SIEMENS

SIPROTEC Communication Module PROFINET IO

Communication Profile

C53000-L1840-C360-1

NOTE

For your own safety, observe the warnings and safety instructions contained in this document.

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Preface

Purpose of this Manual

This manual describes the communication profile of the SIPROTEC 4 Communication Modules with PROFINET IO. The protocol is available on the electrical and the optical EN100 module.

Target Audience

Protection engineers, commissioning engineers, persons who are involved in setting, testing and service of protection, automation, and control devices, as well as operation personnel in electrical plants and power plants.

Scope of Validity of this Manual

This manual is valid for the SIPROTEC 4 Communication Modules with PROFINET IO.

Additional Support

Should further information be desired or should particular problems arise which are not covered sufficiently for the purpose of the purchaser, the matter should be referred to the local Siemens representative.

Our Customer Support Center provides around-the-clock support.

Phone: +49 (180) 524-8437
Fax: +49 (180) 524-2471
Internet: http://www.siprotec.com
E-mail: support.ic@siemens.com

Training Courses

If you are interested in our current training program, contact our training center:

Siemens AG
Siemens Power Academy TD

Humboldtstr. 59

D-90459 Nuremberg
Germany

Phone: +49 (911) 433-7415
Fax: +49 (911) 433-7929
e-mail: power-academy.energy@siemens.com
Internet: www.siemens.com/energy/power-academy

Safety Notes

This manual does not constitute a complete catalog of all safety measures required for operating the equipment (module, device) in question, because special operating conditions may require additional measures. However, it does contain notes that must be adhered to for your own personal safety and to avoid material damage. These notes are highlighted with a warning triangle and different keywords indicating different degrees of danger.

DANGER

Danger means that death or severe injury **will** occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent death or severe injury.

WARNING

Warning means that death or severe injury **can** occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent death or severe injury.

CAUTION

Caution means that minor or moderate injury can occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent minor injury.

NOTICE

Notice means that material damage can occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent material damage.

NOTE

is important information about the product, the handling of the product, or the part of the documentation in question to which special attention must be paid.

Qualified Personnel

Commissioning and operation of the equipment (module, device) described in this manual must be performed by qualified personnel only. As used in the safety notes contained in this manual, qualified personnel are those persons who are authorized to commission, release, ground and tag devices, systems, and electrical circuits in accordance with safety standards.

Intended Use

The equipment (device, module) must not be used for any other purposes than those described in the Catalog and the Technical Description. If it is used together with third-party devices and components, these must be recommended or approved by Siemens.

If the device is not used as specified in the production information and the manual, the intended protection function is impaired.

The correct and safe operation of the product requires adequate transportation, storage, installation, and mounting as well as appropriate use and maintenance.

When operating electric equipment, certain parts of the equipment inevitably carry hazardous voltages. Severe injury or material damage can occur if the appropriate measures are not taken:

- Before making any connections, ground the equipment at the grounding terminal.
- Hazardous voltages can be present on all switching components connected to the power supply.
- Even after the supply voltage has been disconnected can hazardous voltages still be present in the equipment (capacitor storage).
- Equipment with current transformer circuits must not be operated while being open.
- The limiting values specified in the manual or the product information must not be exceeded; this also refers to testing and commissioning

Contents

1 Using PROFINET IO

1.1 General

Application

The Ethernet-based fieldbus protocol PROFINET IO is used in SIPROTEC 4 devices equipped with the 100 Mbit EN100 Ethernet module. The PROFINET IO communication protocol is defined in the standards IEC 61158 and IEC 61748.

NOTE

In this manual, the following short forms are used: **EN100** for the 100 Mbit EN100 Ethernet module, **SIPROTEC** for SIPROTEC 4, and **DIGSI** for the DIGSI 4 parameterization software.

PROFINET IO is used as additional communication protocol in the EN100 besides the IEC 61850/GOOSE protocol and can be used in parallel with this protocol (see Chapter 2.13).

PROFINET IO is used mainly in industrial energy automation.

Requirements

The SIPROTEC device you are using must support the PROFINET IO protocol. Refer to the associated device manual in this context.

Enter the required settings using the DIGSI parameterization software, version 4.85 or higher.

To set the PROFINET IO protocol, DIGSI must contain the IEC 61850 station configurator.

The parameterization is described in Chapter 3.2.1.

Scope of Delivery

The following device variants with EN100 modules are available when using the PROFINET IO protocol:

- SIPROTEC device with integrated EN100 and implemented PROFINET IO protocol:
  - SIPROTEC device with EN100-E+ (electrical bus interface): RJ45 connection for Ethernet
  - SIPROTEC device with EN100-O+ (optical bus interface): LC connection, multimode fiber cable
- EN100 with implemented PROFINET IO protocol for retrofittings at existing devices or for replaced EN100 modules:
  - EN100-E+ (electrical bus interface): RJ45 connection for Ethernet;
    order no. C53207-A351-D688-1
  - EN100-O+ (optical bus interface): LC connection, multimode fiber cable;
    order no. C53207-A351-D689-1

The following manuals provide detailed information on the EN100 module and the IEC 61850 protocol:

- German edition: Handbuch Ethernetmodul EN100, Bestellnr. C53000-G1100-C167-x
- English edition: Manual Ethernet Module EN100, order no. C53000-G1140-C167-x

Extended Scope of Delivery

In addition to the scope of delivery mentioned previously, you can download the following components from the Internet:

- PROFINET IO firmware as PCK file
- PROFINET IO GSDML file
- MIB files for SNMP
- Various manuals: communication profile, bus mapping files

To download the files, go to the following Internet address:

http://siemens.siprotec.de/download_neu/index_e.htm

In addition, you can purchase various Ethernet patch cables as shown in the following table.

Table 1-1 Ethernet Patch Cable (Double Shielded (SFPT), LAN Connector Plugs on Both Sides)

Cable Length	Order No.
0.5 m	7KE6000-8G-D00-0AA5
1.0 m	7KE6000-8G-D00-1AA0
2.0 m	7KE6000-8G-D00-2AA0
3.0 m	7KE6000-8G-D00-3AA0
5.0 m	7KE6000-8G-D00-5AA0
10.0 m	7KE6000-8G-D01-0AA0
15.0 m	7KE6000-8G-D01-5AA0
20.0 m	7KE6000-8G-D02-0AA0

NOTE

Multimode optical fibers in various lengths fitted with LC duplex connectors on both sides are available for the optical EN100 module. See also the ordering information at:

http://siemens.siprotec.de/download_neu/accessories/6XV81xx/6XV8100_FO_Order_Information_10-2010_en.pdf

1.2 Documents

Documents for PROFINET IO

You can obtain documents and up-to-date information on PROFINET from the PROFIBUS/PROFINET international user organization at the Internet address:

http://www.profibus.com

Documents for Bus Mapping

The bus mapping documents describe the data objects which are available in a SIPROTEC device for PROFINET IO.

You can download the bus mapping documents for each device type from the Internet at the following address:

http://siemens.siprotec.de/download_neu/index_e.htm

Example: SIPROTEC 7SJ61/62/64 Multifunctional Protection Relay - PROFINET IO Bus Mapping, order number: C53000-L1800-C361-x

Documents for EN100

The following manuals contain information on the functions available on the EN100 in addition to PROFINET IO, such as IEC 61850, HTML pages, SNMP, etc.:

- German edition: Handbuch Ethernetmodul EN100, Bestellnr. C53000-G1100-C167-x
- US English edition: Manual Ethernet Module EN100, order no. C53000-G1140-C167-x

1.3 Application Example

Figure 1-1 shows an application example for SIPROTEC devices with PROFINET IO protocol and GOOSE. Here, data is exchanged between the substation/IO controller and SIPROTEC/IO device via PROFINET IO protocol. Each IO device is identified by a name and an IP address. The SIPROTEC devices can exchange data with each other via GOOSE. The bus nodes can be connected to the Ethernet as the communication medium via one or multiple Ethernet switches.

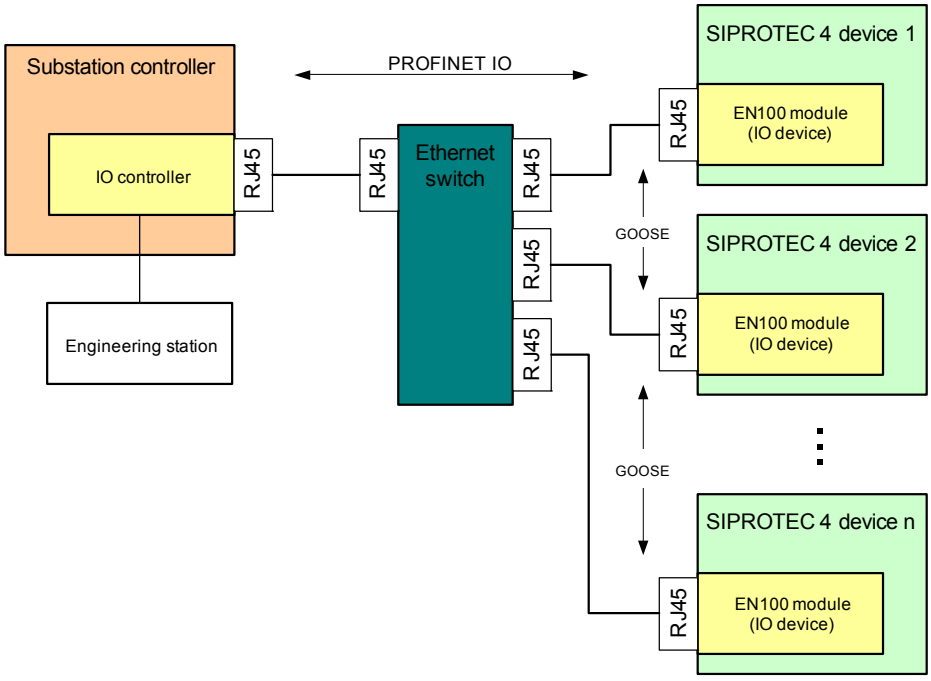

Figure 1-1 Application Example Communication

1.4 Additional Ethernet Services and Protocols

The following additional services and protocols are supported on the EN100. These services can be switched ON or OFF using DIGSI. Siemens recommends switching off unused services for security reasons.

Services

- Module homepage (HTTP)
- Firmware upgrade (HTTP)
- DIGSI 4 over EN100
- SNMP V2
- IEC 61850 and GOOSE
- SNTP

For more information, refer to the following manual:

Ethernet Module EN100 for IEC 61850 with Electrical/Optical 100 Mbit Interface,

Order number C53000-G1140-C167-x

1.5 Firmware Update

The SIPROTEC devices or the single EN100 modules for retrofitting of SIPROTEC devices already contain the PROFINET IO firmware on delivery.

Check before installation of the SIPROTEC device or EN100 module that the latest version of the PROFINET IO module firmware is loaded (ref. to Chapter 2.1).

The Ethernet interface is used for updating the firmware of the PROFINET IO module.

Observe the notes and procedures described in the following documents:

- Firmware/FPGA Update via the Ethernet interface of the EN100 module:

  http://siemens.siprotec.de/download_neu/devices/1_General/Protocols/IEC_61850/EN100%20FW%204.20/EN100_FW_Update_V2.12_en.pdf

- Manual Ethernet Module EN100, Order no. C53000-G1140-C167-x:

  http://siemens.siprotec.de/download_neu/devices/1_General/Doku_Protokolle/Englisch/IEC_61850/COM_IEC61850_MODUL_A10_US.pdf

The PROFINET IO firmware file has the name **PROFINET-IO_VXX.YY.ZZ.pck** (XX.YY.ZZ = version number).

If a PROFINET IO firmware update is available then the self-extracting file **PROFINET-IO_XX.YY.ZZ.exe** can be downloaded from the Internet address:

http://siemens.siprotec.de/download_neu/index_e.htm

NOTE

A valid network configuration (IP address, subnet mask) is required on the EN100 module for the firmware update. Setting the network configuration can be done with a device configuration in DIGSI or using DCP, e.g. with the **Primary Setup Tool** (ref. to Chapter 3.4).

2 PROFINET IO in SIPROTEC

2.1 Identification of Module and Firmware

Module Information Menu

Available on HMI display or via Web monitor:

✧ Select **Enter** → **Test/Diagnosis** → **Module info** → **Port F** (in 7SC80) or **Port B** (depending on the device).

The following information is shown, for example: module type, communication protocol, network settings

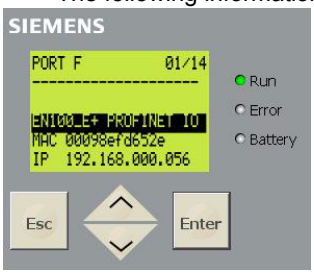

Figure 2-1 Module Information

Module type:

- EN100-E+ - EN100 with electrical Ethernet interface
- EN100-O+ - EN100 with optical fiber Ethernet interface

Communication protocol:

- IEC 61850 - IEC 61850/GOOSE
- PROFINET IO - PROFINET IO with IEC 61850/GOOSE option

MLFB/Version Menu

Available on HMI display or via Web monitor:

✧ Select **Enter** → **Settings** → **Setup/Extras** → **MLFB/Version**, then scroll down twice to show the version number of the firmware on EN100

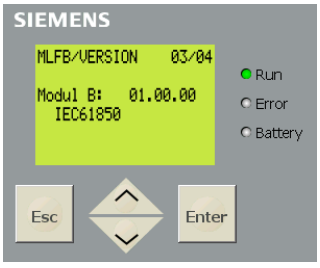

Figure 2-2 MLFB/Version (Note: Module F in 7SC80)

NOTE

The firmware identification IEC 61850 is always displayed here, also when PROFINET IO firmware is loaded.

HTML Page of the EN100 Module (refer to Chapter 4.1)

- If PROFINET IO firmware is loaded, the DNP IP menu is available in the navigation window.
- The firmware version is shown on the homepage of EN100.

Labeling of the PROFINET module

The EN100 modules with PROFINET IO on the rear panel of the SIPROTEC device are labeled as follows:

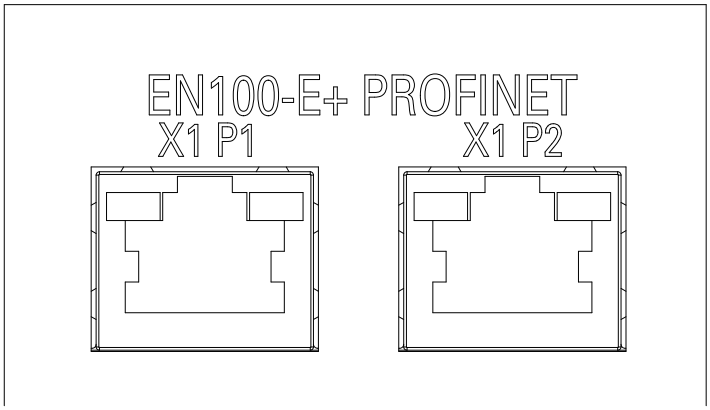

Figure 2-3 Labeling EN100-E+ with PROFINET IO

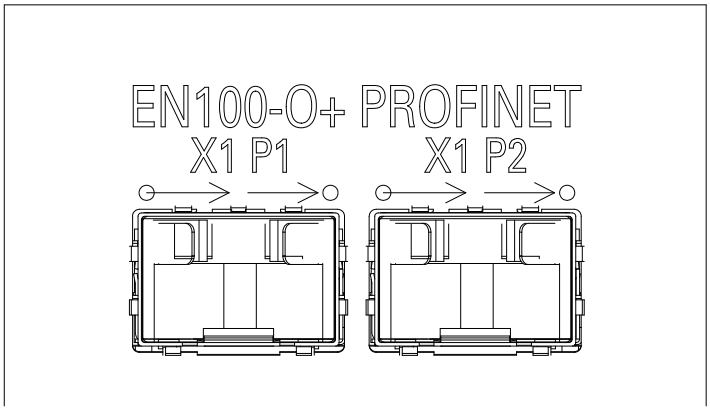

Figure 2-4 Labeling EN100-O+ with PROFINET IO

Meaning of the labeling:

- X1: PROFINET IO interface
- X1 P1: PROFINET IO port 1 (identification as "port-001" via LLDP and SNMP)
- X1 P2: PROFINET IO port 2 (identification as "port-002" via LLDP and SNMP)

2.2 Device Identification

Each PROFINET IO device requires a unique device identification. This device identification consists of the Vendor_ID and the Device_ID, with the Device_ID comprising the device class and device family.

The device identification for a PROFINET IO device in SIPROTEC 4 devices is:

0x002A0E03

and is composed as follows:

Table 2-1 Device Identification

Vendor_ID	**Device_ID**	
	Device class	**Device family**
0x002a (Siemens AG)	0E (Protection and PQ)	03 (SIPROTEC 4)

The device identification is stored, for example, in the GSDML file, see Chapter 3.3.1.

2.3 Data-Type Definitions for IO Data Exchange

The following data types and definitions are used to exchange data between the IO device and IO controller via PROFINET IO:

- Single-point indication
- Single command
- Double-point indication and double command
- Measured value and statistic value
- Metered value
- Message block for event list and process alarm
- Units and unit multiples

2.3.1 Data Type Single-Point Indication (SP, Input)

Number of byte values: 1/8 (1 bit)

Range of values:

0 = OFF

1 = ON

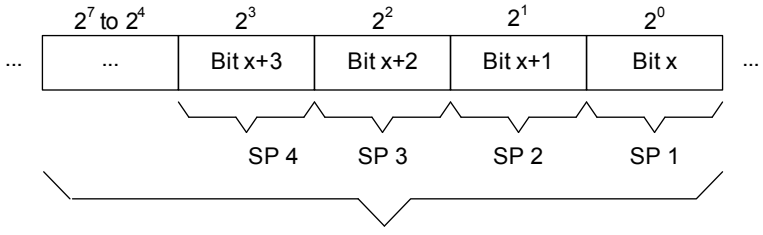

Figure 2-5 Data Type: Single-Point Indication

Status of Indications

The status (valid or invalid) is relevant for indications which are, for example, received in the SIPROTEC device with a GOOSE telegram and subsequently read by the IO controller via PROFINET IO.

A single-point indication containing the status of an indication can be created with CFC (Continuous Function Chart) in DIGSI using the SI_GET_STATUS function block. This second indication can be used in addition to the value for the transmission via PROFINET IO.

2.3.2 Data Type Single Command (SC, Output)

Number of byte values: 1/4 (2 bits)

Range of values:

0 = idle state	bit 1 = 0 and bit 0 = 0
1 = OFF	bit 1 = 0 and bit 0 = 1
2 = ON	bit 1 = 1 and bit 0 = 0
3 = not allowed	bit 1 = 1 and bit 0 = 1

NOTE

Single commands of the SIPROTEC device are controlled via PROFINET IO using 2 bits (analogous to double commands, see Chapter 2.3.3).

The switching direction OFF for single commands with pulse output is not permitted and is rejected in the SIPROTEC device.

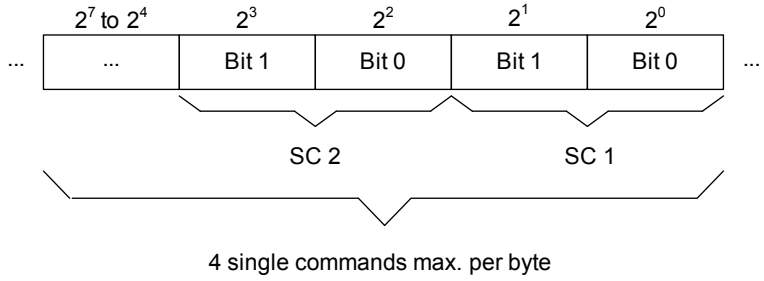

Figure 2-6 Data Type: Single Command

2.3.3 Data Type Double-Point Indication (DP, Input)/Double Command (DC, Output)

Number of byte values: 1/4 (2 bits)

Range of values:

0 = "not applicable"/ disturbed state for DP and idle state for DC	bit 1 = 0 and bit 0 = 0
1 = OFF	bit 1 = 0 and bit 0 = 1
2 = ON	bit 1 = 1 and bit 0 = 0
3 = disturbed state for DP, not allowed for DC	bit 1 = 1 and bit 0 = 1

NOTE

Depending on the data type selected in DIGSI, the values **0** and **3** for double-point indications have the following meaning:

- Type DP: 0 = "not applicable", 3 = disturbed state "00" or disturbed state "11"
- Type DP_I: 0 = "not applicable" or disturbed state "00", 3 = disturbed state "11"

"not applicable": the indication is not routed (not connected to a binary input)

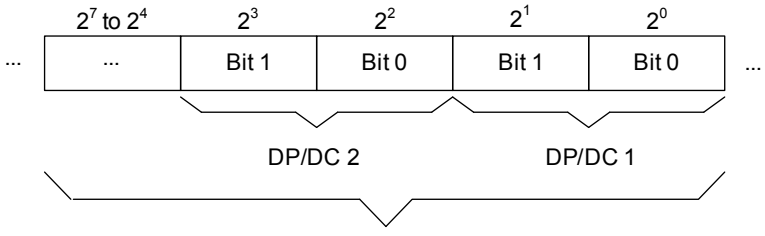

Figure 2-7 Data Type: Double-Point Indication/Double Command

NOTE

The data type double command requires the associated command feedback to be parameterized as double-point indication.

A double command with a single-point indication as feedback or without feedback acquisition is controlled in the same way as a single command via PROFINET IO. This means that the processing of a double command via PROFINET IO depends on the type of the associated feedback.

