SIPROTEC

Communication module DNP 3.0

Communication Database

Revision: 3.0

Edition: August 2004

C53000-L1840-A001-03

Siemens Aktiengesellschaft Buch-Nr. C53000-L1840-A001-03

Preface

Aim of This Manual

The manual is devided into the following topics:

- Asynchronous communication modules
- Introduction
- Parametrization in DIGSI® 4
- Hardware interface

General information about design, configuration, and operation of SIPROTEC® devices are laid down in the SIPROTEC® 4 system manual, order no. E50417-H1176-C151.

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 stations.

DNP V3.0 Specification

The DNP V3.0 specification and the structure of the DNP messages are defined in:

> DNP V3.00 Subset Definitions
Edition 2.00, November 1995
DNP Users Group
Document Nr.: P009-OIG.SUB

> DNP V3.00 Data Object Library
Edition 0.02, July 1997
DNP Users Group
Document Nr.: P009-OBL

> DNP V3.00 Data Link Layer
Edition 0.02, May 1997
DNP Users Group
Document Nr.: P009-OPD.DL

> DNP V3.00 Application Layer
Edition 0.03, May 1997
DNP Users Group
Document Nr.: P009-OPD.APP

> DNP V3.00 Transport Functions
Edition 0.01, May 1997
DNP Users Group
Document Nr.: P009-OPD.TF

Applicability of this Manual

This manual is valid for

- SIPROTEC® 4 devices,
- DNP communication module up to hardware revision 3 and DNP 3.0 communication firmware version 02.00.01 or higher,
- DNP communication module from hardware revision 4 and DNP 3.0 communication firmware version 04.00 or higher

Note:

The DNP protocol is not for all SIPROTEC® devices available. Check the manual of the device or contact your Siemens representative.

For device parameterization **DIGSI® 4 version 4.3 or higher** and DNP standard mappings 3-1 to 3-n (n = device type dependent number of standard mappings) have to be used.

Additional Support

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

Training Courses

Individual course offerings may be found in our Training Catalogue, or questions may be directed to our training center. Please contact your Siemens representative.

Instructions and Warnings

The warnings and notes contained in this manual serve for your own safety and for an appropriate lifetime of the device. Please observe them!

The following terms are used:

DANGER
indicates that death, severe personal injury or substantial property damage will result if proper precautions are not taken.

Warning
indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Caution
indicates that minor personal injury or property damage can result if proper precautions are not taken. This particularly applies to damage on or in the device itself and consequential damage thereof.

Note
indicates information about the device or respective part of the instruction manual which is essential to highlight.

Warning!

Hazardous voltages are present in this electrical equipment during operation. Failure to observe these precautions can result in death, personal injury, or serious material damage.

Only qualified personnel shall work on and in the vicinity of this equipment. The personnel must be thoroughly familiar with all warnings and maintenance procedures of this manual as well as the safety regulations.

Successful and safe operation of the device is dependent on proper transportation, storage, mounting and assembly and the observance of the warnings and instructions of the unit manual.

Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, VDE, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

QUALIFIED PERSONNEL

For the purpose of this instruction manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment and the hazards involved. In addition, he has the following qualifications:

- Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Is trained in the proper care and use of protective equipment in accordance with established safety practices.
- Is trained in rendering first aid.

Typographic and Symbol Conventions

The following text formats are used when literal information from the device or to the device appear in the text flow:

`Parameter names`, i.e. designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI® 4), are marked in bold letters of a monospace type style.

`Parameter options`, i.e. possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI® 4), are written in italic style, additionally.

“`Annunciations`”, i.e. designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

Deviations may be permitted in drawings when the type of designator can be obviously derived from the illustration.

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Asynchronous communication modules

1

This chapter shows the hardware and software necessary for DNP 3.0 communication with SIPROTEC® devices and describes the display of module-specific information at the device.

1.1 Communication module types and hardware revisions

1.1.1 Communication module types

Two communication modules are available for the connection of DNP 3.0 to the SIPROTEC® devices:

RS485 bus interface

Asynchronous module with isolated RS-485 interface.

This module also is called AME module (**a**synchronous communication **m**odule **e**lectrical) subsequently.

Fibre-optical bus interface

Asynchronous module with fibre-optical interface.

This module also is called AMO module (**a**synchronous communication **m**odule fibre-**o**ptical) subsequently.

Technical data

The technical data of the above-mentioned asynchrone communication modules are summarized in chap. 4.

1.1.2 Hardware revisions

There exist two different hardware revisions for asynchronous communication modules:

- up to HW revision 3:
  delivery up to the end of year 2004
- from HW revision 4:
  replacement for modules up to HW revision 3, delivery from beginning of 2005

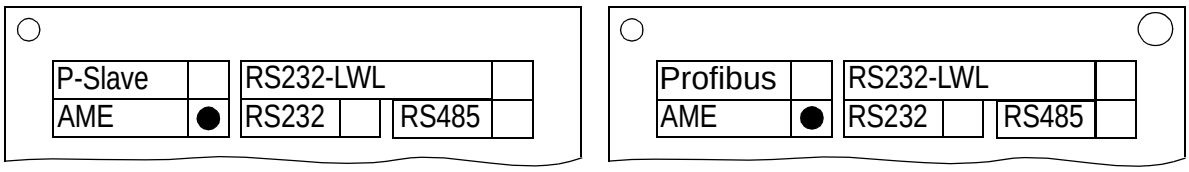
The communication modules from HW revision 4 are function compatible to the modules up to HW revision 3.

Please note the dependency of the DNP 3.0 firmware versions with the HW revisions described in chap. 1.1.3.

The hardware revision of the asynchrone communication modules is also recognizable in build-in condition at the rear of the SIPROTEC® device at the labelling of the communication module mounting bracket:

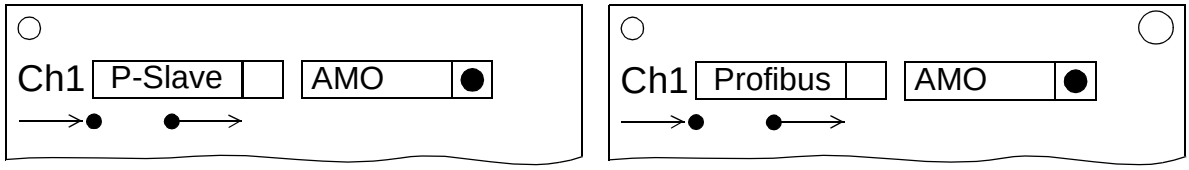
- up to HW revision 3: identification table starts with “P-Slave”
- from HW revision 4: identification table starts with “Profibus”

Asynchronous module RS-485 (AME module)



up to HW revision 3 | from HW revision 4

Asynchronous module fibre-optical (AMO module)



up to HW revision 3 | from HW revision 4

Figure 1-1 HW revisions of the communication moduls, labelling of the mounting brackets

General details about the assembly of communication modules as well as the setting of the terminating resistors on the AME moduls you find in the SIPROTEC4 System Manual (ref. to page 3).

1.1.3 Compatibility of the communication module hardware with DNP 3.0 firmware versions and mapping files

Hardware and firmware

Please note the following listed compatibility between the hardware revisions of the communication modules and the DNP 3.0 firmware versions:

Hardware revision	Firmware version to be used
up to HW revision 3	up to DNP 3.0 firmware V02
from HW revision 4	from DNP 3.0 firmware V04

Table 1-1 Hardware revisions and firmware versions

The DNP 3.0 firmware for communication modules from HW revision 4 is:

- function compatible with firmware versions for modules up to HW revision 3 (i.e. contains all there contained functionalities),
- offers additional functionalities, e.g.:
  - display of module-specific information at the device (ref. to chap. 1.2),
  - additional baud rate support (ref. to chap. 3.1),
  - reading of device information via DNP (object number 0),
  - reading of device date and time via DNP (object 51, variation 1),
  - reading object 30 with variation 4 and object 20 with variation 6.

