an internal system initialization is carried out (hardware initialization, RAM test, setup of the basic objects). After successful initialization, a boot up frame [COB-ID: 700_{hex} + node ID / data (1 byte): 00_{hex}].

After this, the device is ready for operation and in the Pre-Operational state. Although the device's parameters can be configured in this state (SDOs can be read and written), it will not transfer process data objects (PDOs).
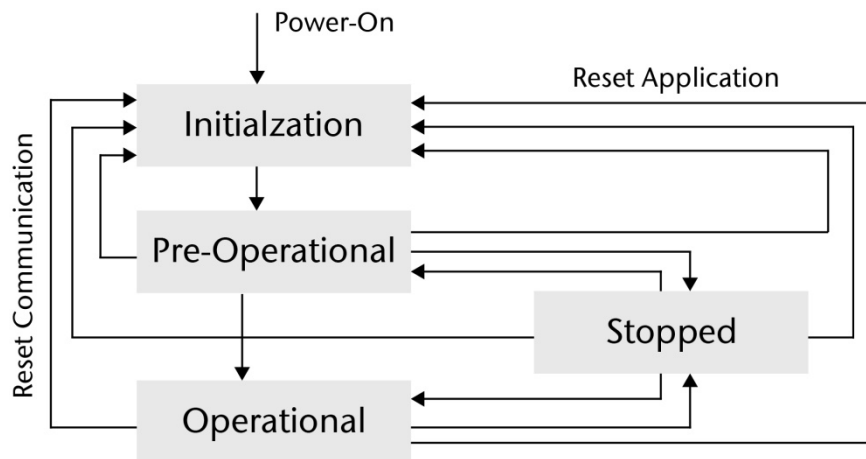
With the NMT command "Operational" [COB-ID: 000_{hex} / data (2 bytes): 01_{hex} node ID], a CANopen device can be switched to the operational status. Once in the Operational state, the coupler's process data will be enabled (RPDO/TPDO communications will be running). The options available for making changes to SDOs may be limited.

With the NMT command "Pre-Operational" [COB-ID: 000_{hex} / data (2 bytes): 80_{hex} node ID], a CANopen device can be switched to the pre-operational status.

With the NMT command "Reset (Application)" [COB-ID: 000_{hex} / data (2 bytes): 81_{hex} node ID], a restart of a CANopen device is triggered.

With the NMT command "Reset Communication" [COB-ID: 000_{hex} / data (2 bytes): 82_{hex} node ID], the CANopen communication of the device is reset. The device is subsequently in the Pre-Operational state.

SYNC:

The SYNC frame is a periodic "Broadcast" frame and is a trigger for CANopen functions. The SYNC frame makes it possible to transfer input data in a synchronized manner and to activate output data simultaneously throughout the whole system. In order to ensure that the intervals at which the SYNC frame are sent are equally spaced, the frame has a high priority level. [COB-ID: 80_{hex}]

Nodeguarding:

With Nodeguarding, a device monitors one or more other CANopen devices by cyclically transmitted telegrams. Each CANopen device must respond to the Nodeguarding request telegram with a status telegram.

[COB-ID: 700_{hex} + node ID / data: 1 byte with the own current CANopen status]

Life guarding:

With Lifeguarding, each requested CANopen device monitors whether the node guarding, once started, is carried out continuously within certain time limits. If the Nodeguarding telegram fails to arrive, the CANopen device can detect this by means of lifeguarding and, for example, set all outputs to the safe state. Nodeguarding and Lifeguarding always run together.

Heartbeat:

Heartbeat monitoring corresponds to Nodeguarding, but no request telegrams are generated by the CANopen network. The heartbeat telegram is sent automatically by the CANopen device (producer heartbeat) and can be evaluated in the network by other CANopen devices (consumer heartbeat).

[COB-ID: 700_{hex} + node ID / data: 1 byte with the own current CANopen status]

Error Behaviour:

The error behaviour of a CANopen device will be defined in the SDO 1029 "Error Behaviour". It is divided in CANopen network and application errors (optionally). Network error can cause that the status of a device will be changed to "Pre-Operational" (default value) or to stop or the status will not be changed. The behaviour for application errors will be defined by the manufacturer.

Emergency message:

If one of the CANopen device detects that something has gone wrong (e.g., life guarding times out), it will send an emergency message on the bus.

[COB-ID: 80_{hex} + node ID / data: 8 bytes]

6 Setup and use

The setup of the PN/CAN Gateway is divided into 3 steps:

1. Transfer EDS or DCF file to the PN/CAN Gateway:

The EDS or DCF file contains the description of all SDOs, their default values of all CAN objects (SDOs) and basic settings of the CANopen Device. The file will be defined by the customer and has to be uploaded after changing. It will be stored by the PN/CAN-Gateway in the flash memory permanently.

2. Parameterize the PN/CAN Gateway in the hardware configurator:

The GSDML file is used to insert the PN/CAN Gateway in the PROFINET engineering tool into the PROFINET network and to define which SDOs are to be exchanged with the PLC.

3. Programming in the PLC:

In the PLC, the state and behavior of the PN/CAN Gateway can be read and controlled via the I/O image. The data of the SDOs are also located in the I/O memory according to the configuration. Handling blocks are not necessary.

6.1 Transfer EDS or DCF file to PN/CAN Gateway

The PN/CAN Gateway is freely configurable as a CANopen device as far as possible. With the import of an EDS or DCF file it is defined which SDOs the PN/CAN-Gateway should support and also the most of the CANopen properties are defined in the file.

An example EDS file for a simple IO-Slave according to CiA standard DS401 ("DS401_IO_Slave_Vxx.eds") can be downloaded from the Helmholz website in the download area of the PN/CAN-Gateway in the section "Software":

The file can be customized in a normal text editor. But there are also special EDS editors, e.g. "Vector CANeds" or "CANopen Architect" which can be used for editing the EDS file in a limited way.

