wieland

samos® PRO

samos® PRO-Gateways

Manual

Doc. no. BA000970

Last Update: 06/2022 [11179]

INFO

Copyright

Subject to change.

Subject to technical changes for reasons of continued development.

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1 ABOUT THIS MANUAL

Please read this section carefully before you work with these operating instructions and the samos® PRO gateways.

1.1 Function of this document

There are three manuals for the samos® PRO system with clearly delineated areas of application as well as installation instructions and brief instructions for each module.

- This **gateway manual** describes all samos® PRO gateways and their functions in detail. It instructs the technical staff of the machine manufacturer or machine operator in the safe installation, configuration, electrical installation, commissioning, operation and maintenance of the samos® PRO gateways.
  This manual does **not** provide operating instructions for the machine, which incorporates modular samos® PRO safety controllers and a samos® PRO gateway. Information in this regard is provided in the operating instructions for each machine.
  This manual is only valid in combination with the other samos® PRO manuals (see *Scope of validity and applicable documents [ch. 1.2, p. 7]*).
- The **software manual** describes the software-supported configuration and parameterization of the samos® PRO safety controller. In addition, the software manual contains a description of the important diagnostic functions for operation and detailed information for identifying and eliminating errors. Use the software manual mainly when configuring, commissioning and operating samos® PRO safety controllers.
- The **hardware manual** describes all of the modules and their functions in detail. Use the hardware manual mainly for designing devices.
- Each module contains the **installation instructions/brief instructions**. These instructions provide information on the fundamental technical specifications of the modules and contain simple installation instructions. Use the installation instructions/brief instructions when installing the samos® PRO safety controller.

This manual contains original operating instructions in accordance with the Machinery Directive.

1.2 Scope of validity and applicable documents

This manual applies to the following gateway modules:

- SP-EN-MOD
- SP-EN-PN
- SP-EN-IP
- SP-PROFIBUS-DP
- SP-CANopen
- SP-EN-ETC

Table 1: Overview of the samos® PRO documentation

Document	Title	Article number
Software manual	samos® PLAN 6 software	BA000967
Hardware manual	samos® PRO hardware	BA000965
Gateway manual	samos® PRO gateways	BA000969
Operating instructions	SP-COPx (Controller modules of the modular samos® PRO safety controller)	BA001119

Document	Title	Article number
Operating instructions	SP-SDI/SP-SDIO Extended modules of the modular safety controller samos® PRO	BA001116
Operating instructions	SP-DIO Unsafe extended module of the samos® PRO modular safety controller	BA001190
Operating instructions	SP-SAC4/SP-SAR4/SP-SARCR22 Analog extended module of the modular safety controller samos® PRO	BA001169
Operating instructions	SP-PROFIBUS-DP Non-safe fieldbus module PROFIBUS-DP	BA001187
Operating instructions	SP-CANopen Non-safe fieldbus module CANopen	BA001188
Operating instructions	SP-EN-ETC Non-safe fieldbus module EtherCAT	BA001178

1.3 Target group

This manual is intended for **planners**, **developers** and **operators** of systems that incorporate modular samos® PRO safety controllers and that need to exchange data with a field bus (of a control) via a gateway.

It is also aimed at persons commissioning a samos® PRO gateway system for the first time or maintaining such a system.

1.4 Information depth

This manual contains information about the following topics related to samos® PRO gateways:

- Mounting
- Integration into the network
- Configuration with the samos® PLAN 6 software
- Data transmission to and from the network
- State information, projection and associated mapping
- Item numbers

Important notes

WARNING

Observing safety information and protective measures

Observe the safety information and protective measures for the samos® PRO gateways described in this manual.

Downloads available from the Internet

Also consult our website on the Internet. At the following link www.wieland-electric.com, you will find:

- the samos® PLAN 6 software
- The samos® PRO manuals available for display and printing in various languages:
  - This gateway manual (BA000969)
  - The hardware manual (BA000965)
  - The software manual (BA000967)
- The GSD file of the SP-PROFIBUS-DP for PROFIBUS-DP
- The EDS file of the SP-CANopen for CANopen

1.5 Abbreviations and definitions

Term	Explanation
{ }	An element array or an element structure
0b	The following are specified in binary format
0x	The following are specified in hexadecimal format
Procedure error	A procedure error occurs if, in redundant input circuits, the two input signals are not equal. Monitoring of inequality is frequently carried out within a tolerated time window.
ACD	Address Collision Detection
ANSI	American National Standards Institute, specified character coding
AOI	Add On Instruction
AOP	Add On Profile
API	Actual Packet Interval
AR	Application Relation, unique communication relationship in PROFINET IO between the PLC and the device
Attribute	Characteristic or property of an object
Bit	Data unit with a value of 0 or 1

Term	Explanation
BOOL	Data type specified for CIP devices; stands for a value of 1 byte, in which each of the 8 bits is viewed individually
Byte, BYTE	Data unit, representing a sequence of 8 bits; without a plus/minus sign, if not specified
CIP	Common Industrial Protocol
Controller module	Controller from the samos® PRO product family
CRC	Cyclic Redundancy Check, a type or the result of a hash function for revealing errors in the area of data storage or transmission
Data block	A data block contains 2-12 bytes of the relevant data set (depending on the gateway used).
Data set	Describes a quantity of associated data, e.g. logic values or system state data. A data set can consist of several data blocks.
I/O	Input/output
EPATH	Encoded Path, especially for CIP applications
EtherNet/IP	Industrially-used Ethernet network, combines standard Ethernet technologies with CIP
Gateway	Connection module for industrially-used networks, such as EtherNet/IP, PROFIBUS DB, CANopen, Modbus TCP, etc.
ID	An identifier or an identity
Instance	The physical representation of an object within a class. It stands for one of several objects within the same object class. (Reference: CIP specification, version 3.18)
IP	Internet protocol
Class	A series of objects representing a similar system component. A class is a generalization of the object, a template for defining variables and methods. All the objects within a class are identical with regard to function and behavior. However, they may have differing attribute values. (Reference: CIP specification, version 3.18)
LSB	Low Significant Byte
MPI	Measured Packet Interval; shows the API at the time of measurement
MSB	Most Significant Byte
O→T	Originator to Target (sender to target device)
ODVA	Open Device Vendor Association
PC	Personal Computer
PCCC	Programmable Controller Communication Command
PLC	Programmable Logic Controller
RPI	Requested Packet Interval
RX	Receive
S/N	Serial number
samos® PLAN 6	Configuration software for controller modules of type SP-COP. The software can be run on a PC and communicates with the controller modules.

Term	Explanation
Service	Service to be performed Examples: GetAttributeSingle, SetAttributeSingle
SHORT_STRING	Data type specified for CIP devices; stands for a character string (1 byte per character, 1 byte length code)
SINT	Short integer = 1 byte
SP-COP	Safety controller consisting of a controller module of the samos® PRO product family, as well as optionally connectable expansion gateways and I/O modules.
SP-COP2-ENI	Controller module, which is equipped with safety inputs and outputs and gateway functions, amongst other things
PLC	Programmable Logic Controller (PLC)
Stuck-at high	Stuck-at high is an error in which the input or output signal gets stuck at On. The causes for a Stuck-at high can be short-circuits to other input and output lines, often called cross-references, or defective switching elements. Stuck-at-High errors such as sequence errors in dual-channel input circuits are detected using plausibility tests or test pulses in input and output circuits.
Stuck-at low	Stuck-at low is an error in which the input or output signal gets stuck at Off. The causes of a stuck-at low can be line interruptions in input circuits or defect switching elements. Stuck-at-Low errors are detected using plausibility tests and do not usually require immediate detection.
T→O	Target to Originator
TCP	Transmission Control Protocol, Internet standard protocol for the transport layer specified in RFC 793
Test pulses or scan gaps	Test pulses or scan gaps are brief switch-offs / interruptions in input and output circuits, which are generated in a targeted manner to detect stuck-at high errors quickly. Test pulses check the switch-off ability of switching elements during operation on an almost continuous basis.
Test pulse error	Test pulse errors are undetected test pulses, which lead to a negative test result and thus switch-off of the affected safety circuits.
TX	Transmit / Send
UCMM	Unconnected Message Manager
UDINT	Unsigned double integer = 4 Bytes = 2 Words Data type specified for CIP applications
UDP	User Datagram Protocol, Internet standard protocol for the transport layer specified in RFC 793
UDT	User Defined Type
UINT	Unsigned double integer = 2 Bytes = 1 Word Data type specified for CIP applications
USINT	Data type specified for CIP applications, which stands for 1 byte without a plus/minus symbol

1.6 Symbols/icons and writing style/spelling standard used

NOTICE These are notes that provide you with information regarding particularities of a device or a software function.

WARNING

Warning!

A warning lets you know about specific or potential hazards. It is intended to protect you from accidents and help prevent damage to devices and systems.

- **Please read and follow the warnings carefully!**
  Failure to do so may negatively impact the safety functions and cause a hazardous state to occur.

Menus and commands

The names of software menus, submenus, options, and commands, selection fields, and windows are written in **bold font**. Example: Click on **Edit** in the **File** menu.

2 SAFETY

This section is intended to support your safety and the safety of the system users.

➡ Please read this section carefully before you work with a samos® PRO system.

2.1 Proper use

The samos® PRO gateways can only be operated in conjunction with a samos® PRO safety controller. The firmware version of the connected controller modules must be at least V1.0.0 and the version of the samos® PLAN 6 configuration software must be at least 1.0.0.

Basic conditions for use

The samos® PRO gateways may only be operated under the following conditions:

- You are operating the gateway within the specified areas of application.
  Further information: Areas of application of the device
- You are operating the gateway within the specified operating limits for voltage, temperature, etc.
  See the following for further information: *Technical data [ch. 12, p. 185]*
- You are observing personnel requirements.
  Further information: *Qualified persons [ch. 2.3, p. 14]*
- You are observing the special operator obligations.
  Further information: *Special obligations of the operator [ch. 2.4, p. 14]*

Improper use

Any other use or secondary use is deemed improper and is therefore not permitted. Any warranty claims for resulting damage made against Wieland Electric GmbH shall be deemed invalid. The risk shall be borne solely by the operator.

This also applies to any independent modifications made to the device.

2.2 Areas of application of the device

Do not use for safety-related data

WARNING

Do not operate a samos® PRO gateway on a safety field bus!

The gateway modules are not suitable for operation with a safety field bus!

They do not only generate safety-related field bus data (state bytes) for control and diagnostic purposes. They do not support any safety mechanisms that would be required for communication within a safety network.

WARNING

Do not use data from a samos® PRO gateway for safety-related applications!

The samos® PRO gateways can be used to integrate non-safety-related data into the logic editor in such a way that the safety function of the samos® PRO system may be adversely affected.

- Never integrate a gateway into a samos® PRO system without having this source or risk checked by a safety specialist.

Specifications for domestic use

If you wish to use the samos® PRO system for domestic purposes, you need to take additional steps to prevent the emission of radio frequency interference in limit class B according to EN 55011. Here are some steps you might take:

- The use of interference suppressor filters in the supply circuit
- Installation in grounded switch cabinets or boxes

2.3 Qualified persons

A safety controller with samos® PRO gateways may only be installed, commissioned and maintained by qualified persons.

Qualified persons are those who

- have suitable technical training **and**
- have been trained by the machine operator in the operation and applicable safety guidelines **and**
- have access to the samos® PRO system manuals and have read them and duly noted their contents.

2.4 Special obligations of the operator

WARNING

The safety instructions and precautions for use of samos® PRO gateways must be adhered to.

Any other use or any changes to the device – including within the scope of installation – shall nullify any kind of warranty claim against Wieland Electric GmbH.

Duty to provide instruction

- This manual must be made available for the operator of the machine on which the samos® PRO system is to be used. The machine operator must be trained by qualified persons and is required to read this manual.

Compliance with standards and regulations

- Please follow the standards and guidelines valid in your country when installing and using the samos® PRO gateways.
- The national/international legal regulations apply to the installation and use of modular samos® PRO safety controllers as well as commissioning and repeated technical testing, particularly the following:
  - EMC Directive 2014/30/EU
  - Work Equipment Directive 2009/104/EC
  - Accident prevention regulations/safety rules

Requirements for electrical installation

- The samos® PRO gateways do not have their own power supply.

2.5 Environmentally friendly behavior

The Wieland controllers and devices are designed in such a way that they stress the environment as little as possible. They use only a minimum of power and resources.

➡ Make sure that you also carry out work while always considering the environment.

2.5.1 Disposal

The disposal of unusable or irreparable devices should always be done in accordance with the respectively valid country-specific waste-elimination guidelines (e.g. European Waste Code 16 02 14).

NOTICE

We will be happy to help you in disposing of these devices.
Simply contact us.

2.5.2 Sorting of materials

WARNING

Important notes

- The sorting of materials may only be carried out by qualified persons!
- Care must be used when disassembling the devices. There is a risk of injuries during this process.

Before you can route the devices to the environmentally-friendly recycling process, it is necessary to sort the various materials of the devices.

➡ Separate the housing from the rest of the components (particularly from the PC board).

➡ Place the separated components into the corresponding recycling containers (see the following table).

Table 2: Overview of disposal according to components

Components	Disposal
Product	
Housing	Plastic recycling
PC boards, cables, connectors, and electric connecting pieces	Electronics recycling
Packaging	
Cardboard, paper	Paper/cardboard recycling

3 PRODUCT DESCRIPTION

samos® PRO gateways allow a samos® PRO system to transmit non-safety-related data for control and diagnostic purposes to the external field bus system and to receive them.

Important safety information

WARNING

Do not operate a samos® PRO gateway on a safety field bus!

The gateway modules are not suitable for operation with a safety field bus!

They do not only generate safety-related field bus data (state bytes) for control and diagnostic purposes. They do not support any safety mechanisms that would be required for communication within a safety network.

Information on the function, configuration and designations

NOTICE

Where not otherwise indicated, this manual always considers the data exchanged between the samos® PRO system and the relevant network from the point of view of the network master (PLC). Thus data sent to the network from the samos® PRO system is termed input data, while data received from the network is termed output data.

Configuration of samos® PRO gateways takes place via the samos® PLAN 6 configuration software, using a PC or Notebook connected to the SP-COPx main module via the USB interface or RJ45 Ethernet interface.

The safety-related logic of the samos® PRO system works independently of the gateway. However, if the system has been configured in such a way that non-safety-related information from the field bus can be integrated into the logic editor, switching off the gateway may result in availability problems.

A samos® PRO gateway can only be operated on a samos® PRO system. It does not have its own power supply. A maximum of two samos® PRO gateways can be operated simultaneously for each system.

Order information: *Order data [ch. 13, p. 191]*

3.1 Version, compatibility, and features

This section will give you an overview as to which module version and/or which version of the samos® PLAN 6 you will need to be able to use a certain gateway.

The following gateways are integrated in the controller module SP-COP2-ENI-x:

- Modbus TCP
- PROFINET IO
- EtherNet/IP

The following gateways are available as extended modules:

- Profibus-DP
- CANopen
- EtherCAT

Table 3: Required versions of the controller module

	Compatibility as of controller module version and higher			
Feature/ functionality	**SP-COP1-x**	**SP-COP2-EN-x**	**SP-COP2-ENI-x**	**samos® PLAN 6**
Modbus TCP (integrated)	---	---	A-01	V1.0
PROFINET IO (integrated)	---	---	B-01.xx	V1.0

	Compatibility as of controller module version and higher			
Feature/ functionality	**SP-COP1-x**	**SP-COP2-EN-x**	**SP-COP2-ENI-x**	**samos® PLAN 6**
EtherCAT (SP-EN-ETC)	C-01.xx	C-01.xx	C-01.xx	V1.0
EtherNet/IP (integrated)	---	---	D-01.xx	V1.0
PROFIBUS DP	A-01	A-01	A-01	V1.0
CANopen	A-01	A-01	A-01	V1.0

Table 4: Version history of the integrated gateway according to controller module version

		Version		
Module type	**Module version**	**Modbus TCP**	**PROFINET IO**	**EtherNet/IP**
SP-COP2-ENI-x	A-01	Yes	---	---
SP-COP2-ENI-x	B-01	Yes	GSDML profile V2.31	---
SP-COP2-ENI-x	C-01	Yes		---
SP-COP2-ENI-x	D-01	Yes		Vol 1 Ed 3.18, Vol 2 Ed 1.19, CT13
SP-COP2-ENI-x	D-03	Master start delay configurable	GSDML profile V2.32	Vol 1 Ed 3.21, Vol 2 Ed 1.22, CT14
SP-COP2-ENI-x	G-01	Yes		Vol 1 Ed 3.27 Vol 2 Ed 1.25, CT17

Version history for CANopen gateways

NOTICE

For new projects, use SP-CANopen gateways with part no. R1.190.0210.1. The firmware of these gateways is constantly being developed and offering new functions.

SP-CANopen gateways with the part no. R1.190.0210.0 should be used for existing projects and the spare parts business. The firmware is **not** developed further to ensure compatibility with older controller modules.

Table 5: SP-CANopen with part number R1.190.0210.0 (discontinuation planned)

Module type	Module version	Certification authority and version	New functions of the version
SP-CANopen	A-01	CAN-CiA according to CiA 310 with CTT version 2010	• First version
SP-CANopen	A-04		• Conversion to a new housing
SP-CANopen	A-06		• Optimization of power consumption

Table 6: SP-CANopen with part no. R1.190.0210.1

Module type	Module version	Certification authority and version	New functions of the version
SP-CANopen	A-02	CAN-CiA according to CiA 310 with CTT 3.0.2.2	• CANopen emergency messages are fully functional. • Minor software improvements

Module type	Module version	Certification authority and version	New functions of the version
SP-CANopen	A-07	CAN-CiA according to CiA 310 with CTT 3.0.2.2	• Conversion to a new housing • Optimization of power consumption • Improvement to the insensitivity of the switch-on sequence between the PLC and samos® PRO • Improvement in downward compatibility • CANopen emergency messages are fully functional.
SP-CANopen	A-08	CAN-CiA according to CiA 310 with CTT 3.0.3.8	• Rectification of the system start problem with certain module configurations of a samos® PRO controller module • Change of CANopen communication type object 1800 with transmission type 255, whereby the date is transmitted asynchronously when the state changes or synchronously after the timer expires. • Adaption of the higher half of byte 4 (M1) of the emergency data to include a diagnosis ID for clear decoding of the error cause • Minor software improvements

Version history for PROFIBUS-DP gateways

NOTICE

For new projects, use SP-PROFIBUS-DP gateways with part no. R1.190.0190.1. The firmware of these gateways is constantly being developed and offering new functions.

SP-PROFIBUS-DP gateways with the part no. R1.190.0190.0 should be used for existing projects and the spare parts business. The firmware is **not** developed further to ensure compatibility with older controller modules.

Table 7: SP-PROFIBUS-DP with part number R1.190.0210.0 (discontinuation planned)

Module type	Module version	Certification authority and version	New functions of the version
SP-PROFIBUS-DP	A-02	PROFIBUS DP-V0	• First version
SP-PROFIBUS-DP	A-05	PROFIBUS DP-V0	• Conversion to a new housing • Optimization of power consumption for energy efficiency

Table 8: SP-PROFIBUS-DP with part no. R1.190.0190.1

Module type	Module version	Certification authority and version	New functions of the version
SP-PROFIBUS-DP	A-03	PROFIBUS DP-V0	• The manufacturer-specific extended diagnostics are fully functional. • Minor software improvements

Module type	Module version	Certification authority and version	New functions of the version
SP-PROFIBUS-DP	A-04	-	• Conversion to a new housing
SP-PROFIBUS-DP	A-06	–	• Optimization of power consumption for energy efficiency • The manufacturer-specific extended diagnostics are fully functional.
SP-PROFIBUS-DP	A-07	-	• Improvement in downward compatibility • Rectification of the system start problem with certain module configurations of a samos® PRO controller module • Improvement of the display: LED lights up red again instead of green in the event of an error. • Minor software improvements

Version history for EtherCAT gateways

Table 9: SP-EN-ETC with part number R1.190.0160.0

Module type	Module version	Certification authority and version	New functions of the version
SP-EN-ETC	A-01	according to ETG.7000 with CTT V2.0.42.0	• First version
SP-EN-ETC	A-02	according to ETG.7000 with CTT V2.0.42.0	• Conformity with new test tool • Minor software improvements
SP-EN-ETC	A-03	according to ETG.7000 with CTT V2.0.42.0	• Conversion to a new housing
SP-EN-ETC	A-04	according to ETG.7000 with CTT V2.2.1.0	• Optimization of power consumption for energy efficiency • Prevention of high-frequency whistling under certain load conditions • Configurable station alias for interoperability with Omron PLCs • Adaptations regarding the EtherCAT Conformity Test Suite CCT 2.2.1.0 with adaptations to SII, Object Dictionary and transition from PreOp → SafeOp • Adaptations regarding interoperability with Lenze PLCs • Minor software improvements

Info

- You can find the module version on the type plate of the modules.
- You will find the samos® PLAN 6 version in the main menu.
- The latest software version is available in the Internet at the following address www.wieland-electric.com.

- Newer modules are backwards-compatible, which means that each module can be replaced with a module having a higher module version.
- You can find the date of manufacture for a device on the type plate in the **S/N** field in the format <Product no.>yywwnnnnn (yy = year, ww = calendar week).

3.2 Equipment variants

There are six samos® PRO gateways for various network types.

The Modbus TCP / PROFINET IO, EtherNet/IP or SP-EN-ETC gateway is suitable for Ethernet networks. The SP-PROFIBUS-DP and SP-CANopen gateway are used for fieldbus communication.

WARNING

Restrictions for Ethernet connections

- The Ethernet connection can only be linked to autonomous networks or demilitarized zones (DMZ).
- The device must never be connected directly to the Internet.
- Always use secure data tunnels (VPN) to exchange data via the Internet.

Table 10: Equipment variants and their main characteristics

Gateway	Network type	Ethernet IP socket interface
SP-EN-MOD	Modbus TCP with master and slave operation	Client/Server on TCP Port 502
SP-EN-PN	PROFINET IO device	UDP ports 34964, 49152
SP-EN-IP	EtherNet/IP device	TCP port 44818, UDP port 2222
SP-PROFIBUS-DP	PROFIBUS DP slave	- -
SP-CANopen	CANopen slave	- -
SP-EN-ETC	EtherCAT slave	- -

NOTICE

You will find the manufacturing date of a device on the type label in the S/N field in the format yywwnnnn (yy = year, ww = calendar week, nnnn = sequential serial number within a calendar week).

3.3 Data transferred to the network (network input data sets)

Available data

The samos® PRO gateways can provide the following data:

- Process data
  - **Logic results from** the samos® PRO safety controller (see *Routing table [ch. 5.1.3, p. 44]*)
  - **Input values** (HIGH/LOW) for all samos® PRO input expansion modules in the system
  - **Output values** (HIGH/LOW) for all samos® PRO input/output expansion modules (see *Module state / input and output values [ch. 3.3.1, p. 25]*)
  - **Output data** from another network, i.e. data received from a second gateway in the samos® PRO system (see *Transmission of data from a second network [ch. 3.3.3, p. 26]*)
- Diagnostics
  - **Test values** (CRCs): (see *Data set 2 [ch. 11.5.2, p. 175]*)
  - **Error and state information**: *Error and state information for the modules [ch. 3.3.4, p. 27]*

Default values

Data from gateways or the non-secure SP-DIO I/O expansion module is categorically not secure. Default values are taken up in the error state of the controller. The default value of input/output values is 0 and the default value of status values is 1.

Data sets

The physical modules are not presented as typical hardware modules in the network. Instead, the data provided by the samos® PRO system has been arranged in four *input data sets*.

- **Data set 1** (max. 50 bytes) contains the process data. It can be compiled with the aid of samos® PLAN 6. In the form in which it is delivered, the content of data set 1 is preconfigured; it can be freely modified.
  Details: see table *"Overview of input data sets" [ch. 3.3, p. 21]*
  For the SP-PROFIBUS-DP gateway, data set 1 was divided into five input data blocks, with data blocks 1–4 each containing 12 bytes and data block 5 two bytes.
  For the SP-CANopen gateway, data set 1 was divided into four blocks, each with 8 bytes.
  You will find more detailed information in the corresponding section for each gateway.
- **Data set 2** (32 bytes) contains the test values (CRCs) for the system configuration.
  See table “Overview of input data sets 1–3 (basic settings for Modbus TCP)" below
- **Data set 3** (60 bytes) contains the state and diagnostic data for the various modules, with four (4) bytes per module, with the controller module comprising 3 x 4 bytes. Details: see table *"Meaning of module state bits" [ch. 3.3.4, p. 27]*
- **Data set 4** (60 bytes) is currently filled with reserved values.

NOTICE

As of module version samos® PRO F-01, the setting of multibit values (16 bit and 32 bit) is supported. The format and dimensioning is described in the software manual (see *Mapping function block values to gateways [ch. 5.3, p. 49]*).

The following table provides an overview of which data sets are provided by which gateway.

Table 11: Availability of data sets 1–4

	Data set 1	Data set 2	Data set 3	Data set 4
SP-COP2-ENI	Modbus TCP PROFINET IO EtherNet/IP	Modbus TCP PROFINET IO EtherNet/IP	Modbus TCP PROFINET IO EtherNet/IP	Modbus TCP PROFINET IO
SP-EN-ETC	EtherCAT	EtherCAT	EtherCAT	-
SP-PROFIBUS-DP	PROFIBUS DP	–	–	–
SP-CANopen	CANopen	SDOs[1)]	SDOs[1)]	–
[1)] The SP-CANopen is used to provide diagnostic data via CANopen SDO (service data objects). More information about how to provide state and diagnostic data with the aid of the CANopen gateway may be found here: *CANopen gateway [ch. 10, p. 127]*				
[2)] Readable with instance 2 of class 120				
[3)] Readable with instance 3 of class 120 and byte 52 to 111 of assembly 167				

Table 12: Overview of input data sets 1–3 (basic setting for Modbus TCP)

	Data set 1	Data set 2	Data set 3	Data set 4
Byte 0	Input values for Module 0 (I1..I8)	Project CRC	Module state SP-COPx	Reserved
Byte 1	Input values for Module 0 (I9..I16)		Module state SP-COPx	
Byte 2	Input values for Module 0 (IQ1..IQ4)		Test pulse comparison, controller module inputs	
Byte 3	Output values for Module 0 (Q1..Q4, IQ1..IQ4)		Test pulse comparison, controller module inputs	
Byte 4	Direct data (Off) 0	Internal CRC[1)]	Test pulse comparison, controller module inputs	
Byte 5	Direct data (Off) 1		State of two-channel controller module inputs	

	Data set 1	Data set 2	Data set 3	Data set 4
Byte 6	Direct data (Off) 2		State of two-channel controller module inputs	
Byte 7	Direct data (Off) 3		Reserved	
Byte 8	Direct data (Off) 4	Reserved	Stuck-at error at controller module outputs	Reserved
Byte 9	Direct data (Off) 5		Stuck-at error at controller module outputs	
Byte 10	Direct data (Off) 6		Reserved	
Byte 11	Direct data (Off) 7		Reserved	
Byte 12	Input values for Module 1		State of Module 1	
Byte 13	Input values for Module 2		State of Module 1	
Byte 14	Input values for Module 3		State of Module 1	
Byte 15	Input values for Module 4		State of Module 1	
Byte 16	Input values for Module 5		State of Module 2	
Byte 17	Input values for Module 6		State of Module 2	
Byte 18	Input values for Module 7		State of Module 2	
Byte 19	Input values for Module 8		State of Module 2	
Byte 20	Input values for Module 9		State of Module 3	Reserved
Byte 21	Input values for Module 10		State of Module 3	
Byte 22	Input values for Module 11		State of Module 3	
Byte 23	Input values for Module 12		State of Module 3	
Byte 24	Output values for Module 1	Reserved	State of Module 4	Reserved
Byte 25	Output values for Module 2		State of Module 4	
Byte 26	Output values for Module 3		State of Module 4	
Byte 27	Output values for Module 4		State of Module 4	
Byte 28	Output values for Module 5		State of Module 5	
Byte 29	Output values for Module 6		State of Module 5	
Byte 30	Output values for Module 7		State of Module 5	
Byte 31	Output values for Module 8		State of Module 5	
Byte 32	Output values for Module 9	Not available	State of Module 6	Reserved
Byte 33	Output values for Module 10		State of Module 6	
Byte 34	Output values for Module 11		State of Module 6	
Byte 35	Output values for Module 12		State of Module 6	
Byte 36 … Byte 47	Not allocated		State of Module 7 … Status of Module 9	
Byte 48			State of Module 10	
Byte 49			State of Module 10	
Byte 50	Not available	Not available	State of Module 10	Reserved

	Data set 1	Data set 2	Data set 3	Data set 4
Byte 51			State of Module 10	
Byte 52 … Byte 55			State of Module 11 … Status of Module 11	
Byte 56			State of Module 12	
Byte 57			State of Module 12	
Byte 58			State of Module 12	
Byte 59			State of Module 12	
Length	50 bytes	32 bytes	60 bytes	60 bytes
[1] The use of the internal CRC in dataset 2 is only permitted for diagnostic purposes so that Wieland Technical Support can continue to provide support.				

NOTICE When dual-channel input or output elements have been configured for an I/O module, only the lowest bit constitutes the input or output state (on/off) of the corresponding element. It is represented by the tag name of the element. The highest bit represents the state of this input/output.

NOTICE The input values in data set 1 do not represent the physical state at the input terminals, but the pre-processed input values that are used for logic processing.

Table 13: ***Overview of data sets when analog input modules are used (alternative data set 1)***

	Data set 1	Data set 2	Data set 3	Data set 4
Byte 0	Input values for Module 0 (I1..I8)	Project CRC	Module state SP-COPx	Reserved
Byte 1	Input values for Module 0 (I9..I16)		Module state SP-COPx	
Byte 2	Input values for Module 0 (IQ1..IQ4)		Test pulse comparison, controller module inputs	
Byte 3	Output values for Module 0 (Q1..Q4, IQ1..IQ4)		Test pulse comparison, controller module inputs	
Byte 4		Internal CRC[1]	Test pulse comparison, controller module inputs	
Byte 5			State of two-channel controller module inputs	
Byte 6			State of two-channel controller module inputs	
Byte 7			Reserved	
Byte 8		Reserved	Stuck-at error at controller module outputs	Reserved
Byte 9			Stuck-at error at controller module outputs	
Byte 10			Reserved	
Byte 11			Reserved	
Byte 12			State of Module 1	
Byte 13			State of Module 1	
Byte 14			State of Module 1	
Byte 15			State of Module 1	

	Data set 1	Data set 2	Data set 3	Data set 4
Byte 16			State of Module 2	
Byte 17			State of Module 2	
Byte 18			State of Module 2	
Byte 19			State of Module 2	
Byte 20			State of Module 3	Reserved
Byte 21			State of Module 3	
Byte 22			State of Module 3	
Byte 23			State of Module 3	
Byte 24		Reserved	State of Module 4	Reserved
Byte 25			State of Module 4	
Byte 26			State of Module 4	
Byte 27			State of Module 4	
Byte 28			State of Module 5	
Byte 29			State of Module 5	
Byte 30			State of Module 5	
Byte 31			State of Module 5	
Byte 32		Not available	State of Module 6	Reserved
Byte 33			State of Module 6	
Byte 34			State of Module 6	
Byte 35			State of Module 6	
Byte 36 … Byte 47			State of Module 7 … Status of Module 9	
Byte 48			State of Module 10	
Byte 49			State of Module 10	
Byte 50	Not available	Not available	State of Module 10	Reserved
Byte 51			State of Module 10	
Byte 52 … Byte 55			State of Module 11 … Status of Module 11	
Byte 56			State of Module 12	
Byte 57			State of Module 12	
Byte 58			State of Module 12	
Byte 59			State of Module 12	
Length	50 bytes	32 bytes	60 bytes	60 bytes

[1)] The use of the internal CRC in dataset 2 is only permitted for diagnostic purposes so that Wieland Technical Support can continue to provide support.

3.3.1 Direct gateway output values

It is possible to write values directly from the **Logic** view to a gateway. Four bytes have been reserved for this purpose in the basic settings for data set 1; however, up to the total number of 50 bytes of data set 1 may be configured as direct gateway output values. You can obtain additional information at: *Direct gateway output values [ch. 5.4, p. 49]*.

3.3.2 Module state / input and output values

The samos® PRO gateways can transmit the input and output states of all modules connected to the samos® PRO system to the network. Data set 3 contains a non-modifiable configuration. Moreover, data set 1 can be adapted to contain up to 4 bytes of collective state information. Only the input and output values for data set 1 have been predefined and these can be freely adapted. You will find more detailed information in the section on the relevant gateway, as well as in the following section: *Configuration of gateways with samos® PLAN 6 [ch. 5, p. 41]*

Module state

The samos® PRO gateways can transfer the state of the linked modules to the network. A total of 4 bytes are available for this purpose.

Table 14: Module state

Module state	Size	Meaning	Assignment
Input data state	2 bytes	One sum bit per module for the state of the module inputs 0 = error 1 = no error	Bit 0 = SP-COPx Bit 1 = 1. Extension module Bit 2 = 2nd Expansion module … Bit 13 = 1. Gateway Bit 14 = 2. Gateway Bit 15 = reserved
Output data state	2 bytes	One sum bit per module for the state of the module outputs 0 = error 1 = no error	

You will find information about the meaning of the state bits at: software manual, Internal inputs for controller modules

NOTICE The input and output states of the SP-SDI and SP-SDIO modules is only available from firmware version V2.00.0.

Input and output values for the modules

- **Input values for I/O modules**
  1 byte for data set 1 is available for every expansion module. The input values show the state of the preliminary evaluation of the I/O module. This corresponds to the state of the element in the controller module logic. The level at the associated terminal cannot be clearly detected from this, as the data may be set to low, irrespectively of the level at the input terminal, by means of the cross-connection detection or two-channel evaluation (e.g. I1-18).
  When two-channel input elements have been configured for an I/O module, only the lower-value bit represents the pre-evaluation state of the corresponding element (e.g. bit 0 for I1 and I2, bit 2 for I3 and I4, bit 4 for I5 and I6, bit 6 for I7 and I8). The higher-value bit (bit 1, 3, 5 and 7) is used as follows in this case:
  0 = error 1 = no error
- **Output values for I/O modules**
  1 byte for data set 1 is available for every module with outputs. The output values indicate the state of the control information from the logic of the controller module for the relevant element of the I/O module. The level of the associated terminals cannot be clearly detected from this, as the output may be switched off via the cross-connection detection or the overload connection function.

When two-channel output elements have been configured for an I/O module, only the lower-value bit represents the control information (e.g. bit 0 for Q1 and Q2, bit 2 for Q3 and Q4, bit 4 for Q5 and Q6, bit 6 for Q7 and Q8). The higher-value bit (bit 1, 3, 5 and 7) is not used as follows in this case (low):

3.3.3 Transmission of data from a second network

If your samos® PRO system contains two gateways, it is possible to forward information which the first gateway receives from a network (e.g. from a Modbus PLC) via the second gateway to a second network (e.g. to a PROFIBUS master) and vice versa.

3.3.4 Error and state information for the modules

Data set 3 and 4 contain the state information for the modules that will be transferred to the network.

Ten bytes are transmitted for SP-COPx controller module. For each SP-SDI and SP-SDIO I/O module, four bytes are transmitted in the Little Endian format, e.g. as a 32-bit word, with the first byte being placed into the least significant byte of the whole number (extreme left) and the fourth byte into the most significant byte of the whole number (extreme right).

Data sets 3 and 4 cannot be adapted.

Module status bits of the controller module SP-COPx

The module state bits have the following meaning, if not otherwise indicated:

0 = error

1 = no error

Reserved bits have the value 1

NOTICE You can find an explanation of the technical terms used below here: *Abbreviations and definitions [ch. 1.5, p. 9]*

Table 15: Meaning of module state bits of controller module SP-COPx (only for Modbus)

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	B2 status	Collective error fast shut-off	B1 status	Configuration state	A1 status	External module state	Internal module state	Reserved
Byte 1	Module state output data	Module state of input data	Reserved	Reserved	IQ3+IQ4 power requirement 0: Overcurrent 1: no overcurrent	IQ1+IQ2 power requirement 0: Overcurrent 1: no overcurrent	Q3+Q4 power requirement 0: Overcurrent 1: no overcurrent	Q1+Q2 power requirement 0: Overcurrent 1: no overcurrent
Byte 2	I8 vs. T2/4 test pulse comparison	I7 vs. T1/3 test pulse comparison	I6 vs. T2/4 test pulse comparison	I5 vs. T1/3 test pulse comparison	I4 vs. T2/4 test pulse comparison	I3 vs. T1/3 test pulse comparison	I2 vs. T2/4 test pulse comparison	I1 vs. T1/3 test pulse comparison
Byte 3	I16 vs. T2/4 test pulse comparison or HW limit frequency I16	I15 vs. T1/3 test pulse comparison or HW limit frequency I15	I14 vs. T2/4 test pulse comparison or HW limit frequency I14	I13 vs. T1/3 test pulse comparison or HW limit frequency I13	I12 vs. T2/4 test pulse comparison	I11 vs. T1/3 test pulse comparison	I10 vs. T2/4 test pulse comparison	I9 vs. T1/3 test pulse comparison
Byte 4	0: Cable break at I16 1: OK or not used	0: Cable break at I15 1: OK or not used	0: Cable break at I14 1: OK or not used	0: Cable break at I13 1: OK or not used	IQ4 vs. T2/4 test pulse comparison	IQ3 vs. T1/3 test pulse comparison	IQ2 vs. T2/4 test pulse comparison	IQ1 vs. T1/3 test pulse comparison
Byte 5	I15/I16 dual-channel state 0: Error 1: ok or not used	I13/I14 dual-channel state 0: Error 1: ok or not used	I11/I12 dual-channel state 0: Error 1: ok or not used	I9/I10 dual-channel state 0: Error 1: ok or not used	I7/I8 dual-channel state 0: Error 1: ok or not used	I5/I6 dual-channel state 0: Error 1: ok or not used	I3/I4 dual-channel state 0: Error 1: ok or not used	I1/I2 dual-channel state 0: Error 1: ok or not used

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 6	0: Inversion window of Sensor 2 1: OK or not used	0: Inversion window of Sensor 1 1: OK or not used	0: Frequency difference I14 vs. I16 1: OK or not used	0: Frequency difference I13 vs. I15 1: OK or not used	0: Phase difference I14 vs. I16 too low 1: OK or not used	0: Phase difference I13 vs. I15 too low 1: OK or not used	IQ3/IQ4 dual-channel state 0: Error 1: ok or not used	IQ1/IQ2 dual-channel state 0: Error 1: ok or not used
Byte 7	0: I16 Stuck at low 1: OK or not used	0: I16 Stuck at high 1: OK or not used	0: I15 Stuck at low 1: OK or not used	0: I15 Stuck at high 1: OK or not used	0: I14 Stuck at low 1: OK or not used	0: I14 Stuck at high 1: OK or not used	0: I13 Stuck at low 1: OK or not used	0: I13 Stuck at high 1: OK or not used
Byte 8	Q4 Stuck at low	Q4 Stuck at high	Q3 Stuck at low	Q3 Stuck at high	Q2 Stuck at low	Q2 Stuck at high	Q1 Stuck at low	Q1 Stuck at high
Byte 9	IQ4 (Output) Stuck at low	IQ4 (Output) Stuck at high	IQ3 (Output) Stuck at low	IQ3 (Output) Stuck at high	IQ2 (Output) Stuck at low	IQ2 (Output) Stuck at high	IQ1 (Output) Stuck at low	IQ1 (Output) Stuck at high

Module state bits of the I/O modules SP-SDI and SP-SDIO

NOTICE

The module state bits for the SP-SDI and SP-SDIO modules are only fully supported from firmware version 1.2.x.

The module state bits have the following meaning, if not otherwise indicated:

0 = error

1 = no error

Table 16: Meaning of the module state bits of the safe I/O modules SP-SDI and SP-SDIO

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Collective error fast shut-off	Power supply for Q1 .. Q4	Configuration of this module is valid.	Not used (error history flag)	External module state	Internal module state	Not used ("executing state")
Byte 1	Module state of output data	Module state of input data	Reserved	Reserved	Two-channel evaluation of input I7–I8	Two-channel evaluation of input I5–I6	Two-channel evaluation of input I3–I4	Two-channel evaluation of input I1–I2
Byte 2	Test impulse comparison I8 vs. X2	Test impulse comparison I7 vs. X1	Test impulse comparison I6 vs. X2	Test impulse comparison I5 vs. X1	Test impulse comparison I4 vs. X2	Test impulse comparison I3 vs. X1	Test impulse comparison I2 vs. X2	Test impulse comparison I1 vs. X1
Byte 3	Q4 Stuck-at low 0: Stuck-at error 1: no stuck-at	Q4 Stuck-at high 0: Stuck-at error 1: no stuck-at	Q3 Stuck-at low 0: Stuck-at error 1: no stuck-at	Q3 Stuck-at high 0: Stuck-at error 1: no stuck-at	Q2 Stuck-at low 0: Stuck-at error 1: no stuck-at	Q2 Stuck-at high 0: Stuck-at error 1: no stuck-at	Q1 Stuck-at low 0: Stuck-at error 1: no stuck-at	Q1 Stuck-at high 0: Stuck-at error 1: no stuck-at

Module state bits of the SP-DIO I/O module

The module state bits have the following meaning if not otherwise indicated; normally only the first byte of the total state is transmitted:

0 = error

1 = no error or reserved

Table 17: Meaning of the module state bits of the SP-DIO expansion module

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Reserved	Power supply Y1-Y4 and IY5-IY8	Configuration status	Not used (error history flag)	External module state	Internal module state	Not used ("executing state")
Byte 1	Module state output data	Module state input data	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Byte 2	Reserved							
Byte 3	Reserved							

Status bits of analog value modules SP-SAR4, SP-SAC4 and SP-SACR22

Table 18: Meaning of status bits of analog value modules SP-SAR4, SP-SAC4 and SP-SACR22

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Reserved	SAC4 and SACR22: Voltage outputs X1…X4	Configuration status	Not used (error history flag)	External module state	Internal module state	Not used ("executing state")
Byte 1	Reserved	Module state of input data	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Byte 2	Below lower limit of monitoring range I4 or Rbx[2]	Below lower limit of monitoring range I3 or Rax[1]	Below lower limit of monit. range I2 or R2x	Below lower limit of monit. range I1 or R1x	Above upper limit of monit. range I4 or Rbx fn:2	Above upper limit of monit. range I3 or Rax[1]	Above upper limit of monit. range I2 or R2x	Above upper limit of monit. range I1 or R1x
Byte 3	Open circuit I4 or Rbx[2]	Open circuit I3 or Rax[1]	Open circuit I2 or R2x	Open circuit I1 or R1x	Short-circuit I4 or Rbx[2]	Short-circuit I3 or Rax[1]	Short circuit I2 or R2x	Short circuit I1 or R1x

Bits 1, 2 and 14 are available in the logic editor as corresponding status inputs.

Module state bit of the gateways

The module state bits have the following meaning if not otherwise indicated; normally only the first byte of the total state is transmitted:

0 = error

1 = no error

Table 19: Meaning of gateway module state bits

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved	Module state output data	Module state input data	Configuration status	Not used (error history flag)	Reserved	Internal module state	Not used ("executing state")
Byte 1	Reserved							
Byte 2	Reserved							
Byte 3	Reserved							

Example

Module 2 (SP-SDIO) has a short-circuit after high (24 V) at output 3. The following module state is transmitted to the network (only the first 20 of 60 bytes are shown):

Byte address	**00**	**01**	**02 …**	**03 11**	**04 12**	**05 13**	**06 14**	**07 15**	**08 16**	**09 17**	**10 18**	**11 19**	**…**
Byte	3 0	2 1	1 …	0 11	3 0	2 1	1 2	0 3	3 0	2 1	1 2	0 3	…
Value	FF	FF	FF	FF	FF	FF	FF	FF	**EF FB**	FF	FF	**FB EF**	…
Meaning	Status of controller module				Status of module 1 (SP-SDIO)				**State of module 2** (SP-SDIO)				…

The first relevant byte for the module 2 error described above is module state byte 0 for module 2. This is byte 11 with the hexadecimal value FB (1111 1011):

Bit #	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Value	1	1	1	1	1	**0**	1	1

This corresponds to the error message "Summary of bits 0.5 to 0.7 (external error)", byte 0, bit 2 in the following table: *Meaning of the module state bits of the safe I/O modules SP-SDI and SP-SDIO [ch. 3.3.4, p. 28]*

The second relevant byte is the module state byte 3 for module 2. This is byte 08 with the hexadecimal value EF (1110 1111):

Bit #	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Value	1	1	1	**0**	1	1	1	1

This corresponds to the error message "Short circuit monitoring of output 3, short circuit after high", byte 3, bit 4 in the following table: *Meaning of the module state bits of the safe I/O modules SP-SDI and SP-SDIO [ch. 3.3.4, p. 28]*

NOTICE

- Reserved (for future use) = static 1 (no state change)
- Not used (can be 0 or 1), both values occur.
- If there is no module, all values - including the reserved values - are set to logical 1.

3.3.5 Transmission time of input and output data via an external gateway

The transmission time and thus the delay of the data depends on the number and amount of configured gateway data.

1 gateway and up to 10 bytes of data 4 ms additional delay.

2 gateways and up to 10 bytes of data 8 ms additional delay.

1 gateway and up to 50 bytes of data 20 ms additional delay.

2 gateways and up to 50 bytes of data 40 ms additional delay.

NOTICE For every 10 bytes, there is a delay of 4 ms. The maximum amount of configured data in one direction is received and a second gateway doubles this time.

3.4 Data received from the network (network output data sets)

The data from data set 1 (max. 50 bytes) received from the network may be differently arranged, depending on the protocol. For the Modbus TCP, this data set was divided into five data blocks, each with 10 bytes. In the SP-PROFIBUS-DP gateway, output data blocks 1-4 each contain 12 bytes, while output data block 5 contains 2 bytes. CANopen only defines 4 data blocks, each with 8 bytes.

Table 20: Output data block 1–5 of the various gateways

	Size of output data block				
Gateway	**Block 1**	**Block 2**	**Block 3**	**Block 4**	**Block 5**
SP-PROFIBUS-DP / PROFINET IO	12 bytes	12 bytes	12 bytes	12 bytes	2 bytes
SP-CANopen	8 bytes	8 bytes	8 bytes	8 bytes	–
SP-EN-ETC / Modbus TCP / EtherNet/IP	10 bytes	10 bytes	10 bytes	10 bytes	10 bytes

The content of the output data blocks can be used in the logic editor, as well as made available for another network via a second gateway within the samos® PRO system.

NOTICE

- In order to use network data in the logic editor or as input for another network, you must assign a tag name for each bit to be used.
- Bits without specific tag names will not be available in the logic editor or for routing via a second gateway. Detailed information about how to assign tag names for the data received may be found in the corresponding sections of the chapters on the various gateways.
- You can monitor current communication with the network with the aid of input data state bits for receiving data from the network and the output data state bit for transmitting data to the network in the logic editor. When the gateway detects a communication error, both the content of the data sets and the associated state bit are set to zero (logical 0).
- When all communication fails, the data of the output data sets and the input data state bit are set to zero (logical 0).
- When a connection is closed while others remain available, the LED MS or LED state will flash red/green for a total of 10 seconds and an entry will be made in the error log. In this case the state bits are not affected.

WARNING

Do not use the same output data block number for two different PLC connections or TCP/IP sockets!

The output data block of the Ethernet gateways can be described in parallel via all communication interfaces or TCP/IP sockets (e.g. Modbus TCP/IP and Ethernet TCP/IP) if they make use of the same output data block number. In this case the last message will always overwrite the data received earlier.

4 INSTALLATION AND BASIC CONFIGURATION

4.1 Installing/removing

4.1.1 Installing modules on DIN rails

WARNING

Only for control cabinets with protection class IP 54 or higher!

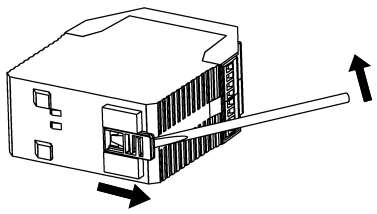
The samos® PRO system is only suitable for installations in a switchbox having at least protection class IP 54.

Info

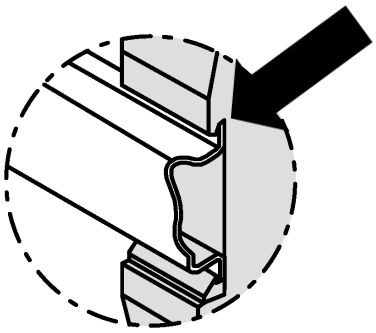
- Basic safety:
  Gateways and extended modules may not be removed or added when the operating voltage is switched on.
- Grounding:
  The DIN rail must be conductively connected to the protective earth conductor (PE).
- ESD protection measures:
  Observe suitable ESD protection measures during installation.
  Failure to do so could result in damage to the internal safety bus.
- Protect connector openings:
  Undertake suitable measures so that no foreign bodies can penetrate connector openings, particularly those for the program removable storage.
- Module width:
  The modules are placed in a mounting box that is 22.5 mm or 45 mm wide depending on type.
- Quality of DIN rail:
  The mounting boxes are suitable for 35 mm DIN rails as per EN 60715.
- Sequence of modules:
  The samos® PRO system has the controller module on the far left. The two optional gateways follow directly to the right next to the controller module. The expansion modules only follow thereafter.
- Save space for subsequent model replacement:
  The modules are connected via the plug connection integrated into the housing. Note that the samos® PRO modules must be pulled about 10 mm apart before a module replacement so that the corresponding module can be removed from the DIN rail.
- Standards to be taken into consideration:
  Installation according to EN 50274

Step 1: Installing a controller module

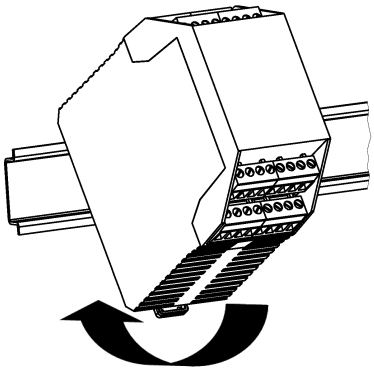
➡ Use a screwdriver to pull the mounting foot outward.



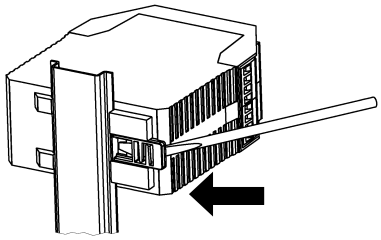
➡ Hang the module on the DIN rail.
Important! Make sure that the screening spring fits correctly.
The screening spring of the module must be placed onto the DIN Rail so that it is secure and has good electrical contact.



➡ Fold the module onto the DIN rail.



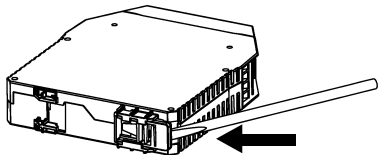
➡ Use a screwdriver to move the mounting foot against the DIN rail until the mounting foot latches into position with an audible click.



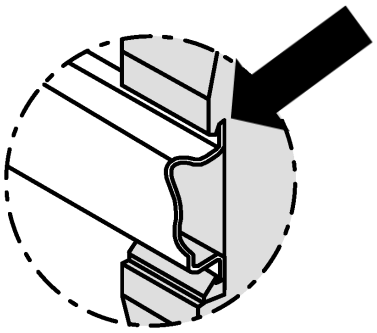
➡ Make sure that the module is securely seated on the DIN rail.
Attempt to pull the module from the DIN rail using slight pressure. If the module stays connected to the DIN rail during this test, then the installation is correct.

Step 2: Installation of gateways or expansion modules

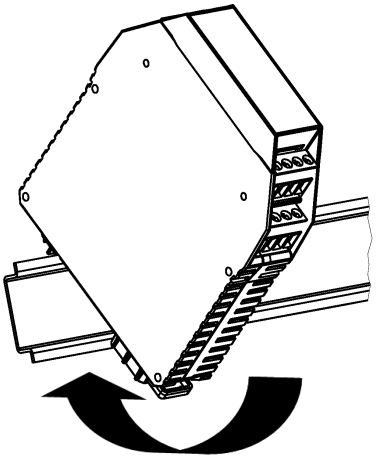
➡ Use a screwdriver to pull the mounting foot outward.