2.3.4 Measured Values and Statistic Values

Number of byte values: 4 (32 bits)

Range of values: $\pm 1.7 * 10^{38}$

Measured values and statistic values are transmitted in 32 bit floating-point format. The format consists of a sign bit (S), exponent and mantissa as shown in the following:

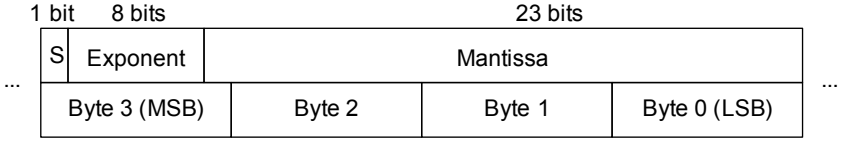

Figure 2-8 Data Type: Measured Value/Statistic Value

In DIGSI, these values have the following data type:

- Measured values: data type measured value MV
- Statistic values: data type value indication VI

Sign Bit (S)

The sign bit (S) is set if measured values are negative.

Measured Values (Mantissa and Exponent)

The value of a measured value is obtained as follows:

0 < Exponent < 255: resulting value = $(-1)^{<sign>} * 2^{(<exponent> - 127)} * 1,<mantissa>$

Exponent = 0: resulting value = 0

Exponent = 255, mantissa not equal to 0: invalid (Not a Number, NaN)

Quality Information

"Not a Number" (NaN) floating-point numbers are used to specify the quality of measured values.

Table 2-2 Quality Information

Floating-point number (hexadecimal)	**Status**	**Remark**
0x7F800000	Overflow	Overflow of the measured value
0x7F800001	Invalid	Measured value invalid or not computable, for example frequency or cos ϕ when voltage or current is too low.
0x7F800002	Not calculated	The internal data image was not updated after a restart.
0xFF800000	Falling below	Falling below the measured value

2.3.5 Metered Values

Number of byte values: 4 (32 bits)

Range of values: 0 to +4 294 967 295

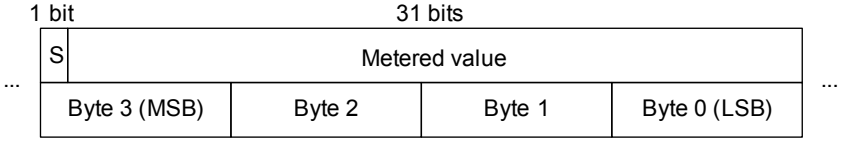

Figure 2-9 Data Type: Metered Value

Status Bit (S)

The metered value with set status bit (S) is invalid for the following reasons:

- Invalid metered value after initial start/restart of the device
  (status bit is deleted after 2 restoring intervals of the metered value following initial start/restart)
- The external error bit for pulse metered values for the binary input is set.

NOTE

- The metered value in the SIPROTEC device overflows when 7FFFFFFFH + 1 to 0.
- Transmission of the status bit can be disabled in application cases where transmission of the metered value status bit is not desired or where it could lead to erroneous interpretations during analysis in the IO controller. In these cases, the status bit always assumes the value 0.
  See also Figure 2-16 in this context.

To convert the 32-bit pulse metered value into an energy value in floating-point format, conversion factors can be determined via acyclic read accesses.

See Chapter 2.4, IO module counters 04 in this context.

2.3.6 Message Block for Event List and Process Alarm

Number of byte values: 10

The complex data type **message block** defines an entry in the event list via PROFINET IO (see Chapter 2.6) and is used for the data field of the **summary process alarm** (see Chapter 2.7).

The message block contains an identification of the single-point indications and double-point indications which are sent in the event list or in the process alarm, plus the value and the associated time-stamp information.

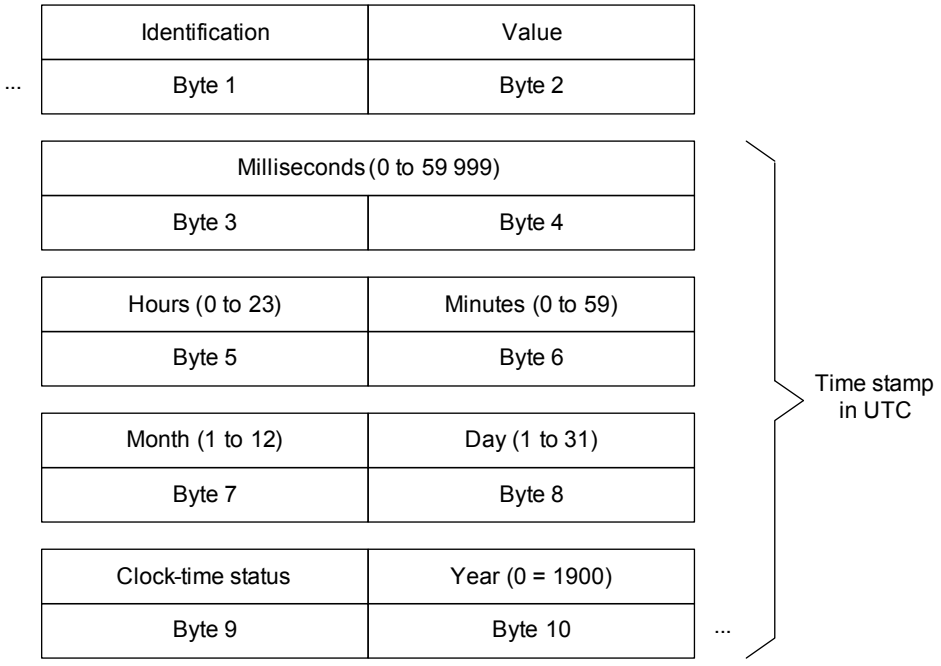

Figure 2-10 Data Type: Message Block

Byte 1: Identification

Byte 1 identifies a single-point indication or double-point indication using its PROFINET IO mapping data-object number.

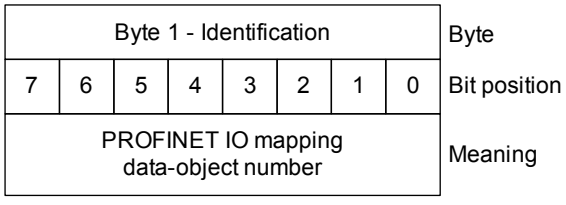

Figure 2-11 Byte 1 - Identification in the data type Message Block

Byte 2: Value

Byte 2 in the message block contains the value of an indication after registering a change, plus an identifier whether it is a single-point indication or a double-point indication.

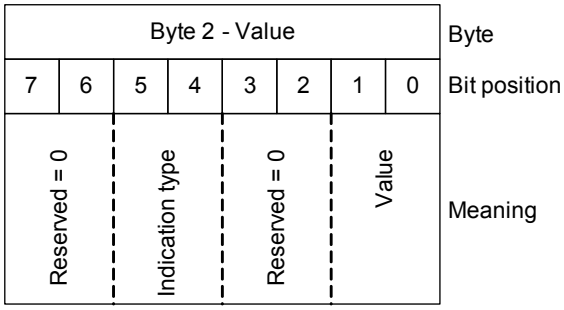

Figure 2-12 Byte 2 - Value in the data type Message Block

- Value (bit 0 and bit 1)
  - Single-point indication (binary output):
    00 = OFF
    01 = ON
  - Double-point indication (binary output):
    00 = disturbed state
    01 = OFF
    10 = ON
    11 = disturbed state
- Indication type (bit 4 and bit 5)
  01 = 1 = single-point indication
  10 = 2 = double-point indication

Example:

A change from ON to OFF of a single-point indication is transmitted with the value byte:

$00010000_{bin} = 10_{hex}$.

Byte 3 through Byte 10: Time Stamp

The real-time stamp is transmitted with the data depicted in Figure 2-10 for the instant of time the indication was changed. Time and date are indicated in UTC (Universal Time Coordinated).

NOTE

Correction factors for daylight saving time and local settings are not considered.

Meaning of the clock status (byte 9):

- 00_{hex} = time is valid
- 20_{hex} = time is invalid (clock failure)

2.3.7 Unit IDs, Units, and Unit Multipliers

The following unit IDs are assigned to the units of the measured values, statistic values and metered values:

Table 2-3 Units and Unit Multipliers

ID	Unit, unit multiplier		ID	Unit, unit multiplier		ID	Unit, unit multiplier
1	dimensionless		33	kΩ		172	MWh
3	%		51	W		173	GWh
4	°		53	kW		174	kvar
5	°C		54	MW		175	Mvar
11	A		61	VA		176	Gvar
12	mA		63	kVA		177	kvarh
13	kA		64	MVA		178	Mvarh
17	h		71	Hz		179	Gvarh
21	V		92	km		184	GVA
22	mV		95	miles		185	°F
23	kV		170	GW		203	MOhm
31	Ω		171	kWh		-	-

The unit IDs can be read via acyclic telegrams, see Chapter 2.8.2.

2.4 IO Modules

The IO modules described in the following are available for the PROFINET IO configuration of the SIPROTEC devices in the IO controller. For this purpose, the GSDML file, which contains the description of the IO modules, is loaded into the parameterization software of the IO controller.

Figure 2-13 shows an example for selecting the IO modules of the SIPROTEC IO device with electrical Ethernet interface in the Siemens parameterization software Step7 and a configuration example of a SIPROTEC device for PROFINET IO. For more information on the parameterization, refer to Chapter 3.

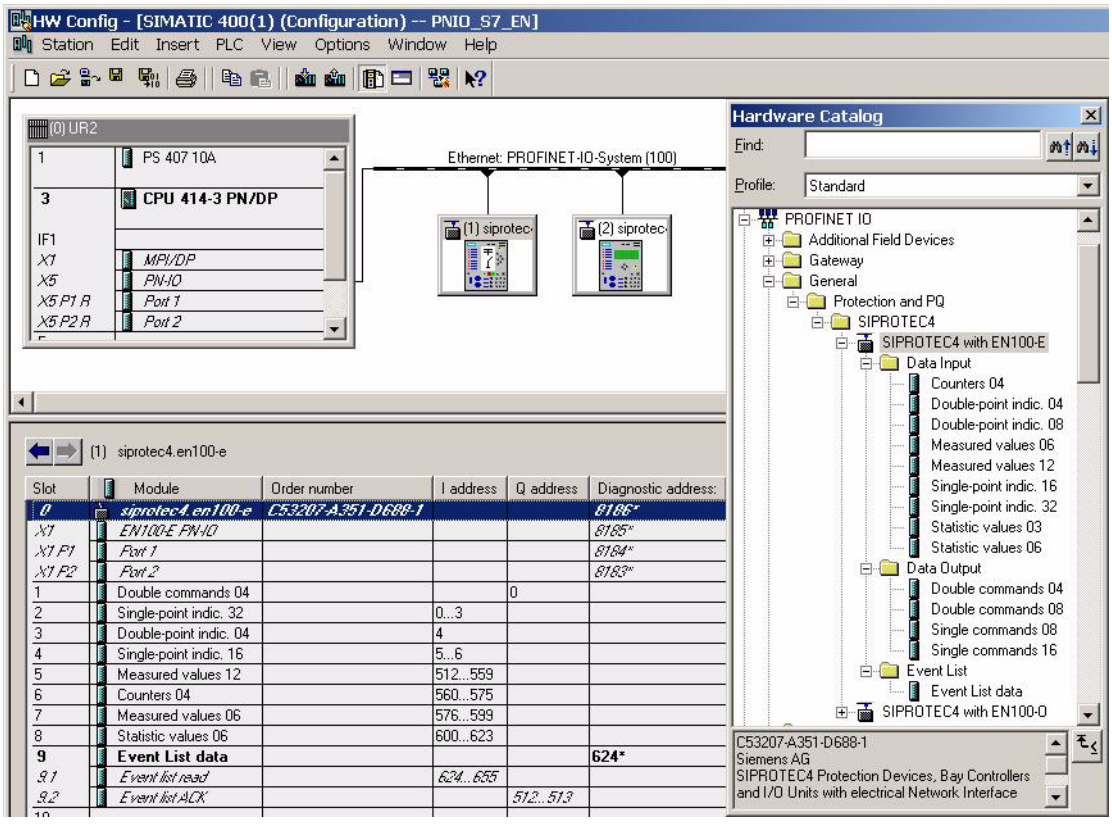

Figure 2-13 Parameterization Example

PROFINET IO Bus Interface DAP (Device Access Point)

The DAP module is always plugged in at slot 0 of the IO device and cannot be removed. The module describes the physical device data such as interface and port. In addition, it is possible to read or write device-related diagnoses and acyclic telegrams.

Cyclic data exchange	None
Acyclic reading/writing of data (standard PROFINET IO services)	• Reading of diagnostics data and I&M data 0, 1, 2, 3, 4 *) • Writing of I&M data 1, 2, 3, 4
Acyclic reading/writing of data (SIPROTEC-specific)	None
Parameters	None

*) I&M data = data for device identification and maintenance

IO Module Single-Point Indications 16

Single-point indications 16	
Category in the hardware catalog	Input data
Data type	16 single-point indications; see Chapter 2.3.1
Data size	2 bytes
Acyclic reading/writing of data	None
Parameters	Each single-point indication can be assigned to the process alarm (see Chapter 2.7). Default setting: all not assigned

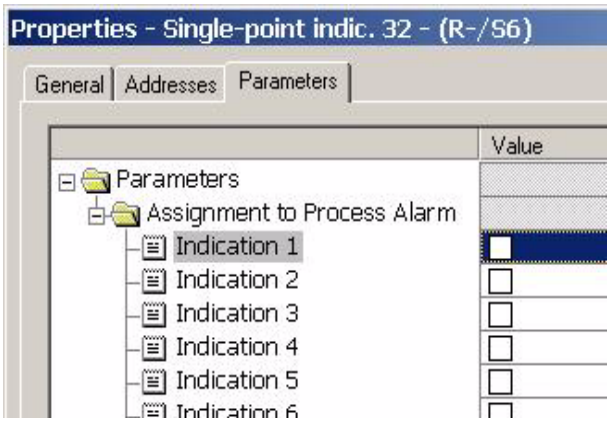

Figure 2-14 Single-Point Indication 16

NOTE

The indication number **indication x** (see Figure 2-14) is not identical with the PROFINET IO mapping data-object number. It refers to the indication in this IO module. The indication number in each IO module starts with number 1.

IO Module Single-Point Indications 32

Single-point indications 32	
Category in the hardware catalog	Input data
Data type	32 single-point indications; see Chapter 2.3.1
Data size	4 bytes
Acyclic reading/writing of data	None
Parameters	Each single-point indication can be assigned to the process alarm (see Chapter 2.7). Default setting: all not assigned

IO Module Double-Point Indications 04

Double-point indications 04	
Category in the hardware catalog	Input data
Data type	4 double-point indications; see Chapter 2.3.3
Data size	1 byte
Acyclic reading/writing of data	None
Parameters	Each single-point indication can be assigned to the process alarm (see Chapter 2.7). Default setting: all not assigned

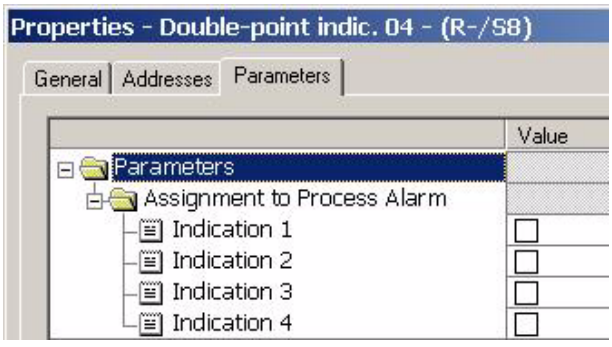

Figure 2-15 Double-Point indication 04

IO Module Double-Point Indications 08

Double-point indications 08	
Category in the hardware catalog	Input data
Data type	8 double-point indications; see Chapter 2.3.3
Data size	2 bytes
Acyclic reading/writing of data	None
Parameters	Each single-point indication can be assigned to the process alarm (see Chapter 2.7). Default setting: all not assigned

IO Module Measured Values 06

Measured values 06	
Category in the hardware catalog	Input data
Data type	6 measured values as Float32 value (floating point); see Chapter 2.3.4
Data size	24 bytes
Acyclic reading of data	Reading of 6 unit IDs as unsigned 16 bit value; see Chapter 2.8.2 Reading from: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Acyclic writing of data	None
Parameters	None

IO Module Measured Values 12

Measured values 12	
Category in the hardware catalog	Input data
Data type	12 measured values as Float32 value (floating point); see Chapter 2.3.4
Data size	48 bytes
Acyclic reading of data	Reading of 12 unit IDs as unsigned 16 bit value; see Chapter 2.8.2 Reading from: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Acyclic writing of data	None
Parameters	None

IO Module Statistic Values 03

Statistic values 03	
Category in the hardware catalog	Input data
Data type	3 statistic values (value indication) as Float32 value (floating point); see Chapter 2.3.4
Data size	12 bytes
Acyclic reading of data	Reading of 3 unit IDs as unsigned 16 bit value; see Chapter 2.8.2 Reading from: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Acyclic writing of data	Default setting or resetting of the statistic values using an acyclic data telegram; see Chapter 2.8.1. Writing to: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Parameters	None

IO Module Statistic Values 06

Statistic values 06	
Category in the hardware catalog	Input data
Data type	6 statistic values (value indication) as Float32 value (floating point); see Chapter 2.3.4
Data size	24 bytes
Acyclic reading of data	Reading of 6 unit IDs as unsigned 16 bit value; see Chapter 2.8.2 Reading from: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Acyclic writing of data	Default setting or resetting of the statistic values using an acyclic data telegram; see Chapter 2.8.1. Writing to: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Parameters	None

IO Module Counters 04

Counters 04	
Category in the hardware catalog	Input data
Data type	4 metered values; see Chapter 2.3.5
Data size	16 bytes
Acyclic reading of data	Reading of 4 unit IDs as unsigned 16 bit value; see Chapter 2.8.2 Reading from: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
	Reading of 4 conversion factors as Float32 value (floating point); see Chapter 2.8.3 Reading from: • Slot: slot number of the plugged module • Subslot: 1 • Index: 101
Acyclic writing of data	Default setting or resetting of the statistic values using an acyclic data telegram; see Chapter 2.8.1. Writing to: • Slot: slot number of the plugged module • Subslot: 1 • Index: 100
Parameters	Selection whether the MSB (Most Significant Bit) of the metered values is to be used as status bit. This configuration is then valid for all metered values in this IO module. If this option is not selected, the MSB is always zero. Default setting: the MSB is used as status bit.

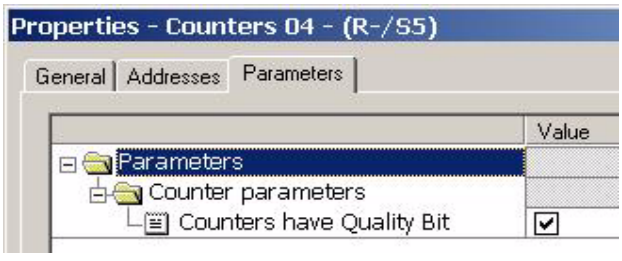

Figure 2-16 Counters

IO Module Single Commands 08

Single commands 08	
Category in the hardware catalog	Output data
Data type	8 single commands; see Chapter 2.3.2
Data size	2 bytes
Acyclic reading/writing of data	None
Parameters	None

IO Module Single Commands 16

Single commands 16	
Category in the hardware catalog	Output data
Data type	16 single commands; see Chapter 2.3.2
Data size	4 bytes
Acyclic reading/writing of data	None
Parameters	None

IO Module Double Commands 04

Double commands 04	
Category in the hardware catalog	Output data
Data type	4 double commands; see Chapter 2.3.3
Data size	1 byte
Acyclic reading/writing of data	None
Parameters	None

IO Module Double Commands 08

Double commands 08	
Category in the hardware catalog	Output data
Data type	8 double commands; see Chapter 2.3.3
Data size	2 bytes
Acyclic reading/writing of data	None
Parameters	None

IO Module Event List Data

Event list	
Category in the hardware catalog	Event list
Data type	Message blocks and control bytes for event list; see Chapter 2.3.6
Data size	32 bytes input and 2 bytes output
Acyclic reading/writing of data	None
Parameters	None

2.5 Assignment of IO Modules to SIPROTEC Data Objects

The following components and dependencies are involved in an access to the device data via PROFINET IO:

- Data-object image of the SIPROTEC device
- Mapping SIPROTEC data objects to PROFINET IO
- IO modules for PROFINET IO parameterization

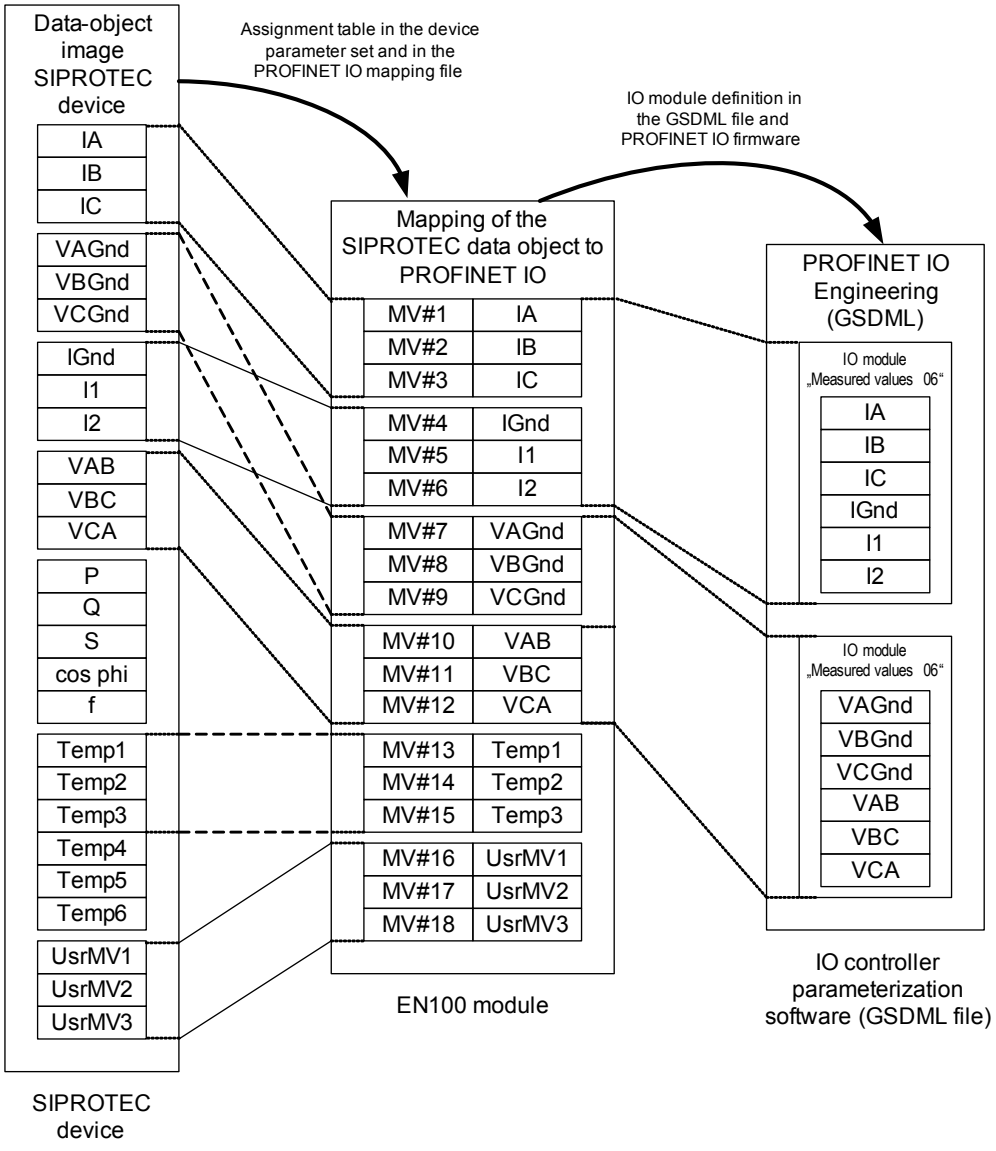

Figure 2-17 Example Assignment of the IO Modules to SIPROTEC Data Objects (Measured Values)

See also the example given in Figure 2-18.