The content of the EDS file is in the document "CiA 306: Electronic Device Description (EDD)", which can be downloaded from the CiA website: https://www.can-cia.org/can-knowledge/canopen/cia306/

On the right side of this page is a section of an EDS file.

The DCF file is a special variant of the EDS file, which in addition to the basic description of all objects and parameters already contains preset values of a concretely configured CANopen device, as well as the Node-ID and the bit rate. For a EDS file, the Node-ID and the bit rate will be defined in the PROFINET configuration.

```
[FileInfo]
CreatedBy=MD
ModifiedBy=MD
Description=DS401 IO Slave
CreationTime=11:52AM
CreationDate=09-05-2017
ModificationTime=01:37PM
ModificationDate=14-10-2020
FileName=DS401_IO_Slave_V10.eds
FileVersion=1
FileRevision=1
EDSVersion=4.0

[DeviceInfo]
VendorName=Helmholz GmbH & Co. KG
VendorNumber=0x00000223
ProductName=PN/CAN GW - IO Slave
ProductNumber=0x0000010E
RevisionNumber=0x00030000
OrderCode=700-672-PNC01
BaudRate_10=1
BaudRate_20=0
BaudRate_50=1
BaudRate_125=1
BaudRate_250=1
BaudRate_500=1
BaudRate_800=1
BaudRate_1000=1
SimpleBootUpMaster=0
SimpleBootUpSlave=1
Granularity=0
DynamicChannelsSupported=6
CompactPDO=0
GroupMessaging=0
NrOfRXPDO=4
NrOfTXPDO=4
LSS_Supported=0

[MandatoryObjects]
SupportedObjects=3
1=0x1000
2=0x1001
3=0x1018

[1000]
ParameterName=Device Type
ObjectType=0x7
DataType=0x0007
AccessType=ro
DefaultValue=0x000F0191
PDOMapping=0
```

To transfer the file to the PN/CAN Gateway the software "EDS-DCF Uploader" and a USB cable with mini-USB connector is required. The software and the driver for the USB interface of the PN/CAN Gateway can be downloaded from the Helmholz website.

After starting the "Uploader" the PN/CAN Gateway is searched and displayed via USB.

With "Upload" the EDS file can be selected and uploaded. With "Load" the file name of the EDS file currently stored in the PN/CAN Gateway is displayed.
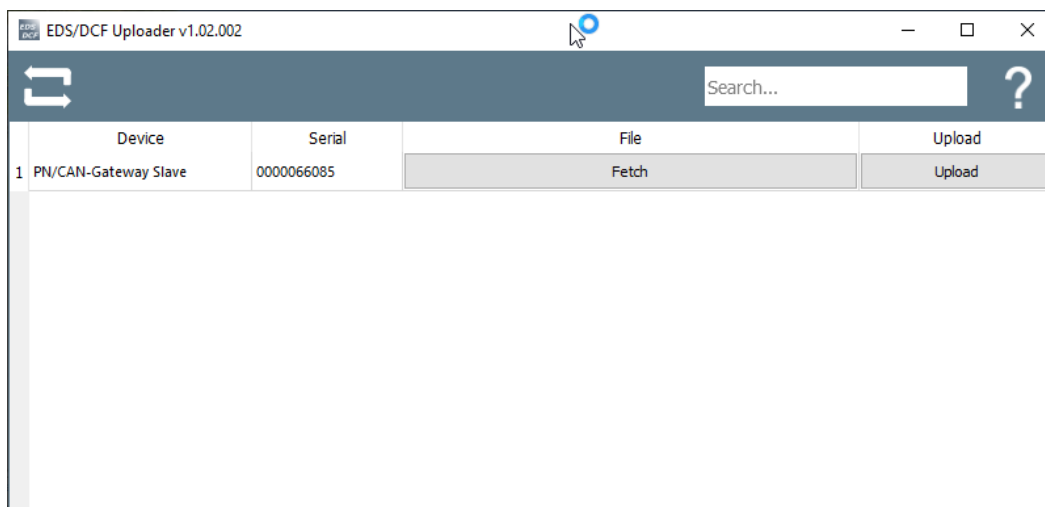
After the upload, the EDS file is stored in the flash memory of the PN/CAN Gateway and will automatically interpreted and used during the starting phase. The PN/CAN-Gateway is now ready for operation.

Next, the PN/CAN Gateway must be configured in the PROFINET PLC.

6.2 Configure Gateway

6.2.1 Install GSDML file

The GSDML file is available in the download area of the PN/CAN Gateway CANopen Slave at www.helmholz.de.