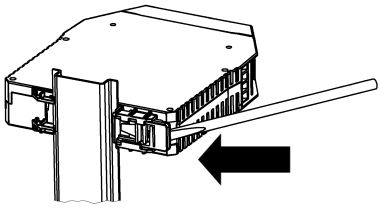
➡ Hang the module on the DIN rail.
Important! Make sure that the screening spring fits correctly.
The screening spring of the module must be placed onto the DIN Rail so that it is secure and has good electrical contact.



➡ Fold the module onto the DIN rail.

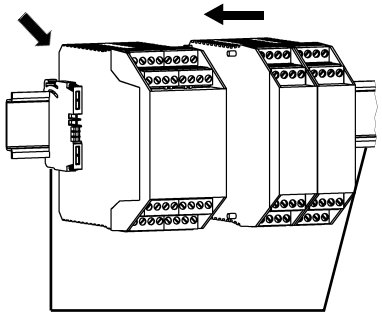


➡ Use a screwdriver to move the mounting foot against the DIN rail until the mounting foot latches into position with an audible click.



➡ Make sure that the module is securely seated on the DIN rail.
Attempt to pull the module from the DIN rail using slight pressure. If the module stays connected to the DIN rail during this test, then the installation is correct.

➡ If you are installing multiple modules:
Push the individual modules together in the direction of the arrow until the lateral plug connection between the modules audibly latches into position.



➡ Install an end terminal into the module furthest to the left and another end terminal into the module furthest to the right.

After installation

Once you have installed the modules, the following steps are required:

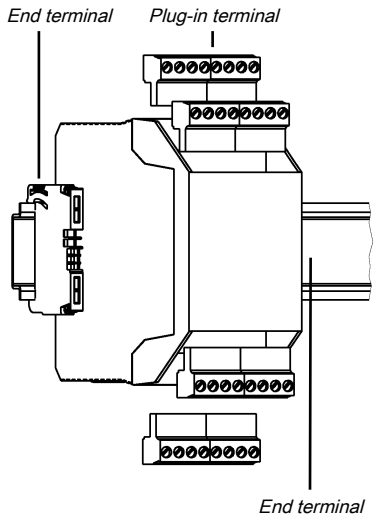
- Connect the modules electrically.
- Configure modules (see: software manual).
- Check the installation before first commissioning.

4.1.2 Removing modules from the DIN rail

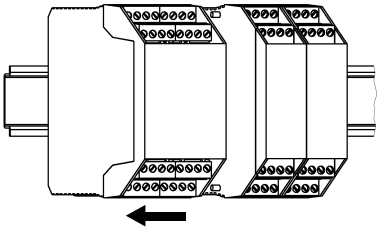
Step 1: Removing a controller module

➡ De-energize the samos® PRO system.

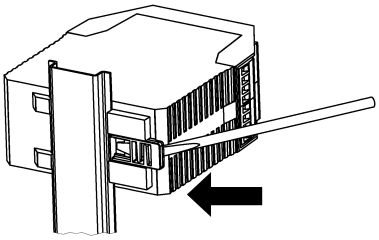
➡ Remove plug-in terminals with wiring and remove the end terminal.



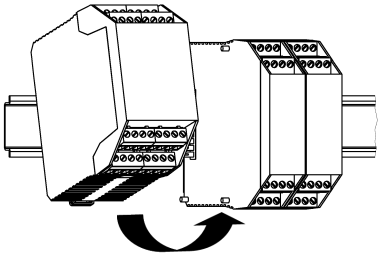
➡ If expansion modules or gateways are used:
Slide the controller module in the direction of the arrow until the lateral plug connection is disconnected.



➡ Unlock the module.
To do this, pull the mounting foot of the module outward using a screwdriver.



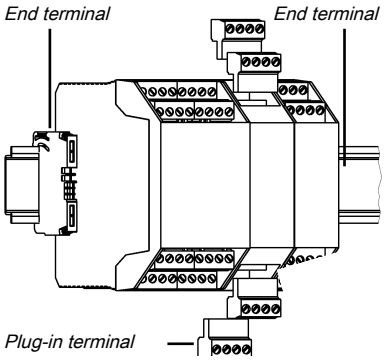
➡ Fold the module away from the DIN rail and remove from the rail.



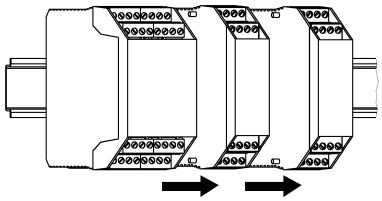
Step 2: Removing gateways and expansion modules

➡ De-energize the samos® PRO system.

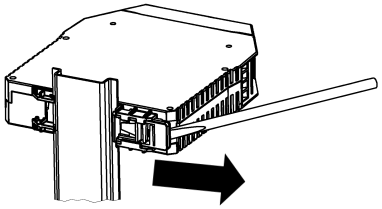
➡ Remove any plug-in terminals with wiring and remove the end terminals.



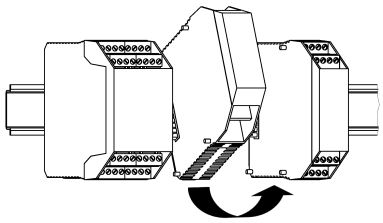
➡ Pull the modules apart from one another individually in the direction of the arrow until the lateral plug connection is disconnected.



➡ Unlock the module.
To do this, pull the mounting foot of the module outward using a screwdriver.



➡ Fold the module away from the DIN rail and remove from the rail.



4.2 Electrical installation

WARNING

Switch off the power supply to the system!

It is possible for the system to be unexpectedly started while you are connecting the devices.

NOTICE

- samos® PRO gateways meet EMC conditions as set out in the EN 61000-6-2 specification for use in an industrial environment.
- In order to ensure complete EMC safety, the DIN rail must be connected to functional earth (FE).
- The switch box or installation housing for the samos® PRO system must meet at least the requirements of protection class IP 54.
- Installation according to EN 50274.
- Electrical installation as per EN 60204-1.
- The external power supply of the devices must be able to bridge a short-term power outage of 20 ms in accordance with EN 60204-1.
- The power supply must meet the regulations for low-voltage with safe disconnection (SELV, PELV) in accordance with EN 60664 and EN 50178 (Electronic equipment for use in power installations).
- Ensure that all modules of the samos® PRO system, the connected protective devices and the power supplies are connected to the same ground connection. The ground of the RS-232 interface is internally connected to the ground of the power supply for the controller module (A2).
- Connect the screening of all field bus and Ethernet cables to functional earth (FE) just before they lead into the control cabinet.

4.3 Initial configuration steps

How do you configure gateways? This chapter provides some brief guidelines.

Table 21: Guidelines for gateway configuration

Step	Description
1	**Establishing a link between the gateway and PC** See here for more detailed information: Software manual, chapter "Connecting to the safety controller"
2	**Configure gateway** You will find detailed information in this regard at the following points in the gateway manual: • *Modbus TCP gateway [ch. 6, p. 55]* • *PROFINET IO-Gateway [ch. 7, p. 67]* • *EtherNet/IP gateway [ch. 8, p. 78]* • *PROFIBUS DP gateway [ch. 9, p. 111]* • *CANopen gateway [ch. 10, p. 127]* • *EtherCAT gateway [ch. 11, p. 162]*
3	**Transmitting and verifying the configuration** See here for more detailed information: Software manual, chapter "Transferring the system configuration"

5 CONFIGURATION OF GATEWAYS WITH SAMOS® PLAN 6

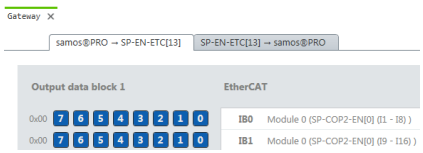
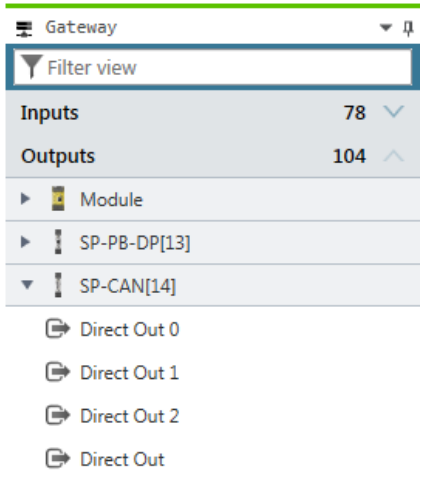
This chapter gives you an overview of how to configure gateways in samos® PLAN 6. It explains

- how the graphical user interface is laid out for the gateway configuration in samos® PLAN 6,
- how you can carry out typical configuration tasks connected to gateways in samos® PLAN 6.

NOTICE You will find more detailed information about the graphical user interface of samos® PLAN 6 in the Software manual.

5.1 The graphical user interface

You can edit the configuration for gateways in the graphical user interface of samos® PLAN 6 in the following windows:

Window	Brief explanation
Gateway view 	Depending on module configuration, shows two or three tabs with the routing tables and additional gateway functionalities. Details: *Layout and content of the tabs [ch. 5.1.3, p. 44]*
Gateway docking window 	Show inputs and outputs available for the gateway configuration as a hierarchical tree structure. Details: *"Gateway" and "Properties" docking windows [ch. 5.1.4, p. 46]*

5.1.1 Activating gateway functionality

The **Gateway** view is only available in samos® PLAN 6 when you actively use the gateway functionality. Basically you can set up the gateway functionality in two ways:

Scenario 1: You are using a gateway module

You implement the gateway functionality via a supplementary module, as indicated in the following example. Here the SP-CAN module is used:

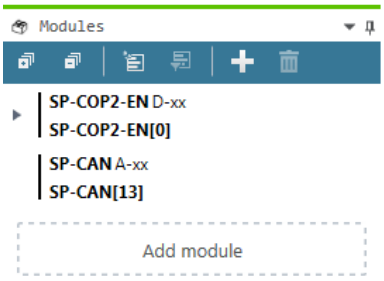


Illustration 1: Module configuration with gateway module

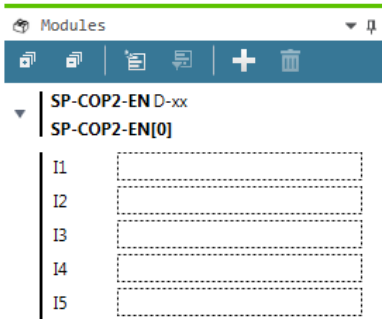
Scenario 2: You are using the gateway function on the module SP-COP2-ENI

You implement the gateway functionality via the controller module. In this case you must use the SP-COP2-ENI module as the controller module for the controller and explicitly set the gateway functionality there.

How to activate the gateway function on the SP-COP2-ENI module:

➡ Open the **Modules** docking window.

➡ Select the SP-COP2-ENI module.



➡ Open the **Properties** docking window.

➡ Select the desired gateway function from the **Gateway** selection list.

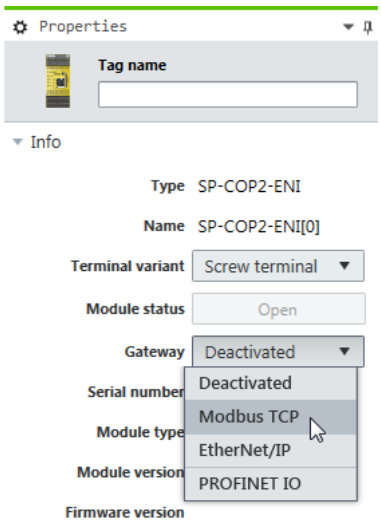


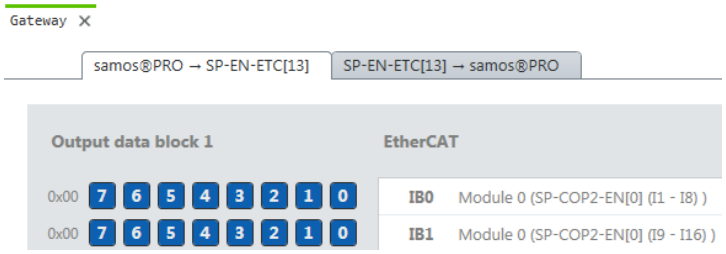
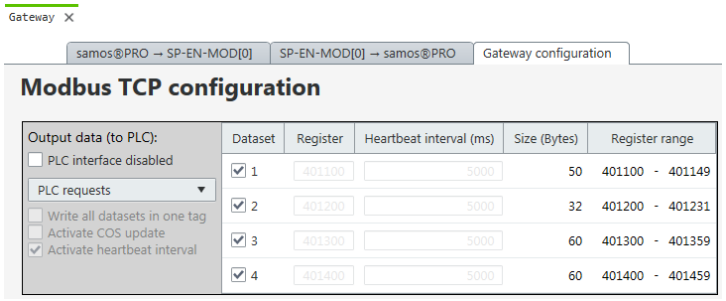
Illustration 2: SP-COP2-ENI module with activated gateway function

5.1.2 "Gateway" view

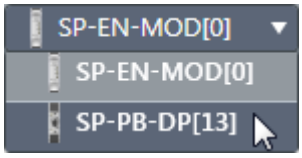
If you have activated the gateway functionality in samos® PLAN 6 automatically the **Gateway** view is active. There you can edit the gateway configuration.

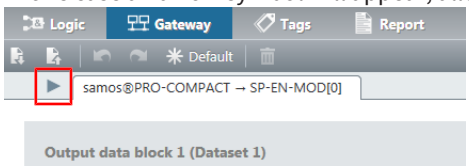
Design

Depending on module configuration, in the **Gateway** view, you will see two or three tabs:

Module configuration	Design
You use a gateway module for gateway configuration	In the **Gateway** view you see two tabs with the routing tables for the input and output values. Example: SP-EN-ETC module 
You are using the gateway function of the SP-COP2-ENI module	In the **Gateway** view you see an additional third tab **Gateway configuration**. It contains the basic settings for the gateway function of the SP-COP2-ENI module: 

Visualization

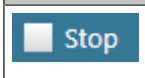
- **If you are using several gateways**
  The **Gateway** view always only shows one gateway configuration. If you are using several gateways, you can toggle between the configurations by making use of the **Select data set view** menu:
  

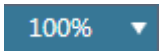
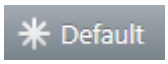
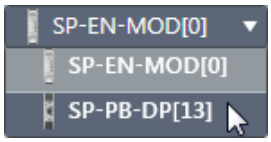
- **When the program window is very small**
  If the window in which you have opened samos® PLAN 6 is very small, not all tabs may be shown. In this case an arrow symbol will appear, allowing you to toggle between the tabs:
  

Commands

Via the command bar of the **Gateway** view, you have access to the following view-specific features:

Table 22: Key

Element	Description
	Only with a connection to the controller: Stops the controller.

Element	Description
	Only with a connection to the controller: Starts a stopped controller.
	**Zoom** This determines the size of the display in the **Gateway** view work area.
	**Undo** This renders the last action undone.
	**Redo** This makes an action that has been undone redone.
	**Standard** This resets the configuration of the gateways to the basic settings. Also see: *Basic settings for the process data [ch. 5.2.2, p. 47]*
	**Data set view selection** When you are using several gateways: Changes between the gateway configurations.
	**Importing/exporting** Allows for the import/export of the configuration defined in the **Gateway** view. **Notes**: • **Important:** When you import a configuration, all changes made before that have not been saved will be lost. You cannot undo this command. • Available storage formats: SPG, XML, CSV You can use the import/export function to import the tag names used for a project into a PLC program, or to export them from a PLC program into samos® PLAN 6.
	**Exporting the configuration for hmiPLAN** Only active for TCP gateway mode. Exports the data points of the gateway configuration to a CSV file (file format *hmiPLAN.CSV). You can import this CSV file into the hmiPLAN software and use it there to visualize machines and systems.
	**Delete** This deletes the currently selected element.

5.1.3 Layout and content of the tabs

The tabs of the **Gateway** view contain the following data and features:

Tab 1: Routing table with output values (data bytes)

Transmission direction: samos® PRO -> Network/field bus

The mapping is shown in tabular form. Bits which have been used appear on a dark blue background. In online mode, the input data of the relevant gateway is displayed (byte display 0x00 at the start of the relevant line).

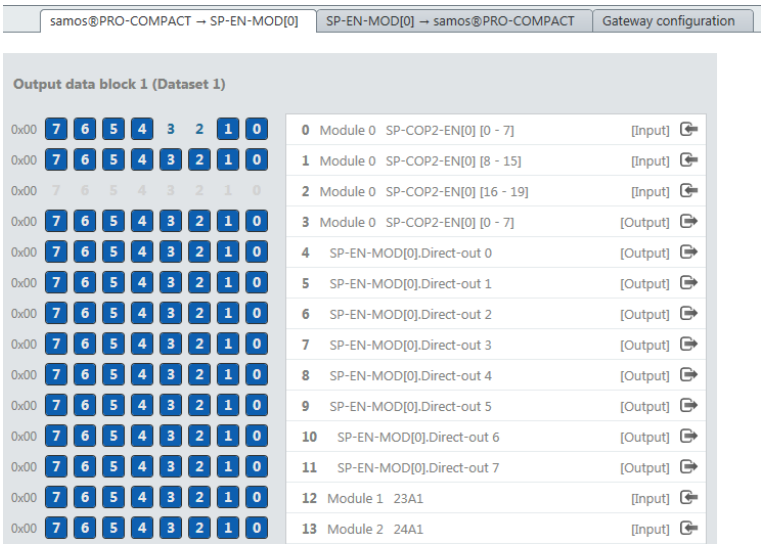


Illustration 3: Routing table with output values

Tab 2: Routing table with input values (data bytes)

Transmission direction: Network/field bus -> samos® PLAN 6

Visualization: as per Tab 1

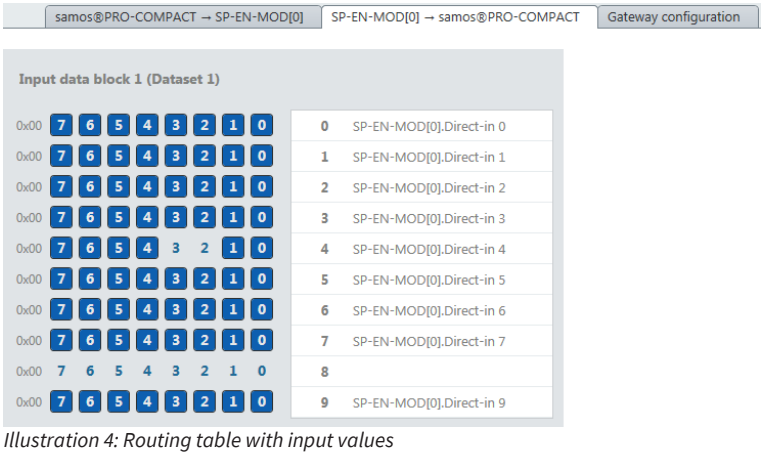


Illustration 4: Routing table with input values

Tab 3: "Gateway configuration"

Tab 3 only appears if you have activated SP-EN-MOD or SP-EN-IP.

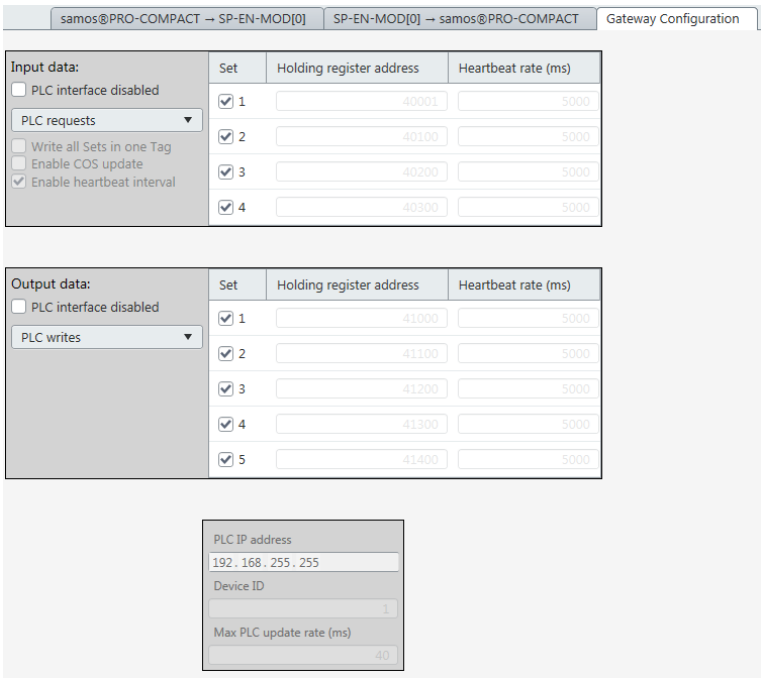


Illustration 5: "Gateway configuration" tab for SP-EN-MOD

NOTICE

Allocation of input and output data

The output and input data listed here refer directly to the data blocks in tab 1 and tab 2.

- **Output data (to PLC)** group:
  Only **data set 1** can be configured. This refers directly to **Output data block 1** in tab 1.
- **Input data (from PLC)** group:
  Data set 1 to **data set 5** refer directly to **input data block 1** to **input data block 5** in tab 2.

5.1.4 "Gateway" and "Properties" docking windows

In addition to the **Gateway** view, in the gateway configuration in samos® PLAN 6 you work with the following windows:

"Gateway" docking window

From the **Gateway** docking window you can drag hardware data bytes into empty cells in the routing table (**Gateway** view).

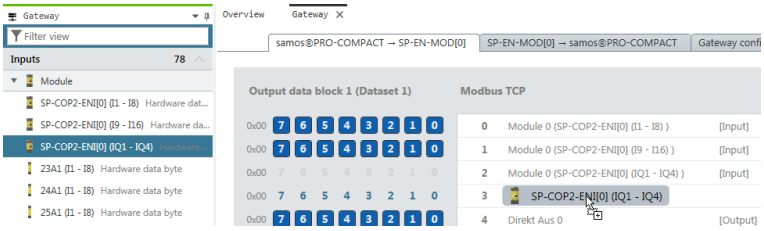


Illustration 6: Drag data bytes into the routing table using drag & drop

NOTICE

You can make use of the same data byte several times in the routing table.

"Properties" docking window

In the **Properties** docking window, the configuration dialog appears for the data byte which you have selected in the **Gateway** view.

Depending on the data byte, you can configure individual parameters. You can also allocate tag names here.

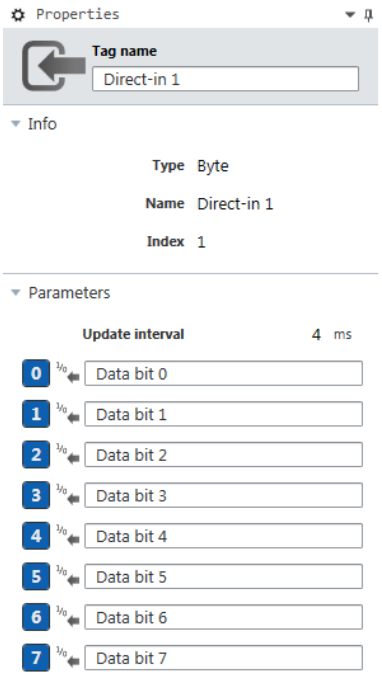


Illustration 7: Configuration dialog in the “Properties” docking window

5.2 Function and basic settings

5.2.1 Routing

The process diagram, transferred to the network from the samos® PRO gateway, comprises the operating data (e.g. logic results, state of inputs and outputs) and the diagnostic data (e.g. module status, CRCs). This data have been arranged in 4 data sets.

Table 23: Content of data sets 1–4

Data set	Content	Size	Configurable
1	Process data	50 bytes	Yes
2	CRCs	32 bytes	No
3	State and diagnosis	60 bytes	No
4	Reserved	60 bytes	No

The process data in Data Set 1 may consist of up to 50 bytes, irrespective of the network protocol used. These 50 bytes have been divided into one or several data blocks, depending on the network protocol. Detailed information about the modularization of the data sent to the network may be found in the section on the relevant gateway and in the following table: *"Preset configuration for process data transmitted in the network" [ch. 5.2.2, p. 48]*

The content of data set 1 has been pre-configured with the addition of a gateway module or a gateway function, but can be freely configured with a granularity of 1 byte (see *Basic settings for process data [ch. 5.2.2, p. 47]* and *Configuring the gateway output values (tab 1) [ch. 5.4, p. 49]*).

The diagnostic data in data sets 2-4 depends on the network protocol used and is described in the chapter on the relevant gateway.

5.2.2 Basic settings for the process data

After the addition of the gateway, the process data is pre-configured. Depending on the gateway used, this data is divided into several data blocks.

The following table provides an overview of which bytes have been allocated to the preset configuration and how the data at the various gateways are modularized.

Table 24: Preset configuration for the process data transmitted in the network

	Modbus TCP		PROFIBUS DP	
Byte	**Preset allocation**	**Initial data set**	**Preset allocation**	**Initial data block**
0	Input values for Module 0 (I1..I8)	#1 (50 bytes)	Input values for Module 0 (I1..I8)	#1 (12 bytes)
1	Input values for Module 0 (I9..I16)		Input values for Module 0 (I9..I16)	
2	Input values for Module 0 (IQ1..IQ4)		Input values for Module 0 (IQ1..IQ4)	
3	Output values for Module 0 (Q1..Q4,IQ1-IQ4)		Output values for Module 0 (Q1..Q4,IQ1-IQ4)	
4	Direct data (Off) 0		Direct data (Off) 0	
5	Direct data (Off) 1		Direct data (Off) 1	
6	Direct data (Off) 2		Direct data (Off) 2	
7	Direct data (Off) 3		Direct data (Off) 3	
8	Direct data (Off) 4		Direct data (Off) 4	
9	Direct data (Off) 5		Direct data (Off) 5	
10	Direct data (Off) 6		Direct data (Off) 6	
11	Direct data (Off) 7		Direct data (Off) 7	
12	Inputs for Module 1	*Continued* #1 (50 bytes)	Inputs for Module 1	#2 (12 bytes)
13	Inputs for Module 2		Inputs for Module 2	
14	Inputs for Module 3		Inputs for Module 3	
15	Inputs for Module 4		Inputs for Module 4	
16	Inputs for Module 5		Inputs for Module 5	
17	Inputs for Module 6		Inputs for Module 6	
18	Inputs for Module 7		Inputs for Module 7	
19	Inputs for Module 8		Inputs for Module 8	
20	Inputs for Module 9		Inputs for Module 9	
21	Inputs for Module 10		Inputs for Module 10	
22	Inputs for Module 11		Inputs for Module 11	
23	Inputs for Module 12		Inputs for Module 12	
24	Outputs for Module 1	*Continued* #1 (50 bytes)	Outputs for Module 1	#3 (12 bytes)
25	Outputs for Module 2		Outputs for Module 2	
26	Outputs for Module 3		Outputs for Module 3	
27	Outputs for Module 4		Outputs for Module 4	
28	Outputs for Module 5		Outputs for Module 5	
29	Outputs for Module 6		Outputs for Module 6	
30	Outputs for Module 7		Outputs for Module 7	
31	Outputs for Module 8		Outputs for Module 8	
32	Outputs for Module 9		Outputs for Module 9	
33	Outputs for Module 10		Outputs for Module 10	
34	Outputs for Module 11		Outputs for Module 11	

	Modbus TCP		PROFIBUS DP	
Byte	**Preset allocation**	**Initial data set**	**Preset allocation**	**Initial data block**
35	Outputs for Module 12		Outputs for Module 12	
36-47	Not allocated	*Continued* #1 (50 bytes)	Not allocated	#4 (12 bytes)
48-49	Not allocated		Not allocated	#5 (2 bytes)

The preset allocation of the bytes can be freely configured, as shown in the following section.

5.3 Mapping function block values to gateways

Multibit values from function blocks with internal data (e.g. for analog function blocks) can be forwarded to gateways or sent from the gateways to samos® PLAN 6.

To use this function, the corresponding bytes from the function blocks must be mapped to datasets of the gateway.

NOTICE

The setting of multi-bit values is supported from samos® PRO, module version F-01 and higher. The format and dimensioning is described in the software manual in the chapter "Referencing the function blocks" as **internal values**.

Requirements

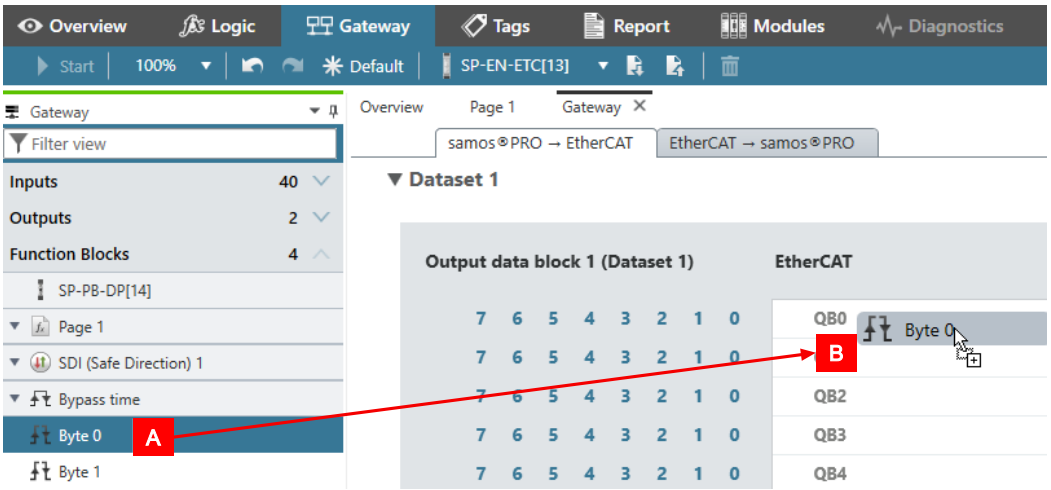
- Only possible for modules as P variant with module version F or higher.
- The logic uses function blocks with internal values, e.g. function block **Cyclic operation** (see Internal values).
- The logic is correctly connected and error-free.

Procedure

➡ In the **Gateway** view in the **Gateway** docking window, open the **Function Blocks** fold-out area.

➡ Select the desired byte of an internal value of a function block.

➡ Drag this byte (A) to the desired dataset of the gateway (B).



⇨ Internal value of the function block is mapped and forwarded to the gateway.

5.4 Configuring the gateway output values (tab 1)

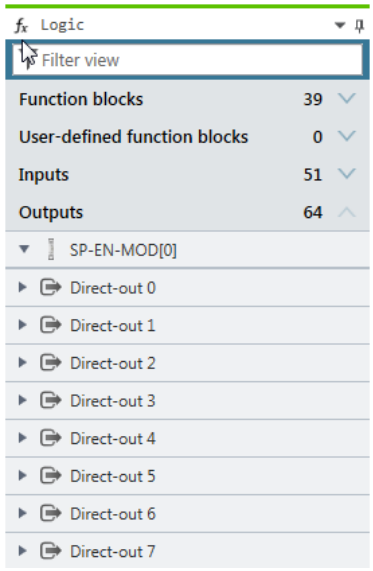
You can use the following settings for the output values of a gateway in tab 1:

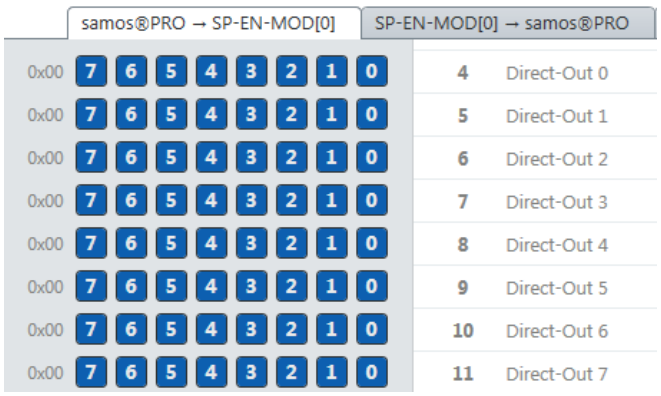
Basic setting

Depending on the gateway function selected, you will find four or eight bytes in tab 1, which are reserved as direct gateway output values. You can also see these bytes in the **Logic** docking window.

Example: SP-CANopen module with eight predefined outputs for gateways:

"Logic" docking window	"Gateway" view
In the **Logic** docking window you see these four bytes **Outputs**:	In the **Gateway** view these four outputs appear in the first tab:





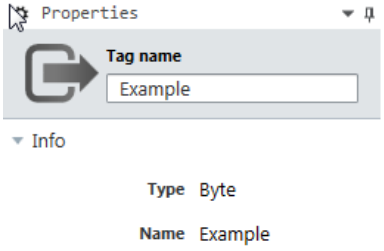
Change tag names of a predefined output value

Tag names have already been pre-assigned to the predefined output values (bytes). You can change these tag names:

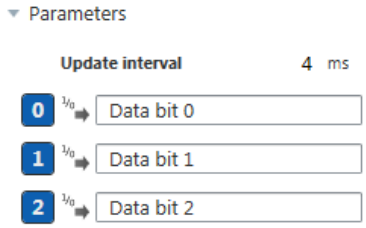
➡ In the **Gateway** view click on the byte, whose tag name you want to change.

➡ Open the **Properties** docking window.

➡ If you wish to change the tag name of the byte:
Overwrite the pre-allocated tag name of the byte with the desired new value in the configuration dialog.



➡ If you also want to change the tag names of individual bits:
Overwrite the pre-allocated values with the desired new value under **Parameters** in the configuration dialog.

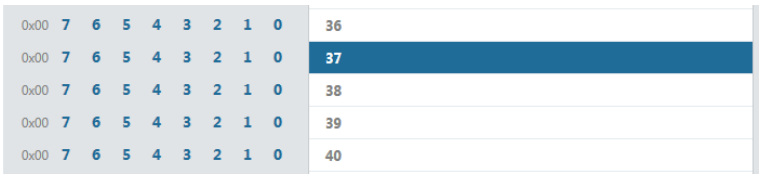


In the **Logic** view, these bits will appear with the corresponding tag names.

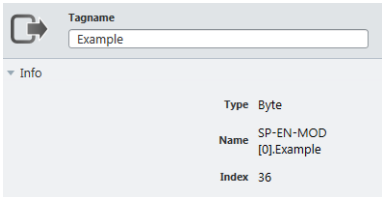
Configuring additional direct gateway output values

You can add new output values (bytes) in addition to the pre-allocated output values in the **Gateway** view.

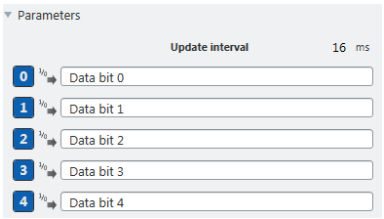
➡ Click on an empty byte in the Gateway view.



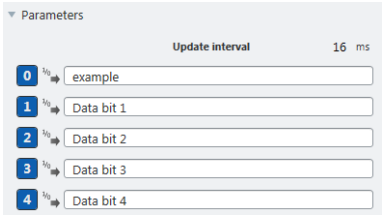
➡ Open the **Properties** docking window and assign a tag name for the byte in the configuration dialog.



⇨ Tag names for all bits are automatically pre-allocated under **Parameters**.



➡ If you also want to change the tag names of individual bits:
Overwrite the pre-allocated values with the desired new value under **Parameters** in the configuration dialog.



In the **Logic** view, these bits will appear with the corresponding tag names.

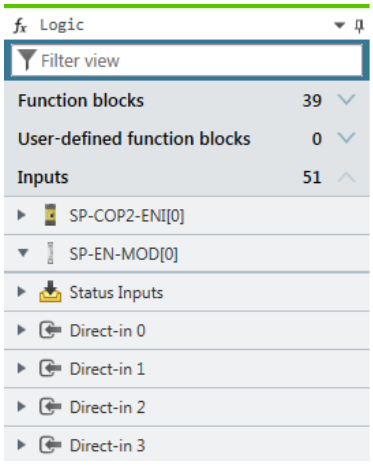
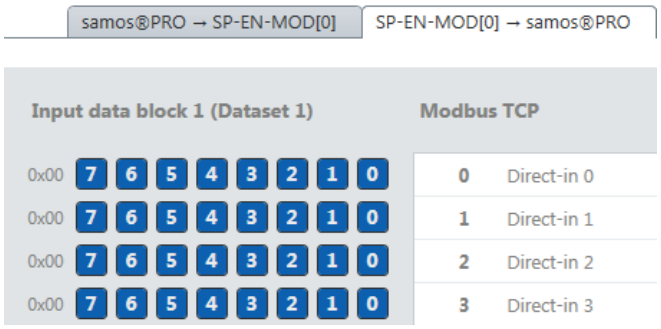
5.5 Editing the gateway input values (tab 2)

You can use the following settings for the output values of a gateway in tab 2:

Basic setting

Depending on the gateway function selected, you will find four or eight bytes in tab 2, which are reserved as direct gateway input values. You can also see these bytes in the **Logic** docking window.

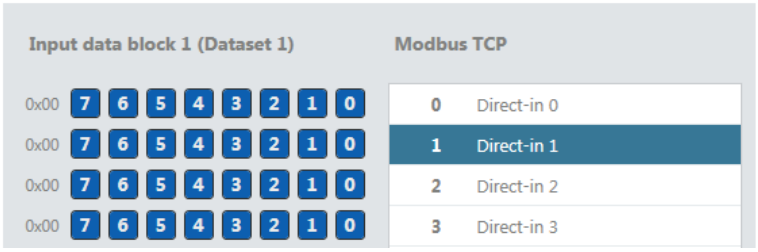
Example: SP-CANopen module with four predefined inputs for gateways:

"Logic" docking window	"Gateway" view
In the **Logic** docking window you see these four bytes under **Inputs**:	In the **Gateway** view, these four inputs appear in tab 2:
	

Change tag names of a predefined input value

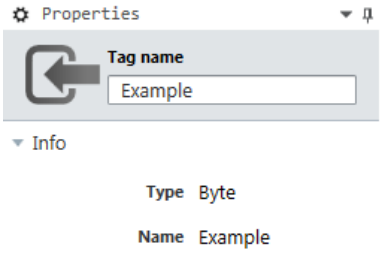
Tag names have already been pre-assigned to the predefined input values (bytes). You can change these tag names:

➡ In the **Gateway** view click on the byte, whose tag name you want to change.

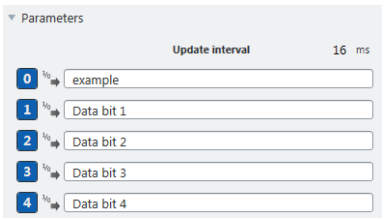


➡ Open the **Properties** docking window.

➡ If you wish to change the tag name of the byte:
Overwrite the pre-allocated tag name of the byte with the desired new value in the configuration dialog.



➡ If you also want to change the tag names of individual bits:
Overwrite the pre-allocated values with the desired new value under **Parameters** in the configuration dialog.

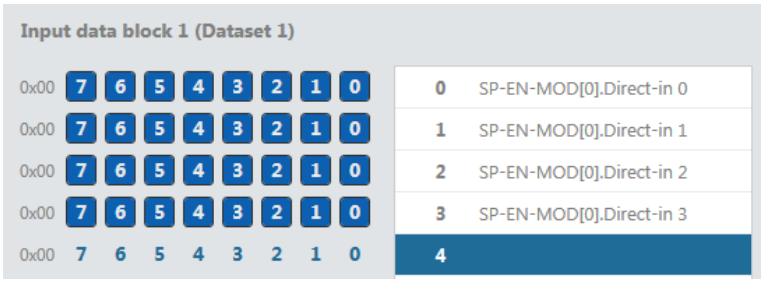


In the **Logic** view, these bits will appear with the corresponding tag names.

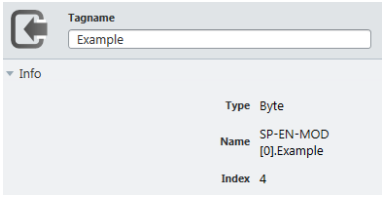
Configuring additional gateway input values

You can add new output values (bytes) in addition to the pre-allocated output values in the **Gateway** view.

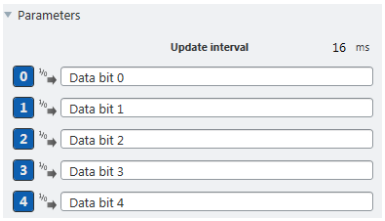
➡ Click on an empty byte in the Gateway view.



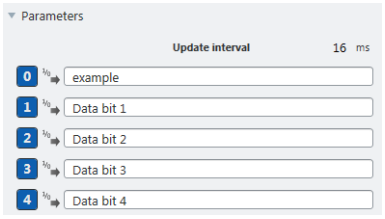
➡ Open the **Properties** docking window and assign a tag name for the byte.



⇨ Tag names for all bits are automatically pre-allocated under Parameters.



➡ If you also want to change the tag names of individual bits:
Overwrite the pre-allocated values with the desired new value under **Parameters**.



In the **Logic** view, these bits will appear with the corresponding tag names.

5.6 Monitoring process data

You can monitor your gateway configuration directly in samos® PLAN 6. This can be done in simulation mode (limited monitoring option) or by means of an active link to a samos® PRO system.

NOTICE

The samos® PRO gateways always show the actual physical state of the inputs and outputs of the connected modules and equipment. This means that even when the force mode is active and inputs that are physically **Low** are forced to **High** (or vice versa), the actual physical state of these inputs is transmitted to the PLC and not the (virtual) forced state. However, if one or several outputs change their state as a result of one or several inputs being forced, the changed state of these outputs will also be transmitted to the PLC, as the actual physical state of the equipment outputs has changed.

Simulation mode (offline mode)

You can test a gateway configuration offline in simulation mode. Use the logic analyzer for this purpose and manually set the desired inputs to **High** or **Low**.

Read here how to work with the simulation mode and logic analyzer: Software manual, chapter "Simulating logic programming"

Monitoring with an active connection (online mode)

You can also test a gateway configuration online by establishing a link between samos® PLAN 6 and a samos® PRO system.

Read here how to activate the online mode and what you need to take into account: Software manual, chapter "Connecting to the safety controller"

NOTICE

LED behavior for active connections

If you are linked to a samos® PRO installation, the status LEDs in the **Module** view of samos® PLAN 6 will light up in the same way as for the connected system.

Further information about the status LEDs may be found in the documentation for the relevant module:

- *Modbus TCP gateway [ch. 6.4, p. 63]*
- *PROFIBUS-DB gateway [ch. 9.4, p. 124]*
- *CANopen gateway [ch. 10.15, p. 159]*

6 MODBUS TCP GATEWAY

The controller module SP-COP2-ENI can be used for Modbus TCP. The internal SP-EN-MOD (Modbus TCP Gateway) is a component of the SP-COP2-ENI device and is activated by the gateway configuration:

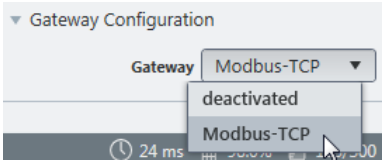


Illustration 8: Activation of Modbus TCP on the SP-COP2-ENI module

The Modbus TCP gateway supports the following:

- Modbus TCP with master and slave operation
- Ethernet TCP/IP socket interface, polling and auto-update function

6.1 Interfaces and operation

The SP-COP2-ENI is equipped with a RJ-45 socket.

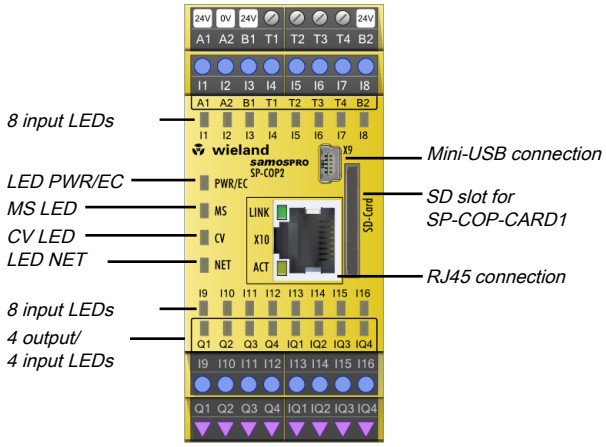


Illustration 9: Interfaces and display elements

Further information

- Here in this manual:
  Diagnostics and troubleshooting [ch. 6.4, p. 63]
- In the hardware manual:
  Device state and LED displays in the controller modules

6.2 Basic configuration – allocation of an IP address

The SP-COP2-ENI module is configured with the help of the samos® PLAN 6 configuration software.

Step 1: Add SP-COP2-ENI module

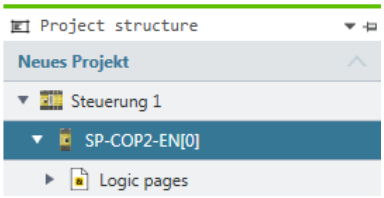
➡ Start samos® PLAN 6 and open the **Modules** docking window.

➡ Add the controller module SP-COP2-ENI.
Instructions: Software manual, chapter "Adding modules"

Step 2: Open configuration dialog

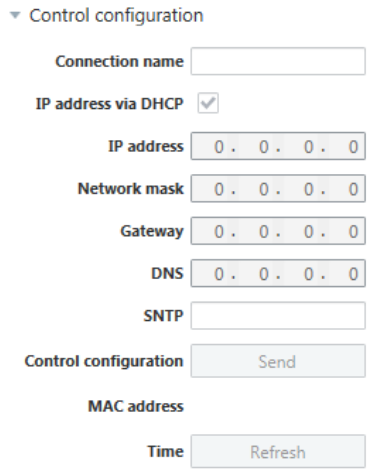
➡ Switch to the **Project structure** docking window.

➡ Click on the top element, which represents the controller.



➡ Open the **Properties** docking window.

⇨ You will see the control configuration dialog.



Step 3: Store configuration

➡ Enter the following values under **Control configuration**:
- valid IP address
- subnet mask
- if required: valid IP address for a default gateway
OR:
Alternatively activate DHCP.

➡ Ensure that samos® PLAN 6 is connected to the samos® PRO system.
The samos® PRO system must not be in **Run (Execute)** mode. The **Start/Stop** button in the command bar of the **Modules** view must be set to **Start**.

More detailed information on connecting with the controller: Software manual, chapter "Connecting to the safety controller"

➡ Click **Send** in the **Properties** docking window to transfer the configuration to the samos® PRO system.

6.3 Configuration of the Modbus-TCP interface to the PLC - how the data are transferred

Application characteristics for Modbus TCP

- Support of standard addressing conventions for Modbus TCP
- Master and slave operation

Requirements for the PLC for Modbus TCP

- The PLC must support the Modbus TCP protocol.
- The PLC must either support the Read Holding Registers and Write Multiple Registers commands or the Read/Write Multiple Registers command.

The configuration steps in this section determine how the data are to be transmitted to the higher-level PLC.

There are two different methods of transmission for each transmission direction, i.e. samos® PRO **to network** and **network to** samos® PRO:

- Receiving method Polling/PLC requests (gateway as slave)
  This method allows the PLC regularly to request data using polling.
  When this method is used, the data are returned in the response to the data request. The PLC requests data by accessing the receiving data address of the SP-COP2-ENI module via a read-holding-register telegram.
- The master receiving method gateway writes to the PLC (auto-update, gateway as master)
  When the SP-EN-MOD module sends data to the PLC, these are immediately written to a memory location in the PLC.
- Slave transmission method - PLC writes (gateway as slave)
  With this method, the PLC sends telegrams to the SP-COP2-ENI module to write to the output data sets. For this purpose, the PLC writes data into defined addresses.
- The master transmission method gateway reads from the PLC (auto-update, gateway as master)
  With the master transmission method, the SP-COP2-ENI module polls the PLC for the output data sets.

NOTICE

The configuration is regarded as faulty when the IP address of the PLC is zero and the read transfer mode and/or write transfer mode has been set for the master.

The number of possible connections to the PLC depends on whether the SP-COP2-ENI module is operated as a master or as a slave. Depending on the setting, up to 6 PLCs can simultaneously address the SP-COP2-ENI module.

Table 25: Maximum number of possible Modbus TCP connections for the individual operating modes

Operating mode of the SP-COP2-ENI module	Maximum number of connections
Output data (to PLC): Gateway writes Input data (from PLC): Gateway reads	1 outgoing connection 1 incoming connection
Output data (to PLC): Gateway writes Input data (from PLC): PLC writes	1 outgoing connection 6 incoming connections
Output data (to PLC): PLC reads Input data (from PLC): Gateway reads	6 outgoing connections 1 incoming connection
Output data (to PLC): PLC reads Input data (from PLC): PLC writes	6 outgoing connections 6 incoming connections

The following table describes the configuration, depending on the transmission method:

Gateway is master

Table 26: Configuration directive – gateway as master

Essential settings in the gateway configuration (via SP-COP2-ENI)	Settings required for the PLC program and/or in the Modbus TCP configuration tool
Choose **Gateway writes to tag/file** and/or **Gateway reads from register** to configure the gateway as a master.	–
Select which data are to be written to the PLC or read from it.	–

Essential settings in the gateway configuration (via SP-COP2-ENI)	Settings required for the PLC program and/or in the Modbus TCP configuration tool
Define where the selected data in the PLC memory are to be written to: Enter the register address(es). Example: "40001" and/or you can determine from which location in the PLC memory the selected data are to be read: Enter the register addresses.	Ensure that the addresses allocated in the samos® PRO are available and that they contain the data intended for the samos® PRO- system.
Choose how often these data are to be transmitted.	–
Define from and to where the data in the Modbus-TCP network are to be read and written: Enter the IP address and the slot number of the PLC controller.	–

Gateway as slave

Table 27: Configuration directive – gateway as slave

Essential settings in the gateway configuration (via SP-COP2-ENI)	Settings required for the PLC program and/or in the Modbus TCP configuration tool
Select **PLC requests** and **PLC writes** in the gateway configuration dialog.	–
–	Select which data are to be written to the gateway or read from it. Ensure that the PLC program writes the data into the addresses allocated to the gateway (see Table "*Data addressing for the SP-COP2-ENI as recipient [ch. 6.3, p. 62]*").

NOTICE

The address settings for the Modbus TCP gateway are 1-based. Please subtract 1 from the register address set in samos® PLAN 6 for a 0-based address setting.

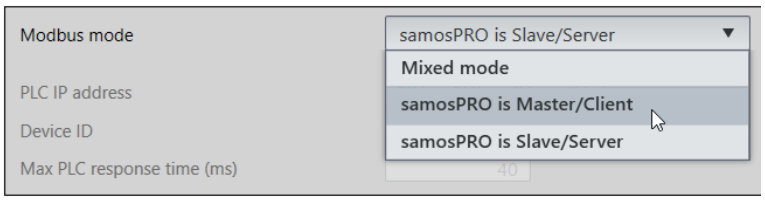
Example: Register 1100 corresponds to the Modbus address 1099.

Master mode: SP-COP2-ENI reads from/writes to the PLC

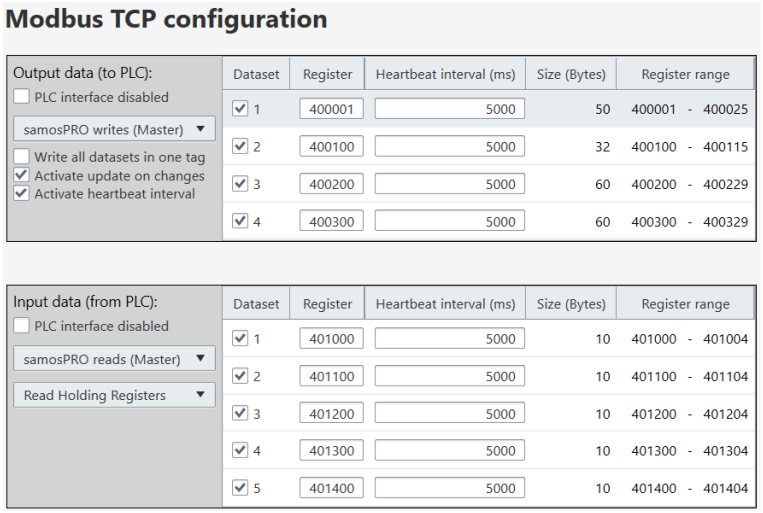
Carry out the following steps to configure the gateway as a master:

➡ Change to the **Gateway** view and click on the **Gateway configuration** tab.

➡ Select the samosPRO is Master/Client option at the very bottom of the **Modbus mode** section.



⇨ The settings required for master mode are activated automatically in the **Output data (to PLC)** and **Input data (from PLC)** sections.