Data-Object Image of the SIPROTEC Device

The data-object image contains all data objects which the SIPROTEC device offers with the current values and qualities. The size of the data-object image depends on the number of configured database objects.

It is possible to parameterize additional data objects in DIGSI besides the predefined data objects.

Each data object in the SIPROTEC device has a unique object address for identifying and accessing this data object.

Mapping SIPROTEC Data Objects to PROFINET IO

The mapping describes all SIPROTEC data objects which are sent or received via communication, and defines their position or identification in PROFINET IO. This can include all available data objects or only subsets thereof.

The following 2 main elements exist:

- Assignment table in the device parameter set
- PROFINET IO mapping file

After device startup with a valid device configuration, the 2 main elements mentioned previously are available in the EN100 module and can be analyzed using the PROFINET IO firmware.

Although the data volumes for each data type are defined in the mapping (for example: 20 indications, 10 measured values, etc.), the assignment to SIPROTEC data objects of the same type can be modified when parameterizing the devices using DIGSI.

Each PROFINET IO data object is assigned a PROFINET IO mapping data-object number, starting at 1 for each data type (for example, MV#1, see Figure 2-17).

IO Modules for PROFINET IO Parameterization

The maximum data volume per data type for the data exchange is described in the respective bus mapping manual. The preset data-object assignments or the assignments entered during parameterization in DIGSI define the data at the individual mapping positions.

Only such data is transmitted via PROFINET IO which is represented by the respective IO modules.

The assignment of IO module data contents to the PROFINET IO mapping data-object numbers always starts at the smallest PROFINET IO mapping data-object number, see Figure 2-17.

The IO modules of one type do not have to follow directly one after another in the IO controller parameterization software.

The option of assigning data in DIGSI allows the data to be configured as desired so that, for example, fewer IO modules are required.

If too many IO modules of the same type have been added during parameterization, causing the maximum number of PROFINET IO objects for this data type to be exceeded, the IO device will recognize this during startup of the PROFINET IO communication. An error indication will be sent to the IO controller.

IO modules which cannot be assigned to any PROFINET IO objects are left unconsidered during the further data exchange.

Example as Shown in Figure 2-17

The SIPROTEC device delivers 18 measured values (MV#1 through MV#18). However, only 12 measured values (current, voltage) are to be transmitted and assigned to the PROFINET IO mapping in DIGSI (MV#1 through MV#12). In this case, either 6 measured values respectively are taken over into 2 IO modules **measured values 06** from the GSDML file of the SIPROTEC device, or 12 measured values in one IO module **measured values 12** of the IO controller parameterization software.

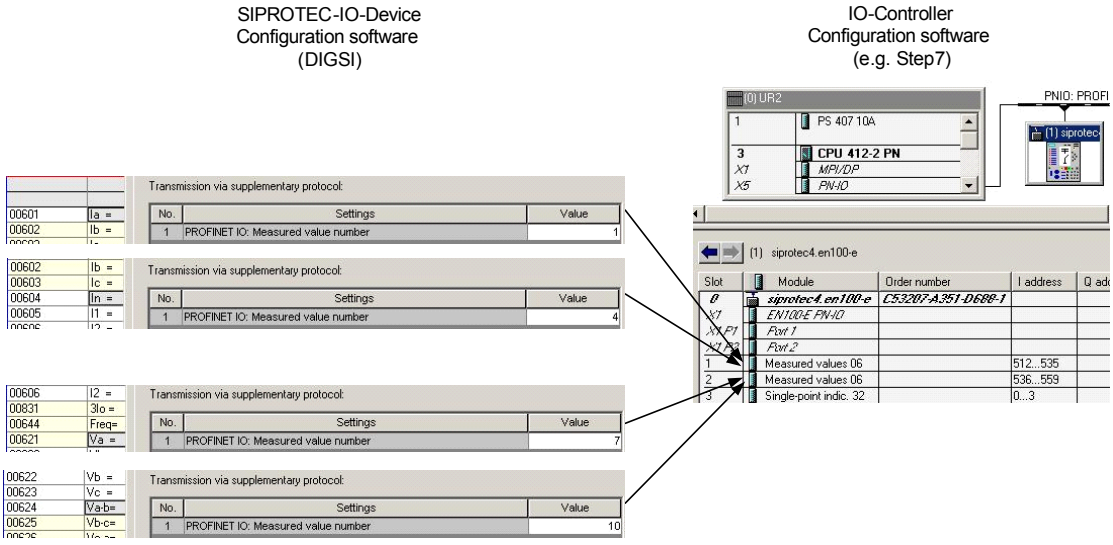

Figure 2-18 Parameterization Example of Assigning the IO Modules to SIPROTEC Data Objects

2.6 Event List

The event list is an autonomous ring buffer in the PROFINET IO communication module, in which value changes (only single-point and double-point indications) are entered with a time stamp. These time stamps can be transmitted via cyclic data exchange using the handshake method (read/acknowledge) described in Chapter 2.6.3.

The event list is empty after an initial start or restart of the SIPROTEC device. Non-transmitted indications are lost during initial start or restart of the SIPROTEC device.

Only such indications of the SIPROTEC device which are also included in the cyclic PROFINET IO telegram in input direction are entered in the event list when values change. No entry is made for status changes and command-sequence states.

The event list can contain a maximum of 500 entries. When adding a new entry to a full event list, the oldest entry is deleted and the IO controller is notified of a buffer overflow with a bit in the handshake byte "Control_I" in input direction.

The event list is not deleted when communication is interrupted. Entries for indication changes are still stored and transmitted to the IO controller (including buffer overflow identification) after the communication connection has been restored.

The event list entries are transmitted to the IO controller in the message blocks of the PROFINET IO telegram and must be acknowledged by the IO controller (see Chapter 2.6.3).

The data types and the handshake mechanism used are proprietary, because PROFINET IO does not offer an event list by default. The event lists handshake mechanism is a part of the cyclic data exchange.

In the GSDML file of the SIPROTEC devices, the event list is defined as an autonomous IO module, see Chapter 2.4.

2.6.1 Input Direction

The following structure corresponds to the IO module **event list**, data in input direction, and the data area of the **process alarm**, see Chapter 2.7.

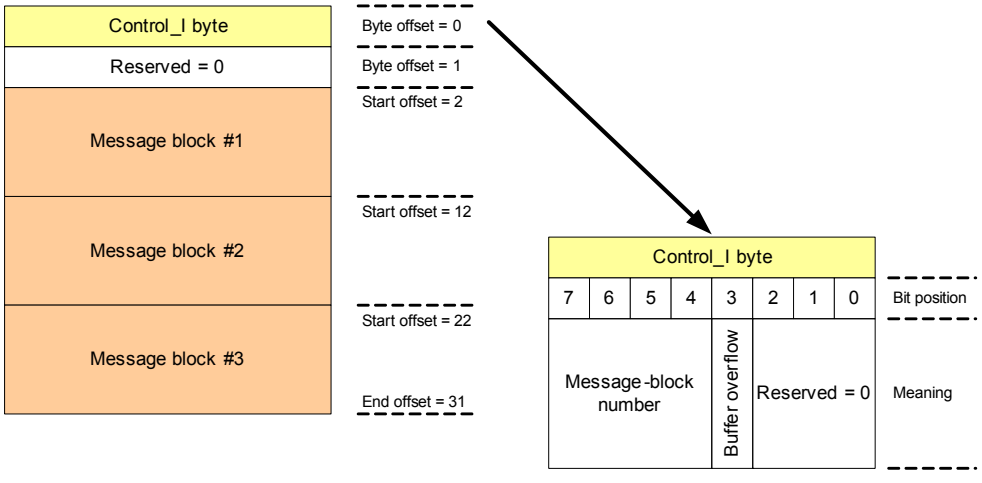

Figure 2-19 Structure of the Event List, Input Direction (Read)

Message-Block Number of the Event List

- The transmission of message blocks starts with message block 1. The message-block number is increased by 1 for each transmission of message blocks until reaching message block 15. Subsequently, the transmission starts again with message block 1. A maximum of 3 entries are transmitted per message block from the event list.
- The message-block number only has the (initial) value 0 if the event list does not contain any entry when initializing or restarting the SIPROTEC device. After the first entry has been transmitted to the event list and the associated message-block number has been increased for the next entry, the value 0 is not assigned anymore.
- If the telegram contains no entry or fewer than 3 entries in the event list, the unused message blocks are filled with zeros.
- If no indication changes are transmitted, the message-block number remains constant during this time. In this case, the message-block number transmitted last is transmitted repeatedly until new entries are made in the event list.

Message-Block Number in the Process Alarm

- The message-block number is increased by 1 for each process alarm (3 messages max. per process alarm), starting with message block 1 until reaching message block 15. Subsequently, the transmission begins with message block 1 again.
- The first process alarm after the start of communication of the SIPROTEC device is sent with the message-block number 1.
- If the process alarm is caused by only one or 2 messages, the unused message blocks are filled with zeros.

Buffer Overflow of the Event List

The buffer overflow of the event list signals a set bit. This bit is reset when the buffer overflow no longer exists.

Buffer Overflow for Process Alarm

The bit for signaling a buffer overflow is not used.

Message Block #1 through Message Block #3

See Chapter 2.3.6.

2.6.2 Output Direction

The following structure corresponds to the IO module **event list**, data in output direction. The structure is not used for process alarms.

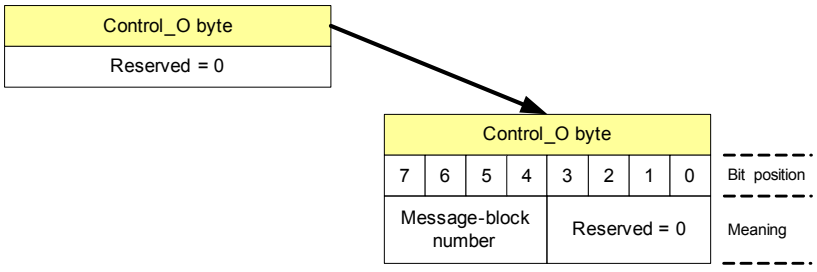

Figure 2-20 Structure of the Event List, Output Direction (ACK)

Message-Block Number

The message-block number in the Control_O byte serves for reception acknowledgement and analysis of the message block. After having analyzed the message blocks, the PROFINET IO controller copies the message-block number of the Control_I byte of the input telegram to the Control_O byte of the output telegram.

The SIPROTEC device repeats the respective message block so often until the IO controller correctly mirrors back the message-block number of the Control_I byte into the Control_O byte.

2.6.3 Handshake Mechanism (Example)

In the following example of the event list handshake mechanism, the initial situation is defined as follows:

- 3 message blocks were last transmitted and acknowledged by the IO controller.
- The current message-block number is $14_{dec} = E_{hex}$.

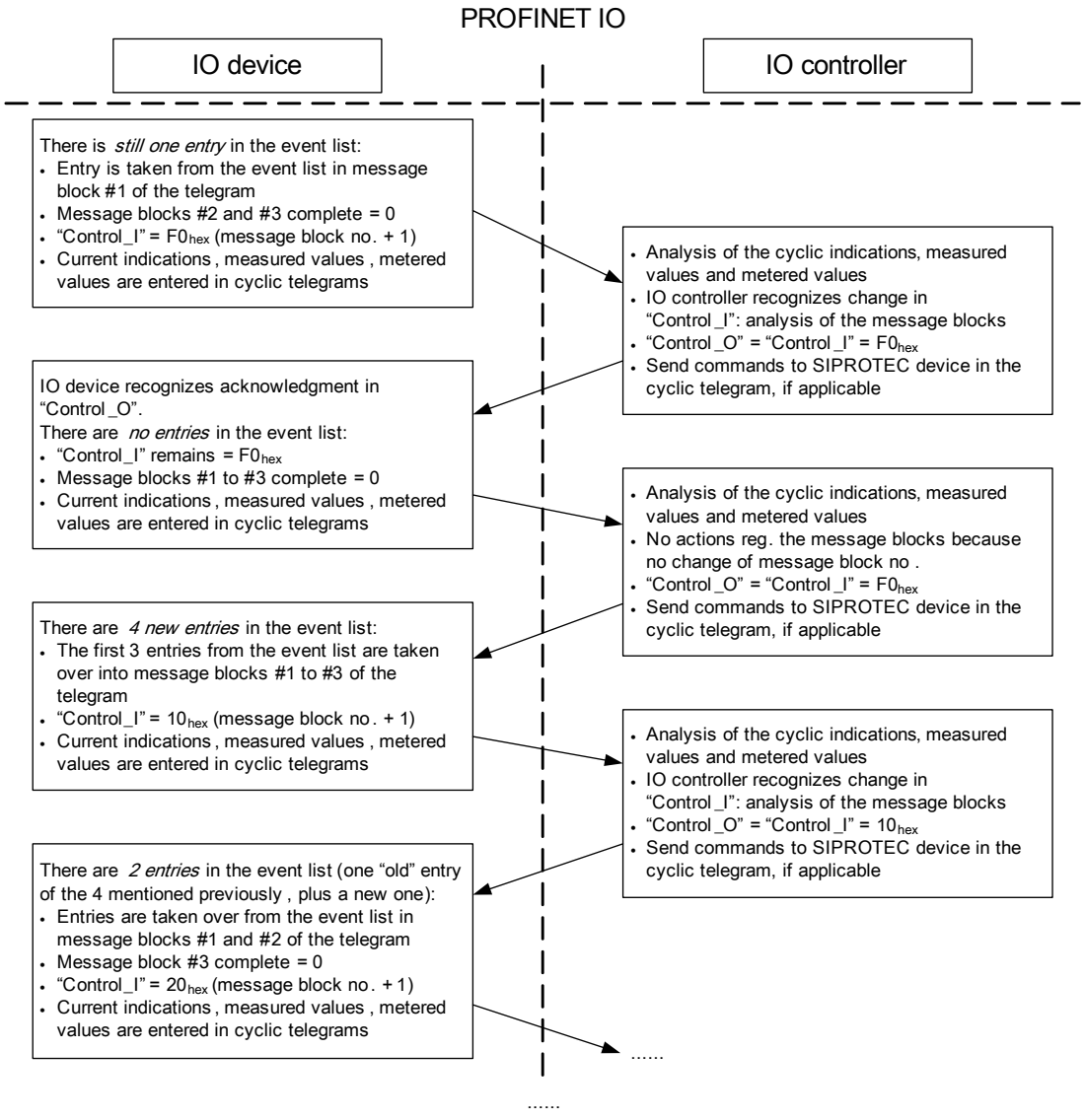

Figure 2-21 Handshake Mechanism (Example)

NOTE

Several PROFINET IO bus cycles can lie between a new telegram from the IO device and the data analysis by the IO controller (and vice versa), that is the arrows do not indicate a bus cycle but the direction of the higher-level telegram exchange.

2.7 Process Alarm

Process alarms in PROFINET IO use the RTA mechanism (Real Time Alarm) and are only sent as **indication ON** or as **indication RAISING**.

The SIPROTEC device offers one process alarm which is named **Summary Process Alarm**.

An alarm is issued when the value of at least one indication of the SIPROTEC device linked with the alarm changes.

When parameterizing the IO controller, it can be decided for each SIPROTEC indication sent via PROFINET IO whether the indication is assigned to the process alarm **Summary Process Alarm** or not (see Figure 2-14 and Figure 2-15).

Using process alarms provides the advantage that these alarms can be analyzed like an interrupt in the PLC (Programmable Logic Controller) with assigned alarm blocks, thereby reducing the response to indication changes (see Chapter 3.3.2.5).

If more than one indication was assigned to the process alarm **Summary Process Alarm**, an alarm means that the value of one or more assigned indications has changed.

If several indications, which are combined to form the process alarm **Summary Process Alarm**, change virtually simultaneously in the SIPROTEC device, the following applies:

1. If a change of the first indication is detected, an alarm is sent immediately.
2. The IO controller processes and acknowledges the PROFINET IO alarm. During this time, no second process alarm is possible via PROFINET IO.
3. Further indication changes that can cause a process alarm are stored internally.
4. When the running alarm processing has been terminated and another alarm is present in the EN100, this alarm is output by the IO device. This alarm can contain up to 3 stored indications.

The process alarm telegram contains alarm information consisting of a header plus additional alarm information. User-specific data are transmitted in the additional alarm information. The additional alarm information for the process alarm **Summary Process Alarm** contains the identifications and time stamps of up to 3 indications which trigger the alarm. The same structure as for the event list data transmission is used here, see Chapter 2.6.1.

If the additional alarm information contains several indications, these indications belong to the same IO module.

The process alarm **Summary Process Alarm** is always identified as follows:

- Slot = slot of the IO module to which the indication triggering the alarm is assigned
- Subslot = 1
- Structure ID = 200 as source

There is only this one process alarm for the PROFINET IO implementation for SIPROTEC devices.

If the SIPROTEC device does not communicate with the IO controller, no process alarm is processed and no indication changes are stored for the process alarm.

2.8 Acyclic Reading and Writing of Data

2.8.1 Presetting and Resetting Metered Values and Statistic Values

An acyclic write telegram is defined for presetting and resetting the metered values and statistic values. Depending on the definition of the IO module, up to 8 values can be set with this telegram. The order of the values in the telegram corresponds to the order of the values in the IO module, see Chapter 2.4. A masking byte allows selecting the values to be set.

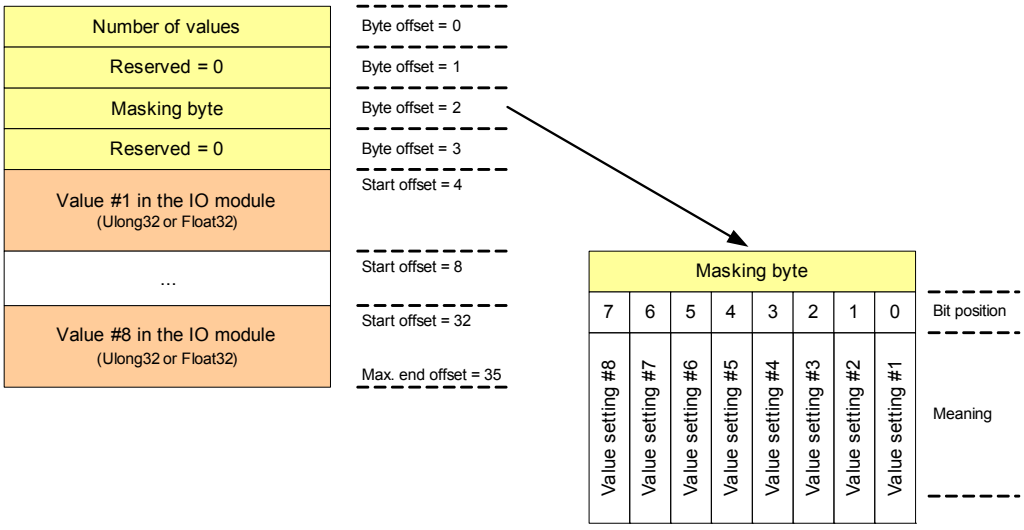

Figure 2-22 Acyclic Data Telegram, Presetting and Resetting Metered Values and Statistic Values

Number of Values

- IO module for metered values: 4
- IO module for statistic values: 3 or 6

Masking Byte

Each bit in this byte corresponds to one value in the telegram. The associated value is only evaluated in the device if the masking bit is set. Unused masking bits must be set to zero.

Value #1 through Value #8

Depending on the data type, the values to be set are transmitted at the respective telegram positions as Unit32 for metered values or as Float32 for statistic values. The telegram always only contains as many value entries as entered in the byte "Number of values".

Siemens recommends setting unused values to zero, for example values for which no masking bit is set.

NOTE

For statistic values:

The EN100 rejects invalid Float32 values (Not a Number values) and does not take over such values.

NOTE

For metered values:

After having set a metered value, this value is immediately applied in the SIPROTEC device and shown on the display. Updating via PROFINET IO is only initiated with the next restore cycle.

The range of value for setting metered values is 0 to 7FFFFFFFH. When setting a greater value in the telegram, the most significant bit (MSB) is automatically set to 0 on the EN100 and the value resulting thereof is transmitted to the SIPROTEC device.