Install the GSDML file in the TIA Portal in the menu "Options" / "Manage general station description files (GSD)".
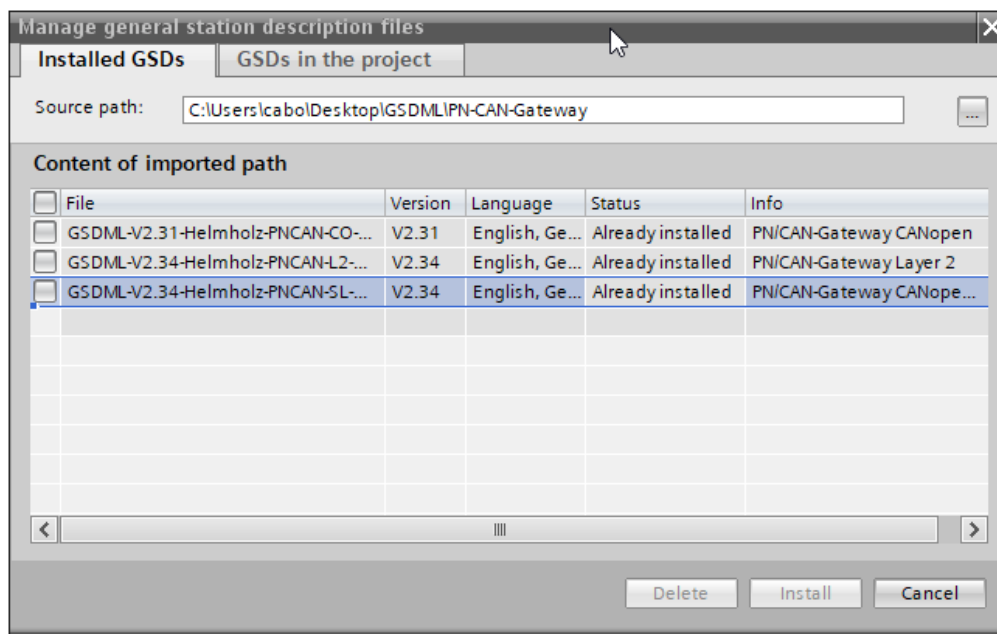
The PN/CAN Gateway can be found in the hardware catalog under "Other field devices → PROFINET IO → Gateway → Helmholz PN/CAN Gateways".

Insert the "PN/CAN Gateway **CO Slave**" into the project and connect it to your PROFINET network.
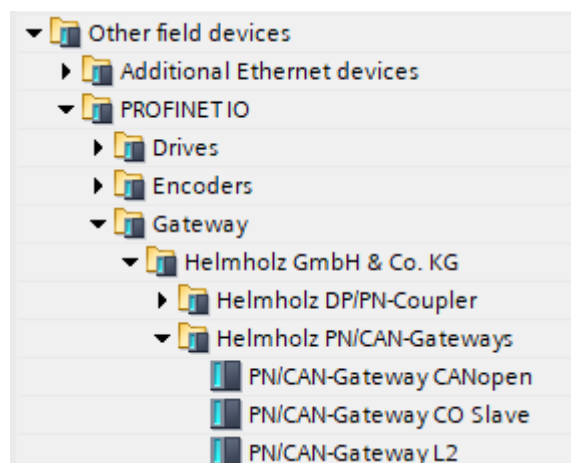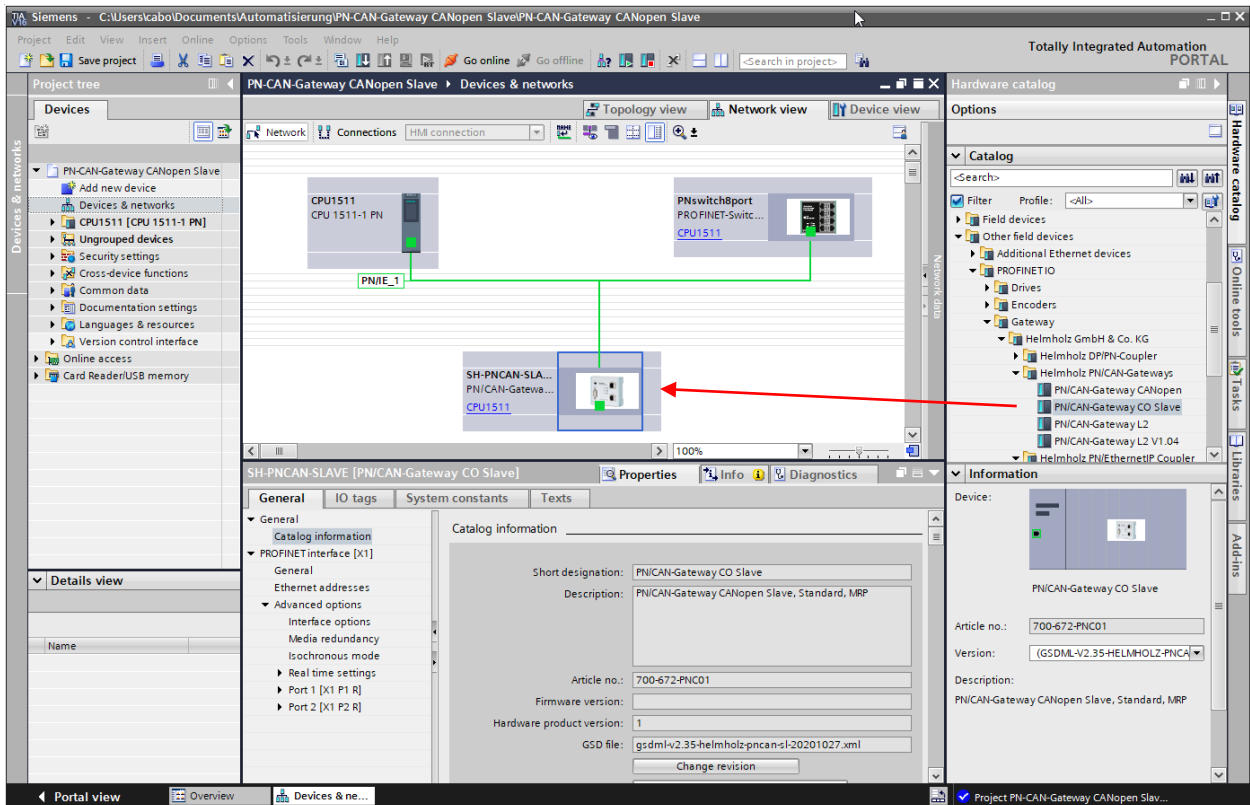
By calling the properties, a unique PROFINET name should be assigned to the PN/CAN Gateway and the IP address checked for plausibility.