Quick reference

You can make the following additional settings:

“Output data (to PLC)” section	
Area highlighted in gray	
Selection list	Set automatically: Determines the transmission method. Value required for master mode: samosPRO writes (master)
All data sets in one tag	Optional Defines that all data sets are to be written to a single address in the PLC memory. In this case the register address defined for Data Set 1 will be used.
	Note: The following two settings can be activated simultaneously. They determine the frequency of data transmission.
Activating updates following changes	Recommended Determines that the SP-COP2-ENI module immediately updates the data in the PLC as soon as changes are made to the data sets.
Activate heartbeat interval	Recommended Use the heartbeat intervals which you defined in the **Heartbeat interval** column to activate the update of the selected data sets.
Columns highlighted white	
Data set	Determines which data are to be written to the PLC or read from it. Select the checkboxes for the desired data sets. You will find a detailed description of the data sets here: *Data transferred to the network (network input data sets) [ch. 3.2, p. 20]*
Register	Define from and to where in the PLC memory the selected data should be read and written.

“Output data (to PLC)” section	
Heartbeat interval (ms)	Defines how often the data sets are to be updated. Requirement: You have selected the option **Activate heartbeat interval** (see above).
Register range	Shows the registers in the PLC to which the process data is written.

“Input data (from PLC)” section	
Selection list 1	Set automatically: Determines the transmission method. Value required for master mode: samosPRO reads (master)
Selection list 2	Defines which of the two modbus commands is used: • **Read holding registers**: Activates the **Read holding registers** command (see "Module commands" table below). • **Read input registers**: Activates the **Read input registers** command (see "Module commands" table below).
Data set column	Determines which data are to be written to the PLC or read from it. Mark the control boxes for the desired data sets for this purpose. You will find a detailed description of the data sets here: *Data transferred to the network (network input data sets) [ch. 3.2, p. 20]*
Register column	Define from and to where in the PLC memory the selected data should be read and written.
Column **heartbeat interval**	Defines how often the data sets are to be updated.

"Modbus mode” section	
PLC IP address **Device ID**	The parameters define from and to where the data in the Modbus-TCP network are to be read and written:
Maximum refresh time for PLC	Define the maximum rate (or the minimum time interval) for transmitting the data sets to the PLC. This setting depends on the processing speed of the PLC. Minimum = 10 ms, maximum = 65535 ms. The basic setting of 40 ms is suitable for most PLC Note: When these values are greater than the heartbeat interval, the **heartbeat interval** will be slowed down to this value.

➡ Connect samos® PLAN 6 with the samos® PRO system and transmit the configuration.
More detailed information on the link to the controls: Software manual, chapter "Connecting to the safety controller"

Write to the PLC

NOTICE

The following restrictions apply when the gateway operates as a master and writes the input data sets to the PLC:

- The address of the input data sets (preset in samos® PLAN 6) must be the same as defined in the PLC.

- The PLC variable that is to incorporate the data must meet the following conditions:
  - in the address range 40xxxx (for Schneider Modicon PLC),
  - an array of 16-bit words,
  - long enough to contain the defined input data set array.
- All input data sets are transmitted to the PLC in 16-bit word format, with the first byte having the lowest value, i.e. on the far right of the integer, while the second byte has the highest value, i.e. on the very left of the integer.

Reading from the PLC

NOTICE

The following restrictions apply when the gateway operates as a master and reads the output data sets from the PLC:

- The address of the output data sets must be the same as defined in the PLC.
  Please note: The value of the Modbus addresses must be 1 lower than the register data. See also: "Figure 8" in "MODBUS Application Protocol V1.1b3"
- The PLC variable from which the data are requested must meet the following conditions:
  - They fall into the address range 40xxxx (for Schneider Modicon PLCs).
  - There is an array of 16-bit words for the output data sets that is long enough to accommodate the entire output data set.
- All output data sets are transmitted to the PLC in 16-bit word format, with the first byte having to be placed as the lowest value, i.e. on the far right of the integer, while the second byte will have the highest value, i.e. on the very left of the integer.

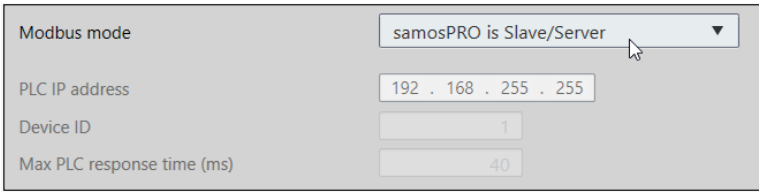
Slave/server mode - PLC reads from / writes to SP-COP2-ENI

In this operating mode, the SP-COP2-ENI module provides the data as a slave at the request of the PLC. If this operating mode is desired:

➡ Launch samos® PLAN 6.

➡ Change to the **Gateway** view and click on the **Gateway configuration** tab.

➡ Select the samosPRO is Slave/Server option at the very bottom of the **Modbus mode** section.



⇨ The minimum settings required for slave mode are activated automatically in the **Output data (to PLC)** and **Input data (from PLC)** sections.

⇨ Unavailable options are grayed out.

You can make the following additional settings:

Table 28: "Output data (to PLC)" and "Input data (from PLC)" sections

Setting	Description/procedure
Data set column	Determines which data can be written to the PLC or read from it. Mark the control boxes for the desired data sets for this purpose. You will find a detailed description of the data sets here: *Data transferred to the network (network input data sets) [ch. 3.2, p. 20]*
Size (bytes) column	Exact number of bytes to be read out or written. The number of 16-bit data types usual for TCP modbus is exactly half.

Setting	Description/procedure
Register range column	Registers to be addressed in SP-COP2-ENI

➡ Connect samos® PLAN 6 with the samos® PRO system and transmit the configuration.
More detailed information on the link to the controls: Software manual, chapter "Connecting to the safety controller"

PLC writes output data sets

The following restrictions apply when the PLC writes the output data sets:

- The equipment index must not be equal to zero.
- The telegram must be sent in Word format.
- All output data sets are transmitted to the PLC in 16-bit word format, with the first byte having to be placed as the lowest value, i.e. on the far right of the integer, while the second byte will have the highest value, i.e. on the very left of the integer.

PLC polls the input data sets

- The following restrictions apply:
- The equipment index must not be equal to zero.
- The PLC variable that is to incorporate the data must meet the following conditions:
  - It falls into the address range 40xxxx (for Schneider Modicon PLCs).
  - There is an array of 16-bit words that is long enough to accommodate the entire output data set.
- All input data sets are transmitted to the PLC in 16-bit word format, with the first byte having the lowest value, i.e. on the far right of the integer, while the second byte has the highest value, i.e. on the very left of the integer.

NOTICE Configure the PLC data polling in such a way that a data telegram is exchanged at least every minute between SP-COP2-ENI and the PLC. The TCP connection will otherwise be interpreted as not used and terminated.

NOTICE The data from the PLC to the SP-COP2-ENI module assumes the value zero in the samos® PLAN 6 logic program if the Modbus TCP connection is terminated by the PLC itself or by a timeout.

SP-COP2-ENI as slave – data addressing

The following table lists the addresses for reading out the data sets.

Unit ID 1

Table 29: Data addressing for the SP-COP2-ENI as recipient

Register (Base 1)	Description	Access	Scope (words)
1000	Request data for all activated input data sets	Reading	1..101 [1]
1100	Request data from input data block 1-5	Reading	1..25
1200	Request CRC data	Reading	1..16
1300	Request diagnostic data	Reading	1..30
1400	Reserved	Reading	1..30
2000	Write all activated output data sets	Read, write	1..25 [2]
2100	Write data from output data set 1	Read, write	1..5
2200	Write data from output data set 2	Read, write	1..5
2300	Write data from output data set 3	Read, write	1..5

Register (Base 1)	Description	Access	Scope (words)
2400	Write data from output data set 4	Read, write	1..5
2500	Write data from output data set 5	Read, write	1..5
[1] Corresponds to all activated input data sets. [2] Must correspond to all activated output data sets. Example: If only output data sets 1 and 2 have been activated, 10 words (20 bytes) must be written. If all output data sets have been activated, 25 words (50 bytes) must be written.			

Modbus commands and error messages

The SP-COP2-ENI module supports the following Modbus commands and error messages:

Table 30: Modbus commands

Modbus command	Value
Read holding registers	3
Read input[1] registers	4
Write single register	6
Write multiple registers	16 (10hex)
Read/write multiple registers	23 (17hex)
[1] starting with module version A-03	

Table 31: Modbus error messages

Modbus error response	Description
1 Function not permitted	The requested function is not supported
2 Data address not permitted	Undefined data address received
3 Data value not permitted	Request with prohibited data values, e.g. insufficient data requested for a data set
4 server errors	An error occurred during execution of the server.

6.4 Diagnostics and troubleshooting

You can find information on the diagnostics of the samos® PRO system in the software manual.

Table 32: Troubleshooting on the SP-COP2-ENI

Error	Possible cause	Possible remedy
Key: ○ LED off / ✷ LED flashes / ● LED lights up		

Error		Possible cause	Possible remedy
samos® PLAN 6 cannot set up a connection to the samos® PRO gateway.		• The SP-COP2-ENI module has no power supply. • The SP-COP2-ENI module is not in the same physical network as the PC. • A different subnet mask has been set in the TCP/IP settings for the PC. • The module was been preconfigured and has a permanently set IP address or an IP address allocated to a DHCP server that has not been allocated.	• Switch on the power supply. Check the Ethernet wiring and the network settings of the P and correct them where necessary. • Set the PC to a network address 192.168.1.0 (For module SP-COP2, the delivery state of the SD card sets address 192.168.1.5, which may not be used for the PC.) • Alternatively activate DHCP on the PC and link the SP-COP2-ENI module and the PC to a network, using an active DHCP server. (The delivery state of the SD card activates a DHCP client on the SP-COP2 module. If no DHCP server is found within about 1 minute during an active network connection, the address 192.168.1.5 is set in the SP-COP2 module.) • Check the communication settings in samos® PLAN 6.
The SP-COP2-ENI module does not provide any data.		• The SP-COP2-ENI module has been configured for data transmission to the PLC, but no Ethernet communication has been established or the communication is faulty. • Duplicate IP address detected. Another network device has the same IP address.	At least one Ethernet link must be established. • Set up the Ethernet link on the PC, check the Ethernet wiring, check the Ethernet settings in the PLC and in samos® PLAN 6. • If no Ethernet communication is required, deactivate the Ethernet connections / PLC interfaces on the SP-COP2-ENI. • Correct the IP address and switch the system off and on again.
LED PWR/ EC	Green		
LED LINK	Green		
LED ACT	Orange		
The SP-COP2-ENI module does not provide any data.		• Configuration required. • The configuration has not yet been fully transmitted. • The module version of the controller module does not support the gateway function.	• Configure the SP-COP2-ENI module and transfer the configuration to the system. • Wait until the configuration has been fully transferred. • Use the controller module with the required module version.
LED PWR/ EC	Green		
LED LINK	Green		
LED ACT	Orange		
MS LED	Red (1 Hz)		
The SP-COP2-ENI module does not provide any data.		• No data set was activated. • No Ethernet communication interface was activated.	• Activate at least one data set.
LED PWR/ EC	Green		
LED LINK	Green		

Error		Possible cause	Possible remedy
LED ACT	Orange		
MS LED	Green		
The SP-COP2-ENI module does not provide any data.		The SP-COP2-ENI module is in the “Stop” state.	The controller module is stopped. • Start the controller module (switch to Run mode).
LED PWR/ EC	Green		
MS LED	Green (1 Hz)		
The SP-COP2-ENI module functioned correctly after configuration but suddenly provides no more data.		• The SP-COP2-ENI module is operated in slave mode, the IP address is allocated by a DHCP server. • Following a restart of the SP-COP2-ENI module or the DHCP server, another address was allocated to the SP-COP2-ENI module, which is unknown to the PLC.	• Allocate a fixed IP address to the SP-COP2-ENI module. **or** • Reserve a fixed IP address for the SP-COP2-ENI module in the DHCP server (manual assignment using the MAC address of the SP-COP2-ENI module).
LED PWR/ EC	Green		
LED LINK	Green		
LED ACT	Orange		
MS LED	Green		
The SP-COP2-ENI / the samos® PRO system is in the “Critical error” state.		• The SP-COP2-ENI module is not properly connected to the other modules. • The module connection plug is dirty or damaged. • Another module in the samos® PRO system has an internal critical error. • The voltage supply for the SP-COP2-ENI module is or was outside the specifications.	• Plug the SP-COP2-ENI module in correctly. • Clean the connection plug and socket. • Switch on the power supply again. • Check the power supply. • Check the other modules of the samos® PRO system.
LED PWR/ EC	Red		
LED LINK	Green		
LED ACT	Orange		
MS LED	Red		

6.5 Status bits

The Modbus TCP Gateway SP-EN-MOD sets status bits, which are available in the logic editor of samos® PLAN 6 for processing.

Table 33: Meaning of the state bits SP-EN-MOD[0] in the logic editor

Name of the state bits	Set to 1, if ...	Reset to 0 ...
Output status	... At least one output data byte was sent without error.	... If there is a missing Modbus TCP connection to the PLC.
Input status	... At least one input data byte was sent without error.	... If there is a missing Modbus TCP connection to the PLC.

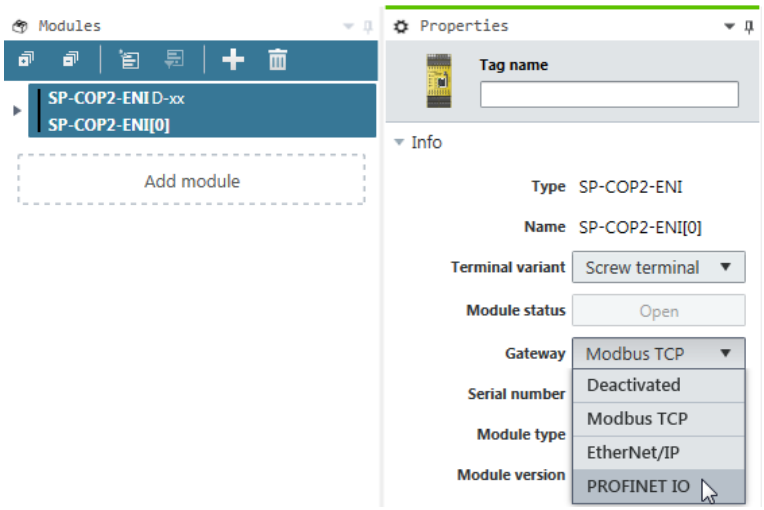
Name of the state bits	Set to 1, if ...	Reset to 0 ...
Internal state	… The Modbus function in SP-COP2-ENI is ready for communication From module version E-01.01: If the Modbus function in SP-COP2-ENI is ready for communication or if at least one input or output byte was downloaded or transmitted without errors.	... If an error has occurred in the Modbus function.

7 PROFINET IO-GATEWAY

The SP-COP2-ENI module can be used for PROFINET IO.

You will find the GSDM file and the equipment symbol for integration in a PLC of the product website of the SP-COP2-ENI module on the Internet (www.wieland-electric.com).

The internal SP-EN-PN (PROFINET IO Gateway) module is part of the device SP-COP2-ENI. You can activate it in the configuration dialog of the SP-COP2-ENI module in the **Properties** docking window:



NOTICE Selection of SP-EN-PN is possible on the SP-COP2-ENI module starting from module version B-xx.

Supported features

The SP-COP2-ENI module supports:

- PROFINET IO Conformance Class A
- Cyclical EA communication (RT)
- LLDP
- DCP
- Auto MDI
- Auto negotiation
- I&M 1-4
- Equipment diagnostics, alarms

Currently not supported:

- SNMP
- Shared Input, Shared Device
- FSU
- MIB II
- Port statistics

The number of PROFINET controllers (PLCs) which can simultaneously connect to a SP-COP2-ENI device via PROFINET is limited to one.

7.1 Interfaces and operation

Interfaces and operation are identical to that of the Modbus TCP Gateway.

Read the following section: *Interfaces and operation [ch. 6.1, p. 55]*

7.2 Basic configuration - Assigning a device name and an IP address

Configuration and diagnostics of the SP-COP2-ENI is possible both with the help of the samos® PLAN 6 configuration software and the PROFINET IO network programming tool (e.g. SIEMENS TIA Portal).

Configuration using PROFINET IO

In the delivery state, a MAC address is stored in every PROFINET IO field device such as the SP-COP2-ENI module. The symbolic name (NameOfStation) **Test station** is stored on the SD card in the delivery state.

NOTICE

- In accordance with IEC 61158-6-10 no capital letters are permitted for the symbolic name (NameOfStation).
- This NameOfStation is used by the I/O controller (e.g. the PLC) to assign an IP address to the field device.
- If the IP address is also used for other communication via Ethernet, such as TCP/IP or for the configuration via Ethernet, please note that the PLC changes the IP address and can thus interrupt the other communication.

The IP address is assigned in two steps.

➡ Assign a unique system-specific name to the Gateway, using either the network configuration tool such as SIEMENS TIA Portal, or using the samos® PLAN 6 software. In samos® PLAN 6 this is the **Connection name**.
Where do you edit the connection name in samos® PLAN 6? Open the **Project structure** docking window and there click on the **Controller** entry right at the top. Additionally open the **Properties** docking window and enter the desired value there in the configuration dialog under **Connection name**.

➡ A (unique) system-specific name can be used by the I/O-Controller (i.e. the PLC) to assign the IP address to the gateway now before the system is booted.

NOTICE

The MAC address of the SP-COP2-ENI module is printed on the device's nameplate (Example: 00:07:17:02:03:05).

Using the Siemens TIA Portal to assign device names

In the **Online accesses** area, select the network card connected to the network which can be used to access the SP-COP2-ENI device. In the **Assign name** function area, edit the **PROFINET device name** field and then select **Assign name**.

This will permanently assign the new device name to the SP-COP2-ENI device.

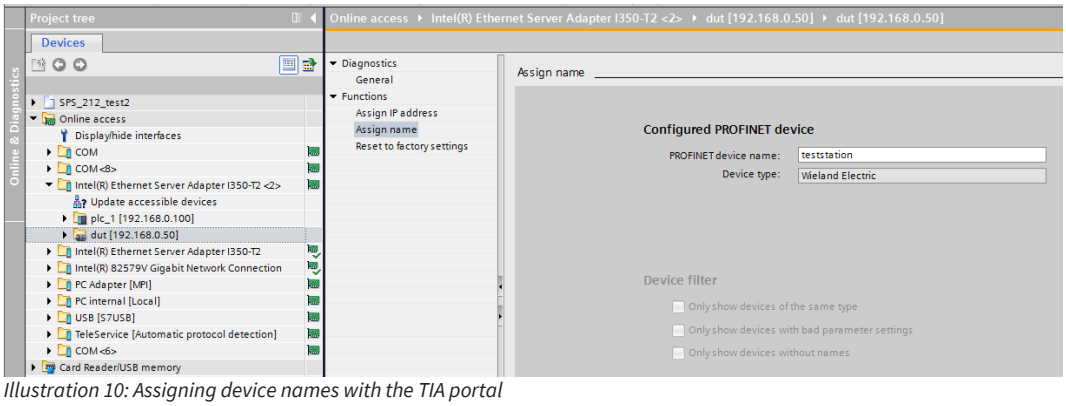


Illustration 10: Assigning device names with the TIA portal

Assign device name via the software

➡ Launch samos® PLAN 6 and connect to the controller module SP-COP2-ENI.

➡ Press the **Stop** button in the **Modules** view to stop the application.

➡ In the **Modules** view click on the blue background and open the **Properties** docking window.

⇨ You will see the controller configuration dialog.

➡ Edit the connection name and click the **Send** button.

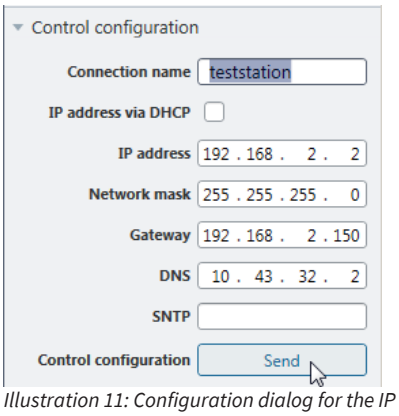


Illustration 11: Configuration dialog for the IP data and the device name

NOTICE

- The format of the device name must correspond to the specification of the PROFINET standard.
- Ensure that the address for the default gateway matches the address set by the PLC for the gateway. If no router is used, then Siemens Step 7 uses the same IP address for the default gateway as for the SP-COP2-ENI module.
- If a project file with an active PROFINET IO is provided on the SP-COP2-ENI module, then only one device in samos® PLAN 6 can be found by USB. If you would like to use the Ethernet to connect with the SP-COP2-ENI module then select **Edit** in the **Connect** dialog, where you then set the IP address of the SP-COP2-ENI module.

Set the IP address using the software

The IP address is typically assigned by the PROFINET IO controller (e.g. PLC). The SP-COP2-ENI module, however, also allows the configuration of the entire samos® PRO system via Ethernet TCP/IP. It can be necessary in this case to already assign an IP address to the SP-COP2-ENI before the PROFINET IO network is set up. This can also be done in the configuration dialog shown above.

7.3 PROFINET configuration of the gateway - how the data are transferred

The following steps are required to configure communication between the PLC and the gateway.

NOTICE

This documentation does not address the installation of the PROFINET IO network or the other components of the automation system project in the network configuration tool. It is assumed that the PROFINET project in the configuration program, e.g. the SIEMENS TIA Portal, has already been set up. The examples presented are based on configurations created with the help of the SIEMENS TIA Portal.

Step 1: Install the device master file (GDSML file)

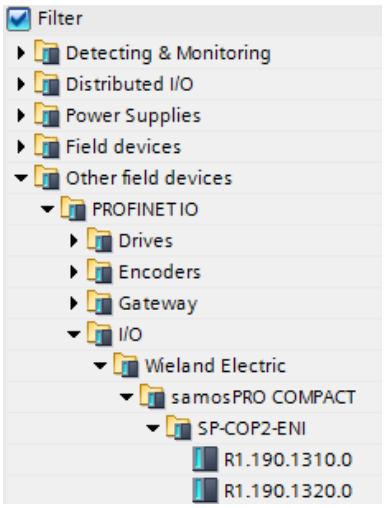
Before the SP-COP2-ENI module can be used for the first time as part of the network configuration tool, e.g. the SIEMENS TIA Portal, the device master file (GSDML file) of the gateway must first be installed in the hardware catalog of the tool.

➡ Download the GSDML file and the equipment symbol from the product site of the SP-COP2-ENI module (eshop.wieland-electric.com/de).

➡ Follow the instructions for installing GSDs in the online help section or in the user manual for the PROFINET network configuration tool.

If you are using SIEMENS TIA Portal, then the SP-COP2-ENI module appears in the following location in the hardware catalog:

Additional field devices > PROFINET IO > I/O > Wieland Electric > samosPRO COMPACT > Head module > SP-COP2-ENI



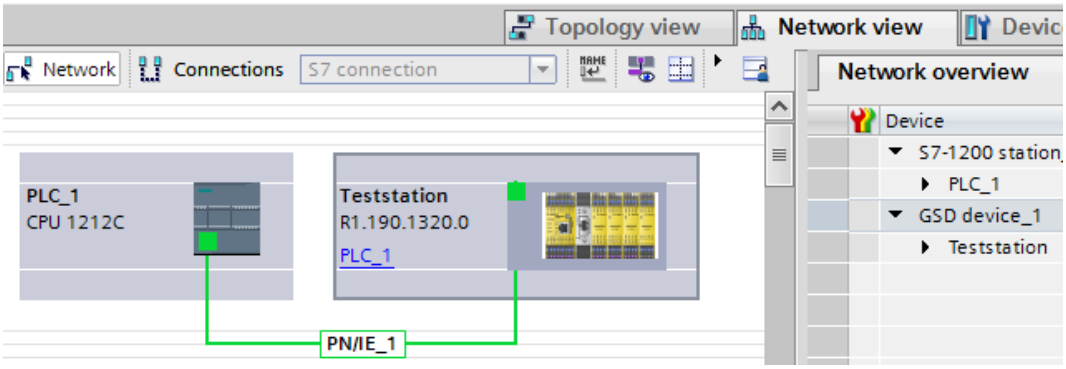
Step 2: Add the gateway to the project

To make the system of the samos® PRO system available in the process diagram of the PLC, the gateway must first be added to the hardware configuration. The procedure to be used depends on the hardware configuration software of the PLC used. Please also read the documentation for the corresponding software in this regard.

The example below shows how the gateway is added to a SIEMENS TIA Portal project.

➡ Use Drag & Drop in the **Network view** to drag the device to the Ethernet PROFINET IO network.

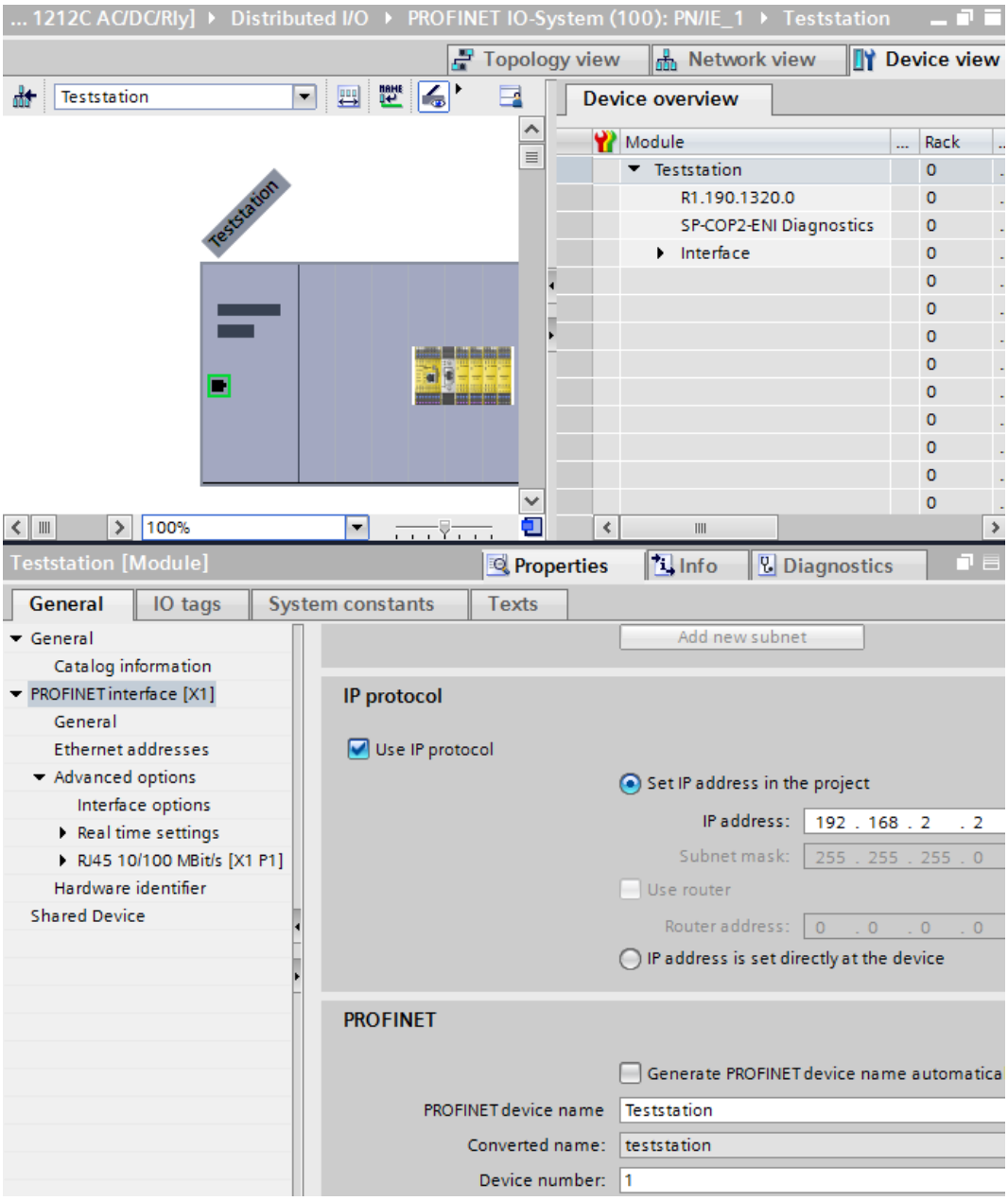
Example:



Step 3: Configure the gateway properties

➡ Double-click the hardware symbol of the SP-COP2-ENI module.

➡ Configure the IP address, the device name, and the update interval of the cyclical I/O data exchange. Select the **Properties** tab for this.



NOTICE

The PLC can only communicate with the SP-COP2-ENI module if the PLC software and the gateway use the same gateway name.
In accordance with IEC 61158-6-10 no capital letters are permitted for the symbolic name (NameOfStation).

7.4 PROFINET configuration of the gateway - which data are transferred

Cyclical data

The physical I/O modules are not presented in the PROFINET IO hardware catalog as typical hardware modules in the network. Instead, the data provided by the samos® PRO system has been arranged in various data blocks. Every data block represents a module in the PROFINET IO hardware catalog. The GSDML supports 13 Slots in which the modules can be placed. This makes is possible to use each data set one time (see illustration *"Configuration" [ch. 7.4, p. 73]*).

Process data from module to PLC

The SP-COP2-ENI module provides 5 input data blocks (virtual device modules) which contain the process image. These can be exclusively placed in each corresponding slot 16 to 20.

NOTICE

Input data blocks 1 to 4 each contain 12 bytes, while input data block 5 contains 2 bytes.

The content of the input data blocks can be freely selected. The data assignment in samos® PLAN 6 is pre-configured in accordance with the following:

Table 34: Predefined content of input data block 1 to 5 of the SP-COP2-ENI module

	Data block 1	Data block 2	Data block 3	Data block 4	Data block 5
Byte no. per data block	Input data	Input data	Input data	Input data	Input data
Byte 0	Input values SP-COP2-ENI	I/O module 1 input values	I/O module 1 output values	Not allocated	Not allocated
Byte 1	Input values SP-COP2-ENI	I/O module 2 input values	I/O module 2 output values	Not allocated	Not allocated
Byte 2	Input values SP-COP2-ENI	I/O module 3 input values	I/O module 3 output values	Not allocated	Not available
Byte 3	Output values SP-COP2-ENI	I/O module 4 input values	I/O module 4 output values	Not allocated	
Byte 4	Logic data values	I/O module 5 input values	I/O module 5 output values	Not allocated	
Byte 5	Logic data values	I/O module 6 input values	I/O module 6 output values	Not allocated	
Byte 6	Logic data values	I/O module 7 input values	I/O module 7 output values	Not allocated	
Byte 7	Logic data values	I/O module 8 input values	I/O module 8 output values	Not allocated	
Byte 8	Logic data values	I/O module 9 input values	I/O module 9 output values	Not allocated	
Byte 9	Logic data values	I/O module 10 input values	I/O module 10 output values	Not allocated	
Byte 10	Logic data values	I/O module 11 input values	I/O module 11 output values	Not allocated	
Byte 11	Logic data values	I/O module 12 input values	I/O module 12 output values	Not allocated	
Length	12 bytes	12 bytes	12 bytes	12 bytes	2 bytes
Byte offset	0	12	24	36	48

1 byte for data set 1 is available for every expansion module. The input values show the state of the preliminary evaluation of the I/O module. This corresponds to the state of the element in the controller module logic. The level at the associated terminal cannot be clearly detected from this, as the data may be set to low, irrespectively of the level at the input terminal, by means of the cross-connection detection or two-channel evaluation (e.g. I1-18).

When two-channel input elements have been configured for an I/O module, only the lower-value bit represents the pre-evaluation state of the corresponding element (e.g. bit 0 for I1 and I2, bit 2 for I3 and I4, bit 4 for I5 and I6, bit 6 for I7 and I8).
The higher-value bit (bit 1, 3, 5 and 7) is used as follows in this case:
0 = error, 1 = no error

Further information

You will find information about how to configure the process diagram in the description of the (*The graphical user interface [ch. 5.1, p. 41]*) user interface.

Data from the PLC to the SP-COP2-ENI module

There are 5 output data blocks having 10 bytes each. These can be exclusively placed in each corresponding slot 21 to 25.

The content of these data blocks can be used as input in the samos® PLAN 6 logic editor or forwarded to another network by a second gateway. Every bit to be used must be assigned a tag name in order to provide the desired bits in the logic editor or for forwarding. Bits without tag names are not available.

Detailed information about how you can assign and adapt the tag names of the input and output data can be found here:
Software manual, chapter "Adapting display names of project components"

NOTICE

The standard value of the gateway data bit is zero following activation of the SP-COP2-ENI device.

If the connection to PLC is terminated, then all of the gateway data bits in the samos® PLAN 6 logic editor assume the value zero.

NOTICE

For output data with IOPS=Bad, all of the gateway data bits in the samos® PLAN 6 logic editor assume the value zero. This is the case, for example, if the PLC is stopped.

Settings in the PROFINET IO network configuration tool

➧ Only drag the required data blocks from the hardware catalog of the SIEMENS TIA Portal to the corresponding slots of the SP-COP2-ENI module within the configuration table.

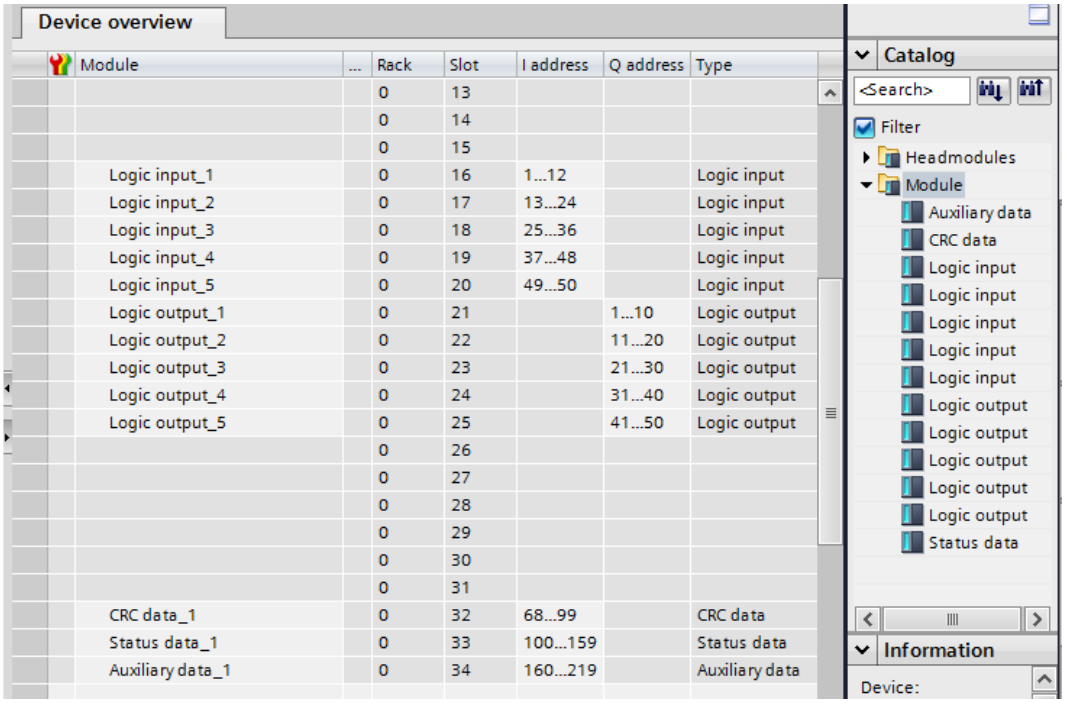


Illustration 12: Configuration of the SP-COP2-ENI module

NOTICE

The input and output addresses indicate the location of the cyclical data in the memory. These can be addressed via the absolute addresses %I and %Q in the SIEMENS TIA portal.

Acyclical data and alarms

Read out data

The PLC can read out the diagnostic data of the samos® PRO system. The diagnostic information is provided in three data sets, data sets 2, 3, and 4:

Data set 2 comprises 32 bytes and contains the project file's CRC 32. This can only be placed in slot 32.

Data set 3 comprises 60 bytes and contains the status of SP-COP2-ENI module and the individual I/O modules. This can only be placed in slot 33. See the following to interpret the status bits in data set 3: Table *"Meaning of the module status bits of the controller module" [ch. 3.3.4, p. 27]* and Table *"Meaning of the module status bits of the I/O modules" [ch. 3.3.4, p. 28]*

Data set 4 (auxiliary data) comprises 60 bytes and is currently filled with reserved values. This can only be placed in slot 34.

NOTICE

Data set 4 in Slot 34 does not function with all versions of the SIEMENS TIA portal.

Information & Management

The SP-COP2-ENI module supports the I&M information defined in the PROFINET IO specification. The following I&M information can be read out:

Table 35: Readable I&M information

Name	Size	Value range	I&M	Storage location
MANUFACTURER_ID (Vendor ID)	2 bytes	397 = 0x18D	0	SP-COP2-ENI
ORDER_ID (Order ID)	64 bytes	"R1.190.1310.0 + 51 blank spaces and "R1.190.1320.0 " + 51 blank spaces	0	SP-COP2-ENI
SERIAL_NUMBER (IM_Serial_Number)	8 bytes	"16010001" to "99129999"	0	SP-COP2-ENI
HARDWARE_REVISION (IM_Hardware_Revision)	2 bytes	101 to 9999	0	SP-COP2-ENI
SOFTWARE_REVISION (IM_Software_Revision)	6 to 9 Bytes	"V0.1.0" to "V99.99.99"	0	SP-COP2-ENI
Device ID		1320	0	SP-COP2-ENI
REV_COUNTER (IM_Revision_Counter)	2 bytes	0 to 65535	0	SD card
PROFILE_ID (IM_Profile_ID)	2 bytes	0x0000 (Non-profile)	0	SP-COP2-ENI
PROFILE_SPECIFIC_TYPE (IM_Profile_Specific_Type)	2 bytes	0x0003 (IO modules)	0	SP-COP2-ENI
IM_VERSION (IM_Version)	2 bytes	1	0	SP-COP2-ENI
IM_SUPPORTED (IM_Supported)	2 bytes	10 (= 0b1010)	0	SP-COP2-ENI
TAG_FUNCTION	32 bytes	32 Bytes à 0x20..0x7E	1	SD card
TAG_LOCATION	22 bytes	32 Bytes à 0x20..0x7E	1	SD card
INSTALLATION_DATE (IM_Date)	16 bytes		2	SD card[1)]
DESCRIPTOR (IM_Descriptor)	54 bytes	54 Byte à 0x00..0xFF	3	SD card
IM_Signature	54 bytes	54 Byte à 0x00..0xFF	4	SD card
[1)] Subject to changes				

Alarms

Alarms can be acyclically read using the PROFINET IO alarm infrastructure. When an error in the samos® PRO system occurs, the PROFINET IO gateway sends a corresponding diagnostics alarm to the network. The details of the diagnostics alarm (text and help) are then available through the SIMATIC PLC interface. The RALRM (SFB54) function block in OB82 (diagnostics interrupt) allows you to make the details of the sent alarm directly available in the PLC program.

NOTICE

All alarms are output to module 0.

The cause of the alarm is displayed by an error message from the GSDML file.

The possible causes of an alarm can be found in the software manual, Section "List of all error messages".

7.5 Diagnostics and troubleshooting

Information on the diagnosis of the samos® PRO system can be found in the software manual, Section "List of all error messages".

Table 36: Troubleshooting on the SP-COP2-ENI module

Error		Possible cause	Possible remedy
Key: ○ LED off / ✳ LED flashes / ● LED lights up			
The SP-COP2-ENI module does not provide any data.		• The SP-COP2-ENI has been configured for data transmission to the PLC, but no Ethernet communication has been established or the communication is faulty. • Duplicate IP address detected. Another network device has the same IP address. • Incorrectly formatted PROFINET device name	• PROFINET IO must be activated in the project file. At least one Ethernet link must be established. Check the Ethernet wiring, check the Ethernet settings in the PLC and in samos® PLAN 6. • Correct the IP address and switch the system off and on again. • Compare the device name between the PROFINET master and the SP-COP2-ENI module.
LED PWR/EC	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		
MS LED	● Green		
The SP-COP2-ENI module does not provide any data.		• Configuration required. • The configuration has not yet been fully transmitted. • The module version does not support any PROFINET IO.	• Configure the SP-COP2-ENI module with a project file in which PROFINET IO is activated and transfer the configuration to the SP-COP2-ENI module. • Use an SP-COP2-ENI device starting with module version B-xx.
LED PWR/EC	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		
MS LED	✳ / ✳ Red/green		
The SP-COP2-ENI module does not provide any data.		• The samos® PRO system is in the stop state.	• Start the controller module (switch to Run mode).
LED PWR	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		

Error		Possible cause	Possible remedy
MS LED	Green (1 Hz)		
The SP-COP2-ENI module does not provide any data.		• The IP address for the SP-COP2-ENI module is assigned by a DHCP server. Following a restart of the SP-COP2-ENI module or the DHCP server, another address was allocated to the SP-COP2-ENI module, which is unknown to the PLC.	• Either assign a permanent IP address to the SP-COP2-ENI module or reserve a permanent IP address for the SP-COP2-ENI module in the DHCP server (manual assignment using the MAC address of the SP-COP2-ENI module).
LED PWR/EC	Green		
LED LINK	Green		
LED /ACT	Yellow		
MS LED	Green		
The SP-COP2-ENI / the samos® PRO system is in the “Critical error” state.		• The SP-COP2-ENI module is not properly connected to the samos® PRO modules. • The module connection plug is dirty or damaged. • Another samos® PRO module has an internal critical error.	• Insert the I/O module correctly. Clean the connection plug and socket. • Switch on the power supply again. • Check the other samos® PRO modules.
LED PWR	Green		
LED LINK	Green		
LED /ACT	Yellow		
MS LED	Red		

7.6 Deactivation of the PROFINET IO function

If the SP-COP2-ENI device is started with an activated PROFINET IO function, then this function remains active until the device is switched off.

For this reason, switch the device off after sending a project without PROFINET IO function. This is required, for example, if you convert the gateway function in the samos® PRO project from PROFINET IO to Modbus TCP.

7.7 Status bits

The PROFINET IO gateway SP-EN-PN sets state bits, which are available in the logic editor of samos® PLAN 6 for processing.

Table 37: Meaning of the state bits SP-EN-PN[0] in the logic editor

Name of the state bits	Set to 1, if ...	Reset to 0 ...
Output status	… Data from slot 16, 17, 18, 19, 20, 32 or 33 was transmitted without error.	… No AR (Application Relation) exists.
Input status	… Data from slot 21, 22, 23, 24 or 25 was downloaded from a PLC without error.	… No AR (Application Relation) exists.
Internal state	… An AR (Application Relation) is active.	... No AR exists.

An Application Relation (AR) is a clear communication relationship between two communication partners, for example a PLC and a device. The AR is initialized during PLC start-up. Cyclical input and output data, acyclical data using read/write services and alarms are exchanged bidirectionally between the PLC and the device within this AR.

7.8 Optimizing performance

Only use the data blocks from the hardware catalog of the module that you actually need for your application.

Sequence the process data in the routing tables within a data block without gaps (see *Layout and content of the tabs [ch. 5.1.3, p. 44]*). Then check whether this will enable you to do without the use of individual data blocks from the hardware catalog. This helps to reduce the number of data bytes periodically exchanged in the network.

8 ETHERNET/IP GATEWAY

This chapter describes the "EtherNet/IP-Gateway" function of the SP-COP2-ENI module.

The EtherNet/IP protocol is not described in this chapter. If you have little or no experience with this, please refer to the ODVA documentation for more information. Some content can be found in the glossary (see *Abbreviations and definitions [ch. 1.5, p. 9]*).

NOTICE

Use of the term “Device” in this chapter

This chapter uses the term “Device” as a synonym for the controller module SP-COP2-ENI.

8.1 Interfaces and operation

Interfaces and operation are identical to that of the Modbus TCP Gateway.

Read the following section: *Interfaces and operation [ch. 6.1, p. 55]*

8.2 Data sheet

The SP-COP2-ENI module supports EtherNet/IP from product version D-01.01. The following functions are integrated:

- Implicit message transmission (transport class 1)
- Explicit message transmission (transport class 3, connected)
- Device profile: Discrete universal I/O device
- UCMM Message Server (no connection)
- Supported objects: Message router, connection manager, port, identity, Ethernet link, TCP/IP, I/O point and group (discrete), vendor class 0x78, assembly
- Up to five simultaneous encapsulation sessions (input and output)
- Assemblies of a variable size
- Supported addressing: Class/instance/attribute and symbol tag
- Agreement with CIP (Common Industrial Protocol) specification and with EtherNet/IP CIP specification, according to table *Module versions and referenced specification versions for EtherNet/IP [ch. 8.2, p. 78]*
- Details EDC file with ODVA conformity test
- Supported PCCC commands: Read and write word range, read and write input, read and write protected logic input with two and three address fields for connection to PLC 3, PLC 5, PLC 5/250, PLC 5/VME, SLC 500, SLC 5/03, SLC 5/04 and MicroLogix-1000
- Automatic configuration of semi and full duplex connections as well as of connections with 10 and 100 Mbit/s.
- MS (module state) and NET (network) LED

Table 38: Module versions and referenced specification versions for EtherNet/IP

Module version	CIP (Common Industrial Protocol) specification	EtherNet/IP CIP specification
up to D-01	Version 3.18	Version 1.19
from D-03	Version 3.21	Version 1.22

8.3 Basic setup

8.3.1 Basic configuration of PLC

This chapter briefly describes the basic configuration of the PLC.

Firstly, install the current EDS file for the SP-COP2-ENI module in your PLC configuration program. You can find the current EDS file on the Internet at eshop.wieland-electric.com/de. The following diagram shows you how you can make the setting using the Logix Designer.

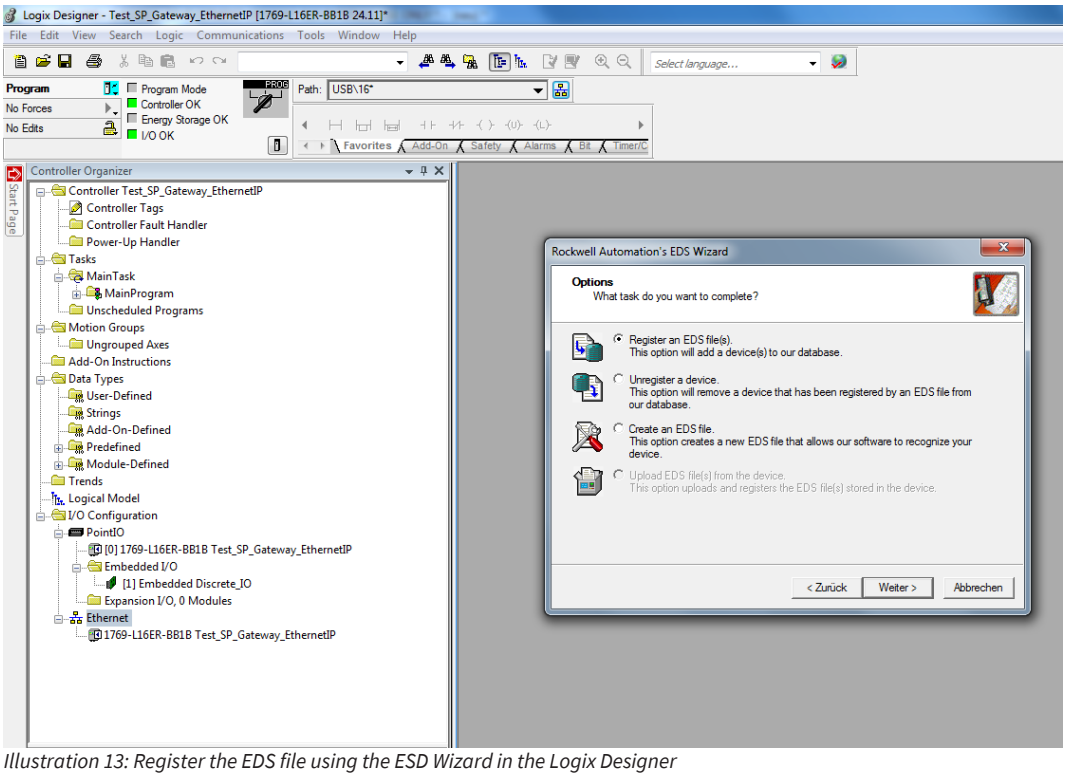


Illustration 13: Register the EDS file using the ESD Wizard in the Logix Designer

The article number is "R1.190.1320.0" and can be filtered according to the vendor name "Wieland Electric" or a part of this name.

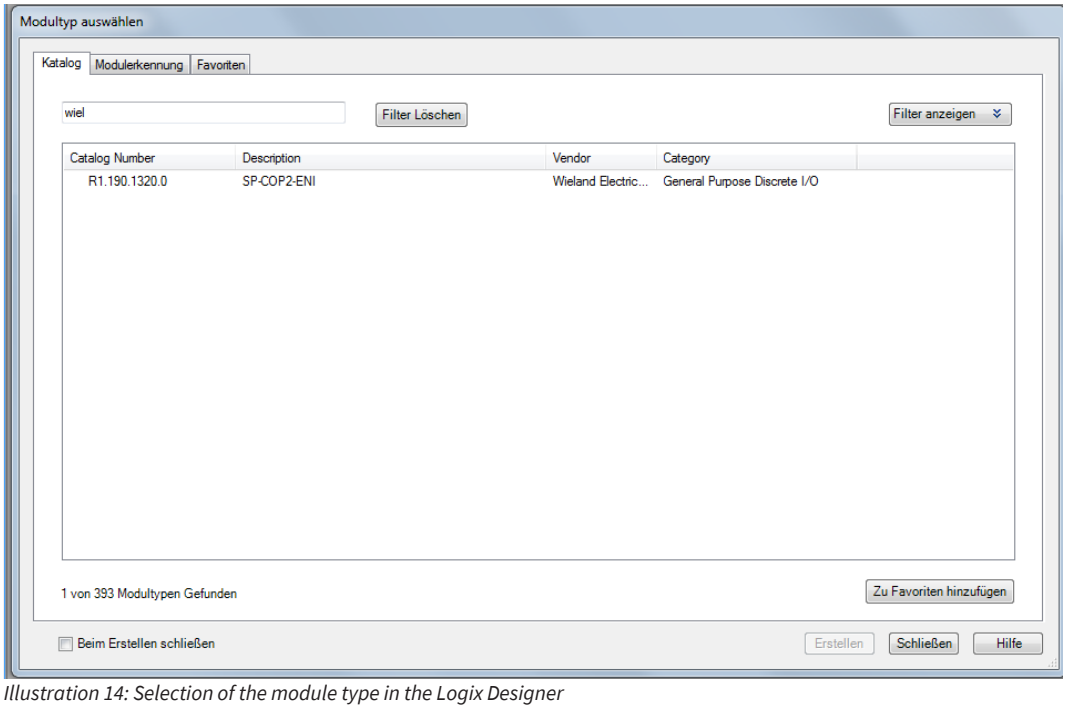


Illustration 14: Selection of the module type in the Logix Designer

In the **Internet Protocol** tab in the Logix Designer, select **Manually configure IP settings**. Select the required IPv4 address and the appropriate network mask.