Example: 9234ABC6H is entered in the telegram; 1234ABC6H is set.

2.8.2 Reading Unit IDs of Measured Values, Statistic Values, and Metered Values

An acyclic read telegram is defined for reading units and unit multipliers. The order of the values in the telegram corresponds to the order of the values in the IO module.

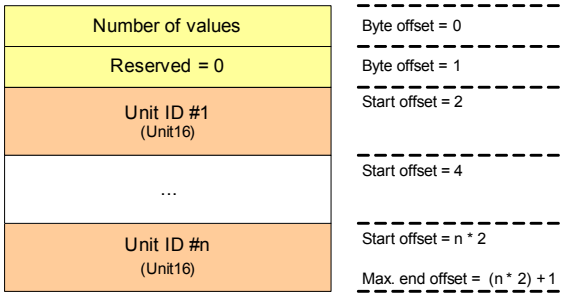

Figure 2-23 Acyclic Data Telegram, Reading Unit IDs

Number of Values

- IO module for measured values: 6 or 12
- IO module for metered values: 4
- IO module for statistic values: 3 or 6

Unit ID #1 through Unit ID #n

The telegram always only contains as many unit IDs as entered in the byte **Number of values**. This also determines the length of the telegram.

The definition of the unit IDs is described in Chapter 2.3.7.

2.8.3 Reading Conversion Factors of Metered Values

An acyclic read telegram is defined for reading conversion factors. The order of the values in the telegram corresponds to the order of the values in the IO module.

Multiplication of the metered value with the conversion factor either yields the associated energy value (for metered values derived from measured values) or the value in the measured unit (for pulse metered values via binary inputs).

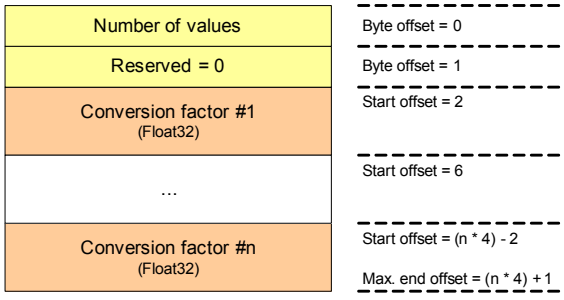

Figure 2-24 Acyclic Data Telegram, Reading Conversion Factors of Metered Values

Number of Values

- IO module for metered values: 4

Conversion Factor #1 through Conversion Factor #n

The telegram always only contains as many conversion factors as entered in the byte **Number of values**. This also determines the length of the telegram.

2.9 Executing Switching Operations via PROFINET IO

2.9.1 Command Output Types for Switchgear Control

The following command types are available in the SIPROTEC device:

Double Commands

Processing of the double commands, output to the switchgear, and feedback is accomplished in the device via 2 outputs and 2 bits respectively, which are defined with 01 = **OFF** and 10 = **ON**.

Single Commands

Processing of the single commands, output to the switchgear, and feedback is accomplished in the device via one output and one bit respectively, which is defined with 0 = **OFF** and 1 = **ON**.

NOTE

The above definition notwithstanding, single commands and double commands in the SIPROTEC device are controlled via PROFINET IO consistently using 2 bits of the PROFINET IO output telegram (see Chapter 2.3.2 and Chapter 2.3.3).

A command can be output in the SIPROTEC device as continuous output or as pulse output.

Continuous Outputs

Commands are issued in the continuous output mode (controlled) if a value transition (signal edge) from **idle state** or **OFF** to **ON** is detected via PROFINET IO for the associated bit pair. The commands remain activated until a value transition occurs from **idle state** or **ON** to **OFF** via PROFINET IO. The definitions of the values for **idle state**, **ON** and **OFF** are described in Chapter 2.3.2 and Chapter 2.3.3.

Pulse Outputs

The SIPROTEC device independently issues a control pulse for switching switchgear, including the observation of the parameterized times.

The switching operation (pulse output via the assigned binary outputs of the SIPROTEC device) is executed when a value change of the associated bit pair is transmitted in the PROFINET IO output telegram

- for double commands from **idle state** or **ON** to **OFF** or from **idle state** or **OFF** to **ON**,
- for single commands from idle state to **ON**.

NOTE

The switching direction **OFF** for single commands with pulse output is not permitted and is rejected in the SIPROTEC device.

2.9.2 Recommended Transmission of Commands via PROFINET IO

Outputs or internal tags are only set via PROFINET IO in the SIPROTEC device if a corresponding value change is detected at the associated bit positions of the IO module in the PROFINET IO output telegram (triggered by change; see description on Continuous Outputs and Pulse Outputs in Chapter 2.9.1).

NOTE

A value change at the associated bit position in the PROFINET IO telegram triggers a command processing operation in the SIPROTEC device. However, this does not mean that the associated output or the associated tagging actually takes the set point value. For example, the setting of an output caused by interlocking can be rejected. The feedback of a switching device or the tagging should be read back for monitoring purposes.

If the bit combination for a command changes and the bit value for ON or OFF is still transmitted (statically) in the cyclic output telegram, this has no consequences in the SIPROTEC device while communication is running.

A statically set bit combination for ON or OFF may cause undesirable command executions when communication is restored in the event of communication interruptions (see Chapter 2.10) or STOP of the PLC (see Chapter 3.3.2.1) or when the PLC switches from STOP to RUN.

Siemens therefore recommends transmitting switching operations or set taggings in SIPROTEC devices via PROFINET IO by using a pulse over the bus:

- Idle state ("00") → ON ("10") → idle state ("00") for switching on
- Idle state ("00") → OFF ("01") → idle state ("00") for switching off

The pulse duration (period during which the bit combinations for ON or OFF apply) should be at least 3 times the set cycle time of the IO device (reference value at least approx. 100 ms).

2.9.3 Multiple Command Output

Command processing in the SIPROTEC device operates in a 100 ms cycle. This includes:

- Command checking
- Command output
- Feedback monitoring
- Generating positive or negative command feedback

After the issuing of a positive command feedback, which is also entered as a change of the value of the switchgear position in the cyclic input telegram via PROFINET IO, command processing remains active for one cycle max. (100 ms).

As the SIPROTEC device does not process several commands in parallel, an additional command, which is received within an active command processing, is rejected with "1 out of n error" and is not executed.

If it is desired that the IO controller issues 2 or more commands directly one after another, a time delay of 100 ms must be observed after reception of the positive command feedback in the cyclic input data until issuing of the next command. This ensures that the subsequent command is executed reliably.

2.9.4 Behavior During Special Operating Conditions

- The IO controller detects a change of the switchgear position not initiated by the IO controller (for example, circuit-breaker trip) by the change of the value of the switchgear position in the associated bit positions of the input telegram.

  If, for example, the IO controller wants to restart the switchgear that was switched off locally, it must first transmit the ACTUAL value (**OFF**) or **idle state** via PROFINET IO and can subsequently restart the switchgear by setting the TARGET value (**ON**).

- The IO controller detects when a switching operation requested via PROFINET IO cannot be executed, because the switching authority is set to LOCAL, for example, or the associated bay interlocking is not satisfied. The IO controller recognizes this because the feedback of the double command/single command in the PROFINET IO input telegram is not updated according to the TARGET switch position (activate a feedback monitoring time in the IO controller if necessary).

  Before a new switching attempt, the ACTUAL switch position for switchgear must first be transmitted again according to the input telegram or idle state via PROFINET IO in the output telegram.

- The behavior during communication interruptions is described in Chapter 2.10.

2.10 Behavior When Communication to IO Controller is Faulted

The following behavior is defined for SIPROTEC devices when the communication to the IO controller is interrupted:

After Having Recognized that the Connection Is Interrupted

1. The marking **SysIntErr.** (error of system interface) in the SIPROTEC device is set to **ON** (logging in the operational indication log, processing in CFC possible).
2. The state of the outputs or switchgear has not changed compared to the state before communication interruption.

After the Communication Has Been Restored

1. The marking **SysIntErr.** (error of system interface) in the SIPROTEC device is set to **OFF** (logging in the operational indication log, processing in CFC possible).
2. The data from the telegrams again received by the IO controller is taken over (if permitted by the switching authority and the interlocking specifications).

If you do not want the switchgear positions of the SIPROTEC devices to be affected after the link between the IO controller and IO device has been restored, **idle state** (value "00") must be issued in the associated bit positions in the output telegram, or the switching authority must be set to **(LOCAL)**.

2.11 Indications to the IO Controller

NOTE

When analyzing the indications of the SIPROTEC device in the IO controller, remember that due to the cycle time of the PROFINET IO system or the time of cyclic processing within a PLC, temporary changes of the value of an indication (**ON** and **OFF** in one cycle) might not be detected.

This applies to protection indications in particular.

Protection Pickup

Protection indications which signal a "protection pickup" status also only apply for the time during which the protection pickup applies.

Protection Trip

The parameter **Minimum duration of trip command** (parameter address = 210) allows you to set the minimum trip-command duration.

This time applies to all protection functions that can initiate tripping.

The associated protection indications transmit the value **ON** after occurrence of a protection trip for the set minimum duration.

2.12 Time Synchronization

In the SIPROTEC device, the time is synchronized via Ethernet using NTP (Network Time Protocol). An SNTP client (including redundant NTP server support) is implemented in the EN100 firmware and also in the PROFINET IO communication module.

NOTE

Use an NTP server for time synchronization via NTP. This server must be installed in the local communication network in which also the IO device is used, for example PLC or PC of the control center. Ensure that the NTP server is synchronized by a higher-level signal source, for example GPS.

The parameterization of NTP for the SIPROTEC device using DIGSI is described in Chapter 3.2.

2.13 PROFINET IO and IEC 61850/GOOSE

The communication protocols PROFINET IO and IEC 61850/GOOSE can be used simultaneously over a shared Ethernet port on the EN100 module. They are differentiated by means of the EtherType (IP, GOOSE, PROFINET IO RT), the UDP port number for PROFINET IO, or the TCP port number for IEC 61850. Other IP-based protocols such as SNTP, SNMP or HTTP run parallel to other dedicated port numbers.

NOTE

All protocols available on the EN100 are activated by default.

If you do not need communication via IEC 61850-MMS and GOOSE, Siemens recommends disabling the IEC 61850 service for this device in DIGSI. This reduces the time for PROFINET IO between a device start and readiness to start communication with the IO controller.

When communicating without IEC 61850 and GOOSE, operation with a minimum PROFINET IO cycle time of 4 ms is also possible. The 4-ms cycle time must not be used together with IEC 61850 and GOOSE (see below).

For parallel operation of IEC 61850/GOOSE and PROFINET IO, the following configuration must not be exceeded, even if more extensive settings are possible in the parameterization tools:

- IEC 61850: 2 process clients maximum in the system
- GOOSE: 5 GOOSE applications maximum per device

  50 data objects as source and 50 data objects as destination for GOOSE interconnections maximum per device

  Minimum monitoring time $\geq$ 10 ms (use standard settings of the communication profile **PriorityLow** in **GOOSE parameters** of the IEC 61850 System Configurator)
- PROFINET IO: minimum cycle time 8 ms

NOTE

Changes in the network settings via DCP affect all IP applications running on the EN100, for example HTTP server and IEC 61850 server. See also Chapter 3.1 and Chapter 3.4.1.

The device names for IEC 61850 (IED name) and PROFINET IO (station name) can be different. The device name for IEC 61850 is assigned in the station configurator. The device name for PROFINET IO is assigned via DCP as described in Chapter 3.4.1.

2.14 Media Redundancy

The EN100 manual, section IEC 61850, contains information on the supported media redundancy procedures.

3 Parameterization

3.1 Configuration of EN100 Network Parameters

Ethernet-Network Settings

The EN100 requires the following Ethernet network parameters for IP-based applications:

- IP address
- Subnet mask
- Default gateway

There are 3 options for setting the parameters:

1. The network parameters are assigned when parameterizing the device using DIGSI and the IEC 61850 system configurator.
2. A commissioning tool (e.g. "Primary Setup Tool", see Chapter 3.4.1) is used to assign the network parameters via DCP.
3. The IO controller assigns the network parameters to the respective addressed IO device (also via DCP) when the PROFINET IO communication is launched.

NOTE

The network setting specified in the IEC 61850 station configurator is activated in the EN100 each time the device parameters and EN100 parameters are loaded or initialized via DIGSI.

Changing the network settings via DCP is possible anytime afterwards. The new network parameters are permanently stored and used in the EEPROM of the EN100. Restarting the SIPROTEC device or EN100 is not necessary and is not automatically executed.

NOTE

A change to the network settings via DCP affects all IP applications running on the EN100, for example HTTP server and IEC 61850 server. See also Chapter 3.4.1.

Chapter 3.4.2 describes how to reset the network parameters to the factory settings via DCP. The EN100 is restarted in the process.

If the network parameters specified via the IEC 61850 system configurator are to be set again after having changed the network settings, either the device is to be loaded/initialized again via DIGSI or the network parameters are to be set via DCP.

NOTE

EN100 with PROFINET IO does not support DHCP.

IO Device Name

The station name for the IO controller to identify the device is another basic setting for the EN100 (PROFINET IO device).

The device names for IEC 61850 (IED name) and PROFINET IO (station name) can be different. The device name for IEC 61850 is assigned in the station configurator. The device name for PROFINET IO is assigned via DCP, see Chapter 3.4.1.

A parameterized station name is permanently stored in the EEPROM of the EN100.

The set station name of the SIPROTEC device is displayed on the HTML page of the PROFINET IO diagnosis (see Chapter 4.1).

3.2 Parameterization with DIGSI

3.2.1 Inserting and Configuring a New Project

NOTE

In order to parameterize the PROFINET IO protocol, the device functions must have been parameterized correctly. Enter the required protocol settings using the DIGSI parameterization software, version 4.86 or higher.

Refer to the DIGSI 4 manual for detailed information in this context.

NOTE

The following parameterization is shown for the 7SJ80. Other relays, must be set in the same way.

NOTE

To set the PROFINET IO protocol, DIGSI must contain the IEC 61850 station configurator.

- ✧ Open **DIGSI Manager**.
- ✧ Click the menu **File** → **New...**

  The **New Project** dialog opens.

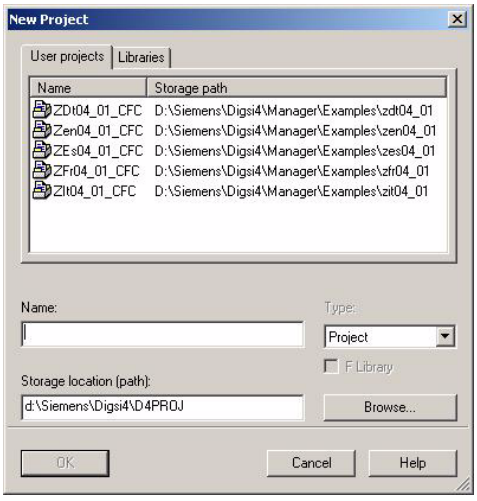

Figure 3-1 New Project Dialog

- ✧ Enter a new project name (7SJ80_PNIO in the example) in the **Name:** field and select the **Storage location (path)**. Next click **OK**.

The following window of DIGSI Manager opens:

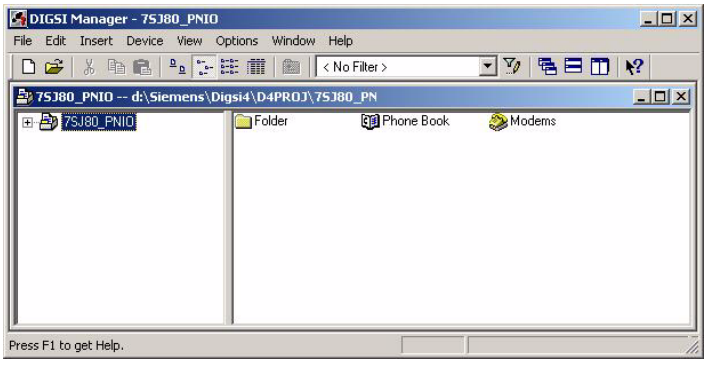

Figure 3-2 DIGSI Manager with a new project

✧ Right-click **Folder** in DIGSI Manager and open the **Device Catalog** via **Insert new object** → **SIPROTEC device**.

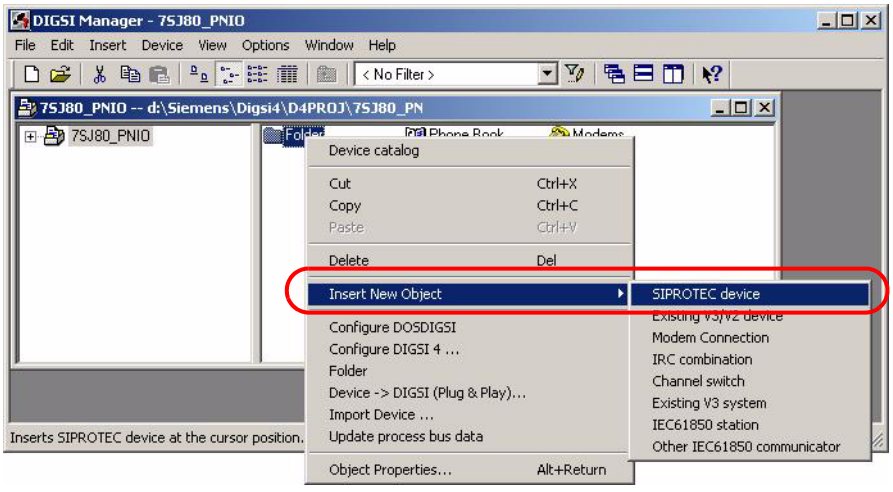

Figure 3-3 DIGSI Manager with an Object Selected

✧ Select the desired SIPROTEC device (Digital Time Overcurrent Protection SJ803/V4.7 in the example) in the **Device Catalog** and move the object into the folder in DIGSI Manager using drag and drop.

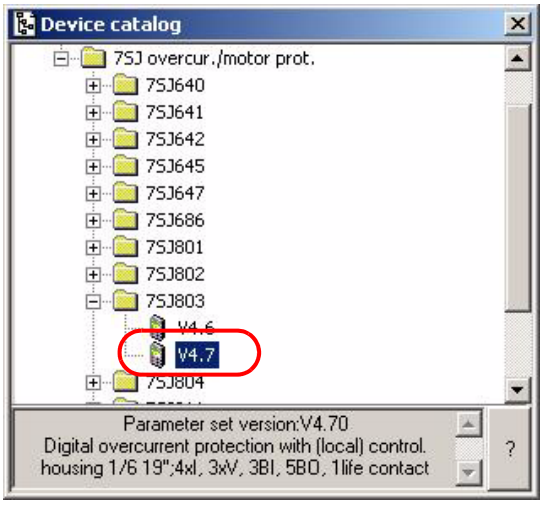

Figure 3-4 Device Catalog

The **Properties - SIPROTEC device** dialog opens (see Figure 3-26).

✧ Configure the order number (**MLFB**) of your device in the **Properties - SIPROTEC device** dialog. Next click **OK**.

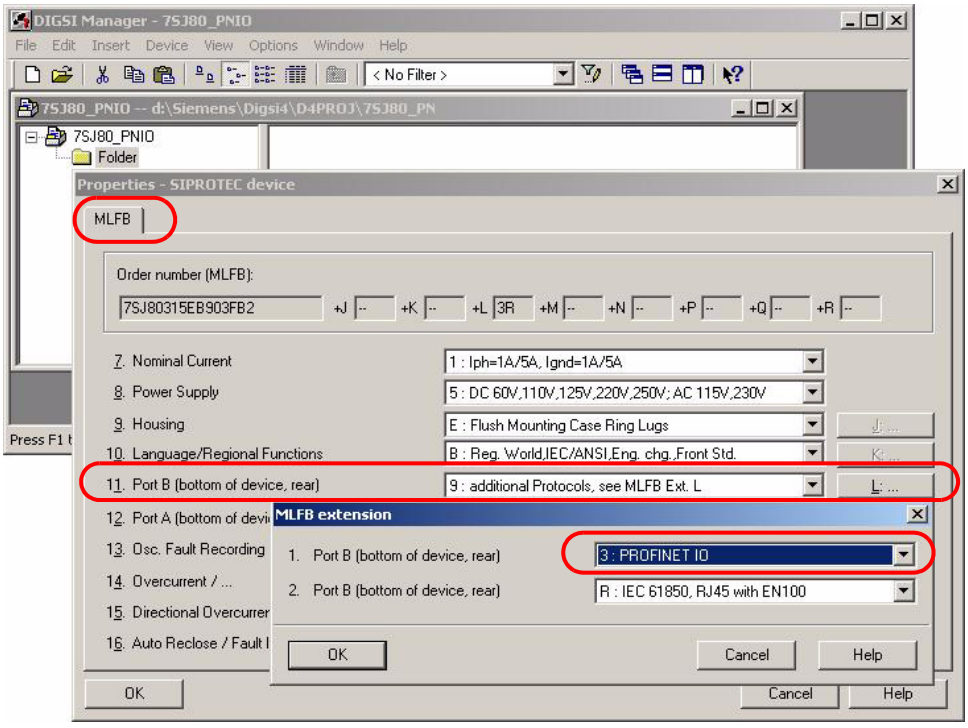

Figure 3-5 Configuring the Order Number (MLFB)

If you have retrofitted the SIPROTEC device or if you want to subsequently install the PROFINET IO protocol, proceed as follows:

✧ In DIGSI Manager, right-click the selected SIPROTEC device (e.g. 7SJ803 V4.7) and then click **Object properties...**.