Note:

If, during loading of the DNP 3.0 firmware on the communication module, a non-compatible hardware revision is recognized, then the firmware update is cancelled.

Please, in case of an abort of loading the DNP 3.0 communication firmware, check first the dependencies indicated in Table 1-1.

After attempting to load a DNP 3.0 firmware version on a non-compatible hardware revision, the SIPROTEC® device remains in the loader mode (display = empty, LED 5 = ON, LED 6 flashing) and loading of a correct firmware version or an initial reset is expected.

If no firmware shall be loaded in this situation, then the device must be switched off and (after at least 3 sec.) switched on again.
The previous firmware configuration is then used furthermore.

Hardware and mapping files

There is no compatibility reduction between DNP 3.0 mapping files of the SIPROTEC® devices and the hardware revision of the communication modules, i.e.:

- the known DNP 3.0 mapping files for SIPROTEC® devices, offered in DIGSI and used so far, are used for parameterization furthermore,
- existing parameterizations can be used further, even if a communication module up to HW revision 3 is replaced by a communication module from HW revision 4 (considering the firmware compatibility in Table 1-1).

1.2 Display of module-specific information at the SIPROTEC device

Note:

The following prerequisites are necessary for using the functionality “Display of module-specific information at the SIPROTEC® device”:

- Asynchronous communication module from HW revision 4 with DNP 3.0 firmware from V04.00,
- SIPROTEC® device firmware which supports this function, e.g.:
  - 7SJ61...7SJ64, 6MD63 device firmware from V4.50,
  - 7SA522, 7SA6 device firmware from V4.50.

Changing parameters for the DNP 3.0 slave of the SIPROTEC® device is exclusively possible using the DIGSI parameterization system.

If the display of module-specific information is not supported by the firmware of the used SIPROTEC® device then the below-mentioned menu items are not offered for selection.

If an asynchronous communication module up to HW revision 3 is used, then in a SIPROTEC® device with above-mentioned firmware V4.50 the following text is displayed in case of selecting the menu item for display of module-specific information:

```
**** LIST EMPTY ****
```

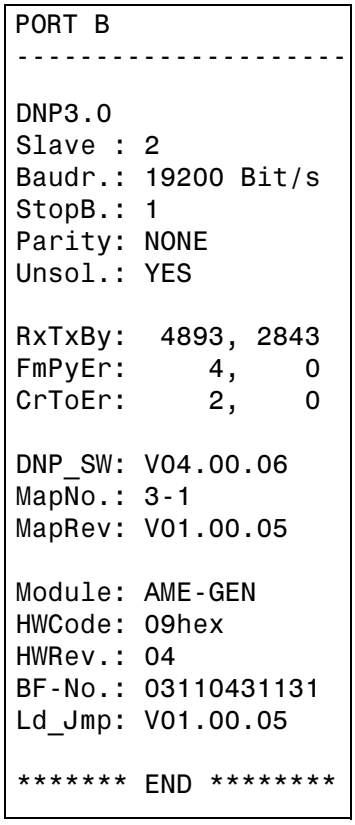
The values in the display of module-specific information are actualized every 500 ms. It is therefore possible that short-time changes of information are not displayed.

The display of module-specific information is accessible with the following menu items or buttons:

- MENU
- Test/Diagnosis → 5
- Modulinfo → 5
- Port B → 1

The maximum number of displayed information, separated in four blocks, is shown in Figure 1-2.

The data in the individual information blocks are explained in the following chap. 1.2.1 to 1.2.4.



Block 1:
Status and parameters of the DNP 3.0 slave.

Block 2:
Status and diagnosis.

Block 3:
DNP 3.0 firmware version as well as number and version of the selected mapping file.

Block 4:
Module hardware information and version number of the boot firmware.

Figure 1-2 Display of module-specific information at the device

Note:

During a request of a large amount of data points (e.g. class 0 data) it can happen, that the display of the module specific information isn't cyclically updated.

1.2.1 Block 1: Status and parameters of the DNP 3.0 slave

Block 1 of the module-specific information shows parameterization data of the DNP 3.0 slave of the SIPROTEC® device (ref. to chap. 3.1).

Note:

If no DNP 3.0 mapping file was selected during parameterization in DIGSI then all entries of Block 1 are marked with the sign '-':

```
Slave : -
Baudr.: -
...
```

Slave Display of the slave address which was entered during parameterization in DIGSI for `GlobalSection.Slave_Addr`.

Baudr. Display of the Baud rate which was entered during parameterization in DIGSI for `GlobalSection.Baud_Rate`.

StopB. Display of the Stop bits which was entered during parameterization in DIGSI for `GlobalSection.Stop_Bit`.

Parity Display of the Parity which was entered during parameterization in DIGSI for `GlobalSection.Parity`.

Unsol. Display whether unsolicited responses configured or not which was entered during parameterization in DIGSI for `GlobalSection.EnableUnsol`.

1.2.2 Block 2: Status and diagnosis

Block 2 contains various diagnosis counters and status information.

Note:

All diagnosis counters, which are shown followingly, are 16 bit values (data range: 0...65535) and start again with 0 after an overflow. Overflows of these counters are not signalized.

RxTxBy Two diagnostic counters of message processing:

1. Counter 1: Quantity of bytes, which the slave has received since last restart of the SIPROTEC® device.
2. Counter 2: Quantity of bytes, which the slave has send since last restart of the SIPROTEC® device.

Note:

If the counter of the quantity of processed bytes is not incremented, then the communication settings (baud rate etc.) are not consistent in the master and the slave device (the counters of framing and/or parity errors then also is incremented, see below).

FmPyEr

Two diagnostic counters for framing and parity errors of the serial data transmission.

A **framing error** is reported by the serial communication module if a stop bit is requested after the reception of a byte but the level at the data line remains low.
If this counter is incremented continuously, then this indicates a wrong baud rate setting.
Disconnecting and re-connecting of the bus line during active communication can be the reason of single framing errors.

If the serial communication is configured with evaluation of parity bits (EVEN or ODD, ref. to chap. 3.1) then a **parity error** indicates a wrong value of a parity bit in the serial byte frame.
Short-time data transmission errors (e.g. because of disturbing influences) are indicated by single incrementing of this counter.
If the counter of parity errors is incremented continuously then the settings for parity bit evaluation are not consistent in the master and the slave device.

CrToEr

Two diagnostic counters for CRC errors and response-time errors.

A **CRC error** is recognized if the result of the CRC calculation of the received DNP 3.0 message is not equal to the CRC value in the DNP 3.0 message from master.
Mostly, the reason of CRC errors are data transmission errors (e.g. because of disturbing influences).

Timeout errors occur if the time for waiting for remote device to confirm is longer than the configured “Link Confirme Timeout” or ”Application Timeout” (ref. to chap. 3.1).

1.2.3 Block 3: Firmware versions and mapping file

Block 3 of the module-specific information shows the DNP 3.0 firmware version as well as the number and version of the selected mapping file.

Note:

If no DNP 3.0 mapping file was selected during parameterization in DIGSI then all entries of Block 2 are marked with the text ’not loaded’:

```
MapNo.: not loaded
MapRev: not loaded
```

DNP_SW

DNP 3.0 firmware version loaded on the communication module.

MapNo.

Number of the selected standard mapping.

The mapping file determines the data size which is available via DNP 3.0 for the SIPROTEC® device.