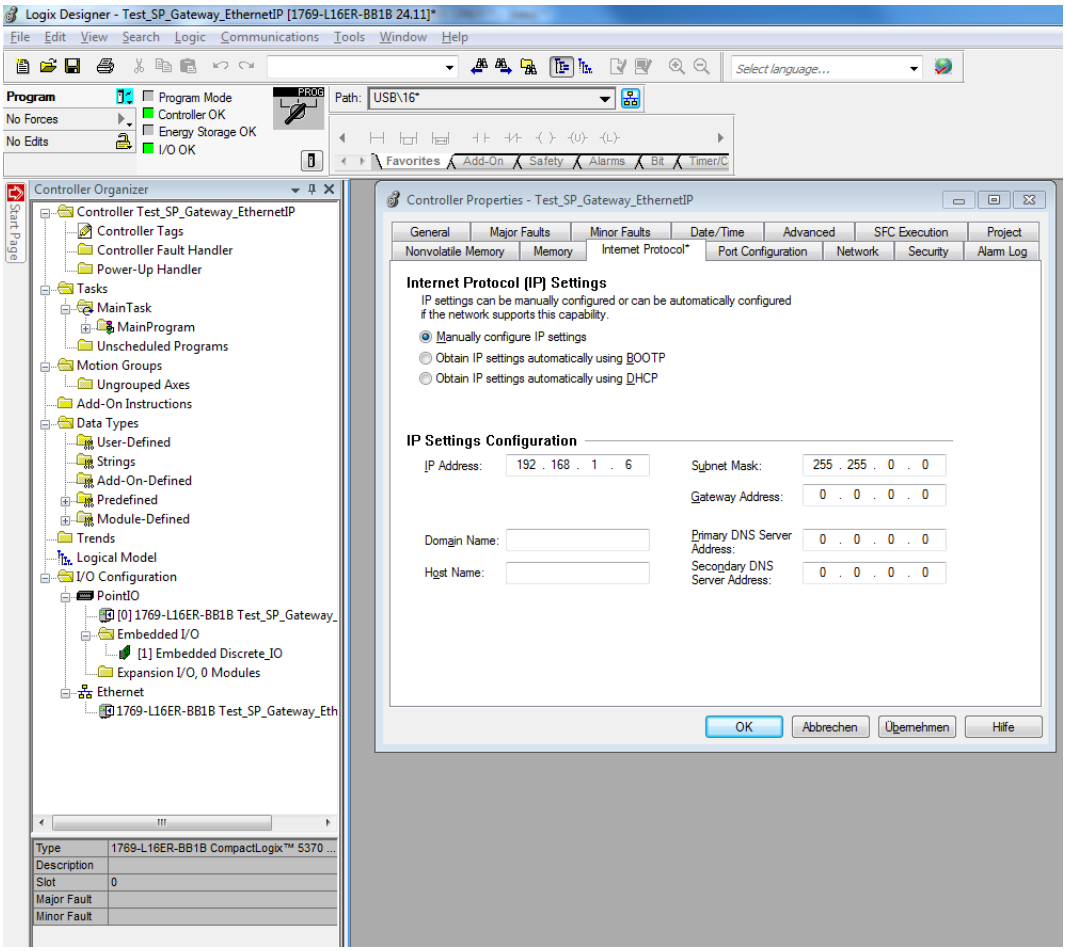


Illustration 15: IPv4 setting for the device in the Logix Designer

The SP-COP2-ENI module is a **General Purpose Discrete I/O Device.** For quick installation, use the connection **Logic Output (1 to 400) and Logic/Physical Input**, if your PLC supports implicit message transmission. The following figure shows the appropriate dialog in the Logix Designer.

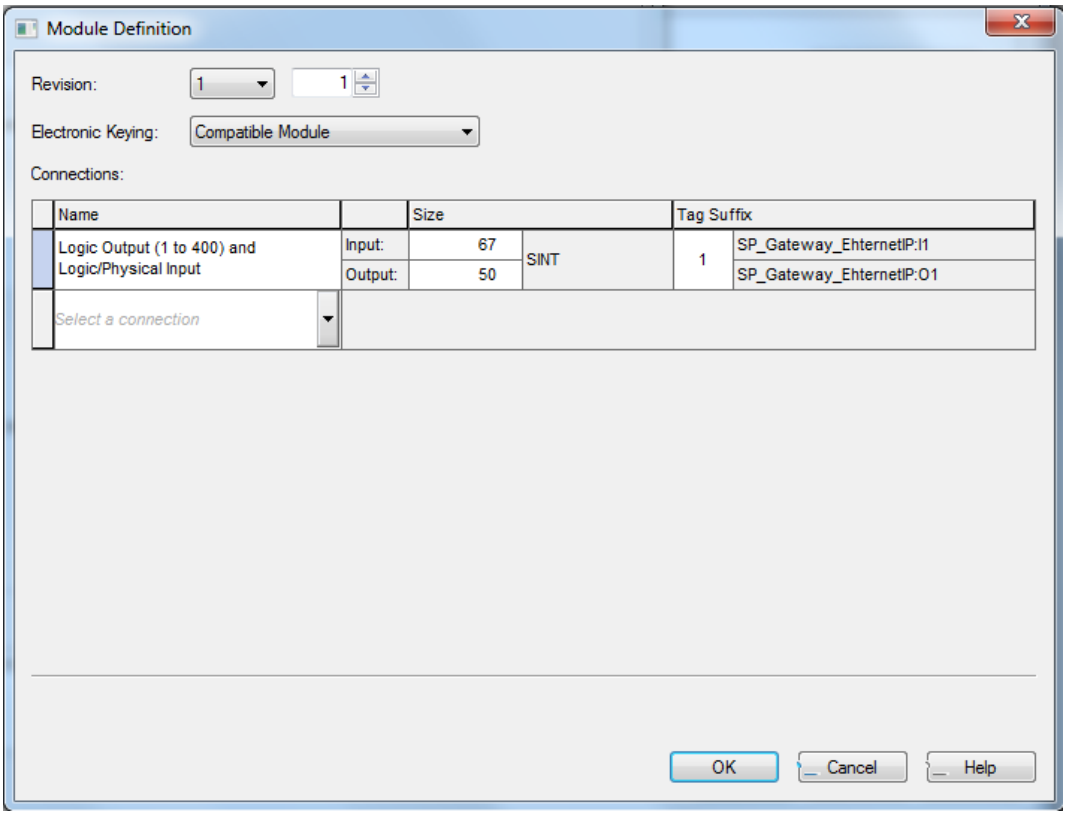


Illustration 16: Basic connection selected in the Logix Designer

This connection comprises up to 50 bytes for data transmission from the PLC to the SP-COP2-ENI module (assembly instance 37). This connection comprises up to 67 bytes for data transmission from the SP-COP2-ENI module to the PLC (assembly instance 57). The following table offers an overview of these data bytes.

Table 39: Data of the class 1 connection "Logic output (1 to 400) and logic/physical input"

Instance	Byte	Access	Data type	Description	Size	Data range
37	0 to 49	Write, read	BYTE[50]	Output bytes, configuration via **Input data block 1 to 5** in samos® PLAN 6 (*More [ch. 8.5.2.1, p. 102]*)	1 to 50 Bytes	0 to 0xff
57	0 to 49	Read	BYTE[50]	Input bytes, configuration via **Output data block 1** in samos® PLAN 6 (*More [ch. 8.5.3.1, p. 103]*)	1 to 50 Bytes	0 to 0xff
	50 to 65	Read	BYTE[16]	Bits of the input terminals (instance 401 to 528 of attribute 3 class 8, currently not listed in samos® PLAN 6) (*More [ch. 8.5.3.1, p. 103]*)	1 to 16 Bytes	0 to 0xff
	66	Read	BYTE	Bit 7: Input state Bit 6: Output state (currently not listed in samos® PLAN 6)	1 bytes	0x00, 0x40, 0x80, 0xc0

Other connections supported by the SP-COP2-ENI module are listed in the following table. You can find information on these assembly instances in the table "*Overview of assembly databytes [ch. 8.5.1, p. 100]*".

Table 40: Class 1 connections supported by the SP-COP2-ENI module

Name of the connection	Assembly for data from the PLC to SP-COP (O→T)	Assembly for data from SP-COP to the PLC (T→O)
Logic output (1 to 400) and logic/physical input	37	57
Logic output (1 to 400) and logic/state/system mode assembly	37	167
Logic output (81 to 400) and logic/physical input	138	57
Logic output (81 to 400) and logic/state/system mode assembly	138	167
Logic output (161 to 400) and logic/physical input	139	57
Logic output (161 to 400) and logic/state/system mode assembly	139	167
Logic output (241 to 400) and logic/physical input	140	57
Logic output (241 to 400) and logic/state/system mode assembly	140	167
Logic output (321 to 400) and logic/physical input	141	57
Logic output (321 to 400) and logic/state/system mode assembly	141	167
Logic/physical input (“Listen only”)	199	57
Logic/state/system mode assembly (“Listen only”)	199	167
Logic/physical input (“Input only”)	198	57
Logic/state/system mode assembly (“Input only”)	198	167

Connection point 199 (= 0xc7) is used for **Listen Only** and connection point 198 (= 0xc6) for **Input Only**. Both possess a data size of zero. This means that the PLC does not make any data available for the SP-COP2-ENI module.

If the PLC only requires process data from the SP-COP module, the user is recommended to use a connection with **Input Only**.

8.3.2 Basic configuration of the controller module

The integrated gateway SP-EN-IP (EtherNet/IP gateway) is a constituent part of the SP-COP2-ENI module.

Activating the gateway

You can activate the integrated gateway in the configuration dialog of the SP-COP2-ENI module in the **Properties** docking window:

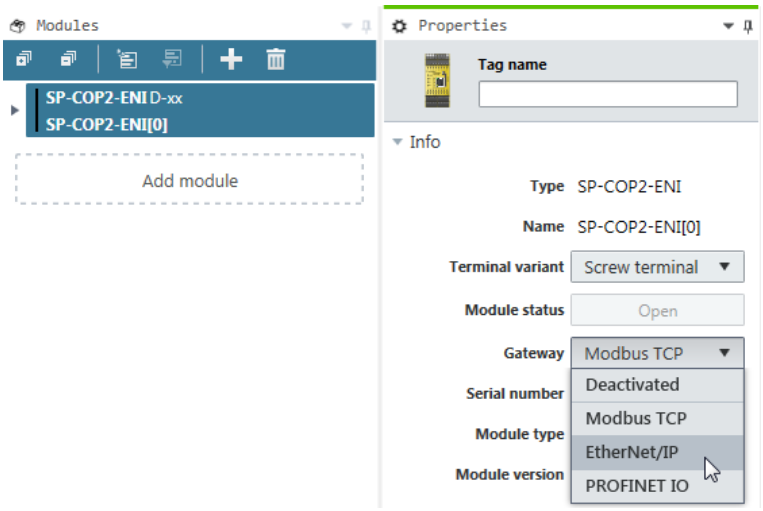


Illustration 17: Activation of EtherNet/IP in samos® PLAN 6

NOTICE

Selection of the SP-EN-IP gateway is possible for modules of type SP-COP2-ENI from version D-01.01.

Adapting the IPv4 data

The IPv4 data of the SP-COP2-ENI module can be adapted to the PLC settings in samos® PLAN 6.

Requirement
During transmission of the IPv4 data, the device must not be in **Run (Execute)** mode. The command bar must be displayed on the left above the **Start** command, as shown in the following illustrations. If this is not the case, stop the device via the **Stop** button.

Required window layout

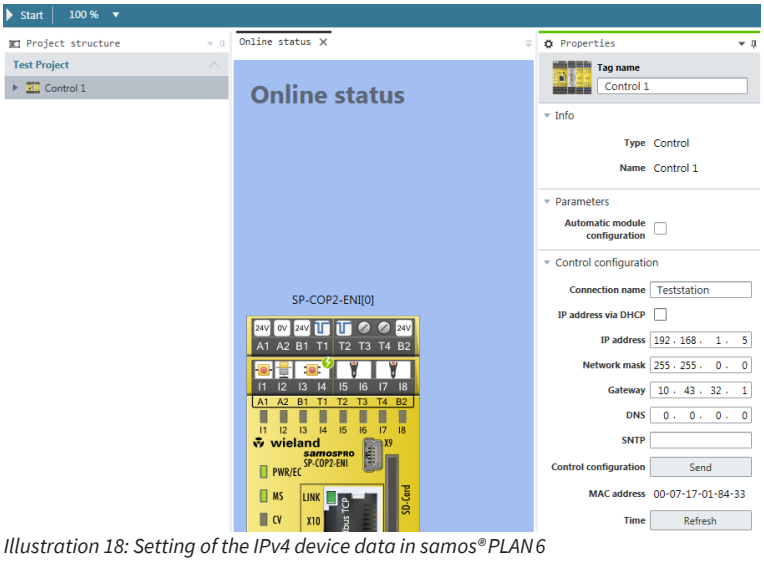


Illustration 18: Setting of the IPv4 device data in samos® PLAN 6

8.3.3 Configuring the data to the PLC

The data transferred to the PLC and thus from the target device to the sender (Target to Originator, T→O) can be adapted in the "samos® PRO → SP-EN-IP[0]" tab of the gateway configuration in samos® PLAN 6. By default, the first three bytes contain data for the input terminals I1 to I16 (and IQ1 to IQ4 in the appropriate configuration as an input). Byte 4 comprises data of the output terminals Q1 to A4 (and IQ1 to IQ4 in the appropriate configuration as an output).

Bytes 12 to 23 comprise data for the input terminals I1 to I8 of the input/output expansion modules. Bytes 24 to 35 comprise data for the output terminals Q1 to Q4 of the expansion modules SP-SDIO or SP-DIO. Bytes 4 to 11 comprise data of the logic editor and are called **Direct Off**.

This standard configuration can be adapted as shown here using drag & drop from the **Gateway** docking window in the tabs for the gateway configuration:

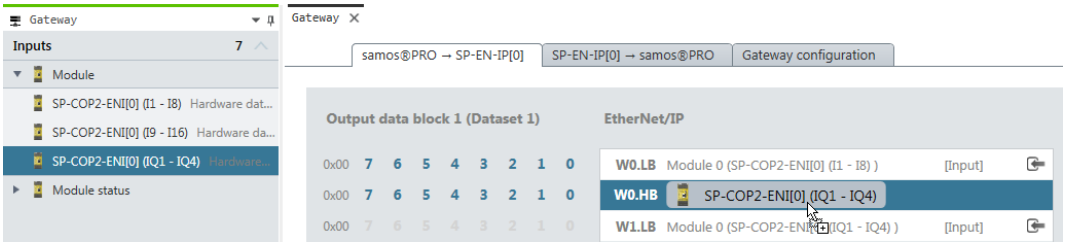


Illustration 19: Adding of bytes to the gateway process image (T→O) using drag-and-drop in samos® PLAN 6

In addition, the tag names of all the bytes in samos® PLAN 6 can be added or edited, in order to be able to use them in the **Logic** view of samos® PLAN 6. User-defined names improve program legibility and troubleshooting. Tag names can be configured in the **Parameters** section of the **Properties** docking window.

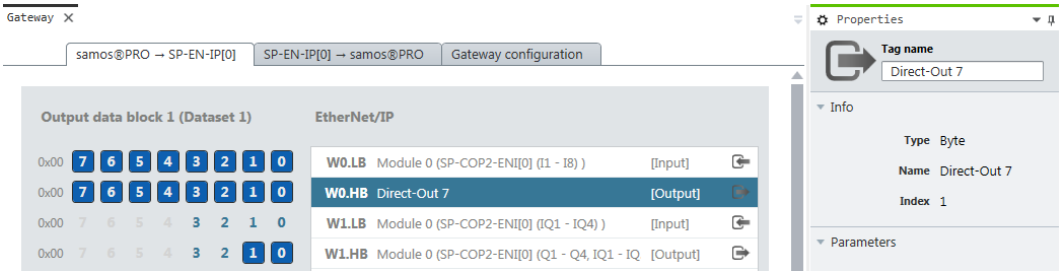


Illustration 20: Adding new data bytes (T→O) for use in the "Logic" view by configuring tag names

8.3.4 Configuring the data from the PLC

Data transmitted by the PLC and thus by the sender to the target device (Originator to Target, O→T) can be named in the "SP-EN-IP [0] → samos® PRO" tab for the gateway configuration in samos® PLAN 6. By default, the logic values **Direct On 0** to **Direct On 3** are assigned to the four first bytes. The names **Data bit 0** to **Data bit 7** are assigned to each bit as standard. Each bit can be used in the **Logic** view of samos® PLAN 6 as an unsafe input element, such as a Restart button or as a signal lamp.

Additional input elements for gateway data can be added as necessary by the configuration of additional tag names.

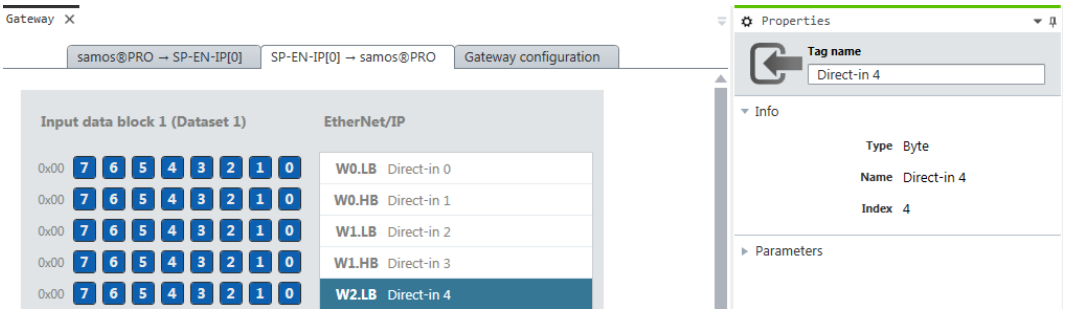


Illustration 21: Adding of a new data byte (T→O) for use in the logic editor by configuring the tag name.

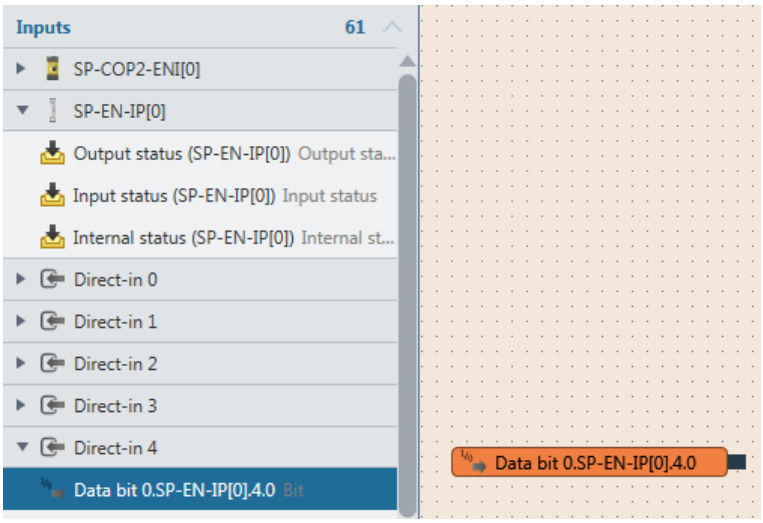


Illustration 22: Adding gateway data elements to the logic editor in samos® PLAN 6 via drag & drop

8.4 Supported CIP objects

8.4.1 Identity object

The identity object is required for all EtherNet/IP-based products. Instance 1, attribute 1 stands for the Vendor ID. Wieland Electric GmbH is listed by the ODVA using the value 314.

Instance 1, attribute 2 stands for the device types. The Open Type Code 0x07 stands for a **discrete universal I/O device.**

Instance 1, attribute 3 stands for the product code. It is of the type UNIT and thus comprises 2 bytes.

The decimal value is always constant at 1320.

Instance 1, attribute 4 stands for the revision, that means the main and supplementary firmware version of the SP-COP2-ENI module, which you can find in the samos® PLAN 6 software as the **Diagnostics version**. You can see both details in the **Properties** docking window, if you select the controller module in the **Modules** docking window after you have connected to the station.

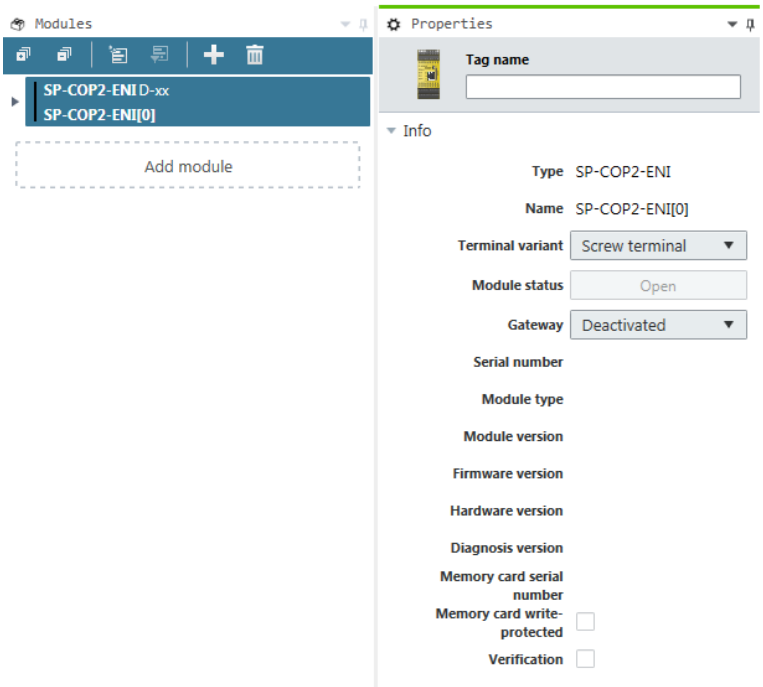


Illustration 23: Display of diagnostic version and hardware version in configuration dialog of the controller module

Instance 1, attribute 5 standard for the current state of the overall device. The data range is listed in the *Device state values table in class 1, instance 1, attribute 5 [ch. 8.4.1, p. 86]*.

Instance 1, attribute 6 stands for the serial number of the device, which can be found under the hardware configuration in samos® PLAN 6. Instance 1, attribute 7 stands for the product name SP-COP2-ENI.

Table 41: Overview of the identity class (0x01) supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
1	0 = Class	1	Read	UINT	Revision	1
1	0 = Class	2	Read	UINT	Max. instance	1
1	0 = Class	3	Read	UINT	Number of instances	1
1	0 = Class	6	Read	UINT	Max. class attribute ID	7
1	0 = Class	7	Read	UINT	Max. instance attribute ID	7
1	1	1	Read	UINT	Vendor ID	314 = 0x13a
1	1	2	Read	UINT	Device type	0x07
1	1	3	Read	UINT	*Product code [ch. 8.4.8.3, p. 97]*	1320
1	1	4	Read	USINT[2]	Revision, software version The “left” byte is the main section and is transmitted first	{1, 1} to {99, 99}
1	1	5	Read	WORD	Device state	See next table
1	1	6	Read	UDINT	Serial number	16010001 to 99539999
1	1	7	Read	SHORT_ STRING	Product name	SP-COP2-ENI

Table 42: Device state values of the SP-COP2-ENI module in class 1, instance 1, attribute 5

State value	Description	Possible system mode
0b0000 xxxx xxxx 0x01	There is at least one EtherNet/IP connection to a PLC (owner of the connection)	4 = Idle 5 = Run 7 = Critical error 21 = Force mode
0b0000 xxxx 0000 010x	Device is configured	4 = Idle 5 = Run 7 = Critical error 21 = Force mode
0b0000 0001 0000 0x0x	Low, removable error	4 = Idle 5 = Run 21 = Force mode
0b0000 0010 0000 0x0x	Low, non-removable error	4 = Idle 5 = Run 21 = Force mode
0b0000 0100 0000 0x0x	Serious, removable error	1 = Init 2 = Configuration required 3 = Configuration running
0b0000 1000 0000 0x0x	Serious, non-removable error	7 = Critical error

8.4.2 Assembly object

All the data of the Class 1 connections are also provided by the Assembly object. The following table offers an overview of this assembly object.

Further information:

- Table *Overview of assembly databytes of the SP-COP2-ENI module [ch. 8.5.1, p. 100]*
- Figure *Data flow with usage of assembly instances [ch. 8.6.2, p. 104]*
  (Shows the data flow upstream of the PLC to the SP-COP2-ENI module and back from the point of view of the individual assemblies.)

Table 43: Overview of the assembly class (0x04) supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
4	0 = Class	1	Read	UINT	Revision of the class	2
4	0 = Class	2	Read	UINT	Max. instance	167
4	0 = Class	3	Read	UINT	Number of instances	7
4	0 = Class	6	Read	UINT	Max. class attribute ID	7
4	0 = Class	7	Read	UINT	Max. instance attribute ID	4
4	37	1	Read	UINT	Number of members	0
4	37	3	Read, write	BYTE[50]	*Bits of the logic outputs [ch. 8.5.2, p. 102]* (Instance 1 to 400 of Class 9)	See [1]
4	37	4	Read	UINT	Number of data bytes	50
4	57	1	Read	UINT	Number of members	0
4	57	3	Read	BYTE[67]	Input bits (Instance 1 to 528 of Class 8)	See [1]
4	57	4	Read	UINT	Number of data bytes	67
4	138	1	Read	UINT	Number of members	0
4	138	3	Read, write	BYTE[40]	*Bits of the logic outputs [ch. 8.5.2, p. 102]* (Instance 81 to 400 of Class 9)	See [1]
4	138	4	Read	UINT	Number of data bytes	40
4	139	1	Read	UINT	Number of members	0
4	139	3	Read, write	BYTE[30]	*Bits of the logic outputs [ch. 8.5.2, p. 102]* (Instance 161 to 400 of Class 9)	See [1]
4	139	4	Read	UINT	Number of data bytes	30
4	140	1	Read	UINT	Number of members	0
4	140	3	Read, write	BYTE[20]	*Bits of the logic outputs [ch. 8.5.2, p. 102]* (Instance 241 to 400 of Class 9)	See [1]
4	140	4	Read	UINT	Number of data bytes	20
4	141	1	Read	UINT	Number of members	0
4	141	3	Read, write	BYTE[10]	*Bits of the logic outputs [ch. 8.5.2, p. 102]* (Instance 321 to 400 of Class 9)	See [1]
4	141	4	Read	UINT	Number of data bytes	10
4	167	1	Read	UINT	Number of members	0
4	167	3	Read	BYTE[112]	Bits of the logic inputs, mode and state bytes (*More [ch. 8.5.3.2, p. 103]*)	See [1]
4	167	4	Read	UINT	Number of data bytes	112

[1] See: Table *Overview of assembly databytes of the SP-COP2-ENI module [ch. 8.5.1, p. 100]*

8.4.3 Discrete input point objects

The discrete input point objects are part of the device profile **Discrete universal I/O device.**

If an error occurs at the terminal input of a specific instance between 401 and 528 and the SP-COP2-ENI module is in **Run** mode, the value of the instance attribute 4 equals 1. In all other cases, the value equals 0.

Table 44: Overview of the discrete input point objects (0x08) supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
8	0 = Class	1	Read	UINT	Revision of the class	2
8	0 = Class	2	Read	UINT	Max. instance	584
8	0 = Class	3	Read	UINT	Number of instances	400 + 128 + 56 Logic + input + output
8	0 = Class	6	Read	UINT	Max. class attribute ID	7
8	0 = Class	7	Read	UINT	Max. instance attribute ID	4
8	1 to 400 and 529 to 584	1	Read	USINT	Number of attributes	3
8	401 to 528	1	Read	USINT	Number of attributes	4
8	1 to 528	2	Read	USINT[4]	List of support attributes	{1, 2, 3, 4}
8	529 to 584	2	Read	USINT[3]	List of support attributes	{1, 2, 3}
8	1 to 400	3	Read	BOOL	The value of the input bit, configured by the **output data set 1** in samos® PLAN 6, stands for the data transferred by the logic of the controller module to the PLC.	0 = Off, 1 = On
8	1 to 400	4	Read	BOOL	State of **output data set 1**	0 = OK
8	401 to 416	3	Read	BOOL	Value of terminals I1 to I16 of the SP-COP2-ENI module	0, 1
8	401 to 416	4	Read	BOOL	State of terminals I1 to I16 of the SP-COP2-ENI module	0, 1
8	417 to 420	3	Read	BOOL	Value of terminals IQ1 to IQ4 of the SP-COP2-ENI module when configured as an input	0, 1
8	417 to 420	4	Read	BOOL	State of terminals IQ1 to IQ4 of the SP-COP2-ENI module when configured as an input	0, 1
8	421 to 430	3	Read	BOOL	Reserved	0
8	431	3	Read	BOOL	Value of B1	Voltage is... 0 = Outside the tolerance 1 = Within the tolerance
8	432	3	Read	BOOL	Value of B2	Voltage is... 0 = Outside the tolerance 1 = Within the tolerance
8	421 to 432	4	Read	BOOL	Reserved	0

Class	Instance	Attrib-ute	Access	Data type	Description	Data range
8	425 + 8 x n to 432 + 8 x n	3	Read	BOOL	Value of terminals I1 to I8 of the SP-SDI[n] / SP-SDIO[n] module, with n = 1 to 12	0, 1
8	425 + 8 x n to 432 + 8 x n = 528	4	Read	BOOL	State of terminals I1 to I8 of the SP-SDI[n] / SP-SDIO[n] module, where n = 1 to 12	0, 1
8	529 to 532	3	Read	BOOL	Value of terminals Q1 to Q4 of the SP-COP2-ENI module	0, 1
8	533 to 536	3	Read	BOOL	Value of terminals IQ1 to IQ4 of the SP-COP2-ENI module when configured as an output	0, 1
8	533 + 4 x n to 536 + 4 x n = 584	3	Read	BOOL	Value of terminals Q1 to Q4 of the SP-SDIO[n] module, where n = 1 to 12	0, 1

8.4.4 Discrete output point objects

The discrete output point objects are part of the device profile **Discrete universal I/O device.**

The samos® PRO system does not permit direct influencing of the security-oriented output terminals. Instead, up to 400 databits can be specified. In this way, it is possible to use the **input data blocks 1 to 5** in samos® PLAN 6 for bit-wise access. The simplest way to control output terminals with a PLC is by connecting the appropriate gateway bit to an output in the logic editor of samos® PLAN 6. The following figure shows an example:

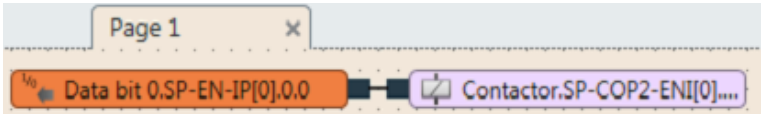


Illustration 24: Direct connection of a gateway input bit to an output terminal of the SP-COP2-ENI module

WARNING

Check your application thoroughly for correctness!

Because the samos® PLAN 6 only checks for logic-internal connection errors, you have to check the following aspects systematically yourself:

- Does your application correspond to the results from the risk analysis and the avoidance strategy?
- Have all of the applicable standards and guidelines been complied with?
  If not, you are placing the machine's operator in danger.

Note that the output terminal is set to **Off** as standard and thus stands for the value “0”. This value is always used when the controller module is not in **Run** mode or it the output is not configured via the logic editor in samos® PLAN 6.

The standard value of gateway output bits can be configured using attributes 5 and 6.

If there is a loss of connection between the PLC and the controller module, instance attribute 5 controls whether the gateway data bit is set or not. The specified value is controlled by instance attribute 6.

A write request to attribute 3 of instances 1 to 400 is refused if the *Assembly instance 37 [ch. 8.5.2.1, p. 102]* is already linked to an active connection to a PLC.

A write request to attribute 3 of instances 81 to 400 is refused if the *Assembly instance 138 [ch. 8.5.2, p. 102]* is already linked to an active connection to a PLC.

A write request to attribute 3 of instances 161 to 400 is refused if the *Assembly instance 139 [ch. 8.5.2, p. 102]* is already linked to an active connection to a PLC.

A write request to attribute 3 of instances 241 to 400 is refused if the *Assembly instance 140 [ch. 8.5.2, p. 102]* is already linked to an active connection to a PLC.

A write request to attribute 3 of instances 321 to 400 is refused if the *Assembly instance 141 [ch. 8.5.2, p. 102]* is already linked to an active connection to a PLC.

Table 45: Overview of the discrete output point objects (0x09) supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
9	0 = Class	1	Read	UINT	Revision of the class	1
9	0 = Class	2	Read	UINT	Max. instance	400
9	0 = Class	3	Read	UINT	Number of instances	400
9	0 = Class	6	Read	UINT	Max. class attribute ID	7
9	0 = Class	7	Read	UINT	Max. instance attribute ID	6
9	1 to 400	1	Read	USINT	Number of attributes	5
9	1 to 400	2	Read	USINT[5]	List of support attributes	{1, 2, 3, 5, 6}
9	1 to 400	3	Write, read	BOOL	The value of the logic output bit, which is configured by the **input data blocks 1 to 5** in samos® PLAN 6, stands for the data transferred by the PLC to the logic of the controller module.	0 = Off, 1 = On
9	1 to 400	5	Write, read	BOOL	Error action (specified value on loss of connection to the PLC)	0 = Interference value, 1 = Last state
9	1 to 400	6	Write, read	BOOL	Interference value	0 = Off, 1 = On

8.4.5 Discrete input group object

The discrete input group objects are part of the device profile **Discrete universal I/O device.**

The object of class 29 plays a role with regard to the alarm bit. It collects the process alarms of all the input terminals of the SP-COP2-ENI module as well as the safe input/output expansion modules in one bit. If an error occurs at at least one input terminal and the SP-COP2-ENI module is in **Run** mode, the value of the attribute 5 of instance 1 equals 1. In all other cases, the value equals 0.

Table 46: Overview of the discrete input group object (0x1D) supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
29	0 = Class	1	Read	UINT	Revision of the class	1
29	0 = Class	2	Read	UINT	Max. instance	1
29	0 = Class	3	Read	UINT	Number of instances	1
29	0 = Class	6	Read	UINT	Max. class attribute ID	7
29	0 = Class	7	Read	UINT	Max. instance attribute ID	5
29	1	1	Read	USINT	Number of attributes	5
29	1	2	Read	USINT[5]	List of support attributes	{1, 2, 3, 4, 5}
29	1	5	Read	BOOL	Group state of all input terminals (state of instances 401 to 420 of class 8)	0 = No error, 1 = Error

8.4.6 Discrete output group object

The discrete output group objects are part of the device profile **Discrete universal I/O device.**

The object of class 30 plays a role with regard to the alarm bit. It collects the process alarms of all the output terminals of a SP-COP2-ENI or SP-SDIO module in one bit. If an error occurs at at least one output terminal and the SP-COP2-ENI module is in **Run** mode, the value of the attribute 5 of instance 1 equals 1. If the SP-COP2-ENI module is in **Critical error** mode, the attribute value is also 1. In all other cases, the value equals 0.

Table 47: Overview of the discrete output group object (0x1D) supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
30	0 = Class	1	Read	UINT	Revision of the class	1
30	0 = Class	2	Read	UINT	Max. instance	1
30	0 = Class	3	Read	UINT	Number of instances	1
30	0 = Class	6	Read	UINT	Max. class attribute ID	7
30	0 = Class	7	Read	UINT	Max. instance attribute ID	6
30	1	1	Read	USINT	Number of attributes	6
30	1	2	Read	USINT[6]	List of support attributes	{1, 2, 3, 4, 5, 6}
30	1	3	Read	USINT	Number of bound instances	56
30	1	4	Read	UINT[56]	Bound instances	{1, ..., 56}
30	1	5	Read	BOOL	Group state of all output terminals (state of instances 529 to 584 of class 8)	0 = No error, 1 = Error

8.4.7 PCCC object

PCCC (pronounced “P C Cube”) is used in several PLCs from Rockwell Automation/Allen Bradley, which still continue to be used. It was developed before CIP and EtherNet/IP were defined. PCCC telegrams are either:

a) Encapsulated in CIP packages (e.g. via EtherNet/IP)

b) The encapsulation of CIP packages.

The SP-COP2-ENI module supports the encapsulation of PCCC data in CIP packages, as described above under b). For this, the class ID 0x67 = 103 was specified.

The PCCC commands listed in the following table are supported by the SP-COP2-ENI module.

All PCCC-related data with a size of 16 bits (word) are available in the “Little Endian” format. This means that the byte with the lowest value is executed first.

Table 48: PCCC commands supported by the SP-COP2-ENI module

Type	CMD	FNC	Description	Command supported by
PLC-5	0x0f	0x00	*Write word range [ch. 8.4.7.2, p. 92]*	PLC-3, PLC-5, PLC-5/250
PLC-5	0x0f	0x01	*Read word range [ch. 8.4.7.3, p. 92]*	PLC-3, PLC-5, PLC-5/250
PLC-5	0x0f	0x67	*Write input [ch. 8.4.7.4, p. 93]*	SLC 5/03, SLC 5/04, PLC 5, PLC-5/250, PLC-5/VME
PLC-5	0x0f	0x68	*Read input [ch. 8.4.7.5, p. 94]*	SLC 5/03, SLC 5/04, PLC 5, PLC-5/250, PLC-5/VME
SLC	0x0f	0xa1	*Read protected logic input with two address fields [ch. 8.4.7.6, p. 95]*	
SLC	0x0f	0xa2	*Read protected logic input with three address fields [ch. 8.4.7.8, p. 96]*	MicroLogix-1000, SLC 500, SLC 5/03, SLC 5/04, PLC 5
SLC	0x0f	0xa9	*Write protected logic input with two address fields [ch. 8.4.7.7, p. 96]*	

Type	CMD	FNC	Description	Command supported by
SLC	0x0f	0xaa	*Write protected logic input with three address fields [ch. 8.4.7.9, p. 96]*	MicroLogix-1000, SLC 500, SLC 5/03, SLC 5/04

8.4.7.1 PCCC telegram structure

Each request telegram comprises 7+5 header bytes.

Table 49: PCCC request header

Name	Data type	Description	Size	Data range
Length	USINT	Header size	1 bytes	7
Vendor	UINT	Vendor ID of the requester	2 bytes	
S/N	UDINT	Serial number of the requester	4 bytes	0 to 2^{32}-1
CMD	USINT	Command	1 bytes	0x0f
STS	USINT	State	1 bytes	0
TNSW	UINT	Transport sequence number	2 bytes	1 to 65535
FNC	USINT	Function code	1 bytes	0x67, 0x68, 0xa2, 0xaa

Each answer telegram comprises 7+4 header bytes or 7+4+1 header bytes, if the state byte is 0xf0.

Table 50: PCCC reply header

Name	Data type	Description	Size	Data range
Length	USINT	Header size	1 bytes	7
Vendor	UINT	Vendor ID of the requester	2 bytes	
S/N	UDINT	Serial number of the requester	4 bytes	0 to 2^{32}-1
CMD	USINT	Command of requester plus Bit 6 set	1 bytes	0x4f
STS	USINT	State	1 bytes	0x00, 0x10, 0xf0
TNSW	UINT	Transport sequence number	2 bytes	1 to 65535
EXT STS	USINT	Extended status, only present if STS = 0xf0	0 to 1 Bytes	

8.4.7.2 Write word range

The SP-COP2-ENI module supports “Write PLC-5 word range” according to the following table:

Table 51: Data structure of Write PLC-5 word range

Name	Data type	Description	Data range
Packet offset	UINT	Offset as number of elements	
Total Transaction	UINT	Number of elements in the transaction	
Address	BYTE[m]	PLC-5 system address, m >= 2	
Payload	UINT[n]	2•n = Number of data bytes	0 to 65535

The answer of the SP-COP2-ENI module does not contain any data, only a state.

8.4.7.3 Read word range

The SP-COP2-ENI module supports “Read PLC-5 word range” according to the following table:

Table 52: Read request data structure of PLC-5 word range

Name	Data type	Description	Data range
Packet offset	UINT	Offset as number of elements	
Total Transaction	UINT	Number of elements in the transaction	0 to value dependent on the assembly size
Address	BYTE[m]	PLC-5 system address, m >= 2	“0” to “:”, “A” to “Z”, “a” to “z”
Size	UINT	Number of elements to be returned	

Table 53: Feedback to the SP-COP2-ENI module of Read PLC-5 word range

Name	Data type	Description	Data range
Payload	UINT[n]	2•n = number of data bytes (up to 244 bytes)	0 to 65535

8.4.7.4 Write input

The SP-COP2-ENI module supports “Write PLC-5 input” according to the following table:

Table 54: Write data structure of PLC-5 input

Name	Data type	Description	Data range
Packet offset	UINT	Offset as number of elements	
Total Transaction	UINT	Number of elements in the transaction	
Address	BYTE[m]	PLC-5 system address, m >= 2	See next table
Type ID	BYTE[n]	Data type and size, n >= 1	

The answer of the SP-COP2-ENI module does not contain any data, only a state, see table *PCCC reply header [ch. 8.4.7.1, p. 92]*. The UINT data format corresponds to writing the format of the word range.

Table 55: Write address structure of PLC-5 input

Address	Data type	Number of elements	Description	Data range
$N37:x	UINT[n]	n	Output assembly of the device profile Discrete universal I/O device, x = 0 to 24, n = 25 - x	0 to 65535
$N138:x	UINT[n]	n	Output assembly of the logic output, configured via the **input data block 2 to 5** in samos® PLAN 6, x = 0 to 19, n = 20 – x	0 to 65535
$N139:x	UINT[n]	n	Output assembly of the logic output, configured via the **input data block 3 to 5** in samos® PLAN 6, x = 0 to 14, n = 15 – x	0 to 65535
$N140:x	UINT[n]	n	Output assembly of the logic output, configured via the **input data block 4 to 5** in samos® PLAN 6, x = 0 to 9, n = 10 – x	0 to 65535
$N141:x	UINT[n]	n	Output assembly of the logic output, configured via the **input data block 4 to 5** in samos® PLAN 6, x = 0 to 4, n = 5 – x	0 to 65535

Address	Data type	Number of elements	Description	Data range
The data range of the number of elements is relative to the assembly sizes. See the table *Overview of assembly databytes of the SP-COP2-ENI module [ch. 8.5.1, p. 100]*				

8.4.7.5 Read input

The SP-COP2-ENI module supports “Read PLC-5 input” according to the following table:

Table 56: Read request data structure of PLC-5 word range

Name	Data type	Description	Data range
Packet offset	UINT	Offset in number of elements	
Total Transaction	UINT	Number of elements in the transaction	0 to value dependent on the assembly size
Address	BYTE[m]	PLC-5 system address, m >= 2	“0” to “:”, “A” to “Z”, “a” to “z”
Size	UINT	Number of elements to be returned	

The answer of the SP-COP2-ENI module is listed in the following table. The first byte of the type ID is 0x9a = 0b1001 1010, meaning that the data type is given in the following byte and the data size in the byte after that. The fourth byte of the type ID is 0x42 = 0b0100 0010, standing for an integer data type of size 2.

Table 57: Feedback to the SP-COP2-ENI module for reading the data structure of the PLC-5 input

Name	Data type	Description	Data range
Type ID	BYTE	Data type and size	Bit 0 to 3: 10 = Size specification in the next but one byte Bit 4 to 7: 9 = Type in the next byte
Type ID	BYTE	Data type	9 = Field of the same elements
Type ID	BYTE	Number of following bytes	1 to n+1
Type ID	BYTE	Data type and size	Bit 0 to 3: 2 = UINT Bit 4 to 7: 4 = Integer
Payload	UINT[n]	2·n = Number of data bytes	0 to 65535

The command data of all assembly instances can be recorded using “Read input”.

In contrast to native addressing of EtherNet/IP assembly instances, the PLC-5 system address contains an element offset which can be used.

The SP-COP2-ENI module supports fields (arrays) of UINT as PCCC data types. Due to the odd size of the assembly instance 57, the firmware contained in the SP-COP2-ENI module assigns an additional byte, to provide an even number of bytes.

The address scheme supported by the SP-COP2-ENI module for Read PLC-5 input is shown in the following table:

Table 58: Read address structure of PLC-5 input

Address	Data type	Number of elements	Description	Data range
$N57:x	UINT[n]	n	Input assembly of the device profile Discrete I/O device , x = 0 to 33, n = 34 - x	Element 1 to 33: 0 to 65535 Element 34 Bit 0 to 7 (LSB): 0x00, 0x40, 0x80, 0xc0 Element 34 Bit 8 to 15 (MSB): 0
$N167:x	UINT[n]	n	Input assembly of:	
			Logic input bits (n = 1-x to 25-x, x = 0 to 24)	0 to 65535
			System state and system mode (n = 26-x, x = 0 to 25)	Bit 0 to 7 (LSB): System mode (1, 2, 3, 4, 5, 7, 21) Bit 8 to 15 (MSB): System state (0x00, 0x40, 0x80, 0xc0)
			State bytes of the controller module (n = 27-x to 56-x, x = 26 to 55)	0 to 65535

Example: “$N57:10” and “Total Transaction = 24” address elements 11 to 34 correspond to bytes 20 to 66 of assembly instance 57.

NOTICE Byte 67, which is not specified in assembly instance 57, is also transferred.

NOTICE The position of the word data with system state and system mode are dependent on the requested amount of data “x”.

8.4.7.6 Read protected logic input with two address fields

The SP-COP2-ENI module supports “Read SLC-protected logic input” according to the following table:

Table 59: Request data structure for Read SLC-protected logic input with two address fields

Name	Data type	Description	Data range
Byte size	USINT	Number of data bytes to be read	Assembly instance 37: 0 to 50 Assembly instance 57: 0 to 67 Assembly instance 167: 0 to 112
File number	USINT	Assembly instance ID	37, 57, 167
File type	USINT	Data type	0x89 = Integer data
Element number	USINT	Offset = ID of the first element of the answer	Assembly instance 37: 0 to 24 – Size/2 Assembly instance 57: 0 to 33 – Size/2 Assembly instance 167: 0 to 55 – Size/2

Table 60: Feedback to the SP-COP2-ENI module for Read SLC-protected logic input with two address fields

Name	Data type	Description	Data range
Payload	UINT[n]	2 · n = Number of data bytes	0 to 65535

8.4.7.7 Write protected logic input with two address fields

The SP-COP2-ENI module supports “Write SLC-protected logic input” according to the following table:

No support is required for assembly instances 138 to 141. The offset, i.e. the first byte, is instead specified by the **element number**.

Table 61: Request data structure for Write SLC-protected logic input with two address fields

Name	Data type	Description	Data range
Byte size	USINT	Number of data bytes to be written	0 to 50
File number	USINT	Assembly instance ID	37
File type	USINT	Data type	0x89 = Integer data
Element number	USINT	Offset = ID of the first element to be sent back	0 to 24 – Size/2
Payload	UINT[n]	n = Size/2	0 to 65535

8.4.7.8 Read protected logic input with three address fields

The SP-COP2-ENI module supports “Read SLC-protected logic input” according to the following table:

Table 62: Request data structure for Read SLC-protected logic input with three address fields

Name	Data type	Description	Data range
Size	USINT	Number of data bytes to be read	Assembly instance 37: 0 to 50 Assembly instance 57: 0 to 67 Assembly instance 167: 0 to 112
File number	USINT	Assembly instance ID	37, 57, 167
File type	USINT	Data type	0x89 = Integer data
Element number	USINT	Offset = ID of the first element of the answer	Assembly instance 37: 0 to 24 – Size/2 Assembly instance 57: 0 to 33 – Size/2 Assembly instance 167: 0 to 55 – Size/2
Subelement	USINT	Doesn’t matter	0 to 254 (for number of bytes 1)

8.4.7.9 Write protected logic input with three address fields

The SP-COP2-ENI module supports “Write SLC-protected logic input” according to the following table:

Table 63: Request data structure for Write SLC-protected logic input with three address fields

Name	Data type	Description	Data range
Size	USINT	Number of data bytes to be written	0 to 50
File number	USINT	Assembly instance ID	37
File type	USINT	Data type	0x89 = Integer data
Element number	USINT	Offset = ID of the first element of the answer	0 to 25 – Size/2

Name	Data type	Description	Data range
Subelement	USINT	Doesn't matter	0 to 254 (for number of bytes 1)
Payload	UINT[n]	n = Size/2	0 to 65535

8.4.8 Vendor object

The vendor object with class ID = 0x78 provides CRC, status and diagnostic data which are not covered by device profile **General purpose discrete I/O device**. Furthermore, it provides an interface to input and output data in a compressed format that therefore reduces network traffic.

Note that several instances have different attribute types and numbers. Several data items are packed together into this vendor object class for legacy reasons.

8.4.8.1 Instance 1

Instance 1, attributes 1 to 50, supply input bytes configured by the **output data set 1** in samos® PLAN 6. This is data transferred by the logic of the controller module to the PLC.

8.4.8.2 Instance 2

Instance 2, attribute 1, supplies the CRC of the active project file created by samos® PLAN 6. Instance 2, attributes 2 to 8 are reserved for future applications.

8.4.8.3 Instance 3

Instance 3, attributes 1 to 60 make state bytes available. The descriptions for each bit are listed in the table *State bytes of the controller module SP-COP2 [ch. 8.4.8.7, p. 99]*. This data corresponds to **data set 3**, which is described at various points in this document.

A value = 1 for bits in instance 3, attributes 1 to 60, stands for "OK"/"Not used"/"Reserved". A value = 0 stands for "Fault" or "Error" or "Outside the limit". "Doesn't matter" means that the value can be equal to 0 or 1.

"EA module at Pos. n" with n = 1 .. 12 stands for the first to twelfth safe or unsafe expansion module.

8.4.8.4 Instance 4

Instance 4, attributes 1 to 60 are reserved for future applications. Values are zero and changes are reserved.

8.4.8.5 Instance 5

Attribute 1 of instance 5 makes the system state/mode of the controller module available. The values are listed in the following table:

Table 64: System state/modes of the SP-COP2-ENI module

System state/mode	Value
Supply voltage A1/2 available	0
Initialization	1
Configuration / project file required	2
Configuration running / project file being downloaded	3
Idle	4
Run	5
Critical error	7
Force mode	21

8.4.8.6 Instance 6

Attribute 1 of instance 6 makes the error code of the most recent error of the controller module available. A value = 0 means that no error has occurred. Attribute 2 supplies the error code of the previous error, etc., up to and including attribute 5.

8.4.8.7 Instance 7

Attributes 1 to 50 of instance 7 represent the **input data blocks 1 to 5** in samos® PLAN 6. They represent the data transferred by the PLC to the logic of the controller module.

Attributes 1 to 50 of instance 7 possess the same data as assembly instance 37, byte 0 to 49.