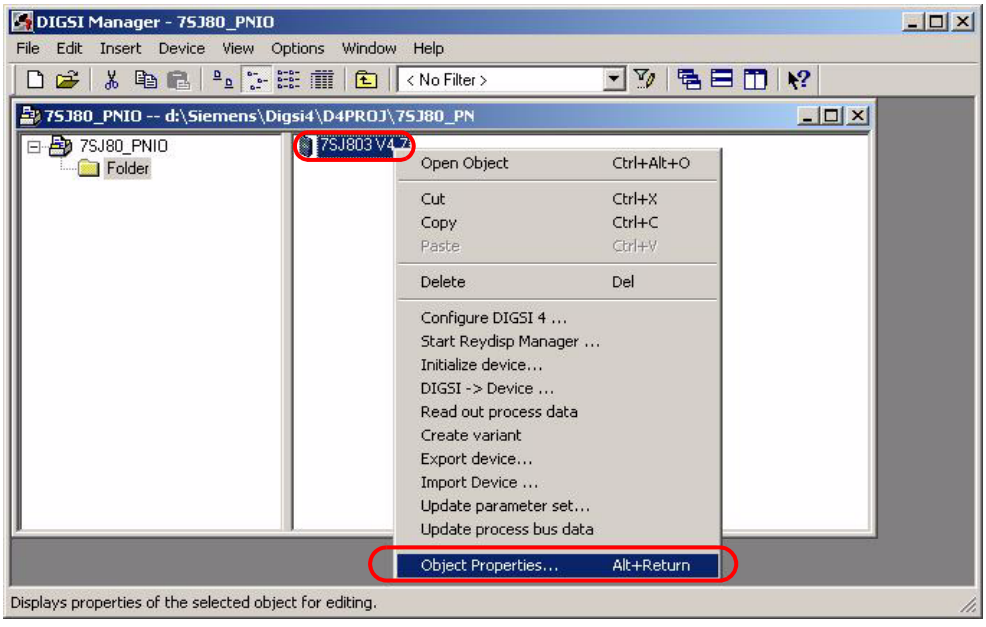

Figure 3-6 Selecting the Object Properties

The **Properties - SIPROTEC device** dialog opens.

✧ On the **Communication Modules** tab → list item **11. Port F (data interface)** *(Port F for 7SC80, Port B for other SIPROTEC devices such as 7SJ61)* → **L: ...** → **Additional information**, select the **PROFINET IO** protocol.

Next click **OK** in both open tabs.

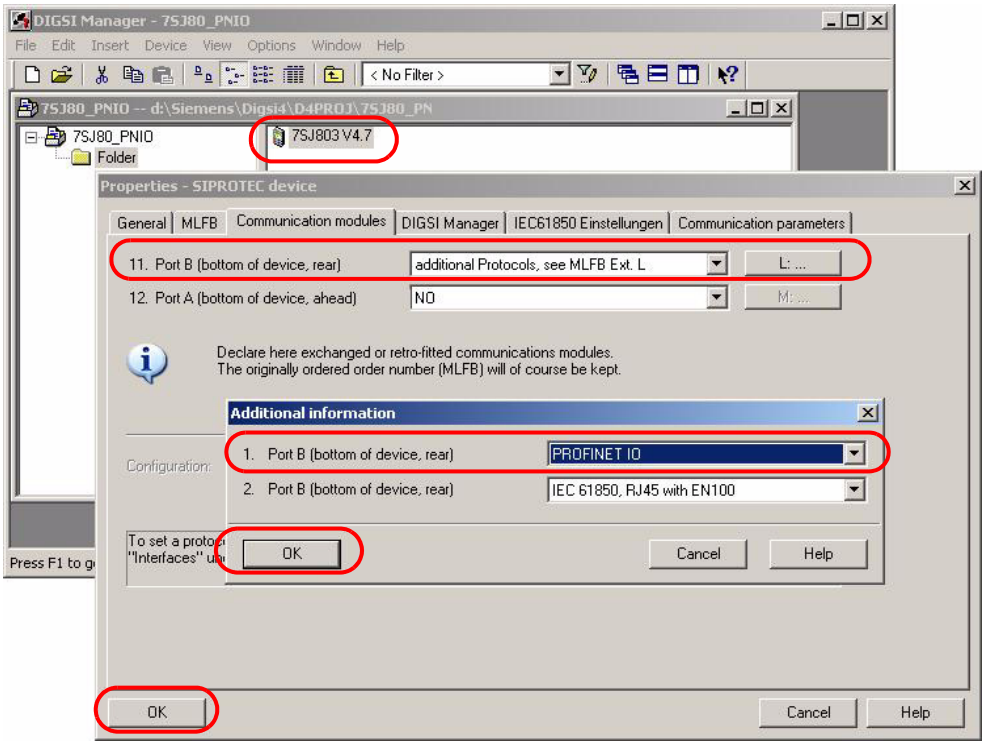

Figure 3-7 Activating the PROFINET IO Protocol

✧ Right-click the **folder** in DIGSI Manager and select the **IEC61850 station** via **Insert new object**.

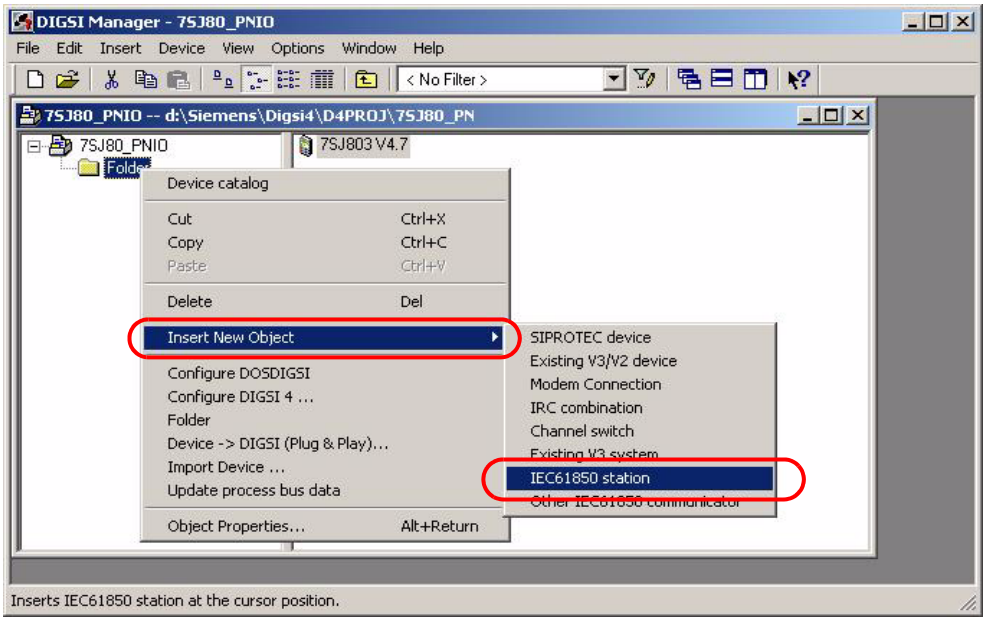

Figure 3-8 Inserting an IEC 61850 Station

An IEC 61850 station is inserted in the window of DIGSI Manager.

✧ In DIGSI Manager, right-click the **IEC 61850 station** and select the menu item **Object properties...**.

The **Properties - IEC61850 station** dialog opens.

✧ Select a device from the **Available IEC61850 devices:** in the **Properties - IEC61850 station** dialog → **Communicators** tab and click **Add**.

The selected device is moved from the **Available IEC61850 devices:** window into the **IEC61850 station communicators:** window.

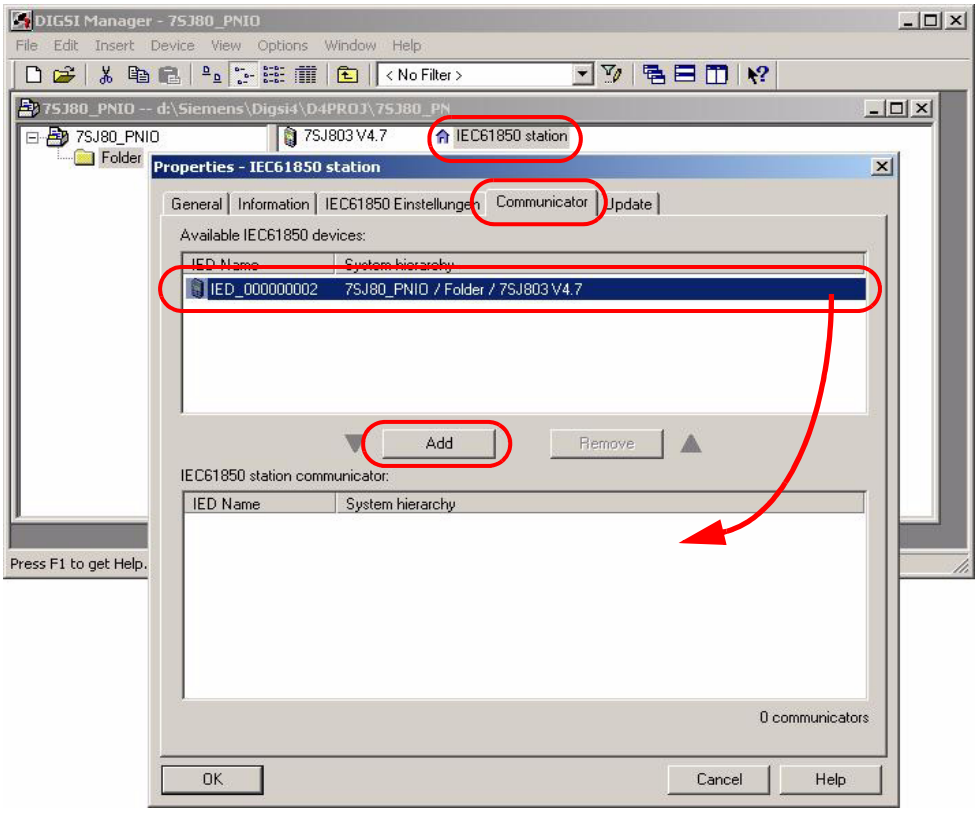

Figure 3-9 Selecting the Communicator

✧ Click **OK**.

✧ Double-click the SIPROTEC device in DIGSI Manager.
The **Open device** dialog opens.

✧ Activate the **Offline** option in the **Connection type** box and confirm with **OK**.

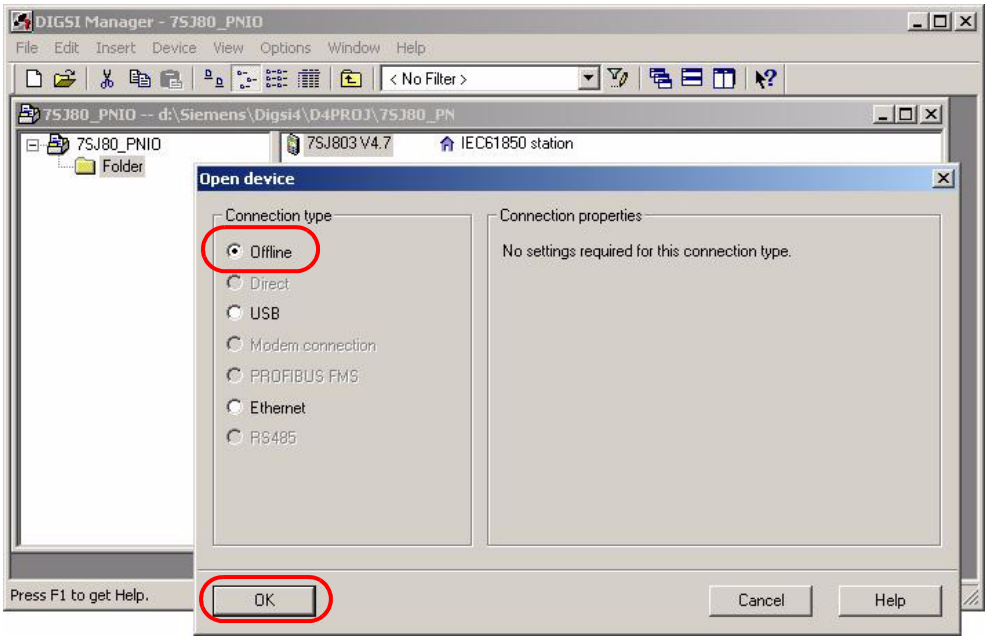

Figure 3-10 Opening the SIPROTEC Device

The following window opens after the initialization:

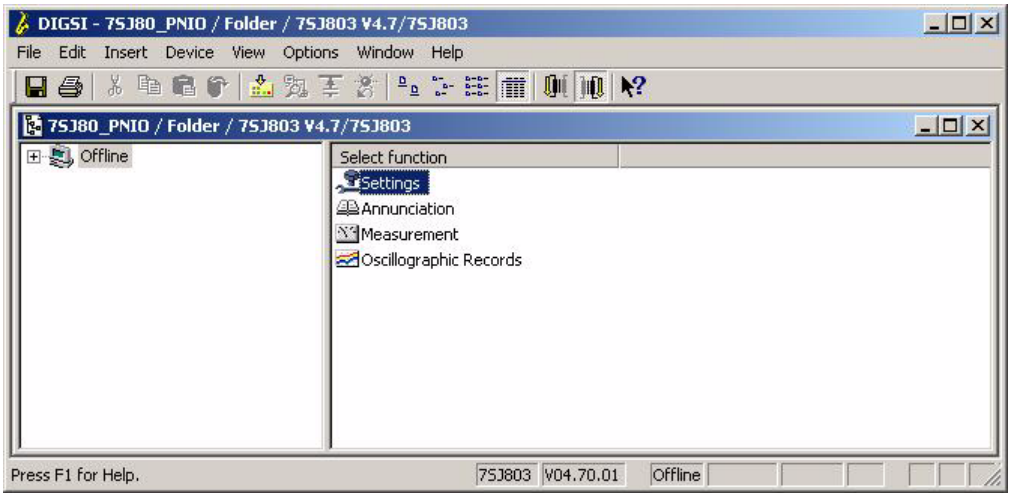

Figure 3-11 Selecting the Functions

3.2.2 Setting the Interfaces

✧ Double-click **Settings**:

The following window opens:

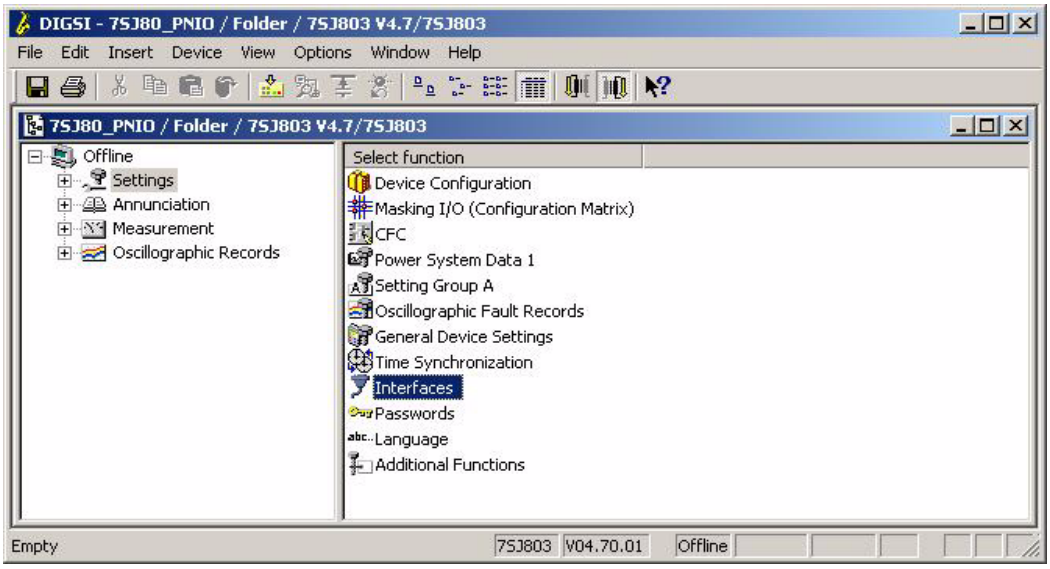

Figure 3-12 Settings

✧ Double-click **Serial Ports**.

The **Interface Settings** dialog opens.

✧ Select the **Additional protocols at device** tab.

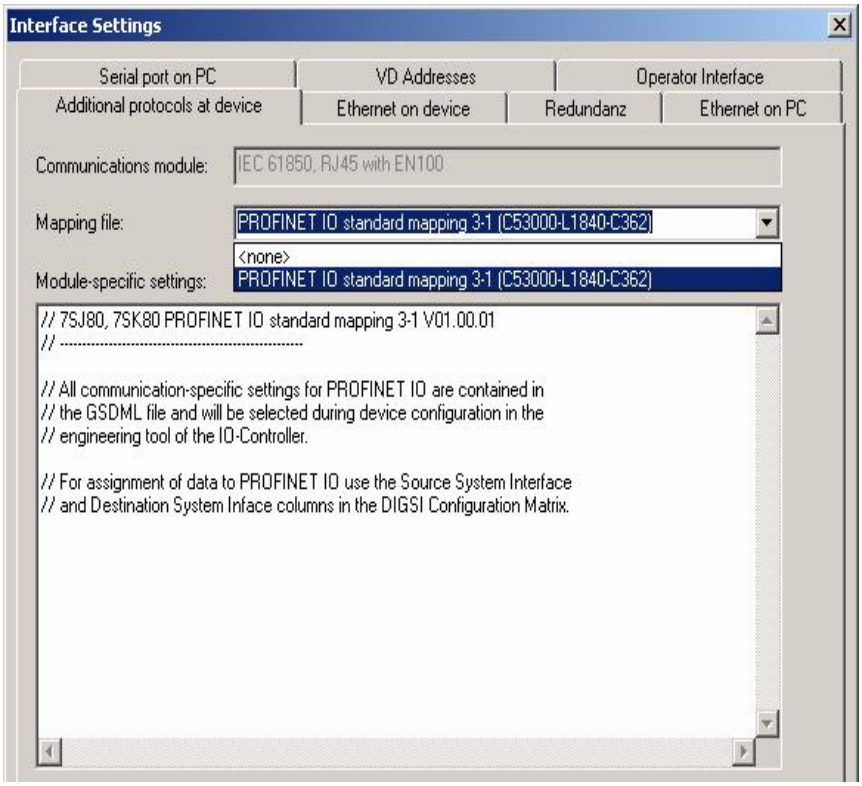

Figure 3-13 Mapping File

Mapping File List Box

If no mapping file is currently assigned to the SIPROTEC device, the **Mapping file** list box contains the following entries:

Table 3-1 Selection without Module-Specific Settings

Selection	Meaning
<none>	Still no mapping file is assigned to the device.
PROFINET IO standard mapping 3-1 through PROFINET IO standard mapping 3-n	Selecting a mapping file 3-1 through 3-n (n = device-specific number of mapping files).

The following selection options are available for an existing mapping file assignment:

Table 3-2 Selection with Module-Specific Settings

Selection	Meaning
<none>	No mapping file is assigned to the device.
<See "Module-specific settings">	This option represents the mapping file currently assigned to the SIPROTEC device with any changes already entered in the **Module-specific settings** text box. The number and version of the mapping file are specified in the first line of the **Module-specific settings** text box.
PROFINET IO standard mapping 3-1 through PROFINET IO standard mapping 3-n	(New) selection of a mapping file 3-1 through 3-n (n = device-specific number of mapping files). All module-specific settings are reset to the default values.

If the mapping file assignment for a SIPROTEC device has been changed, this usually entails a change of the routings of the SIPROTEC objects to the system interface.

After having selected a new mapping file, check the configurations to **destination system interface** or **source system interface** in the DIGSI Configuration Matrix.

To activate and edit the PROFINET IO protocol, proceed as follows:

- ✧ Activate the mapping file **PROFINET IO standard mapping 3-1** in the **Mapping file** list box.
- ✧ If necessary, change the entries to suit your device configuration in the **Module-specific settings** window.
- ✧ Click **OK**.

3.2.3 Customizing the Routings

NOTE

The device features 2 system interfaces.

The first system interface is used for the IEC 61850 protocol. Its parameterization is described in the EN100 manual in the chapter on IEC 61850.

The second system interface is used for the PROFINET IO protocol.

✧ In the **Settings** dialog (see Figure 3-12), double-click the function **Matrix I/O (Configuration Matrix)**.
The **Settings - Masking I/O (Configuration Matrix)** dialog opens.

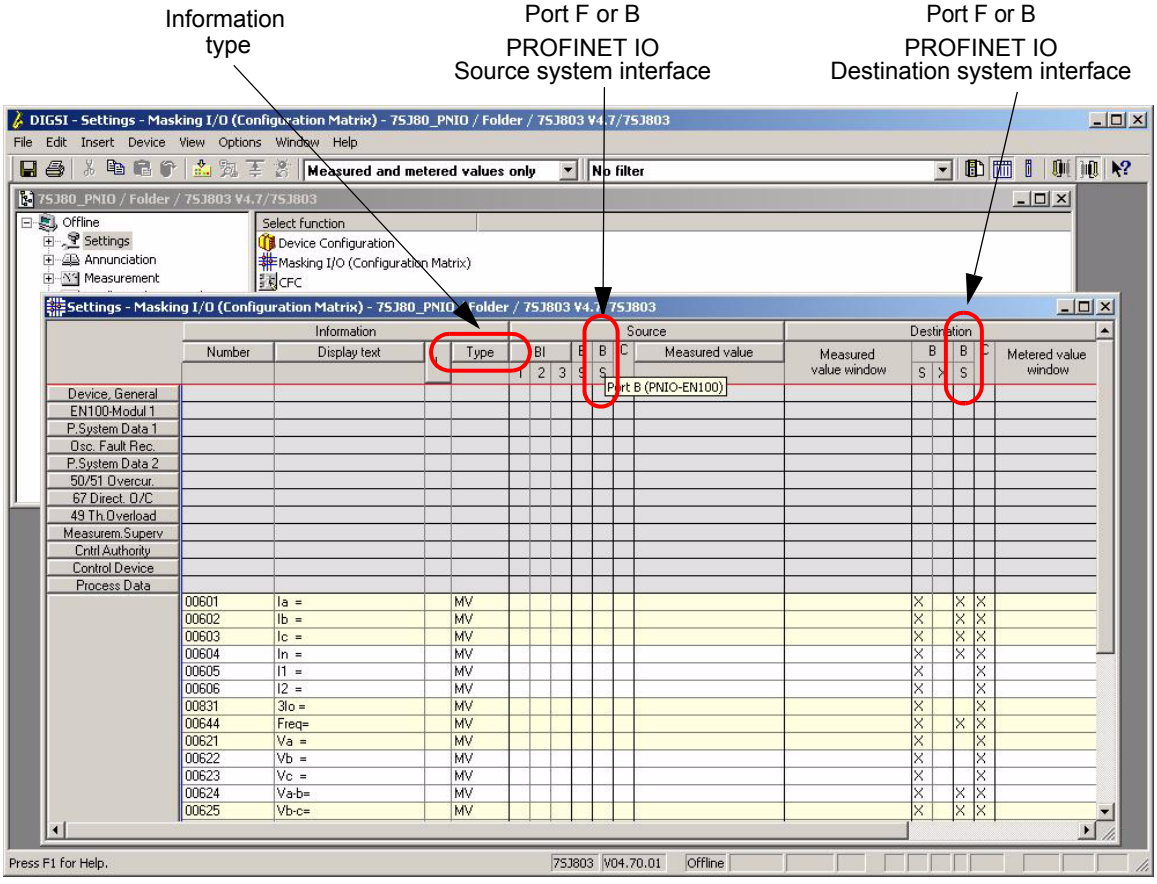

Fig. 3-14 DIGSI Configuration Matrix with Columns for Setting the System Interface

NOTE

In most SIPROTEC devices, port B is used as the **source** and **destination** of the system interface. Port F is used in exceptional cases, e.g. for 7SC80.