Depending on the device type, several standard mappings are offered for parameterization in DIGSI.

MapRev. Version of the selected standard mapping with the number `MapNo.` (see above).

1.2.4 Block 4: Module hardware information and boot firmware version

Block 4 of the module-specific information contains hardware information for the built-in communication module.

Module Hardware type of the communication module built-in in the SIPROTEC® device:

Module	Explanation	Note
PSE_GEN	PROFIBUS module RS-485	not for DNP 3.0, please replace
PSO2_GEN	PROFIBUS module fibre-optical, double loop (with two fibre-optical channels)	not for DNP 3.0, please replace
PSO1_GEN	PROFIBUS module fibre-optical, single loop (with one fibre-optical channel)	not for DNP 3.0, please replace
AME_GEN	Asynchronous modul RS-485	OK
AMO-GEN	Asynchronous modul fibre-optical	OK

Table 1-2 Communication module hardware types

HWCode A hardware designation, coded on the module, in hexadecimal representation.

HWRev. Hardware revision of the communication module.

BF-No. Serial number (production number) of the communication module.

Ld_Jmp Version of the separate boot firmware part for start-up and with loader functions.

Introduction

2

The DNP 3.0 slave is introduced in this chapter. An overview of the devices is presented in their features and scope of functions.

2.1 DNP object types

The communication database profile of the SIPROTEC® devices with DNP3.0 protocol is grouped into the following object types:

Binary Input with Status

Object 01, Variation 02

These points represent the state of a digital input channel or an internal software information point.

It is used for a general interrogation request by a RTU (after a reset or cyclic during runtime) and to synchronize the RTU information database.

They are considered class 1 data (an event with high priority).

Binary Input Change with Time

Object 02, Variation 02

These points represent the changed state of a digital input channel or an internal software information point and the time at which the state changed.

It is used for spontaneous process events.

They are considered class 1 data (an event with high priority)

Binary Output Status

Object 10, Variation 02

These points represent the current status of a binary output channel.

These binary output channels can be controlled by the Control Relay Output Block (ref. to Object 12).

Control Relay Output Block (Direct Operate)

Object 12, Variation 01

These points are used for commands to the process or setting of internal functions.

32-Bit Binary Counter (with Flag)

Object 20, Variation 01

These points are used to represent a counter for active and reactive power.

32-Bit Binary Counter (without Flag)

Object 20, Variation 06

These points are used to represent a counter for active and reactive power.

32-Bit Counter Change Event without Time

Object 22, Variation 01

These points are used to represent a counter for active and reactive power reported as an event.

32-Bit Analog Input (Measured Values)

Object 30, Variation 01

This 32-bit signed value could represent a digitized analog signal or a calculated value.

16-Bit Analog Input (Measured Values)

Object 30, Variation 02

This 16-bit signed value could represent a digitized analog signal or a calculated value.

It is used for a General Interrogation Functionality within the startup procedure or for a measured value snapshot.

16-Bit Analog Input (Measured Values) without Flag

Object 30, Variation 04

This 16-bit signed value could represent a digitized analog signal or a calculated value.

I32-Bit Analog Change Event without Time

Object 32, Variation 01

These points are used to represent a changed analog point.

16-Bit Analog Change Event without Time

Object 32, Variation 02

These points are used to represent a changed analog point.

Time and Date

Object 50, Variation 01

Fuction: write

The time and date object is used for time synchronization.

Fuction: read

Read the system time from device.

Date and time are recorded as milliseconds since midnight, January 1st, 1970, at zero hours, zero minutes, zero seconds and milliseconds.

Class Data

Object 60, Variation 01, 02, 03, 04

These objects specify different classes of information elements.

Class 0 specifies any information objects not assigned to class 1 until class 3.

Classes 1 to 3 specifies groups of event driven information objects.

Class 1 data has higher priority than class 2 , class 3 and static data.

Internal Indication

Object 80, Variation 01

Writing value 00 at index 7 results in resetting of the bit <Restart> in the FLAG byte of all data objects.

2.2 Response time

Some approximate response times on a request with a different numbers of selected points at 9600 baud are:

1 point	→	70 milliseconds
30 points	→	115 milliseconds
376 points	→	670 milliseconds

Parametrization in DIGSI® 4

3

3.1 Protocol specific parameters

The following settings for the serial communication between the DNP 3.0 master and the DNP 3.0 slave have to be defined during parameterization of the SIPROTEC® device.

Names written in `MonoScriptText` are the associated designations of the bus specific parameters in the DIGSI® 4 parameterization software (ref. to chap. 3.2).

Slave address `GlobalSection.Slave_Address`

Permissible DNP 3.0 slave addresses for the SIPROTEC® devices are in the range between 1 and 65532.

Master address `GlobalSection.Master_Address`

Permissible master addresses are in the range between 1 and 65532

Baud rate `GlobalSection.Baud_Rate`

The baud rates 9600 Baud, 19200 Baud, 38400 Baud and 57600 Baud are supported by the DNP 3.0 communication modules

Data Bit `GlobalSection.Data_Bit`

8 data bits are required for a DNP communication.
Changes here have no effect!

Stop Bit `GlobalSection.Stop_Bit`

The DNP 3.0 communication module support one and two stop bits

(devault value = 1)

Parity `GlobalSection.Parity`

0 = no parity (default)

1 = even parity

2 = odd parity

Idle Level `GlobalSection.IdleLevel`

Status for “no signal”. The DNP 3.0 communication module only support “Light off”. Changes have no effect!

Link Retries `GlobalSection.LinkRe_tries`

Number of attempts to retransmit a data link frame that was not confirmed by the remote device (only if frame sent with confirm requested)

default value = 2

Link Confirme Requires

`GlobalSection.LinkConRequires`

Request the remote device to send a data link layer confirm of the last frame sent. Note that this setting is independent of whether the remote device will require this device to send a data link confirm to frames it receives.

0 = not for any frame (default)

1 = for multiframe fragments

2 = for all frames

Link Confirme Timeout

`GlobalSection.LinkConfTimeout`

Amount of time, in ms, to wait for remote device data link layer confirm of the last frame sent before doing retries (only if frame sent with confirm requested). Measured after last byte of data frame sent.

default value = 3000

Application Confirm Requires

`GlobalSection.ApplConRequires`

0 = application confirmations requested only for message fragments containing event data

1 = application confirmations requested for message fragments containing event data, and for non final fragments in a multifragment response (default)

Application Timeout

`GlobalSection.ApplTimeout`

Timeout, in ms, waiting for remote device to confirm previous response, if requested. If application layer confirmations are used with data link confirmations, ensure the application layer confirm timeout is set long enough for all data link retries to complete. (devault value = 5000)
The following formula describes this requirement:

`ApplTimeout > LinkConfTimeout * (LinkRe_tries + 1)`

Need Time Synchronisation

`GlobalSection.NeedTimeSync`

Time interval, in ms, to set the "need time" internal indication (contained in every application response message) which will cause master to write time back to this device.

0 = The internal Indication will never set

Arm Select Timer

`GlobalSection.ArmSelectTimer`

Amount of time, in ms, after a select command in which an operate command must be received.

devault value = 10000

Enable Unsolicited

`GlobalSection.EnableUnsol`

0 = unsolicited responses are not configured, and can never be enabled by the master (default)

1 = unsolicited responses are configured, and must be specifically enabled by the master after an initial unsolicited response.