NOTICE You can find an explanation of the technical terms used below here: *Abbreviations and definitions [ch. 1.5, p. 9]*

Table 65: Overview of the vendor-specific object (Wieland Electric, 0x78), supported by the SP-COP2-ENI module

Class	Instance	Attribute	Access	Data type	Description	Data range
120	0 = Class	1	Read	UINT	Revision of the class	1
120	0 = Class	2	Read	UINT	Max. instance	4
120	0 = Class	3	Read	UINT	Number of instances	4
120	0 = Class	5	Read	UINT[3]	List of optional services	{2, 0x4c, 0x4d}
120	0 = Class	6	Read	UINT	Max. class attribute ID	7
120	0 = Class	7	Read	UINT	Max. instance attribute ID	60
120	1	n+1	Read	USINT	The input byte "n", configured by the **output data set 1** in samos® PLAN 6, stands for the data transferred by the logic of the controller module to the PLC. n = 0 to 49.	0 to 255
120	2	1	Read	UDINT	Project file CRC (data set 2)	0 to 2^{32}-1
120	2	2 to 8	Read	UDINT	Reserved (data set 2)	0
120	3	n+1	Read	BYTE	State byte “n” of the controller module, for which n = 0 to 59	0 to 255
120	4	n+1	Read	BYTE	Additional byte “n” of the controller module, for which n = 0 to 59	0
120	5	1	Read	USINT	SP-COP2-ENI System mode (*See [ch. 8.4.8.5, p. 97]*)	1, 2, 3, 4, 5, 7, 21
120	6	n	Read	UDINT	Error code in the controller module, with n = 1 for the most recently occurred error, n = 2 for the previous error, etc., with n = 1 to 5	0 to 2^{32}-1
120	6	1	Write	UDINT	Clear error list in instance 6	0
120	7	n+1	Write, read	BYTE	Output bit “n”, which is configured by the **input data blocks 1 to 5** in samos® PLAN 6, stands for the data transferred by the PLC to the logic of the controller module. n = 0 to 49.	0 to 255

Table 66: State bytes of the controller module SP-COP2

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Controller module State, voltage B2	Controller module Collective error fast shut-off	Controller module State, voltage B1	Controller module Configuration state	Controller module State, voltage A1/2	Controller module External module state	Controller module Internal module state	Reserved
1	Controller module Output data state	Controller module Input data state	Reserved	Reserved	Controller module IQ3+IQ4 overcurrent	Controller module IQ1+IQ2 overcurrent	Controller module Q3+Q4 overcurrent	Controller module Q1+Q2 overcurrent
2	Controller module I8 Test pulse error	Controller module I7 Test pulse error	Controller module I6 Test pulse error	Controller module I5 Test pulse error	Controller module I4 Test pulse error	Controller module I3 Test pulse error	Controller module I2 Test pulse error	Controller module I1 Test pulse error
3	Controller module I16 Test pulse error or HW limit frequency I16	Controller module I15 Test pulse error or HW limit frequency I15	Controller module I14 Test pulse error or HW limit frequency I14	Controller module I13 Test pulse error or HW limit frequency I13	Controller module I12 Test pulse error	Controller module I11 Test pulse error	Controller module I10 Test pulse error	Controller module I9 Test pulse error
4	Cable break at I16	Cable break at I15	Cable break at I14	Cable break at I13	Controller module IQ4 (input) Test pulse error	Controller module IQ3 (input) Test pulse error	Controller module IQ2 (input) Test pulse error	Controller module IQ1 (input) Test pulse error
5	Controller module I15/I16 Dual channel state	Controller module I13/I14 Dual channel state	Controller module I11/I12 Dual channel state	Controller module I9/I10 Dual channel state	Controller module I7/I8 Dual channel state	Controller module I5/I6 Dual channel state	Controller module I3/I4 Dual channel state	Controller module I1/I2 Dual channel state
6	Inversion error I14 vs. I16	Inversion error I13 vs. I15	Frequency difference I14 vs. I16	Frequency difference I13 vs. I15	Phase difference I14 vs. I16 too low	Phase difference I13 vs. I15 too low	Controller module IQ3/IQ4 Dual channel state	Controller module IQ1/IQ2 Dual channel state
7	I16 Stuck at low	I16 Stuck at high	I15 Stuck at low	I15 Stuck at high	I14 Stuck at low	I14 Stuck at high	I13 Stuck at low	I13 Stuck at high
8	Controller module Q4 Stuck at low	Controller module Q4 Stuck at high	Controller module Q3 Stuck at low	Controller module Q3 Stuck at high	Controller module Q2 Stuck at low	Controller module Q2 Stuck at high	Controller module Q1 Stuck at low	Controller module Q1 Stuck at high
9	Controller module IQ4 (output) Stuck at low	Controller module IQ4 (output) Stuck at high	Controller module IQ3 (output) Stuck at low	Controller module IQ3 (output) Stuck at high	Controller module IQ2 (output) Stuck at low	Controller module IQ2 (output) Stuck at high	Controller module IQ1 (output) Stuck at low	Controller module IQ1 (output) Stuck at high

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
10	Reserved	1. Gateway module Output data state	1. Gateway module Input data state	1. Gateway module Configuration state	Doesn't matter	Reserved	1. Gateway module Internal module state	Doesn't matter
11	Reserved	2. Gateway module Output data state	2. Gateway module Input data state	2. Gateway module Configuration state	Doesn't matter	Reserved	2. Gateway module Internal module state	Doesn't matter
8 + 4·n	Reserved	IO module at pos. n Collective error fast shut-off	IO module at pos. n State, voltage A1/2 (power supply for Q1 to Q4)	IO module at pos. n Configuration state	Doesn't matter	IO module at pos. n External module state	IO module at pos. n Internal module state	Doesn't matter
9 + 4·n	IO module at pos. n Output data state	IO module at pos. n Input data state	Reserved	Reserved	IO module at pos. n I7/I8 Dual channel state	IO module at pos. n I5/I6 Dual channel state	IO module at pos. n I3/I4 Dual channel state	IO module at pos. n I2/I1 Dual channel state
10 + 4·n	IO module at pos. n I8 test pulse error	IO module at pos. n I7 test pulse error	IO module at pos. n I6 test pulse error	IO module at pos. n I5 test pulse error	IO module at pos. n I4 test pulse error	IO module at pos. n I3 test pulse error	IO module at pos. n I2 test pulse error	IO module at pos. n I1 test pulse error
11 + 4·n	IO module at pos. n Q4 Stuck-at low	IO module at pos. n Q4 Stuck-at high	IO module at pos. n Q3 Stuck-at low	IO module at pos. n Q3 Stuck-at high	IO module at pos. n Q2 Stuck-at low	IO module at pos. n Q2 Stuck-at high	IO module at pos. n Q1 Stuck-at low	IO module at pos. n Q1 Stuck-at high

8.5 Supported assembly data

Assemblies are collections of data attributes and are optimized for high performance and a low telegram overhead. The SP-COP2-ENI module supports a series of predefined, static assembly instances for input and output data. Access is possible via various instances of the CIP assembly object. In addition, access is possible both via the implicit and explicit message transmission. The assembly size is variable. It is thus possible to request parts of an assembly. The following table (*Overview of assembly databytes of the SP-COP2-ENI module [ch. 8.5.1, p. 100]*) offers an overview of the supported assembly instances and the meaning of the transmitted data.

8.5.1 List of assembly data

Table 67: Overview of assembly databytes of the SP-COP2-ENI module

Instance	Byte	Access	Data type	Description	Size	Data range
37	0 to 49	Write, read	BYTE[50]	Logic output bytes, configuration via **Input data block 1 to 5** in samos® PLAN 6 (*see [ch. 8.5.2, p. 102]*)	1 to 50 Bytes	0 to 0xff
138	10 to 49	Write, read	BYTE[40]	Logic output bytes, configuration via **Input data block 2 to 5** in samos® PLAN 6 (*see [ch. 8.5.2, p. 102]*)	1 to 40 Bytes	0 to 0xff

Instance	Byte	Access	Data type	Description	Size	Data range
139	20 to 49	Write, read	BYTE[30]	Logic output bytes, configuration via **Input data block 3 to 5** in samos® PLAN 6 (*see [ch. 8.5.2, p. 102]*)	1 to 30 Bytes	0 to 0xff
140	30 to 49	Write, read	BYTE[20]	Logic output bytes, configuration via **Input data block 4 and 5** in samos® PLAN 6 (*see [ch. 8.5.2, p. 102]*)	1 to 20 Bytes	0 to 0xff
141	40 to 49	Write, read	BYTE[10]	Logic output bytes, configuration via **Input data block 5** in samos® PLAN 6 (*see [ch. 8.5.2, p. 102]*)	1 to 10 Bytes	0 to 0xff
57	0 to 49	Read	BYTE[50]	Logic output bytes, configuration via **Output data block 1** in samos® PLAN 6 (*see [ch. 8.5.3, p. 103]*)	1 to 50 Bytes	0 to 0xff
	50 to 65	Read	BYTE[16]	Values of the input terminals Ix	1 to 16 Bytes	0 to 0xff
	66	Read	BYTE	Input and output state	1 bytes	0x00, 0x40, 0x80, 0xc0
167	0 to 49	Read	BYTE[50]	Logic output bytes, configuration via **Output data block 1** in samos® PLAN 6 (*see [ch. 8.5.3, p. 103]*)	1 to 50 Bytes	0 to 0xff
	50	Read	BYTE	Bit 7: Input state Bit 6: Output state Bit 5: Error code ≠ 0	1 bytes	0x00, 0x40, 0x80, 0xc0
	51	Read	BYTE	System mode	1 bytes	1, 2, 3, 4, 5, 7, 21
	52 to 111	Read	BYTE[60]	State bytes of the controller module (*Instance 3 of class 120 [ch. 8.4.8.3, p. 97]*), **output data set 3** (*see [ch. 8.5.3, p. 103]*)	60 bytes	0 to 0xff

The data type of supported assemblies is BYTE, which means strings of 8 bits each. The naming in Logix Designer is SINT, which has the same size of 8 bits each.

If the PLC requires a configuration assembly, any value or even no value can be used for the **assembly instance**. The **size** of the configuration assembly must be zero.

The assembly instances for **Input** and **Output** are listed in Table "*Overview of assembly data bytes from the module [ch. 8.5.1, p. 100]*". These settings can be used in generic EtherNet module configuration in Logix Designer (see illustration below).

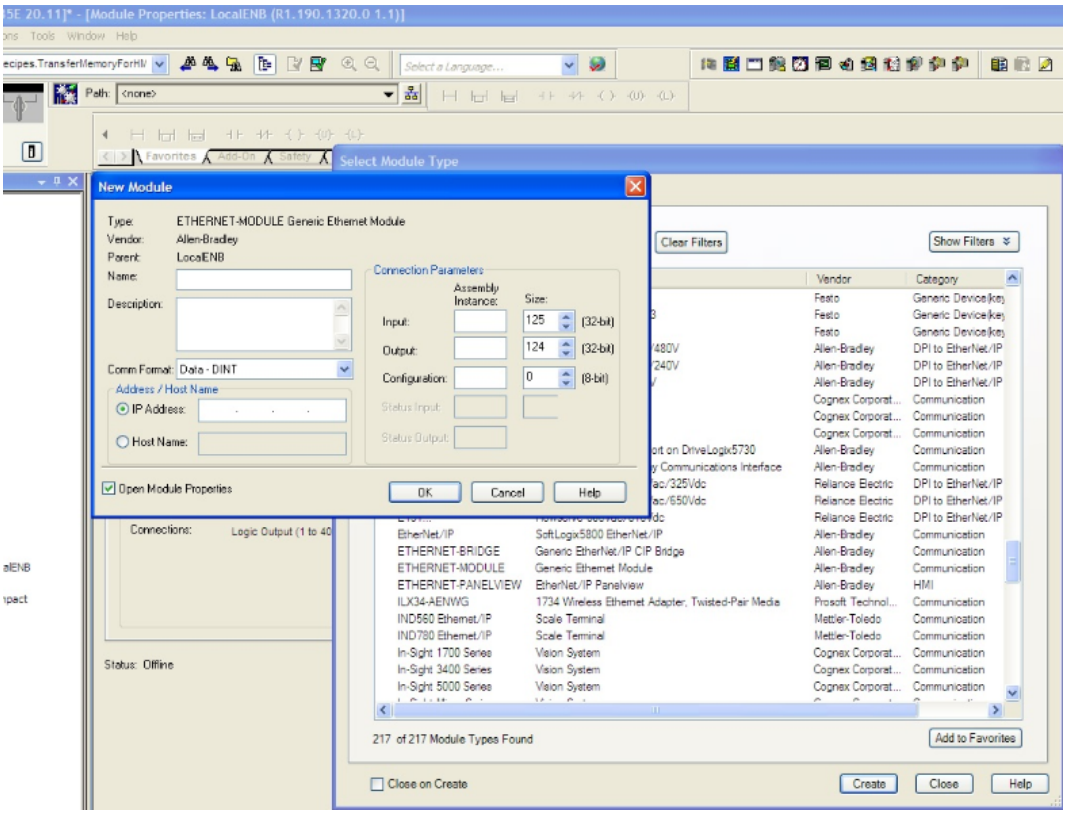


Illustration 25: Generic EtherNet module configuration

8.5.2 Assembly instances for logic output bytes

8.5.2.1 Assembly instance 37 = 0x25

Assembly instance 37 belongs to the device profile **discrete universal I/O device.** It contains output data (O→T) with a scope of up to 50 bytes.

Assembly instance 37 corresponds to **input data block 1 to 5** of the logic data of the SP-COP2-ENI module with a total scope of 50 bytes.

8.5.2.2 Assembly instances 138 = 0x8a to 141 = 0x8d

Assembly instances 138 to 141 are provided to make more than one output data connection available. In Class 1 connections, output data from the PLC to the controller module can only be sent using “Exclusive Owner” rights. If, for example, a PLC “possesses” the assembly instance 138, then it “possesses” the output bytes 10 to 49. By contrast, output bytes 0 to 9 are freely available and can be used by another PLC (O→T).

In a further example, the first PLC “possesses” 10 output bytes of the assembly instance 37, whilst the second PLC “possesses” 10 output bytes of assembly instance 138 and the third assembly instance 139 with 30 output bytes. Here, three PLCs possess “Exclusive Owner” connections with output data. In total, up to five PLCs can share the output data range, each with 10 bytes.

Assembly instance 138 comprises data with a scope of up to 40 bytes, assembly instance 139 comprises data with a scope of up to 30 bytes, assembly instance 140 comprises data with a scope of up to 20 bytes and assembly instance 141 comprises data with a scope of up to 10 bytes.

The first byte of assembly instance 138 is the eleventh byte of the logic data of the SP-COP2-ENI module. In samos® PLAN 6, it has the designation **input data block 2**. The first byte of assembly instance 139 is 21. Byte of the logic data of module SP-COP2-ENI. In samos® PLAN 6, it has the designation **input data block 3**. The first byte of assembly instance 140 is 31. Byte of the logic data of module SP-COP2-ENI. In samos® PLAN 6, it has the designation **input data block 4**. The first byte of assembly instance 141 is 41. Byte of the logic data of module SP-COP2-ENI. In samos® PLAN 6, it has the designation **input data block 5**.

Write requests are refused if the assembly is already used by an active I/O connection.

8.5.3 Assembly instances for logic input bytes

8.5.3.1 Assembly instance 57 = 0x39

Assembly instance 57 belongs to the device profile **discrete universal I/O device.** It contains output data (T→O) with a scope of up to 67 bytes.

The first 50 bytes of assembly instance 57 correspond to the **output data set 1** of the logic data of the SP-COP2-ENI module. The following table explains the meaning of bytes 50 to 66: *Data of the class 1 connection “Logic output (1 to 400) and logic/physical input” [ch. 8.3.1, p. 81]*

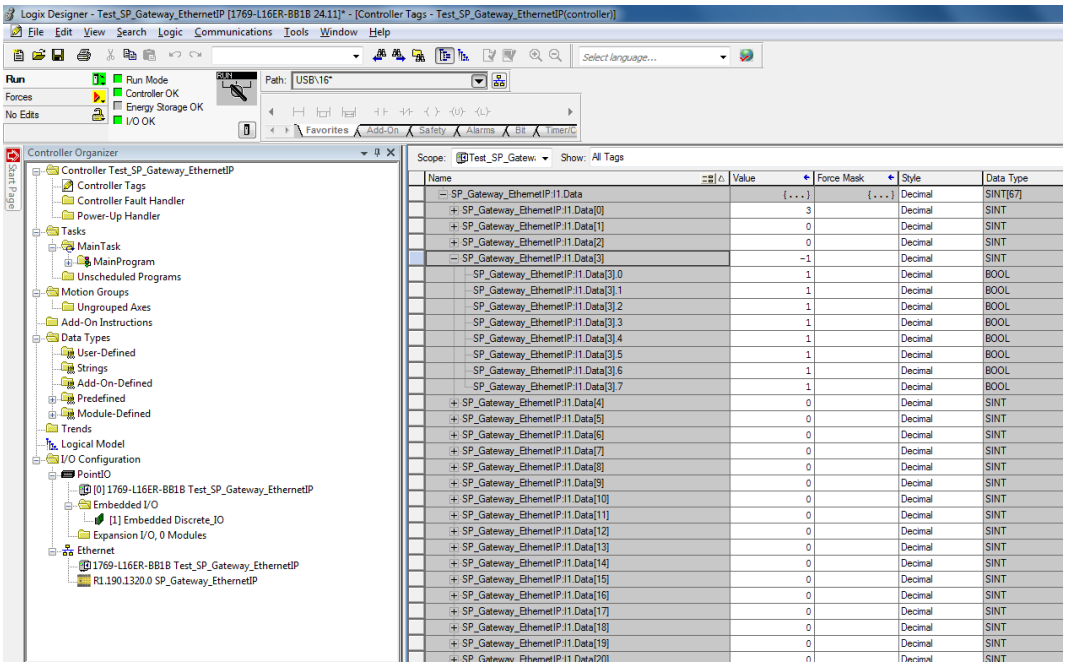


Illustration 26: Example of the display of assembly instance 57 in the Logix Designer

8.5.3.2 Assembly instance 167 = 0xa7

Assembly instance 167 possesses a different data structure to instance 57. Instance 167 makes the data available in the samos® PRO system in more detail.

Assembly instance 167 in the samos® PRO system comprises data (T→O) with a scope of up to 112 bytes.

8.5.3.2.1 Bytes 0 to 49

Assembly instance 167 corresponds to **output data block 1 to 5** of the logic data of the SP-COP2-ENI module with a total scope of 50 bytes.

Here, attributes 1 to 50 are represented as with instance 57.

8.5.3.2.2 Byte 50

Bit 7 of byte 50 of assembly instance 167 has the same value as class 29 instance 1 attribute 5, which represents the group status of all input terminals.

Bit 6 of byte 50 of assembly instance 167 has the same value as class 30 instance 1 attribute 5, which represents the group status of all output terminals.

Bit 5 of byte 50 of assembly instance 167 indicates that an error code is pending in class 120 instance 6 attribute 1.

Bits 0 to 4 of byte 50 of assembly instance 167 are reserved for future use.

8.5.3.2.3 Byte 51

Byte 51 of assembly instance 167 supplies the system mode of the controller modules. It shows the same value as attribute 1 of instance 5 in class 120.

8.5.3.2.4 Bytes 52 to 111

Bytes 52 to 111 of assembly instance 167 make the corresponding state bytes of the controller mode available. They show the same value as attributes 1 to 60 of instance 3 in class 120.

8.6 Access to CIP objects

8.6.1 Explicit messaging

Explicit message transmission uses the TCP/IP protocol as well as an EtherNet/IP-specific encapsulation layer. Explicit message transmission can be connection-free (UCMM) and connected, e.g. session-based. The latter is termed **Class 3 Messaging**. Both UCMM and Class 3 use an EPATH to address the required data. An EPATH is made up of the service, class, instance and attribute ID.

With explicit message transmission, each attribute of the following objects can be accessed:

- *Identity class (0x01) [ch. 8.4.1, p. 86]*
- *Assembly class (0x04) [ch. 8.4.2, p. 87]*
- *Discrete input point object (0x08) [ch. 8.4.3, p. 88]*
- *Discrete output point object [ch. 8.4.4, p. 90]*
- *Discrete input group object (0x1D) [ch. 8.4.5, p. 90]*
- *Discrete output group object (0x1D) [ch. 8.4.6, p. 91]*
- *Vendor-specific object (0x78) [ch. 8.4.8.7, p. 98]*

Each request must possess a valid EPATH referring to the required object/attribute. The appropriate attribute can be read using the GetAttributeSingle service, if it is labeled as **Read** in these tables. The appropriate attribute can be written using the SetAttributeSingle service, if it is labeled as **Write** in these tables.

8.6.2 Implicit messaging

Implicit message transmission uses EtherNet/IP, the UDP/IP protocol as well as an EtherNet/IP-specific encapsulation layer. Implicit message transmission is also termed **Transport Class 1**. The PLC can set up a Class 1 connection with the SP-COP2-ENI module, by placing the service request **Forward_Open** with it. This configures connection information for the exchange of input/output data, e.g. the RPI unicast or multicast connections, amongst other things. Class 1 connections only support assemblies for the exchange of input/output data or “wild cards” to signal data-free heartbeat connections. Configuration assemblies are accepted as part of the Forward_Open-Service, with the exception of TCP/IP objects (Class 0xF5), although are not processed by the SP-COP2-ENI module.

As the configuration details of the connection are only sent once in the Forward_Open-Frame, implicit message transmission is aligned to performance and has a lower telegram overhead than explicit message transmission. Assembly instances possess predefined attributes in a specific order. Nonetheless, the sender, i.e. the PLC; specifies the data size in Forward_Open during the setup of the Class 1 connection. This means that only data byte from the beginning of the instance up to the specified size are exchanged.

The SP-COP2-ENI module supports seven static assembly instances. These are listed in the table *Overview of the assembly class (0x04) supported by the SP-COP2-ENI module [ch. 8.4.2, p. 87]*. All data members of the instance has fixed coding. Dynamic assembly instances are not currently supported by the SP-COP2-ENI module.

An I/O assembly contains either input or output data, but not both at the same time. The following figure shows the data flow when multiple assembly instances are used. Predefined assemblies are interconnected by blue lines, vendor-specific assemblies by black lines. The controller module is shown as a hatched rectangle.

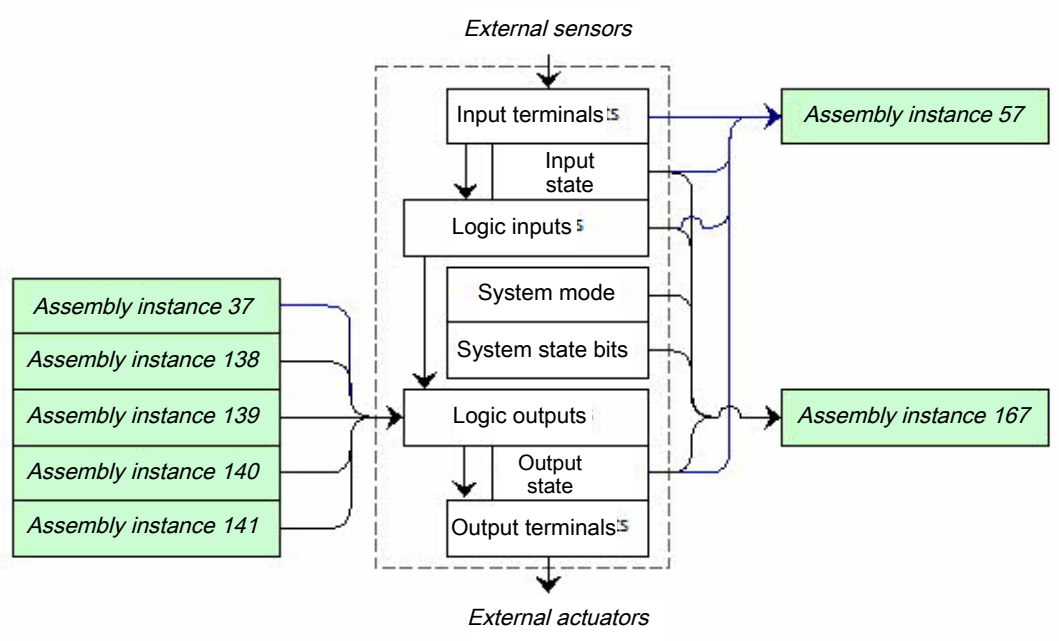


Illustration 27: Data flow when using assembly instances of the SP-COP2-ENI module

8.6.3 Symbolic addressing

In addition to the addressing of assembly instances, symbolic addressing by name is also possible by selecting connections.

In samos® PLAN 6, tag names can be changed in the **Gateway configuration** tab.

Device functionality

Output data (to PLC):

Dataset	Byte	Tag/File-Name	Assembly Instance	Byte
1	0..49	OutDataSet1	57	0..66
2	0..31	OutDataSet2	-	-
3	0..59	OutDataSet3	167	0..111
4	0..59	OutDataSet4	-	-

Input data (from PLC):

Data block	Byte	Tag/File-Name	Assembly Instance	Byte
1	0..9	InDataSet1	37	0..49
2	10..19	InDataSet2	138	10..49
3	20..29	InDataSet3	139	20..49
4	30..39	InDataSet4	140	30..49
5	40..49	InDataSet5	141	40..49

Illustration 28: Configuration of symbolic names for assemblies in samos® PLAN 6

NOTICE

The functions of the UCMM Message Client (unconnected), which can also be configured in samos® PLAN 6, are not available in the module version D-01.01.

8.7 Optimizing performance

A configuration of the number of process data bytes exactly matching the application helps to reduce the volume of periodically exchanged data bytes.

The PLC specifies the number of output bytes in the form of specific Forward_Open Service data as **Connection Size** for O→T. The PLC should set the **Fixed/Variable** bit to 1, meaning **variable**.

The PLC also specifies the number of input bytes. The controller module cyclically transfers data in the scope of the **connection size** for T→O through RPI in the value specified in Forward_Service. If the **fixed/variable** bit is set by the PLC, meaning **variable**, then not all the assembly bytes must be transmitted.

8.8 Connection with more than one PLC

The EtherNet/IP function of the SP-COP2-ENI module allows access by more than one PLC. Up to five encapsulation sessions with input and output data can be set up simultaneously.

If only reading of the process data of the SP-COP2-ENI module is required, “Input only” or “Listen only” connections can also be used. Note that a “Listen only” connection is closed automatically by the SP-COP2-ENI module when the owner, who has set up the “Exclusive” or “Input Only” connection, terminates the connection.

If process data from multiple PLCs are to be transmitted to the SP-COP2-ENI module, the other PLCs can access the assembly instances 138 to 141 for Class 1 connections. Class 3 connections can be set up in parallel, provided that there is no conflict with regard to the owner. Please see the following for more information: *List of assembly data [ch. 8.5.1, p. 100]*

8.9 Troubleshooting and eliminating errors

8.9.1 Notifications via the network

8.9.1.1 Explicit messaging connection

The device status is available by reading class 1, instance 1, attribute 5. Vendor-specific interface for alarms and diagnostic functions for explicit message connections is defined as follows:

The presence of an alarm can be checked by reading class 29, instance 1, attribute 5 and class 30, instance 1, attribute 5. The module mode (**Run** or another state) has to be checked, because the alarm bit is always set to 0 = OK every time the module is not in **Run** mode.

The module mode can be detected by reading class 120 instance 5 attribute 1.

The presence of diagnostic events can be checked by reading class 120 instance 6 attribute 1.

Detailed reasons for process alarms and system diagnostic events can be identified by reading all 60 attributes of class 210 instance 3, which contains the dedicated system status bytes.

8.9.1.2 Implicit messaging connection

If assembly instance 57 is used, bit 6 and 7 of byte 66 signal a process alarm.

If assembly instance 167 is used, bit 6 and 7 of byte 66 signal a process alarm. Bit 5 signals diagnostic events or process alarms when set.

Event details can be queried through explicit message requests, as described here: *Explicit messaging [ch. 8.6.1, p. 104]*

8.9.2 LED states

8.9.2.1 MS (module status)

The SP-COP2-ENI module possesses a two-color (red/green) LED with the designation **MS**. This is the **Module Status Indicator**.

The Module Status Indicator is *dark*, if no power supply is connected. It *flashes green* if the device has not been configured. It *turns green* if the device is running correctly. It *flashes green/red* if the device is performing a switch-on test.

The Module Status Indicator *flashes red* if EtherNet/IP is activated and the device has detected a serious, eliminable error. A faulty project file or one which does not match the hardware is classified as a serious, eliminable error. The display *turns red* if EtherNet/IP is activated and the device has detected a serious, non-eliminable error and there is a **Critical Fault**.

Table 68: MS-LED state (Selection)

Project file	System mode	Ext. Error	MS-LED state
Doesn't matter	Switch on	Doesn't matter	Green -> Red
Deleted	Init	Doesn't matter	Flashing green
Invalid	Init	Doesn't matter	Flashing red
Valid	Idle mode	Doesn't matter	Flashing green
Valid	Run	No	Turns green
Valid	Run	Yes	Turns green/red or flashes red
Valid	Critical error	Doesn't matter	Turns red

8.9.2.2 NET (network status)

The SP-COP2-ENI module possesses a two-color (red/green) LED with the designation **NET**. This is the **Network Status Indicator**.

Table 69: Meaning of the NET LED (used as EtherNet/IP gateway)

NET LED	Meaning / reason
LED off	• Power supply not connected. or • Power supply connected but IP address not configured.
Green (1 Hz)	EtherNet/IP has been activated and an IP address has been configured but there is no CIP connection and an "Exclusive Owner" connection has not yet shown a time-out.
Green	An IP address has been configured, there is at least one CIP connection (of any transport class) and an "Exclusive Owner" connection has not yet shown a time-out.
/ Red/green	During power-on test
Red	EtherNet/IP has been activated, an IP address has been configured and an "Exclusive Owner" connection, for which the device is the target device, has shown a time-out.

The Network Status Indicator is *dark* if no power supply is connected or a power supply is connected but no IP address is configured (interface configuration attribute of the TCP/IP interface object). It *flashes green* if EtherNet/IP is activated and an IP address has been configured but no CIP connection is available and an "Exclusive Owner" connection has not yet shown a time-out. It *turns green* if an IP address has been configured, there is at least one CIP connection (of any transport class) and an "Exclusive Owner" connection has not yet shown a time-out. It *flashes green/red* if the device is performing a switch-on test.

The Network Status Indicator *flashes red* if EtherNet/IP is activated, an IP address has been configured and an "Exclusive Owner" connection, for which the device is the target device, has shown a time-out. The Network Status Indicator only turns green again when all the expired "Exclusive Owner" connections have been restored. The Network Status Indicator switches from flashing red to

being lit in green if all the connections of the previously expired O->T connection points have been restored. Time-outs in other connections than the "Exclusive Owner" connections do not result in the indicator flashing red. The “flashing red” state only applies to connections with the target device. PLCs and CIP routers do not instigate a transition to this state if a created or routed connection shows a time-out.

Table 70: Troubleshooting on the SP-COP2-ENI module (use as EtherNet/IP gateway)

Error		Possible cause	Possible remedy
Key: ○ LED off / ✳ LED flashes / ● LED lights up			
The SP-COP2-ENI module does not provide any data.		• The SP-COP2-ENI has been configured for data transmission to the PLC, but no Ethernet communication has been established or the communication is faulty. • Duplicate IP address detected. Another network device has the same IP address. • Incorrectly formatted PROFINET device name	• PROFINET IO must be activated in the project file. At least one Ethernet link must be established. Check the Ethernet wiring, check the Ethernet settings in the PLC and in samos® PLAN 6. • Correct the IP address and switch the system off and on again. • Compare the device name between the PROFINET master and the SP-COP2-ENI module.
LED PWR/EC	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		
MS LED	● Green		
The SP-COP2-ENI module does not provide any data.		• Configuration required. • The configuration has not yet been fully transmitted. • The module version does not support any PROFINET IO.	• Configure the SP-COP2-ENI module with a project file in which PROFINET IO is activated and transfer the configuration to the SP-COP2-ENI module. • Use an SP-COP2-ENI device starting with module version B-xx.
LED PWR/EC	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		
MS LED	✳ / ✳ Red/green		
The SP-COP2-ENI module does not provide any data.		• The samos® PRO system is in the stop state.	• Start the controller module (switch to Run mode).
LED PWR	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		
MS LED	✳ Green (1 Hz)		
The SP-COP2-ENI module does not provide any data.		• The IP address for the SP-COP2-ENI module is assigned by a DHCP server. Following a restart of the SP-COP2-ENI module or the DHCP server, another address was allocated to the SP-COP2-ENI module, which is unknown to the PLC.	• Either assign a permanent IP address to the SP-COP2-ENI module or reserve a permanent IP address for the SP-COP2-ENI module in the DHCP server (manual assignment using the MAC address of the SP-COP2-ENI module).
LED PWR/EC	● Green		
LED LINK	● Green		
LED /ACT	✳ Yellow		
MS LED	● Green		

Error	Possible cause	Possible remedy
The SP-COP2-ENI / the samos® PRO system is in the “Critical error” state.	• The SP-COP2-ENI module is not properly connected to the samos® PRO modules. • The module connection plug is dirty or damaged. • Another samos® PRO module has an internal critical error.	• Insert the I/O module correctly. Clean the connection plug and socket. • Switch on the power supply again. • Check the other samos® PRO modules.

8.9.2.3 LINK

The SP-COP2-ENI module possesses a green LED with the designation **LINK**. If there is no Ethernet connection, it stays dark. If there is a connection, it switches on.

8.9.2.4 ACT (activity status)

The SP-COP2-ENI module possesses a green LED with the designation **ACT**. If no port activity can be detected, it stays dark. If port activity is detected, it switches on.

8.9.3 Diagnostic functions in the configuration software

Additional diagnostic functions are available on the SD card using a log file with the name history.csv. In addition, the last entries are available in samos® PLAN 6 in the **Diagnostics** view. The timestamp in the **Local time** column provides information about how long the device has been switched on in total.

Diagnostics ×

Message	Message ID	Timestamp	Description	Source	Local time
Kommunikationsfehler (Ethernet/USB)	0x6A060000	14:05:26:13	MFS NO ERROR	Basismodul	
Kommunikationsfehler (Ethernet/USB)	0x6A0C01F4	14:05:26:13	500	Basismodul	
Projektdatei gelesen	0x60000003	14:04:11:10		Basismodul	
Base-Module	0x2B08220D	14:04:09:52	(0000220D)	Base-Module	
Base-Module	0x22010226	14:04:09:52	(00000226)	Base-Module	
Communication Error (Ethernet/USB)	0x6A0B0023	14:04:09:52	35	Base-Module	
Communication Error (Ethernet/USB)	0x6A0B3101	14:04:09:52	49 1	Base-Module	
Project read	0x60000003	14:04:09:51		Base-Module	

Synchronize time

With the safety controller connected you can synchronize the time on the safety controller with the time on the connected diagnostics computer. Even if you disconnect the connection to the controller, the **Diagnostics** view remains active, as long as the associated samos® PLAN 6 project is open.

NOTICE

Instructions in software manual

You can find step-by-step instructions on how to synchronize the time here:

Software manual, chapter "Synchronize time for diagnostic purposes"

8.10 Status bits

The EtherNet/IP gateway SP-EN-IP sets state bits, which are available in the logic editor of samos® PLAN 6 for processing.

Table 71: Meaning of the state bits SP-EN-IP[0] in the logic editor

Name of the state bits	Set to 1, if ...	Reset to 0 ...
Output status	... a GetAttribute command was processed successfully, or ... data of transport class 1 were sent to a PLC without errors.	... if a connection of transport class 1 (implicit connection) was terminated and no further connection exists.
Input status	... a SetAttribute command was processed successfully, or ... data of transport class 1 received without error (consumed), whereby heartbeat data of connection point 198 from the PLC does not count	... a connection of transport class 1 (implicit connection) was terminated for one of the connection points 57, 138, 139, 140 or 141 and no further connection exists to these connection points.
Internal state	... the EtherNet/IP function of the module is ready for communication.	... the EtherNet/IP function of the module is not ready for communication.

9 PROFIBUS DP GATEWAY

The following samos® PRO gateway can be used for PROFIBUS DP:

- SP-PROFIBUS-DP

9.1 Interfaces and operation

Operating and display elements

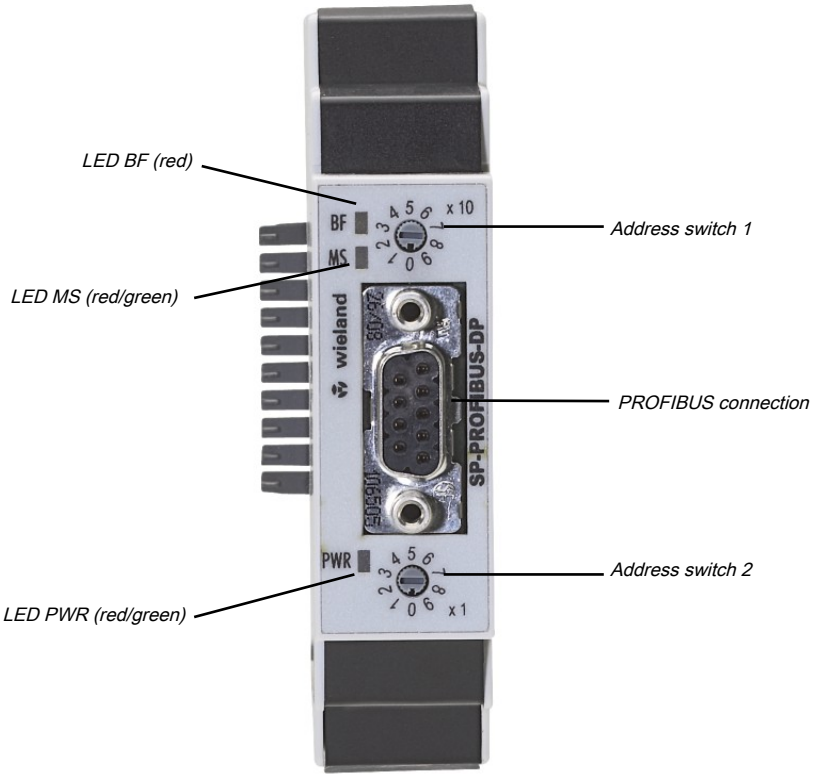


Illustration 29: Operating and display elements of the SP-PROFIBUS-DP module

Table 72: Meaning of the state LEDs on the SP-PROFIBUS-DP module

LED		Meaning
Key: ○ LED off / ✳ LED flashes / ● LED lights up		
BF	○ Off	Connection to the DP master established
	● Red	No bus connection: Field bus cabling interrupted, address error or the master is no longer transmitting to the bus
MS	○ Off	Power supply switched on, waiting for bus-off
	● Green	Run
	● Green	Stop
	✳ / ✳ Red / green	Run, but the gateway has a fault
	✳ Red	1 Hz: Configuration required or is taking place right now 2 Hz: Critical error on the gateway
	● Red	Critical error on another module

LED		Meaning
PWR	Off	No power supply
	Green	Power supply switched on, no error
	Red	Critical error

Table 73: Address switch of the SP-PROFIBUS-DP module

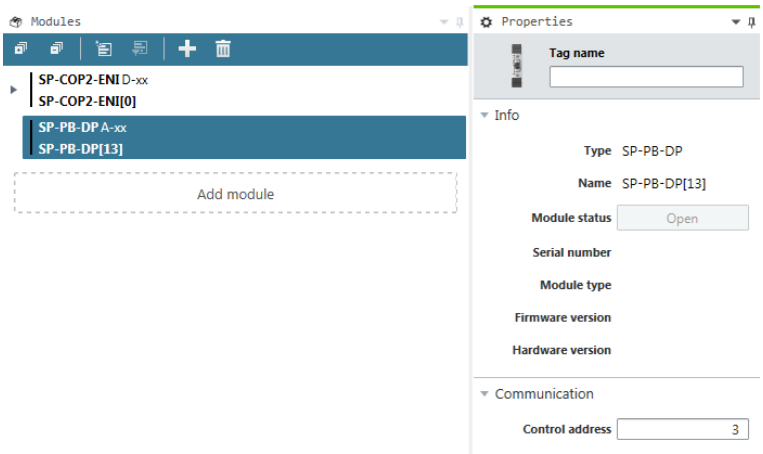
Switches	Function
× 10	Address switch 1 Rotary switch with 10 positions for setting the module address (in tens)
× 1	Address switch 2 Rotary switch with 10 positions for setting the module address (in units)

How to set the PROFIBUS-DP address with the aid of the hardware address switches:

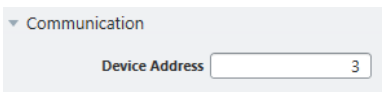
- ➡ Use the hardware address switches at the front of the system to set the PROFIBUS-DP address.
- ➡ Switch the samos® PRO system off and on again.

How to set the PROFIBUS-DP address in the software:

- ➡ Set the two hardware address switches on the front of the device to "00".
- ➡ Launch samos® PLAN 6.
- ➡ Read in the hardware configuration, including the PROFIBUS-DP gateway.
  Instructions: Software manual, chapter "Connecting to the safety controller"
- ➡ Open the **Modules** docking window and select the SP-PB-DP module.
- ➡ Also open the **Properties** docking window.
  - ⇨ You see the configuration dialog for the SP-PB-DP module.



- ➡ Enter the desired value for the **Control address** parameter under **Communication**.



NOTICE

- You can set an address within the 1 ... 99 range with the aid of the hardware address switches.
- You can set an address within the 3 ... 125 range with the aid of the samos® PLAN 6.
- The PROFIBUS master cannot overwrite the address.
- An amended address setting will only become effective once you have switched off the samos® PRO system and switched it on again.
- In the online mode, you can read out the address set at the PROFIBUS-DP gateway by clicking on the **Read** button above the **PROFIBUS address** field.

Pin assignment

Connection to the PROFIBUS-DP field bus is via a 9-pin D-sub socket.

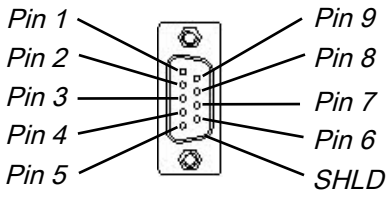


Illustration 30: Pin configuration of D-sub socket and plug for the SP-PROFIBUS-DP module

Table 74: Reference for pin configuration

Pin	Description
1	NC
2	NC
3	RxD/TxD-P
4	CNTR-P
5	GND-EXT
6	+5V-EXT
7	NC
8	RxD/TxD-N
9	CNTR-N (GND-EXT)
SHLD	Screening

Bus cable

The bus topology for PROFIBUS DP is a linear structure consisting of a screened and twisted 2-lead cable with active bus termination at both ends. The potential bus lengths range from 100 m at 12 kbit/s to 1200 m at 94 kbit/s.

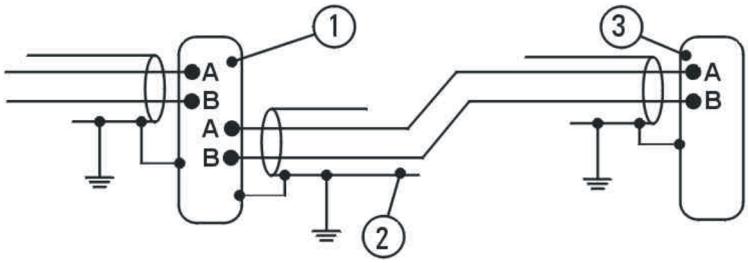


Illustration 31: Bus cable of the SP-PROFIBUS-DP module

Table 75: Reference for pin configuration

Position	Description
1	PROFIBUS user gray

Position	Description
2	Screened bus cable
3	PROFIBUS termination yellow (with integrated terminal resistances)

Line parameters

The bus cable characteristics have been defined in EN 50170 as cable type A.

Table 76: Line parameters of the SP-PROFIBUS-DP module

Characteristic	Value
Wave resistance	135-165 Ω (at a frequency of 3-20 MHz)
Capacity per length unit	< 30 pF/m
Loop resistance	≤ 110 Ω/km
Lead diameter	> 0.64 mm
Wire cross-section	> 0.34 mm^2

These cable parameters provide the following maximum physical dimensions for a bus section:

Table 77: Maximum line lengths of the SP-PROFIBUS-DP module

Baud rate (kbit/s)	Maximum cable length (m)
9.6	1200
19.2	1200
93.75	1200
187.5	1000
500	400
1500	200
12000	100

Data transmission rate

The data transmission rate is automatically set. The maximum baud rate is 12 Mbit/s.

9.2 Projecting

GSD file

Under normal circumstances, the SP-PROFIBUS-DP module is operated on a DP master that reads the device characteristics from the GSD file.

You will find the GSDML file and the equipment symbol for integration in a PLC of the product website of the SP-PROFIBUS-DP on the Internet (eshop.wieland-electric.com/de).

Process data transmitted by the SP-PROFIBUS-DP module

The GSD file of the SP-PROFIBUS-DP module provides input and output data blocks (virtual I/O device modules), which contain the process data. These 5 blocks must be projected in a natural sequence (1, 2, 3, 4, 5) in a DP configurator. No other sequence is possible.

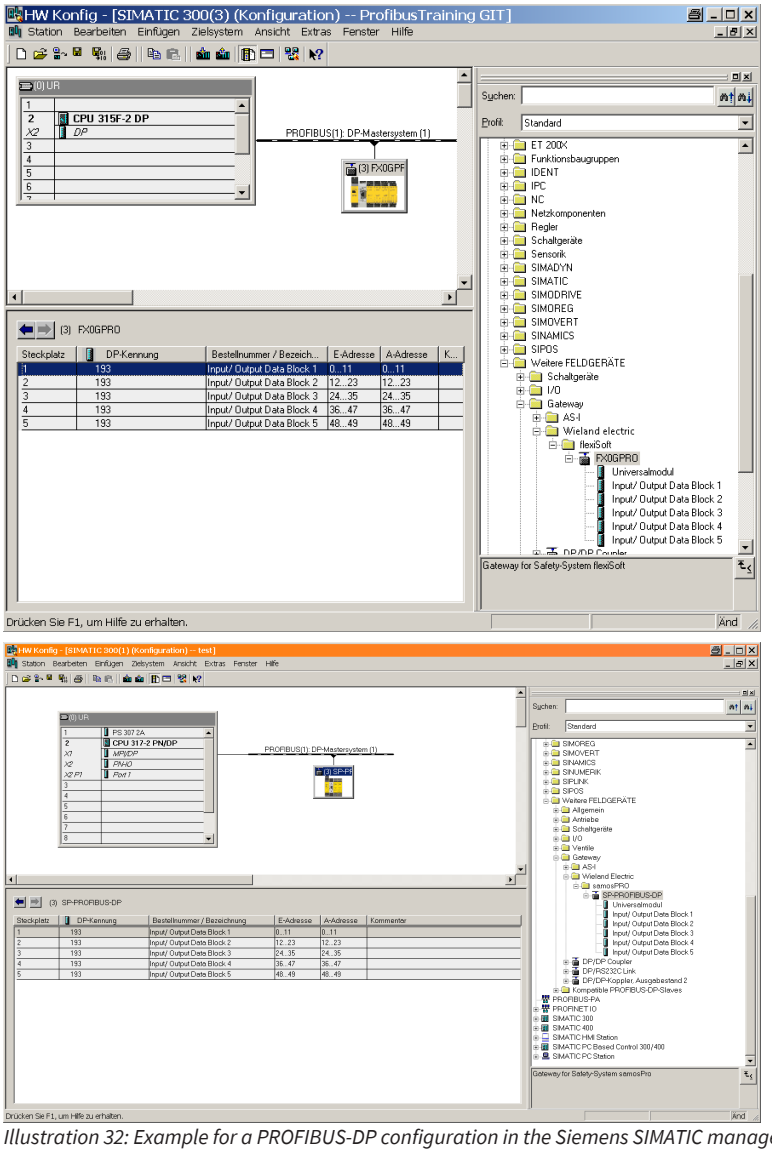


Illustration 32: Example for a PROFIBUS-DP configuration in the Siemens SIMATIC manager

NOTICE

- Depending on the PLC used, further modules may be shown (e.g. "Universal module"). These modules are not required and should be ignored.
- Data blocks 1–4 each contain 12 bytes, while data block 5 contains 2 bytes.

The content of the data blocks can be freely selected, but has been preconfigured as follows in the samos® PLAN 6:

Table 78: Predefined content of input data block 1–5 of the SP-PROFIBUS-DP module

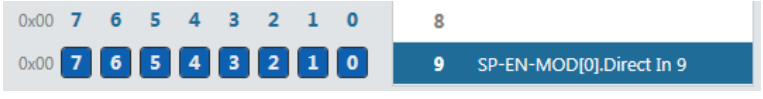
	Data block 1	Data block 2	Data block 3	Data block 4	Data block 5
	Output data block	Output data block	Output data block	Output data block	Output data block
Byte 0	Input values for Module 0 (I1..I8)	Input values for Module 1	Output values for Module 1	Not allocated	Not allocated
Byte 1	Input values for Module 0 (I9..I16)	Input values for Module 2	Output values for Module 2	Not allocated	Not allocated
Byte 2	Input values for Module 0 (IQ1..IQ4)	Input values for Module 3	Output values for Module 3	Not allocated	Not available
Byte 3	Output values for Module 0 (Q1..Q4,IQ1-IQ4)	Input values for Module 4	Output values for Module 4	Not allocated	
Byte 4	Direct data (Off) 0	Input values for Module 5	Output values for Module 5	Not allocated	
Byte 5	Direct data (Off) 1	Input values for Module 6	Output values for Module 6	Not allocated	
Byte 6	Direct data (Off) 2	Input values for Module 7	Output values for Module 7	Not allocated	
Byte 7	Direct data (Off) 3	Input values for Module 8	Output values for Module 8	Not allocated	
Byte 8	Direct data (Off) 4	Input values for Module 9	Output values for Module 9	Not allocated	
Byte 9	Direct data (Off) 5	Input values for Module 10	Output values for Module 10	Not allocated	
Byte 10	Direct data (Off) 6	Input values for Module 11	Output values for Module 11	Not allocated	
Byte 11	Direct data (Off) 7	Input values for Module 12	Output values for Module 12	Not allocated	
Length	12 bytes	12 bytes	12 bytes	12 bytes	2 bytes
Start address	1	13	25	37	49

Detailed information about the content of the process diagram may be found here: *Data transferred to the network (network input data sets [ch. 3.2, p. 20]*).

Delete any bytes not required

You can delete bytes pre-allocated by samos® PLAN 6 that you do not require by clicking on them with the mouse.

- ➡ Launch samos® PLAN 6.
- ➡ Read in the hardware configuration, including the PROFIBUS-DP gateway.
  Instructions: Software manual, chapter "Connecting to the safety controller"
- ➡ Switch to the **Gateway** view.
- ➡ Click on the byte you do not need and wish to delete.



- ➡ Click on the **Delete** icon in the command bar.

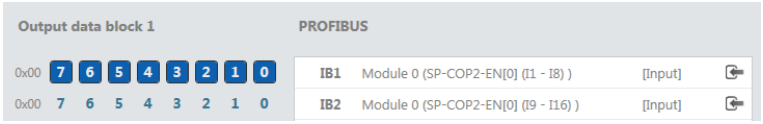
You will find further information about how to configure the process diagram here:

- *Configuration of gateways with samos® PLAN 6 [ch. 5, p. 41]*
- Software manual

Allocating bytes to other addresses

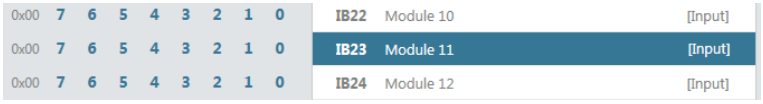
samos® PLAN 6 allocates the addresses by default. You can manually change this address allocation by moving bytes.

In our example, we have shifted **byte 1** to **byte 23** in **tab 1**.



Step 1: Check target address

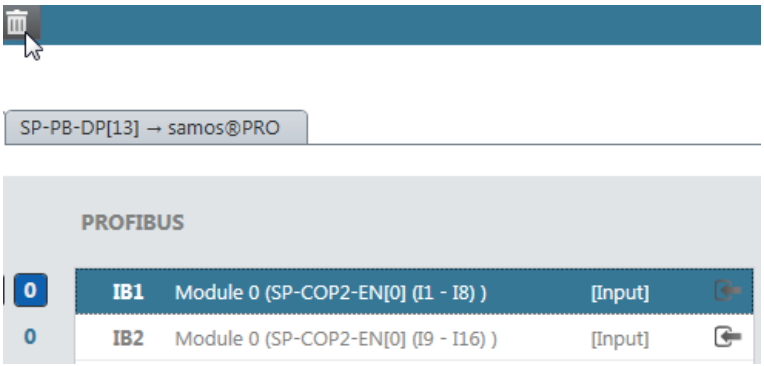
➡ Ensure that the desired address (**byte 23** in our example) has not been allocated.



➡ When the target address is assigned here, delete the bytes placed there.
To do this, click on the byte in the work area and click on the **Delete** symbol in the command bar.

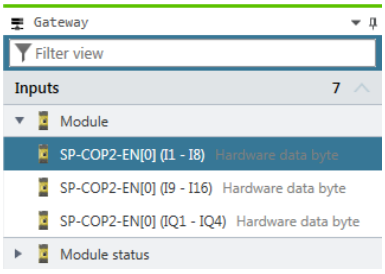
Step 2: Delete byte from original address

➡ Delete the byte you wish to reallocated (**byte 1** in our example).
To do this, click on the byte in the work area and click on the **Delete** symbol in the command bar.

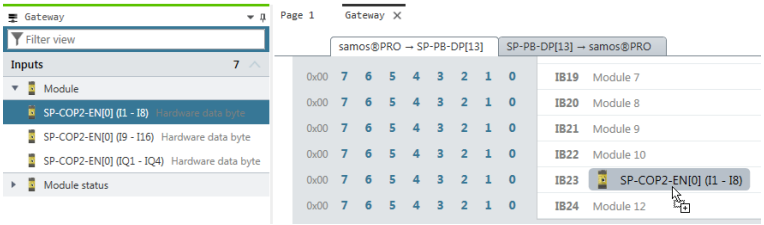


Step 3: Place byte on new target address

➡ Open the **Gateway** docking window and select the desired bytes under the associated module.



➡ Use the mouse button to drag the Byte into the work area on **byte 23**.



9.3 PROFIBUS configuration of the gateway - how the data are transferred

The following steps are required to configure communication between the PLC and the gateway.

NOTICE

This documentation does not address the installation of the PROFIBUS-DP network or the other components of the automation system project in the network configuration tool. It is assumed that the PROFIBUS project in the configuration program, e.g. the SIEMENS SIMATIC Manager, has already been set up. The examples presented are based on configurations created with the help of the SIEMENS SIMATIC Manager.

Step 1: Install the device master file (GSD)

Before the SP-PROFIBUS-DP can be used for the first time as part of the network configuration tool, e.g. the SIEMENS SIMATIC Manager, the device master file (GSD) of the gateway must first be installed in the hardware catalog of the tool.

➡ Download the GSD file and the equipment symbol from the product site of the SP-PROFIBUS-DP module (eshop.wieland-electric.com/de).

➡ Follow the instructions for installing GSDs in the online help section or in the user manual for the PROFINET network configuration tool.

If you are using SIEMENS SIMATIC Manager (HW Config), the gateway will subsequently appear in the hardware catalog under >>**PROFIBUS DP** > **Other field equipment** > **Gateway** > **Wieland** > samosPRO COMPACT.