NOTE

If you do not wish to display all columns and lines in the Configuration Matrix for setting the system interface or for your information, you can minimize them by double-clicking the respective button. To make entries in minimized columns, double-click the corresponding button to maximize the column.

✧ Move the mouse pointer in the **source** and **destination** columns over port **B** (or port F) and find out which column is assigned to PROFINET IO (highlighted in red in Figure 3-14).

When you hover briefly over the letter **B**, the protocol used is displayed (yellow text).

✧ If necessary, adjust the preset routing in the Configuration Matrix in your SIPROTEC device/system as follows. If you do not wish to make any modifications in the DIGSI Configuration Matrix, continue with the Time Synchronization section in this chapter.

✧ To delete all preset routings in order to reconfigure them, right-click port **B** or system interface **S** in **source** or **destination**, respectively. Subsequently, click the prompt **Delete routings on Port B (PNIO-EN100)** or **Delete routings on system interface**.

A window is displayed which informs you that this is not possible or which confirms how many entries are deleted or not deleted. Click **OK** to confirm the information:

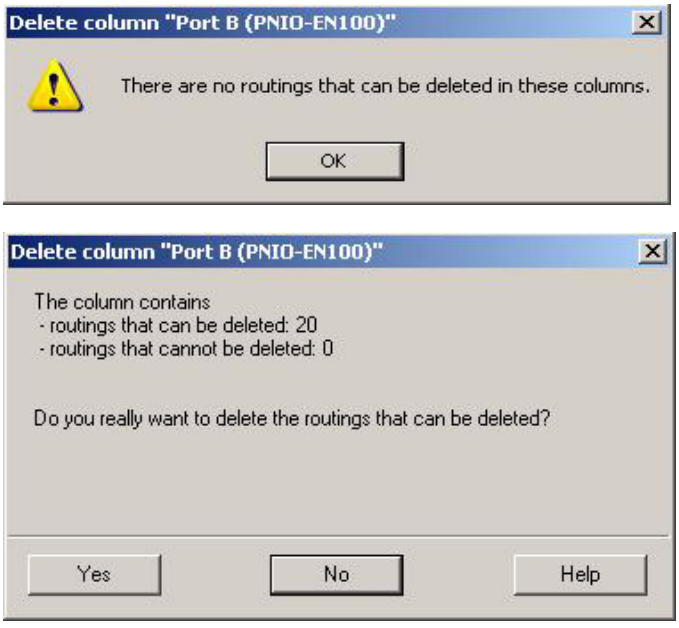

Figure 3-15 Information on the Deletion Process

You can conclude from the **source system interface** and **destination system interface** columns in the DIGSI Configuration Matrix whether an information item is routed to the system interface (PROFINET IO).
A cross ('X') in this column marks the associated information item as "routed to the system interface".

Source System Interface

Routing to the source system interface is possible for the following information types:

- IntSP Internal single-point indications (markers)
- IntDP Internal double-point indications (markers)
- C_XX Commands without feedback acquisition
- CF_XX Commands with feedback acquisition

Destination System Interface

Routing to the destination system interface is possible for the following information types:

- SP Single-point indications
- DP Double-point indications
- OUT Output indications
- IntSP Internal single-point indications (markers)
- IntDP Internal double-point indications (markers)
- MV Measured values
- PMV Pulse metered values
- MVMV Metered values, derived from measured values
- VI Value Indication; DIGSI data type for statistic values

Adding or deleting an information item as **source** or **destination system interface** is accomplished by setting/removing the 'X' in the System interface column (context menu when clicking the right mouse button).

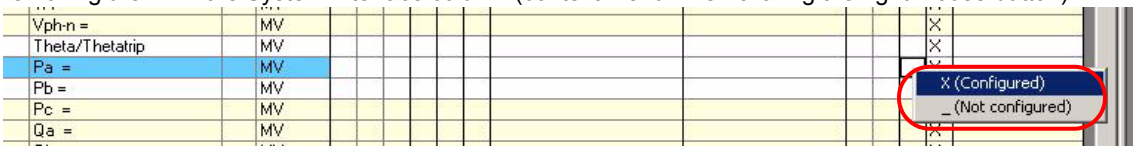

Figure 3-16 Context Menu in the Destination System Interface Column

NOTE

- The maximum number of routable objects of an information type depends on the selected mapping file.

  To transmit, for example, a measured value that is not routed by default in the mapping file via PROFINET IO, first remove an already routed measured value from the system interface to make the space available in the PROFINET IO telegram.

- If all routing options of an information type are occupied, an error indication is displayed (see Figure 3-17) if you try to route more information of this type.

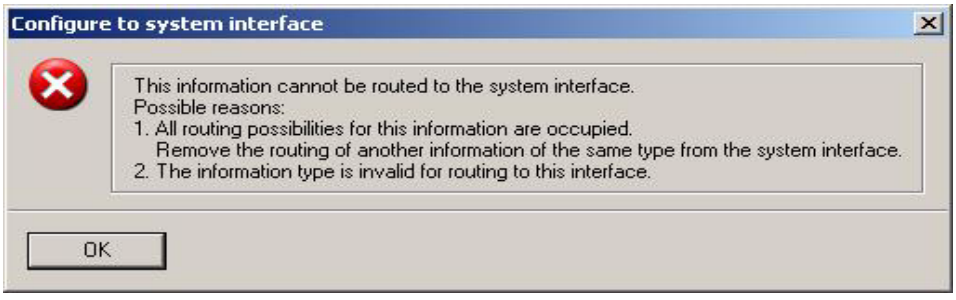

Figure 3-17 Error Indication

Adding a Routing

To add a routing, the selection in the system interface column must be made, and in addition the position of the information in the PROFINET IO telegram must be specified.

For this purpose, the **Object properties** dialog is automatically opened after having added the routing. It can be used to define the position of the information via **Protocol info source B** or **Protocol info destination B/ Measured value destination B.**

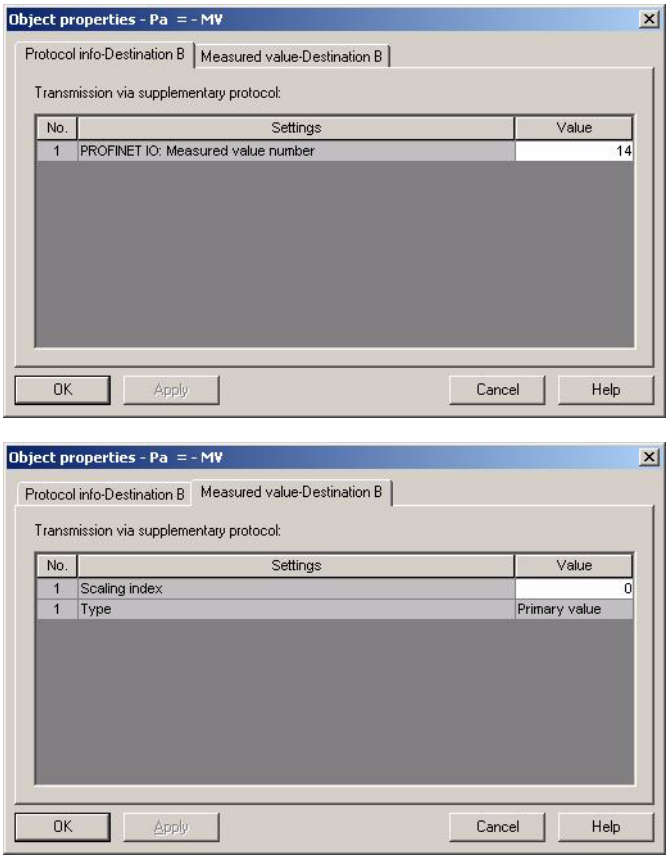

Figure 3-18 Defining the Position of an Information Item in the PROFINET IO Telegram

NOTE

- The information type of double commands for routing as **source system interface** depends on the information type of the associated command-feedback acquisition.

  Only double commands with a double-point indication as feedback can be routed to the positions in the PROFINET IO telegram intended for double commands according to the bus mapping.

  Double commands with a single-point indication as feedback or without feedback acquisition are treated as single commands by PROFINET IO and must be routed to the positions in the PROFINET IO telegram intended for single commands according to the bus mapping.

- It is not possible to read the status of commands without feedback acquisition (routing the command to **destination system interface**).

Changing an Existing Routing

If you want to assign an information item that is already routed to the system interface to a different (free) PROFINET IO telegram position, select the **Object properties** dialog (see Figure 3-18) by selecting the context menu item **Properties...** (right-click the line pertaining to the information in the **Display text**, **Long text** or **Type** column of the DIGSI Configuration Matrix).

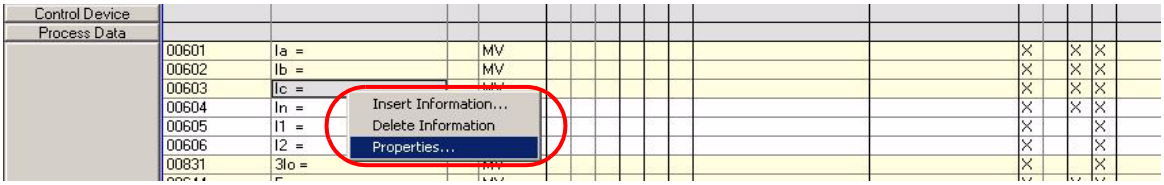

Figure 3-19 Changing an Existing Routing

Depending on the information type in the **Object properties** dialog, select the following parameters in the **Protocol info source F**, **Protocol info destination B** or **Measured value destination B** tabs.

NOTE

A port other than port B (for example port F) may be displayed as the **source** and **destination** of the system interface (device-dependent).

Protocol Information Source

Table 3-3 Protocol Information Source

Parameter	Information types	Remark
PROFINET IO mapping data-object number	IntSP, IntDP, C_XX, CF_XX	See Chapter 2.5

Protocol Information Destination

Table 3-4 Protocol Information Destination

Parameter	Information types	Remark
PROFINET IO mapping data-object number	SP, DP, OUT, IntSP, IntDP, MV, PMV, MVMV, VI	See Chapter 2.5

Measurement Destination

Decision whether the measured value is transmitted as percentage value, primary value or secondary value. Not all 3 options are available for each measured value.

Time Synchronization

✧ If the project requires time synchronization with NTP, double-click **Time Synchronization**.

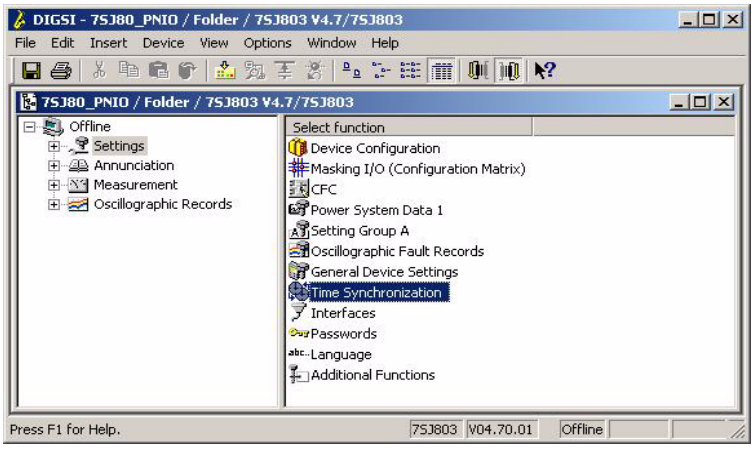

Figure 3-20 Opening the Time Synchronization

The **Time Synchronization & Time Format** dialog opens.

✧ Select the **Ethernet NTP** entry in the **Source of time synchronization** field and set the desired parameters.

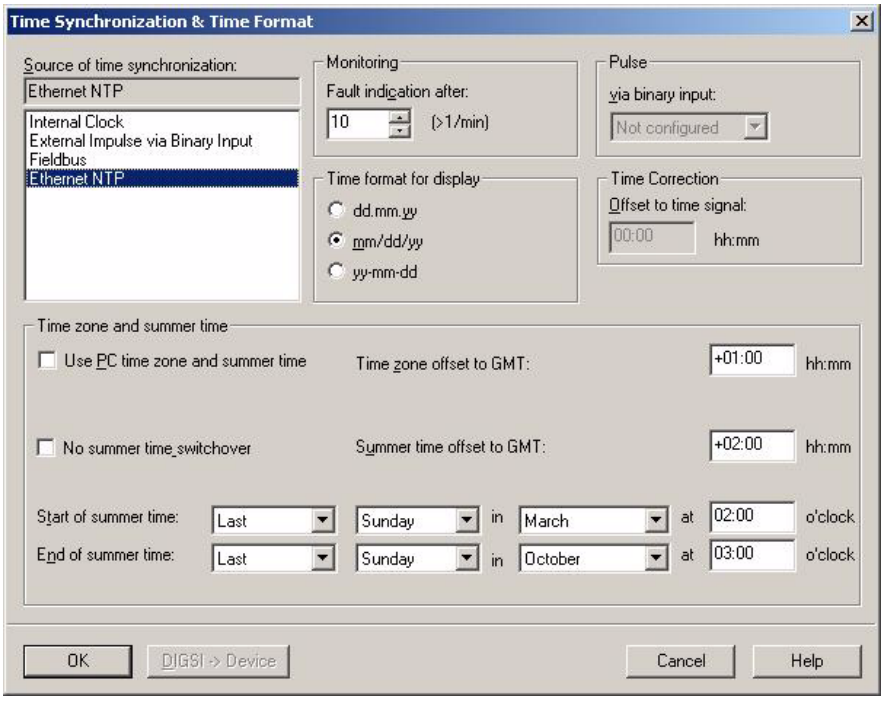

Figure 3-21 Setting the Time Synchronization

✧ Click **OK** to confirm.

✧ Close the SIPROTEC device and confirm that you want to save the modified data.

✧ Close the **Report** window.

✧ Double-click **IEC61850 station** in DIGSI Manager.

NOTE

To synchronize the time via NTP, first import an ICD file of an SNTP server into the device manager. See section **Synchronization via NTP** in this chapter for more information.

✧ The **IEC61850 System Configurator** opens with the **IEC61850 station** application and **Subnet1**.

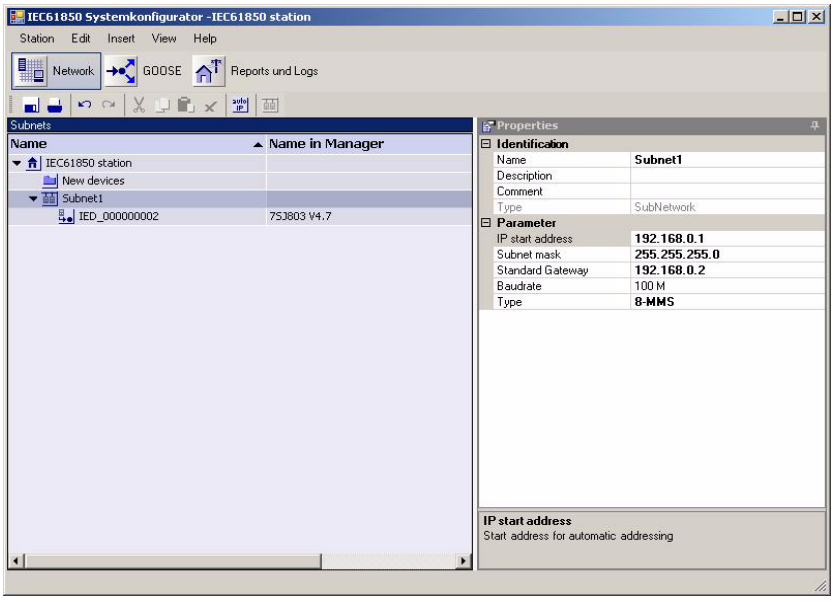

Figure 3-22 System Configurator - Subnet

✧ If necessary, change the **Name** for **Subnet1** in the **Properties** window (right window) and the parameters (for example, IP start address, subnet mask, standard gateway).

✧ Click the SIPROTEC device and change its parameters in the **Properties** window (right window) (for example, IP address, subnet mask, standard gateway).

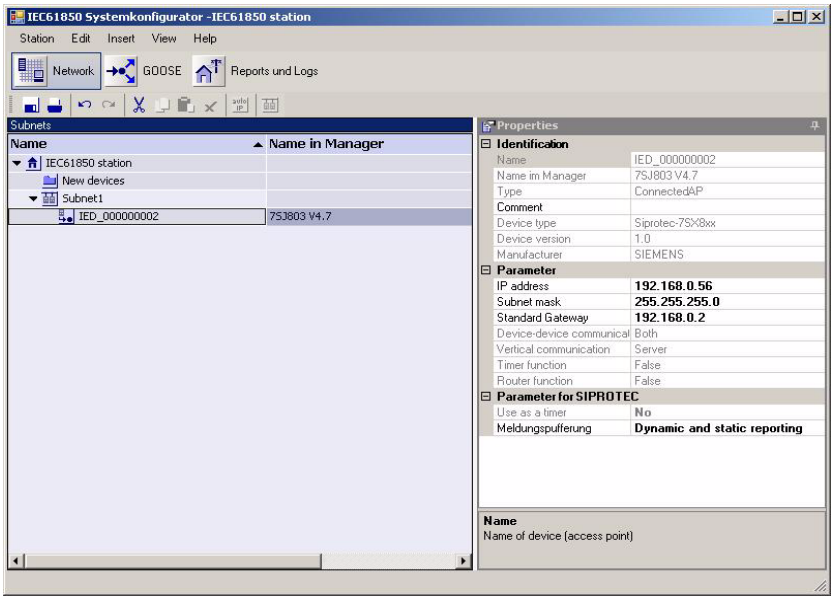

Figure 3-23 System Configurator - SIPROTEC Device

✧ Close the **System Configurator** and confirm saving of the **IEC61850 station** settings with **OK**.

Synchronization via NTP

✧ The following steps are only necessary if synchronization via NTP is required. In this case, time synchronization is performed via one or 2 time servers. A second time server makes the time synchronization redundant.

– Right-click the **folder** and open the **Import device** dialog via **Insert new object** → **Other IEC61850 User**.

– Search for the **sntp.icd** file in the DIGSI folder and click **OK**.
(example (x = hard disk directory): x:\Siemens\Digsi4\SysKon\ICD\sntp.icd)

TEMPLATE is inserted in the DIGSI Manager window.

– Rename **TEMPLATE** to **NTP Server**.

– In DIGSI Manager, right-click the **IEC61850 station** and select the **Object properties...** entry in the menu.

– Select a device from the **Available IEC61850 devices** in the **Properties - IEC61850 station** dialog → **Communicator** tab and click **Add**.

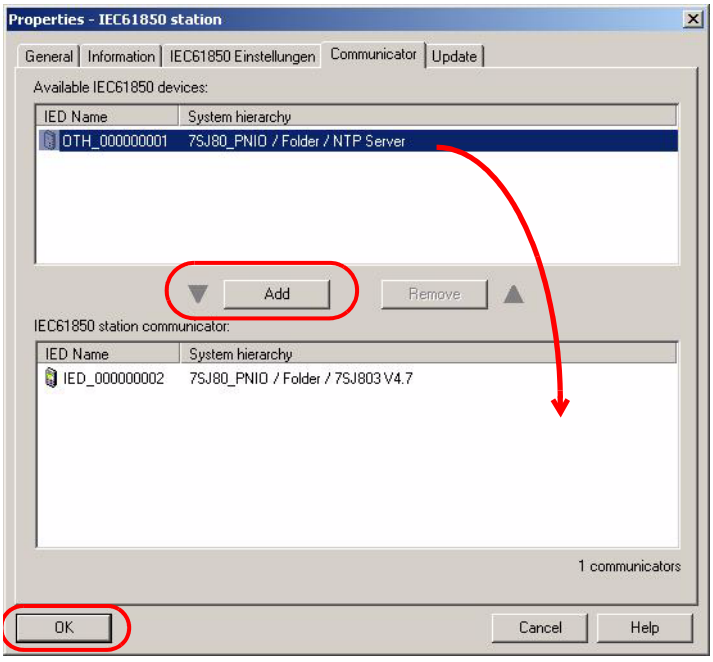

Figure 3-24 Adding an NTP Server

The selected device is moved from the **Available IEC61850 devices** window into the **IEC61850 station communicator** window.

– Click **OK**.

– Double-click **IEC61850 station** in DIGSI Manager.