Unsolicited Events

`GlobalSection.UnsolEvents_1`

For each class of change events (class 1, class 2, and class 3), this controls one condition under which an unsolicited response will be sent: If the number of events in each class meets or exceeds this value, an unsolicited response will be sent.

devault value = 10

Unsolicited Timeout

`GlobalSection.UnsolTimeout_1`

For each class of change events (class 1, class 2, and class 3), this controls one condition under which an unsolicited response will be sent: If the time (in ms) after an event occurs meets or exceeds this value, even if just 1 event occurs, an unsolicited response will be sent.

devault value = 15000

Unsolicited Retry

`GlobalSection.UnsolRetry`

If an unsolicited response is not confirmed within `UnsolConTimeout`, this parameter controls how soon another unsolicited response will be sent.

devault value = 5

Unsolicited Confirm Timeout

`GlobalSection.UnsolConTimeout`

Timeout, in ms, waiting for remote device to confirm previous unsolicited response. If this parameter is zero or less than `ApplTimeout`, the "retry" unsolicited response will be sent as soon as `ApplTimeout` expires (unless a read request was received in the meantime, in which case the read request will be responded first).

devault value = 6000

3.2 Protocol assignment and mapping files

Precondition

The parameterization of DNP 3.0 for a SIPROTEC® device requires:

- selection of DNP 3.0 as system interface,
- selection of a mapping file which fixes the allocation of the data objects of the SIPROTEC® device in the DNP 3.0 messages.

Bus specific parameters have to be defined simultaneously when selecting a mapping file (ref. to chap. 3.1).

3.2.1 Standard mappings 3-1 to 3-n

A number of standard mappings (standard mapping 3-1 to standard mapping 3-n, n = device type dependent number of standard mappings) are available for every SIPROTEC® device type.

Adaption of the allocation

In adaptation to the concrete installation environment the standard allocation can be changed (ref. to chap. 3.3):

- removing of data objects from the DNP 3.0 points,
- routing of data objects to free DNP 3.0 point locations,
- scaling of measured values according to the operating values of the primary equipment.

Note:

The size of the DNP 3.0 numbers (number of commands, annunciations, measured values, metered measurands) in output or input direction is exclusively fixed by the selection of a standard mapping.

The data in the DNP 3.0 messages are defined in the bus mapping documentations of the individual SIPROTEC® devices.

3.2.2 Compatibility with standard mappings of previous versions

Standard mappings 1 to n

The standard mappings 1 to standard mapping n (n = device type dependent number of standard mappings) enclosed to DIGSI® 4.1 for SIPROTEC® devices 7SJ61...7SJ64 and 6MD63 should not be used for new device parameterizations.

A customization of allocations and scalings is not possible with these mappings and the same functional limitations as shown below for standard mappings 2-1 to 2-n are valid.

Standard mappings 2-1 to 2-n

Compatible with standard mappings 3-1 to 3-n but should not be used for new device parameterizations.

3.2.3 Interface selection and mapping selection in DIGSI 4.21

Attention!

The parameterization of DNP 3.0 with the functionalities described in this manual using standard mapping 3-1 to 3-n (n = device type dependent number of standard mappings) and DIGSI 4.21 requires the following preconditions:

- Update of the Parameter generating DLL for communication modules (“PG.DLL”) in the DIGSI directory on the PC to version V02.04.01 or higher.

The update is required because of the extended functionalities of the standard mappings 3-1 to 3-n.
If no update of the Parameter generating DLL is carried out then an error occurs during the translation process of the mapping file when closing the dialog window **Properties - SIPROTEC 4 device** (ref. to Figure 3-1).

You can download the Paramter generating DLL V02.04.01 as

DIGSI 4.21 ServicePack 3
from Internet http://www.digsi.de

or please contact your Siemens representative.

When entering the device MLFB (order number) to create a new SIPROTEC® device in the **DIGSI 4 Manager** for parameterization, you are asked automatically for the selection of DNP 3.0 as system interface if the SIPROTEC® device has a DNP 3.0 communication module at delivery.

Changing the system interface to DNP 3.0 for already existing devices in DIGSI is also possible.

Protocol assignment for system interface

Select the SIPROTEC® device in your project in the **DIGSI 4 Manager** and use the menu item ***Edit - Object properties...*** to open the **Properties - SIPROTEC 4 device** dialog window (ref. to Figure 3-1).

In the property sheet **Communications Modules** the entry “additional protocols, see MLFB Ext. L” has to be selected for “11. SYSTEM-Port”.

By pressing the button “L: ...” the dialog window **Additional information** is opend which is used to enter the type of the communication module.

Please select in the dialog window **Additional information**:

- “Protocol” or “none” (depending on the SIPROTEC® device type) for “1. SYSTEM-Port” and
- “DNP3.0, RS485” or “DNP3.0, 820nm fiber ST-Connector” (depending on the hardware composition of the SIPROTEC® device) for “2. SYSTEM-Port”.

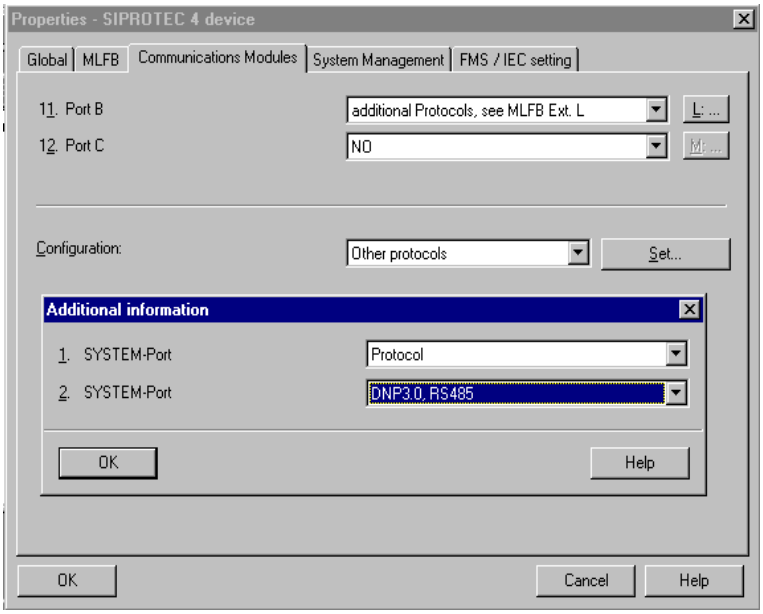
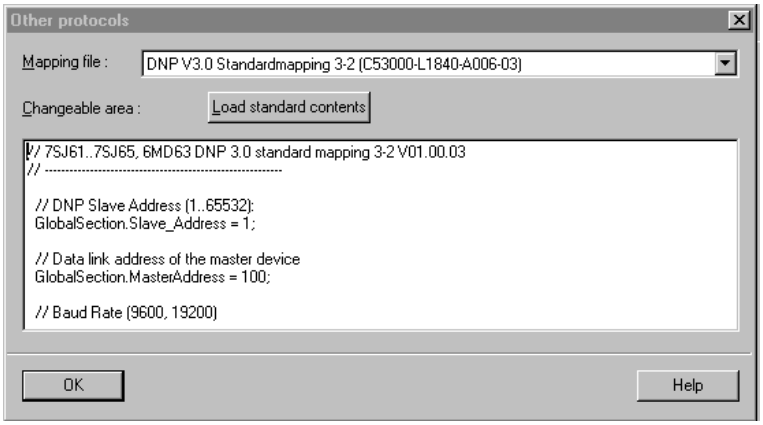
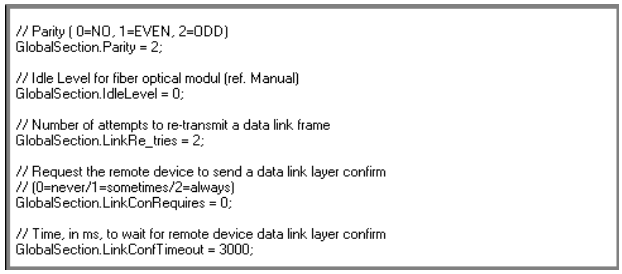


Figure 3-1 DIGSI® 4.21: DNP 3.0 protocol assignment

Mapping file

The mapping file selection is available in the dialog window **`Other protocols`** which is opend by pressing the button “Set ...” in the property sheet **`Communications Modules`** (ref. to Figure 3-1).