The name of the configured device must later be assigned to the physical device (see Chapter 6.3).

6.2.2 Parameterization

The first slot entry "Parameter" contains the module parameters for the behavior of the CANopen master.
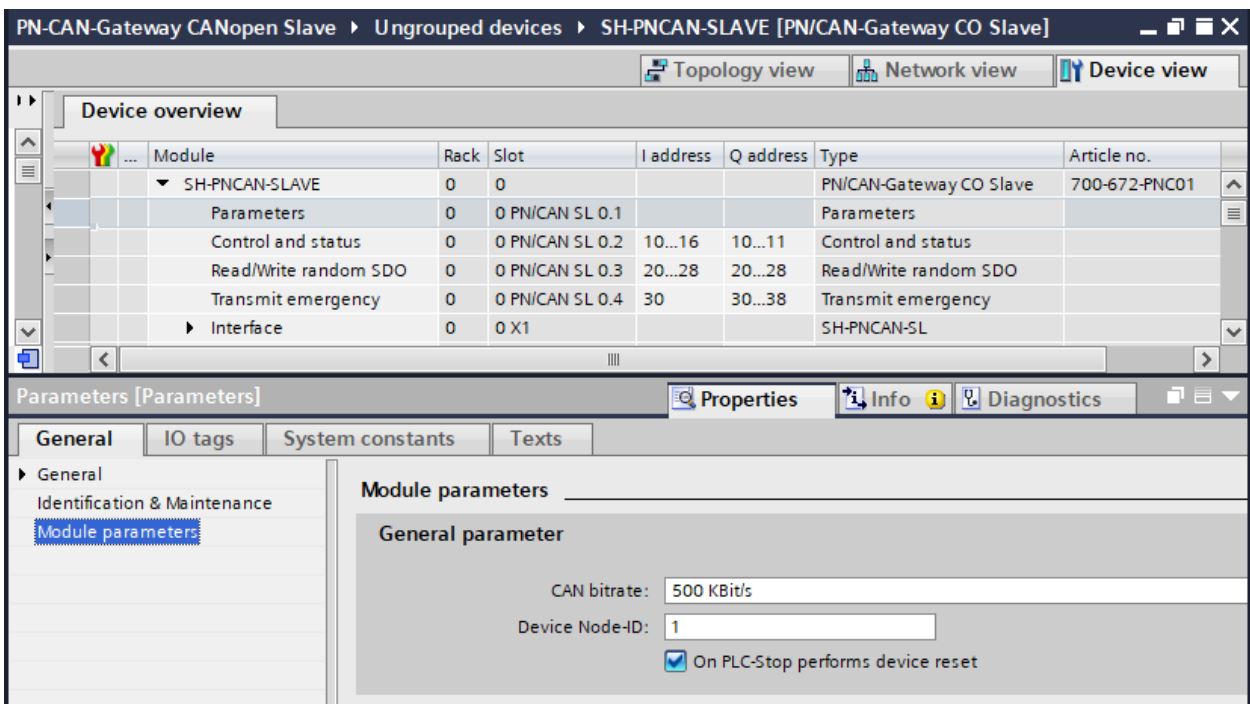
CAN bitrate: The available bit rates are 10, 50, 100, 125, 250, 500, 800 KBit/s and 1 MBit/s.
When using a DCF file, this parameter is ignored, because the bitrate is supplied in the DCF file.

Device Node-ID: Node-ID under which the PN/CAN-Gateway on the CAN bus is active as a device. When using a DCF file, this parameter must be set to 0, the Node-ID is supplied in the DCF file.

On PLC-Stop performs device reset: If the PLC goes into Stop, the PN/CAN Gateway data is set to the initial state and restarted. The values of the SDOs that have not been stored in the Flash are reset to the state of the EDS/DCF file.

6.2.3 Configuration

The data of the SDOs defined by the EDS or DCF file in the PN/CAN Gateway can now be exchanged with the PLC. For each SDO or subindex of an SDO a module with the correct data size of the SDO (1, 2 or 4 bytes) must be inserted in the configuration. In the parameters of the module the SDO index (number) and the subindex are specified. The index must be specified decimal in the PROFINET configuration, even if it is usually specified in hexadecimal in CANopen ($6000_{hex} \rightarrow 24576_{dec}$).

Depending on the access type of the defined SDO you have to choose if the SDO value should be read from the PN/CAN Gateway ("Read SDO"), written to the PN/CAN Gateway ("Write SDO") or both ("Read/Write SDO").

For the EDS example "DS401_IO_Slave_Vxx.eds" the input SDO 6000 must be described from the PLC since these are readable values from the point of view of the CANopen network (inputs). The SDO 6200 can be read by the PLC since these are writable values from the point of view of the CANopen network (outputs).

For modules which read or write SDOs with 2 or 4 bytes, you can additionally set whether the value from or to the CAN bus stays in its byte order or should be rotated.

SDO 6401/1 set, 2 Bytes	0	5		52...53	Set SDO with 2 bytes	
SDO 6411/1 get, 2 Bytes	0	6	52...53		Get SDO with 2 bytes	
	0	7				

SDO 6411/1 get, 2 Bytes [Get SDO with 2 bytes]   🔍 Properties   ℹ️ Info 🛈   📊 Diagnostics

General	IO tags	System constants	Texts

▶ General
  Hardware interrupts
▼ Module parameters
    General parameter
    Module failure
  I/O addresses

General parameter _____

General parameter

  SDO-Index (dec.): `25617`
  SDO-Subindex (dec.): `1`
  ☑ Convert byteorder BE/LE

6.2.4 Maximum extension of a PN/CAN Gateway configuration

The maximum extension of a project configuration is limited by the following parameters:

- The CANopen Device can manage up to 16 RPDOs and 16 TPDOs

- There are 470 slots for inserting modules (SDOs modules with 1, 2, 4 bytes)

- The PROFINET input data can be up to 1440 bytes long

- The PROFINET output data can be up to 1440 bytes long

Exceeding the limits is reported either by the hardware configurator or by an error code at the device status of the PN/CAN Gateway.