The **System Configurator** opens with the **IEC61850 station** application.

– Drag and drop the **NTP server** entered under **New devices (1)** into the **Subnet1** folder.

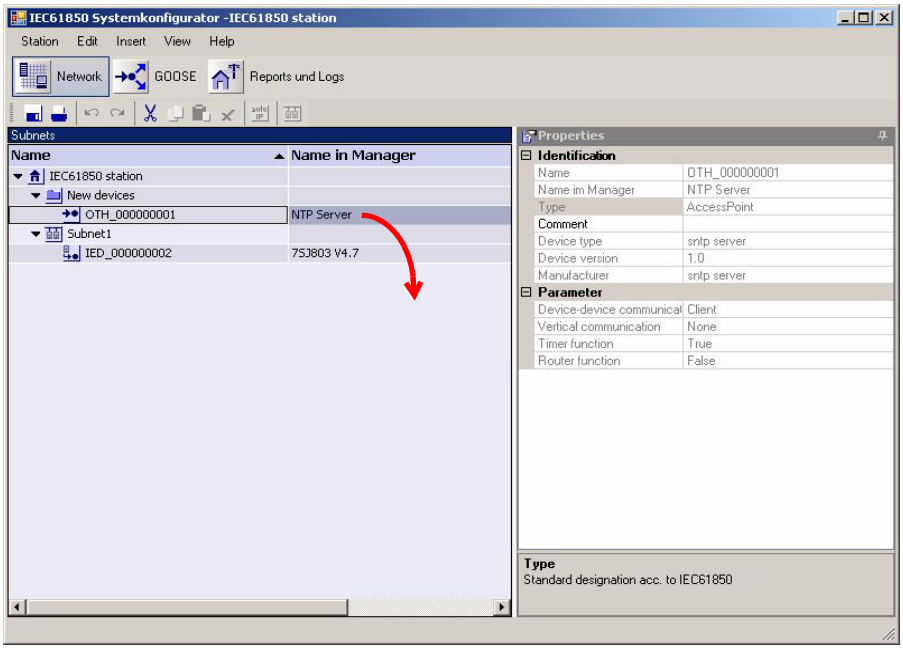

Figure 3-25 Integrating the NTP Server in Subnet1

– Click **NTP server** and enter the **IP address** under **Parameter** in the **Properties** window (right window). Change the **subnet mask** and the **standard gateway**, if necessary.

– Close the **System Configurator** and confirm saving of the IEC 61850 station settings with **OK**.

✧ In DIGSI Manager, right-click the **IEC61850 station** and select the **Object properties...** entry in the menu.

✧ In the **Properties - IEC61850 station** dialog, select the **Update** tab and update the parameter set using the **Update all parameter sets** button.

✧ Close the **Report** window.

Parameterizing the Device Functions

✧ Open the SIPROTEC device from the DIGSI user interface.

✧ Enter all desired settings in the DIGSI user interface (see Figure 3-12)..

NOTE

The DIGSI manual describes these settings, e.g. protection settings, CFC charts and routings to binary inputs/ outputs or LEDs.

✧ Save the parameter set and then close the device on the DIGSI user interface.

Updating the Parameter Sets of IEC 61850

NOTE

To activate the modified parameters, update the parameter set after each time you have made changes in DIGSI Manager.

- ✧ In DIGSI Manager, right-click the **IEC61850 station** and select the **Object properties...** entry in the menu.
- ✧ In the **Properties - IEC61850 station** dialog, select the **Update** tab and update the parameter set using the **Update all parameters** button.
- ✧ Close the **Report** window and the **Properties - IEC61850 station** dialog.

Initializing the SIPROTEC Device

NOTE

The SIPROTEC device only has to be initialized once when a new device has been added.

NOTE

The initialization is always performed via the serial front interface or the USB port at the device. Following successful initialization of the network settings you can now make changes using DIGSI via the Ethernet module.

- ✧ Right-click the SIPROTEC device in DIGSI Manager.
- ✧ Click **Initialize device...** in the menu that opens.
- ✧ Select the **connection type** and the device in the **Initialize device** dialog.
- ✧ Click OK.

3.3 Parameterizing the IO Controller

3.3.1 PROFINET IO Configuration

The SIPROTEC IO device is configured using the parameterization software of the IO controller. For this purpose, the GSDML file of the SIPROTEC IO device is loaded into the parameterization software of the IO controller. This file contains the description of the device properties and the configuration options of the EN100-E+ and EN100-O+ with PROFINET IO.

The GSDML file is named GSDML-V2.25-Siemens-SIPROTEC-<date>.xml,

for example GSDML-V2.25-Siemens-SIPROTEC4-20120525.xml,

with <date> being the version date of the GSDML file.

The GSDML file can be downloaded, see Chapter 1.1 Extended Scope of Delivery.

If communication to an EN100-E+ (electrical) is launched with the configuration for an EN100-O+ (optical) or vice versa, all submodules of the DAP are reported as being invalid and displayed accordingly in the device diagnosis of the IO controller. Communication to the IO modules is possible in spite of this.

NOTE

Observe the information in Chapter 2.13 for setting the minimum PROFINET IO cycle time of the SIPROTEC-IO device if IEC 61850 and GOOSE are used simultaneously.

3.3.2 Siemens S7 PLC and Step7

Observe the following information concerning the configuration when using the SIPROTEC devices via PROFINET IO in combination with Siemens S7 PLC and the Step 7 parameterization software.

Find more information on Siemens S7 PLC and the Step7 parameterization software at:

http://support.automation.siemens.com

The following book provides, among others, more detailed information on the integration of the blocks and functions relevant for PROFINET IO into an S7 program:

Pigan, R.; Metter, M.
Automating with PROFINET
Industrial Communication based on Industrial Ethernet
Publishing House: Publics Corporate Publishing Erlangen
ISBN: 978-3-89578-294-7

3.3.2.1 PLC in STOP during Communication with the SIPROTEC Device

If the PLC is switched from RUN to STOP or switches to STOP due to an internal PLC program response during PROFINET IO communication with the SIPROTEC device, the running PROFINET IO communication between the IO controller of the PLC and the IO device of the SIPROTEC device remains active. Cyclic data exchange continues, that is, communication is not interrupted.

For all IO modules in output direction, however, the IOPS from the PLC are set to "bad" and the data of these IO modules are transmitted with all values equaling zero.

When changing from RUN to STOP, the status of the outputs in the SIPROTEC device remains in the status during RUN.

The tagging SysIntErr. in the SIPROTEC device (see Chapter 2.10) is not set.

During transition from STOP to RUN, the data from the cyclic telegrams are accepted and output for the IO modules in output direction once the IO controller has restored the IOPS for these IO modules to "good".

If you want the outputs of the SIPROTEC device to remain unaffected during transition from STOP to RUN, the idle state (value "00") is to be output at the associated bit positions in the output telegram (see also the information on executing switching operations in Chapter 2.9).

3.3.2.2 Periphery Access Commands

The S7-CPUs can access data received by the connected devices via PROFINET IO or write data to these devices using periphery access commands in the CPU program.

To read a measured value (float value, 4 bytes, see Chapter 2.3.4) from the SIPROTEC device, the command

```
L PID x
```

is used, for example, with x denoting the address of the measured value in the periphery address space of the S7-CPU.

To read, for example, 5 measured values, the above instruction must be executed 5 times with the associated addresses. After each reading operation, the values must be processed or copied in a data block for subsequent processing in the program, for example:

```
L PID x

T DB10.DBD y etc.
```

The measured value read from address x is written to element y of data block DB10 assuming that DB10 is a data block with inputs of the type REAL.

3.3.2.3 Reading and Writing Data with SFC14 and SFC15

The S7 system functions SFC14 ("DPRD_DAT") and SFC15 ("DPWR_DAT") in the CPU program can also be used to transmit data instead of periphery access commands. This is possible for data within an IO module.

To read, for example, all 12 measured values of an IO module "measured values 12" in one call and transmit them into a data block, proceed as follows:

- Create a data block to accommodate the data to be read (with 12 REAL values).
- Call SFC14:

```
CALL SFC14

   LADDR := W#16#200                  // IO module address, for example, 512, hexadecimal
   RET_VAL := MW100                   // for example, flag word 100 as return value
   RECORD := P#DB10.DBX0.0 BYTE 48    // 12 values = 48 bytes to DB10, for example
```

If the destination data-block contains more information than only the 12 measured values and if these do not start at data-block byte 0, you can also start copying at this offset, for example with:

```
CALL "DPRD_DAT"

   LADDR := W#16#200
   RET_VAL := MW100
   RECORD  := P#DB10.DBX24.0 BYTE 48  // 48 bytes to DB10, for example, starting from byte 24
```

3.3.2.4 Reading and Writing Acyclic Data with SFB52 and SFB53

The SIPROTEC-IO device offers acyclic datasets (see Chapter 2.8) that can be read or written with the following system function blocks in the S7 SPS:

- Presetting metered values and statistic values → writing with SFB53 ("WRREC")
- Reading unit IDs → reading with SFB52 ("RDREC")
- Reading metered-value conversion factors → reading with SFB52 ("RDREC")

Reading the unit IDs of an IO module "measured value 12" is illustrated using the following example.

Bear in mind that the SFB52 operates asynchronously, that is, reading the acyclic data can last several PLC user cycles.

Define the structure of the dataset to be read in a data block, for example DB11:

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	NumOfIDs	BYTE	B#16#0	number of read IDs
+1.0	dummy	BYTE	B#16#0	
+2.0	MID1	WORD	W#16#0	unit of measured value 1
+4.0	MID2	WORD	W#16#0	unit of measured value 2
+6.0	MID3	WORD	W#16#0	unit of measured value 3
+8.0	MID4	WORD	W#16#0	unit of measured value 4
+10.0	MID5	WORD	W#16#0	unit of measured value 5
+12.0	MID6	WORD	W#16#0	unit of measured value 6
+14.0	MID7	WORD	W#16#0	unit of measured value 7
+16.0	MID8	WORD	W#16#0	unit of measured value 8
+18.0	MID9	WORD	W#16#0	unit of measured value 9
+20.0	MID10	WORD	W#16#0	unit of measured value 10
+22.0	MID11	WORD	W#16#0	unit of measured value 11
+24.0	MID12	WORD	W#16#0	unit of measured value 12

Figure 3-26 Data block for reading unit IDs

SFB52 Call

The data block DB52 is required as instance DB for calling SFB52. If it does not exist yet, you are prompted automatically whether to generate DB52 when entering the example shown below.

You can use other flags or data blocks instead of those used in the example (DB11, M10, MD21, MW25, and MW100).

```
CALL SFB52, DB52
   REQ := M10.3                  // Triggering the read job
   ID := DW#16#200               // IO module address, e.g. 512, hexadecimal
   INDEX := 100                  // Index of the acycl. data, see Chapter 2.4
   MLEN := 26                    // Length of the data to be read, see Chapter 2.8.2
   VALID := M10.0                // SFB52 return value: TRUE = dataset was read
   BUSY := M10.1                 // SFB52 return value: TRUE = reading in process
   ERROR := M10.2                // SFB52 return value: TRUE = read error
   STATUS := MD21                // SFB52 return value: error code
```

```
LEN := MW25                          // SFB52 return value: length of the read
                                     // Information in bytes
RECORD := P#DB11.DBX0.0 BYTE 26      // Destination for the read data
```

In the example, M10.3 = TRUE triggers reading of the unit IDs.

M10.1 and M10.2 are used to check in each subsequent PLC user cycle whether the reading process is still running or whether an error has occurred.

If the reading process has been completed, M10.0 indicates that the dataset has been read successfully and that the data are available in the destination data block.

Acyclic data (for example to preset metered values or statistic values) is accomplished with SFB53 in a similar way to the SFB52 example for reading:

- Define the structure of the dataset to be written in a data block
- Specify the data to be written in the data block

Triggering the write job by calling SFB53 and checking if the writing process is finished.

3.3.2.5 Analyzing the Process Alarm

The IO device of the SIPROTEC device defines a process alarm to which you can assign the single-point indications and double-point indications transmitted via PROFINET IO (see Chapter 2.7).

The process alarm is analyzed in the S7 PLC using the alarm organization blocks OB40 through OB47 and function block SFB54 ("RALRM"). Depending on the used S7 CPU, not all alarm OBs are available.

The process alarm of the SIPROTEC device is sent via the address of the IO module to which the indication triggering the alarm is assigned. If indications of different IO modules are linked to the process alarm, the process alarm is received via different addresses in the PLC depending on the indication triggering it.

Proceed as follows:

✧ Assign relevant indications to the process alarm via the parameterization (see Figure 2-14 and Figure 2-15).

✧ If the CPU used offers several OB4x alarm OBs, define for each IO module, which contains an indication relevant for the process alarm, which alarm OB triggers the process alarm:

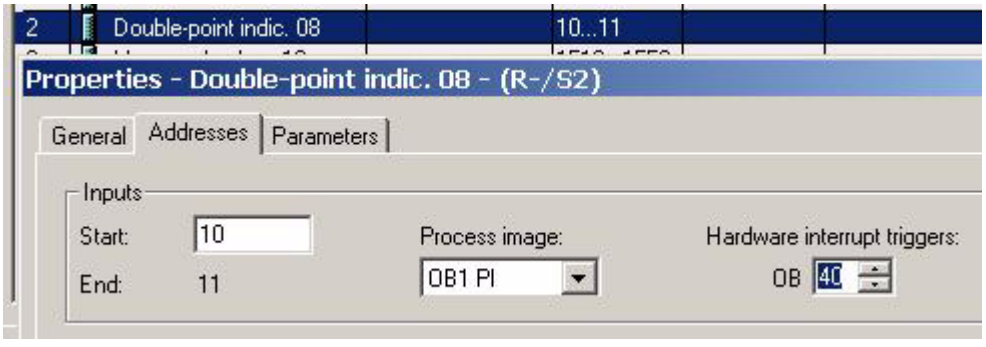

Figure 3-27 Selecting the alarm OB

✧ Define the processing priority of the alarm OB used in the PLC:

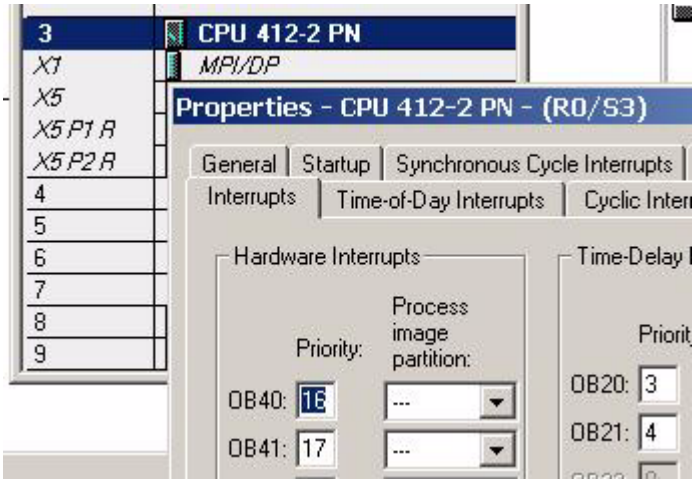

Figure 3-28 Processing priority of the alarm OBs

✧ Insert the required alarm OB into the S7 program.

✧ Define a data block to accommodate the alarm information, for example DB140:

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	NEW	BOOL	FALSE	
+2.0	STATUS	DWORD	DW#16#0	
+6.0	ID	DWORD	DW#16#0	Logical address of the io module which caused the alarm
+10.0	LEN	INT	0	Length of read AINFO data in bytes
+12.0	TINFO	ARRAY[0..31]		Task information
*1.0		BYTE		
+44.0	AINFO	STRUCT		Alarm information
+0.0	HeaderInformation	ARRAY[0..25]		
*1.0		BYTE		
+26.0	AdditionalAlarmInfo	STRUCT		
+0.0	FormatIndication	WORD	W#16#0	= 200 for SIPROTEC process alarm
+2.0	Data	STRUCT		
+0.0	Control_I	BYTE	B#16#0	
+1.0	reserved	BYTE	B#16#0	
+2.0	MessageBlock_1	ARRAY[0..10]		
*1.0		BYTE		
+14.0	MessageBlock_2	ARRAY[0..10]		
*1.0		BYTE		
+26.0	MesageBlock_3	ARRAY[0..10]		
*1.0		BYTE		
=38.0		END_STRUCT		
=40.0		END_STRUCT		
=66.0		END_STRUCT		
=110.0		END_STRUCT		

Figure 3-29 Data block for analyzing the process alarm

✧ In the selected alarm OB, call the SFB54 for copying the alarm information in the data block.

An additional data block, for example DB54, is required as instance DB for calling SFB54. If the block does not exist yet, you are automatically prompted whether to generate DB54 when you enter the following example.

```
CALL SFB54, DB54
    MODE := 1                 // Writing all data to TINFO and AINFO
    F_ID := DW#16#0           // Not relevant if MODE = 1
    MLEN := 60                // Length of the AINFO data to be read in bytes
                              // (26 bytes header, 2 bytes format identifier, 32 bytes data)
    NEW := DB140.DBX0.0       // SFB54 return value: TRUE = new alarm data received
    STATUS := DB140.DBD2      // SFB54 return value: error code
    ID := DB140.DBX6          // SFB54 return value: addr. of the module triggering the alarm
    LEN := DB140.DBX10        // SFB54 return value: length of the received AINFO data
    TINFO := DB140.TINFO      // Destination for task information data
    AINFO := DB140.AINFO      // Destination for alarm information data
```

For calling SFB54 with MODE equal to 0 or 2, see literature reference or STEP 7 help file.

✧ Analyze the read alarm data.

3.4 DCP – Discovery and Basic Configuration Protocol

3.4.1 Network Settings and Device Name

The network settings of the EN100 and the name of the PROFINET IO device can be changed using DCP (Discovery and Basic Configuration Protocol). Use the Primary Setup Tool stated in Figure 3-30 for this purpose.

NOTE

A change to the network settings via DCP affects all IP applications running on the EN100, for example HTTP server and IEC 61850 server. See also Chapter 3.1 and Chapter 3.4.1.

If you change the network settings for a device via DCP, it is no longer possible to access this device via Ethernet using DIGSI. Accessing the device again from DIGSI via Ethernet requires the network settings stored for the device to be identical with those stored on the EN100 modules.

Access via DCP is also possible if no valid EN100 configuration exists for PROFINET IO.

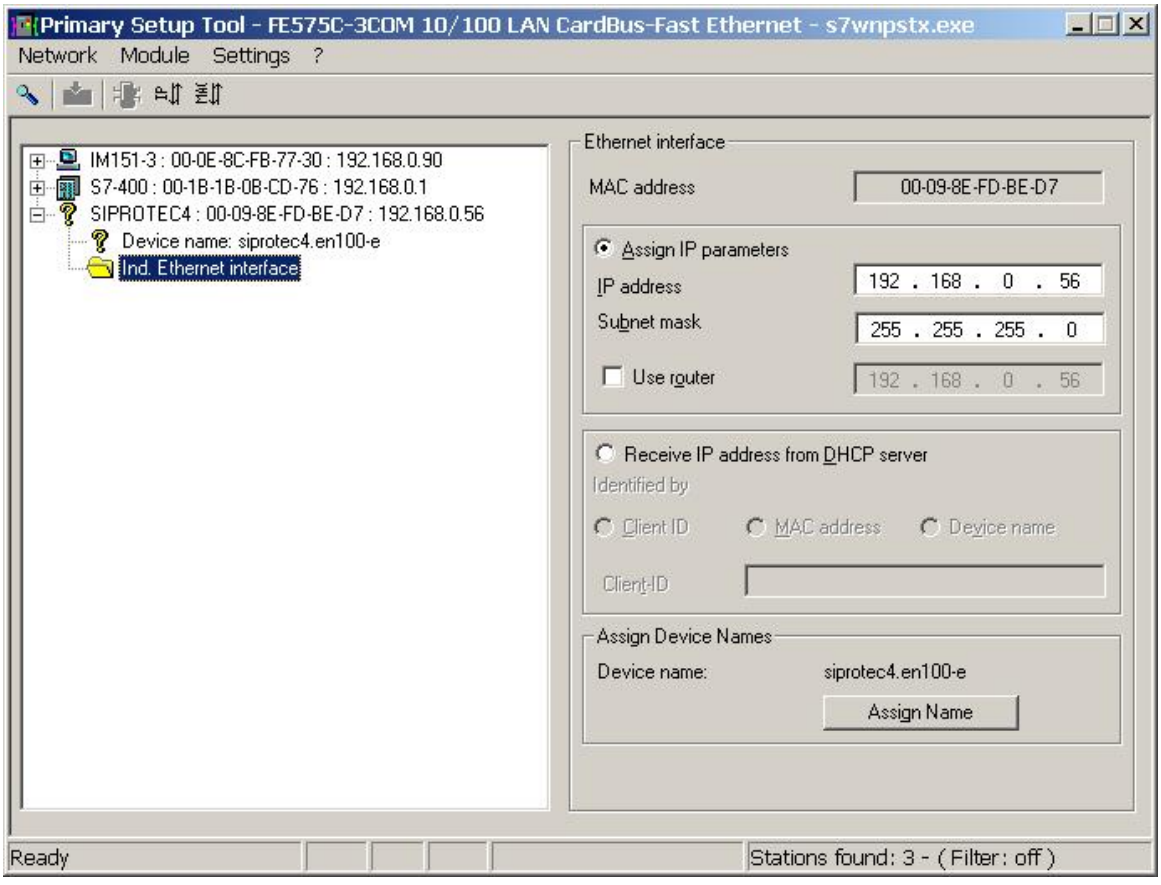

Figure 3-30 Primary Setup Tool: Main Window

3.4.2 Reset to Default Settings

After having restored the factory settings, the EN100 performs a RESET and a restart with the following settings:

- IP address and subnet mask: 0.0.0.0
- Default gateway: 0.0.0.0
- No device name is assigned (empty device name).