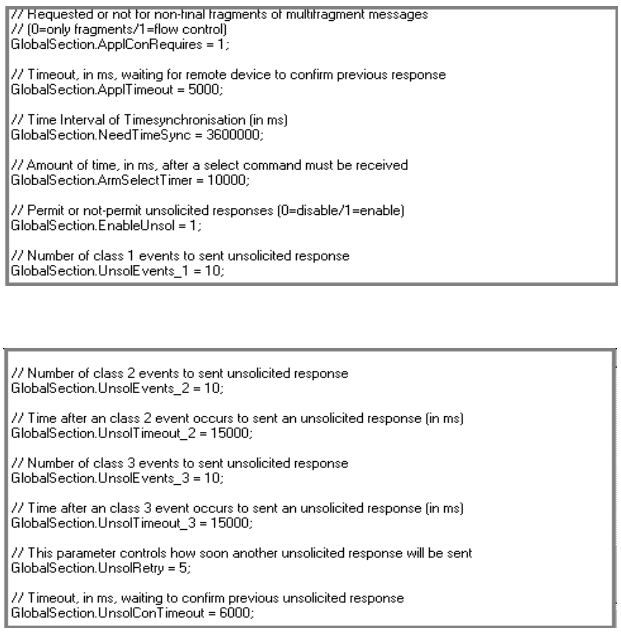


Figure 3-2 DIGSI 4.21: Mapping file selection and bus specific parameters

The list box “Mapping file:” includes all available DNP 3.0 mapping files for the respective SIPROTEC® device type with their name and a reference to the associated bus mapping documentation.

In the edit area “Changeable area:” bus specific parameters can be changed. Please refer to chap. 3.1 for a description of these parameters.

The button “Load standard contents” restores the default values of the bus specific parameters.

Note:

Please, edit only the numbers in the rows which do not start with “//” and note the semicolons at the end of the line.

Editing anything else in the “Changeable area:” may cause an error when closing the **`Properties - SIPROTEC 4`** device dialog window.

Attention!

If after change of a measured value’s scaling (ref. to chap. 3.4) a bus specific parameter is changed then all scalings are reset to their defaults according to the bus mapping documents again.

3.2.4 Interface selection and mapping selection in DIGSI 4.3 or higher

When entering the device MLFB (order number) to create a new SIPROTEC® device in the **DIGSI 4 Manager** for parameterization, you are asked automatically for the selection of DNP 3.0 as system interface if the SIPROTEC® device has a DNP 3.0 communication module at delivery.

Changing the system interface to DNP 3.0 for already existing devices in DIGSI® 4 is also possible.

Protocol assignment for system interface

Select the SIPROTEC® device in your project in the **DIGSI 4 Manager** and use the menu item ***Edit - Object properties...*** to open the **Properties - SIPROTEC 4 device** dialog window (ref. to Figure 3-3).

In the property sheet **Communications Modules** the entry “additional protocols, see MLFB Ext. L” has to be selected for “11. SYSTEM-Port”.

By pressing the button “L: ...” the dialog window **Additional information** is opend which is used to enter the type of the communication module.

Please select in the dialog window **Additional information**:

- “Protocol” or “none” (depending on the SIPROTEC® device type) for “1. SYSTEM-Port” and
- “DNP3.0, RS485” or “DNP3.0 820nm fiber ST-Connector” (depending on the hardware composition of the SIPROTEC® device) for “2. SYSTEM-Port”.

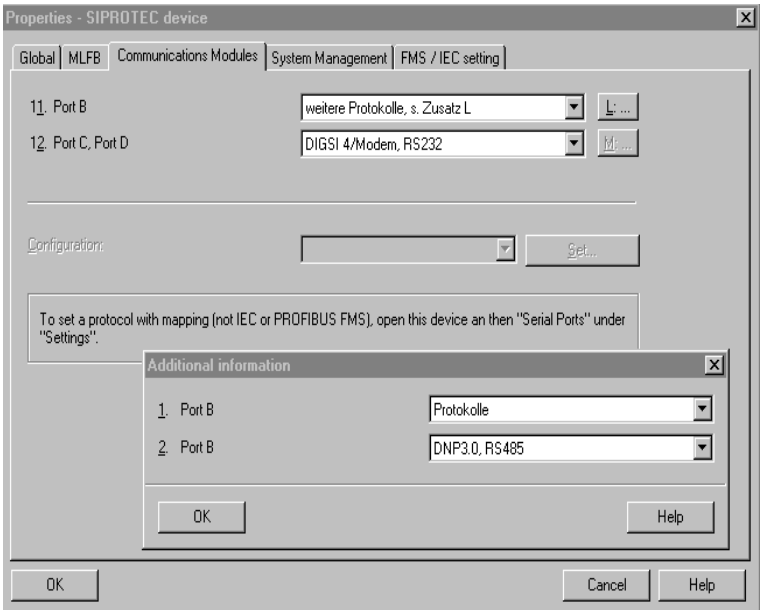


Figure 3-3 DIGSI 4.3: DNP 3.0 protocol assignment

Mapping file

To select a mapping file, please open the SIPROTEC® device in DIGSI® 4.

The dialog window **Interface Settings** (in DIGSI® 4 via ***Settings - Serial Ports***) offers in the property sheet **Supplementary protocols at device** the following dialog elements:

- display of the chosen communication module
  (ref. to page 3-35, “Protocol assignment for system interface”),
- the list box “Mapping file:” which includes all available DNP 3.0 mapping files for the respective SIPROTEC® device with their name and a reference to the associated bus mapping documentation,
- the edit area “Module-specific settings:” to change the bus specific parameters (ref. to chap. 3.1 for a description of these parameters).

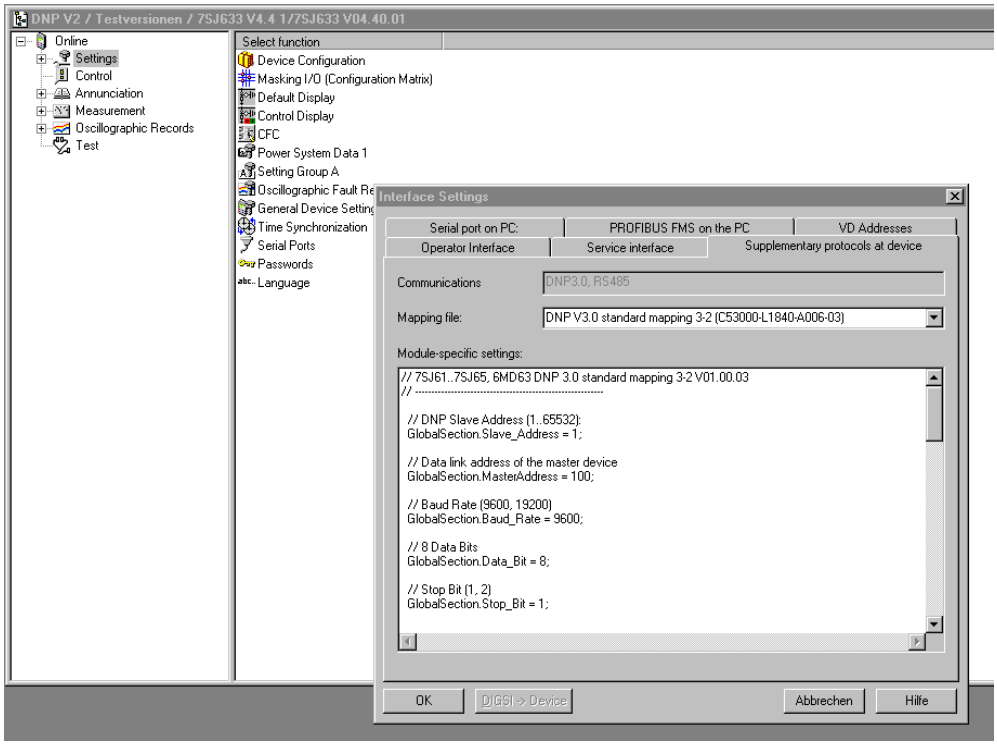


Figure 3-4 DIGSI® 4.3: Mapping file selection and bus specific parameters

List box "Mapping file"