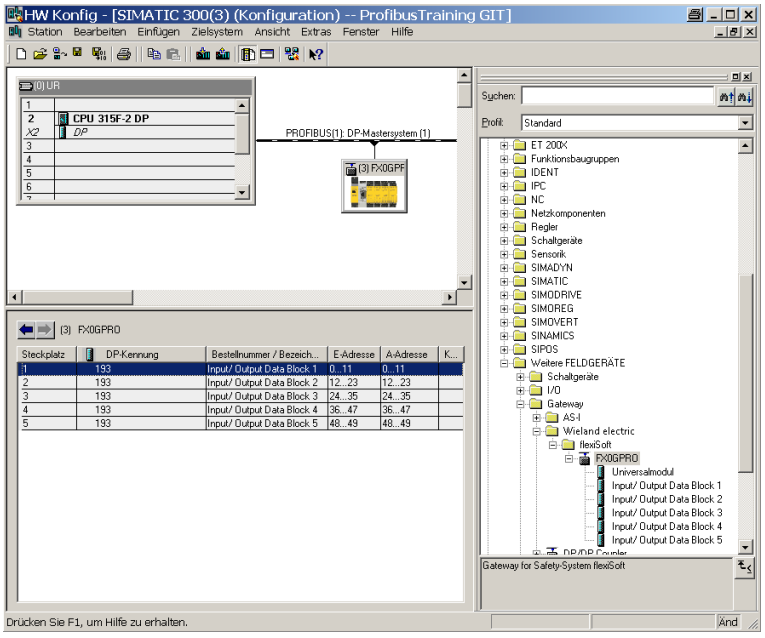
Step 2: Add the gateway to the project

To make the system of the samos® PRO system available in the process diagram of the PLC, the gateway must first be added to the hardware configuration. The procedure to be used depends on the hardware configuration software of the PLC used. Please also read the documentation for the corresponding software in this regard.

The example below shows how the gateway is added to a SIEMENS SIMATIC manager project.

In the SIEMENS SIMATIC hardware manager, you will find the gateway in the hardware catalog under >>**PROFIBUS DP** > **Other field equipment** > **Gateway** > **Wieland** > samosPRO COMPACT.

➡ Use the drag&drop function to pull the equipment into the PROFIBUS network. Example:



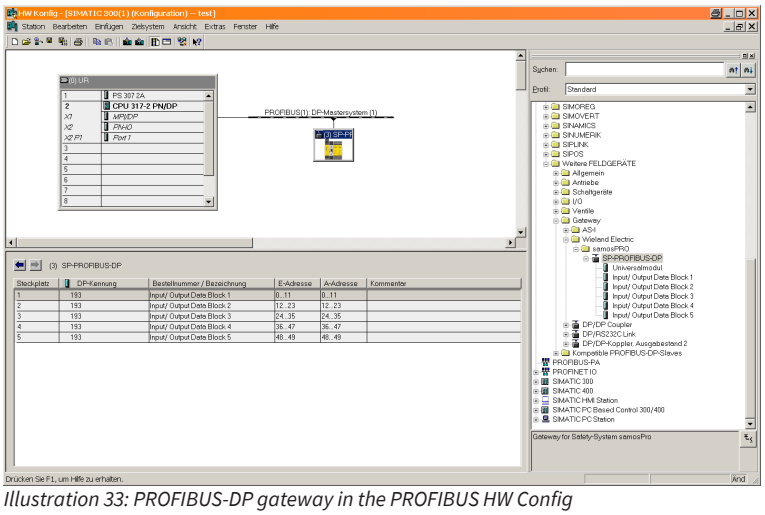


Illustration 33: PROFIBUS-DP gateway in the PROFIBUS HW Config

Diagnostic data of SP-PROFIBUS-DP module

The SP-PROFIBUS-DP module makes diagnostic data available via PROFIBUS-Standard-DP-V0 diagnostics:

- Standard diagnosis (6 bytes)
- Device-related diagnosis State messages or manufacturer-specific messages

Each module has a unique diagnostic ID. The gateway determines the manufacturer-specific diagnosis number based on this ID. In this way, module-specific diagnosis texts can be read out of the GSD. The following table shows the content of the diagnosis messages:

Table 79: Content of the PROFIBUS diagnosis messages

Octet	Content	Comment
7	0x09	Header
8	See following table	Diagnostics ID
9	0	PROFIBUS slot number of the module. The PROFIBUS gateway supports five slots, which do not, however, represent physical slots. For this reason, all messages should be assigned to Slot 0 (the gateway itself).
10 (Bit 0…2)	001 or 010	001 = Incoming error, 010 = Outgoing error
10 (Bit 3…7)	00000…11111	Alarm sequence number, increased on each state change of octet 10, bit 0 … 2 (incoming/outgoing error)
11	0 … 14	Position of the module that caused the diagnosis message. 0 = controller module 1 = 1st I/O module … 13 = 1st Gateway 14 = 2nd Gateway (Relay output expansions are not counted)
12 to 15	Variable	4 bytes with module-specific diagnosis data. See below: Table “PROFIBUS error messages”

The following table shows the diagnostics IDs for the samos® PRO system:

Table 80: Diagnostics IDs of the samos® PRO system

Diagnostics ID	Modules
161	samos® PRO
162	SP-SDI module, SP-SDIO module, SP-DIO module
163	PROFIBUS gateway (SP-PROFIBUS-DP)
164	CANopen gateway (SP-CANopen)
165	EtherCAT gateway (SP-EN-ETC)
166	Reserved
167	Reserved
168	Reserved
169	Reserved
170	Reserved
171	Controller module 1: 32-bit state
172	Controller module 2: 32-bit state
173	Controller module 3: 32-bit state
174	Unsafe I/O module

The following table shows the module-specific diagnostic data (as defined in the GSD) and the corresponding error messages.

Table 81: PROFIBUS error messages

Diagnostics ID	Diagnosis bit (X_Unit_Diag_Bit)	Error cause	Error message
01	0	Reserved	Reserved
	1		Module operating state is Critical Error.
	2		Power supply not in permitted range
	3		Reserved
	4		Configuration of a module in the system is incompatible or invalid
	5		Power supply not in permitted range
	6		Reserved
	7		Communication error on EFI2
	8 to 31		Reserved
11, 12, and 13	0	Controller module	Reserved
	1		Module operating state is Critical Error.
	2		Power supply not in permitted range
	3		Reserved
	4		Configuration of a module in the system is incompatible or invalid
	5		Power supply at B1 not in permitted range
	6		Fast shut-off collective error

Diagnostics ID	Diagnosis bit (X_Unit_Diag_Bit)	Error cause	Error message
	7		Power supply at B2 not in permitted range
	8 to 95		Description of bits 8 to 959: See *Table "Meaning of the module state bits" [ch. 3.3.4, p. 27]*
2	0	I/O module	Reserved
	1		Internal error: Internal tests failed or monitoring test failed or poor process data or self-test failed
	2		External error: External tests failed
	3		Error history element exists: Access with configuration tool
	4		Configuration is incompatible or invalid
	5		Output power supply not in permitted range
	6 to 7		Reserved
	8		Dual-channel evaluation of input 1 - 2: Error detected
	9		Dual-channel evaluation of input 3 - 4: Error detected
	10		Dual-channel evaluation of input 5 - 6: Error detected
	11		Dual-channel evaluation of input 7 - 8: Error detected
2	12	I/O module	Reserved
	13		Reserved
	14		Module state input data
	15		Module state output data
	16		Error of the external test signal at Input 1. Check to short-circuit to high or cabling error
	17		Error of the external test signal at Input 2. Check to short-circuit to high or cabling error
	18		Error of the external test signal at Input 3. Check to short-circuit to high or cabling error
	19		Error of the external test signal at Input 4. Check to short-circuit to high or cabling error
	20		Error of the external test signal at Input 5. Check to short-circuit to high or cabling error
	21		Error of the external test signal at Input 6. Check to short-circuit to high or cabling error
	22		Error of the external test signal at Input 7. Check to short-circuit to high or cabling error
2	23	I/O module	Error of the external test signal at input 8. Check to short-circuit to high or cabling error
	24		Error: Short-circuit after high at Output 1
	25		Error: Short-circuit after low at Output 1
	26		Error: Short-circuit after high at Output 2
	27		Error: Short-circuit after low at Output 2
	28		Error: Short-circuit after high at Output 3

Diagnostics ID	Diagnosis bit (X_Unit_Diag_Bit)	Error cause	Error message
	29		Error: Short-circuit after low at Output 3
	30		Error: Short-circuit after high at Output 4
	31		Error: Short-circuit after low at Output 4
3	0	PROFIBUS gateway	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Module state input data
	6		Module state output data
	7 to 31		Reserved
4	0	CANopen gateway	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Module state input data
	6		Module state output data
	7 to 31		Reserved
5	0	EtherCAT Gateway	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Module state input data
	6		Module state output data
	7 to 31		Reserved
6	0	Other module	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Reserved
	6		Reserved
	7 to 31		Reserved
7	0	Other module	Reserved
	1		Internal error: Internal tests failed

Diagnostics ID	Diagnosis bit (X_Unit_Diag_Bit)	Error cause	Error message
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Reserved
	6		Reserved
	7 to 31		Reserved
8	0	Other module	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Reserved
	6		Reserved
	7 to 31		Reserved
9	0	Other module	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Module state input data
	6		Module state output data
	7 to 31		Reserved
10	0	Other module	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5 to 31		Reserved
14	0	Unsecure IO	Reserved
	1		Internal error: Internal tests failed
	2		Reserved
	3		Reserved
	4		Configuration is incompatible or invalid
	5		Output power supply not in permitted range
	6 to 31		Reserved
15	0	Safe analog value module	Not used ("executing state")
	1		Internal module state

Diagnostics ID	Diagnosis bit (X_Unit_Diag_Bit)	Error cause	Error message
	2		External module state
	3		Not used (error history flag)
	4		Configuration status
	5		SAC4 and SACR22: Voltage outputs X1…X4
	6 to 13		Reserved
	14		Module state input data
	15		Reserved
	16		Overshoot of monitoring range I1 or R1x
	17		Overshoot of monitoring range I2 or R2x
	18		Overshoot of monitoring range I3 or Rax[1]
	19		Overshoot of monitoring range I4 or Rbx fn:2
	20		Undershoot of monitoring range I1 or R1x
	21		Undershoot of monitoring range I2 or R2x
	22		Undershoot of monitoring range I3 or Rax[1]
	23		Undershoot of monitoring range I4 or Rbx[2]
	24		Short circuit I1 or R1x
	25		Short circuit I2 or R2x
	26		Short-circuit I3 or Rax[1]
	27		Short-circuit I4 or Rbx[2]
	28		Open circuit I1 or R1x
	29		Open circuit I2 or R2x
	30		Open circuit I3 or Rax[1]
	31		Open circuit I4 or Rbx[2]

9.4 Diagnostics and troubleshooting

You can find information on the diagnostics of the samos® PRO system in the software manual.

Table 82: Troubleshooting on the SP-PROFIBUS-DP module

Error	Possible cause	Possible remedy
Key: ○ LED off / ✳ LED flashes / ● LED lights up		

Error		Possible cause	Possible remedy
samos® PLAN 6 cannot set up a connection to the samos® PRO gateway		The SP-PROFIBUS-DP module has no power supply	• Switch on the power supply. • Check the communication settings in samos® PLAN 6.
The SP-PROFIBUS-DP module does not provide any data.		• Configuration required. • The configuration has not yet been fully transmitted.	• Configure the SP-PROFIBUS-DP module and transfer the configuration to the system. • Wait until the configuration has been fully transferred.
LED PWR	Green		
LED BF	Off		
MS LED	- Red (1 Hz)		
The SP-PROFIBUS-DP module does not provide any data.		No data set was activated.	Activate at least one data set.
LED PWR	Green		
LED BF	Off		
MS LED	Green		
The SP-PROFIBUS-DP module does not provide any data.		The SP-PROFIBUS-DP module is in the Stop state.	• The controller module/application is stopped. • Start the controller module (switch to Run mode).
LED PWR	Green		
LED BF	Off / red		
MS LED	- Green (1 Hz)		
The SP-PROFIBUS-DP module does not provide any data.		PROFIBUS-Master is in stop mode	Set the PROFIBUS-Master to Run mode
LED PWR	Green		
LED BF	Off		
MS LED	Green		
The SP-PROFIBUS-DP functioned correctly after configuration but suddenly provides no more data.		• The PROFIBUS hardware address of the SP-PROFIBUS-DP module was changed. • The PROFIBUS line has been interrupted.	• Check the PROFIBUS address settings on the hardware. • Check the PROFIBUS cabling. • Check the PROFIBUS master.
LED PWR	Green		
LED BF	Red		
MS LED	/ Red / green		
The SP-PROFIBUS-DP module is in the Critical error state.		• Internal device error on the SP-PROFIBUS-DP module	• Switch the samos® PRO system's power supply off and on again.

Error		Possible cause	Possible remedy
LED PWR	Green	• The module version of the controller module does not support any gateways.	• Check the diagnostic messages with the aid of the samos® PLAN 6. • Use the controller module with the required module version. • If the error persists, replace the gateway.
LED BF	Red		
MS LED	Red (2 Hz)		
The SP-PROFIBUS-DP module / the samos® PRO system is in the “Critical error” state.		• The SP-PROFIBUS-DP module is not properly connected to the samos® PRO modules. • The module connection plug is dirty or damaged. • Another samos® PRO module has an internal critical error.	• Plug the SP-PROFIBUS-DP module in correctly. • Clean the connection plug and socket. • Switch on the power supply again. • Check the other samos® PRO modules.
LED PWR			
LED BF	Off		
MS LED			

10 CANOPEN GATEWAY

The following samos® PRO gateway can be used for CANopen:

- SP-CANopen

10.1 Interfaces and operation

Operating and display elements

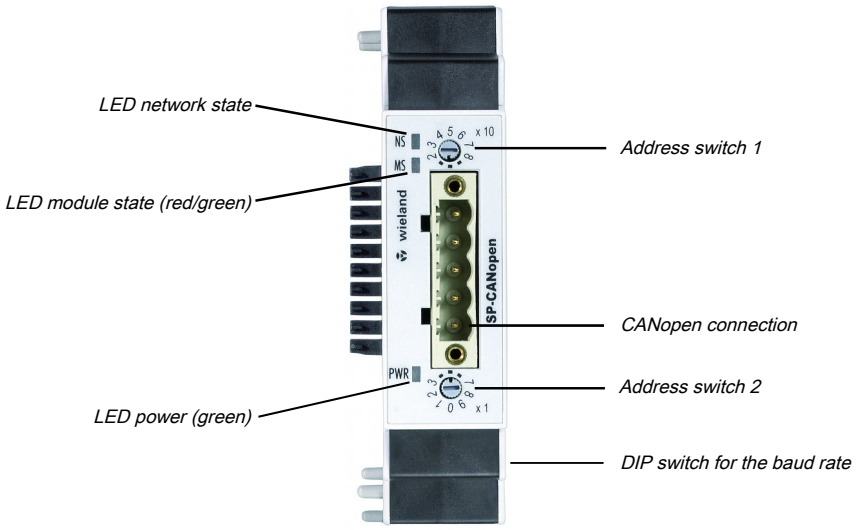


Illustration 34: Operating and display elements of the SP-CANopen module

Table 83: Reference: State LEDs of the SP-CANopen module

LED		Meaning
Key: ○ LED off / ✳ LED flashes / ● LED lights up		
PWR Power	○ Off	No power supply
	● Green	Ready for operation, power supply switched on
	● Red	System error
NS (network status)	○ Off	CANopen state: stopped (except for node guarding and heartbeat, when activated)
	● Green	CANopen state: Ready for operation (PDO and SDO data exchange)
	✳ Green	CANopen state: Pre-operational (only SDO data exchange)
	● Red	CAN-Bus off (hardware problem on CAN - physical layer) or error passive
	✳ Red (1 Hz)	Node guarding failed (NMT master no longer monitors the slave) or heartbeat consumer failure
MS (module status)	○ Off	Switch on
	● Green	Executing, internal safety bus and PDO status: all "Good"
	✳ Green	Idle (cable not connected or node guarding failed)

LED		Meaning
	Red / green	Executing, internal safety bus and PDO status: at least one "Bad"
	Red	Critical error, caused by emergency bit
	Red (1 Hz)	Configuration required or is taking place right now
	Red (2 Hz)	Critical error, caused by gateway itself

Further information: *Diagnostics and troubleshooting [ch. 10.13, p. 155]*

NOTICE

- To allow the PLC to detect the SP-CANopen module as bus participant, the PLC must already be started up, before the samos® PRO system is switched on.
- If a PLC is stopped or is switched off then the SP-CANopen module can go into the **Error passive** or **CAN Bus Off** states. In these cases the samos® PRO system must be reset before reuse with a PLC.

How to set the CANopen address with the aid of the hardware address switches

➡ Set the CANopen address switches using the hardware address switches at the front of the system.

➡ Switch the samos® PRO system off and on again.

Table 84: Address switch on the SP-CANopen module

Switches	Function
× 10	Address switch 1 Rotary switch with 10 positions for setting the module address (in tens)
× 1	Address switch 2 Rotary switch with 10 positions for setting the module address (in units)

How to set the baud rate with the aid of the hardware DIP switches:

➡ Set the baud rate using the DIP switches on the equipment.

➡ Switch the samos® PRO system off and on again.

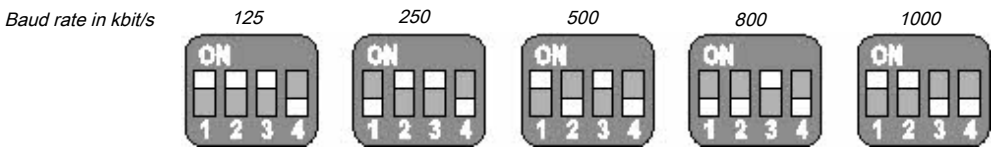


Illustration 35: Setting the DIP switches on the SP-CANopen module

Table 85: Setting the DIP switches on the SP-CANopen module

Baud rate (kbit/s)	DIP 1	DIP 2	DIP 3	DIP 4
125 (default)	On	On	On	On
125	On	On	On	Off
250	Off	On	On	Off
500	On	Off	On	Off
800	Off	Off	On	Off

Baud rate (kbit/s)	DIP 1	DIP 2	DIP 3	DIP 4
1000	On	On	Off	Off

NOTICE

- All other DIP switch settings will set the baud rate to 125 kbit/s.
- When the address switches on the equipment are set to "00", the DIP switch settings are ignored and the baud rate setting in samos® PLAN 6 is used.

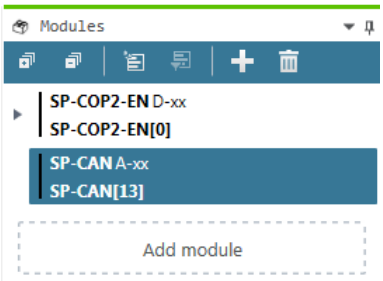
How to set the CANopen address and the baud rate using the software

➡ Set the two hardware address switches on the front of the device to "00".

➡ Launch samos® PLAN 6.

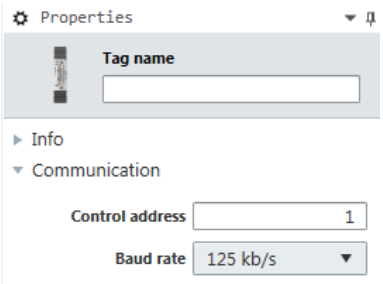
➡ Read in the hardware configuration, including the CANopen gateway.
Instructions: Software manual, chapter "Connecting to the safety controller"

➡ Change to the **Modules** docking window and click the SP-CAN module in the work area.



➡ Open the **Properties** docking window.

⇨ You see the module configuration dialog.



➡ Under **Communication**, enter the desired values for the parameters **Controller address** and **baud rate**.

➡ Connect samos® PLAN 6 with the samos® PRO system and transmit the configuration.
More detailed information on the link to the controls: Software manual, chapter "Connecting to the safety controller"

NOTICE

- You can set an address within the 1 ... 99 range with the aid of the hardware address switches.
- You can set an address within the 1 ... 127 range with the aid of the samos® PLAN 6.
- The CAN-open master cannot overwrite the address.
- When the CANopen address and the baud rate are set with the aid of samos® PLAN 6 , the settings become valid immediately after transferring the configuration (i.e. without first switching the samos® PRO system off and on again). Exception: When the system is in the Bus-Off state, a power cycle is required.

Pin assignment

The connection to the CANopen field bus takes place with the aid of a 5-pin open-style plug.

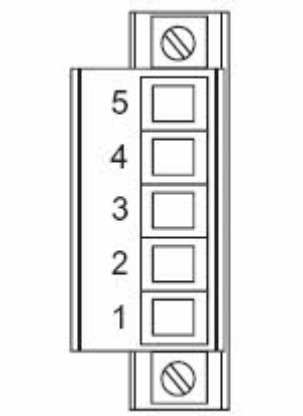


Illustration 36: Open-style plug on the SP-CANopen module

Table 86: Reference: Allocation of open-style plug on the SP-CANopen module

Pin	Description	
5	–	–
4	H CAN_H	CAN High
3	DR (CAN_SHLD)	Screening connection (optional)
2	L CAN_L	CAN Low
1	–	–

Bus cable

CANopen is based on a linear topology with screened, two-lead twisted-pair cables and terminal resistances at both bus ends. The screening is connected to ground at both ends. The transmission rate depends on the network length and ranges from 125 kbit/s to 1000 kbit/s. The potential network lengths range from 20 m at 1000 kbit/s to 500 m at 125 kbit/s.

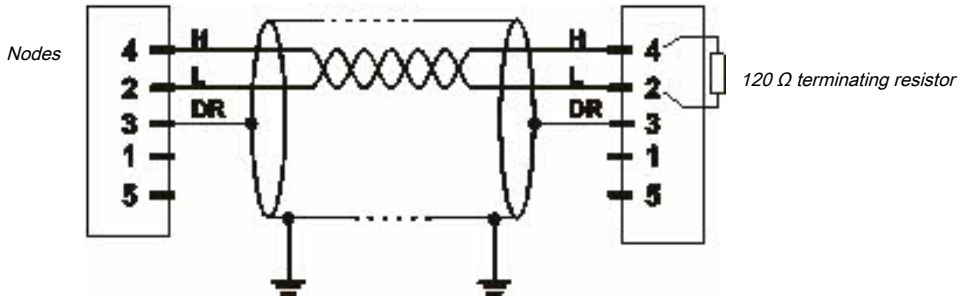


Illustration 37: CANopen bus cable

NOTICE

It is not necessary to connect a power supply (Pin 1/5) to the SP-CANopen module.

The following maximum physical values are possible:

Table 87: Maximum line lengths on the SP-CANopen module

Bit rate (kbit/s)	Maximum cable length (m)
125	500
250	250
500	100
800	40
1000	20

EDS file

The equipment characteristics are described with the aid of the electronic data sheet (EDS) file), that makes use of any standard bus configuration tool.

Yocan find the EDS file and the equipment symbol for integration into a PLC of the product website of the SP-CANopen module on the Internet (eshop.wieland-electric.com/de).

10.2 CANopen configuration of the gateway - how the data are transferred

NOTICE

This documentation does not address the installation of the CANopen network or the other components of the automation system project in the network configuration tool. It is assumed that the CANopen project in the configuration program, e.g. 3S Software CoDeSys 2.x, has already been set up. The examples presented are based on configurations created with the help of CoDeSys 2.3.

The following steps are required to configure communication between the PLC and the gateway.

Step 1: Install the electronic data sheet (EDS file)

Before the SP-CANopen module can be used for the first time as equipment in the network configuration tool, e.g. CoDeSys 2.3, the electronic data sheet (EDS file) of the gateway must first be installed in the hardware catalog of the tool.

- ➡ Download the EDS file and the equipment symbol from the product site of the SP-CANopen module (eshop.wieland-electric.com/de).
- ➡ Follow the instructions for the installation of EDS files in the online help section or in the user manual for the CANopen network configuration tool.

Example – How to install the EDS file with CoDeSys 2.3:

- ➡ Open the window for editing the **control configuration**.

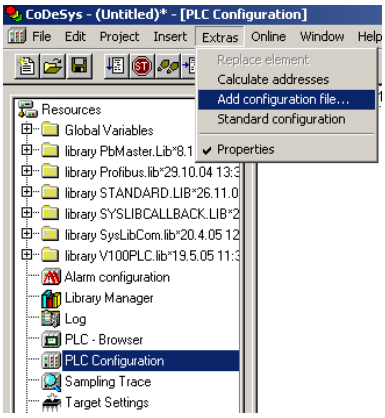


Illustration 38: CoDeSys editing window for control configuration

- ➡ Choose the command **Add configuration file...** from the Extras menu. A file selection window is opened.
- ➡ Select the EDS file of the SP-CANopen module and click the **Open** button.

Step 2: Add the gateway to the controls

To make the system of the samos® PRO system available in the process diagram of the PLC, the gateway must first be added to the hardware configuration. The procedure to be used depends on the hardware configuration software of the PLC used. Please also read the documentation for the corresponding software in this regard.

- ➡ Open the window for editing the **control configuration** and select the controls.
- ➡ Click the controller with the right mouse button or open the **Insert** menu.

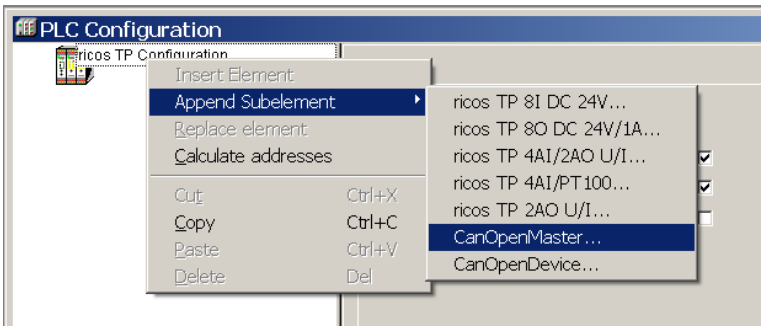


Illustration 39: Attaching a CanMaster with CoDeSys 2.3

- Select the command **CanMaster ....** from one of the two menus under **Attach sub-element.** A CanMaster will be attached to the controls.
- Now select the CanMaster.
- Click the CanMaster with the right mouse button or open the **Insert** menu.

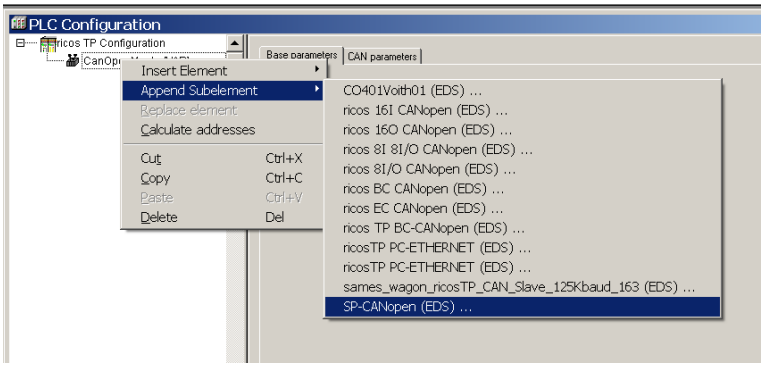


Illustration 40: Attaching the SP-CANopen module with CoDeSys 2.3

- In one of the two menus, under **Attach subelement**, select the command "SP-CANopen00000 (EDS)", to attach the SP-CANopen module to the CanMaster.

Step 3: Select and configure the process data objects (PDOs)

Once you have added the device to the automation network, you must configure the process data objects to be used and how to transfer them.

Example – How to install the PDO transmission type with CoDeSys 2.3:

- In the Control Configuration edit window, select the SP-CANopen module. Then click the Send PDO mapping index card on the right.

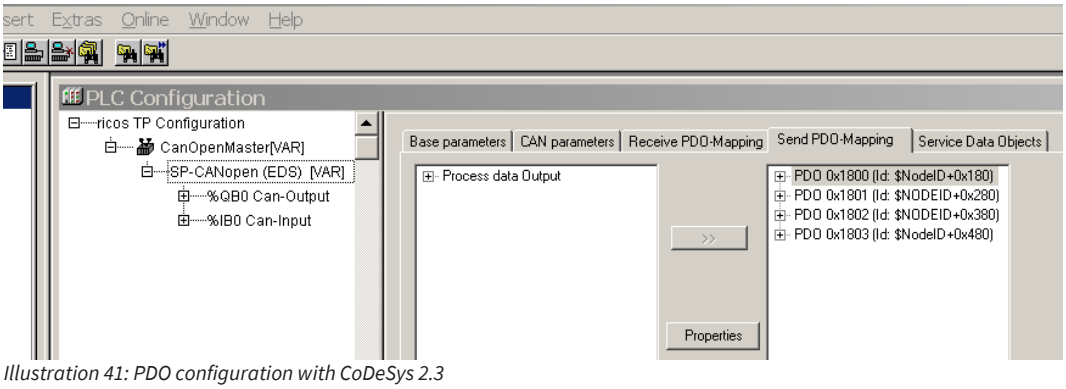


Illustration 41: PDO configuration with CoDeSys 2.3

- Select one of the PDOs shown (e.g. PDO 1) and click on the Properties button. The PDO Properties dialog window will open.

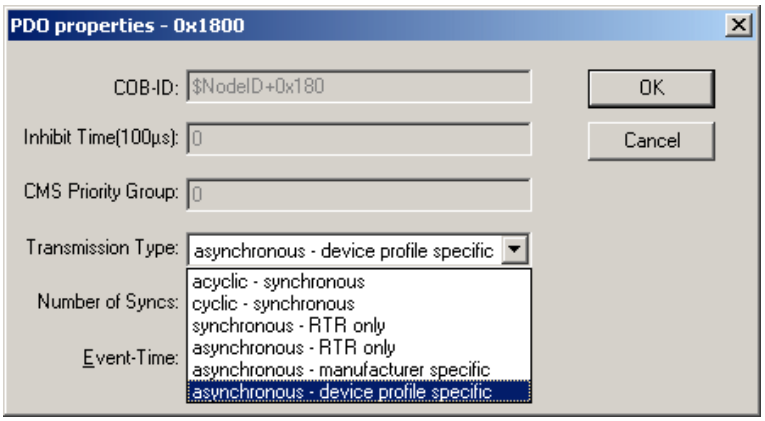


Illustration 42: PDO Properties dialog window in CoDeSys 2.3

- From the selection, choose the desired transmission type for the PDO, enter the event time in ms and click on OK. More detailed information in this regard may be found in the section "Transmission types for the TxPDOs" on page 107 and in the manual for your CanOpen configuration software.
- Repeat these steps for the other transmission and receiving PDOs.

10.3 CANopen configuration of the gateway - which data are transferred

Each CANopen device stores its data in objects listed in the object directory. The service data objects (SDOs) mainly contain the CANopen configuration data, while the process data are stored in process data objects (PDOs). Communication objects are used to read and write these SDOs and PDOs and to control the devices. The following sections contain more detailed descriptions of the various objects.

Predefined Connection Set (PCS)

The Predefined connection set provides a simple CAN identifier structure. The SP-CANopen gateway makes communication objects available, which can be contacted or transmitted using this CAN Identifier. The PCS consists of 2 broadcast objects (NMT and SYNC) and a total of 12 peer-to-peer objects. Each of these objects has a clear 11-bit CAN identifier, which consists of a function code and a device address. The device address for the broadcast objects is 0, while that for the other objects is within the range of 1 ... 127.

Table 88: Structure of the CAN identifiers

Bit number										
10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Function code				Device address						

Table 89: PCS communication objects

Object	**CAN identifier**	**Meaning**
Broadcast objects		
Peer-to-peer objects		
NMT	00h	Network management
SYNC	80h	Sync message
EMERGENCY	081h…0FFh	State message
TxPDO1	181h…1FFh	Send process data object 1
RxPDO1	201h…27Fh	Receive process data object 1

Object	CAN identifier	Meaning
Broadcast objects		
Peer-to-peer objects		
TxPDO2	281h…2FFh	Send process data object 2
RxPDO2	301h…37Fh	Receive process data object 2
TxPDO3	381h…3FFh	Send process data object 3
RxPDO3	401h…47Fh	Receive process data object 3
TxPDO4	481h…4FFh	Send process data object 4
RxPDO4	501h…57Fh	Receive process data object 4
TxSDO	581h…5FFh	Send service data project
RxSDO	601h…67Fh	Receive service data object
NMT-ErrorControl	701h…77Fh	Node guarding

Each object starts with a CAN identifier, followed by a RTR bit (remote transmission request), followed by a data length code (DLC), followed by 0 to 8 data bytes. The DLC (4 bits) provides the number of data bytes.

10.4 NMT – network management

The broadcast object NMT is used to start, stop or initialize CANopen devices. A device in the CANopen network must take on the role of the NMT master for this purpose. This is usually the PLC. All other devices are regarded as NMT slaves. NMT services are broadcast services to which the slaves do not generate responses.

All NMT objects start with the CAN-ID 00h.

Broadcast service for an NMT slave with the address N:

Table 90: Network management for an NMT slave with the address N

CAN-ID	DLC	DATA							
00h	2	OP	N						

Broadcast service for all NMT slaves:

Table 91: Network management for all NMT slaves:

CAN-ID	DLC	DATA							
OP	**NMT command**			**Explanation**					
00h	2	OP	0						
80h	Go to "Pre-Operational"			After booting, an NMT slave will automatically go into the pre-operational state. In this state, communication via SDOs is permitted, but not via PDOs. The NMT slave can be set to this state from another state.					

CAN-ID	DLC	DATA	
OP	**NMT command**		**Explanation**
01h	Go to "Operational"		The operational state is reached from the "pre-operational" state. Communication via PDOs is possible in this state and the CANopen slave responds to sync commands. **Note:** During the transition to the NMT operational state, each slave sends a TxPDO with the transmission type = 255, so that the NMT master is informed about the current input configuration.
02h	Go to "Prepared/Stopped"		Communication via SDO or PDO is not possible in this state and the device also does not respond to sync commands.
81h	Go to "Reset node"		This will trigger a re-initialization of the CANopen function in the NMT slave.
82h	Go to "Reset communication"		This will trigger a re-initialization of the CANopen function in the NMT slave; the toggle bit for node guarding is set to 0.

Example for resetting all communication:

The following NMT object (CAN-ID = 00h) contains 2 data bytes (DLC = 2). Data byte 1 contains the command "Reset communication" (82h), data byte 2 addresses this command to all devices in the CANopen network (address = 0):

Table 92: Example of an NMT object for resetting all communication

CAN-ID	DLC	DATA							
00h	2	82h	0						

10.5 SYNC

The SYNC command results in all TxPDOs of a CANopen slave being sent. It is thus possible to prompt the slave with the aid of SYNC.

Table 93: Prompting of inputs with the aid of SYNC

CAN-ID	DLC	DATA							
80h	0								

The slave sends all input values when he receives this command. All TxPDOs are sent.

To ensure that the slave automatically sends the current input values when receiving a SYNC command, the transmission type for the relevant PDOs must be set to 1 (cyclic, synchronous). In addition, the device must be in the "operational" state.

It is possible to amend the transmission type for the TxPDOs with the aid of the SDOs 1800 … 1803 (PDO communication parameter) and to amend Sub-Object 2. The following types are permitted:

- Acyclic/synchronous = 0
- Cyclic/synchronous = 1 = 1 ... 240
- Acyclic once device profile = 255 (only for TxPDO 1 … 4, digital inputs)

10.6 Emergency

A CANopen slave with the address N sends an emergency message to inform the other devices of an error state.

Table 94: Emergency messages

CAN-ID	DLC	DATA							
80h + N	8	ErrL	ErrH	Err-Reg	M1	M2	M3	M4	M5
ErrL, ErrH		Emergency error code, 16-bit Low Byte/High Byte 7001h … 7003h: General error							
Err-Reg		Error register, CANopen object SDO 1001h							
M1		The higher-order half-byte contains the diagnostics ID from module version A-08. The low-order half-byte contains the module index and thus corresponds to the module address of the module list and names the module causing the error. The diagnostics ID can additionally be determined from the contents of SDO 1027 with the subindex (= M1 + 1), whereby only the low-order half-byte of M1 may be used here. The diagnostics ID is required as an index for the "CANopen Emergency Messages" table (see below) to assign the status bits to the corresponding module.							
M2 … M5		4 bytes, module-specific state bits. Active bits are high (= "1"). (see below: Table “CANopen Emergency Messages")							

The following table shows the module-specific diagnostic data and the corresponding error messages.

The diagnostic bit indicates the position of the affected bit and not the bit value itself; the bit value indicates the error case and has the value "0" here; see also *Diagnostic example from CANopen Gateway module version A-08 [ch. 10.14, p. 158]*.

Table 95: CANopen emergency messages

Diagnostics ID	Diagnostic bit (M5 … M2)	Emergency cause	Emergency message
01	**00**	samos® PRO	Reserved
	01		Internal error: Internal tests failed
	02		Power supply not in permitted range
	03		Reserved
	04		Configuration of a module in the system is incompatible or invalid
	05		Power supply not in permitted range
	06		Reserved
	07		Communication error on EFI2
	08 to 31		Reserved
10 [1], **11** [2], **12** [3], **13** [4]	**00**	Controller module	Reserved
	01		Internal error: Internal tests failed
	02		External error: External tests failed

Diagnostics ID	Diagnostic bit (M5 … M2)	Emergency cause	Emergency message
	03		Power supply at A1 not in permitted range
	04		Configuration of a module in the system is incompatible or invalid
	05		Power supply at B1 not in permitted range
	06		Fast Shut-Off collective fault
	07		Power supply at B2 not in permitted range
	08 to 95		Description of bits 8 to 95: See *Meaning of module state bits of controller module SP-COPx (only for Modbus) [ch. 3.3.4, p. 27]*
	[1] Diagnostics ID 10 relates to bit 00-31 or bit 32-63 or bit 64-95, the assignment is not unique [2] Diagnostics ID. 11 relates to bit 00-31 [3] Diagnostics ID. 12 relates to bit 32-63 [4] Diagnostics ID 13 relates to bit 64-95		
02	**00**	Secure I/O modules	Reserved
	01		Internal error: Internal tests failed
	02		External error: External tests failed
	03		Error history element exists: Access with configuration tool
	04		Configuration is incompatible or invalid
	05		Output power supply not in permitted range
	06		Reserved
	07		Reserved
	08		Dual-channel evaluation of input 1-2: Error detected
	09		Dual-channel evaluation of input 3-4: Error detected
02	**10**	Secure I/O modules	Dual-channel evaluation of input 5-6: Error detected
	11		Dual-channel evaluation of input 7-8: Error detected
	12		Reserved
	13		Reserved
	14		Module state input data
	15		Module state output data

Diagnostics ID	Diagnostic bit (M5 … M2)	Emergency cause	Emergency message
	16		Error of the external test signal at Input 1. Check whether there is a short-circuit to High or a cabling error
	17		Error of the external test signal at Input 2. Check whether there is a short-circuit to High or a cabling error
	18		Error of the external test signal at Input 3. Check whether there is a short-circuit to High or a cabling error
	19		Error of the external test signal at Input 4. Check whether there is a short-circuit to High or a cabling error
	20		Error of the external test signal at Input 5. Check whether there is a short-circuit to High or a cabling error
	21		Error of the external test signal at Input 6. Check whether there is a short-circuit to High or a cabling error
02	**22**	Secure I/O modules	Error of the external test signal at input 7. Check whether there is a short-circuit to High or a cabling error
	23		Error of the external test signal at input 8. Check whether there is a short-circuit to High or a cabling error
	24		Error: Short-circuit after high at Output 1
	25		Error: Short-circuit after low at Output 1
	26		Error: Short-circuit after high at Output 2
	27		Error: Short-circuit after low at Output 2
	28		Error: Short-circuit after high at Output 3
	29		Error: Short-circuit after low at Output 3
	30		Error: Short-circuit after high at Output 4
	31		Error: Short-circuit after low at Output 4
03	**00**	PROFIBUS gateway	Reserved
	01		Internal error: Internal tests failed
	02		Reserved

Diagnostics ID	Diagnostic bit (M5 … M2)	Emergency cause	Emergency message
	03		Reserved
	04		Configuration is incompatible or invalid
	05		Module state input data
	06		Module state output data
	07 to 31		Reserved
04	**00**	CANopen gateway	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid
	05		Module state input data
	06		Module state output data
	07 to 31		Reserved
05	**00**	EtherCAT gateway	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid
	05		Module state input data
	06		Module state output data
	07 to 31		Reserved
06	**00**	Reserved	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid
	05 to 31		Reserved
07	**00**	Reserved	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid

Diagnostics ID	Diagnostic bit (M5 … M2)	Emergency cause	Emergency message
	05 to 31		Reserved
08	**00**	Reserved	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid
	05 to 31		Reserved
09	**00**	Reserved (other module)	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid
	05		Module state input data
	06		Module state output data
	07 to 31		Reserved
14	**00**	Unsecure IO	Reserved
	01		Internal error: Internal tests failed
	02		Reserved
	03		Reserved
	04		Configuration is incompatible or invalid
	05		Output power supply not in permitted range
	06 to 31		Reserved
15	0	Safe analog value module	Not used ("executing state")
	1		Internal module state
	2		External module state
	3		Not used (error history flag)
	4		Configuration status
	5		SAC4 and SACR22: Voltage outputs X1…X4
	6 to 13		Reserved
	14		Module state input data
	15		Reserved

Diagnostics ID	Diagnostic bit (M5 … M2)	Emergency cause	Emergency message
	16		Overshoot of monitoring range I1 or R1x
	17		Overshoot of monitoring range I2 or R2x
	18		Overshoot of monitoring range I3 or Rax[1]
	19		Overshoot of monitoring range I4 or Rbx fn:2
	20		Undershoot of monitoring range I1 or R1x
	21		Undershoot of monitoring range I2 or R2x
	22		Undershoot of monitoring range I3 or Rax[1]
	23		Undershoot of monitoring range I4 or Rbx[2]
	24		Short circuit I1 or R1x
	25		Short circuit I2 or R2x
	26		Short-circuit I3 or Rax[1]
	27		Short-circuit I4 or Rbx[2]
	28		Open circuit I1 or R1x
	29		Open circuit I2 or R2x
	30		Open circuit I3 or Rax[1]
	31		Open circuit I4 or Rbx[2]

NOTICE

The allocation of the diagnostic bits for M2 to M5 is as follows:

Bit 0	Bit 1	…	Bit 7	Bit 8	…	Bit31
M5.0	M5.1	…	M5.7	M4.0	…	M2.7

Also see about this

Diagnostic example from CANopen Gateway module version A-08 [▶ 158]

10.7 Node guarding

An NMT master (e.g. a PLC with integrated CANopen master) uses the NMT-Error-Control object to detect a failure of an NMT slave with the

address N. The NMT slave must respond to the query of the NMT master within the node guarding time. The node guarding time must be monitored by the NMT master.

The NMT master sends a CAN message with the identifier <700h + node ID> and RTRBit (remote transmission request).

Query of NMT master:

Table 96: Query of NMT master

CAN-ID	RTR	DLC	DATA							
700h + N	1	0								

The slave (e.g. the SP-CANopen module) then sends a state byte 1 with the following content:

Response of the slave:

Table 97: Response of the slave

CAN-ID	DLC	DATA							
700h + N	1	Byte1							

Table 98: Remote transmission request

Bit	Meaning	
7	Toggle bit changes its value between two consecutive queries	
6…0	NMT status	4 = Stopped 5 = Operational 127 = Pre-operational

Bootup

On booting, the gateway sends a bootup message with the CAN-ID 700h+N, DLC = 1 and byte 1 = 0.

Heartbeat producer

When the gateway has been configured as a heartbeat producer (i.e. when SDO 1017 contains a value for the producer heartbeat time, see table *"Supported SDOs" [ch. 10.10, p. 145]*), then sends a cyclical message with the CAN-ID 700h+N, DLC = 1 and Byte 1 = 05h. The toggle bit (bit 7) is always 0.

Heartbeat consumer

When the gateway has been configured as a heartbeat consumer (i.e. when SDO 1016.1 contains a value for the consumer heartbeat time, see table *"Supported SDOs" [ch. 10.10, p. 145]*), then at least one node guarding message must be received within the configured consumer heartbeat time (typically from a NMT master).

10.8 PDO communication

Process data objects (PDOs) are the real-time objects of the CANopen field bus. They are sent without a protocol overhead, i.e. the receiver sends no confirmation.

The SP-CANopen module provides four transmit process data objects (TxPDOs), which contain the process data to be sent to the network, and four receive process data objects (RxPDOs) for the process data received from the network.

CANopen objects are addressed with the aid of 11-bit CAN identifiers. As a pre-set, the CAN identifier derives each object from the object type and the configured CANopen device address. The CAN identifier of the PDOs can be changed by using SDOs 1400 to 1403 for the RxPDOs and SDOs 1800 to 1803 for the TxPDOs ("PDO linking").

NOTICE

Each process data object contains 8 bytes.

The content of the process data objects can be freely selected, but has been preconfigured as follows in samos® PLAN 6:

Table 99: Preset for the content of the transmit process data objects (TxPDOs) of the SP-CANopen module

	PDO#1	PDO#2	PDO#3	PDO#4
	Output data - Block 1	**Output data - Block 2**	**Output data - Block 3**	**Output data - Block 4**
Byte 0	Input values for Module 0 (I1..I8)	Input values for Module 1	Input values for Module 9	Output values for Module 5
Byte 1	Input values for Module 0 (I9..I16)	Input values for Module 2	Input values for Module 10	Output values for Module 6
Byte 2	Input values for Module 0 (IQ1..IQ4)	Input values for Module 3	Input values for Module 11	Output values for Module 7
Byte 3	Output values for Module 0 (Q1..Q4,IQ1-IQ4)	Input values for Module 4	Input values for Module 12	Output values for Module 8
Byte 4	Direct data (Off) 1	Input values for Module 5	Output values for Module 1	Output values for Module 9
Byte 5	Direct data (Off) 2	Input values for Module 6	Output values for Module 2	Output values for Module 10
Byte 6	Direct data (Off) 3	Input values for Module 7	Output values for Module 3	Output values for Module 11
Byte 7	Direct data (Off) 4	Input values for Module 8	Output values for Module 4	Output values for Module 12

Detailed information about the content of the process diagram may be found here:
Configuring the gateway output values (tab 1) [ch. 5.4, p. 49]

You will find further information about how to configure the process diagram here:

- *Configuration of gateways with samos® PLAN 6 [ch. 5, p. 41]*
- Software manual

NOTICE

- The process data can also be written and read with the aid of service data objects SDO 6000 and SDO 6200 (see *SDO communication [ch. 10.9, p. 144]*). Easy access via SDO is recommended for diagnostic purposes. More rapid PDO communication is to be used for normal operation.
- After starting up or changing the configuration (either with the aid of the CANopen master or with samos® PLAN 6), the LED MS of the CANopen gateway flashes red/green until an initial transmit/receive data exchange has taken place via PDO or SDO 6000/SDO 6200 in the CANopen network.

TxPDO 1…4

A transmit-PDO transmits data from the CANopen gateway to a CANopen device.

Table 100: TxPDO 1…4

CAN ID	DLC	Data							
181-1FF	8	B1	B2	B3	B4	B5	B6	B7	B8
281-2FF	8	B9	B10	B11	B12	B13	B14	B15	B16
381-3FF	8	B17	B18	B19	B20	B21	B22	B23	B24
481-4FF	8	B25	B26	B27	B28	B29	B30	B31	B32

B1…B32: CAN telegram bytes as in the network input data, with the aid of samos® PLAN 6 (see *Configuring the gateway output values (tab 1) [ch. 5.4, p. 49]*).

The gateway sends one or several TxPDOs when at least one of the following events occurs:

- At least one input or output byte has changed its value and the transmission type for the TxPDO that contains this byte has the value 255.
- At least one input or output byte has changed its value and the gateway contains a SYNC command and at least one TxPDO has transmission type 0.
- When the transmission type is n = 1 ... 240, n sync commands are required in order to send the TxPDO.
- The transmission type for a TxPDO is 254 or 255 and the event timer (SDO 1800,5 for TxPDO1) has a value of N > 0. In this case this TxPDO is sent every N ms.
- A TxPDO can also be called up with the aid of a remote transmission request (RTR). This requires a CAN telegram to the gateway that contains the CAN-ID of the desired TxPDOs with DLC = 0 and RTR = 1.

The operating state of the device must be "operational" for all transmission methods (see *Table "Network management for all NMT slaves" [ch. 10.4, p. 134]*).

RxPDO 1…4

A receive-PDO transmits data from a CANopen device to the CANopen gateway.

Table 101: RxPDO 1…4

CAN ID	DLC	Data							
201-1FF	8	B1	B2	B3	B4	B5	B6	B7	B8
301-2FF	8	B9	B10	B11	B12	B13	B14	B15	B16
401-3FF	8	B17	B18	B19	B20	B21	B22	B23	B24
501-4FF	8	B25	B26	B27	B28	B29	B30	B31	B32

B1…B32: CAN telegram bytes as for the gateway input data, with the aid of samos® PLAN 6.

The transmission type 255 is preset for all RxPDOs. This means that the gateway immediately transmits the RxPDO data on to the controller module. This setting cannot be changed.

10.9 SDO communication

SDOs are service data objects. They contain a wide spectrum of different data. This includes configuration as well as input and output data.

Contrary to PDO communication, the receipt of each SDO is answered at protocol level,

i.e. the receiving device sends a confirmation.

This CANopen PCS implementation supports the following protocols:

- SDO Download Expedited (write SDO)
- SDO Upload Expedited (read SDO)
- Upload SDO Segment Protocol (segmented reading of an SDO)

SDO Download Expedited (write SDO)

The client sends a request to server N. The 16-bit index and the sub-index for the SDO to be written form part of this message. In addition, the request contains 4 data bytes with the data to be written.

Table 102: Write SDO

CAN ID	DLC	Data							
600h + N	8	23h	SDO_L	SDO_H	SUB	Byte 1	Byte 2	Byte 3	Byte 4

SDO_L = SDO-Index, Low Byte

SDO_H = SDO-Index, High Byte

SUB = SDO-Subindex

The server then responds with a confirmation:

Table 103: SDO write confirmation

CAN ID	DLC	Data							
580h + N	8	60h	SDO_L	SDO_H	SUB	Byte 1	Byte 2	Byte 3	Byte 4

Byte 1 to 4 in the write confirmation contain zeros.

SDO Upload Expedited (read SDO)

The client requests the content of an SDO by submitting a request to server N. The 16-bit index and the sub-index for the SDO to be read form part of this message. Byte 1 to 4 in the read request contain zeros.

Table 104: Read SDO

CAN ID	DLC	Data							
600h + N	8	40h	SDO_L	SDO_H	SUB	Byte 1	Byte 2	Byte 3	Byte 4

The server responds with the following message. Bytes 1 to 4 contain the value of the requested object.

Table 105: SDO read confirmation

CAN ID	DLC	Data							
580h + N	8	42h	SDO_L	SDO_H	SUB	Byte 1	Byte 2	Byte 3	Byte 4

The CANopen data types UDINT and UINT

In order to transmit the data types UDINT or UINT, the data must be in Intel format. For example, the 32-bit value 12345678h in data bytes 5, 6, 7 and 8 must be transmitted in the following order: [5] = 78, [6] = 56, [7] = 34, [8] = 12.

NOTICE

This also applies to the SDO index in data bytes 2 and 3, which is of the data type UINT. This means that the low byte is transmitted in data byte 2 and the high byte in data type 3.

Example: The following messages are required to read SDO 1003,1 of the CANopen device with device address 2. The data type of the data to be read is UDINT.

The client sends:

CAN ID	DLC	Data							
602h	8	40h	03h	10h	01h	00h	00h	00h	00h

The server responds:

CAN ID	DLC	Data							
582h	8	42h	03h	10h	01h	08h	00h	50h	02h

The combined response data result in the 32-bit word 02500008h.

10.10 SDO object directory

Each CANopen device manages its SDOs in an object directory. The complete object directory is formally described in an EDS file. Many CANopen tools can ready this EDS file and therefore know the object characteristics of the CANopen device.

The following table shows all SDOs for the SP-CANopen gateway.