IP-based applications (e.g. HTTP server and IEC 61650 server) are only launched when a valid network setting has been assigned via DCP.

The EN100 restart causes the following message to be entered in the error log (error file) of the device and the module reset to be identified as output of a DCP reset request:

Err = 65, Task = DPR1, Code = DPR1, Pos = 97H, AddInformation = 42000000 800004444

3.4.3 Device Identification

To identify a device in a system (even without a name or IP address assigned), the DCP protocol provides a flashing LED (or alternative solution) as signaling feature. The flashing lasts 3 s at a flashing frequency of 1 Hz (0.5 s switched on, 0.5 s switched off).

To use this feature, the device must contain an associated indication (e.g. "DCP Ident") of the *internal single-point indication* (IntSP) type and must be configured as source **PROFINET IO** and as destination **LED**.

If PROFINET IO was selected as system interface, this indication is available and preconfigured by default in the SIPROTEC device.

If the routing for this indication has been changed, then reconfigure the indication as:

- "source system interface PROFINET IO" with single command number 10000 (see Figure 3-31)
- destination to an LED of your choice

Remove any existing routing of this indication in the operational indication log of the device.

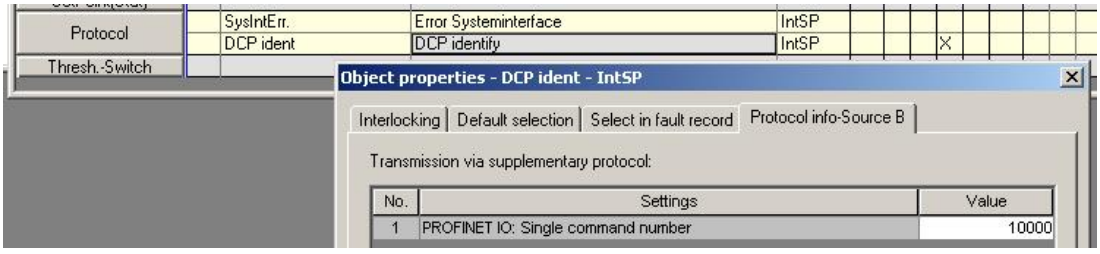

Figure 3-31 "Source system interface PROFINET IO" with Single Command Number 10000

After having activated the device identification function (e.g. using the Primary Setup Tool, see Figure 3-32), the **DCP Ident** indication is controlled via the PROFINET IO firmware according to the flashing intervals.

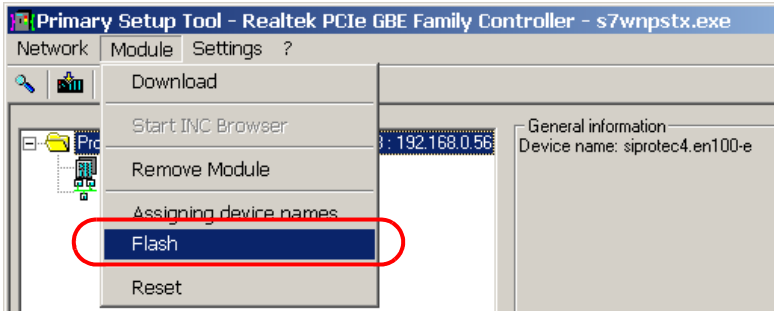

Figure 3-32 Primary Setup Tool: Service Selection

NOTE

The Primary Setup Tool repeatedly sends the DCP command for device identification after expiration of the 3 s until canceled via a dialog. This is why the associated LED at the device flashes permanently until the process is canceled in the Primary Setup Tool.

NOTE

A valid PROFINET IO parameterization must have been carried out in DIGSI in order to identify the device with the "DCP Identify" indication, and the switching authority of the device must be set to "remote". All other DCP services are also available without PROFINET IO parameterization in DIGSI.

4 PROFINET IO Diagnosis

4.1 Diagnosis HTML Page of EN100

For the PROFINET IO diagnosis, the web server of the EN100 contains the menu item **PROFINET IO** (see Figure 4-1), which takes the user to an HTML page for diagnosis purposes.

NOTE

The diagnosis page is displayed in English language only.

Open the HTML page as follows:

✧ Enter the IP address of the device in the browser according to the following rule:

http://IP address/home

for example: http://192.168.0.56/home

The EN100 homepage opens.

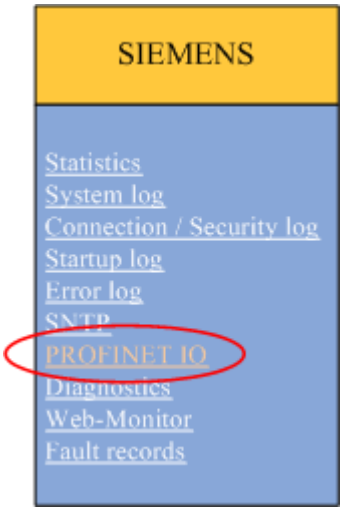

Figure 4-1 Menu of the EN100 Homepage

✧ Click the **PROFINET IO** entry in the navigation window.

The PROFINET IO diagnosis page opens.

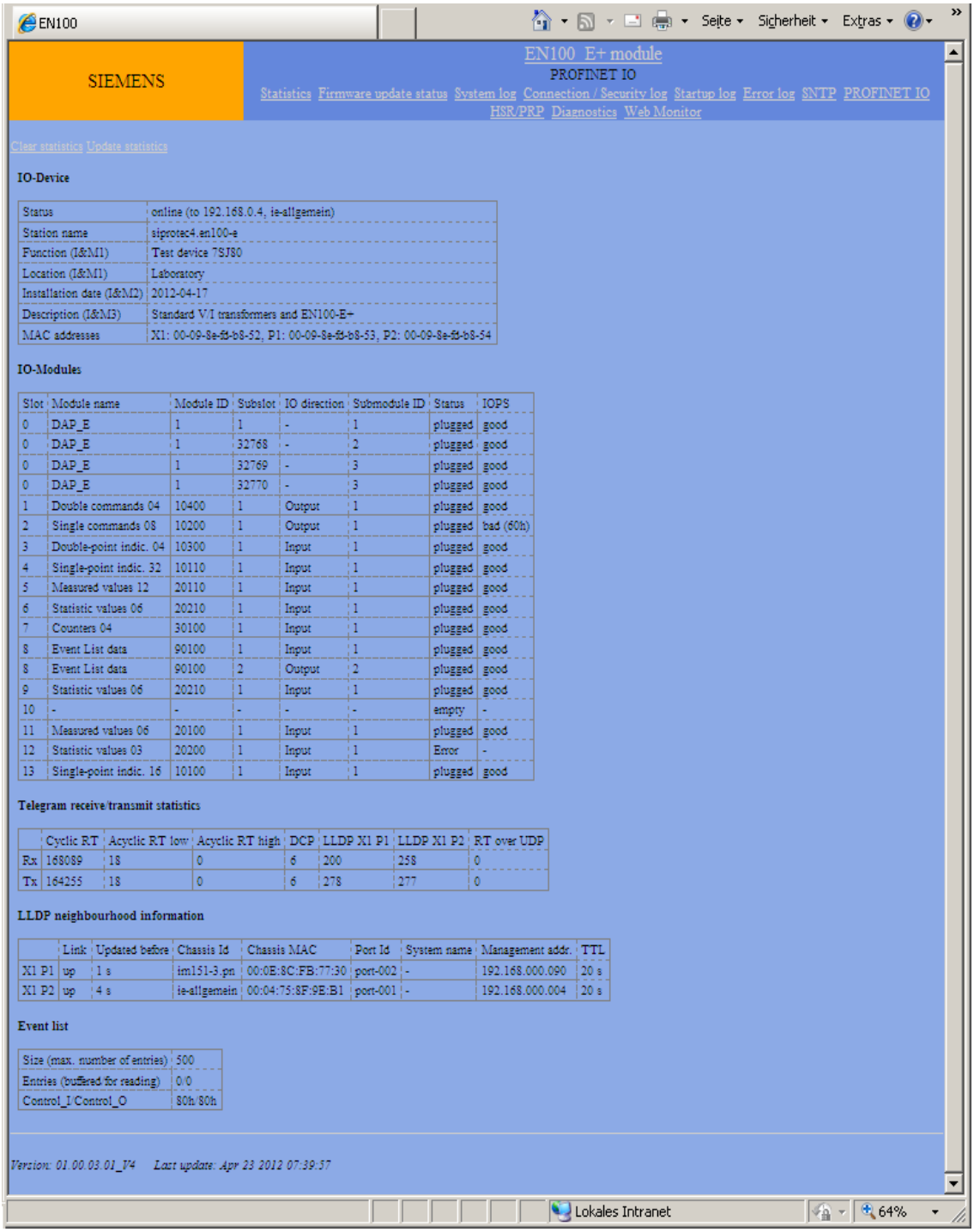

Figure 4-2 PROFINET IO Diagnosis Page

At use of PROFINET IO with fiber optical interface the column **FO power budget** is displayed in the information block **IO-DEVICE** in addition.

MAC addresses	X1: 00-09-8e-fd-fe-1b, P1: 00-09-8e-fd-fe-1c, P2: 00-09-8e-fd-fe-1d
FO power budget	X1 P1: 11.4 dB, X1 P2: 8.6 dB

Figure 4-3 Detail from the PROFINET IO Diagnosis Page at Use of the Fiber Optical Interface

The PROFINET IO diagnosis page contains the following information blocks:

- IO device
- IO modules
- Telegram receive/transmit statistics
- LLDP neighborhood information
- Event list

IO Device

Diagnosis	Description
Status	Communication status with IO controller (online or offline)
Station name	Station name of the SIPROTEC device
Function Location Installation date Description	**Identification and Maintenance** data I&M1 through I&M3 stored in the device and written via acyclic PROFINET IO telegrams (see Chapter 4.3)
MAC addresses	X1: Interface MAC address P1, P2: Port MAC addresses
FO power budget	Fiber optical power budget of the receive signal on the ports P1 and P2 in dB

IO Modules

NOTE

The IO modules table only contains entries if the SIPROTEC IO device communicates with the IO controller.

IO modules in the SIPROTEC device are plugged dynamically as specified by the parameterization in the IO controller when the communication is initialized.

If no PROFINET IO communication exists, no IO modules are plugged.

The following table shows the IO modules parameterized in the IO controller for the SIPROTEC device and the status of these IO modules in the SIPROTEC IO device.

Diagnosis	Description
Slot	Slot number (18 IO modules max. plus DAP can be plugged)
Module name	Name of the plugged IO module
Module ID	Identification number of the module type as per GSD file
Subslot	Subslot number
IO direction	Data direction (input data or output data)

Diagnosis	Description
Submodule ID	Identification number of the submodule type for the respective module type as per GSD file
Status	Plugged: the IO module is plugged and ready to exchange data Empty: no IO module plugged/parameterized Error: no mapping file assignment for the IO module possible; no data exchanged with this module
IOPS	Value of the local IOPS for DAP and input data or value of the IO controller IOPS for output data.

NOTE

Empty slots after the last plugged IO module are not displayed. A maximum of 18 slots is possible.

Telegram Receive/Transmit Statistics

The table contains the number of received and transmitted telegrams for each specified protocol.

The counters can be reset via **Clear statistics** (in the upper left section of the HTML page).

LLDP Neighborhood Information

The table contains information about the devices connected to the Ethernet ports X1 P1 and X1 P2 of the EN100 (neighborhood information). This information is analyzed from the data of the LLDP telegrams sent by the connected devices.

The time **Updated before** indicates when the last LLDP telegram from the respective neighboring device was received. If this time is greater than the time specified in the **TTL** (Time to Live) column, this indicates that no LLDP telegrams have been received anymore from the neighboring device, e.g. due to connection problems. However, the neighborhood information last read is still displayed.

Clear statistics (upper left section of the HTML page) can be used to delete the information until the next LLDP telegram is received.

Event List

Diagnosis	Description
Size	Maximum possible number of entries in the event list
Entries	Current number of entries in the event list and how many of these are transmitted during the next handshake cycle (3 entries max.), e.g.: • Entries (buffered/for reading): 12/3 Twelve entries are currently contained in the event recorder and additionally three entries are currently offered to the IO controller in the message blocks of the Event List IO module. A buffer overflow is also shown in this line for the duration of signaling of this indication to the IO controller, e.g.: • Entries (buffered/for reading): 500/1 overflow
Control_I/Control_O	Current values of the Control_I and Control_O bytes

See also Chapter 2.6.

4.2 PROFINET IO Error Indication in the SIPROTEC 4 Device

Display in DIGSI

The indication **SysIntErr.** (error of the system interface) is used for the PROFINET IO error indication. In the DIGSI configuration matrix, this indication is available in the **Protocol** menu.

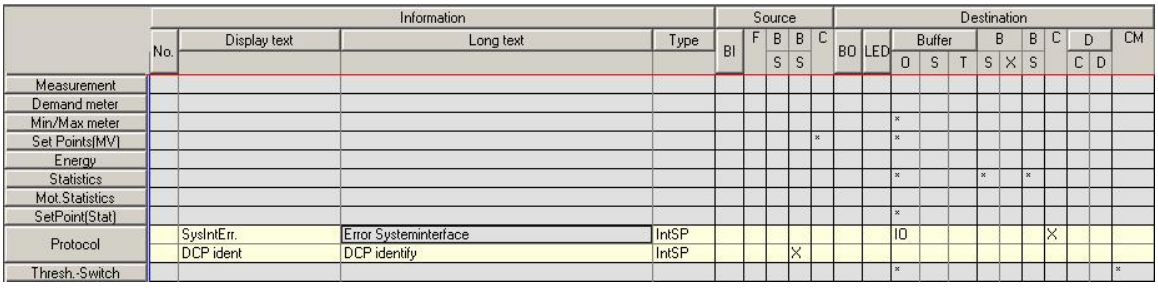

Figure 4-4 Error Indication of the System Interface (DIGSI)

The following table contains the description of the error indication:

Table 4-1 Error Indication SysIntErr.

Error indication	After restart	ON → OFF	OFF → ON
SysIntErr.	= ON	Change to OFF if the IO controller is connected and cyclic IO data are exchanged.	Change to ON if the IO controller is not connected anymore or if no cyclic data are exchanged anymore.

Display in DIGSI for EN100

Other general EN100 indications show the initial status of the EN100 and the status of the Ethernet connection:

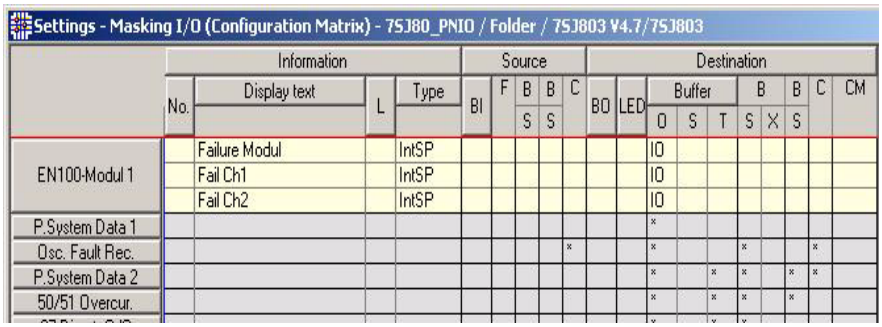

Figure 4-5 PROFINET IO Indications - EN100

Table 4-2 Error Indication from EN100

Error indication	After restart	ON → OFF	OFF → ON
Failure Module	ON	EN100 is ready, the starting sequence via DPR was executed successfully.	The device or module was started (reset/restart)
Fail Ch1	ON	Ethernet connection at X1 P1/ X1 P2 established	Ethernet connection at X1 P1/ X1 P2 disconnected
Fail Ch2	ON		

4.3 I&M – Identification and Maintenance

The PROFINET IO implementation in SIPROTEC devices supports reading of I&M0 data plus reading and writing of I&M1, I&M2, I&M3 and I&M4 data.

The I&M0 data have the following content:

Table 4-3 Content of I&M0 Data

Name	Content
VendorID	= 0x002A (PROFINET vendor ID of Siemens AG)
OrderID	Order number (MLFB) of the PROFINET IO EN100 module
SerialNumber	Serial number of the EN100 module
HardwareRevision	Hardware version of the EN100 module
SWRevision.Prefix	= 'V' (officially released version)
SWRevision.FunctionalEnhancement	Software version of the PROFINET IO firmware: <FunctionalEnhancement>.<BugFix>.<InternalChange> for example 01.00.00
SWRevision.BugFix	
SWRevision.InternalChange	

NOTE

The order number (MLFB) and the serial number of the SIPROTEC device are shown, for example, on the EN100 homepage in the "Startup log" (see Figure 4-1).

5 Technical Data

5.1 Technical Data of the EN100

The following manuals contain a detailed list of the technical data of the EN100:

- German edition: Handbuch Ethernetmodul EN100, Bestellnr. C53000-G1100-C167-x
- US English edition: Manual Ethernet Module EN100, order no. C53000-G1140-C167-x

Since EN100 modules are installed in SIPROTEC devices, both the technical data of the EN100 and the technical data of the used SIPROTEC devices apply.

Glossary

C

CFC	**C**ontinuous **F**unction **C**hart
Client	Device in the communication network that sends data requests or commands to the server devices and receives responses from these devices

D

DAP	**D**evice **A**ccess **P**oint: usually in slot 0 of the IO device; interface data and port data can be read.
DB	Data block (in S7 programming)
DC	Double command; data type
DCP	**D**iscovery and **C**onfiguration **P**rotocol
DHCP	**D**ynamic **H**ost **C**onfiguration **P**rotocol enables the network configuration to be assigned to the devices by a DHCP server.
DIGSI	Parameterization software for SIPROTEC 4 devices
DP	Double-point indication; data type
DST	**D**aylight **S**aving **T**ime

E

EEPROM	**E**lectrically **E**rasable **P**rogrammable **R**ead-**O**nly **M**emory; integrated circuit in the EN100 for permanently storing the network parameters, station name and I&M data
EN100	100-Mbit Ethernet module for SIPROTEC 4 devices
Ethernet	Cable-based data network technology for local data networks

G

Gateway	Enables networks based on different protocols to communicate with each other
GOOSE	**G**eneric **O**bject **O**riented **S**ubstation **E**vent
GSDML	**G**eneric **S**tation **D**escription as X**ML** file

H

HTML	**H**yper**T**ext **M**arkup **L**anguage
HTTP	**H**yper**T**ext **T**ransfer **P**rotocol

I

IEC	**I**nternational **E**lectrotechnical **C**ommission: standardization body; communication standard for substations and protection devices
IED	**I**ntelligent **E**lectronic **D**evice
Indication CLEARED	The status of the indication changes from ON to OFF, that is the indication is deleted.

Indication RAISING	The status of the indication changes from OFF to ON, that is the indication is currently present.
Input direction/ Input data	Data-transmission direction from the IO device to the IO controller with the direction of data transmission always being observed from the location of the IO controller. This transmission direction is also referred to as the monitoring direction.
IO controller	Controlling device in a PROFINET IO network
IO device	Controlled device in a PROFINET IO network
IO module	Module in the IO device which executes a part of or all input and output functionalities (indications, measured values, commands, etc.) of the device, including the associated parameter settings via the PROFINET IO parameterization software. An IO module can be either real hardware (hardware module for the data acquisition in a modular IO device, for example ET200S from Siemens I IA) or a virtual module. The module can be parameterized for different applications in a SIPROTEC device.
IOCS	**I**nput/**O**utput **C**onsumer **S**tatus
IOPS	**I**nput/**O**utput **P**rovider **S**tatus
IP	**I**nternet **P**rotocol
IP address	Addresses in computer networks based on the Internet protocol
I&M	Device **I**dentification **and M**aintenance functions

L

LLDP	**L**ower **L**ayer **D**iscovery **P**rotocol
LSB	**L**east **S**ignificant **B**it

M

MIB	**M**anagement **I**nformation **B**ase: Information that can be queried or modified via the SNMP network management protocol
MLFB	(Maschinenlesbare Fabrikatebezeichnung), order number
MMS	**M**anufacturing **M**essage **S**pecification
MRP	**M**edia **R**edundancy **P**rotocol
MSB	**M**ost **S**ignificant **B**it

N

NaN	**N**ot **a N**umber means "invalid": result of an invalid computing operation
NRT	**N**on-**R**eal **T**ime; PROFINET IO NRT processing when using UDP
NTP	**N**etwork **T**ime **P**rotocol: standard for synchronizing clocks in computer systems using packet-based communication networks (see RFC5905)

O

OB	Organization block (in S7 programming)
OID	**O**bject **Id**entifier (of the data point in an SNMP MIB)
Output direction/ Output data	Data-transmission direction from the IO controller to the IO device with the direction of data transmission always being observed from the location of the IO controller. This transmission direction is also referred to as the control direction.

P

PLC	**P**rogrammable **L**ogic **C**ontroller
PRP	**P**arallel **R**edundancy **P**rotocol

R

RJ45	Ethernet plug connector
RSTP	**R**apid **S**panning **T**ree **P**rotocol
RT	**R**eal **T**ime (PROFINET IO RT uses Ethernet EtherType 0x8892)
RTA	Real **T**ime **A**larm (PROFINET IO alarm processing)

S

SC	Single command; data type
Server	Sends data upon the client's request
SFB	System function block (in S7 programming)
SFC	System function (in S7 programming)
SNMP	**S**imple **N**etwork **M**anagement **P**rotocol: monitors and controls network elements from a central station.
SNTP	**S**imple **N**etwork **T**ime **P**rotocol: simplified version of the NTP
SP	Single-point indication; data type
Step 7	Software for programming programmable logic controllers (PLC) of the SIMATIC-S7 family of Siemens AG

T

TCP	**T**ransmission **C**ontrol **P**rotocol

U

UTC	**U**niversal **T**ime **C**oordinated: universal time standard referred to the time at the prime meridian
UDP	**U**ser **D**atagram **P**rotocol

V

VI	**V**alue **I**ndication; DIGSI data type for statistic values

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