If no mapping file is currently assigned to the SIPROTEC® device then the following entries are available in the list box "Mapping file":

Selection	Meaning
<none>	No mapping file is assigned to the device.
DNP 3.0 standard mapping 3-1 ... DNP 3.0 standard mapping 3-n	Selection of a mapping file 3-1 to 3-n (n = device type dependent number of standard mappings).

The following entries can be selected at an already existing mapping file assignment:

Selection	Meaning
<none>	No mapping file is assigned to the device.
<see module-specific settings>	This selection indicates the currently to the device assigned mapping file with the changes of bus specific parameters already carried out in the edit area "Module-specific settings". Number and version of the mapping file have to be taken from the first line in the edit area "Module-specific settings".
DNP 3.0 standard mapping 3-1 ... DNP 3.0 standard mapping 3-n	(New) Selection of a mapping file 3-1 to 3-n (n = device type dependent number of standard mappings). All bus specific parameters are reset to default values.

If the mapping file assignment was changed for a SIPROTEC® device, then this is in general connected with a change of the routing of the SIPROTEC® objects to the system interface.

Please, check after choice of a new mapping file the allocations to "Destination system interface" or "Source system interface" in the **`DIGSI configuration matrix`**.

Edit area "Module-specific settings"

Please, edit only the numbers in the rows which do not start with "//" and note the semicolons at the end of the line.

Editing anything else in the "Module-specific settings" may cause an error when closing the **`Interface Settings`** device dialog window.

3.3 Customization of the allocation

The identification whether an SIPROTEC® information is routed on system interface (DNP) is shown in the columns "Source system interface" and "Destination system interface" in the DIGSI® 4 Configuration matrix.

A cross ('X') in this column indicates the associated information as "routed on system interface".

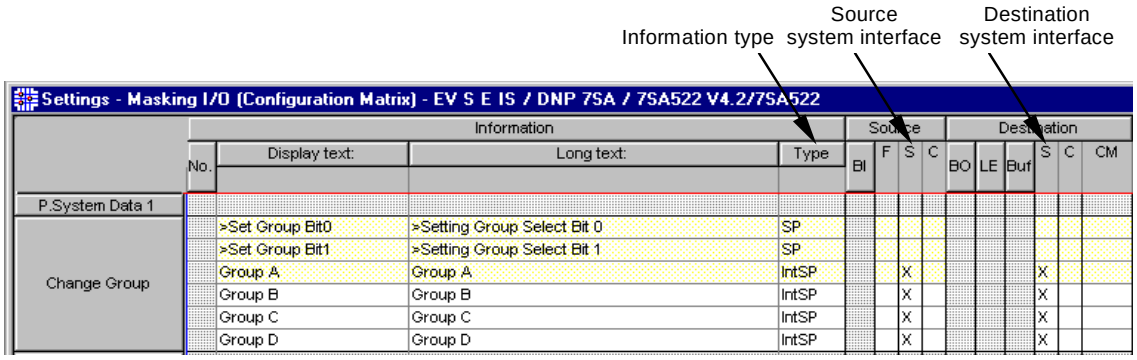


Figure 3-5 DIGSI® 4 Configuration matrix with columns for system interface routing

Source system interface

The SIPROTEC® object can be controlled via DNP.

This is possible for the following information types:

IntSP	Internal single-point indication (tagging)
IntDP	Internal double-point indication (tagging)
SC/DC	Singel control/Double control without feedback from process
SF/DF	Singel control/Double control with feedback from process

Destination system interface

The value of the SIPROTEC® object is transmitted to the DNP master.

This is possible for the following information types:

SP	Single-point indication
DP	Double-point indication
Out	Output indication
IntSP	Internal single-point indication (tagging)
IntDP	Internal double-point indication (tagging)
MV	Measured values
MVMV	Power meter (metered value, source is a measured value)
PMV	Pulse (metered value, source is a pulsed binary input)

To add or remove an information to "Source system interface" or "Destination system interface" set/reset the cross ('X') in the associated column of the DIGSI® 4 configuration matrix (pop-up menu when pressing the right mouse button).

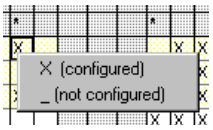


Figure 3-6 Pop-up menu in DIGSI® 4 Configuration matrix

Note:

The max. number of routable objects of an information type varies according to the chosen mapping file.

If e.g. a measured value, not routed in the mapping file per default, shall be transferred via DNP then first a measured value already routed has to be removed from system interface so that the DNP information point gets available.

An error message is shown if all routing possibilities of an information type are occupied and if it is nevertheless tried to route an information of this type.

Adding an allocation

Adding an allocation requires (in addition to the identification in the system interface column of the DIGSI® 4 Configuration matrix) the selection of the position of the information in the DNP point list as well as the definition of DNP specific parameter (e.g. Class number) and scaling values for measured values (scaling of measured values ref. to chap. 3.4.3).

Therefore, after adding the allocation the "Object properties" dialog window which is used to define the message position of the information is opend automatically.

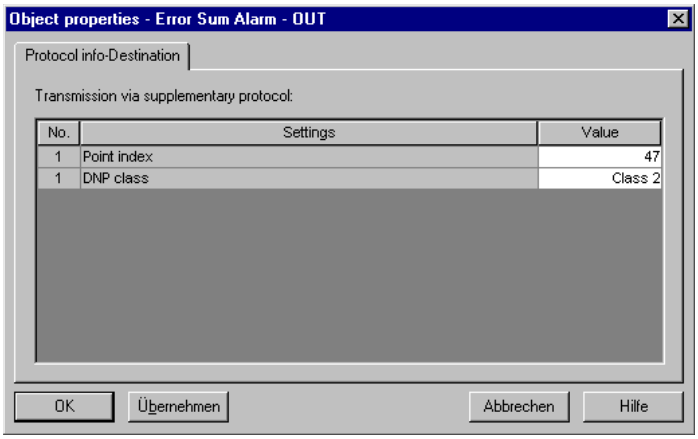


Figure 3-7 Definition of the position of an information in the DNP point list

Changing of an existing allocation

If an information, already routed on system interface, shall get another (empty) position in the DNP point list, then the "Object properties" dialog window (ref. to Figure 3-7) has to be used to this ("Properties ..." in the pop-up menu when pressing the right mouse button in the row associated to the information in one of the columns "Display text", "Long text" or "Type").