Table 106: Supported SDOs

SDO #	Type
1000	Device type

SDO #	Type
1001	Error register
1003	Error list (error history)
1005	COB ID SYNC
1008	Device name
1009	Hardware version
100 A	Software version
100C	Guard Time
100D	Life Time Factor
1016	Consumer Heartbeat Time
1017	Producer Heartbeat Time
1018	Identification
1027	Module list
1400…1403	Communication parameter for RxPDO 1 … 4
1600…1603	Mapping parameter for RxPDO 1 … 4
1800…1803	Communication parameter for TxPDO 1 … 4
1A00…1A03	Mapping parameter for TxPDO 1 … 4
3100	Module state bits
3200	Project CRC
3300	Module type code
6000	Process data input objects
6200	Process data output objects

You will find more detailed information about these SDOs in the CANopen standard draft DS 301 V4.02 (DSP 301 V4.1).

SDO 1001: Error register

The error register is a bit field of 8 bits and indicates the type of error if one of the subsequent bit positions is set to "1".

Table 107: Unsupported error register values

Bit position	Meaning
0	"generic error"
4	"communication error"
7	"communication error"

SDO 1003: Error list (error history)

SDO 1003 is an array that contains the last 10 error codes that the gateway has reported with the aid of emergency messages. Array index 0 contains the number of error codes recorded in SDO 1003.

A new error is recorded in index 1, while older errors will in this case be renumbered (incremented by 1). The array index can be overwritten with a 0 from the outside, thus completely deleting the array.

NOTICE

- Not all errors reported with the aid of emergency messages are recorded in SDO 1003, only the errors listed here:
  Error and state information for the modules [ch. 3.3.4, p. 27] and table "*CANopen Emergency Messages [ch. 10.6, p. 136]*"
- The entries in SDO 1003 are in UDINT format and normally divided into 16 bits of error code and 16 bits of additional information. In the event of an emergency, the module state diagnosis (4 bytes) will be entered here.

SDO 1005: COB ID SYNC

SDO 1005 contains the COB-ID of the sync object. This value has been preset to 80h, but can be changed.

NOTICE

When you change the COB-ID of the sync object, please ensure that the new ID has not already been allocated to another communication object.

SDO 1008: Device name

SD0 1008 contains a device name (VISIBLE STRING).

NOTICE

This SDO cannot be read with a simple "SDO upload expedited". The "Upload SDO segment protocol" command (client command code ccs = 3) must be used instead, as described in the CANopen specifications DS 301.

SDO 1009: Hardware version

SDO 1009 contains the current hardware version of the device (VISIBLE STRING).

NOTICE

This SDO cannot be read with a simple "SDO upload expedited". The "Upload SDO segment protocol" command (client command code ccs = 3) must be used instead, as described in the CANopen specifications DS 301.

SDO 100A: Software version

SDO 100A contains the current software version of the device (VISIBLE STRING).

NOTICE

This SDO cannot be read with a simple "SDO upload expedited". The "Upload SDO segment protocol" command (client command code ccs = 3) must be used instead, as described in the CANopen specifications DS 301.

SDO 100C: Guard Time

The guard time (UINT) multiplied by the life time factor (SINT) results in the life guarding time.

Life Guarding Time [ms] = Guard Time [ms] × Life Time Factor

During the Life Guarding Time, the master must send at least one node guarding message to the slave. When the life guarding time is exceeded (life guarding error), the gateway reports a cable break error and sets all network process data to 0; the LED NS starts to flash red.

In the slave, life guarding is activated by the first node guarding message when the life guarding time has not been set to 0. When the guard time or the life time factor are set to 0 after activating life guarding, life guarding will be deactivated.

Also see: *Guarding protocols [ch. 10.11, p. 151]*.

SDO 100D: Life Time Factor

SDO 100D contains the Life Time Factor (SINT). See SDO 100C.

NOTICE

The Life Time Factor must either be = 0 (deactivated) or V 1.5.

SDO 1016: Consumer Heartbeat Time

The gateway is configured as a heartbeat consumer if SDO 1016 contains a value greater than 0 for the consumer heartbeat time. The consumer heartbeat time is given in ms.

The NMT master must send at least one node guarding message to the slave within this time. When the consumer heartbeat time is exceeded (life guarding error), the gateway reports a cable break error and sets all network process data to 0; the LED NS starts to flash red.

SDO 1017: Producer Heartbeat Time

The gateway can also act as a heartbeat producer, i.e. send a heartbeat signal.

This allows another device to detect whether the heartbeat producer (i.e. the gateway) is still functioning correctly.

The producer heartbeat time is given in ms. For internal processing, it is rounded up to the next higher multiple of 4. If the heartbeat time is set to 0, the heartbeat signal is deactivated.

The heartbeat signal consists of a cyclic CAN message with the identifier 700h + device address.

NOTICE

It is not possible to use heartbeat signals and life guarding messages simultaneously, as both functions make use of the same CAN identifier.

Also see: *Guarding protocols [ch. 10.11, p. 151]*

SDO 1018: Identification

This SDO contains basic information about the gateway.

Table 108: Content of SDO 1018

Subindex	Mapping	Format	Description
1	Manufacturer ID	UDINT	Unique manufacturer identification number (e.g. Wieland Electric)
2	Product description	UDINT	Device variant
3	Revision number	UDINT	Software version of the device
4	Serial number	UDINT	Serial number of the device

SDO 1027: Module list

The module list contains the module type and diagnostics ID (module ID) of all safe samos®PRO modules in the system.

Example:

Subindex = 03 -> 0x00000602, whereby: 02 = Diagnostics ID[1)] 06 = module type[2)]
Further information: [1)] See: Table *"CANopen Emergency Messages" [ch. 10.6, p. 136]* [2)] See below: Table "Module types"

Table 109: Content of SDO 1027

Subindex	Meaning	Format
0	SDO 1027 entries	SINT
1…15	Module slot positions	SINT

Table 110: Module types

Subindex	Module type
0	SP-COP1 (CPU without Ethernet)

Subindex	Module type
1	SP-COP2-EN (CPU with Ethernet)
2	SP-COP2-ENI (CPU with Modbus/TCP, PROFINET IO, EtherNet/IP)
4	SP-SDI (secure input module)
6	SP-SDIO (secure I/O module)
7	PROFIBUS DP gateway
9	CANopen gateway
14	SP-DIO (non-secure I/O module)
22	EtherCAT gateway

SDO 1400 … 1403: Communication parameters for the RxPDOs

SDO 1400 to 1403 can be used to configure the communication parameters for RxPDOs 1 to 4, e.g. SDO 1400 defines the parameters for RxPDO 1, etc.

Table 111: Content of SDO 1400 ... 1403

Subindex	Mapping	Format	Description
1	COB ID	UDINT	CAN identifier for this PDO, write-protected
2	Receive mode	SINT	Fix 255 (asynchronous mode)

The receive mode (read/write) determines how the PDO is to be received. For RxPDOs, the receive mode has been set to 255 (asynchronous mode). In this mode, the data of a RxPDOs received are directly routed to the outputs.

NOTICE

When the receive mode is set to a value other than 255, an error code is generated (abort code 0609 0030h, invalid parameter value).

SDO 1600 … 1603: Mapping parameters for the RxPDOs

This SDO cannot be used, as mapping of the RxPDOs takes place with the aid of the samos® PLAN 6.
Also see: Table *"Pre-set for the content of the transmit process data objects (TxPDOs)" [ch. 10.8, p. 143]*

SDO 1800 … 1803: Communication parameters for the TxPDOs

SDO 1800 to 1803 can be used to configure the communication parameters for TxPDOs 1 to 4, e.g. SDO 1800 defines the parameters for TxPDO 1, etc.

Table 112: Content of SDO 1800 ... 1803

Subindex	Mapping	Format	Description
1	COB ID	UDINT	CAN identifier for this PDO, write-protected
2	Transmission type	SINT	Defines when the PDO is to be sent
5	Event timer	UINT	in ms

The transmission type for all TxPDOs to 255 (asynchronous mode, event-driven) has been preset.

The event timer contains the time in Ms for the cyclic transmission of the TxPDOs.

Transmission types for the TxPDOs

Table 113: Transmission types for the TxPDOs

TxPDO	Synchronous	Asynchronous	RTR
1, 2, 3, 4	0, 1…240	254, 255	253

NOTICE

When the transmission type is set to an invalid value, an error code is generated (abort code 0030 0030h, invalid parameter value).

Synchronous: Synchronous transmission mode 0 means that the TxPDO is sent after receiving a Sync command, but only if data has changed. The synchronous transmission types n = 1 ... 240 mean that the TxPDO is sent after the nth Sync command is received.

Asynchronous, event-driven by timer: The asynchronous transmission type 254 (with a configured event timer) means that the TxPDO is sent each time when the event timer has expired. For example, a value of 500 for the event timer means that the gateway sends the respective TxPDO every 500 ms.

Asynchronous, event-driven with change of state: The asynchronous transmission mode 255 (without configured event timer) means that the TxPDO is sent each time at least one input bit contained in this PDO has changed.

Asynchronous, event-controlled by timer or status change: The asynchronous transmission type 255 (with a configured event timer) means that the TxPDO is sent each time when the event timer has expired or at least one input bit has changed. For example, a value of 500 for the event timer means that the gateway sends the respective TxPDO at least every 500 ms or in case of a change.

RTR, on request: Transmission type 253 means that the TxPDO can be requested with the aid of an RTR (remote transmission request). This requires a CAN message to the gateway with DLC = 0, RTR = 1 and the COB-ID of the TxPDO. The gateway then responds with the requested TxPDO.

SDO 1A00 … 1A03: Mapping parameters for the TxPDOs

This SDO cannot be used, as mapping of the TxPDOs takes place with the aid of the samos® PLAN 6.

Also see: Table "*Pre-set for the content of the transmit process data objects (TxPDOs) [ch. 10.8, p. 143]*"

SDO 3100: Module state bits

SDO 3100 contains the module state bits of the samos® PRO system (see *Table "CANopen Emergency Messages" [ch. 10.6, p. 136]*). Active bits are low (= "0").

Table 114: Content of SDO 3100

SDO array	Data set parameters	Module	Size
3100.1-3	Status of Module 0	Controller module	UDINT
3100.4	Status of Module 1	Expansion	UDINT
…	…	…	…
3100.14	Status of Module 11	Expansion	UDINT
3100.15	Status of Module 12	Expansion	UDINT

NOTICE

The positions of the modules are numbered in the samos® PLAN 6 from 0 to 14. Thus the sub-index for SDO 3100 = Position + 3, with the first three sub-indices for the SP-COPx module being used.

SDO 3100 can only be read.

SDO 3200: Project CRC, internal CRC, reserved

Table 115: Content of SDO 3200

SDO array	Data set parameters	Size
3200.1	Project CRC	UDINT

SDO array	Data set parameters	Size
3100.2	System CRC[1)]	UDINT
3200.3	Reserved (EFI ACR CRC)	UDINT
[1)] The use of the internal CRC in dataset 2 is only permitted for diagnostic purposes so that Wieland Technical Support can provide further assistance.		

SDO 6000: Process data input objects

The 32 bytes of the process input data can be written into SDO array 6000. These are the same data as in RxPDO 1-4 (see *PDO Communication [ch. 10.8, p. 142]*). The mapping is as follows:

Table 116: Mapping table for SDO 6000 – RxPDO 1-4

SDO 6000	RxPDO
6000.1	RxPDO 1, Byte 1
…	…
6000.8	RxPDO 1, Byte 8
6000.9-16	RxPDO 2, Byte 1-8
6000.17-24	RxPDO 3, Byte 1-8
6000.25-32	RxPDO 4, Byte 1-8

SDO 6000 can only be written.

SDO 6200: Process data output objects

The 32 bytes of the process output data can be written into SDO array 6200. These are the same data as in TxPDO 1-4 (see *PDO Communication [ch. 10.8, p. 142]*). The mapping is as follows:

Table 117: Mapping table for SDO 6200 – TxPDO 1-4

SDO 6200	TxPDO
6200.1	TxPDO 1, Byte 1
…	…
6200.8	TxPDO 1, Byte 8
6200.9-16	TxPDO 2, Byte 1-8
6200.17-24	TxPDO 3, Byte 1-8
6200.25-32	TxPDO 4, Byte 1-8

SDO 6200 can only be read.

10.11 Guarding protocols

CANopen offers several possibilities for active monitoring of the correct function of the field bus interface (e.g. cable break detection).

WARNING

Always use either node guarding or heartbeat!

Guarding is compulsory according to the CIA CANopen specifications DS 301. Please always active either node guarding or heartbeat. When no guarding has been configured, the samos® PRO system cannot detect an interruption of the CANopen communication, for example an interrupted network cable. In this case the input and output data of the CANopen gateway may "freeze".

Heartbeat

A heartbeat producer is a CANopen device that sends a cyclic heartbeat message. This makes it possible for all other CANopen devices to detect whether the heartbeat producer still functions correctly and what its current status is. Heartbeat messages are transmitted at regular intervals, the Producer Heartbeat

Time, which may be configured with the aid of SDO 1017. The configured 16-bit value

is rounded up to the next higher multiple of 4 ms.

A heartbeat consumer is a CANopen device that expects a cyclic node guarding message within a certain time interval, i.e. the consumer heartbeat time, which can be configured with the aid of SDO 1016. If the heartbeat consumer does not receive a node guarding message within the configured consumer heartbeat time, it sends a life guarding emergency message and sets the process input data to 0. In addition, the gateway sends a "cable break" error message that can be processed by the controller module.

Node guarding

Node guarding is carried out by a NMT master. This can be any CANopen device that can fulfill this function as a client. The NMT master sends a cyclic node guarding message to the device to be monitored, which must respond within a certain time, which is monitored by the NMT master. If the device to be monitored does not respond within the node guarding time, the NMT master treats this as a malfunction of the device and takes the corresponding actions.

Life Guarding

Life guarding is carried out by the gateway itself. In the gateway, the life guarding time is calculated from the values of SDO 100C (guard time) and SDO 100D (life time factor). If the gateway does not receive a node guarding message from an NMT master once within this life guarding time, the gateway sends an internal "cable break" error message, which can be processed by the controller module, and the LED NS starts to flash red.

NOTICE

- The gateway can detect a cable break when life guarding has been activated, i.e. when both SDO 100C and SDO 100D have a value not equal to 0. In this case, Life Guarding starts as soon as the first Node Guarding request is received from an NMT master and ends when the master sends the “Reset Communication” command.
- Alternatively cable break detection is possible when the gateway has been configured as a heartbeat consumer. In this case the cable break detection is carried out by the gateway itself.
- Heartbeat (producer) works without node guarding. In this case gateway cannot detect a cable break on the field bus.
- Heartbeat and node guarding / life guarding cannot be simultaneously used.
- If the configuration has been changed in such a way that life guarding is deactivated or activated, the entire samos® PRO system must be restarted, so that the CANopen network communication can again be correctly established.

The following table provides an overview of the supported guarding protocols, depending on the configuration of SDO 1016 and SDO 1017 (heartbeat), SDO 100C (guard time) and SDO 100D (life time factor).

Table 118: Overview and comparison of the guarding protocols

SDO 1016	SDO 1017	SDO 100C × 100D	Heartbeat gateway	Life Guarding Gateway	Node guarding NMT master
0	0	0	Not permitted: Always make use of either node guarding or heartbeat!		
0	0	> 0	Deactivated	**Cable break detection**	**Required**

SDO 1016	SDO 1017	SDO 100C × 100D	Heartbeat gateway	Life Guarding Gateway	Node guarding NMT master
> 0	0	0	**Cyclic heartbeat (consumer)**	**Cable break detection**	**Possible for other slaves**
0	> 0	0	**Cyclic heartbeat (producer)**	Not possible	Not possible, but guarding as a heartbeat consumer is possible
> 0	> 0	0	**Cyclic heartbeat (producer und consumer)**	Cable break detection	Not possible
> 0	> 0	> 0	**Not permitted**		

NOTICE It does not make sense to use heartbeat and life guarding simultaneously.

10.12 Error objects

The SP-CANopen module reports CAN-specific errors (e.g. initialization errors, cable brackets, CAN communication errors) to the controller module as internal safety bus errors.

Emergency object

The emergency producer (CANopen gateway) sends the emergency object to the emergency consumer (any CANopen device, usually the controller) when CAN-specific errors occur or an error state occurs, as described in the table *"CANopen Emergency Messages" [ch. 10.6, p. 136]*.

The emergency object is sent as described in DS 301 (CANopen specifications) in accordance with the following table:

Table 119: Emergency states and transitions

Emergency state Before	Transition	Module-specific alarms	Emergency state After
Error-free	1	Incoming error	Error occurred
Error occurred	2	Error removed, other errors pending	Error occurred
Error occurred	3	Incoming error, other errors pending	Error occurred
Error occurred	4	All errors removed	Error-free

The gateway is in one of two possible emergency states, either *error-free* or *errors detected*. Emergency objects are sent, depending on the transitions between these two emergency states. The error code in the emergency object shows the emergency state in which the gateway currently is (also see table below).

Overview of error objects

Table 120: CAN-specific errors

Error	Internal safety bus error code	Error type	Emergency error code Error register M1…M5	Error history SDO 1003	Results/possible remedy
CAN data overflow CAN control overflow in Rx Fifo	0x4501	Warning	0x8110 0x11 1, 0, 0, 0, 0	–	• CAN messages have been lost. • Limited band width. • Check the CAN settings, increase the baud rate, reduce the number of participants or the data volume.
CAN-error-passive CAN control takes place in an error-passive state	0x4503	Warning	0x8120 0x11 0, 0, 0, 0, 0	–	The gateway is only sending recessive bits, i.e. it is invalidating its own messages. The cause is either a hardware fault on the gateway or an external malfunction of the data transmission. • Check the cabling.
CAN bus off The CAN controls are in the bus off state	0x4504	Warning	–	–	Major transmission error. The CAN controls have separated the connection to the bus. Possible hardware defect. • Switch the samos® PRO system off and on again.
CAN-Tx-Fifo overflow The CAN controls have no transmission resources	0x4506	Warning	0x8110 0x11 2, 0, 0, 0, 0	–	CAN messages that were to be sent from the gateway have been lost. The number of events for which the gateway is to send CAN messages is too high for the set baud rate. • Increase the baud rate or change the configuration of the gateway.
CAN initialization failed. The CAN controls could not be initialized	0xC507	Critical	–	–	The CAN controls or the transceiver may be defective. • Replace the SP-CANopen module with a new device.
CANopen Life Guarding CANopen Life Guarding has found a cable break	0x4508	Warning	0x8130 0x11 0, 0, 0, 0, 0	–	The gateway has generated a life guarding error message: Either an error has occurred on the node guarding or the heartbeat NMT master or the CAN cable has been interrupted. • Check the CANopen master. • Check the cabling.

Table 121: Module-specific alarms

Alarm	Internal safety bus error code	Emergency state transition	Emergency error code Error register M1…M5	Error history SDO 1003	Further information
Gateway detects incoming error according to trigger conditions	–	1	0xFF01 0x81 M1 = Module index M2…M5 = Module diagnostic data	M2, M3, M4, M5	See *Table "CANopen Emergency Messages" [ch. 10.6, p. 136]*
Gateway detects outgoing error, other errors exist	–	2	0xFF02 0x81 M1 = Module index M2…M5 = Module diagnostic data	M2, M3, M4, M5	
Gateway detects incoming error, other errors exist	–	3	0xFF03 0x81 M1 = Module index M2…M5 = Module diagnostic data	M2, M3, M4, M5	
All errors removed	–	4	0x0000 0x00 M1 = 0 M2…M5 = 0	–	

10.13 CANopen diagnostic examples

Example 1: Secure IO module in position 3, output Q4 has a short-circuit to high

The gateway sends am Emergency message (see Table "*CANopen Emergency Messages [ch. 10.6, p. 136]*").

CAN-ID	DLC	DATA							
08C	8	03	FF	01	03	40	00	00	00

The CANopen address of the gateway is 12 (= C Hex). The secure IO module has position 1 in the samos® PRO system.

08C: Identifier (80 + C)

8: Data length code: This is followed by 8 bytes

03FF: Error code FF03: Device-specific error

01: Error register 01 of SDO 1001H

03: Module index M1: Module in position 3

40: Module state bit 30 (bit 6 of byte M2) = 1: Short-circuit to high at output 4 (see *Table "CANopen Emergency Messages" [ch. 10.6, p. 136]*)

Reading the current module status bits from SDO 3100:

PLC requests:

CAN-ID	DLC	DATA							
60C	8	40	00	31	04	00	00	00	00

60C: Identifier (600 + C)

8: Data length code: This is followed by 8 bytes

40: Expedited upload requirement

00 31: Index 3100

04: Subindex: Module in Position 1 (module position = subindex – 3)
(See table *"Content of SDO 3100" [ch. 10.10, p. 150]*)

Gateway response:

CAN-ID	DLC	DATA							
58C	8	42	00	31	04	BF	FF	FF	FB

58C: Identifier (580 + C)

8: Data length code: This is followed by 8 bytes

42: Upload response, size of data set is not shown

00 31: Index 3100

04: Subindex: Module in Position 1 (module position = subindex – 3)
(See table *"Content of SDO 3100" [ch. 10.10, p. 150]*)

FB: Error byte M5, Bit 2 = 0: external error

BF: Error byte M2, Bit 30 = 0. Error: Short-circuit after high at Output 4

Reading of error from the error history in SDO 1003:

PLC requests:

CAN-ID	DLC	DATA							
60C	8	40	03	10	01	00	00	00	00

60C: Identifier (600 + C)

8: Data length code: This is followed by 8 bytes

40: Expedited upload requirement

03 10: Index 1003

01: Sub-index: last error

Gateway response:

CAN-ID	DLC	DATA							
58C	8	42	03	10	01	40	00	00	00

58C: Identifier (580 + C)

8: Data length code: This is followed by 8 bytes

42: Upload response, size of data set is not shown

03 10: Index 1003

01: Sub-index: last error

40: Module state bit 30 (bit 6 of byte M2) = 0: Short-circuit after high at Output 4

Example 2: Secure I/O module with error at two-channel input I1/I2

The gateway sends am Emergency message (see *Table "Emergency Messages [ch. 10.6, p. 136]*").

CAN-ID	DLC	DATA							
08C	8	03	FF	01	0B	00	00	01	00

The CANopen address of the gateway is 12 (= C Hex). The SP-SDI module has position 11 in the sam-os® PRO system.

08C:	Identifier (80 + C)
8:	Data length code: This is followed by 8 bytes.
03FF:	Error code FF03: Device-specific error
01:	Error register 01 of SDO 1001H
0B:	Module index M1: Module in position 11 (B Hex)
01:	Module status bit 8 (bit 0 of byte M4) = 1: dual channel evaluation of inputs 1–2: Error detected (see *Table "CANopen Emergency Messages" [ch. 10.6, p. 136]*)

Reading the current module status bits from SDO 3100:

PLC requests:

CAN-ID	DLC	DATA							
60C	8	40	00	31	0F	00	00	00	00

60C:	Identifier (600 + C)
8:	Data length code: This is followed by 8 bytes
40:	Expedited upload requirement
00 31:	Index 3100
0F:	Subindex 0F = Module to position 12 (module position = subindex – 3) (see also table *"Content of SDO 3100" [ch. 10.10, p. 150]*)

Gateway response:

CAN-ID	DLC	DATA							
58C	8	42	00	31	0F	FF	FF	FE	FB

58C:	Identifier (580 + C)
8:	Data length code: This is followed by 8 bytes
42:	Upload response, size of data set is not shown
00 31:	Index 3100
04:	Subindex: Module in Position 1 (module position = subindex – 3) (See table *"Content of SDO 3100" [ch. 10.10, p. 150]*)
FB:	Error byte M5, Bit 2 = 0: external error
FE:	Error byte M4, bit 0 = 0: two-channel evaluation of inputs 1–2: Error detected (See *Table "CANopen Emergency Messages" [ch. 10.6, p. 136]*)

Reading of error from the error history in SDO 1003:

PLC requests:

CAN-ID	DLC	DATA							
60C	8	40	03	10	01	00	00	00	00

60C:	Identifier (600 + C)
8:	Data length code: This is followed by 8 bytes
40:	Expedited upload requirement
03 10:	Index 1003
01:	Sub-index: last error

Gateway response:

CAN-ID	DLC	DATA							
58C	8	42	03	10	01	00	00	01	00

58C:	Identifier (580 + C)
8:	Data length code: This is followed by 8 bytes
42:	Upload response, size of data set is not shown
03 10:	Index 1003
01:	Sub-index: last error
01:	Module status bit 8 (bit 0 of byte M4) = 0: two-channel evaluation of inputs 1–2: Error detected

10.14 Diagnostic example from CANopen Gateway module version A-08

Example of emergency message: Dual channel evaluation of inputs I1/I2 not OK

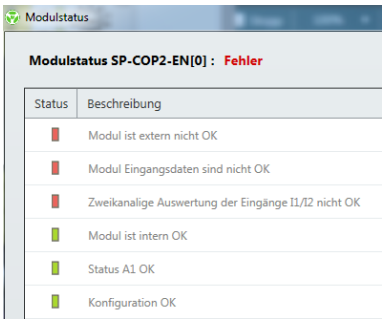


Illustration 43: Module status display of the error in samos® PLAN 6

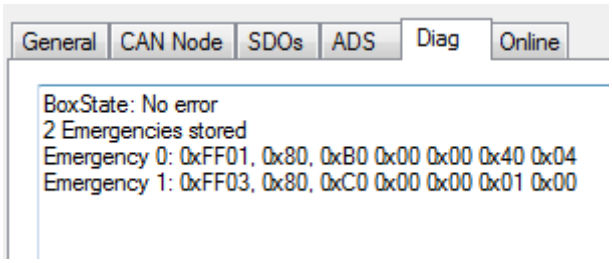


Illustration 44: Emergency message from the diagnostics of a PLC

Table 122: Decoding of the Emergency 0 message

ErrL, ErrH	0xFF01	Gateway detects incoming error according to trigger conditions	See *Module-specific alarms [ch. 10.12, p. 155]*
Err-Reg	0x80	Error register corresponds to SDO 1001:00 "80" 7-bit high: Manufacturer: Specific	See *Availability of data sets 1–4 [ch. 3.3, p. 21]*
M1	0xB0	Diagnostics ID 11 (B): Bit 00 – 31 (Byte 0 – 3) Module index: 0	See *Emergency messages [ch. 10.6, p. 136]*
M2	0x00	Diagnostic bit 24 – 31 (Byte 3): –	See *Emergency messages [ch. 10.6, p. 136]* See *CANopen emergency messages [ch. 10.6, p. 136]* See *Meaning of module state bits of controller module SP-COPx (only for Modbus) [ch. 3.3.4, p. 27]*SP-COPx
M3	0x00	Diagnostic bit 16 – 23 (Byte 2): –	
M4	0x40	Diagnostic bit 8 – 15 (Byte 1): Module state input data	
M5	0x04	Diagnostic bit 0 – 7 (Byte 0): External module status	

Table 123: Decoding of the Emergency 1 message

ErrL, ErrH	0xFF03	Gateway detects incoming error, other errors exist	See *Module-specific alarms [ch. 10.12, p. 155]*
Err-Reg	0x80	Error register corresponds to SDO 1001:00 "80" 7-bit high: Manufacturer: Specific	See *Availability of data sets 1–4 [ch. 3.3, p. 21]*

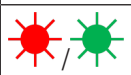
M1	0xC0	Diagnostics ID 12 (B): Bit 32 – 63, Module index: 0	See *Emergency messages [ch. 10.6, p. 136]*
M2	0x00	Diagnostic bit 56 – 63 (Byte 7): –	See *Emergency messages [ch. 10.6, p. 136]* See *CANopen emergency messages [ch. 10.6, p. 136]* See *Meaning of module state bits of controller module SP-COPx (only for Modbus) [ch. 3.3.4, p. 27]*SP-COPx
M3	0x00	Diagnostic bit 48 – 55 (Byte 6): –	
M4	0x01	Diagnostic bit 40 – 47 (Byte 5): I1/I2 dual channel status	
M5	0x00	Diagnostic bit 32 – 39 (Byte 4): –	

10.15 Diagnostics and troubleshooting

You can find information on the diagnostics of the samos® PRO system in the software manual.

Table 124: Troubleshooting on the SP-CANopen module

Error		Possible cause	Possible remedy
Key: ○ LED off / ✳ LED flashes / ● LED lights up			
The SP-CANopen module does not provide any data.		• Configuration required, node guarding or heartbeat message was not sent. • The configuration has not yet been fully transmitted.	• Configure the SP-CANopen module and transfer the configuration to the system. • Wait until the configuration has been fully transferred.
LED PWR	● Green		
LED NS	○ Off		
MS LED	✳ Red (1 Hz)		
The SP-CANopen module does not provide any data.		The configuration has not yet been fully transmitted.	Wait until the configuration has been fully transferred.
LED PWR	● Green		
LED NS	● Green		
MS LED	✳ Red (1 Hz)		
The SP-CANopen module does not provide any data.		No PDO transfer since switch-on.	• Start the PDO transfer. • Transfer the PDO via SDO 6000 or SDO 6200.
LED PWR	● Green		
LED NS	● Green		
MS LED	✳ / ✳ Red / green		
The SP-CANopen module does not provide any data.		• No PDO transfer since switch-on. • Wrong baud rate (CAN transceiver possibly in error passive). • Wrong node ID or CANopen address.	• Start the PDO transfer. • Transfer the PDO via SDO 6000 or SDO 6200. • Check and correct the baud rate. • Check and correct the address.
LED PWR	● Green		
LED NS	✳ Green		

Error		Possible cause	Possible remedy
MS LED	 Red / green	• The CAN cable was interrupted.	• Check the CANopen cabling.
The SP-CANopen module does not provide any PDO data.		• The SP-CANopen module is in the Idle state. • Node guarding or heartbeat messages are sent. • The samos® PRO configuration has not been verified and the controller module has been stopped.	• The controller module/application is stopped. • Start the controller module (switch to Run mode). • Verify the configuration with the samos® PLAN 6 and start the controller module.
LED PWR	Green		
LED NS	Off /l Red / l Green		
MS LED	 Green (1 Hz)		
The SP-CANopen module does not provide any PDO data.		Supply voltage too low.	Check the power supply.
LED PWR	Green		
LED NS	Green		
MS LED	Off		
The SP-CANopen module does not provide any data.		Brief drop in power supply.	• Check the power supply. • Reset the samos® PRO system.
LED PWR	Red		
LED NS	Red		
MS LED	Red		
The SP-CANopen module does not provide any data.		• Wrong node ID or CANopen address. • Wrong baud rate (CAN transceiver possibly in error passive), the SP-CANopen module is in idle state.	• Check and correct the address. • Check and correct the baud rate.
LED PWR	Green		
LED NS	 Green (1 Hz)		
MS LED	 Green (1 Hz)		
The SP-CANopen module does not provide any data.		• Wrong baud rate and the transceiver of the SP-CANopen module is in bus-off state (hardware problem at the physical CAN level). • The CAN cable was interrupted.	• Check and correct the baud rate. • Check the CANopen cabling. • Reset the samos® PRO system.
LED PWR	Green		
LED NS	Red		
MS LED	 Red / green		
The SP-CANopen module does not provide any data.		• CANopen master is in the stop or pre-operational state • Another slave could not be initialized during initialization of the bus system.	• Set the CANopen master to the run state (CANopen state operational). • Check whether all slaves on the bus have been switched on.
LED PWR	Green		
LED NS	 Green (1 Hz)		

Error		Possible cause	Possible remedy
MS LED	Green	• CANopen state of the SP-CANopen module is pre-operational. Wrong node ID or CANopen address.	• Check the CANopen cabling. • Check whether the CAN master starts automatically. • Check and correct the CANopen address.
The SP-CANopen module does not provide any data.		• The transceiver of the SP-CANopen module is in the Error Passive state. • The CAN cable was interrupted.	• Check the CANopen cabling. • Check the diagnostic messages with the aid of the samos® PLAN 6. • Reset the samos® PRO system.
LED PWR	Green		
LED NS	Red		
MS LED	Green		
The SP-CANopen module does not provide any data.		• Node guarding or heartbeat consumer failure • The guarding configuration was changed.	• Check the CANopen cabling. • Check the life guarding time (life time factor V 1). • Check the heartbeat consumer time (should be V 1.5 × heartbeat producer time). • Check the diagnostic messages with the aid of the samos® PLAN 6. • Reset the samos® PRO system.
LED PWR	Green		
LED NS	Red (1 Hz)		
MS LED	Red / green		
The SP-CANopen module is in the critical error state		• Internal equipment error on the SP-CANopen module. • The module version of the controller module does not support samos® PRO gateways.	• Switch the samos® PRO system's power supply off and on again. • Check the diagnostic messages with the aid of the samos® PLAN 6. • Use the controller module with the required module version. • If the error persists, replace the gateway.
LED PWR	Green		
LED NS	Red		
MS LED	Red (2 Hz)		
The SP-CANopen / the samos® PRO system is in the **Critical error** state.		• The SP-CANopen module is not properly connected to the samos® PRO modules. • The module connection plug is dirty or damaged. • Another samos® PRO module has an internal critical error.	• Plug the SP-CANopen module in correctly. • Clean the connection plug and socket. • Switch on the power supply • once again. • Check the other samos® PRO modules.
LED PWR	Red		
LED NS	Off		
MS LED	Red		

11 ETHERCAT GATEWAY

The samos® PRO EtherCAT gateway can only be used in combination with controller modules of module version C-xx or higher.

The module version defines the current version of the hardware and software and can also be read on the side of the housing. Later versions have different letters as the first letter of the module version in alphabetical order (e.g. the module version **D-xx** would be a more recent version).

Illustration 45: Side label on a samos® PRO module

NOTICE

You can find detailed information on which configurations you can deploy the EtherCAT gateway in here:

Version, compatibility, and features [ch. 3.1, p. 16]

Configuration example

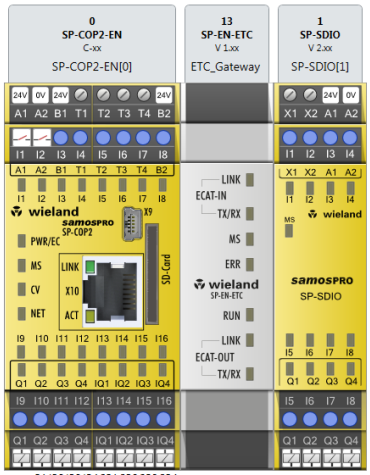


Illustration 46: Configuration example: SP-COP2-EN (0) , SP-EN-ETC (13), SP-SDIO (1)

11.1 Interfaces and operation

Operating and display elements

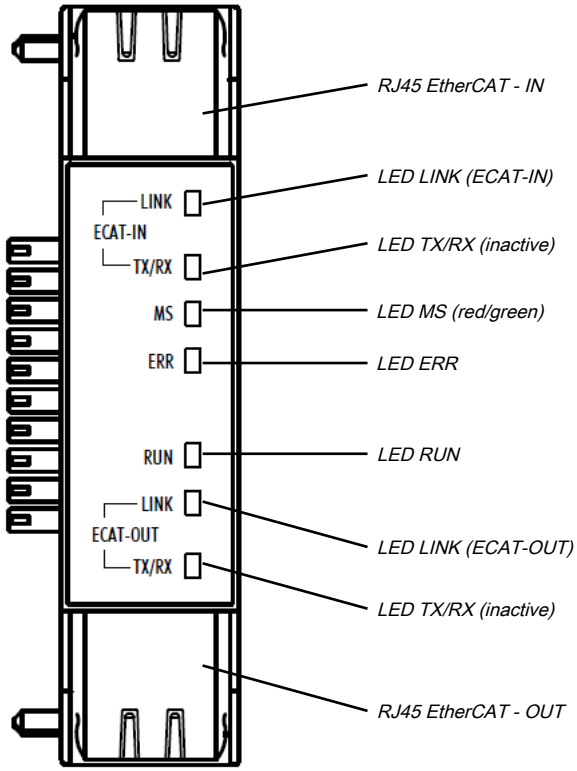


Illustration 47: Operating and display elements of the SP-EN-ETC module

Table 125: Meaning of the state LEDs on the SP-EN-ETC module

LED		Meaning
Key: ○ LED off / ✳ LED flashes / ● LED lights up		
ECAT-IN		
LINK	○ Off	No EtherCAT device connected, no connection.
	● Green	EtherCAT device connected.
	✳ Green	Communication with connected EtherCAT device
TX/RX	○ Off	Not used
MS	○ Off	No voltage supply / No connection to the head-end station
	● Green	On: samos® PRO system in operation.
	✳ Green	Flashing 1 Hz: samos® PRO system stopped
	✳ / ✳ Red / green	Alternate flashing: Run but the gateway has an error (e.g. no EtherCAT connection)
	✳ Red	Flashing 1 Hz: Configuration required or is taking place right now

LED		Meaning
	Red	On: Critical error
ERR	Off	**No error:** The EtherCAT communication of the device is in operation
	Red	**Double flash** **Application watchdog timeout:** An application watchdog timeout occurred (Example: Sync Manager watchdog timeout)
	Red	**Single flash** **Unrequested status change:** The slave device application has autonomously changed the EtherCAT status: The "Change" parameter in the ALStatus register is 0x01:change/ error.
	Red	**Blink** **Invalid configuration:** General configuration error (Example: The configuration has not yet been fully transmit-ted.)
	Red	**On** **Watchdog timeout:** A watchdog timeout has occurred. (Example: The application controller is no longer responding)
RUN	Off	**Off** **"INIT":** The device is in the INIT state.
	Green	**On** **"OPERATIONAL"**
	Green	**Blink** **"PRE-OPERATIONAL"**
	Green	**Single flash** **"SAFE-OPERATIONAL"**
ECAT-OUT		
LINK	Off	No EtherCAT device connected, no connection
	Green	**On** EtherCAT device is connected
	Green	**Blink** The device sends/receives Ethernet frames
TX/RX	Off	This LED is not used

Table 126: Information about the light behavior of the EtherCAT status LEDs

LED states	Description
On	The indicator is constantly on.
Off	The indicator does not come on.

LED states	Description
Blink	The indicator is switched on or off in phases at a frequency of 2.5 Hz.
Single flash	The indicator shows one short flash (200 ms) followed by a longer off phase (1000 ms).
Double flash	The indicator shows a sequence of two short flashes (200 ms each) interrupted by a short off phase (200 ms). The sequence is finished by a long off phase (1000 ms).

11.2 EtherCAT basics

General information

Field buses have been established in automation engineering for many years. Since on the one hand there is demand for ever higher speeds, but on the other hand the technical limits have already been reached with this technology, new solutions must be sought.

The Ethernet known from the office world, with its available-everywhere 100Mbit/s, is very fast. The type of cabling used there and the rules governing access rights mean that this Ethernet is not real-time capable. This effect has been rectified with EtherCAT.

EtherCAT

For EtherCAT: EtherCAT is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

EtherCAT stands for Ethernet for Controller and Automation Technology. It was originally developed by Beckhoff Automation GmbH and is now supported and further developed by the EtherCAT Technology Group (ETG). The ETG is the world's largest international users and manufacturers association for industrial Ethernet with around 1450 member firms (as at October 2010).

EtherCAT is an open Ethernet-based fieldbus system that is standardized in the IEC. As an open fieldbus system, EtherCAT satisfies the user profile for the area of industrial real-time systems.

Unlike traditional Ethernet communications, in EtherCAT the I/O data are exchanged at 100MBit/s in full duplex mode, while the telegram passes through the coupler. Since in this way a telegram reaches lots of devices in the transmit and receive direction, EtherCAT has a useful data rate of over 90%.

The EtherCAT protocol, optimized for process data, is transported directly in the Ethernet telegram. In turn, this can consist of several sub-telegrams, each serving one memory area of the process image.

Transmission medium

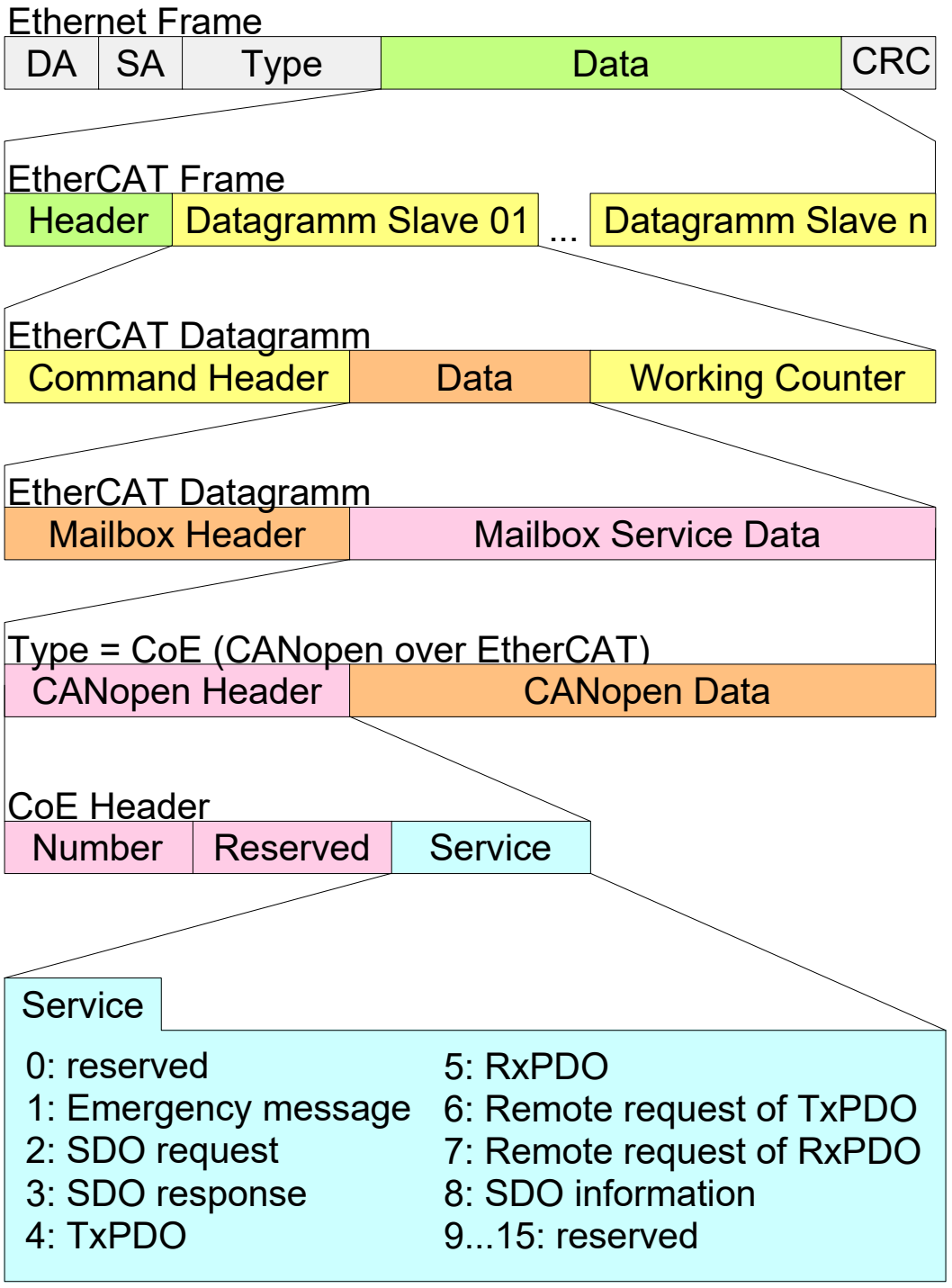
EtherCAT uses Ethernet as the transmission medium. Standard CAT5 cable is used. Cable lengths of up to 100m between 2 devices are possible.

Only EtherCAT components may be used in an EtherCAT network. To implement topologies deviating from the linear structure corresponding EtherCAT components are required that support this. It is not possible to use hubs.

Communication principle

In EtherCAT the master sends a telegram to the first device. This extracts the data intended for it from the data flow, inserts its response data into the telegram and sends the telegram on to the next device. The next device processes the telegram in the same way.

If the telegram has reached the last device, this recognizes that no more devices are connected and sends the telegram back to the master. In this way the telegram is sent via the other pair of wires through all devices to the master (full duplex). The connection sequence and the use of full-duplex technology means EtherCAT is a logical ring.



DA	Destination address	SA	Source address
CRC	Checksum	Type	Ether type (example: the entry 0x88A4 means Ether-CAT protocol.)

Components

The components of the CoE interface are listed below:

EtherCAT State Machine

The EtherCAT State Machine controls the state of the EtherCAT coupler.

Station alias

The EtherCAT address is enumerated automatically by the master. If a special address shall be assigned, the station alias is available. The Wieland EtherCAT slave does not support the allocation of the station alias by the master, but an alias can be set in samos® PLAN 6 which is taken over by the slave as an alias if the value is not equal to zero.

NOTICE

The transfer of the station alias is only supported from module version A-04. For previous module version, only the automatic negotiation of the address works.

Object directory

The object directory lists all parameter, diagnostic, process or other data which can be read or described via EtherCAT. The SDO information service provides access to the object directory.

Process data

The EtherCAT data link layer is optimized for the fast transfer of process data. This determines how the process data of the device is assigned to the EtherCAT process data and how the application on the device is synchronized to the EtherCAT cycle.

The assignment of the process data (mapping) is done via the PDO Mapping and the SyncManager PDO Assign objects. These describe which objects from the object directory are transferred as process data with EtherCAT. The SyncManager Communication objects determine the cycle time with which the associated process data are transferred via EtherCAT and in what form it is synchronized for transmission.

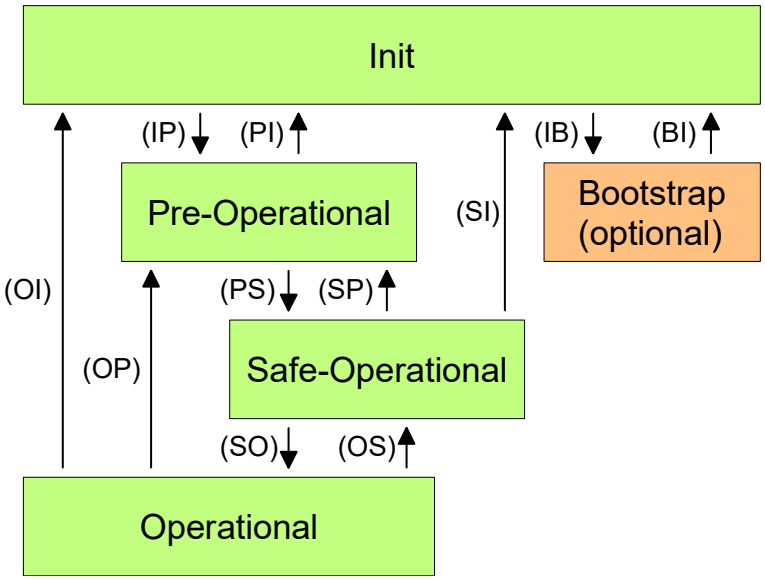
ESI file: Wieland SP EN ETC V1.2.xml

You will receive an ESI file from Wieland for the EtherCAT gateway. This file is located either on the enclosed disk or in the download area of www.wieland-electric.com. Install the ESI files in your PLC software configuration tool. Further details on installation of the ESI files can be found in the PLC manual.

11.3 EtherCAT state machine

States

A state machine is implemented in every EtherCAT coupler. For each state it is defined which communication services are active via EtherCAT. The state machine is controlled by the EtherCAT master.



IP	Start mailbox communication	PI	Stop mailbox communication

PS	Start input update	SP	Stop input update
SO	Start output update	OS	Stop output update
OP	Stop input update, stop output update	SI	Stop input update, stop mailbox communication
OI	Stop output update, stop input update Stop mailbox communication	IB	Start mailbox for firmware update in bootstrap mode (not implemented)
BI	Restart/stop mailbox		

INIT

After being switched on, the EtherCAT coupler is in the "Init" state. In this state neither mailbox nor process data communication are possible. The EtherCAT master initializes the SyncManager channels 0 and 1 for mailbox communication.

Pre-Operational (Pre-OP)

In the transition from **Init** to **Pre-Op**, the EtherCAT checks whether the mailbox was initialized correctly.

In the **Pre-Op** state mailbox communication is possible but not process data communication. Furthermore, in this state the settings for the transmission of process data and module-specific parameters are transmitted where they deviate from the standard settings.

Safe-Operational (Safe-OP)

In the transition from Pre-Op to Safe-Op the EtherCAT coupler checks whether the channels for process data communication are correct. Before it acknowledges the state change, the EtherCAT gateway copies current output data into the corresponding DP RAM areas of the EtherCAT gateway controller. In the Safe-Op state mailbox and process data communication are possible. Here the output data are updated cyclically while the input data are set to zero.

Operational (Op)

In the "Op" state the EtherCAT gateway copies the data in the RX-PDO onto its input data set 1. The output data set 1 is copied by the gateway into the TX-PDO and sent to the EtherCAT master.

Bootstrap optional (Boot)

not implemented

11.4 Bus topology and cabling

EtherCAT uses Ethernet as the transmission medium. Standard CAT5 cable is used. Cable lengths of up to 100m between 2 devices are possible.

Only EtherCAT components may be used in an EtherCAT network. To implement topologies deviating from the linear structure corresponding EtherCAT components are required that support this. It is not possible to use hubs.

An EtherCAT network always consists of a master and any number of EtherCAT slaves (gateways or couplers). Each EtherCAT slave has an RJ45 socket **IN** and **OUT**. The incoming EtherCAT cable from the direction of the master should be plugged into the socket labeled **IN**. The RJ45 socket **ECAT-OUT** is used to connect further EtherCAT devices in the same strand in order to create so-called "daisy chains". In the last device the **OUT** socket remains free.

EtherCAT RJ45 bus interface

NOTICE The device supports the Auto Crossover function.

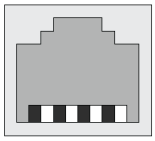
Pin	Signal	Design
1	TX+	
2	TX-	
3	RX+	
4	Term 1	
5	Term 1	
6	RX-	
7	Term 2	
8	Term 2	
Housing	Screen	

Table 127: Ethernet connection data

Pin	Signal
Medium	2 x 2 pair twisted copper cable, CAT5 (100 MBit/s)
Cable length	max. 100m
Transfer rate	100 MBit/s

Important notes

- Use of hubs:
  Hubs are **not permitted** in EtherCAT networks.
- Use of switches:
  Switches in EtherCAT networks are only permitted between EtherCAT master and the first EtherCAT slave (100 Mbit/s, full duplex). Wieland Electric GmbH offers its own switches under the product family name "Ethernet Switch".
- Terminator:
  If the gateway is the last device, the EtherCAT topology does not require a terminator.
- Recommendation
  Take appropriate measures to protect the data cables and connectors against high mechanical load. We recommend a fixed installation in conjunction with tension relief.

11.5 Data transferred into the network

Available data

The samos® PRO EtherCAT gateway can provide the following data:

- Process data
  - **Logic results from the** samos® PRO (see *Routing Table [ch. 5.1.3, p. 44]*)
  - **Input values** (HIGH/LOW) for all samos® PRO input expansion modules in the system
  - **Output values** (HIGH/LOW) for all samos® PRO input/output expansion modules (see *Module state / input and output values [ch. 3.3.1, p. 25]*)
  - **Output data** from another network, i.e. data received from a second gateway in the samos® PRO system (see *Transmission of data from a second network [ch. 3.3.3, p. 26]*)
- Diagnostics
  - **Test values** (CRCs) (see *Data set 2 [ch. 11.5.2, p. 175]*)
  - **Error and state information** for all modules (see *Error and state information for modules [ch. 3.3.4, p. 27]*)

Data sets

The physical samos® PRO modules are not presented as typical hardware modules in the network. Instead, the data provided by the samos® PRO system have been arranged in three input data sets.

11.5.1 Data set 1

Data set 1 (50 bytes) contains the process data. It can be compiled with the aid of samos® PLAN 6. In the form in which it is delivered, the content of data set 1 is preconfigured; it can be freely modified.

NOTICE

Not allocated means that the byte value is equal to 0x00. However, the user can freely assign these bytes.