6.3 Assign the PROFINET device-name

When the configuration of the PN/CAN Gateway has been completed in the hardware configurator, it can be loaded into the PLC.

In order for the PN/CAN Gateway to be found by the PROFINET controller, the PROFINET device name must be assigned to the PN/CAN Gateway. To do this, use the "Assign device name" function, which you can access with the right mouse button or in the Online menu when the PN/CAN Gateway is selected.

Use the "Refresh list" button to search the network for PROFINET stations. With "Assign Name" the PROFINET device name can be assigned to the device.
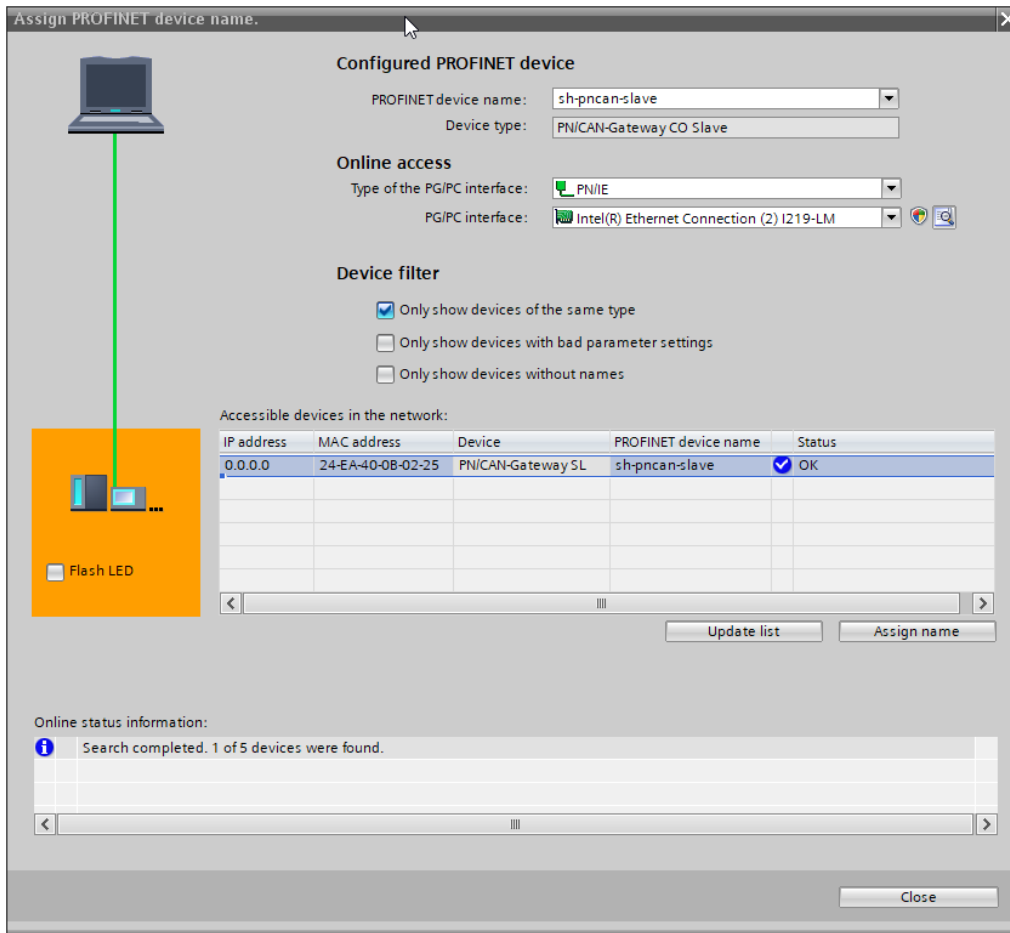
The clear identification of the PN/CAN Gateway is ensured here by the MAC address of the device. The MAC address of the device is on the front of the PN/CAN Gateway.

If the PN/CAN Gateway has been assigned the correct PROFINET device name, it is recognized by the PLC and configured. When the configuration has run correctly, the blue "Mode" LED should blink.

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 IPSet Tool:

7 Programming in the PLC

No handling blocks are required in the PLC for operation. The control and status request of the PN/CAN Gateway can be performed directly via the I/O image with the module "Control and Status".

...	Module	Rack	Slot	I address	Q address	Type	Article no.
	▼ SH-PNCAN-SLAVE	0	0			PN/CAN-Gateway CO Slave	700-672-PNC01
	Parameters	0	0 PN/CAN SL 0.1			Parameters	
	Control and status	0	0 PN/CAN SL 0.2	10...16	10...11	Control and status	
	Read/Write random SDO	0	0 PN/CAN SL 0.3	20...28	20...28	Read/Write random SDO	
	Transmit emergency	0	0 PN/CAN SL 0.4	30	30...38	Transmit emergency	
	▶ Interface	0	0 X1			SH-PNCAN-SL	

The most important function of the control and status bits is to control the CANopen slave state.

After power-on the PN/CAN Gateway interprets the EDS/DCF file and initialized all needed objects and functions.
State: Initialization.

After configuration by the PLC via PROFINET, the gateway is ready for operation and can switch to the Pre-Operational state.