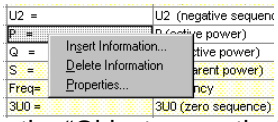


Figure 3-8 Pop-up menu in the “Object properties” dialog window

Dependent on the information type the following parameters are to select in the property sheet "Protocol info source" or "Protocol info destination" of the "Object properties" dialog window:

Protocol info source

Parameter	Comments	Info types
Point index	The index indicates the position in the DNP point list of Binary Outputs.	IntSP, IntDP, SC/ DC, SF/DF
Flags	Command properties (Latch ON/OFF, ... - depending on the object info type)	

Protocol info destination

Parameter	Comments	Info types
Point index	The index indicates the position in the DNP point list of Binary Inputs, Analog Inputs or Counters (depending on the object info type).	SP, DP, Out, IntSP, IntDP, MV, MVMV, PMV
DNP Class	Class of the DNP information object.	

Example

The information "Error sum alarm" (ref. to Figure 3-7) is transferred after routing to "Destination system interface" at DNP Binary Input point list index no. 47 as a Class 2 data object.

Note:

Only the positions in the DNP point list (Point index) are offered to the selection on which the information type still can be routed according to the mapping file and the current occupancy.

Binary incoming annunciations

Binary incoming annunciations (marked with the sign '>' in the name, e.g. ">BLOCK 21 Dist.") cannot be routed directly as "Source system interface". A control of these objects via DNP as a substitute for using binary inputs is however often meaningful.

To do this, Taggings (information type: IntSP) routed to "Source system interface" as well as "Destination CFC" are used. The binary incoming annunciation which is routed as "Source CFC" is connected via a CONNECT module in CFC to the tagging.

Example

Control of object ">BLOCK 21 Dist." using a user-defined Tagging via DNP:

- In the DIGSI® 4 configuration matrix set the source for ">BLOCK 21 Dist." to CFC output.
- Create a user-defined Tagging from the Information catalog and connect this information to CFC input and to "Source system interface" (e.g. in the "User-allocated single commands" block of the Binary Output point list, ref. to Point lists manuals of the SIPROTEC® devices).

- Open a CFC working page and insert a CONNECT module.
- Connect the input ("BO X“) of the CONNECT module with user-defined Tagging object.
- Connect the output ("Y BO“) of the CONNECT module with the operand ">BLOCK 21 Dist." (group: "21 Dis general").
- Save and translate the CFC working page.

The object ">BLOCK 21 Dist." (and with that the associated protective function) can be influenced by changing the value of the user-defined Tagging object via DNP now.

3.4 Scaling of measured values

Measured values will be transferred via DNP between the SIPROTEC® device and the DNP master as integer values but they are in general available in the SIPROTEC® device in floating-point format as a percentage referred to the parameterized nominal values of the primary equipment.

3.4.1 Measurement conversion

Before transmission of a measured value via DNP a measurement conversion (scaling) must be executed in the SIPROTEC® device.

Scaling

Scaling of a measured value to the format for the transmission via DNP means the definition of:

- *Type,*
- *Scaling factor,*
- *Zero offset.*

Type

Decision, whether the measured value is transmitted as percentage value or whether a conversion shall take place into primary or secondary value before (depending on the measured value not all of these three possibilities are available, e.g. no secondary values for power values).

Threshold value

Changes of measured values are transmitted using DNP object 32 (Analog Change Event) only if the accumulated change differences of the 16-Bit Analog Input exceed the threshold value.

Scaling factor

The measured value in the SIPROTEC® device (floating-point format) is multiplied by the *Scaling factor* before transformation to an integer value. With that it is possible to transfer fractional digits by multiplication by a multiple of 10 in the integer value.

Zero offset

The *Zero offset* is added to the result of the multiplication of the measured value in the SIPROTEC® device (floating-point format) by the scaling factor.

The measured value in the integer format for transmission via DNP is calculated summarizing according to the following formula:

$$\text{Measured value}_{\text{Integer}} = \text{Measured value}_{\text{Float}} * \text{Scaling factor} + \text{Zero offset}$$

in which "Measured $\text{value}_{\text{Float}}$" is a percentage value or, if necessary, changed into primary value or secondary value before (according to the definition of *Type*).

3.4.2 Number representation in dependence of the parametrization

For specification of the scaling of a measured value it must be known in which number format (number of the relevant fractional digits) the measured value is available in the SIPROTEC® device and to which unit it refers.

Percentage value

A scaling factor of 100 is recommended for percentage values.

With that the "Measured $\text{value}_{\text{Integer}}$" in the DNP message has to be interpreted as:

+/- 32767 corresponds to +/- 327.67 %

Secondary value

The transmission of a measured value as secondary value is meaningful only in few cases (e.g. transducer measured values in mA).

The number of significant fractional digits depends on the installations and transducers data.

Primary value

The fractional digits and the respective unit at primary values depends tightly on the parameterized nominal values of the primary equipment (DIGSI® 4: "Power system data 1" and "Power system data 2").

Voltages: V_a, V_b, V_c, $V_{a\text{-}b}$, $V_{b\text{-}c}$, $V_{a\text{-}c}$, $3V_0$, V1, V2

Parameter: 1103 Full Scale Voltage

Parameter area	Number representation / unit
1.0 ... 10.0 kV	0.00 ... 99.99 kV
>10.0 ... 100.0 kV	0.0 ... 999.9 kV
>100.0 ... 1000.0 kV	0 ... 9999 kV
>1 MV	0 ... 99.99 MV

Displacement voltages: V_N

Parameter: 0203 Voltage Transformer - Rated Primary Voltage
0211 Ratio factor V_{ph}/V_{delta}

Product of parameters 0203 and 0211	Number representation / unit
100.0 ... 1000.0 V	0 ... 9999 V
>1.0 ... 10.0 kV	0.00 ... 99.99 kV
>10.0 ... 100.0 kV	0.0 ... 999.9 kV
>100.0 ... 1000.0 kV	0 ... 9999 kV
>1 MV	0.00 ... 99.99 MV

Currents: I_a, I_b, I_c, $3I_0$, I_1, I_2
Parameter: 1104 Full Scale Current

Parameter area	Number representation / unit
10 ... 100 A	0.0 ... 999.9 A
>100 ... 1000 A	0 ... 9999 A
>1 ... 10 kA	0.00 ... 99.99 kA

Ground currents: I_{Ns} ,I_N
Parameter: 0205 Current Transformer – Rated Primary Current
0221 Ratio factor I_4 / I_{ph} for CT's

Product of parameters 0205 and 0221	Number representation / unit
0.0 ... 1.0 A	0 ... 9999 mA
>1.0 ... 10.0 A	0.00 ... 99.99 A
>10.0 ... 100.0 A	0.0 ... 999.9 A
>100.0 ... 1000.0 A	0 ... 9999 A
>1.0 kA ... 10.0 kA	0.00 ... 99.99 kA
>10 kA	0.0 ... 999.9 kA

Power: P, Q, S
Parameter: 1103 Full Scale Voltage
1104 Full Scale Current

Product of parameters 1103 and 1104 multiplied by $\sqrt{3}$	Number representation / unit
10.0 ... 100.0 kW (kVAR)	0.0 ... 999.9 kW (kVAR)
>100.0 ... 1000.0 kW (kVAR)	0 ... 9999 kW (kVAR)
>1.0 ... 10.0 MW (MVAR)	0.00 ... 99.99 MW (MVAR)
>10.0 ... 100.0 MW (MVAR)	0.0 ... 999.9 MW (MVAR)
>100.0 ... 1000.0 MW (MVAR)	0 ... 9999 MW (MVAR)
>1.0 ... 10.0 GW (GVAR)	0.00 ... 99.99 GW (GVAR)
>10 GW (GVAR)	0.0 ... 999.9 GW (GVAR)

Example

Definition of the scaling for a power measurement value

In the parameter set is configured:

Full Scale Voltage (1103):V_{prim} = 400 kV

Full Scale Current (1104):I_{prim} = 1000 A

It follows:

$V_{prim} * I_{prim} * \sqrt{3}$ = 692.82 MW (MVAR)

In the SIPROTEC® device the power measurement values are available with the following number representation and unit (see table above):

0 ... 9999 MW (MVAR)

According to this a scaling factor of 1 is meaningful.