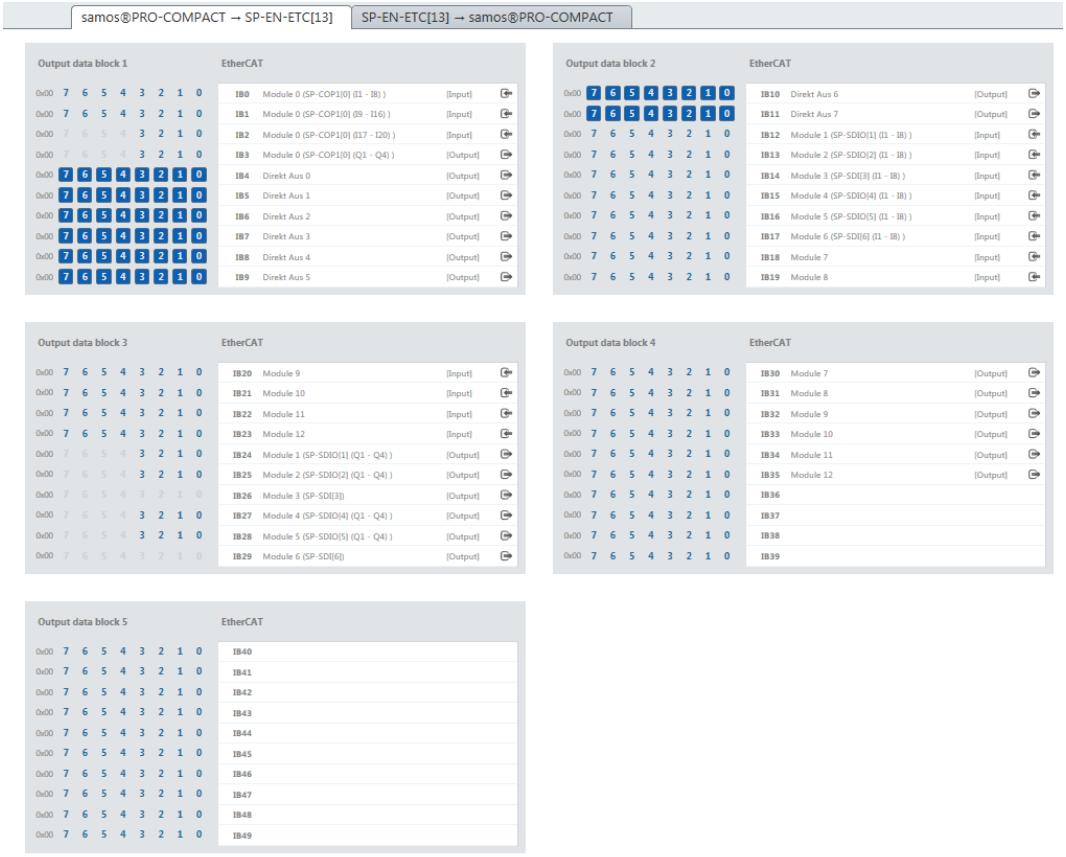
Table 128: Data set: Output data set 1 samos® PRO to --> SP-EN-ETC

Output data block 1		**Output data block 2**	
Byte 0	Input values for Module 0 (I1..I8)	Byte 10	Not allocated
Byte 1	Input values for Module 0 (I9..I16)	Byte 11	Not allocated
Byte 2	Input values for Module 0 (IQ1..IQ4)	Byte 12	Input values for Module 1
Byte 3	Output values for Module 0 (Q1..Q4, IQ1..IQ4)	Byte 13	Input values for Module 2
Byte 4	Not allocated	Byte 14	Input values for Module 3
Byte 5	Not allocated	Byte 15	Input values for Module 4
Byte 6	Not allocated	Byte 16	Input values for Module 5
Byte 7	Not allocated	Byte 17	Input values for Module 6
Byte 8	Not allocated	Byte 18	Input values for Module 7
Byte 9	Not allocated	Byte 19	Input values for Module 8
Output data block 3		Output data block 4	
Byte 20	Input values for Module 9	Byte 30	Output values for Module 7
Byte 21	Input values for Module 10	Byte 31	Output values for Module 8
Byte 22	Input values for Module 11	Byte 32	Output values for Module 9
Byte 23	Input values for Module 12	Byte 33	Output values for Module 10
Byte 24	Output values for Module 1	Byte 34	Output values for Module 11
Byte 25	Output values for Module 2	Byte 35	Output values for Module 12
Byte 26	Output values for Module 3	Byte 36	Not allocated
Byte 27	Output values for Module 4	Byte 37	Not allocated
Byte 28	Output values for Module 5	Byte 38	Not allocated
Byte 29	Output values for Module 6	Byte 39	Not allocated
Output data block 5			
Byte 40	Not allocated		
Byte 41	Not allocated		
Byte 42	Not allocated		
Byte 43	Not allocated		
Byte 44	Not allocated		
Byte 45	Not allocated		
Byte 46	Not allocated		
Byte 47	Not allocated		
Byte 48	Not allocated		

Output data block 1		Output data block 2	
Byte 49	Not allocated		
Total length	**50 bytes**		

Tag names pre-assigned in the software for the EtherCAT gateway

The data set 1 is divided into five input data blocks for clarity, whereby data blocks 1 to 5 each contain 10 bytes.



Direct gateway output values

It is possible to write values directly from the logic editor to the gateway. These valuesare freely programmable and are transferred to the EtherCAT network in the Transmit PDO. Four bytes have been reserved for this purpose in the basic settings for data set 1; however, up to the total number of 50 bytes of data set 1 may be configured as direct gateway output values. Please see the following for more information: *Direct gateway output values [ch. 3.3.1, p. 25]*

Module state / input and output values

The samos® PRO gateway can transmit the input and output states of all samos® PRO modules connected to the samos® PRO system over to the network. Data set 3 contains a non-modifiable configuration. Moreover, data set 1 can be adapted to contain up to 4 bytes of collective state information. Only the input and output values for data set 1 have been predefined and these can be freely adapted. You will find more detailed information in the section on the relevant gateway, as well as in the following section: *Configuration of gateways with samos® PLAN 6 [ch. 5, p. 41]*

Module state

The samos® PRO gateway can transfer the state of the linked modules to the network. A total of 4 bytes are available for this purpose.

Table 129: Module state

Module state	Size	Meaning	Assignment
Input data state	2 bytes	One sum bit per module for the state of the module inputs 0 = error 1 = no error	Bit 0 = SP-COPx Bit 1 = 1. Module Bit 2 = 2. Module … Bit 12 = 12. Module Bit 13 = 1. Gateway Bit 14 = 2. Gateway Bit 15 = reserved
Output data state	2 bytes	One sum bit per module for the state of the module outputs 0 = error 1 = no error	

You will find information about the meaning of the state bits here in the software manual, chapter “Internal inputs for controller modules"

- **Input values for I/O modules**
  1 byte for data set 1 is available for every expansion module. The input values show the state of the preliminary evaluation of the I/O module. This corresponds to the state of the element in the controller module logic. The level at the associated terminal cannot be clearly detected from this, as the data may be set to low, irrespectively of the level at the input terminal, by means of the cross-connection detection or two-channel evaluation (e.g. I1-18).
  When two-channel input elements have been configured for an I/O module, only the lower-value bit represents the pre-evaluation state of the corresponding element (e.g. bit 0 for I1 and I2, bit 2 for I3 and I4, bit 4 for I5 and I6, bit 6 for I7 and I8). The higher-value bit (bit 1, 3, 5 and 7) is used as follows in this case:
  0 = error 1 = no error

Table 130: Module state (input data status, byte 1)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Module 7	Module 6	Module 5	Module 4	Module 3	Module 2	Module 1	SP-COPx

Table 131: Module state (input data state, byte 2)

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Reserved	Gateway 2	Gateway 1	Module 12	Module 11	Module 10	Module 9	Module 8

- **Output values for I/O modules**
  1 byte for data set 1 is available for every module with outputs. The output values indicate the state of the control information from the logic of the controller module for the relevant element of the I/O module. The level of the associated terminals cannot be clearly detected from this, as the output may be switched off via the cross-connection detection or the overload connection function.
  When two-channel output elements have been configured for an I/O module, only the lower-value bit represents the control information (e.g. bit 0 for Q1 and Q2, bit 2 for Q3 and Q4, bit 4 for Q5 and Q6, bit 6 for Q7 and Q8). The higher-value bit (bit 1, 3, 5 and 7) is not used as follows in this case (low):

Table 132: Module state (output data status, byte 1)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Module 7	Module 6	Module 5	Module 4	Module 3	Module 2	Module 1	SP-COPx

Table 133: Module state (output data state, byte 2)

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Reserved	Gateway 2	Gateway 1	Module 12	Module 11	Module 10	Module 9	Module 8

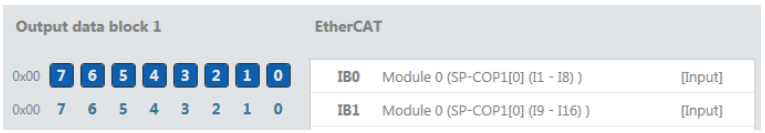
Transmission of data from a second network

If your samos® PRO system contains two gateways, it is possible to forward information which the first gateway receives from a network (e.g. from an EtherCAT PLC) via the second gateway to a second network (e.g. to a PROFIBUS master) and vice versa.

Expert setting: Allocating bytes to other addresses

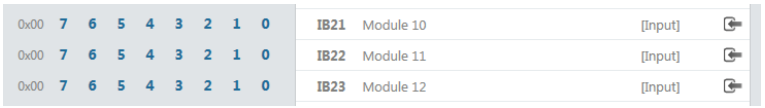
samos® PLAN 6 has pre-assigned the addresses according to a default. You can manually change this address allocation by moving any number of bytes.

In our example, we have shifted **byte 1** to **byte 23** in output data block **0**.



Step 1: Check target address

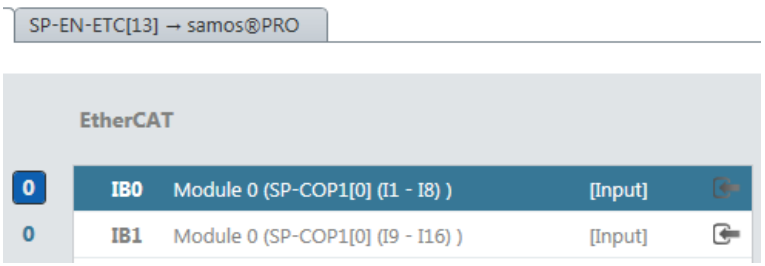
➡ Ensure that the desired address (**byte 23** in our example) has not been allocated.



➡ When the target address is assigned here, delete the bytes placed there.
To do this, click on the byte in the work area and click on the **Delete** symbol in the command bar.

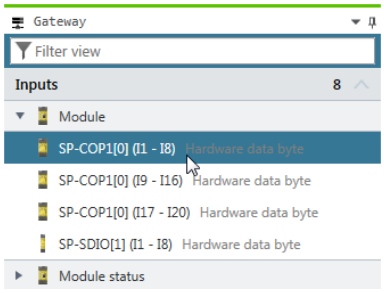
Step 2: Delete byte from original address

➡ Delete the byte you wish to reallocated (**byte 0** in our example).
To do this, click on the byte in the work area and click on the **Delete** symbol in the command bar.

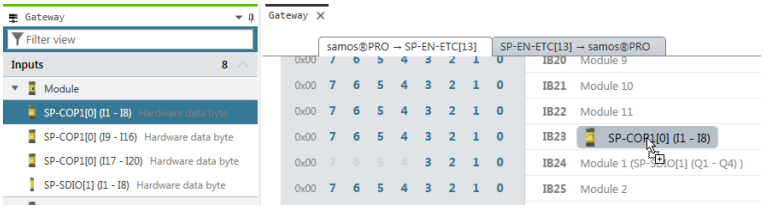


Step 3: Place byte on new target address

➡ Open the **Gateway** docking window and select the desired bytes under the associated module.



➡ Use the mouse button to drag the Byte into the work area on **byte 23**.



11.5.2 Data set 2

Data set 2 (32 bytes) contains the test values (CRCs) for the system configuration.

Configuration check values (CRCs)

Data set 2 contains the following configuration check values of the samos® PRO system: Project CRC of the project file created with samos® PLAN 6.

The CRC is 4 bytes long. Data set 2 can be read only. The data (Project CRC, System CRC) is available in Little Endian format.

The project CRC with Modbus/TCP is transmitted in Big Endian format.

Table 134: Output data set 2 samos® PRO to --> SP-EN-ETC

Byte	Assignment
Byte 0	Project CRC Value is on the first page in the project report from samos® PLAN 6. Example: CRC Station 1: 0x2ac78506
Byte 1	
Byte 2	
Byte 3	
Byte 4	Internal CRC[1)]
Byte 5	
Byte 6	
Byte 7	
Byte 8 to byte 31	Reserved for the future
Length	**32 bytes**
[1)] The use of the internal CRC in dataset 2 is only permitted for diagnostic purposes so that Wieland Technical Support can continue to provide support.	

11.5.3 Data set 3

Data set 3 (60 bytes) contains the state and diagnostic data for the various modules, with four (4) bytes per module, with the controller module comprising 3 x 4 bytes. For more details, see Table *"Meaning of module state bits of the secure I/O modules" [ch. 3.3.4, p. 28]*.

Error and state information for the modules

Data set 3 contains the state information for the modules that will be transferred to the network.

Ten bytes are transmitted for each controller module. For each SP-SDI or SP-SDIO I/O module, four bytes are transmitted in the Little Endian format, e.g. as a 32-bit word, with the first byte being placed into the least significant byte of the whole number (extreme left) and the fourth byte into the most significant byte of the whole number (extreme right).

Data set 3 cannot be changed.

NOTICE

- Reserved (for future use) = static 1 (no state change)
- Not used (can be 0 or 1), both values occur.
- If there is no module, all values - including the reserved values - are set to logical 1.

Table 135: Output data set 3 samos® PRO to --> SP-EN-ETC

Byte	Assignment
Byte 0	Module state SP-COPx
Byte 1	Module state SP-COPx
Byte 2	Test impulse comparison SP-COP inputs
Byte 3	Test impulse comparison SP-COP inputs
Byte 4	Test impulse comparison SP-COP inputs
Byte 5	State of dual-channel SP-COP inputs
Byte 6	State of dual-channel SP-COP inputs
Byte 7	Reserved
Byte 8	Stuck-at error at SP-COP outputs
Byte 9	Stuck-at error at SP-COP outputs
Byte 10	Reserved
Byte 11	Reserved
Byte 12	Status of Module 1
Byte 13	Status of Module 1
Byte 14	Status of Module 1
Byte 15	Status of Module 1
Byte 16	Status of Module 2
Byte 17	Status of Module 2
Byte 18	Status of Module 2
Byte 19	Status of Module 2
Byte 20	Status of Module 3
Byte 21	Status of Module 3
Byte 22	Status of Module 3
Byte 23	Status of Module 3
Byte 24	Status of Module 4
Byte 25	Status of Module 4
Byte 26	Status of Module 4
Byte 27	Status of Module 4

Byte	Assignment
Byte 28	Status of Module 5
Byte 29	Status of Module 5
Byte 30	Status of Module 5
Byte 31	Status of Module 5
Byte 32	Status of Module 6
Byte 33	Status of Module 6
Byte 34	Status of Module 6
Byte 35	Status of Module 6
Byte 36	Status of Module 7
Byte 37	Status of Module 7
Byte 38	Status of Module 7
Byte 39	Status of Module 7
Byte 40	Status of Module 8
Byte 41	Status of Module 8
Byte 42	Status of Module 8
Byte 43	Status of Module 8
Byte 44	Status of Module 9
Byte 45	Status of Module 9
Byte 46	Status of Module 9
Byte 47	Status of Module 9
Byte 48	Status of Module 10
Byte 49	Status of Module 10
Byte 50	Status of Module 10
Byte 51	Status of Module 10
Byte 52	Status of Module 11
Byte 53	Status of Module 11
Byte 54	Status of Module 11
Byte 55	Status of Module 11
Byte 56	Status of Module 12
Byte 57	Status of Module 12
Byte 58	Status of Module 12
Byte 59	Status of Module 12
Length	**60 bytes**

11.6 Data received from the network

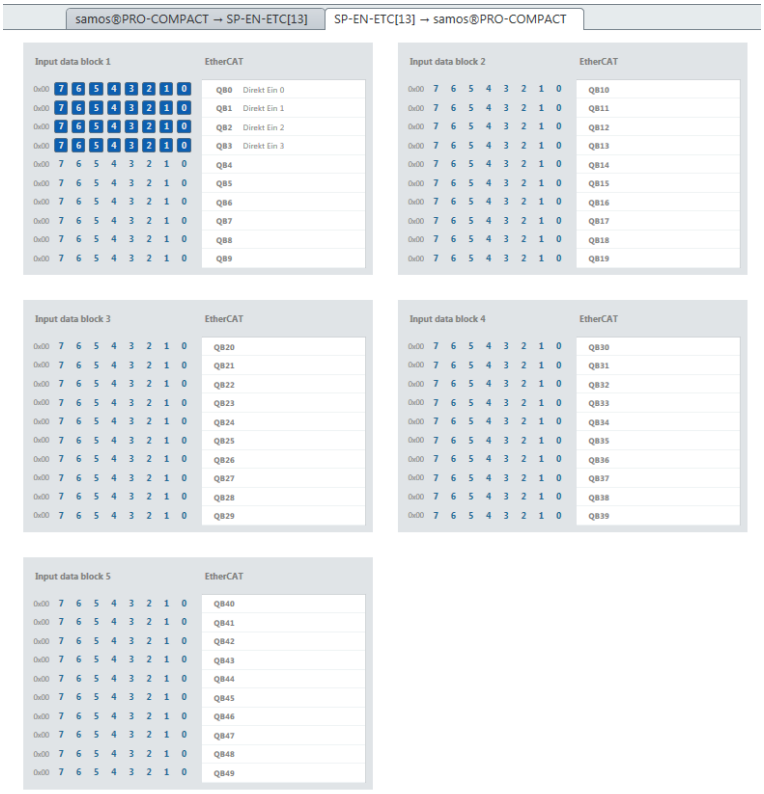
The data received from the network is divided into five data blocks of 10 bytes each for clarity.

The content of the input data blocks can be used in the logic editor of the samos® PLAN 6, as well as made available for another network via a second gateway within the samos® PRO system.

NOTICE

- In order to use network data in the logic editor or as input for another network, you must assign a tag name for each bit to be used.
- Bits without specific tag names will not be available in the logic editor or for routing via a second gateway. Detailed information about how to assign tag names for the data received may be found in the corresponding sections of the chapters on the various gateways.
- You can monitor current communication with the network with the aid of input data state bits for receiving data from the network and the output data state bit for transmitting data to the network in the logic editor. When the gateway detects a communication error, both the content of the data sets and the associated state bit are set to zero (logical 0).
- When all communication fails, the data of the output data sets and the input data state bit are set to zero (logical 0).
- When a connection is closed while others remain available, the LED MS or LED state will flash red/green for a total of 10 seconds and an entry will be made in the error log. In this case the state bits are not affected.

Tag names pre-assigned in the software for the EtherCAT gateway



Delete any bytes not required

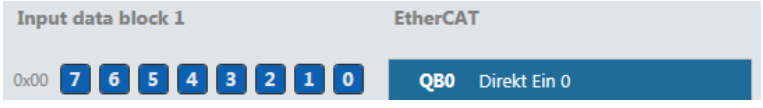
You can delete bytes pre-allocated by samos® PLAN 6 that you do not require by clicking on them with the mouse.

➡ Launch samos® PLAN 6.

➡ Read the hardware configuration, including the SP-EN-ETC gateway.
Instructions: Software manual, chapter "Connecting to the safety controller"

➡ Switch to the **Gateway** view.

➡ Click on the byte you do not need and wish to delete.



➡ Click on the **Delete** icon in the command bar.

You will find further information about how to configure the process diagram here:

- *Configuration of gateways with samos® PLAN 6 [ch. 5, p. 41]*
- Software manual

Structure of the data block

The input data block consists of 50 bytes (byte 0 to 49) of data that is transferred from the EtherCAT network to the SP-EN-ETC gateway. The content of the data bytes does not meet the requirements of a safety system. The values are only current as long as the gateway to the EtherCAT network is connected and the gateway status is **Operational**. As soon as the state machine of the gateway adopts a state other than **Operational**, this data is set to zero.

Also see: *Gateway state machine [ch. 11.3, p. 167]*

Table 136: Input data block 1–5 of the SP-EN-ETC module to --> samos® PRO

	Input data block 1	Input data block 2	Input data block 3	Input data block 4	Input data block 5
Byte 0	Byte 0	Byte 10	Byte 20	Byte 30	Byte 40
Byte 1					
Byte 2					
Byte 3					
Byte 4					
Byte 5					
Byte 6					
Byte 7					
Byte 8					
Byte 9	Byte 9	Byte 19	Byte 29	Byte 39	Byte 49
Length	10 bytes	10 bytes	10 bytes	10 bytes	10 bytes

11.7 Configuring an EtherCAT network

A device description file (ESI = **E**therCAT **S**lave **I**nformation) in XML format is delivered with the SP-EN-ETC. The EtherCAT master integrates this file into the EtherCAT system so that the master has the necessary EtherCAT configuration data and can establish a connection to the gateway.

Please read the manual depending on your controller to see which steps are required in detail.

11.8 EtherCAT configuration of the gateway - how the data are transferred

The following steps are required to configure the communication between the PLC programming system and the gateway. Configuration in the programming system is done by integrating a standardized ESI description file.

NOTICE

This documentation does not address the installation of the EtherCAT network or the other components of the automation system project in the network configuration tool. It is assumed that the EtherCAT project in the configuration program (e.g. Beckhoff TwinCAT) has already been set up. The examples presented are based on configurations created with the help of Beckhoff TwinCAT.

Step 1: Install the EtherCAT slave description file

Before the SP-EN-ETC module can be used for the first time as part of the network configuration tool (e.g. Beckhoff TwinCAT), the gateway description file must first be installed in the hardware catalog of the tool.

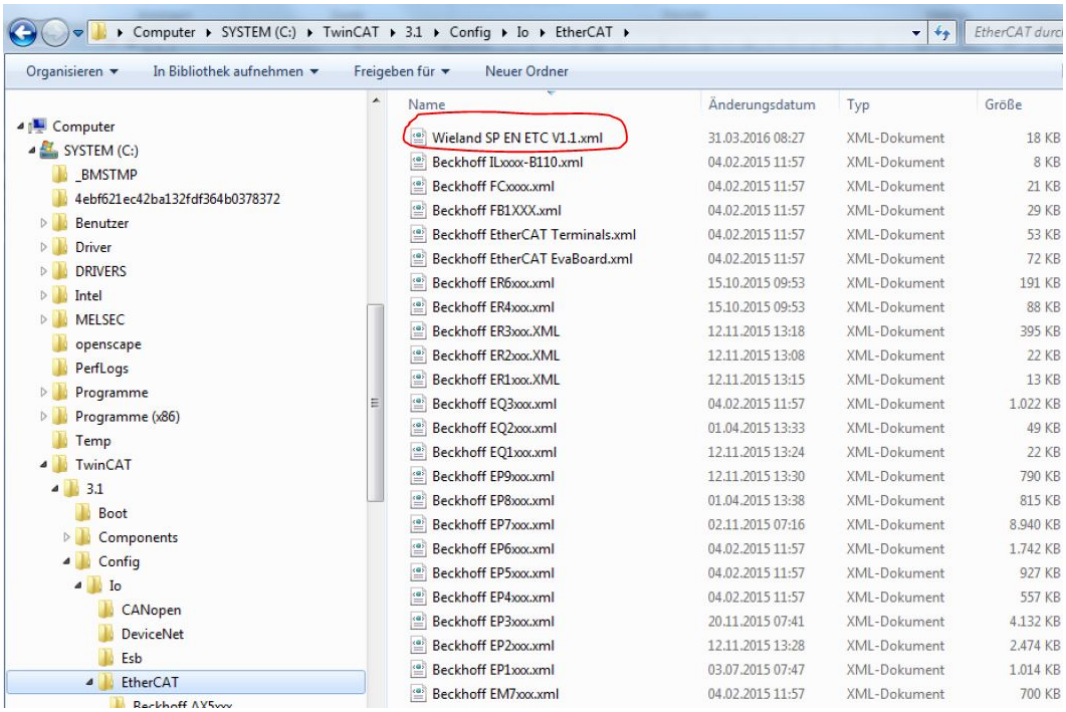
- ➡ Download the GSD file and the equipment symbol from the product site of the SP-EN-ETC module (eshop.wieland-electric.com/de).
- ➡ Follow the instructions to install XML in the online help or user manual of the EtherCAT network configuration tool for the master or for the EtherCAT control system.

Step 2: Add the gateway to a PLC project

To make the system of the samos® PRO system available in the process diagram of the PLC, the gateway must first be added to the hardware configuration. The procedure to be used depends on the hardware configuration software of the PLC used. Please also read the documentation for the corresponding software in this regard.

The example below shows how the gateway is added to a control project in Beckhoff TwinCAT.

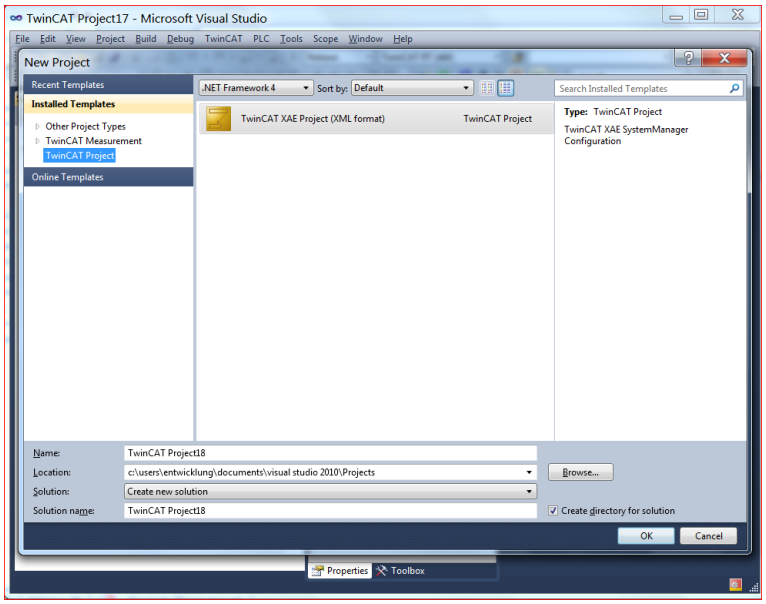
- ➡ Copy the description file Wieland SP EN ETC V1.1.xml to the TwinCAT folder. An example of a typical installation can be seen below:

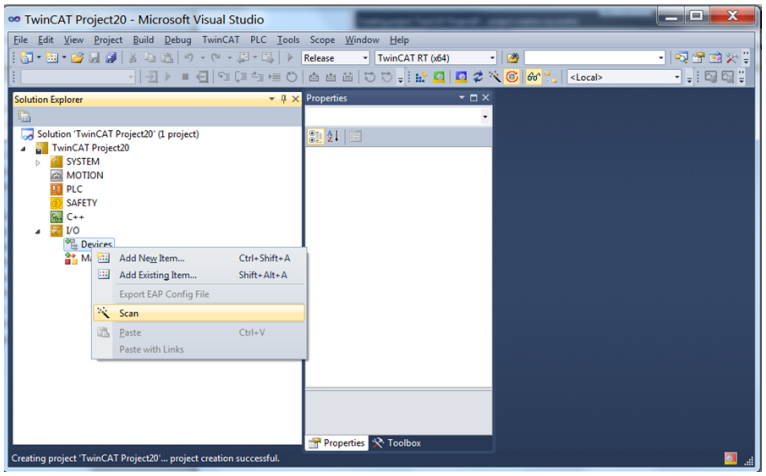


- ➡ If a path is to be specified in the ESI file in which, for example, the description file for the expansion modules is locates, create this path in the directory exactly as described in the file.
- ➡ Re-start TwinCAT.
  Note: The folder with the current description files is only read when the program is restarted.

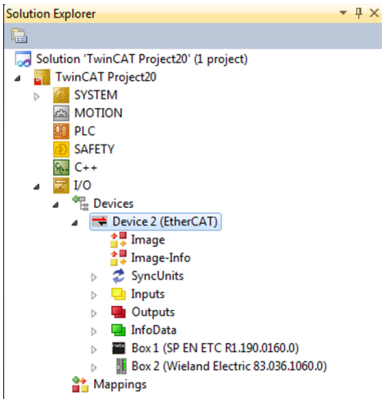
Example: This is not true for the gateway, but is important for other slaves.

Step 3: Create a new project





After you have connected the controller – i.e. the EtherCAT master to the EtherCAT slaves – you can scan the connected slaves.



TwinCAT shows the found slaves in the Solution Explorer as a box with the corresponding device names.

Table 137: Error

Error	Cause
Box is displayed with no device names.	ESI file was not found.

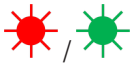
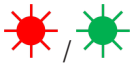
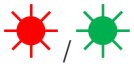
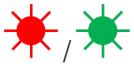
Error	Cause
No EtherCAT slave (box) is displayed.	Modules are not connected to the EtherCAT master or are not powered.
The input data (inputs) are not up to date or all have the value 0.	The controller module is at stop or no data was mapped to output data set 1. Data sets 2 and 3 are displayed once the controller module is in the RUN state.
The output data (outputs) is transmitted to the gateway but not displayed in the input data sets.	No tags have been created in the input data set.

11.9 Diagnostic LEDs on the gateway and troubleshooting

You can find information on the diagnostics of the samos® PRO system in the software manual.

Table 138: Troubleshooting on the SP-EN-ETC module

Error		Possible cause	Possible remedy
Key: ○ LED off / ✳ LED flashes / ● LED lights up			
samos® PLAN 6 cannot set up a connection to the controller module.			• Switch on the power supply. • Check the communication settings in samos® PLAN 6.
The SP-EN-ETC does not provide any input data.		After switch-on: • EtherCAT not connected.	• Connect RJ45 cable to ECAT-IN.
MS LED	✳ / ✳ Red / green		
The SP-EN-ETC does not provide any input data.		After switch-on: • RJ45 is connected to the port, no data on the EtherCAT Net.	• Activate EtherCAT.
MS LED	✳ / ✳ Red / green		
LINK (ETHERCAT-IN)	● Green		
The SP-EN-ETC does not provide any input data.		After switch-on: • RJ45 is connected to the port, EtherCAT not active.	• Activate EtherCAT and initialize gateway. **Init** state
MS LED	✳ / ✳ Red / green		
LINK (ETHERCAT-IN)	✳ Green		
Controller errors		• Incorrect EtherCAT configuration, gateway is addressed with incorrect data. • Gateway is in **Pre-Op** state.	• Check network and device configuration. • Switch power off and back on.
MS LED	✳ Red		

Error		Possible cause	Possible remedy
RUN	 Green / flashing		
ERR	 Red / flashing		
LINK	 Green		
The SP-EN-ETC does not provide any input data.		After switch-on: • Gateway state is **Init**.	• Switch EtherCAT to **Op** state.
MS LED	 Red / green		
LINK	 Green		
LINK	 Green		
The SP-EN-ETC does not provide any input data.		After switch-on: • Gateway state is **Pre-Op**.	• Switch EtherCAT to **Op** state.
MS LED	 Red / green		
RUN	 Green		
LINK	 Green		
The SP-EN-ETC does not provide any input data.		• Gateway state is **Safe-Op**.	• Switch EtherCAT to **Op** state.
MS LED	 Red / green		
RUN	 Green/flash		
LINK	 Green		
The SP-EN-ETC does not provide any input data.		• No EtherCAT data, but there is a bus connection to next EtherCAT slave.	• Re-start EtherCAT master or supply master with power. • Check RJ45 cable. • Repair interruption to the EtherCAT network.
MS LED	 Red / green		
RUN	 Green/flash		

Error		Possible cause	Possible remedy
ERR	 Red / double flash		
LINK (ETHERCAT-IN)	 Green		

Notes on troubleshooting

- **LINK LEDs**
  Use the state of the LINK LEDs to check whether there is a connection to the Ethernet.
- **Cables**
  Check that the pin assignment of the used cable is correct.
- **Configuration**
  Make sure that the gateway is installed right next to the controller module and that no more than 2 samos® PRO gateways are connected. Also ensure that only a maximum of 12 I/O extended modules are connected next to the gateways.
- **Mechanical strength**
  Check whether the RJ 45 connectors are engaged by gently pulling on the EtherCAT connection cables.
  In case of high mechanical load, secure the RJ45 cable with a tension relief.

12 TECHNICAL DATA

12.1 Modbus TCP, PROFINET IO and EtherNet/IP gateway

Use the SP-COP2-ENI controller module for the Modbus TCP, PROFINET IO and EtherNet/IP functionalities.

You will find the technical data for this module here:
Hardware manual, Chapter "Controller module"

12.2 EtherCAT gateway

Interface	Minimal	Typical	Maximum
Field bus	EtherCAT		
Connection technology	RJ45 socket		
Transfer rate	100 Mbit/s (100 Base-TX)		
Device type	EtherCAT slave		
Data length: Inputs	50 bytes from EtherCAT to samos® PRO		
Data length: Outputs	142 bytes (50 + 32 + 60) from samos® PRO to EtherCAT		
Galvanic isolation	Yes - between EtherCAT (RJ45) and system voltage		
Type of insulation	Function insulation		
Field bus	EtherCAT		

12.3 PROFIBUS DP

Interface	Minimal	Typical	Maximum
Field bus	PROFIBUS-DP-V0		
Interface level	RS-485		
Connection technology	9-pin D-sub socket		
Slave address (set via rotary switch)	0		99
Slave address (set in samos® PLAN 6[1)]	3		125
Baud rate (automatic adaptation)			12 MBaud
Baud rate (kbits/s with standard line)			Maximum line length
9.6/19.2/93.75			1200 m
187.5			1000 m
500			400 m
1.500			200 m
12.000			100 m
Line parameters	see *PROFIBUS-DP gateway [ch. 9, p. 111]*		
[1)] To set the slave address via software, the hardware address setting must be "0".			

12.4 CANopen gateways

Interface	Minimal	Typical	Maximum
Field bus	CANopen DS-301		
Interface level	RS-485		
Connection technology	5-pin "open style" socket		
Slave address (set via rotary switch)	0		99
Slave address (set in sam-os® PLAN 6 [1])	1		127
Baud rate (kbits/s with standard line)			Maximum line length
125			500 m
250			250 m
500			100 m
800			40 m
1000			20 m
Line parameters	see *CANopen gateway [ch. 10, p. 127]*		
[1] To set the slave address via software, the hardware address setting must be "0".			

12.5 Technical data for supply circuit

These technical data apply to all gateway modules.

Supply circuit (e.g. via internal safety bus)	Minimal	Typical	Maximum
Supply voltage	16.8 V DC	24 V DC	30 V DC
Power consumption			2.4W

12.6 General technical data

These technical data apply to all gateway modules.

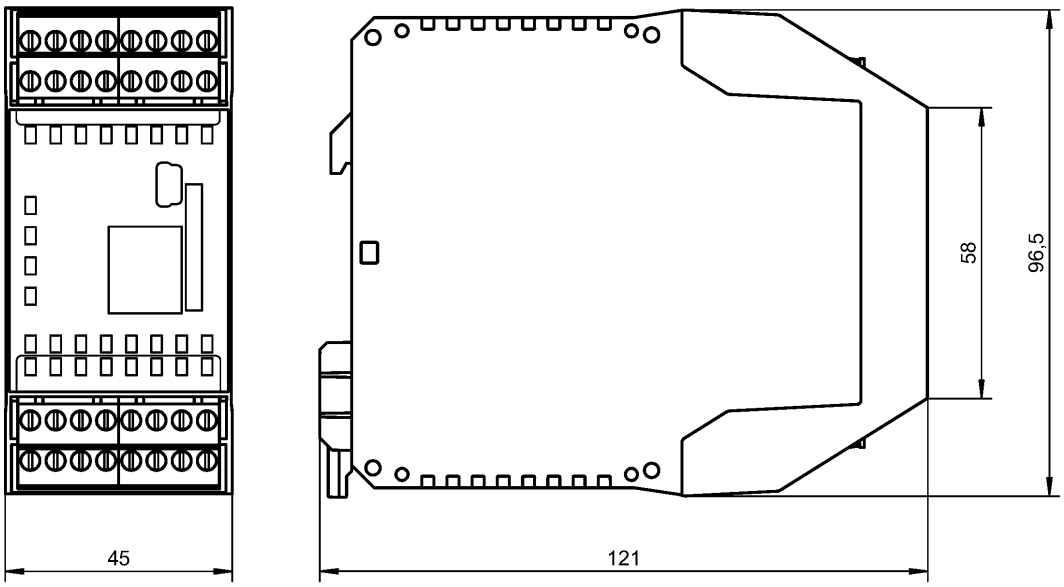
	General technical data
Connection terminals	
Field bus	See: *Interfaces and operation [ch. 9.1, p. 111]*
Climatic conditions	
Environmental operating temperature T_A	-25 to +55°C
Storage temperature	-25 to +70°C
Relative humidity	10 to 95%, non-condensing
Climatic conditions (EN 61131-2) Air pressure during operation	 860 to 1060 hPa
Mechanical strength	
Fatigue strength	5 … 150 Hz (EN 60068-2-6)

General technical data	
Shock resistance • Continuous shock • Single shock	 10 g, 16 ms (EN 60068-2-29) 30 g, 11 ms (EN 60068-2-27)
Electric safety	See SP-COPx
Protective type (EN 60529)	IP 20
Protection class	III
Electromagnetic compatibility	EN 61000-6-2/EN 55011 Class A
Mechanics and set-up	
Housing material	Polycarbonate
Housing type	Device for installation in switch box
Housing protection type/terminals	IP 20/IP 40
Color	Light gray
Weight	0.16 kg
Internal safety bus	10-pin plug on the right 10-pin bushing on the left
DIN rail	DIN rail TH 35 according to EN 60715

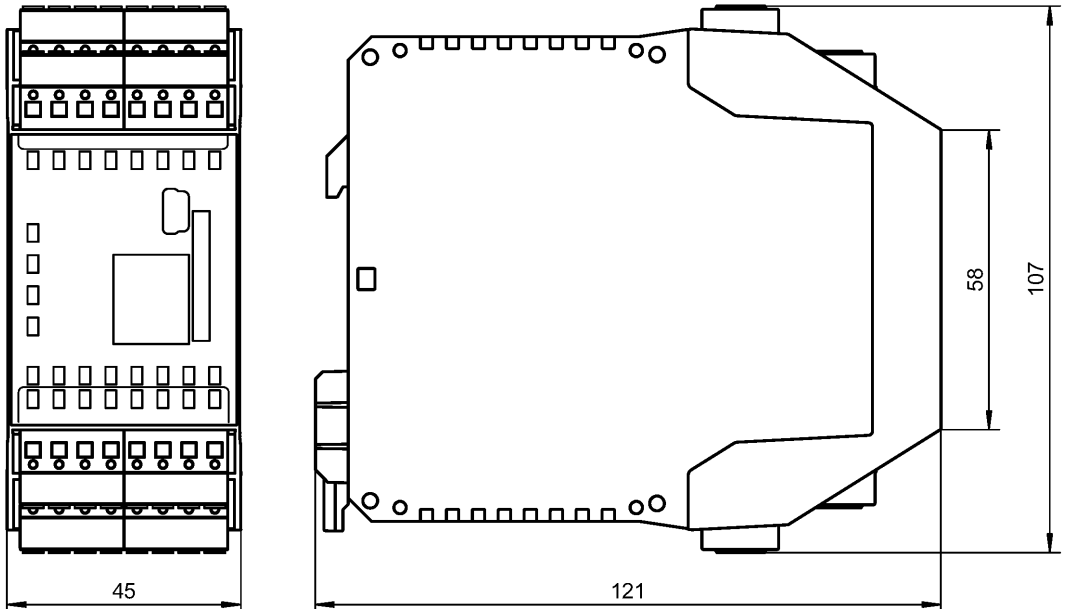
12.7 Dimensional drawings

12.7.1 Controller module

Screw terminal

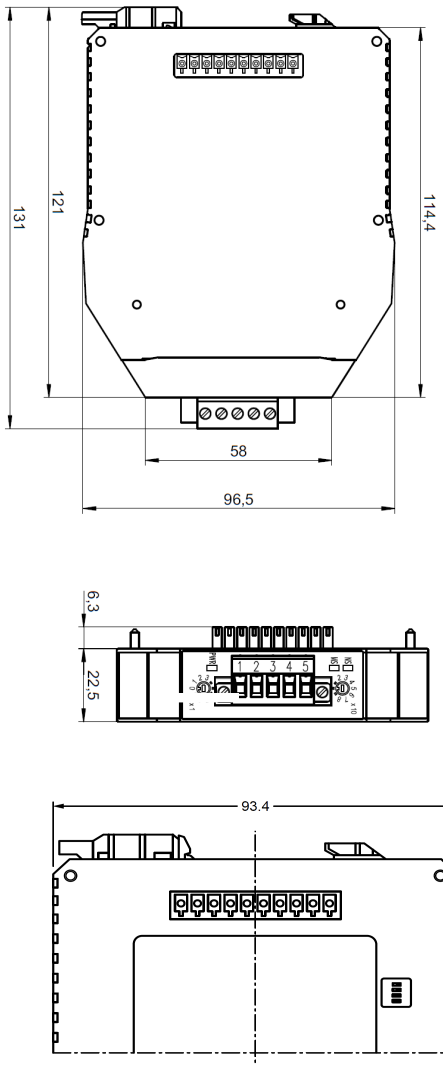


Spring-loaded terminal



12.7.2 CANopen and PROFIBUS gateways

SP-CANopen



SP-PROFIBUS-DP

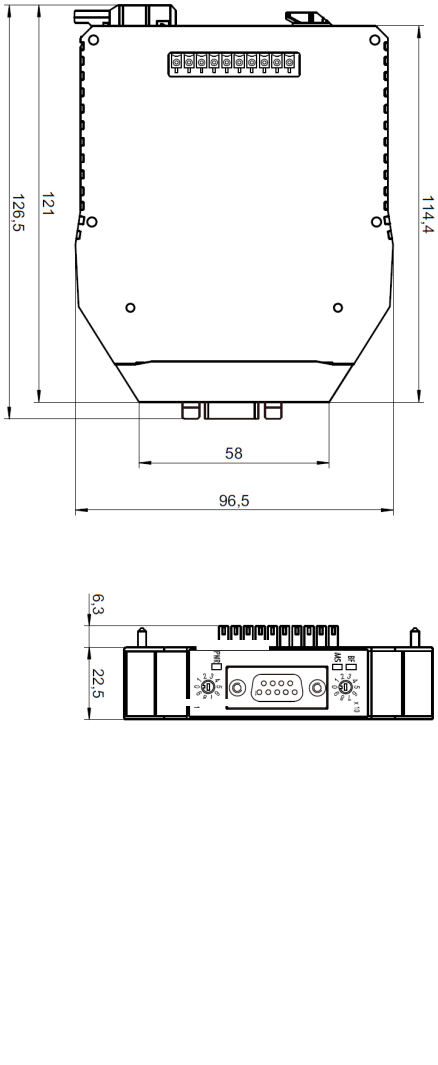


Illustration 48: Dimensional drawing CANopen and PROFIBUS gateways (mm)

12.7.3 EtherCAT gateway

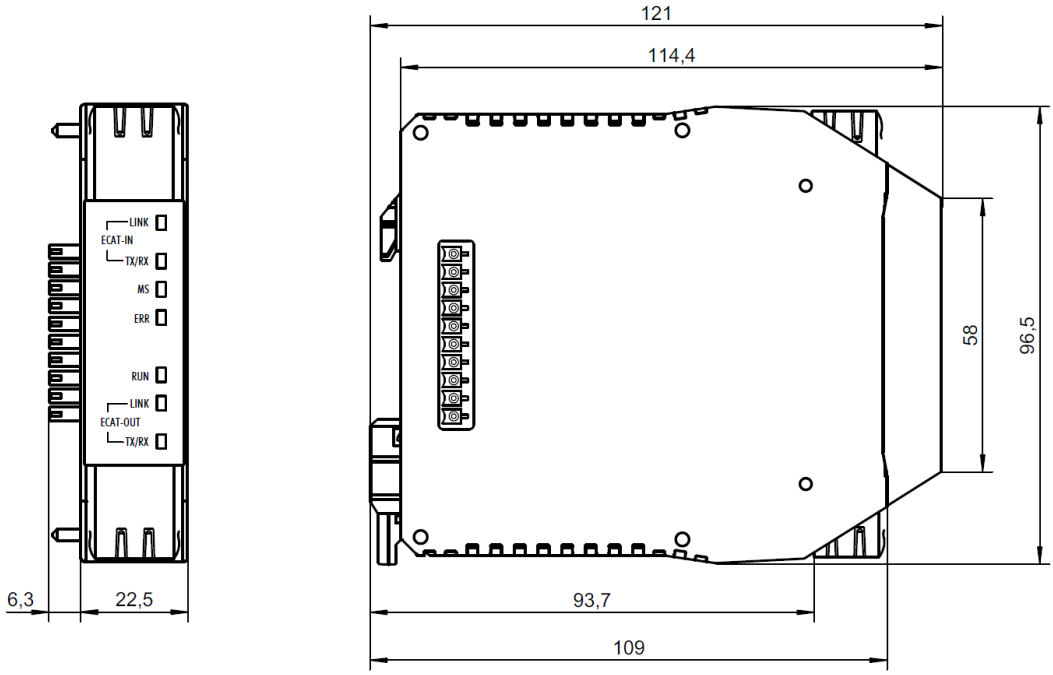


Illustration 49: Dimensional drawing EtherCAT gateway (mm)

13 ORDER DATA

13.1 Hardware modules and accessories

Table 139: Order numbers for the samos® PRO modules

Type	Description	Part number
SP-COP1-A	Controller module, COMPACT BASIC variant, USB port, 20 inputs / 4 outputs Screw terminals, pluggable	R1.190.1110.0
SP-COP1-C	Controller module, COMPACT BASIC variant, USB port, 20 inputs / 4 outputs Spring-loaded terminals, pluggable	R1.190.1120.0
SP-COP1-P-A	COMPACT module, COMPACT PLUS variant, USB port, 20 inputs / 4 outputs with press and analog functions Screw terminals, pluggable	R1.190.1130.0
SP-COP1-P-C	Controller module, COMPACT PLUS variant, USB port, 20 inputs / 4 outputs with press and functions Spring-loaded terminals, pluggable	R1.190.1140.0
SP-COP2-EN-A	Controller module, COMPACT BASIC variant, USB and Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs Screw terminals, pluggable	R1.190.1210.0
SP-COP2-EN-C	Controller module, COMPACT BASIC variant, USB and Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs Spring-loaded terminals, pluggable	R1.190.1220.0
SP-COP2-EN-P-A	Controller module, COMPACT PLUS variant, USB and Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs with press and analog functions Screw terminals, pluggable	R1.190.1230.0
SP-COP2-EN-P-C	Controller module, COMPACT PLUS variant, USB and Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs with press and analog functions Spring-loaded terminals, pluggable	R1.190.1240.0

Type	Description	Part number
SP-COP2-ENI-A	Controller module, COMPACT BASIC variant, USB and industrial Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs Screw terminals, pluggable	R1.190.1310.0
SP-COP2-ENI-C	Controller module, COMPACT BASIC variant, USB and industrial Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs Spring-loaded terminals, pluggable	R1.190.1320.0
SP-COP2-ENI-P-A	Controller module, COMPACT PLUS variant, USB and industrial Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs with press and analog functions Screw terminals, pluggable	R1.190.1330.0
SP-COP2-ENI-P-C	Controller module, COMPACT PLUS variant, USB and industrial Ethernet port, 16 inputs / 4 outputs and 4 configurable inputs or outputs with press and analog functions Spring-loaded terminals, pluggable	R1.190.1340.0
SP-COP-CARD1	Program removable storage	R1.190.1000.0
SP-CABLE-USB1	1.8 m USB configuration capable	R1.190.1010.0
SP-CABLE-ETH1	2 m Ethernet configuration capable	R1.190.1020.0
SP-PLAN6	CD with samos® PLAN 6 programming software and manuals	R1.190.1030.0
SP-COP-STARTER-SET	Kit consisting of one each of SP-COP2-EN-A, SP-SDIO, SP-COP-CARD1, SP-PLAN6, SP-CABLE-USB1	R1.190.1100.0
SP-CANopen	CANopen gateway (discontinuing)	R1.190.0210.0
SP-CANopen	CANopen gateway (new)	R1.190.0210.1
SP-PROFIBUS-DP	PROFIBUS-DP gateway (discontinuing)	R1.190.0190.0
SP-PROFIBUS-DP	PROFIBUS-DP gateway (new)	R1.190.0190.1
SP-EN-ETC	EtherCAT Gateway	R1.190.0160.0
SP-SDIO84-P1-K-A	Safe input/output expansion with output test pulses 8 inputs/4 outputs Screw terminals, pluggable	R1.190.0030.0
SP-SDIO84-P1-K-C	Safe input/output expansion with output test pulses 8 inputs/4 outputs Spring-loaded terminals, pluggable	R1.190.0040.0
SP-SDI8-P1-K-A	Safe input expansion 8 inputs Screw terminals, pluggable	R1.190.0050.0

Type	Description	Part number
SP-SDI8-P1-K-C	Safe input expansion 8 inputs Spring-loaded terminals, pluggable	R1.190.0060.0
SP-DIO84-P1-K-A	Standard input/output expansion 4 inputs / 4 outputs and 4 configurable inputs or outputs Screw terminals, pluggable	R1.190.1050.0
SP-DIO84-P1-K-C	Standard input/output expansion 4 inputs / 4 outputs and 4 configurable inputs or outputs Screw-loaded terminals, pluggable	R1.190.1060.0
SP-SAR4-A	Analog module, 4 safe RTD inputs, screw terminals, pluggable	R1.190.1610.0
SP-SAR4-C	Analog module, 4 safe RTD inputs, spring-loaded terminals, pluggable	R1.190.1620.0
SP-SAC4-A	Analog module, 4 safe 0-20mA inputs, screw terminals, pluggable	R1.190.1630.0
SP-SAC4-C	Analog module, 4 safe 0-20mA inputs, spring-loaded terminals, pluggable	R1.190.1640.0
SP-SACR22-A	Analog module, 2 safe RTD inputs, 2 safe 0-20mA inputs, screw terminals, pluggable	R1.190.1650.0
SP-SACR22-C	Analog module, 2 safe RTD inputs, 2 safe 0-20mA inputs, spring-loaded terminals, pluggable	R1.190.1660.0
WKFN 2.5 E/35 GO-URL	fasis series level terminal with diode	56.703.8755.9
APFN 2.5 E/35	Terminal plate for WKFN 2.5 E/35	07.312.7355.0

13.2 Modules for contact expansion

Type	Description	Part number
SA-OR-S1-4RK-A	samos output module, 24 V DC, 2×2 enabling current paths, 2×2 signaling outputs, pluggable terminals screws	R1.180.0080.0
SA-OR-S1-4RK-C	samos output module, 24 V DC, 2×2 enabling current paths, 2×2 signaling outputs, pluggable spring-loaded terminal	R1.180.0430.0
SA-OR-S2-4RK-A	samos output module, 24 V DC, 1×2 enabling current paths, 1×2 signaling outputs, pluggable terminals screws	R1.180.0320.0
SA-OR-S2-4RK-C	samos output module, 24 V DC, 1×2 enabling current paths, 1×2 signaling outputs, pluggable spring-loaded terminal	R1.180.0440.0
SNE 1	Forcibly actuated single relay, 24 V DC, 2 changeovers, plug socket	R1.188.3950.0

Type	Description	Part number
SNE 4004K-A	Contact expansion, 24 V DC, 4 NC contacts, 3 NO contacts, Screw terminals, pluggable	R1.188.0590.0
SNE 4004K-C	Contact expansion, 24 V DC, 4 NC contacts, 3 NO contacts, Spring-loaded terminals, pluggable	R1.188.1980.0
SNE 4012K-A	Contact expansion, 24 V DC, 2 NC contacts, 1 NO contacts, Screw terminals, pluggable	R1.188.3910.0
SNE 4012K-C	Contact expansion, 24 V DC, 2 NC contacts, 1 NO contacts, Spring-loaded terminals, pluggable	R1.188.3920.0
SNE 4024K-A	Contact expansion with 2 relay groups, 24 V DC, 2 x 2 NC (normally closed contact), 2 x 1 NO (normally open contact), Screw terminals, pluggable	R1.188.3930.0
SNE 4024K-C	Contact expansion with 2 relay groups, 24 V DC, 2 x 2 NC (normally closed contact), 2 x 1 NO (normally open contact), Spring-loaded terminals, pluggable	R1.188.3940.0
SNE 4028S-A	Contact expansion, 24 V DC, 8 NC contacts, 2 NO contacts, Screw terminals, pluggable	R1.188.3120.0
SNE 4028S-C	Contact expansion, 24 V DC, 8 NC contacts, 2 NO contacts, Screw terminals, pluggable	R1.188.3540.0

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