The state change to Operational can now be executed via the CAN bus from the CANopen network or actively controlled by the PLC.
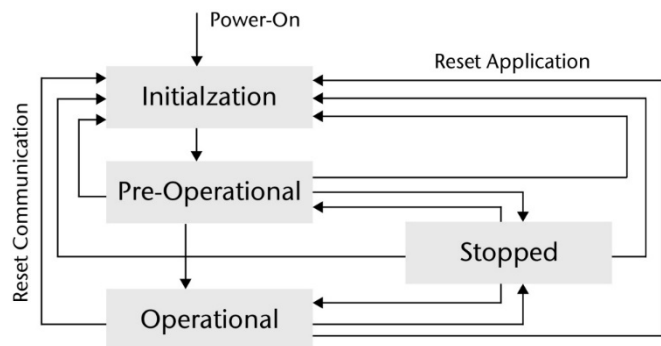
7.1 Control

Two output bytes are available to control the PN/CAN Gateway.

Byte/Bit	7	6	5	4	3	2	1	0
Out 0	-	-	-	-	State Change Command			
Out 1	-	-	-	-	SYNC Acknowledge (Toggle bit)	"SYNC lost" Reset Bit	NMT Limitation	

Change State Command: The PLC can use these bits to change the state of the CANopen Device directly.

Value 0: no command
Value 1: Change to "Pre-Operational"
Value 2: Change to "Stop"
Value 3: Change to "Operational"
Value 14: Communication Reset
Value 15: Reset

NMT Limitation: Defines the state up to which the CANopen Device can be switched directly from the CANopen network. This setting can be used, for example, to prevent the CANopen network from switching the Device directly to Operational even though the application is not yet ready from the PROFINET side.

> Value 0: Limitation in Boot-Up
> Value 1: the slave is only switchable until Pre-Operational
> Value 2: the slave is only switchable until stop
> Value 3: the slave can be switched operational

NOTE

The slave control of the NMT states can be executed either by state change command from the PLC or via the CANopen master with an adjustable NMT limitation.

Which control type is active can be configured in SDO 2FFF/0 via the EDS/DCF file, see chapter 8.1.

SYNC Acknowledge: Acknowledgement of the SYNC indication toggle bit in status byte 1, bit 3. In case of inequality with SYNC indication, the consistent input data must be stored in the PLC and then this bit must be set equal to the SYNC indication bit.

Reset bit "SYNC lost": Reset the error bit "SYNC lost" in status byte 1, bit 2.

7.2 Status

The status of the PN/CAN Gateway consists of 7 input bytes.

Byte/Bit	7	6	5	4	3	2	1	0
In 0	Gateway operational	**Display of NMT command from CAN:** 1 = Pre-Operational / 2 = Stop / 3 = Operational / 4 = COM-Reset / 5 = Reset			Mirroring of the PLC command			
In 1	-	1 = CAN-Bus not connected	**Active device state:** 0 = Initialization 1 = Pre-Operational 2 = Stop 3 = Operational		SYNC-Indication (Toggle bit)	SYNC lost	Mirror of NMT limitation	
In 2	CAN receive error counter							
In 3	CAN send error counter							
In 4	First slot number with parameterization error							
In 5								
In 6	Configuration error number							

Gateway operational indicates that the PN/CAN Gateway is configured and addressable. The bit is also set if the configuration is incorrect.

Display of NMT command from CAN: Display of the last NMT command received via CAN bus.

Mirroring of the PLC command: Display of the "command state change" received from the PLC

CAN-Bus not connected: no other participant recognizable or wire break detected

Active device state: actual NMT status of the CANopen device

SYNC-Indication: Toggling this bit signals the receipt of a new SYNC telegram. The toggling of the bit signals that new consistent IN data are available in the PLC, these data must be stored and then the SYNC acknowledge bit must be pulled up.

SYNC lost: If the SYNC acknowledge bit is set too late after a SYNC reception, the bit "SYNC lost" is set. The error bit can be cleared with a positive edge at control byte 1, bit 2.

Mirror of NMT limitation: The NMT limitation set in the control byte is displayed here for checking purposes.

CAN receive/transmit error counter: Counter for receive and transmit errors on CAN message level

First slot number with parameterization error: Slot number of the module in the hardware configuration in which a parameterization error occurred.

Configuration error number: Cause of the parameterization error in the above mentioned slot

7.3   Read/write random SDO

With the pluggable modules for reading and writing SDOs a cyclic I/O access to the SDO data with a size of up to 4 bytes can be performed. In case SDOs with more than 4 bytes of data are to be read or written or SDOs are to be accessed only rarely, the module "read/write any SDO" can be used.
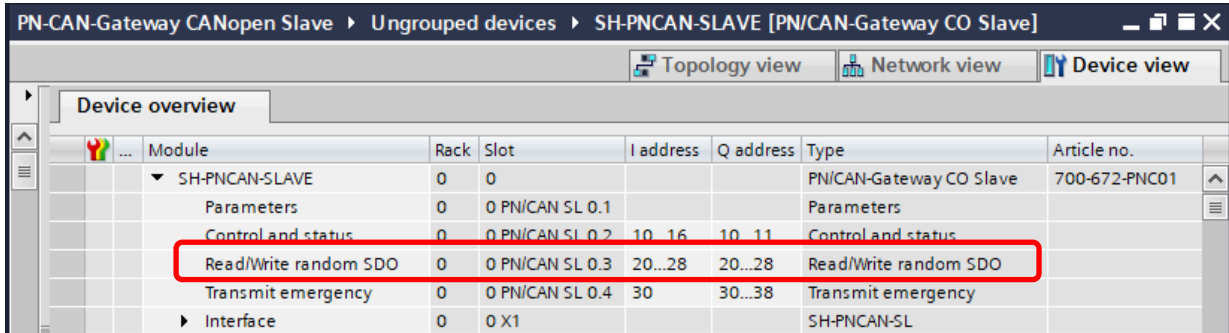
With this module an SDO can be accessed randomly on a command based exchanged.