With that the "Measured $value_{Integer}$" in the DNP message has to be interpreted as:

+/- 32768 corresponds to +/- 32768 MW (MVAR)

3.4.3 Parametrization of scaling values in DIGSI® 4

The "Object properties" dialog window contains for measured values -besides the property sheet "Protocol info source" or "Protocol info destination" – an additional property sheet titled "Measured value destination".

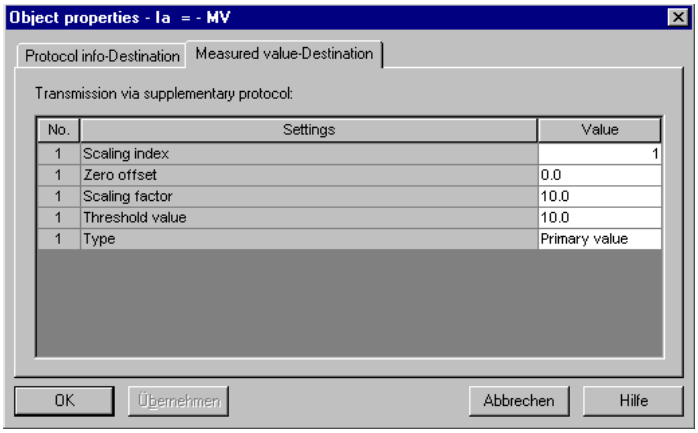


Figure 3-9 Scaling settings of a measured value

The change of the scaling and with that customization to the installation-specific operating values is made by selection of one scaling index in the "Object properties" dialog window of the measured value.

Scaling index

A predefined scaling possibility (settings of *Type, Threshold value, Scaling factor* and *Zero offset*) is summarized using a scaling index.

Scaling Index	Type	Threshold value	Scaling factor	Zero offset
0	Primary value	1.0	1.0	0.0
1	Primary value	10.0	10.0	0.0
2	Primary value	100.0	100.0	0.0
3	Primary value	1000.0	1000.0	0.0
4	Primary value	10000.0	10000.0	0.0
5	Secondary value	1000.0	1000.0	0.0
6	Percentage value	100.0	100.0	0.0
7	Secondary value	10.0	1.0	0.0
8	Secondary value	100.0	10.0	0.0
9	Secondary value	1000.0	100.0	0.0

Note:

If after change of the scaling a bus specific parameter is changed (e.g. DNP Slave address, ref. to chap. 3.2), then all scalings are reset to their defaults according to the point lists (ref. to Point lists manuals of the SIPROTEC® devices) again.

3.5 Time synchronisation

For time synchronization of the SIPROTEC® devices via DNP protocol the "Source of time synchronisation" has to be configured as "Fieldbus" in DIGSI® 4.

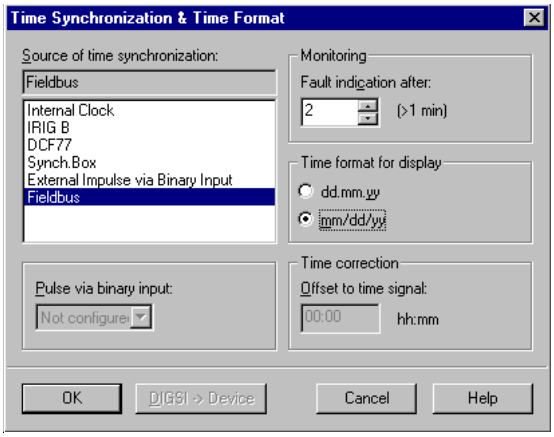


Figure 3-10 Source of time synchronisation

Two additional parameter influence the time synchronisation:

Time Interval of Timesynchronisation

Interval of the DNP slave time synchronisation requests to the DNP master (ref. to chap. 3.2, Figure 3-2).

For best precision of time synchronisation a value of 1 min (60000 ms) is recommended.

Time synchronisation monitoring

The SIPROTEC® device supervises the continuous reception of time synchronisation messages.

After the time duration of "Fault indication after:" (ref. to Figure 3-10) the fault indication "Clock SyncError" in the SIPROTEC® device is set to ON and remains ON until the next time synchronisation message is received.

The value of "Fault indication after:" must be chosen greater than the "Time Interval of Timesynchronisation"(ref. to chap. 3.1).

Hardware interface

4

Two communication modules are available for the connection of DNP3.0 to the SIPROTEC® devices.

AME module Universal asynchronous communication module with isolated RS485 interface.

AMO module Universal asynchronous communication module with fibre-optical interface.

4.1 Technical data of the RS485 modul

Connection	9-pin D-SUB port; signals A, B, RTS, VCC1 and GND1 (s. table below)
Protocol	half-duplex
Maximum Distance of Transmission	3300 ft
Test voltage	500 V_{AC}
Bus termination	Integrated, activatable terminating resistors 221 Ω between A and B 392 Ω between B and VCC1 or A and GND1 Input resistance not terminated ≥ 10 kΩ, then bus termination via bus plug with integrated terminating resistors.
Level	Transmitter: Low: -5 V ≤ U_{A-B} ≤ -1.5 V High: +5V ≥ U_{A-B} ≥+1.5V Receiver: Low: U_{A-B} ≤ -0.2V High: U_{A-B} ≥ +0.2V Transmitter and receiver are surge-proof in case of voltage-range –7V ...+12V between A and GND1 and/or B and GND 1
Maximum of DNP-devices connected to the same bus segment without any repeater	32*

Table 4-1 Technical data of the connection via the RS485 module

*For exclusive utilisation of ***AME*** modules at the bus.
This value could be smaller depending on the used DNP master and further modules at the bus.
If more then 32 devices at the bus are needed, RS485 repeaters which support bit retiming have to be used

Pin	RS485 signal	Meaning
1	Shield	Shield / operational ground
2		
3	A	RS485 connection pin A
4	RTS	Directions control RTS (TTL level)
5	GND1	Ground to VCC1
6	VCC1	Supply voltage +5V DC (max. 100 mA, supply voltage for terminating resistors)
7		
8	B	RS485 connection pin B
9		

Table 4-2 Assignment of the bus connection at the device (D-SUB outlet)

4.2 Technical data of the fiber-optical modul

Connection	fibre-optical interface, Rx and Tx, 820nm, BFOC/2.5
Protocol	half-duplex
Max. line length	- 2000 m / 1.25 miles for glass fiber 62.5/125 µm - approx. 2 m / 6,56 feet for plastic fibre
Optical budget	min. 8 dB for glass fiber 62.5/125 µm
Status for “no signal“	“Light off”

Table 4-3 Technical data of the connection via fibre-optical module

Glossary

AR	**A**utomatic **R**ecloser
CFC	**C**ontinuous **F**unction **C**hart
DC	**D**ouble **C**ommand
DIGSI® 4	Parameterization system for SIPROTEC® devices
DNP	**D**istributed **N**etwork **P**rotocol
DP	**D**ouble-**p**oint Indication
Input data/ input direction	Data from the DNP **slave to the** DNP **master**.
Mapping	Allocation of the SIPROTEC® data objects to the DNP point index.
Output data/ output direction	Data from the DNP **master to the** DNP **slave**.
RTU	**R**emote **T**erminal **U**nit
SC	**S**ingle **C**ommand
SP	**S**ingle-**p**oint Indication

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To

Siemens AG

Dept. PTD PA D DM

D–13623 Berlin

Germany

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