Control SDO transfer (9 bytes outputs):

Byte/Bit	7	6	5	4	3	2	1	0
Out 0	1 = Enable SDO transfer	-	Length for SDO write: 0 = 1 Byte … 3 = 4 Bytes		1= swap byte order	0 = read SDO 1 = write SDO	1 = start transfer	1 = Freeze
Out 1	SDO-Index							
Out 2								
Out 3	SDO-Subindex							
Out 4	Byte offset for SDOs with length > 4 bytes							
Out 5	Data							
Out 6								
Out 7								
Out 8								

Status of SDO transfer (9 bytes inputs):

Byte/Bit	7	6	5	4	3	2	1	0
In 0	1 = SDO transfer enabled	1 = SDO error	Read length for SDO: 0 = 1 Byte … 3 = 4 Bytes		Mirror of "swap byte order"	0 = read SDO 1 = write SDO	1 = transfer running	1 = Freezed
In 1	SDO Data							
In 2								
In 3								
In 4								
In 5	SDO Abort code							
In 6								
In 7								
In 8								

> **i** NOTE
>
> As long as the freeze – bit is set, the access from the CAN bus of the corresponding SDO is blocked.

7.3.1 Transfer of SDO data > 4 Byte

VISIBLE-STRING: The data must be read or written continuously from the beginning to the end, starting at byte index 0. The byte offset must be increased in steps of 4 bytes for each job. Offset 0 is the indicator for a new transmission. The last write operation must be performed with 'Freeze' = 0. This also redefines the length of the string. It must not exceed the maximum length from the EDS definition.

When reading, the 'Freeze' bit may be set during the last transfer, since the string length may be shorter than the EDS agreement. In this case it is internally forced to 0. Only as much is read as is available (actual block length read is in SDO status). The SDO is always released during the last transfer.

A string must always be read until the 'Freeze' bit becomes 0. Otherwise, the SDO remains blocked. An abort of reading is always possible in the job with 'Freeze' = 0.

Only characters >= 0x20 and <= 0x7F may be included, otherwise error message 0x06000030 is issued. An end NULL must not be transmitted!

In practice, it is recommended to fill up with spaces up to the length agreed in the EDS file.

OCTET-STRING: Here it is possible to read and write in blocks of 1..4 Byte. The offset is to be indicated here as byte offset! The length of the OCTET STRING remains constant according to the EDS file and is limited of a maximum of 120 bytes. The length + offset must not exceed this length. During writing and reading the SDO remains locked during 'Freeze' = 1. The 'Freeze' bit in the order may be set when reading over the end. In this case it is internally forced to 0.

If the reading is to be aborted before the end of the OCTET STRING, the 'Freeze' bit in the job must be 0, otherwise the SDO remains disabled.
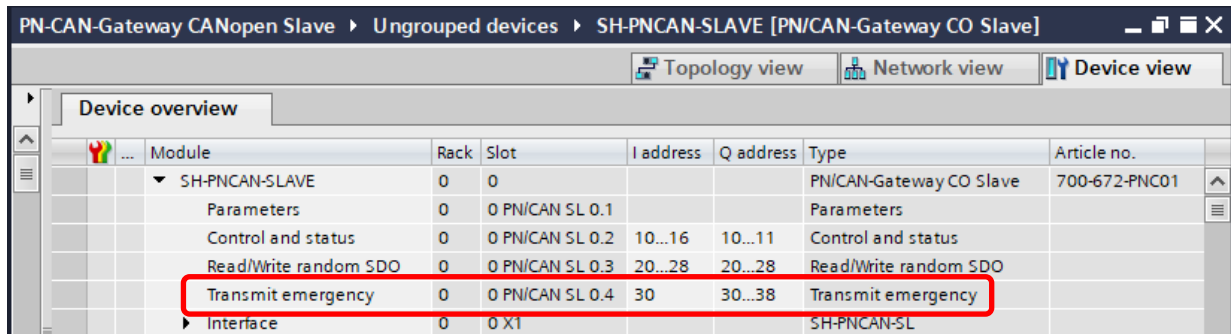

NOTE

For the random writing and reading of SDOs, we will gladly provide you with a sample program. Please ask the support at support@helmholz.de.

7.4   Transmitting Emergency Messages

Emergency messages report a serious error of a CANopen device over the CAN bus. The module "Transmit emergency" enables the PLC application to send an emergency message at any time.

Emergency command (9 bytes):

Byte/Bit	7	6	5	4	3	2	1	0
Out 0	-	-	-	-	-	-	1= enable emergencies	Toggle bit transmit emergency
Out 1	Emergency error code							
Out 2								
Out 3	Error register							
Out 4	Manufacturer specific error code							
Out 5								
Out 6								
Out 7								
Out 8								

Emergency status (1 Byte):

Byte/Bit	7	6	5	4	3	2	1	0
In 0	-	-	-	-	-	-	1= emergencies are enabled	Mirror of „transmit emergency" toggle bit

To send emergency messages, bit 1 in byte 0 must first be set. The bit 0 in byte 0 must always be reset in this step (synchronization of the toggle-bit between the application and the device).

Next, the 8 data bytes of the emergency message must be written into the output area and bit 0 in byte 0 must be toggled. In bit 0 of the status byte, it can be recognized whether the emergency message has been accepted by the PN/CAN Gateway for transmission.

A new emergency message can then be triggered by toggling bit 0 again.

7.4.1 Internal Emergency messages of PN/CAN Gateway

The PN/CAN Gateway also sends its own emergency messages if errors occur during CANopen or PROFINET communication.

0x5010 – 0x5013   NMT status change due to PLC stop

0x5020 – 0x5023   PROFINET connection broken

0x6201 – 0x6203   NMT state change by the PLC

0x7001   An NMT transition was received at the CAN but cannot be performed due to the state of the PN/CAN Gateway.

0x7002   Sent to NMT-BOOTUP if the PN/CAN Gateway can start but the module configuration is inappropriate (wrong SDO, wrong permissions).

0x8020   NMT transition to a higher state prevented due to limitation by PLC

0x8021   Profile prohibits transition due to PLC STOP

0x8022   Profile prohibits transition due to PROFINET connection termination

0x8130   Nodeguarding time has been exceeded

0x8210   received RPDO length too short (not processed)

0x8220   Received RPDO length too long (being processed)

0x8211   RTR polling received with length > 0

0x8250   The RPDO event timer was exceeded

7.5 PROFINET Diagnostic messages

The PN/CAN Gateway supports the following diagnostic alarms:

1   Configuration error: Node-ID > 0 is not allowed for a configuration with DCF file

2   According the EDS/DCF configuration the configured SDO cannot be written.

3   The configured SDO is not available in the EDS/DCF configuration.

4   Configured SDO length does not correspond to that in the EDS/DCF configuration.

5   The Consumer-Heartbeat Node-ID cannot be the Node-ID of the device.

6   Unknown module type used (perform firmware update if necessary)

7   Node ID must be > 0 because no DCF configuration is used.

8   SDO with same index is used in at least two modules

9   EDS/DCF project is too big

10   SDOs with data type "Visible String" or "Octet String" cannot be used in slots

8 Internal SDO

Some SDOs have functionality in the PN/CAN Gateway that influence the behavior of the gateway or represent it´s state.

8.1 Start-up behavior SDO 2FFF

This SDO is used to configure the start-up and restart behavior of the PN/CAN Gateway. It can be set accordingly in the EDS/DCF file. Only subindex 0 is available.

Bit	31	30	29	28	27	26	25	24
	0	0	0	0	0	0	0	0
Bit	23	22	21	20	19	18	17	16
	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8
	3		1	1	3		1	1
Bit	7	6	5	4	3	2	1	0
	0	1	0	0	**Behavior upon NMT command from CAN bus:** 0 = "Operational" if configured 1 = PLC Run is needed for "Operational" 2 = NMT limitation by PLC active			

8.2 Status SDO 2FFE

Contains the first two bytes of the PN/CAN Gateway status as shown in the PLC (see chapter 7.2).

8.3 Error register SDO 1001

Bit	7	6	5	4	3	2	1	0
	PLC configuration error	PROFINET not connected	PLC in Stop	-	PDO length wrong	Heartbeat Timeout	Nodeguarding Timeout	Always 1, if there is an error

8.4 Error memory SDO 1003

The error memory holds up to 16 entries in 32 bit format, subindex 1 contains the most recent entry, subindex 16 the oldest entry.

8.5 Node-ID SDO 100B

The SDO contains the active Node-ID of the CANopen slave in sub-index 0. If necessary, the Node-ID can be written by the PLC before the CANopen Device on the CAN bus becomes active.

9 LED-based diagnosis

MODE	
Off	No power supply or device defective
Blue on	PN/CAN Gateway is correctly configured via PROFINET & CANopen device is "Operational"
Flashing blue	PN/CAN Gateway is correctly configured via PROFINET & CANopen device is in "Pre-Operational" or "Stop" state
Fast flashing blue	PN/CAN Gateway is correctly configured via PROFINET & CANopen device is in boot-up or waiting for start command
Red on	No connection with PROFINET controller (PLC), no PROFINET configuration
Flashing red	Connection with the PROFINET controller (PLC) exists, but a configuration error exists
Fast flashing red	There is an error in the EDS/DCF file
CAN RX	
Flashing green	CAN frame is received without errors
Red	CAN bus error in the recipient PN/CAN Gateway has not been configured yet No connection
Flashing red	CAN receive overflow (Overrun)
CAN TX	
Flashing green	CAN frames are being transmitted
Red	Transmission not possible (e.g. false Baud rate, CAN bus disrupted) PN/CAN Gateway has not yet been configured No connection
BF/SF	
yellow	MODE flashes red: Configuration error MODE on blue: CAN alarm active
red	PROFINET network error

10 Technical data

Order no.	700-672-PNC01
Name	PN/CAN Gateway, PROFINET/CANopen Slave
Scope of delivery	PN/CAN gateway with power plug
Dimensions (D x W x H)	35,5 x 83,5 x 76 mm
Weight	Approx. 160 g
PROFINET interface (X1)	
Number	1
Connection	2x RJ45, integrated switch
Transmission rate	100 Mbps full duplex
Protocol	PROFINET IO device as defined in IEC 61158-6-10
I/O image size	1440 bytes
Features	PROFINET Conformance Class C, Media redundancy (MRP client), Automatic addressing, Topology detection (LLDP, DCP), Diagnosis alarms
CAN interface	
Number	1
Type	ISO/DIN 11898-2 CAN High-speed physical layer
Connection	9-pin D-sub male connector
Protocol	CANopen Slave as defined in DSP301 V4.2
Baud rate	10, 50, 100, 125, 250, 500, 800, 1000 kbps
TPDOs/RPDOs	16 / 16
Features	NMT, Nodeguarding/Heartbeat, Sync, Emergencies
USB interface	
Protocol	Full-speed USB 2.0 device
Connection	USB-C
Electrically isolated	500 V
Power supply	
Operating voltage	24 V DC, 18 ... 30 V DC
Current draw	Max. 150mA
Power dissipation	Max. 4 W
Ambient conditions	
Ambient temperature	0° C to 60° C
Transport and storage temperature	-20° C to 80° C
Relative humidity	95% without condensation
Protection rating	IP 20
Mounting position	As desired
Approvals	CE